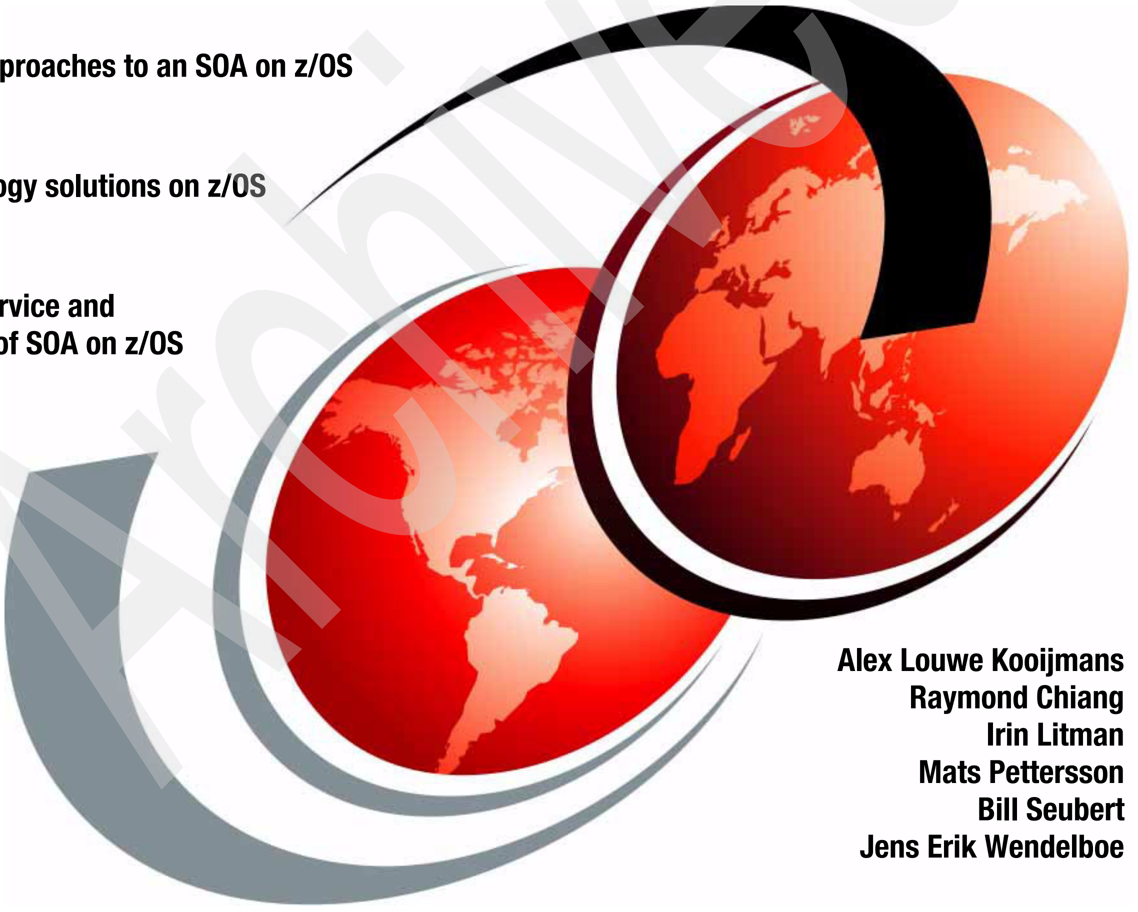
SOA Transition Scenarios for the IBM z/OS Platform

Migration approaches to an SOA on z/OS

SOA technology solutions on z/OS

Quality of Service and governance of SOA on z/OS



Alex Louwe Kooijmans
Raymond Chiang
Irin Litman
Mats Pettersson
Bill Seubert
Jens Erik Wendelboe

Redbooks

ibm.com/redbooks

International Technical Support Organization

SOA Transition Scenarios for the IBM z/OS Platform

March 2007

SG24-7331-00

Note: Before using this information and the product it supports, read the information in "Notices" on page ix.

First Edition (March 2007)

Contents

Notices

Trademarks

The following terms are trademarks of the International Business Machines Corporation in the United States, other countries, or both:

AIX®	IBM®	System p™
BladeCenter®	IMS™	System z™
CICS®	MVS™	System z9™
DB2 Universal Database™	Parallel Sysplex®	Tivoli Enterprise™
DB2®	Rational Unified Process®	Tivoli®
DFSMSdss™	Rational®	WebSphere®
eServer™	Redbooks™	Workplace™
Everyplace®	Redbooks (logo) ™	Workplace Forms™
Geographically Dispersed Parallel Sysplex™	RequisitePro®	z/OS®
GDPS®	RACF®	z/VM®
HiperSockets™	REXX™	zSeries®
	RUP®	z9™

The following terms are trademarks of other companies:

Oracle, JD Edwards, PeopleSoft, Siebel, and TopLink are registered trademarks of Oracle Corporation and/or its affiliates.

SAP, and SAP logos are trademarks or registered trademarks of SAP AG in Germany and in several other countries.

Enterprise JavaBeans, EJB, Java, Java Filter, JavaBeans, JavaScript, JDBC, JDK, JSP, J2EE, J2SE, Sun, and all Java-based trademarks are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.

Microsoft, Visual Basic, Windows, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Linux is a trademark of Linus Torvalds in the United States, other countries, or both.

Other company, product, or service names may be trademarks or service marks of others.

Preface

This IBM® Redbook focuses on the process of transitioning from an existing IT landscape on z/OS® to an SOA-enabled landscape. So if you are a system architect or solution designer and you need to make decisions about SOA enablement or transitioning on the z/OS platform, this book offers an excellent starting point. It describes patterns, transition approaches, migration scenarios, and the features and functions of the available technology options. And specialists who are interested in technical details of the solutions will also find plenty of useful information.

Service Oriented Architecture (SOA) is a hot topic on the agendas of many CIOs and architects. But the bright and shining landscape of an SOA, with all the advantages it offers, is quite different from the reality that currently exists in many IT environments; the IT is too complex, too tightly integrated, and too inflexible. The time to market of IT changes is often unacceptably long, and organizations are often not ready for an SOA. And although many IT professionals believe that SOA will make IT more flexible and significantly reduce the time to market, the challenge of how to execute toward a full-blown SOA implementation still remains.

This publication will help you to meet that challenge. It helps you define an SOA strategy on z/OS, follow the appropriate implementation steps, and decide what technology to use. And although it is written from an architectural point of view with a focus on the z/OS platform, much of the information is applicable to non-z/OS platforms as well.

The team that wrote this IBM Redbook

This IBM Redbook was produced by a team of specialists from around the world working at the International Technical Support Organization, Poughkeepsie Center.

Alex Louwe Kooijmans is a Project Leader with the International Technical Support Organization (ITSO) in Poughkeepsie, NY. He specializes in WebSphere®, Java™, and SOA on System z™ with a focus on integration, security, high availability and application development. Previously he worked as a Client IT Architect in the Financial Services sector with IBM in The Netherlands, advising financial services companies on IT issues such as software and hardware strategy and on demand. Alex has also worked at the Technical Marketing Competence Center for zSeries® and Linux® in Boeblingen, Germany, providing support to customers implementing Java and WebSphere on zSeries. From 1997 to 2000, Alex completed a previous assignment with the ITSO, managing various IBM Redbooks™ projects and delivering workshops around the world.

Raymond Chiang is a WebSphere IT Specialist working in IBM Global Services, responsible for designing, deploying and managing complex z/OS WebSphere infrastructure for major clients in Canada. He has 18 years of experience in the areas of Enterprise Architecture, IT design and Technical Assurance. Raymond is an IBM Certified SOA Solution Designer, a Certified Systems Expert on WebSphere Application Server for z/OS, and a Sun™ Certified Java Programmer.

Irin Litman is an IBM Certified Specialist in Mainframe Connectivity and Networking. Prior to joining IBM in 2003, he worked for Deutsche Bank for 13 years in the areas of Networking, Mainframe Connectivity, Mainframe e-Business, and System Architecture. His current areas of interest include SOA and Integration.

Mats Pettersson is a Senior IT Architect working in the Financial Services Sector in Sweden. He has 23 years of IT experience, mostly focusing on Application Development and Systems Integration. Mats enjoys broad technical experience as a result of working on different platforms and using various consulting methodologies, from business and IT alignment to implementation.

Bill Seubert is a Certified System z Software Architect in the United States. He has more than 20 years of experience in mainframe and distributed computing, including 17 years at IBM as a Systems Engineer, Large Systems Specialist, and an e-Business Technical Specialist and developer. He holds a Bachelors of Science degree in Computer Science from the University of Missouri, Columbia. His areas of expertise include z/OS, WebSphere integration software, and software architecture. Bill speaks frequently to IBM clients on the topics of System z basics, application integration architecture and SOA, and Enterprise Modernization. He also works with the IBM Academic Initiative in building and teaching university courses for students new to the mainframe, and has given presentations describing how IBM is helping to revitalize the mainframe workforce.

Jens Erik Wendelboe is an IT Specialist in Strategy and Design and Service Delivery in Denmark. He has 32 years of experience in most parts of z/OS. His areas of expertise include WebSphere MQ and applications management. He has written extensively on application design and roles in systems programming.

Thanks to the following people for their contributions to this project:

International Technical Support Organization, Poughkeepsie Center

Jonathan Adams
Distinguished Engineer, Project and Technical leader of the IBM Patterns for e-Business, IBM Software Group, IBM United Kingdom

Timothy Durniak
Development Center for Solution Integration (CSI), IBM Systems & Technology Group, Poughkeepsie

James Goethals
System z9™ Industry Infrastructure Solutions Support, IBM Systems & Technology Group, Raleigh

Mitch Green
IBM Washington Systems Center (WSC), IBM Systems & Technology Group, Gaithersburg

Thomas J Hackett
Technical sales support, Service Oriented Architecture, IBM Systems & Technology Group

Rick Robinson
Manager, EMEA Software Services Architecture Practice, Certified IT Architect, IBM United Kingdom

Become a published author

Join us for a two- to six-week residency program! Help write an IBM Redbook dealing with specific products or solutions, while getting hands-on experience with leading-edge technologies. You'll have the opportunity to team with IBM technical professionals, Business Partners, and Clients.

Your efforts will help increase product acceptance and customer satisfaction. As a bonus, you'll develop a network of contacts in IBM development labs, and increase your productivity and marketability.

Find out more about the residency program, browse the residency index, and apply online at:

ibm.com/redbooks/residencies.html

Comments welcome

Your comments are important to us!

We want our IBM Redbooks to be as helpful as possible. Send us your comments about this or other IBM Redbooks in one of the following ways:

- Use the online **Contact us** review redbook form found at:

  ibm.com/redbooks

- Send your comments in an eimail to:

  redbooks@us.ibm.com

- Mail your comments to:

  IBM Corporation, International Technical Support Organization
  Dept. HYTD Mail Station P099
  2455 South Road
  Poughkeepsie, NY 12601-5400

1

Introduction

Today, many Information Technology (IT) professionals are aware of the concepts and principles that underlie a Service Oriented Architecture (SOA). And after an SOA is fully deployed, the benefits that result become obvious. The challenge, however, is to reach a level of SOA maturity such that these benefits become tangible. In this IBM Redbook we focus on the process of transitioning from an existing IT landscape on z/OS to an SOA-enabled landscape.

In this chapter we start by describing the approach we use to achieve this objective. We explain the starting scenarios and some approaches to transitioning, and explore solution techniques and service interface patterns. Finally, we highlight the book's organization and objectives, and describe the target audience.

1.1 Our approach

The main objectives of an SOA are to achieve a better alignment between business and IT; increase the flexibility of the IT environment; and reduce the time to market for IT solutions. Merely enabling a bit of SOA here and there may introduce new technology, but such an approach will not actualize these objectives.

The point is that full exploitation of an SOA requires an enterprise-wide vision and strategy, as well as broad acceptance by an organization. Everyone in the organization needs to be heading in the same direction, and every IT activity needs to fit into the larger picture.

Furthermore, achieving an effective SOA requires a well-planned transition process. Most enterprises already utilize multiple applications and a complex IT infrastructure, and those elements will need to start playing their role in an SOA, which presents a considerable challenge. Getting to an SOA is somewhat like reconstructing a network of highways, without interrupting the traffic flow. For this reason, putting in place a transition plan containing interim steps is vital—especially on the z/OS platform, because so many mission-critical applications reside on z/OS.

In this publication we focus on the SOA-enablement of existing IT landscapes on z/OS, rather than on the “greenfields” approach (that is, just following what you learned about SOA and implementing it in a new application). The challenge is not to build a new application using SOA principles—but rather to incorporate existing applications into a Services Oriented Architecture. The same is true for the IT infrastructure: building a new infrastructure by utilizing SOA principles is ultimately easier than converting a fully operational infrastructure into an SOA-enabled one.

As mentioned, our focus is on transitioning from an existing IT landscape on z/OS to an SOA-enabled one. We have found ways to “organize” this transition such that the transition can be done in phases, and that the right decisions can be made regarding technology. The transition approach is depicted in Figure 1-1 on page 3.

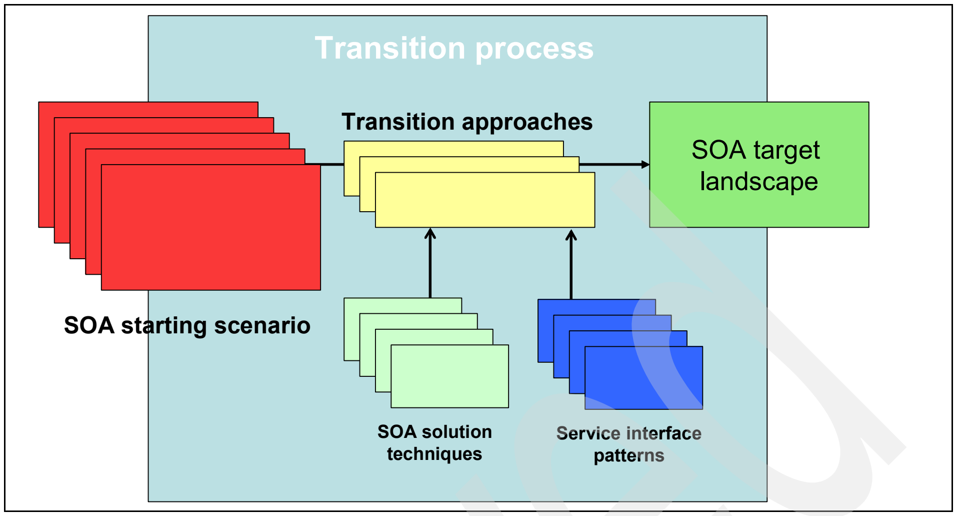


Figure 1-1 SOA transition process

We use the following terms to describe this transition process:

Starting scenario	This reflects the current state of technology used on z/OS. The starting scenario influences which transition approach has to be taken, and which *solution techniques* are possible.
Transition approach	This determines the level of SOA maturity that will be achieved.
Solution technique	This describes the technology option available to implement SOA enablement.
Service interface pattern	This describes a certain way of interfacing with the newly created services. The service interface pattern is an architectural decision, but it limits the solution techniques available.
SOA implementation scenario	The combination of a *starting scenario*, a *transition approach*, a *service interface pattern* and one or more *solution techniques* determines the *SOA implementation scenario*.

1.1.1 Starting scenarios

In this section we identify the most common starting scenarios. For more in-depth explanations, refer to Chapter 3, “Starting scenarios” on page 55.

- 3270 application

  Applications within this scenario typically include a 3270-style user interface, and all application components are run inside a transaction system such as CICS® or IMS™.

  This scenario is detailed in 3.2, “Starting scenario - 3270 application” on page 56. The applicable solution techniques are detailed in 5.2, “SOA implementation scenarios for a 3270 application” on page 137.

- Multichannel

  Applications within this scenario include a middle tier capable of serving multiple channels. The middle tier is typically implemented using J2EE™ technology and using a J2EE application server.

  This scenario is detailed in 3.3, “Starting scenario - multichannel” on page 64. The applicable solution techniques are detailed in 5.3, “SOA implementation scenarios for multichannel” on page 164.

- Batch

  Application functions that are implemented in batch can also become part of an SOA.

  This scenario in detailed in 3.4, “Starting scenario - batch” on page 73. The applicable solution techniques are detailed in 5.4, “SOA implementation scenarios for batch” on page 185.

- Data integration

  This scenario does not contain significant application logic, but rather tools and technology to extract, load, aggregate, and integrate data from a variety of data sources.

  This scenario is detailed in 3.5, “Starting scenario - data access and integration” on page 80. The applicable solution techniques are detailed in detail in 5.5, “SOA implementation scenarios - data access and integration” on page 199.

- Homegrown SOA

  We consider a “homegrown SOA” as an IT environment in which some principles of SOA have been implemented already.

  This scenario is detailed in 3.6, “Starting scenario - homegrown SOA” on page 89. The applicable solution techniques are detailed in 5.6, “SOA implementation scenarios for homegrown SOA” on page 216.

Note: A combination of these scenarios is also possible.

1.1.2 Transition approaches

Depending on the level of SOA maturity that already exists and the SOA maturity to be achieved, the appropriate *transition approach* can be selected. For each starting scenario identified in 1.1.1, "Starting scenarios" on page 4, there are three transition approaches available, as explained here:

Improve The Improve approach focuses on *service enabling* the assets that already exist.

Service enablement means that assets get a new type of interface that opens them up for service consumers. And depending on the starting scenario and certain criteria, a *solution technique* can be chosen to enable this.

The Improve approach should not require any recoding or redevelopment of applications. Also, the improve scenario does not really implement an Enterprise Service Bus (ESB) yet. The SOA maturity level achieved with this approach is moderate, and this approach should be seen as an interim step towards the next phase.

Adapt The Adapt approach focuses on *service integration*.

The vehicle to achieve flexible service integration is the ESB. Implementing an ESB will have some impact, both from a technical perspective and an organizational point of view. The SOA maturity level achieved with this approach is higher and will definitely lead to SOA benefits.

Innovate The Innovate approach results in a restructured, rewritten application that natively conforms to SOA-compliant standards and protocols. An innovated application is fully modularized so that it can be more easily reused in the future.

One of the biggest problems in existing assets is the level of reusability. The ideal level of granularity for a certain service may not match at all with any of the existing assets. In such cases, code may need to be redeveloped or "refactored" in order to make it better match the required service granularity.

After following the Innovate approach, all assets should have a service interface, an ESB must be present, and the services are optimzed (that is, they have the appropriate granularity).

1.1.3 Solution techniques

For each combination of starting scenario and transition approach, there are one or more *solution techniques* available. Solution techniques include a technology solution that helps to achieve the goal of a specific phase of SOA enablement.

The solution techniques for the Improve transition approach focus on service enablement. The solution techniques for the Adapt transition approach on service integration. The solution techniques for the Innovate approach focus on full SOA enablement.

The solution techniques are discussed in Chapter 5, "SOA implementation scenarios" on page 131, and they are categorized by starting scenario and transition approach.

1.1.4 Service interface patterns

The service interface patterns are discussed in more detail in 4.3.2, "Service interface patterns" on page 121. Each transition approach can be combined with one or more service interface patterns.

1.2 Target audience

This publication is written from an architectural point of view, with a focus on the z/OS platform. However, much of the information provided is useful for non-z/OS platforms as well.

If you are an architect or solution designer and you need to make decisions on SOA-enablement or transition on the z/OS platform, this book is an excellent starting point. It provides information about the patterns, transition approaches, and features and functions of the technology options available.

If you are a specialist and more interested in the technical details of the solutions available, you may find also some good starting points in this book. Note, however, that providing detailed how-to implementation steps is beyond the scope of this publication.

1.3 Objectives of this book

This IBM Redbook provides information that will help you make informed decisions about transforming an enterprise to an SOA on the z/OS platform.

- It helps you to understand the traditional application landscape on z/OS, and what transition approach to take towards SOA.
- It helps you to select technologies to implement SOA.
- It provides a few case studies to illustrate what is possible.

1.4 How this book is organized

The chapters in this book are organized as follows:

- Chapter 2, “Target SOA architecture on z/OS” on page 9, explains the SOA basics and what an ideal SOA on z/OS would look like. The chapter also positions IBM software solutions to accommodate the implementation.
- Chapter 3, “Starting scenarios” on page 55, presents an overview of the application landscape as it currently exists on most z/OS systems. We included this overview for two reasons:
  - It provides useful basic knowledge of the z/OS environment for system architects who are somewhat unfamiliar with z/OS.
  - It provides a categorization of currently implemented scenarios. Those categorizations, in turn, determine what route should be taken towards SOA enablement. (For example, a 3270 application landscape and a batch application landscape may require different approach and solution techniques.)
- Chapter 4, “The SOA transition process” on page 97, discusses topics that are important to know before you start any SOA transition project. It covers methodologies, tools, and patterns.
- Chapter 5, “SOA implementation scenarios” on page 131, focuses on SOA solutions and solution techniques. For each combination of starting scenario and transition approach, the chapter discusses the available solution techniques.
- Chapter 6, “Towards service integration and process integration” on page 223, details the Enterprise Service Bus (ESB), service integration, and process integration.
- Chapter 7, “SOA governance on z/OS” on page 261, examines SOA governance. Without proper governance, an SOA may just become a one-time effort, and all benefits may disappear over time.

- Chapter 8, “SOA and z/OS Quality of Service” on page 273, focuses on Quality of Service (Do’s) aspects of the z/OS platform in an SOA. Those Do’s aspects need to accommodate the non-functional requirements (Infers) of the overall solution.
- Chapter 9, “SOA enablement case studies” on page 331, offers two case studies in which we apply some of the SOA theory. Both of these case studies are based on real implementations.

2

Target SOA architecture on z/OS

In this chapter we discuss the various aspects of an SOA architecture on z/OS, and describe how such an architecture can be realized using products from the IBM portfolio. We name it a “target architecture”, to emphasize that this is a recommended architecture, to be reached at the end of a chain of transition stages. Finally, we describe the end stage of the “SOA journey”.

2.1 Overview

We proceed in this chapter as follows:

In 2.2, “The context” on page 11, we establish the context for the discussion and analysis by describing the type of enterprise for which we plan the ideal SOA architecture.

In 2.3, “SOA basics” on page 12, we discuss basic SOA concepts and architectural principles, and specify what we expect from such an architecture.

In 2.4, “IBM SOA reference architecture” on page 19, we describe the IBM SOA reference architecture and go through the conceptual building blocks of the reference architecture. After setting the stage for the SOA architecture we identify, for each SOA building block, the available options and the way these options are implemented in products on the z/OS platform.

In 2.5, “Criteria to determine whether SOA has been implemented successfully” on page 26, we establish a set of criteria with which we can determine if a specific implementation option (that is, a specific combination of IBM products with their features) satisfies the requirements of the IBM SOA reference architecture.

In 2.6, “IBM options on z/OS platform for each building block of SOA reference architecture” on page 28, we summarize IBM software products available for each part of the IBM SOA reference architecture. In 2.7, “Analysis of the IBM products available for the SOA on z/OS” on page 30, we mention the most important features of those products with regards to SOA.

Finally, we identify a set of possible implementation options for the z/OS platform (that means we have sets of products that, when put together, implement the SOA reference architecture). We examine each implementation option, describing the set of features made available by each. We differentiate between the options and explain exactly where there are overlaps and where there is missing functionality. The implementation options are discussed in 2.8, “Implementation options for the SOA architecture on z/OS” on page 44.

2.2 The context

In this section we describe the context in which the subsequent discussion will take place. We assume that we are in an enterprise with the following characteristics:

- It is a medium-to-large enterprise with applications that have evolved over years. It contains a mixture of applications (and types of data processing) encompassing all scenarios mentioned in Chapter 3, “Starting scenarios” on page 55.
- The enterprise has numerous applications positioned on the z/OS platform, but also has applications positioned on the distributed platforms. These applications were created at different points in time, independently of each other, and they belong administratively to different departments in the enterprise. Various clients access these applications, using different client technologies.
- These applications interact (inside the z/OS platform, but also between z/OS and the distributed platforms) through a variety of connectivity and middleware options. WebSphere MQ is a predominant middleware, but proprietary protocols abound, specifically in the client-server scenario.
- The applications were designed without the concept of service consumer or service provider. The interaction between the applications (and also between clients and applications) is not based on standards, but instead on the technologies available at the time the applications were written.
- Most applications do not have a clear separation between the presentation, business logic and data layer. There are a few exceptions, present in the multichannel scenario (J2EE enablement), where this separation was successful.
- Real-time integration between applications is only partly done (for instance, using the WebSphere MQ protocol). A great deal of integration takes place through daily or hourly FTP or batch jobs that exchange data between applications. The Extract Transform and Load (ETL) pattern is also used here.
- The applications do not appear as services, for the most part, although some attempts had been made to implement multichannel-enabled applications and “homegrown SOA” architectures.

In this context there are many (perhaps, long-term) benefits that the organization will reap by moving to an SOA architecture and consequently enabling the applications as services.

For a detailed analysis of the benefits brought by an SOA architecture we recommend the following documents:

- Hurwitz report “Thinking from Reuse - SOA for Renewable Business”, which is available at the following site:

  `ftp://ftp.software.ibm.com/software/soa/pdf/IBMThinkingfromReuse.pdf`

- CBDI white paper “Business Flexibility Through SOA”, which is available at the following site:

  `ftp://ftp.software.ibm.com/software/soa/pdf/CBDIWhitepaperBusinessFlexibilityThroughSOA.pdf`

2.3 SOA basics

In the following sections we describe, at a very high level, some SOA basic concepts (definitions, services, design points, SOA lifecycle).

2.3.1 SOA basic concepts

Service Oriented Architecture (SOA) is a business-centric IT architectural approach that supports integrating the business as linked, repeatable business tasks or services. SOA helps users build composite applications which draw upon functionality from multiple sources within and beyond the enterprise to support horizontal business processes. A *composite application* is a set of related and integrated services that support a business process built on SOA.

As a gross generalization, a *service* is a repeatable task within a business process. After identifying the business processes, we identify within them the set of tasks performed within the process. Next, we define these tasks as services, and the business process is then a *composition* of services. A number of techniques have been devised to help you identify the appropriate granularity and construction of services derived from the business design. The Service Oriented Modeling and Analysis (SOMA) technique is such an approach.

From this definition of service, *service orientation* is a way of integrating the business as a set of linked services. A Service Oriented Architecture, then, is an architectural style for creating an enterprise IT architecture that exploits the principles of service orientation to achieve a tighter relationship between the business and the information systems that support the business. Finally, an SOA-based enterprise architecture will yield composite applications.

2.3.2 SOA perspectives

From the perspective of the business, SOA is about modeling the business (capturing the business design), and gaining insight from that effort to refine the business design.

The Enterprise IT Architect will see SOA as being about two things: the style of architecture, and the set of principles that govern it.

- SOA describes a style of enterprise architecture that structures artifacts in the information system as a set of services that can be composed to form other services.
- SOA establishes a set of principles for loose coupling, modularity, encapsulation, re-use and composability that will yield the flexibility needed to ensure the information system is able to keep up with the rate of change demanded in the business design.

The Infrastructure IT Architect can gain value from SOA by exploiting the tools and methodologies offered by SOA for automating the business design that remains valuable to the business over time.

From the perspective of application programmers, SOA is a set of programming models and tools for building, accessing and assembling services that implement the business design together with a runtime that will execute those services efficiently.

From the perspective of the operations staff, a benefit of SOA is that it enables them to implement IT changes incrementally, replacing complex chains of machine and software dependencies with modularized services that can be substituted, tailored, modified, and deployed in a granular fashion over a virtualized infrastructure.

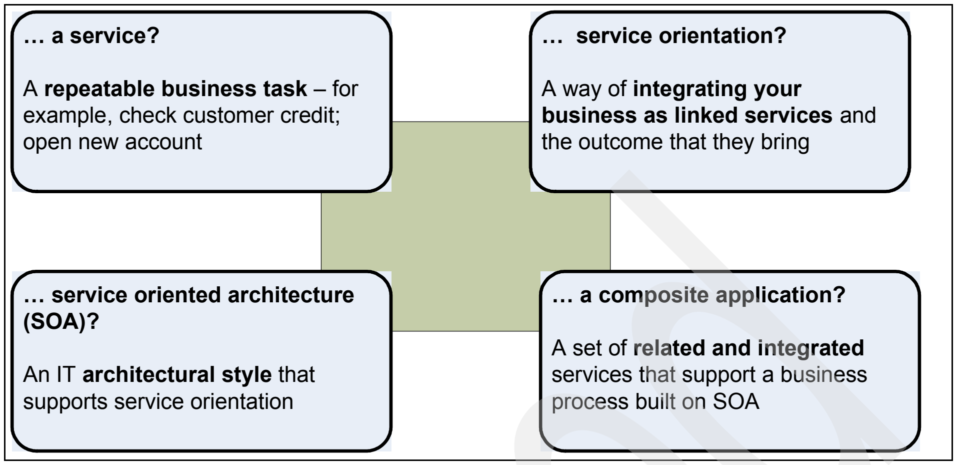

… a service?
A **repeatable business task** – for example, check customer credit; open new account
… service orientation?
A way of **integrating your business as linked services** and the outcome that they bring
… service oriented architecture (SOA)?
An IT **architectural style** that supports service orientation
… a composite application?
A set of **related and integrated** services that support a business process built on SOA

Figure 2-1 SOA definitions

2.3.3 Defining a service

An SOA is an architectural approach to defining integration architectures that are based on the concept of services. A service can be described as a function that can be offered or provided to a consumer. This function can be an atomic business function, or part of a collection of business functions that are strung together to form a process.

The most commonly agreed-on aspects of a service are that:

- Services *encapsulate* a reusable business function.
- Services are defined by explicit, *implementation-independent* interfaces.
- Services are invoked through communication protocols that stress *location transparency* and *interoperability*.

Ideally, a service should be reusable and should be accessed by more than one consumer; that is, by more than one system in the architecture. It is, therefore, important to get the service description and reusability correct.

Services can be invoked independently by either external or internal service consumers to process simple functions, or they can be chained together to form more complex functionality or devise new functionality quickly.

Note: The SOA does not specify that the consumer need any specific protocol to have access to a service. A key principle in SOA is that a service is not defined by the communication protocol that it uses but instead, should be defined in a protocol-independent way that allows different protocols to be used to access the same service.

Ideally, a service should only be defined once, through a *service interface*, and should have many implementations with different access protocols. For more detailed information about this topic, refer to More about Service Identification in 4.1.1, “Service Oriented Modeling and Architecture (SOMA)” on page 98.

Loose coupling versus tight coupling

The SOA architecture and many other documents refer to the concept of *loose coupling* as opposed to *tight coupling*. But what exactly does this mean?

Tight coupling means that applications are highly dependent on each other, as described here:

- Dependencies are created when two or more resources are linked together by requiring either a common platform, middleware, or integration product.
- Such applications use inflexible message formats that cannot be changed without impacting the resources that exchange the message.
- Such applications contain “hard wiring” through coding of “connectivity” information inside the applications.

  This hard-wiring” of applications offers certain benefits:

  – It is easier to perform security checking if each application “knows” the other.
  – It is easy to repair an application’s failure because you always know where the partner application resides.
  – Using a tightly coupled application development approach provides certain safeguards from a quality of service, security, privacy, data integrity, and complex transaction processing perspective, as compared to Web services architecture.
  – Tightly coupled applications know how their partner applications behave (and this implies an ability to ensure a reliable conversation between applications, as well as the ability to ensure performance characteristics to a certain degree).
  – Tightly coupled applications are inherently more easily managed (because both endpoints are known).

But this “hard-wiring” has disadvantages too:

- Applications need to be told by a programmer how to find each other, how to communicate with each other, and they also require long-term management and repair.
- You spend a lot of time defining the connections and relationships between cooperating applications.
- Agility is constrained as the virtualization of resources can be difficult to achieve because the resource cannot be relocated without rebuilding all of its hard-wired dependencies.
- Agility is also constrained as the ability to change resources, or use an alternative provider, is reduced because of the tight coupling to the current resource or its technology platform.

The principle of loose coupling is that dependencies between the service consumer or requestor and the service provider are minimized to enable agility.

The benefits of the loosely coupled approach are:

- Building loosely coupled applications is simpler because developers do not need to spend a great deal of time defining where partner applications can be found and defining the rules that allow them to communicate.
- Maintenance of loosely coupled applications may also be easier. For instance, should one side of a loosely coupled application fail, a replacement application can be sought dynamically and run automatically.
- Loose coupling of applications provides a level of flexibility and interoperability that cannot be matched using traditional approaches.

The conclusions are:

- Tight coupling is comparatively complex and difficult, but is inherently reliable, secure, and tunable. Tight coupling constrains the ability to adapt to changing business and technology requirements.
- Loose coupling provides benefits such as dynamic lookup and heterogeneous, cross-platform interoperability, but requires an architecture and a software implementation for the security, reliability, manageability, and other mission-critical purposes.

The key benefit of loose coupling is *agility*. The service layer helps to isolate change in the providing or requesting applications. For example, the frequency of change in the business process, or the device and technology diversity used in the requesting application, might be more frequent than that in the core back-end systems that are used by the service provider.

In this chapter we concentrate on the building of an architecture for the loosely coupled applications, in order to reap the benefits mentioned here, while simultaneously keeping the Quality of Service benefits inherently available with a tight coupled solution. In Chapter 5, “SOA implementation scenarios” on page 131, we see which kinds of scenarios can be transformed in such a way that the resulting environment is composed of loosely coupled services.

Service granularity

Coarse-grained access defines the granularity in a service or component that requires clients to make very few method invocations to accomplish a business activity. For example, if a typical client needs to update a single customer record, then a service based on coarse-grained access would have the client update all attributes of a customer in a single invocation, either by passing all the items as arguments to a procedure, or by passing an entire customer object as the argument. As a general rule, coarse-grained access is a good practice with Web services because it minimizes the number of network round trips.

The main disadvantage to coarse-grained access over *fine-grained* access is that it creates rigidity in how clients work with the service. For instance, if a client was redesigned so that a single attribute of a customer is to be updated separately from the other attributes, then the client might still have to update the entire customer when only one attribute has changed.

As a general rule, overly fine-grained access should not be used as Web services because each method invocation requires object marshalling and demarshalling. This creates a great deal of computing and network overhead, which can degrade performance far more than the efficiency gained by sending a few small pieces of data.

However, powerful counter examples of successful and reusable fine-grained services exist. More realistically, there are many useful levels of service granularity in most SOAs, as the following examples show:

- Technical functions (such as logging)
- Business functions (such as a service called `getAddress`)
- Business transactions (such as `orderStock`)
- Business processes (such as `dailyTransactionSettlement`)

We can define, for example, the coarse-grained service `dailyTransactionSettlement`, which is a complex, long running service (it might be a batch-oriented process). This service might be composed from several fine-grained services.

2.3.4 IBM SOA lifecycle

The SOA lifecycle is the framework of the IBM SOA strategy. As Figure 2-2 on page 19 shows, the SOA lifecycle consists of these stages:

- Model

  Use modeling tools to define the business process, at a business function level, and model the actual services that will be part of an assembled, composite application.

- Assemble

  Assemble the individual services and write the code that is needed to implement the business rules for the application. Services may be re-used, or they may be developed new.

- Deploy

  Deploy the services to run-time environments, such as transaction management engines like WebSphere Application Server, CICS, IMS, and so on. Use integration components, primarily an Enterprise Service Bus (ESB), to link together the various services needed for the composite application.

- Manage

  Implement the management infrastructure for monitoring and managing the services and the service infrastructure. This includes not only IT management tools, but also business management and monitoring tools to measure actual business activities.

- Governance

  Ensure that the SOA is developed and maintained in the way we originally intended it to be. A common problem in IT is that developers and project teams deviate too easily from the architecture. The quality and benefits from an SOA depend on the discipline that everybody has in following the defined architecture.

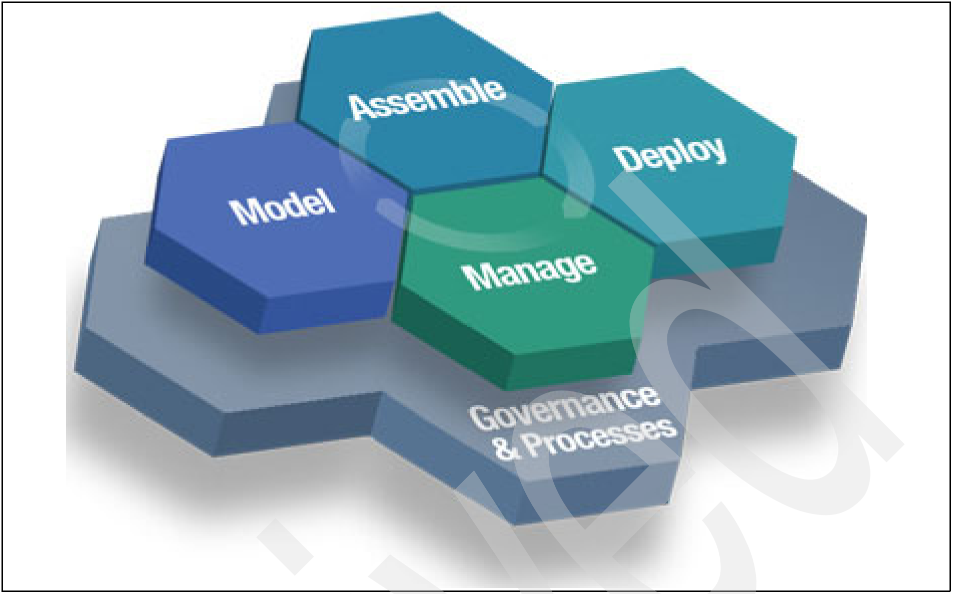
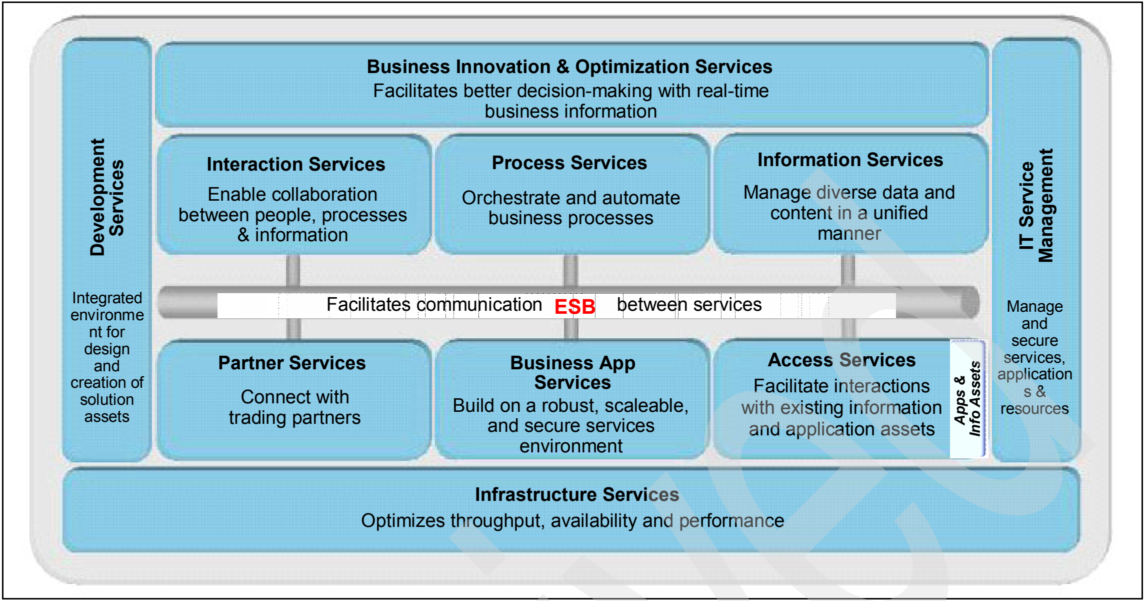


Figure 2-2 IBM SOA lifecycle

2.4 IBM SOA reference architecture

The IBM SOA reference architecture presented in Figure 2-3 on page 20 includes building blocks that are used by the system and application architect to position the infrastructure elements and the decomposed parts of the application in a service-oriented way. In this section we describe these building blocks and their role in the architecture.



Business Innovation & Optimization Services
Facilitates better decision-making with real-time business information
Development Services
Integrated environment for design and creation of solution assets
Interaction Services
Enable collaboration between people, processes & information
Process Services
Orchestrate and automate business processes
Information Services
Manage diverse data and content in a unified manner
IT Service Management
Manage and secure services, applications & resources
Facilitates communication ESB between services
Partner Services
Connect with trading partners
Business App Services
Build on a robust, scaleable, and secure services environment
Access Services
Facilitate interactions with existing information and application assets
Apps & Info Assets
Infrastructure Services
Optimizes throughput, availability and performance

Figure 2-3 IBM SOA reference architecture

Referring to Figure 2-3, the building blocks are:

- Development Services
- Business Innovation and Optimization Services
- The Enterprise Service Bus (ESB)
- Interaction Services
- Process Services
- Information Services
- Access Services
- Partner Services
- Business Application Services
- Infrastructure Services
- IT Services Management Services

The boxes labeled Interaction Services, Process Services, Information Services, Partner Services, Business Application Services and Access Services are the parts in which we deploy application software to capture the domain logic specific to the business design. The other parts of the architecture exist to assist the rest of the SOA Lifecycle. We will use these other parts in the modeling of the business design, construction and assembly of the software, deployment of the applications, and management of the operational system and the implemented business design.

There is a reason for the way in which these building blocks were positioned in the diagram; the supporting functions (represented by Infrastructure Services, IT Services Management, Deployment Services) are positioned on the borders of the figure, surrounding with their functionality the “runtime” building blocks.

Next, we examine in detail what the IBM SOA reference architecture defines for these building blocks. Later on we will fill the blocks with the available IBM implementation options.

2.4.1 Development Services

Development Services is an essential component of any comprehensive integration architecture. These services enable different people, involved in the development of a custom application, to develop the artifacts based on their skills, expertise, and role within the enterprise, as described here:

- Business analysts analyze business process requirements using modeling tools that allow processes to be charted and simulated.
- Software architects model the system structure and behavior.
- Integration specialists design specific interconnections in the integration solution.
- Programmers develop new business logic with little concern for the underlying platform.

Development Services enable joint development, asset management, and collaboration among all these people. A common repository and functions common across all the developer perspectives (for example, version control functions, project management functions, and so on) are provided through a unified development platform

2.4.2 Business Innovation and Optimization Services

Business Innovation and Optimization Services provide monitoring capabilities that aggregate the operational and process matrix in order to efficiently manage systems and processes.

These capabilities are delivered through a set of comprehensive services that collect and present both IT and process-level data. This allows business dashboards, administrative dashboards, and other IT-level displays to be used to manage system resources and business processes.

The point here is that these services get insight not only into IT processes, but also into the business processes, and so they can deliver not only the traditional IT information, but also information about the business aspects of the application.

Runtime data and statistics can be delivered, from Business Innovation and Optimization services to Development Services. This allows analysis and an iterative process of reengineering.

2.4.3 The Enterprise Service Bus (ESB)

At the core of the SOA reference architecture is the Enterprise Service Bus (ESB). This architectural construct delivers all the interconnectivity capabilities required to use (and reuse) services implemented across the entire architecture. The ESB provides the following fundamental services:

- Transport Services that provide the fundamental connection layer
- Event Services that allow the system to respond to specific events that are part of a business process
- Mediation Services like transformation and validation services that allow loose coupling between interacting services in the system

The Enterprise Service Bus (ESB) is a “silent partner” in the SOA logical architecture. Its presence in the architecture is transparent to the services of your SOA application. However, the presence of an ESB is fundamental to simplifying the task of invoking services. It makes use of services wherever they are needed, independent of the details of locating those services and transporting service requests across the network to invoke those services wherever they reside within your enterprise.

The ESB enables the substitution of one service implementation by another with no effect to the clients of that service (this is one of the most important design points in SOA). This requires both the service interfaces that are specified by SOA, and that the ESB allows client code to invoke services in a manner that is independent of the service location (location transparency), communication protocol (transport neutrality) and interaction protocol.

The fact that the ESB is interposed between participants provides the opportunity to modulate their interaction through a logical construct called a *mediation*. ESB implementations offer basic mediation constructs such as the following:

- Protocol switch

  Its role is to transcode requests from one interaction protocol or API to another.

- Transform

  Its role is to translate the message payload from one schema to another; this may include encryption.
- Enrich

  Its role is to augment the message payload with external information.
- Route

  Its role is to change the route of a message, selecting among service providers based on selection criteria.
- Distribute

  Its role is to distribute the message to a set of interested parties.
- Monitor

  Its role is to observe messages as they pass through mediation unchanged. It can be used to monitor service levels, to support billing, and to support auditing.
- Correlate

  Its role is to derive complex events from message and event streams.

These basic mediation constructs can be combined to realize more complex patterns, like the *canonical adapter* (protocol switch followed by a transformation) or the “transform-log-route” mediation.

The ESB is not the only infrastructure component in an SOA. Although individual scenarios vary, there are other, commonly occurring components whose role we should position relative to the ESB:

- The Business Service Directory provides the details of available services to systems that participate in an SOA. In order to perform routing of service interactions, the ESB obviously requires at least basic routing information, which might be provided by an ESB Namespace Directory, or by simpler means such as a routing table.

  However, this routing information is not necessarily the same as the business service directory SOA component; the role of the Business Service Directory is to provide details of services that are available to perform business functions. The Business Service Directory might be an open-standard UDDI directory, or some other registry and repository construct.

  Such implementations can achieve one of the primary goals of a Business Service Directory: to publish the availability of services and encourage their reuse across the development activity of an enterprise.
- Business Service Choreography is used to orchestrate sequences of service interactions into short-lived or long-lived business processes.

- The ESB Gateway is used to provide a controlled point of external access to services where the ESB does not provide this natively. Larger organizations are likely to keep the ESB Gateway as a separate component.

  An ESB Gateway can also be used to federate ESBs within an enterprise. For more information on the ESB, refer to the IBM Redbook *Patterns: Implementing an SOA Using an Enterprise Service Bus*, SG24-6346.

2.4.4 Interaction Services

Interaction Services support the presentation logic of the business design components that enable the interaction between applications and end users. Interactions may be tailored to role-sensitive contexts, adjusting what is seen and the behavior presented to the external world based on who the user is, what role they are performing, and where they are in the world.

2.4.5 Process Services

Process Services provide the control and management services that allow integration and automation of business processes that span people, workflows, applications, different systems and platforms and meld them into single, orchestrated application. Process services include various forms of compositional logic, the most notable of which are *business process flows* and *business state machines* (finite-state machines for business composition).

2.4.6 Information Services

Information Services provide the capabilities required to federate, replicate, integrate, analyze and transform data sources. These services provide access to the data repositories through various techniques such as accessing stored procedures as Web services, providing standardized interfaces to non-relational data repositories, and other access mechanisms that return information as a Service.

2.4.7 Access Services

Access Services provide bridging capabilities between legacy applications, pre-packaged applications and enterprise data stores. These access services make available the functions and data of the *existing* enterprise applications as services, thereby allowing them to be reused and incorporated (like other service components) into functional flows that represent business processes.

This includes simple wrapping of those functions and rendering them as services (when the existing function is a good match with the semantic requirements of the business model in which it will be used), or in more complex cases, augmenting the logic of the existing function to better meet the needs of the business design. In the latter case, the access service may invoke multiple legacy functions to achieve the semantic requirements of the service.

2.4.8 Partner Services

In many enterprises, business processes involve interactions with outside partners and suppliers. Partner Services provide the document, protocol, and partner management services required for business-to-business processes and interactions.

In some ways Partner Services look like interaction services, by projecting a view of the business to partners and controlling the interaction with them as an external entity. In other respects Partner Services look like access services, by rendering the capabilities of a partner as a service so that those functions can be composed into your business processes like any other service.

2.4.9 Business Application Services

Business Application Services implement the core business logic. These are service components created specifically as services within a business model and that represent the *basic building blocks* of your business design. These services are not decomposable within the business model, but can be composed to form higher level services.

2.4.10 Infrastructure Services

Infrastructure Services provide functions for scalability and performance, security and resource virtualization capabilities. These include the hardware and software for deployment of the actual business services and service infrastructure. The Infrastrucure Services component provides the required degree of Quality of Service.

Many of the Infrastructure and IT Service Management services perform functions tied directly to hardware or system implementations, and others provide functions that interact directly with integration services provided in other elements of the architecture through the ESB. These interactions typically involve services related to security, directory, and IT operational systems management.

2.4.11 IT Services Management Services

IT Services Management Services provide security, directory, IT system management, service level automation and orchestration, and virtualization functions. The infrastructure required to support an SOA and the applications cooperating in an SOA are typically dispersed over several platforms and technologies, and is therefore significantly more complex than traditional infrastructure necessary for “self-contained” applications.

SOA Management can be thought of in three layers:

- Business Service Management provides for service level planning, business impact monitoring, and prioritization of event management.
- Composite Application Management provides support for securing the SOA environment, flow content analysis, end-user response time monitoring for service requests, service problem diagnosis, and application trace information that you can then pass back to your development environment.
- Resource Management enables orchestration, provisioning, infrastructure health monitoring, and event automation.

2.5 Criteria to determine whether SOA has been implemented successfully

The criteria which are used in determining whether the implemented architecture in an enterprise is an SOA are derived from the SOA benefits. There are different degrees of SOA compliance, but since we are attempting to describe “ideal” implementations here, we look at the criteria for a “state of the art” SOA implementation. Also refer to Chapter 4, “The SOA transition process” on page 97 and especially 4.1, “Methodologies for analyzing the business and application environment” on page 98 for more information about this topic.

Each complete SOA implementation option should allow the following:

- Modeling, construction, deployment (in the runtime instances) and management of service components

  This means having an integrated set of tools and runtimes that allow the consequent implementation of the SOA lifecycle.
- Positioning the services as loosely coupled, reusable, and composable elements

  This means using connection and calling mechanisms between services, with clearly described interfaces (that use non-proprietary, recognized standards). The result will be that we can replace components at will, provided they respect the defined interface. It also means having available tools for composing applications by putting together services and describing the business flow using these services. To run the "composed" application (processes), we need a runtime that is able to reach the service providers and run the business logic.

- Location transparency

  This means we should have in our SOA implementation the service directory component that allows the discovery of the services, their calling methods, and QoS.

- Transport neutrality

  This means that the implementation should allow the services to be "called" in standardized ways, without associating (or restricting) them to any specific transport protocol. This also means we need mediations and transformation services that will allow service consumers to call service providers, even if they implement different protocols.

- The possibility to attach, find, and use internal and external legacy and packaged applications as coarse-grained services, through the use of adapters, gateways, and other artifacts
- The possibility to attach, find, and use "information as service" components, as well as other future components (through easy, implemented extensions)
- The possibility to manage the deployed services, from both a traditional IT view and a business-oriented view, thus allowing us an insight into the composite application

Now that we defined the criteria for SOA, we move on a "SOA journey" to achieve them. This journey will (in almost all cases) take place in steps, moving from different stages of *service enablement*, to several stages of *service integration* and lastly into several stages of *process integration*.

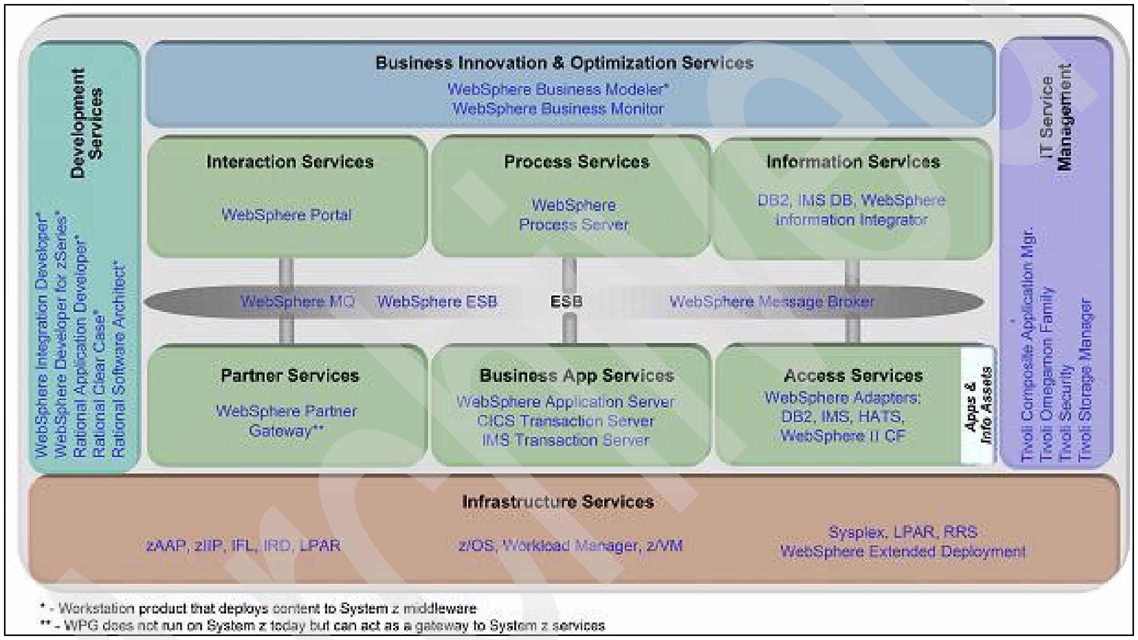
Therefore, the path to the "ideal" SOA architecture will be a succession of steps, a combination of positioning SOA infrastructure products and SOA-enablement of applications. The speed and depth of the implementations are, as always, based on the exact enterprise landscape and, most important, of the requirements of the enterprise.

In the next section we describe the IBM products for each building block of the SOA reference architecture.

2.6 IBM options on z/OS platform for each building block of SOA reference architecture

In the following section we show the IBM implementation options (set of products) that are available on the z/OS platform. We position the products over the building blocks of the SOA reference architecture, and present an overview of the delivered functionality.

Figure 2-4 shows the available IBM products on the z/OS platform, and their positioning in the IBM SOA reference architecture.



Business Innovation & Optimization Services
WebSphere Business Modeler*
WebSphere Business Monitor
Development Services
WebSphere Integration Developer*
WebSphere Developer for zSeries*
Rational Application Developer*
Rational Clear Case*
Rational Software Architect*
Interaction Services
WebSphere Portal
Process Services
WebSphere Process Server
Information Services
DB2, IMS DB, WebSphere Information Integrator
WebSphere MQ
WebSphere ESB
ESB
WebSphere Message Broker
Partner Services
WebSphere Partner Gateway**
Business App Services
WebSphere Application Server
CICS Transaction Server
IMS Transaction Server
Access Services
WebSphere Adapters:
DB2, IMS, HATS,
WebSphere II CF
Apps & Info Assets
IT Service Management
Tivoli Composite Application Mgr.
Tivoli Omegamon Family
Tivoli Security
Tivoli Storage Manager
Infrastructure Services
zAAP, zIIP, IFL, IRD, LPAR
z/OS, Workload Manager, z/VM
Sysplex, LPAR, RRS
WebSphere Extended Deployment
* - Workstation product that deploys content to System z middleware
** - WPG does not run on System z today but can act as a gateway to System z services

Figure 2-4 IBM SOA reference architecture and the IBM products on z/OS

2.6.1 Infrastructure Services

Here we see all IBM hardware and software features (implemented as hardware features of the System z platform, or in the z/OS operating system, or in the WebSphere products on z/OS). These are the hardware and operating system features which allow the implementation of the desired QoS levels for availability (Parallel Sysplex®), performance and optimization (Workload Manager, specific usage of the processors, such as zAAP, zIIP and IFL, WebSphere XD), and security and transactional capabilities (RRS).

2.6.2 Development Services

In this area we position among others the WebSphere Business Modeler, the Rational® development tools and the WebSphere Integration Developer products. These are the tools that allow the developer to construct the service artifacts, define their interfaces, integrate the services in process flows, and deploy them in the runtimes.

2.6.3 IT Services Management Services

In this area we position products such as IBM Tivoli® Composite Application Monitor, the Tivoli Omegamon family and Tivoli security products, such as Tivoli Access Manager (TAM). These are supporting products that are necessary in order to get insight into the different SOA layers (operational systems, service components, services, business processes).

2.6.4 Business Innovation and Optimization Services

In this area we see products such as WebSphere Business Modeler and WebSphere Business Monitor. These products are necessary when we have already created and deployed services, and now wish to construct and deploy composite applications and process flows.

2.6.5 Interaction Services

In this area we position the WebSphere Portal and the Workplace™ WebSphere Everyplace® products. These products can be used when the enterprise reaches the point of integrating the user interfaces into a unified presentation, and allowing the user interfaces flexible access to information and services.

2.6.6 Process Services

In this area we see the WebSphere Process Server (WPS) product. This product will be used when the enterprise disposes of a sufficient number of services and starts combining them into process flows, positioning the business rules in these flows and therefore outside the business logic component.

2.6.7 Information Services

In this area we see the IBM products that allow access to data, such as DB2® and IMS DB, as well as products that provide “information as a service” functionality, such as WebSphere Information Integrator.

2.6.8 Partner Services

In this area we position the WebSphere Partner Gateway product. This product will be used at the point where the enterprise wants to access service components located at the partners, or would like to make available its services to the partners. Usually this happens after the infrastructure for the Enterprise Service Bus has been positioned.

2.6.9 Business Application Services

In this area we see products that run the services that implement business logic. These products include WebSphere Application Server, CICS Transaction Server, and IMS Transaction Manager.

2.6.10 Access Services

Here we see the IBM products that allow access to legacy applications, like WebSphere Adapters, Host Access Transformation Services (HATS) and WebSphere IICF. These products can be implemented when the enterprise decides to service-enable legacy applications. Later on, through the use of an ESB, the service-enabled legacy applications can be reused by new composite applications.

2.6.11 Enterprise Service Bus (ESB)

In this area we position WebSphere ESB (WESB) and WebSphere Message Broker (WMB) products. The ESB is a central component in any SOA implementation, and the positioning might be necessary as soon as the enterprise has a need for “reusing” services (and, in the process, having the need for mediations, transformation, routing, protocol independence, location transparency and so on).

2.7 Analysis of the IBM products available for the SOA on z/OS

Now that we know what IBM products are available for each building block, it is time to determine the features implemented by them. Instead of presenting a “data sheet” for all the products involved, we show how specific features are there for a purpose, namely to implement SOA architecture requirements.

We concentrate only on the features that are related to SOA, that is, all features that were built into the products with the purpose of enhancing the QoS of the architecture or enabling the SOA features.

IBM is following an obvious strategy in regard to the z/OS products for the SOA reference architecture. One of the activities is to go over all the building blocks, identify the products that play a role in that area, and SOA-enable them. This means:

- If the product is a development tool, it is enhanced with the ability to produce SOA components to run on z/OS runtimes and the ability of SOA-enabling existing components. For example, WebSphere Developer for z (WDz) produces fully SOA-enabled business components to run in WebSphere Application Server, CICS TS, IMS TM and DB2. It produces all the necessary artifacts needed (for the provider and for the consumer).

  WebSphere Developer for z is also able to enable existing components like Java Beans, CICS and IMS transactions, DB2 stored procedures. These artifacts might be WS-Binding files, SOAP proxies, presentation components, portlets and so on. The development tools provide all these features in an integrated way, encompassing the entire cycle of application development.

  Another example of a development tool is WebSphere Integration Developer (WID), which can be used to produce process flows that in turn are able to call new or existing SOA components. The development tools are also enabled to deploy the components on the runtimes.
- If the product is a runtime for business logic, then IBM makes sure it is sufficiently enhanced (or provides a new product) so that it is able to run SOA components. For example, WebSphere Application Server is able to run SOA-enabled components (Web services). This is also valid for CICS Transaction Server.

  When the products do not directly support Web services, IBM delivers additional tools, wrappers, adapters, or gateways that allow existing components to be used as SOA services. WebSphere Process Server is an example of a new runtime which was provided specifically to run processes.
- The development and runtime products are constantly enhanced by implementing the standards as they stabilize (for example, the set of WS-* standards in the area of Web services). IBM ensures consistency in the support of the Web Services standards across the products, and therefore their interoperability, and interoperability with other software implementations.
- The runtimes are constantly enhanced to support a variation of transports, interaction patterns, languages used for development, and so on. This is done to increase flexibility and allow developers freedom of decision about many aspects of the implementation, but still ensure that the services fit in the SOA architecture.

- For some of the SOA building blocks (like the ESB), IBM delivers several options to better fulfill the market requirements. The available options are described in Chapter 6, “Towards service integration and process integration” on page 223. Depending on the enterprise requirements, IBM recommends using either the new WebSphere ESB product or the enhanced WebSphere Message Broker product.
- If the product is for Information Services, then IBM enhances it to allow the concept of “information as service”. Refer to 5.5, “SOA implementation scenarios - data access and integration” on page 199 for more information about this topic.
- If the product belongs to interactive access (like WebSphere Portal), IBM enables it to be able to participate in the SOA architecture. This means adding features that allow portlets to consume SOA components.
- IBM enhances existing management products and delivers new ones in order to be able to manage the whole lifecycle of the SOA components. Each runtime is improved in such a way that the Tivoli management tools are able to see “inside” and manage the SOA service component.

Other IBM activities make the z/OS platform more attractive to enterprises. Enhancements increase the functionality and standards of the products running on z/OS, improve the QoS of the platform, and reduce the Total Cost of Ownership (TCO). The TCO reduction is implemented in many ways, including by using zAAP processors, achieving performance improvements in the runtimes, and virtualization.

In this chapter we concentrate mostly on runtimes. For more information about development tools, refer to 4.2, “Tools to assist in the SOA transformation process” on page 110.

2.7.1 WebSphere Application Server for z/OS

In this section we describe the most important features of WebSphere Application Server for z/OS Version 6.1 that directly benefit the SOA.

Core features that increase reusability and service integration

- WebSphere Application Server for z/OS, V6.1 supports Session Initiation Protocol (SIP) servlets, which are voice clients added as SOA participants.
- Web Services Gateway enables Web services invocation by users from inside and outside the firewall with the benefit of robust security protection and a centralized point of control.
- New Web services standards are supported, including WS-Business Activity, WS-Notification, and WS-I Basic Security Profile.

- A powerful built-in JMS engine helps extend the reach of new and existing applications. A JMS service consumer can participate directly in the SOA.
- Extensive Web services support, and close proximity to core mainframe assets, allow the easy reuse and development of composite applications.

Note: WebSphere Application Server for z/OS provides much more functionality than the features mentioned here. We only concentrate on Web services-related features in this section.

Features that implement QoS

- As a fully participating member of a Parallel Sysplex, WebSphere Application Server for z/OS delivers features such as a High Availability Manager and backup cluster support.
- The unified clustering framework has been enhanced to provide Web services and Session Initiation Protocol (SIP) servlet clustering capabilities.
- Out-of-the-box security configurations and user registry, compliance with government standards, and stringent Web services security are provided.
- High throughput and scalability with JDK™ 5 enhancements and improved cache off-loading are provided.
- Local connections to DB2 Universal Database™ for z/OS are leveraged, which eliminates unnecessary path length and significantly improves performance.
- A unique architecture is employed that derives significant value from integration with z/OS WLM, which enables a flexible deployment environment.

Note: This list simply highlights features related to the Quality of Service that is supported in WebSphere Application Server for z/OS. For more information about WebSphere Application Server for z/OS and QoS, such as security, availability, and integration, you can refer to the appropriate IBM Redbooks.

2.7.2 WebSphere Portal

This section discusses the most important features of WebSphere Portal for z/OS Version 6.0 that directly benefit the SOA. For more detailed information about this topic, including the announcement letter, refer to this site:

`http://www.ibm.com/software/genservers/portalzos/index.html?S_TACT=103BGW01&S_CMP=campaig`

Core features that increase reusability and service integration

- IBM WebSphere Portal delivers a complete set of capabilities that enable the assembly and orchestration of presentation components.
- WebSphere Portal supports JSR 168, a standard Application Programming Interface (API) for creating portlets as the integration component between applications and portals on a J2EE platform.
- WebSphere Portal supports the Web Services for Remote Portlets (WSRP) standard, for dynamically integrating business applications.
- WebSphere Portal also fully leverages IBM WebSphere Host Access Transformation Services (HATS) to quickly and easily extend legacy applications into a portal via reusable portlets.
- Orchestration is supported through Human Task List (BPEL) and cooperative portlets.

Note: WebSphere Portal for z/OS Version 6.0 provides much more functionality than the highlights mentioned here; look for a forthcoming IBM Redbook about this topic.

2.7.3 WebSphere Process Server

In this section we describe the most important features of WebSphere Process Server for z/OS Version 6.0 that directly benefit the SOA.

Core features that increase reusability and service integration

- Support for Web services including SOAP/HTTP, SOAP/JMS, WSDL 1.1 and WS-* Standards including WS-Security and WS-Atomic Transactions.
- Support for a variety of messaging protocols including JMS 1.1, WebSphere MQ, TCP/IP, SSL, HTTP(S), and multicast for optimum flexibility and improved asset reuse (more ways to interact between service consumers and service providers).
- Standards-based connectivity to integrate applications and services.
- Easy interoperability with WebSphere Family including WebSphere Application Server, WebSphere MQ, and WebSphere Message Broker.
- Messaging services for clients running in non-Java applications in C/C++ and Microsoft® .NET environments. The Web services Client is a JAX-RPC-like Web services client for C++ that enables users to connect to Web services hosted on WebSphere from a C++ environment.
- Java 2 Platform Enterprise Edition (J2EE) Connector Architecture (JCA) Version 1.0 and Version 1.5 resource adapters to access back-end systems.

- Support for the entire suite of IBM WebSphere Business Integration Adapters Support for Web services.
- Support for JMS through integrated WebSphere messaging resources (with full connectivity to existing IBM WebSphere MQ technology-based networks).
- Support for Web services (based on Java Specification Request [JSR] 109 and Java application programming interface (API) for XML (JAX)-RPC technology).
- Support for calling Enterprise JavaBeans™ (EJB™) session beans.
- Support for exposing and calling IBM CICS or IBM IMS programs as enterprise services.

Features that implement the "loosely coupled" concept

- Built on the WebSphere Enterprise Service Bus (WESB) for service-oriented integration (therefore inherits the already available service integration).
- WebSphere Process Server handles the integration logic, transformations, routing, and rules.
- Dynamic business processes are supported.
- Visual description of processes that span people, systems, applications, tasks, rules, and the interactions among them
- Supports short-running and long-running business processes.
- Integrates fault handling for easy, in-flow exception handling.
- WebSphere Process Server contains a business rule component that provides support for rule sets ("if-then" rules) and decision tables. Business rules are categorized into *rule groups* which hide implementation details from the consumer, and which are accessed like any other component.

Features that implement QoS

- Support for transactions involving multiple resource managers using the two-phase commit process. This capability is available for both short-running processes (single transaction) and long-running processes (multiple transactions).
- Multiple steps in a business process can be configured into one transaction by modifying transaction boundaries in WebSphere Integration Developer (WID), then deployed into WebSphere Process server.
- Transaction rollback-like functionality is provided for loosely coupled business processes that cannot be undone automatically by the application server.

2.7.4 WebSphere ESB

In this section we discuss the most important features of WebSphere Enterprise Service Bus for z/OS Version 6.0 that directly benefit the SOA.

Core features that increase reusability and service integration

- Support for a variety of messaging protocols including JMS 1.1, WebSphere MQ, TCP/IP, SSL, HTTP(S), and multicast for optimum flexibility and improved asset reuse (more service consumers and service providers can participate).
- A broad range of interaction models (request/reply, point-to-point, publish/subscribe and multicast) can be used.
- Advanced Web services support can be leveraged to incorporate SOAP/HTTP, SOAP/JMS, WSDL 1.1, Web Services Gateway. WebSphere ESB supports WS-* Standards including WS-Security and WS-Atomic Transactions, and includes a UDDI 3.0 Registry that can be used to publish and manage service end-point metadata.
- Message Service Client for C/C++ extends the JMS model for messaging to non-Java applications.
- Message Service Client for .NET enables legacy or .NET applications to participate in JMS-based information flows (additional service consumers).
- Web Services Client is a JAX-RPC-like Web services client for C++ that enables users to connect to Web services hosted on WebSphere from within a C++ environment.
- J2EE client support from WebSphere Application Server, including Web services Client, EJB Client, and JMS Client.

Features that implement the “loosely coupled” concept

- WebSphere ESB will handle the integration logic, transformations, routing and rules.
- Customized routing - transport/protocol-specific routing and content-based routing.
- Protocol transformation between a variety of protocols: HTTP, IIOP, JMS.
- Format transformation between standards including XML, SOAP, JMS messages, and many more when used with adapters.
- Supplied mediation function for database interaction.
- Support for message logging to database and message augmentation by database lookup.

- Administrator support for reconfiguring service interactions.
- Avoidance of system downtime by adding or replacing integration logic dynamically.

Features that implement QoS

- Scalability, clustering, and failover capabilities inherited from the WebSphere runtime.
- Utilization of common WebSphere Administrative Console to enable system management across WebSphere Application Server, WebSphere ESB, and WebSphere Process Server.
- Support for global transactions. A global transaction is required when mediating and routing messages must be coordinated into a single transaction, or when several mediation handlers in a mediation handler list must be coordinated into a single transaction. Setting the global transaction property ensures transactional integrity between a mediation that accesses the resources owned by other resource managers, and the messaging engine.
- End-to-end security requirements are addressed regarding authentication, resource access control, data integrity, confidentiality, privacy, and secure interoperability (SCA security and message level security on top of the security features delivered by WebSphere Application Server, Java, and the z/OS platform).
- Tight integration with IBM Tivoli security, directory, and systems management offerings (Tivoli Access Manager, Tivoli Directory, Tivoli Composite Application Manager for SOA).

2.7.5 WebSphere Message Broker

In this section we describe the most important features of WebSphere Message Broker for z/OS Version 6 that directly benefit the SOA.

Core features that increase reusability and service integration

- Numerous connectivity options allow practically each service to attach to the Message Broker.
- Integrated WebSphere MQ transports for Enterprise, Mobile, Real-Time, Multicast and Telemetry end-points extend the scope of client types.
- Native JMS interoperability is provided, which acts as a bridge between any combination of different JMS providers.

Note: WebSphere Message Broker for z/OS Version 6 offers a full range of ESB functions, but a detailed examination is beyond the scope of this IBM Redbook. You can learn more about the ESB and the role of WebSphere Message Broker for z/OS in 6.3, “Stage two - “service integration”” on page 227. You can also refer to the IBM Redbook *Implementing an Advanced ESB using WMB V6 and WESB V6 on z/OS*, SG24-7335.

Features that implement the “loosely coupled” concept

- WebSphere Message Broker handles the integration logic, transformations, routing and rules.
- Distribution of any type of information across and between multiple, diverse systems and applications.
- Reduction in the number of point-to-point interconnections and simplified application programming by removal of integration logic from the applications.
- Validation and transformation of messages in flight between any combination of different message formats, including Web Services, other XML formats, and non-XML formats.
- Routing of messages based on (evaluated) business rules to match information content and business processes.
- Dynamic reconfiguration of information distribution patterns without reprogramming end-point applications.
- Mediation (providing routing, transformation, and logging) between Web Service requesters and providers.
- Mediation between Web Services and other integration models, as both a service requester and a service provider.

Features that implement QoS

- Option to use Java for processing and transformation allows for offloading of this function onto zAAP processors for System z implementation.
- WebSphere Message Broker supports both WebSphere MQ queue sharing and queue clustering. WebSphere MQ queue sharing is a unique concept for high availability that is only available on z/OS.

2.7.6 WebSphere Service Registry and Repository

In this section we describe the most important features of WebSphere Service Registry and Repository (WSRR) that directly benefit the SOA.

Important: At the time of writing, WSRR is not yet available for the z/OS platform. The announcement can be found at this site:

`http://www.ibm.com/fcgi-bin/common/ssi/ssialias?infotype=an&subtype=ca&appname=Demonstration&htmlfid=897/ENUS206-315`

Core features that improve reusability and service integration

- Enables the publication, discovery, subscription, and governance of services. The registry component records the definition of the services (what they offer) and where they are located. In addition, the repository covers details such as how the services are used, by whom, and why.
- Enables the dynamic locating of the service based on the description of the interfaces and QoS requirements

2.7.7 WebSphere Host Access Transformation Services

In this section we describe the most important features of WebSphere Host Access Transformation Services (HATS) that directly benefit the SOA.

Features that enable existing applications as services or creation of new services

- Provides programmed access to 3270 host transactions through standard Web services interfaces.
- Combines data selected from multiple host sources with Java technology-based applications to create new WebSphere applications. You can encapsulate transactions with host systems into reusable business objects, such as Web services, Java beans or Enterprise JavaBeans (EJB).

Features that increase reusability and service integration

- HATS can run directly in the WebSphere Portal environment and take advantage of integration with other portlets in the portal, so the portlets can become service consumers of 3270 SOA-enabled applications.

Features that implement QoS

- Leverages the security-rich features provided by IBM WebSphere Application Server and IBM WebSphere Portal. Secure Sockets Layer (SSL) and Secure

HTTP (HTTPS) provide robust security between the host application, the mid-tier server, and the end user.

2.7.8 CICS Transaction Server

In this section we describe the most important features of CICS Transaction Server Version 3.1 that directly benefit the SOA.

Core features that improve reusability and service integration

- CICS is capable of being a Web Service provider and consumer through a variety of native (CICS Web services support) and adapter (CICS Transaction Gateway) technologies. This dual provider and consumer role means that CICS is now a full participant in the B2B and B2C world of e-portals and e-marketplaces.
- CICS supports Web services sent over the HTTP and WebSphere MQ transports for flexible deployment options, dependent on the requirement of applications.
- CICS supports SOAP-enablement features like Link3270 bridge, JCA, Service Flow Modeler (SFM)[1] and the Service Flow Runtime (SFR).
  - The Service Flow Modeler can be used to model the flow between CICS services, create interactions with CICS applications and expose the flow as a Web Service.
  - The Service Flow Runtime contains adapters and other supporting code that allow the flow to run. SFM and SFR are presented in “Variation 2: CICS Service Flow Feature (CICS Transaction Server V3.1)” on page 142.
- CICS TS V3.1 supports new technical constructs such as *pipelines* and *handlers*, which enable the processing of the headers the SOAP messages and therefore allow the implementation of the WS-* specifications.
- CICS TS V3.1 supports the following specifications: SOAP 1.1 and 1.2, WS-I Basic Profile 1.1, WS-Security (SOAP message security), WS-Coordination, WS-AtomicTransaction.
- CICS TS V3.1 supports new technical constructs such as *channels* and *containers* which improve features for the business logic (enhanced CICS data exchange) and form the infrastructure basis for the SOAP/Web services artifacts.
- CICS TS V3.1 supports transactions written in Java, enabling more flexibility for the implementation of the service providers.

[1] The Service Flow Modeler (SFM) is part of the WebSphere Developer for z product.

- Web services tooling is available for creating a Web service out of an existing program (bottom up) or creating a program based on available WSDL (top down).

2.7.9 IMS Transaction Manager

In this section we describe the most important features of IMS Transaction Manager that directly benefit the SOA.

Important: Most of the features mentioned here will become available in IMS V10. The announcement letter can be found at:

```
http://www.ibm.com/common/ssi/fcgi-bin/ssialias?subtype=ca&infotype=an&appname=iSource&supplier=897&letternum=ENUS206-238
```

The IMS SOAP Gateway and MFS Web support are also available in IMS V9.

Core features that improve reusability and service integration

- IMS is capable of being a Web service provider through IMS SOAP Gateway and other access components.
- Integrated Connect XML Adapter support for COBOL enables reuse of IMS applications as Web services.
- IMS calllout enables IMS applications as clients to interoperate with business logic outside of the IMS environment (for example, Web service or J2EE application).
- IMS SOA Composite Business application support enables integration of IMS transactions in SOA-based composite business applications.
- MFS Web support enables access to existing IMS MFS based transactions from WebSphere Application Server. Refer to "Variation 3: IMS using MFS Web Support" on page 144 for more information about this topic.
- IMS Connector for Java PL/I application support allows IMS transactions to be enabled as Web services without IMS application changes.

2.7.10 DB2

In this section we describe the most important features of DB2 for z/OS that directly benefit the SOA.

Core features that improve reusability and service integration

- DB2 can act as service provider through the Web Services Object Runtime Framework (WORF), which runs in WebSphere Application Server.

- DB2 can act as a service consumer, using DB2 User Defined Functions (UDFs). Optionally, the DB2 XML extender can be used to parse the results from an incoming SOAP message.
- DB2 supports native XML and XQuery processes that access XML. The XQuery modules can be used as SOA bindings in Web services that run in WebSphere Application Server. This means that we have an additional possibility to reach data stored in DB2.
- DB2 can also be accessed by PHP Web services deployed in WebSphere Application Server, through the "Zend Core for IBM" package. Zend Core for IBM is a certified PHP development and production environment that includes tight integration with the DB2 family of database servers, and native support for XML and Web services. For more information, including usage scenarios, refer to the IBM Redbook *Powering SOA with IBM Data Servers*, SG24-7259.

Features that implement QoS for the SOA architecture

- The positioning of WORF inside the WebSphere Application server enables DB2 service providers to take full advantage of the QoS offered by WebSphere Application Server.

2.7.11 SOA systems management on z/OS

In addition to a set of calls and responses, a service has many other characteristics such as performance, availability, capacity and security, which together are considered as Quality of Service. SOA not only exposes how to call a service, but also defines a set of characteristics for how the calls will be serviced, for example:

- How fast should the service respond, according to the Service Level Agreement (SLA)?
- When will the service be available, according to the SLA?
- Who may make calls to the service (authentication, authorization)?
- How many calls can be done in a certain period of time (performance, capacity)?
- What calls and which attributes (security) must be logged?
- How should calls be routed (capacity)?

Figure 2-5 on page 43 shows the integrated SOA management view, which is exactly what we need. It shows a group of Tivoli products that delve into the different layers of the SOA architecture and coordinate the information extracted. This allows for the management of the SOA infrastructure and the services that run on the infrastructure.

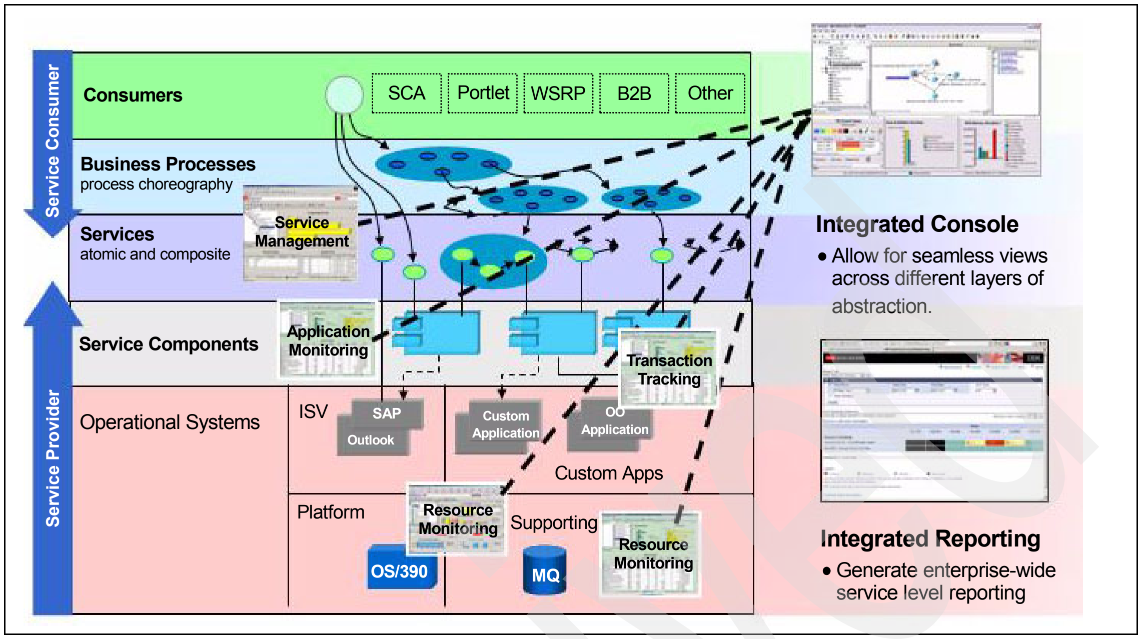


Figure 2-5 Integrated SOA management with IBM Tivoli on z/OS - a complete view

Figure 2-6 shows the Tivoli products mapped to the SOA reference architecture.

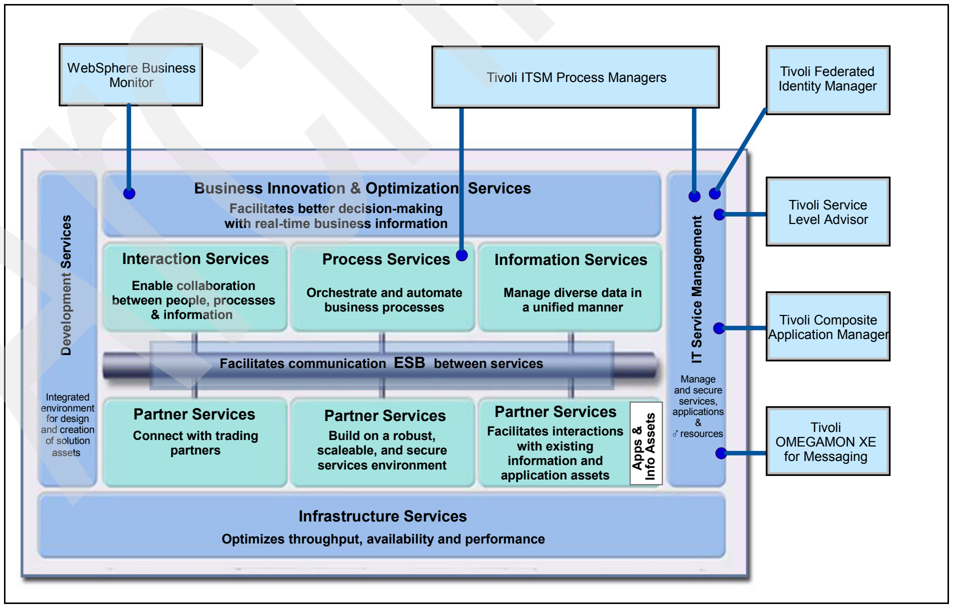

WebSphere Business Monitor
Tivoli ITSM Process Managers
Tivoli Federated Identity Manager
Tivoli Service Level Advisor
Tivoli Composite Application Manager
Tivoli OMEGAMON XE for Messaging
Business Innovation & Optimization Services
Facilitates better decision-making with real-time business information
Development Services
Integrated environment for design and creation of solution assets
Interaction Services
Enable collaboration between people, processes & information
Process Services
Orchestrate and automate business processes
Information Services
Manage diverse data in a unified manner
Facilitates communication ESB between services
Partner Services
Connect with trading partners
Partner Services
Build on a robust, scaleable, and secure services environment
Partner Services
Facilitates interactions with existing information and application assets
Apps & Info Assets
IT Service Management
Manage and secure services, applications & resources
Infrastructure Services
Optimizes throughput, availability and performance

Figure 2-6 Mapping of IBM Tivoli products to the SOA reference architecture

2.7.12 IBM Tivoli Composite Application Manager for SOA V6.0

In this section we describe the most important features of Tivoli Composite Application Manager (ITCAM) for SOA that directly benefit the SOA.

Core features that implement QoS for the SOA architecture

- Service problem identification and resolution through content views that allow a drill-down from services to applications to IT resources
- Service management alerts and automation
- Integrated service level reporting and monitoring
- Enables understanding, managing, and tracking of service performance

2.7.13 IBM Tivoli Composite Application Manager for WebSphere

In this section we describe the most important features Tivoli Composite Application Manager (ITCAM) for WebSphere that directly benefit the SOA.

Core features that implement QoS for the SOA architecture:

- Fast problem analysis across components of the SOA reference architecture (Portal, J2EE, CICS, IMS)

2.8 Implementation options for the SOA architecture on z/OS

At this point we know the options available on each building block of the IBM SOA reference architecture, and we have described in detail the functionality delivered by the implementations. Now we can create sets of products (what we call here “implementation options”), and then determine whether the criteria set is fulfilled. We also identify the gaps between the options, and differentiate between them.

The main differentiator between the options described is the “depth” of the SOA implementation, and that is manifested in the level of the coupling of services and the amount of orchestration that is achieved.

Important: The SOA implementation options described here are examples. You can create variations of the three implementation options.

The purpose of the SOA implementation options is to show to what extent progress can be made towards SOA enablement, depending on the products used.

2.8.1 SOA implementation option 1 - service enablement

The rationale behind this option is “Let’s see what this SOA enablement will give us for a very limited application set” (selected from several scenarios). We use some of the IBM tools and products available for SOA enablement and determine how they work in production. We will tread carefully and with limited budgeting.

In this implementation, some applications were service-enabled and some reusability was achieved; we installed some pieces of the SOA infrastructure. Some SOA criteria were fulfilled.

Figure 2-7 shows, for SOA implementation option 1, the positioning of the IBM products relative to the IBM SOA reference architecture.

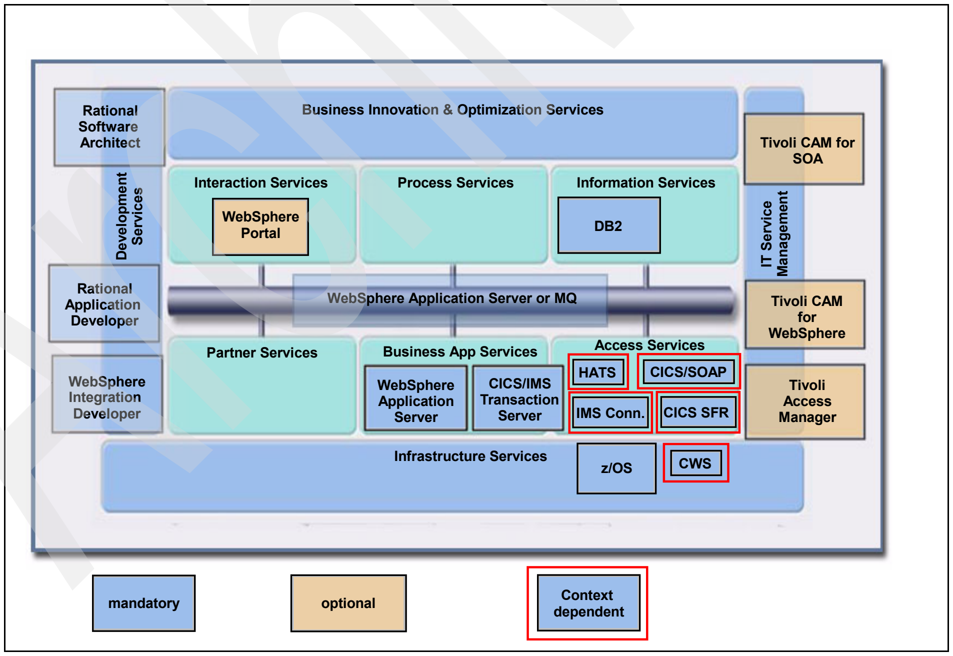


Figure 2-7 Mandatory and optional IBM products for service enablement

Table 2-1 lists the characteristics of this SOA implementation option.

Table 2-1 Characteristics of SOA implementation option 1 - service enablement

Implementation Option 1	**Characteristic**
Name	Service enablement
When to implement	► Need to service-enable a few applications ► Need some reusability of services ► Have some of the described scenarios in the enterprise, and want to migrate them to SOA ► Already have some applications that may be converted easily as services
Infrastructure services	Provided by z/OS (mandatory)
Development services	Rational Application Developer or an equivalent tool (mandatory) or WebSphere Integration Developer (optional)
IT Services Management Services	Tivoli family (optional)
Business Innovation and Optimization Services	WebSphere Business Integration Modeler, WebSphere Business Integration Monitor (both not necessary at this stage)
Interaction Services	WebSphere Portal (optional, depending on context)
Process Services	WebSphere Process Server (not necessary at this stage)
Information Services	DB2, IMS DB (as required in the context of the enterprise)
Partner Services	WebSphere Partner Gateway (not necessary at this stage)
Business Application Services	WebSphere Application Server (mandatory), CICS Transaction Server, IMS Transaction Manager (as required by the context)

Implementation Option 1	Characteristic
Access Services	WebSphere Adapters (as required by the context), HATS, CICS Web Services support, CICS Web Support, IMS Connect, IMS SOAP Gateway (depending on scenario)
ESB	WebSphere ESB or WebSphere Message Broker (optional, only if the context requires; otherwise, implement a light-ESB using WebSphere MQ)

Table 2-2 lists the various fulfillment degrees of SOA criteria, for the applications enabled as services (meaning “what we get by implementing this option”).

Table 2-2 SOA criteria fulfilled in SOA implementation option 1 - service enablement

SOA criteria	Have we reached this?
Modeling, constructing, deployment	*Yes*, necessary tools are in place
Management of services	*No* (Tivoli management not in place)
Loosely coupled services	*Moderate* (because no real ESB in place)
Reusable services	*Yes, but of limited use since no ESB is in place*
Composable services (processes)	*No*, modeler and runtime for process server are not there
Location transparency	*Moderate* for MQ solutions, *No* for all the others (reason: no real ESB in place)
Transport neutrality	*No* (no ESB with transformation in place)
Legacy applications as coarse-grained service	*Yes*
Insight into business services	*No* (Tivoli management not in place)

2.8.2 SOA implementation option 2 - service integration

The rationale behind this option is “We know what we might get out of SOA, we have already Web services projects and small implementations in the J2EE area. We start by putting a mini-SOA in place and see how it plays out. We select a few applications (preferably from different scenarios, perhaps a legacy application and a J2EE application) and convert them to SOA in a tactical way (using some

IBM tools) or a strategic way (using top-down analysis). We achieve some SOA criteria quickly for some urgent projects. We integrate the applications that already implement Web services in the SOA architecture and see whether reusability is achieved. If it plays well, then we will expand”.

It is “SOA lite” with the addition of a few more infrastructure components and with expanded SOA-enablement; more SOA criteria are fulfilled, so we are on the right path.

Figure 2-8 shows the positioning of the IBM products relative to the SOA reference architecture.

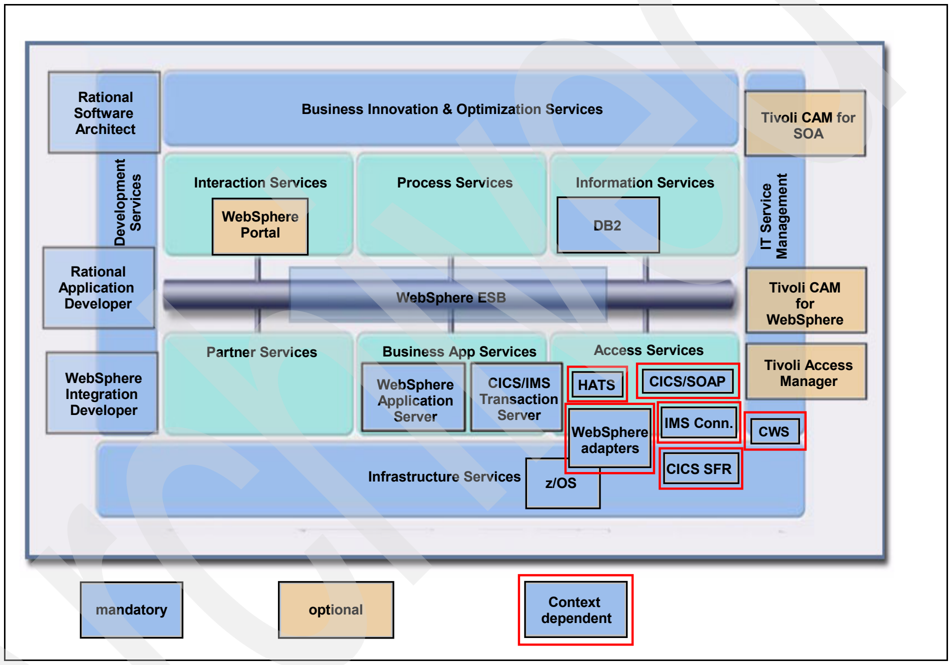


Figure 2-8 Mandatory and optional IBM products for service integration

Table 2-3 lists the characteristics of this SOA implementation option.

Table 2-3 Characteristics of SOA implementation option 2 - service integration

Implementation Option 2	Characteristic
Name	Service integration

Implementation Option 2	Characteristic
When to implement	► Need to fulfill quite some SOA criteria in a more strategic way ► Need reusability of the existing Web services, and a loosely coupled way of integration, including mediation ► Have more time and budget to invest in a strategic SOA infrastructure ► Have some of the described scenarios in the enterprise, and want to SOA-enable them ► Already have some service-enabled applications that may be integrated
Infrastructure Services	Provided by z/OS (mandatory)
Development Services	WebSphere Integration Developer or WebSphere Message Broker Toolkit (mandatory) on top of the tools mentioned in SOA implementation option 1
IT Services Management Services	Tivoli family (optional)
Business Innovation and Optimization Services	WebSphere Business Modeler, WebSphere Business Monitor (optional and not necessary at this stage)
Interaction Services	WebSphere Portal (optional)
Process Services	WebSphere Process Server (not necessary at this stage)
Information Services	DB2, IMS DB (as required in the context of the enterprise)
Partner Services	WebSphere Partner Gateway (not necessary at this stage)
Business Application Services	WebSphere Application Server (mandatory), CICS Transaction server, IMS Transaction Server (as required by the context)
Access Services	WebSphere Adapters (as required by the context), HATS, CICS Web Services support, CICS Web Support, IMS Connect, IMS SOAP Gateway (context dependent)

Implementation Option 2	Characteristic
ESB	WebSphere ESB or WebSphere Message Broker (either one is mandatory) for service providers that implement Web services

Table 2-4 lists the various fulfillment degrees of SOA criteria, for the applications integrated as services (means "what we get by implementing this option").

Table 2-4 SOA criteria fulfilled in SOA implementation option 2 - service integration

SOA criteria	Have we reached this?
Modeling, constructing, deployment	Yes, necessary tools are in place
Management of services	No (Tivoli management not in place)
Loosely coupled services	Moderate to full (ESB is in place)
Reusable services	Yes, and because of the ESB, also practical
Composable services (processes)	No, modeler and runtime for process server are not there
Location transparency	Moderate for MQ solutions, Yes for all that use ESB
Transport neutrality	Yes (for all that use ESB)
Legacy applications as coarse-grained service	Yes
Insight into business services	No (Tivoli management not in place)

2.8.3 SOA implementation option 3 - process integration

The rationale behind this option is "We are in a bind. We have numerous projects that cannot progress because of the monolithic structure of the applications. We need to reuse components that are locked inside the applications, and we want to integrate them, but we do not have the architecture that allows this and also not the necessary infrastructure. Our applications use several protocols and interaction models, but the whole thing becomes unmanageable as we install new applications or try to change existing ones. We need to put something in the middle, to do all this "translation" and to "loosen" the dependencies between the applications. We have urgent requirements for new applications, we have seen that we can create process flows that reuse some of our existing applications (or application parts), but we need to make out of those application parts "reusable services”. Our partners are connecting to our applications using various methods, and every new partner represents a costly change. We know what SOA might do for us, and we trust the concept. We will apply the IBM methodologies for identifying business services, decomposing applications and so on, but we will also use tactical solutions (wrapping) where necessary. Our application landscape contains instances of all initial scenarios. We have the funding for this project, and we need a state-of-the art SOA implementation. We have to move fast in several areas simultaneously (SOA-enablement and SOA-infrastructure), and achieve fast results, but we have to be careful to keep the SLA and performance levels as required”.

Process integration is, as the name describes, a full-blown implementation of the IBM SOA reference architecture using many existing IBM products. Such an implementation fulfills all SOA criteria, and is recommended for a specific type of enterprise, with a specific set of requirements and a specific application landscape.

Figure 2-9 shows the positioning of the IBM products relative to the IBM SOA reference architecture.

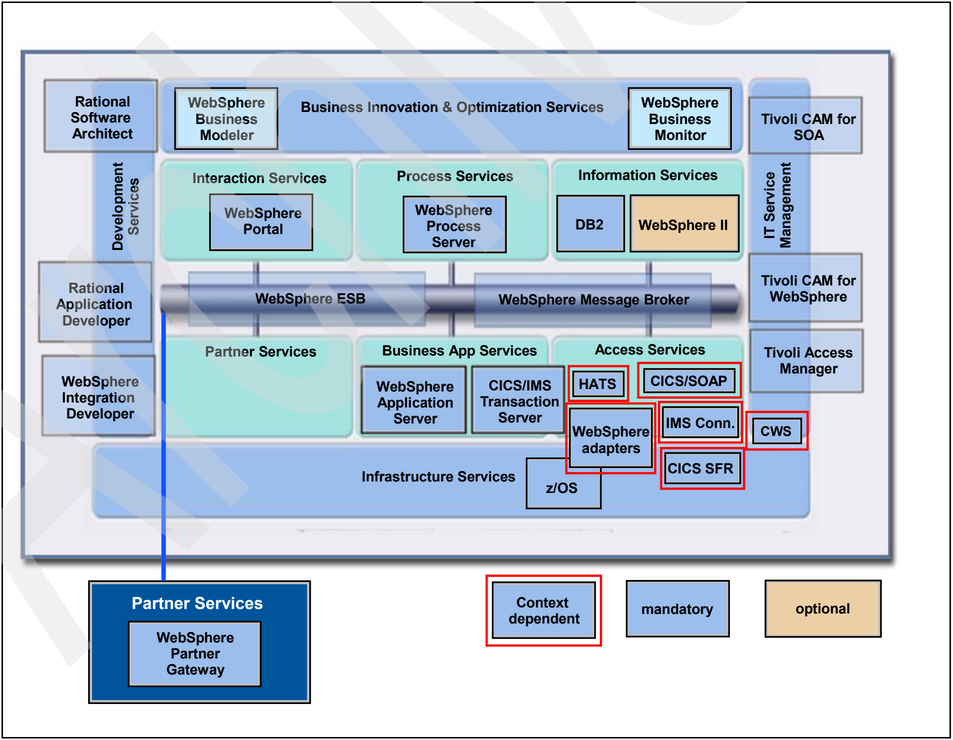


Figure 2-9 Mandatory and optional IBM products for process integration

Table 2-5 on page 52 lists the characteristics of the SOA implementation option process integration.

Table 2-5 Characteristics of SOA implementation option 3 - process integration

Implementation Option 3	**Characteristic**
Name	Process integration
When to implement	► Need to completely fulfill SOA criteria ► Have a high number of different connectivity requirements ► Need high reusability of services ► Need to execute a fast move to SOA, simultaneously in the area of SOA-enablement and SOA infrastructure ► Need a fast implementation of mediations, transformation, routing ► Have all described scenarios in the enterprise, and want to migrate them fast to SOA ► Have already some applications that may be converted easily as services ► Need to integrate user interfaces and reach easily the services
Infrastructure Services	Provided by z/OS (mandatory)
Deployment services	WebSphere Integration Developer (mandatory) on top of the tools mentioned for SOA implementation options 1 and 2
IT Services Management Services	Tivoli family (initially optional, to be installed when there are a number of services in place)
Business Innovation and Optimization Services	WebSphere Business Modeler (initially optional), WebSphere Business Monitor (as soon as the business requires it)
Interaction Services	WebSphere Portal (mandatory)
Process Services	WebSphere Process Server (initially optional, to be installed when process flows are necessary)
Information Services	DB2, IMS DB, WebSphere Information Integrator (as required in the context of the enterprise)

Implementation Option 3	Characteristic
Partner Services	WebSphere Partner Gateway (on distributed, if the context requires it)
Business Application Services	WebSphere Application Server (mandatory), CICS Transaction Server, IMS Transaction Manager (as required by the context)
Access Services	WebSphere Adapters (as required by the context), HATS, CICS Web Services support (context-dependent), WebSphere IICF (context dependent)
ESB	WebSphere ESB *or* WebSphere Message Broker

Table 2-6 shows the various fulfillment degrees of SOA criteria, for the applications integrated as processes (means "what we get by implementing this option").

Table 2-6 SOA criteria fulfilled in SOA implementation option 3 - process integration

SOA criteria	Have we reached this?
Modeling, constructing, deployment	*Yes*, necessary tools are in place
Management of services	*Yes* (Tivoli management tools in place)
Loosely coupled services	*Full* (both ESB products are in place)
Reusable services	*Yes*
Composable services (processes)	*Yes*, modeler and runtime for process server are in place
Location transparency	*Yes* (for all that use one of the ESB products)
Transport neutrality	*Yes* (for all that use one of the ESB products)
Legacy applications as coarse-grained service	*Yes*
Insight into business services	*Yes* (Tivoli management products are in place)

2.8.4 Conclusion

The implementation options discussed in this chapter indicate how progress can be made in SOA enablement by adding products or solutions to infrastructure. We have also seen that in existing IT environments SOA should be implemented in steps and according to budget and time constraints. Avoid using a “big bang” approach.

3

Starting scenarios

In this chapter we describe possible scenarios that are used as starting points for our discussions about how to SOA-enable an IT landscape. Each starting scenario covers one or more variations, and is described using certain characteristics. The starting scenarios are: 3270 application; multichannel; batch; data integration; and homegrown SOA.

In this IBM Redbook, we do not cover the reasons *why* to move from a starting scenario to an SOA; we consider that these decisions are already made. Instead, we focus on possible ways *how* you can SOA-enable the different scenarios.

We use the IBM SOA reference architecture to illustrate where the different building blocks and characteristics of a scenario fit into the overall solution. The IBM SOA reference architecture is described in 2.4, “IBM SOA reference architecture” on page 19.

3.1 Overview

We map the starting scenarios to the IBM SOA reference architecture in order to identify what is missing in the current scenario, and to therefore be better able to define what is needed when it comes to migrating the starting scenario towards an SOA. Note, however, that highlighting and commenting on an IBM SOA reference architecture building block does not necessarily mean that the scenario is SOA-enabled.

The main starting scenarios used in this chapter are:

- 3270 application - in 3.2, "Starting scenario - 3270 application" on page 56
- Multichannel - in 3.3, "Starting scenario - multichannel" on page 64
- Batch - in 3.4, "Starting scenario - batch" on page 73
- Data integration - in 3.5, "Starting scenario - data access and integration" on page 80
- Homegrown SOA - in 3.6, "Starting scenario - homegrown SOA" on page 89

Within each scenario, some variations may exist.

Note: It is very likely that an IT landscape on z/OS contains a combination of these starting scenarios. In such cases, different transition approaches and different solution techniques may be required for each identified scenario and its associated applications and IT infrastructure.

3.2 Starting scenario - 3270 application

The 3270 scenario is a common scenario. It consists of a 3270 terminal connected to a host application that runs transactions in CICS or IMS. Data resides in DB2, a IMS DL/I database, or a VSAM file.

Figure 3-1 on page 57 illustrates the 3270 starting point scenario.

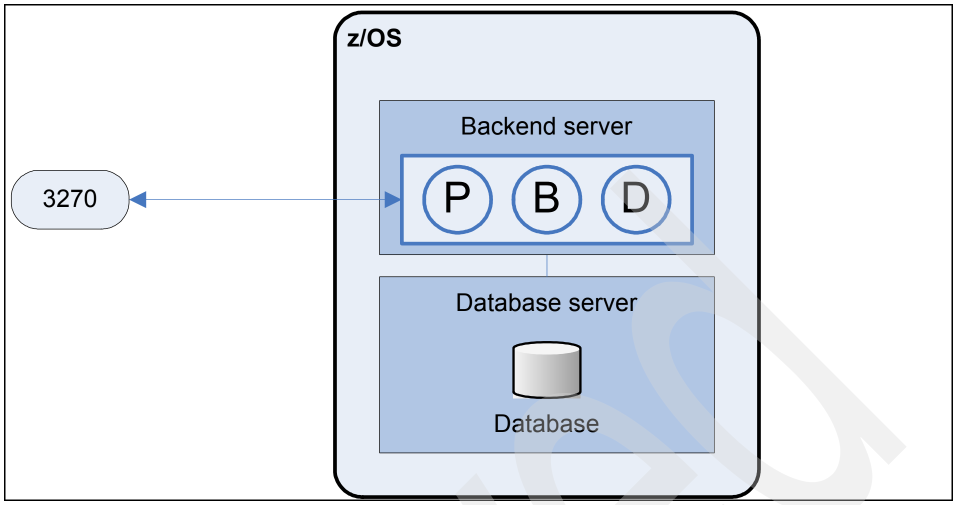


Figure 3-1 Conceptual overview of the 3270 starting point scenario

Note: In the figures in this chapter, presentation logic is represented by the circle with a letter P. The business logic is represented by the circle with a letter S, and the data access logic by the circle with a letter D.

Technical functions are represented by the circle with a letter T.

3.2.1 A typical 3270 application

In many enterprises, a 3270 application has evolved over years. The application may have been developed during the 1970s or 1980s, and there may be different coding standards and techniques used, resulting in a code that is complex to maintain.

Often the application is divided into a presentation layer and a business layer, but separation between those layers might not always be strictly implemented, as illustrated in Figure 3-2 on page 58. Common technical functions are used for DB access.

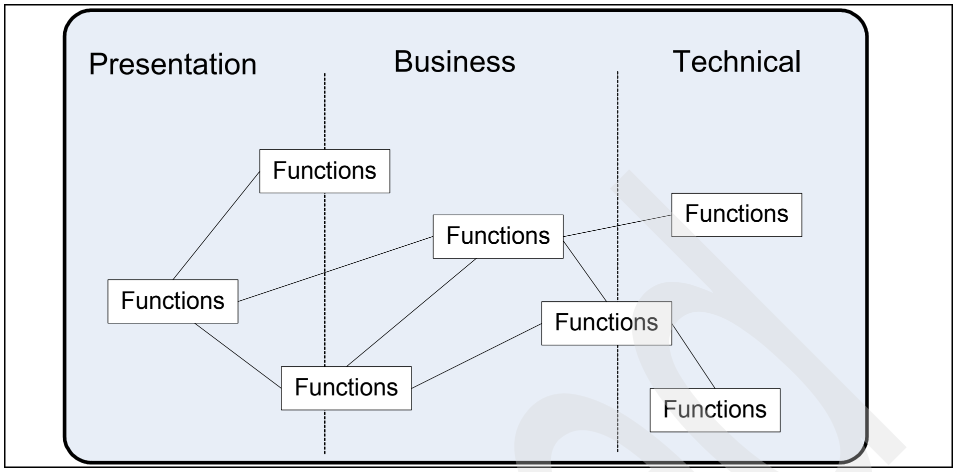


Figure 3-2 Example of separation between business, application, and technical logic in a 3270 application

3.2.2 3270 application variations

In this section we demonstrate two technology variations of the 3270 scenario:

- One variation uses a CICS 3270 application as a starting point, as shown in Figure 3-3.

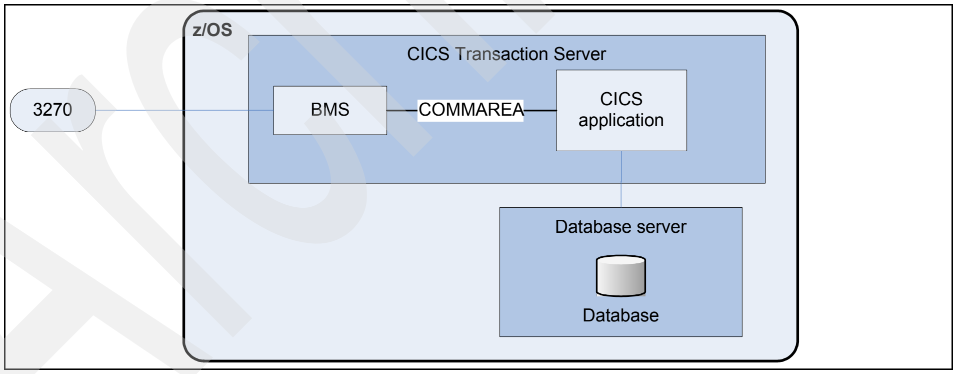


Figure 3-3 Variation showing a logical view of a 3270 CICS application

In this variation, the CICS application is structured using Basic Mapping Support (BMS) for the presentation logic, and using the CICS COMMAREA for communication between the components. This results in distinct layers between the presentation logic and business logic.

- Another variation uses a 3270 IMS application as starting point, as shown in Figure 3-4.

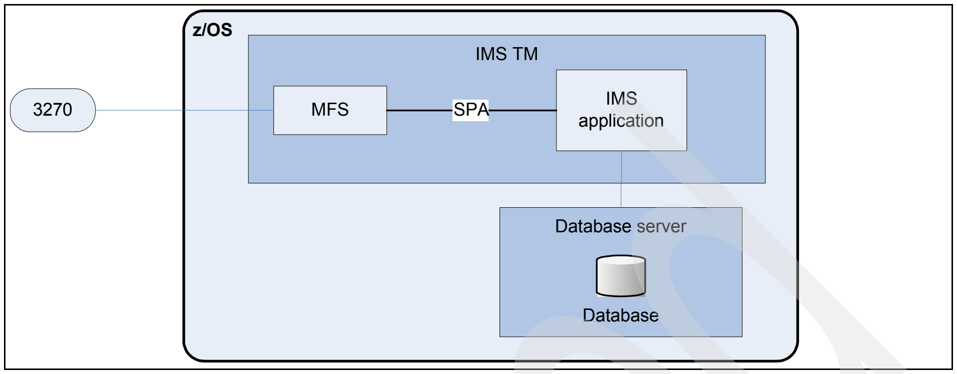


Figure 3-4 Variation showing a logical view of a 3270 IMS application

As in the CICS variation, this application is layered, but uses IMS techniques. Message Format Service (MFS) is used as the screen mapper, and Scratch Pad Area (SPA) is used for communication. This variation also has a clear layering between the presentation logic and business logic.

These two variations look very similar when illustrated using this notation. But when it comes to the migration scenarios, there are many different technology and product options to consider.

Of course, there are other areas to consider in addition to the user interface and the communication mechanism used within a specific transaction manager. An important area is the data model. If you want to SOA-enable one 3270 (silo)-based application, you have one data model to handle. Multiple 3270s (silos) will bring more data models, with possible overlapping terms and entities. So this is a complex area in itself and we cover data implications separately in 3.5, “Starting scenario - data access and integration” on page 80.

3.2.3 3270 application characteristics

It is interesting to note that in each application, old or new, we try to address the same things. For example, we address presentation and data access. But the other types of service that we have defined in the IBM SOA reference architecture may already be present in traditional applications, such as 3270 applications.

Figure 3-5 on page 60 shows how the characteristics of a 3270 application related to the IBM SOA reference architecture.

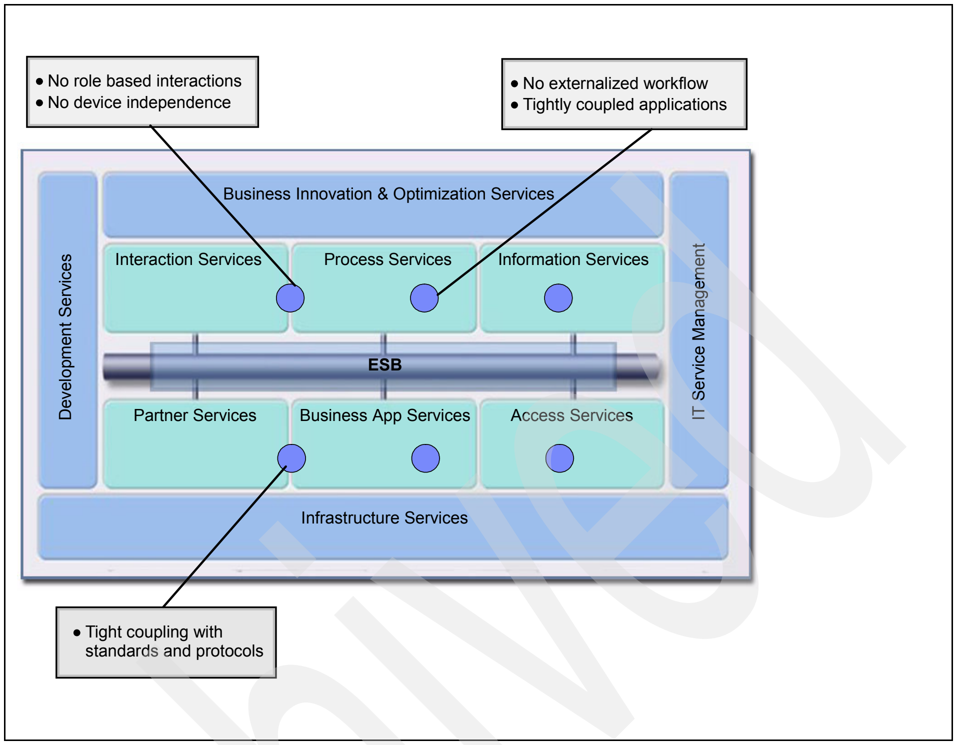


Figure 3-5 3270 scenario fit into the IBM SOA reference architecture

Referring to Figure 3-5, the characteristics of the 3270 application are:

- Presentation logic is implemented in CICS or IMS.
- Business logic layer is implemented in CICS or IMS as well.
- Data resides in DB2, in an IMS DL/I database, or in VSAM files.
- Integration with external systems is based on either native techniques (such as APPC or TCP/IP), or WebSphere MQ.
- Most commonly used languages are COBOL, PL/I, C, C++, and in some cases even Assembler. The programs may already be written in the Java language.
- There is no support for device independence. A 3270 application targets a 3270 device.
- The navigation flow for the dialogues is kept and implemented within of the application. The dialogues are tightly coupled with each other, and there is most probably not an external tool for coordinating the (screen) flow. The same is true for the *mediation*, which is hand-coded.

Interaction Services

There are different ways for a user to access a 3270 application. Usually, it is done from a terminal window, but there may be a layer in between, for example using:

- Host Access Transformation Services (HATS) or Host On Demand (HOD).
- A "fat client" connecting to IMS using Open Transaction Manager Access (OTMA) and using IMS Connect.
- A "fat client" connecting to CICS using the CICS Transaction Gateway (CICS TG)[1] or using CICS Web Support (CWS).

Some characteristics in the IBM SOA reference architecture that are usually not supported by a 3270 application are:

- Role-based interactions, where the application is adjusting according to a specific role
- Device independence, where the same business logic can be invoked from different "channels"

Process services

Process Services is a key element in an SOA, and it implies that there is a "point of control" keeping track of the flow and dependencies between the various service components in that flow. For a more comprehensive overview of Process Services, refer to 2.4.5, "Process Services" on page 24.

We can generally say that there are no Process Services out of the box in a 3270 application environment, but some 3270 application environments may have included hand-coded Process Services to achieve certain workflow requirements.

What can be done quite easily in a 3270 application environment running in CICS or IMS is to keep a central point of control for the screen flow. However, screen flow is not the same as workflow—and is definitely not the same as Process Services. In contrast with Process Services as part of an SOA, the dialogue flow within a traditional 3270 application is maintained by the transaction manager in which the application is running, and is usually controlled from menus. There is no coordination done of the overall workflow, and there is a high dependency between the different dialogs in the application.

A workflow in an SOA may contain manual tasks as well as automated steps. Neither form of workflow is supported by a 3270 application environment, but as noted previously, much can be achieved by hand-coding.

[1] CICS TG only supports 3270 interfaces when using the External Call Interface (ECI) interface. This interface is only supported when CICS TG runs on a distributed UNIX® or Windows® platform.

Business services in an SOA that are choreographed by, for example, BPEL, are relatively coarse-grained. 3270 programs usually represent a low level of granularity. There will probably not be a one-to-one mapping between a 3270 program and a service in an SOA.

Information Services

A 3270 application usually relies on DB2, IMS DL/I, or VSAM as data sources. Access to data according to the IBM SOA reference architecture is done through Access Services as described in “Access Services” on page 63.

Enterprise Service Bus

On a high level, the role of the Enterprise Service Bus (ESB) is to connect loosely coupled services. As discussed in 2.4.3, “The Enterprise Service Bus (ESB)” on page 22, it includes the following fundamental services:

- Transport services
- Event services
- Mediation services

A 3270 application in itself is usually not enabled for an ESB, but there is some functionality provided by the infrastructure, which could be considered to have “flavors” of an ESB. This is the case, for example, when:

- The transport is provided by WebSphere MQ or “in-house” developed middleware
- WebSphere Message Broker (WMB) is used for integration
- There is some level of event handling and mediation implemented in the application logic itself

Partner Services

There are many standards and protocols for interaction with partners, such as:

- WebSphere MQ
- Sockets
- SNA/APPC
- SWIFT
- EDI

As with Interaction Services, the IBM SOA reference architecture states that there should be a loose coupling between the business logic and the Partner Services logic, preferably through an ESB. This is probably not the case in a 3270 application scenario.

Business Application Services

According to the IBM SOA reference architecture, the components found in this building block are usually created with a component model, or service perspective, in mind. Examples of implementations are J2EE and possibly .Net. Therefore, a typical 3270 application would not reside here.

Access Services

For our 3270 application scenario, Access Services would need to provide support for the following environments:

- CICS Transaction Server
- IMS Transaction Manager
- WebSphere MQ
- DB2
- IMS Database Manager
- VSAM

Infrastructure Services

The infrastructure in this scenario is completely based on z/OS and the qualities that this environment provides.

Development Services

Development of a 3270 application usually includes screen design tools and templates for code structure (for example, database access).

The development environment does not necessarily need to be based on a GUI, but in most cases an Integrated Development Environment (IDE) provides more productivity and better time to market. An IDE is typically used on a Windows or Linux workstation, and the applications are deployed onto the z/OS environment.

New development is most likely done in COBOL or C/C++, but Java is picking up, as well.

Depending on the application architecture and the programming style, there may not be a clear separation of presentation and business logic in a typical 3270 application.

IT Services Management Services

As with Infrastructure Services, described in “Infrastructure Services” on page 63, z/OS provides all the functionality for security, automation, provisioning and so on. Additionally, IBM Tivoli or other third-party tools may be in use.

3.2.4 Challenges when moving to an SOA

In an SOA, reusability and “separation of concerns” are very important aspects. To gain full benefit from an SOA, most 3270 applications will need to be decomposed and refactored to achieve the right level of service granularity and separation of concerns, which will mean at a minimum loose coupling between the user interface logic and the business logic.

The code of existing 3270 applications may be difficult to decompose. For example, there are probably identical code blocks across different applications doing nearly the same tasks, possibly acting on the same data.

Business rules are embedded in the code. Changes to business rules imply significant effort will be needed to analyze, design, and implement such changes in the code. And finally, it is not uncommon to have many different programming styles, because 3270 applications have developed from the early 1970s until now.

3.3 Starting scenario - multichannel

By *multichannel*, we mean an architecture that is able to support various channels. A channel is associated to the usage of a specific *device*. As illustrated in Figure 3-6 on page 65, examples of channels are ATM, fat client, browser, PDA, smart phone, and so on. All these different channels connect to the same infrastructure and make use of the same business and data access logic.

Therefore, the multichannel scenario is difficult to describe as one scenario. It is rather a combination of several different integration and access styles.

As a starting point, the multichannel scenario is defined with the following attributes:

- There is support for different channels (for example, browser via HTTP/HTTPS, fat client via RMI/IIOP, ATM via TCP/IP, and so on).
- There is usually a mid-tier, where the different channels converge. Usually this mid-tier hosts components that wrap business and technical functionality.
- Back-end services and transactions are callable through a standardized API or through a service interface.
- Client/server concepts are used, meaning there is a fat client, with both business and presentation logic, and sometimes even with direct data access from the client.

But there are also other characteristics that could make up a multichannel application:

- Messaging-centric systems (for example, native WebSphere MQ-enabled IMS and CICS transactions)
- “Headless” transactions without a service interface
- Web and J2EE applications developed as silos, or as reusable, component-based application architectures (non-SOA)
- APPC/CPI-C applications

Figure 3-6 shows the typical multichannel architecture, in which all channels communicate with a common layer implemented in a J2EE application server. The common layer then accesses all sorts of back-end transaction and database servers for business logic and data access logic. The J2EE application server may also perform business and data access logic itself.

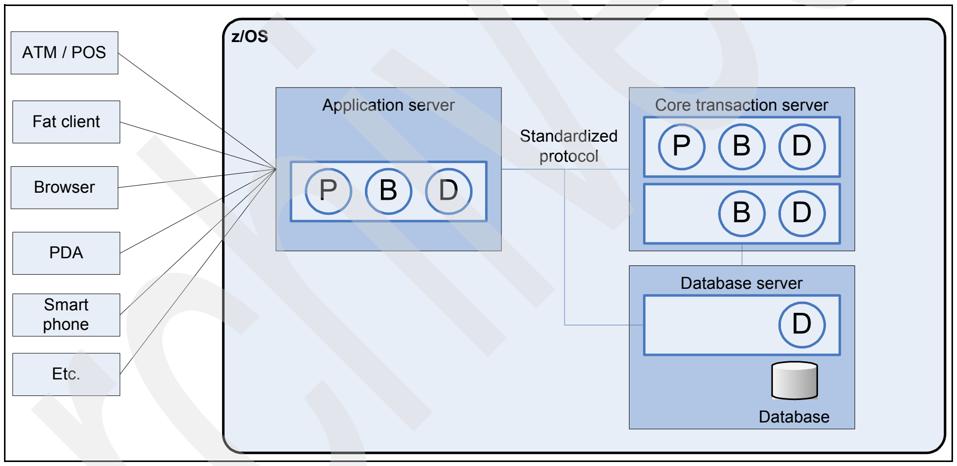


Figure 3-6 Conceptual overview of the multichannel starting scenario

The presentation logic for the different channels is handled by the components in the application server. The core transaction functions are exposed through *proxy* components in the application server. This proxy functionality will most probably be found in the business layer of the application server, as illustrated in Figure 3-7 on page 66.

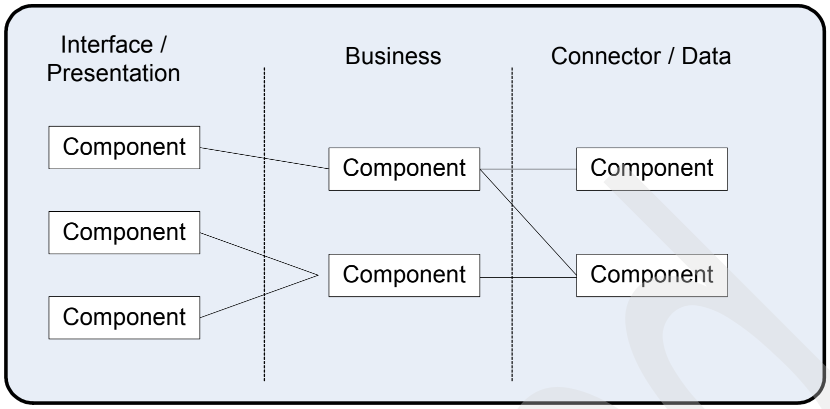


Figure 3-7 Logical structure of the component layer in the application server

We assume that the core transaction server logic has been divided in business and data access functions, as illustrated in Figure 3-8.

The core business functionality is present in the back-end transaction server. It may be accessed through, for example, connectors or messaging middleware like WebSphere MQ.

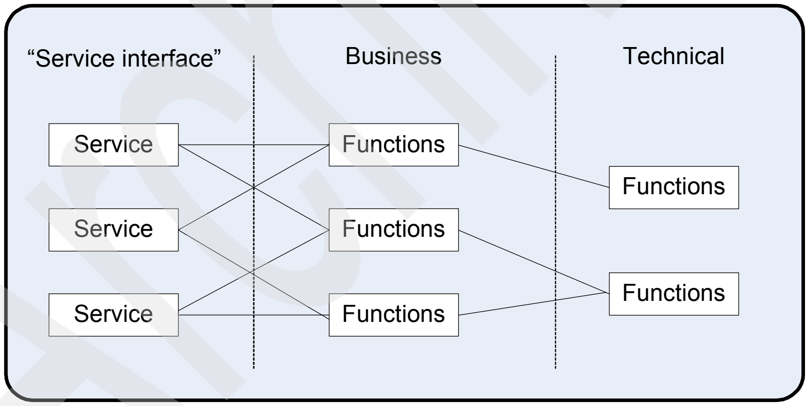


Figure 3-8 Logical structure of the core functions in the transaction server layer

Note the following points:

- Data in this scenario resides, as usual, in DB2, DL/I databases, or VSAM files.
- Integration with external systems is based on WebSphere MQ, APPC or TCP/IP or other protocols over TCP/IP, such as HTTP.

- The most commonly used languages in the transaction server are COBOL, PL/I, C and even some Assembler. The application server typically uses Java, but COBOL, PL/1 and C /C++ may also be present, depending on the server technology used.
- There is a certain degree of loose coupling, especially if WebSphere MQ is used.
- A large degree of encapsulation is implemented and reuse is provided through published interfaces. However, different services may have been implemented for similar or even identical functions.
- The Quality of Service (QoS) is at a high level.

3.3.1 Multichannel variations

In the multichannel scenario, the application server may be a J2EE server like WebSphere Application Server, or the middle tier may be implemented in a transaction server like CICS or IMS (although it will be more difficult to support multiple channels).

In either case, the integration with the core business transactions may go through messaging middleware like WebSphere MQ. If the application server is a WebSphere Application Server, the core back-end transactions may be accessed through connectors.

If the application server is a CICS or IMS transaction server, it may also be accessed by direct, synchronously calling functions.

Different technologies can be exploited for dynamic workload balancing. In the front-end application server, dispatchers, sprayers and eventually Workload Manager (WLM) can be used.

A proprietary service directory may be implemented, providing some level of abstraction and indirection of the function invocations. Location transparency may also be provided, and reuse is enforced by publishing of functions and their interfaces.

If fat clients are used, all of the presentation logic and some of the business logic exists on the client. It is unlikely that you will be able to reuse any of these code entities directly.

3.3.2 Multichannel characteristics

The architecture in the multichannel scenario assumes that there has been some degree of standardization and structuring around common services and communication protocols.

However, the infrastructure components are still tightly coupled. Usually, there are different technologies and standards involved. There are also, most probably, multiple implementations of similar core functions. Figure 3-9 illustrates a multichannel starting scenario that fits into the SOA reference architecture.

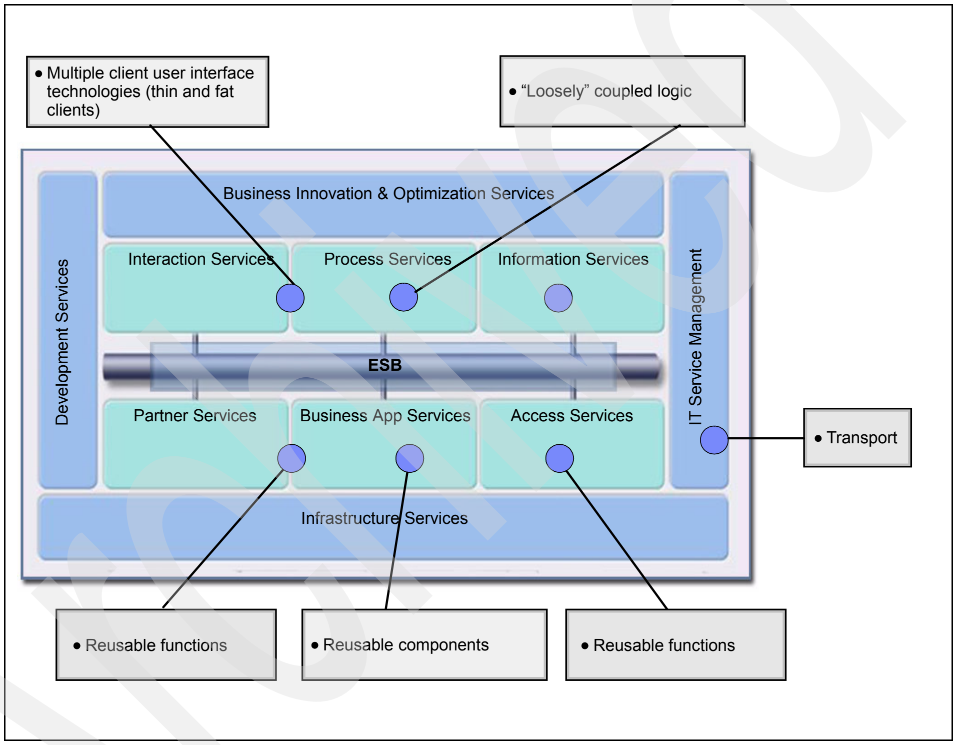


Figure 3-9 Multichannel starting scenario fit into the SOA reference architecture

As with the 3270 application starting scenario, we now discuss characteristics for the multichannel starting scenario, in the context of the IBM SOA reference architecture.

Interaction Services

Significant for the Interaction Service in the multichannel starting scenario is that there are multiple client user interface technologies involved. There may also be multiple communication protocols that need to be supported. Thus we have named this starting scenario “multichannel”. Figure 3-10 displays multichannel starting scenario considerations.

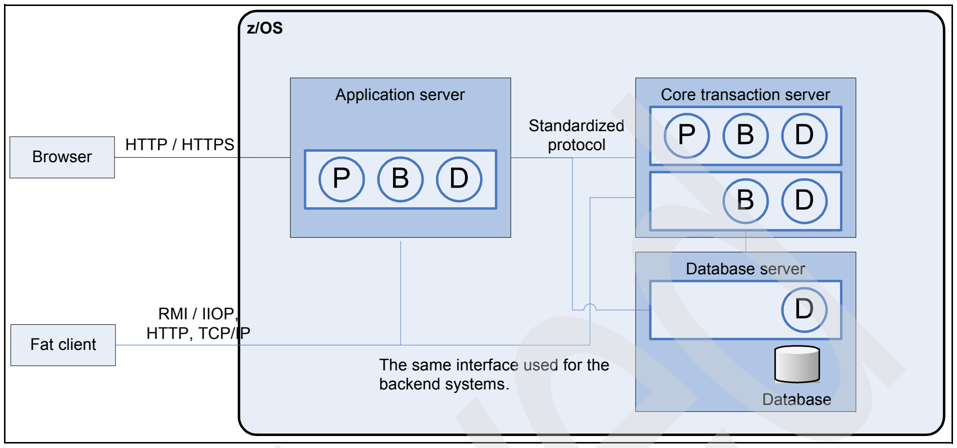


Figure 3-10 Multichannel starting scenario considerations

Client user interface technologies

In the case of a Web browser-based solution, there is no logic executing on the actual client, except perhaps for some JavaScript™ or a Java applet. The navigation and the dialogs are created on the application server tier, for example using a JSP™ or servlet. The entire flow, and the Model/View/Controller pattern is in this case implemented and controlled from the application server tier.

In the case of a fat client, the workflow and dialogues are implemented in the client tier. The client handles all the dialog flows, and it knows which programs to call. Those interfaces may be provided by the application server, or perhaps even directly from the core transaction server or the database server.

Communication protocols

As illustrated in Figure 3-10, the protocol used for the thin (browser) client is HTTP/HTTPS. For the fat client, there are several options (for example, HTTP, RMI/IIOP, TCP/IP or WebSphere MQ).

There may be some level of role-based interaction in this scenario. In the thin client case, access to the server be provided by a portal running inside the application server tier. In the fat client case, it could be implemented by a framework or technology in the application itself. The drawback of implementing role-based behavior in both thin clients and fat clients using this model is that there will be very limited reusability between the two, and the maintenance cost is high.

There may also be some level of device independence implemented in the application server tier. For example, it may not require significant effort to adjust to a PDA or other small devices, as long as they use a standard protocol, such as HTTP.

Process Services

Although there may be a fairly loose coupling between the presentation logic and the business logic, the application flow is still not coordinated by external tooling in the area of workflow or process choreography. It is contained within the application, in most cases making use of a framework.

Information Services

In our scenario, there is no direct access to operational data, and the application usually relies on DB2, IMS DL/I or VSAM as data source. Access to data is according to the IBM SOA reference architecture done through access services as described in “Access Services” on page 63.

Enterprise Service Bus

In this scenario, there may be some level of ESB functionality, and that is probably in the area of transport services. We use a standardized middleware for accessing the functions provided by the core applications.

Although it may be implemented in different places, there may also be some kind of mediation going on in the application server tier, or in the fat client.

There may be some level of event handling implemented in the application logic.

Partner Services

There are many standards and protocols for interaction with partners. In this scenario, there might be some reusable functions evolving. For example:

- WebSphere MQ
- Sockets
- SNA/APPC
- SWIFT
- EDI

As with interaction services, the IBM SOA reference architecture states that there is a loose coupling between the business logic and the partner services logic, preferably through an ESB.

In this scenario, it may be that the functions provided by the application server tier act as an entry point to services. But there are still in-house developed solutions, which are not serviced or callable by an external standardized tool.

Business Application Services

This scenario is using functions in the Business Application Services building block. For the thin client, the user interface, navigation and business logic reside in the application server, and is most likely implemented using J2EE, exposing reusable components.

Access Services

Access Services are heavily used for accessing the back-end core functions. Reusable functions are created in the core back-end systems. Support is needed for accessing:

- WebSphere MQ
- CICS Transaction Server
- IMS Transaction Manager
- Proprietary middleware may be implemented

The back-end core functions need support to access data in:

- DB2
- IMS DL/I
- VSAM

Infrastructure Services

The infrastructure in this scenario is mostly based on z/OS and the qualities that this environment provides.

Because there is additional support for different clients in this scenario, there are also requirements for other infrastructure services (for example, management of Windows, Linux and PDA clients). So there are parts of the infrastructure where the z/OS level of QoS cannot be guaranteed. This is especially true with a fat client scenario.

Development Services

This scenario introduces a heterogeneous development environment. Development in this kind of scenario spans several technologies, standards and languages, such as:

- Core transaction server

  On the technical level, support is needed to modify the back-end transactions so they can provide standardized access through the chosen middleware interface.

  Some kind of a dictionary is required to keep definitions and requirements of the services provided by the transaction server.

Development is most likely done in COBOL, C/C++, PL/I or Assembler, and in some cases, Java.

- Application server

  A development environment for J2EE is required in order to build the components for the application server tier.

  The components that are deployed to this tier support presentation logic as well as some business logic. Support for calling the back-end core functions is provided through APIs and frameworks.

- Fat client

  A development environment is required to support the specific platform of the fat client. Fat clients may be deployed on, for example, Windows, Linux, or PDAs.

IT Services Management Services

As described in “Infrastructure Services” on page 63, z/OS provides the functionality for security, automation, provisioning and so on. There are also client platforms and various communication protocols to manage. Support is required for more environments than simply z/OS.

3.3.3 Challenges when moving to an SOA

In this scenario there has already been implemented some level of separation and decomposition of the presentation and business logic. But usually there are overlapping functions deployed on different platforms.

Different standards and technologies are used, which could make it hard to reuse functionality.

There may also be different levels of granularity on the different service interfaces, because the services are tailored for a specific channel.

Key questions to consider when migrating to an SOA are:

- Keeping QoS at a high level.
- Reusing core services and data. Can the applications be reused, or do they need to be rewritten?
- Enablement of open standards. Which standards to use?
- Client technologies. Are Web-based solutions based on Portal, Ajax, or rich client good enough? Or do the user interactions require the characteristics of a fat client.
- z/OS integration with distributed technologies (.Net).

3.4 Starting scenario - batch

A typical scenario probably present in all enterprises is the batch scenario. Figure 3-11 gives an illustration.

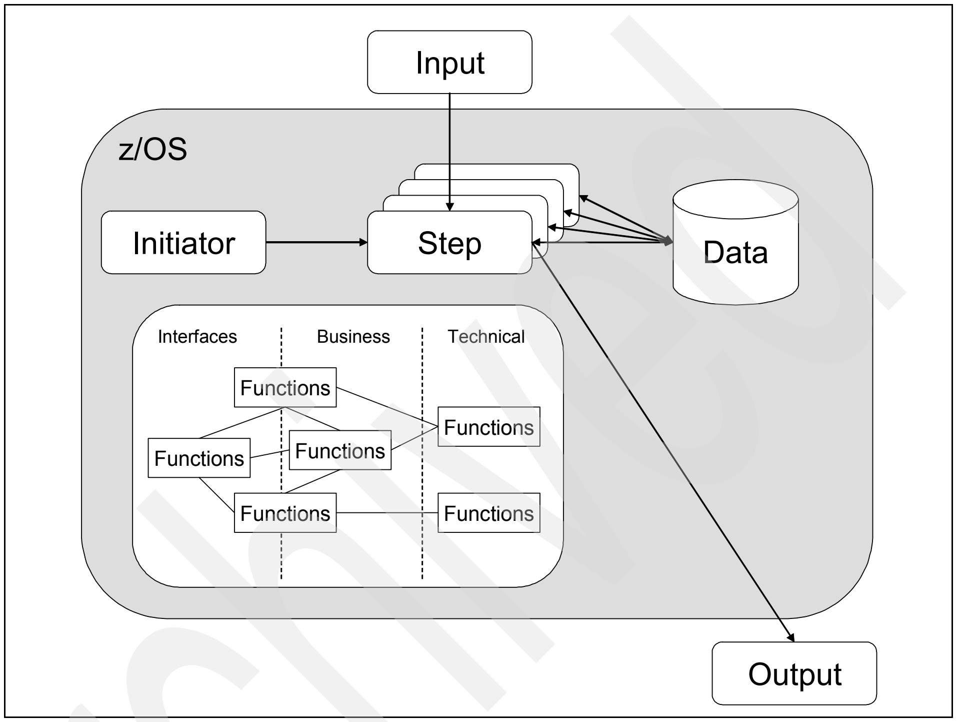


Figure 3-11 Logical overview of the batch starting scenario

The batch job is initiated inside z/OS, triggered in the following ways:

- From a scheduling mechanism or tool, such as Tivoli Workload Scheduler (TWS) for z/OS (formerly OPC)
- Directly from TSO
- Via the internal reader in a transaction server such as CICS or IMS
- By WebSphere MQ (WMQ) or WebSphere Message Broker (WMB)

A typical batch job consists of one or more steps, organized by means of the JCL.

The application logic in a program step may include a multitude of program modules. The programs implement a mix of interface logic, business logic, data access logic and technical logic (for example, logging).

Each individual step may receive input from different sources:

- JCL parameters
- SYSIN data sets
- Temporary data sets from earlier steps
- Persistent data sources like databases, keyed data sets or Generation Data Groups (GDG) data sets
- WebSphere MQ queues from processes inside the enterprise or from a business partner

Steps may produce output to different medias and locations:

- Return codes used to manage the subsequent flow of the job, information to the system management infrastructure and possibly involving the operations staff.
- Temporary data sets to subsequent steps. May be used for pure temporary information, subsequent printing or perhaps EDI or FTP processing and so on.
- Persistent data sources like databases, keyed datasets or GDG data sets
- WebSphere MQ queues internally located, or occurring at a business partner site
- The printing subsystem via SYSPRINT

The programming language is typically a third generation language, but it could be a fourth generation language.

In the batch scenario, the Quality of Service (QoS) is at a very high level. High availability and continuous operations may be achieved by running several LPARs in a Parallel Sysplex or a Geographically Dispersed Parallel Sysplex™ (GDPS®) with dynamic workload balancing provided by tools such as WLM. And scalability may be provided simply by adding more capacity. In many cases, very large and complex batch environments run unattended or with a minimum of support staff onsite.

The application flow is characterized by:

- High volumes of data to be processed
- High performance needed to process the high volumes of data

The jobs usually run unattended, and are scheduled automatically. Recovery from error conditions is usually happening automatically, as well. Exceptions may require human intervention by an operator.

There may be several dependencies, for instance:

- Must run in batch service window due to dependencies on Online Transaction Processing (OLTP).
- Must run in a certain sequence with predecessors and successors.
- Dependencies on time, such as which time of the day or which day of the month.

3.4.1 Batch variations

Following are examples of variations of the application design:

- All logic is implemented in one job step, with or without a clear separation of different types of logic.
- Separation of types of logic has taken place and is implemented in separate job steps as well; for example, one step for interface logic, one step for data access, and so on.
- Separation of types of logic has taken place and is implemented in separate subroutines of one program.

3.4.2 Batch characteristics

We describe the characteristics of this scenario in the context of the IBM SOA reference architecture, and thinking about possible service enablement; see Figure 3-12 on page 76.

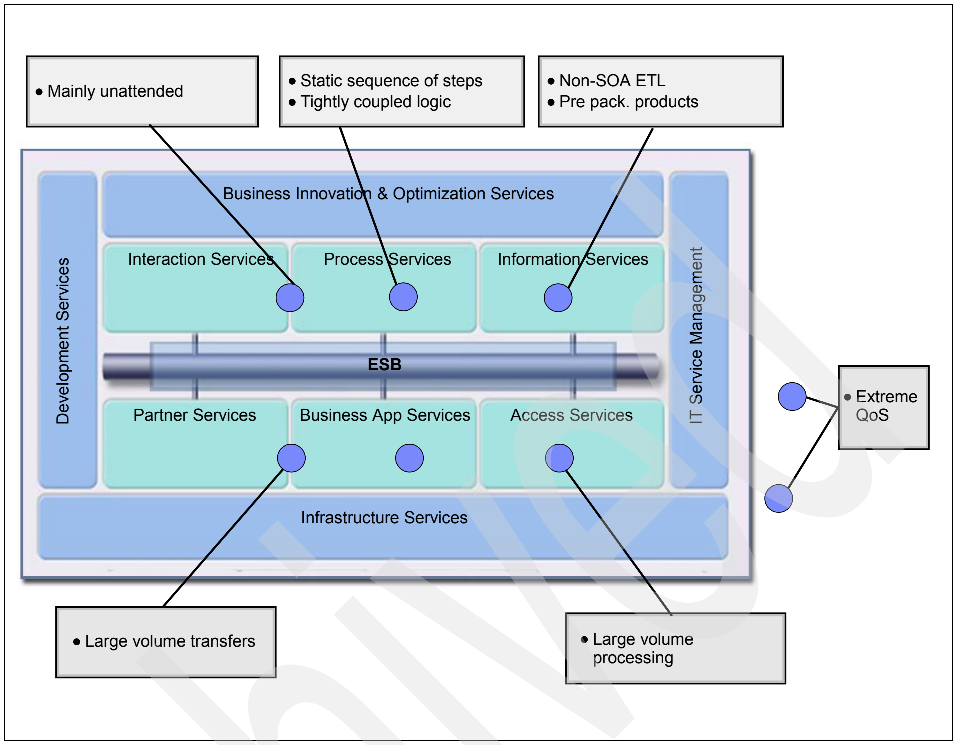


Figure 3-12 Batch scenario fit into the IBM SOA reference architecture

Interaction Services

Note the following points:

- Jobs are initiated by a scheduler, or manually. There is no user interface involved, from an application point of view.
- Operator intervention may be required, either for device mounting or handling of events and exceptions.
- Batch jobs may be triggered by messages entering a WMQ queue used for reception of data or maybe just for triggering.
- There may be some calendar or mail integration provided to inform business users of the progress and completion of the job.

Process Services

To some extent, there is a certain workflow within a batch environment. There are dependencies between jobs, and between steps in jobs. Jobs and job steps may occur conditionally, depending on the outcome of another job or job step.

Those dependencies are usually maintained, monitored, and executed from a job scheduler tool.

The flow of jobs and job steps is usually quite static and at the time of execution there is no human intervention, unless an exception takes place.

Information Services

Batch is an excellent environment for extracting, transforming, processing and loading the vast amounts of data present in the databases (for instance, for building and maintaining a data warehouse or creating daily business reports).

Enterprise Service Bus

Integration between components (programs executed in jobsteps) is typically taking place by means of data sets, such as GDG, VSAM, QSAM or sequential data sets. Also UNIX files are possible, as well as so-called “TEMP” data sets. Additionally, WebSphere MQ is a possibility within a batch environment, in which case programs in job steps read from or write to queues in WebSphere MQ.

In traditional batch environments, we do not see the full function ESB positioned for a modern state-of-the-art SOA, as discussed in 6.3, “Stage two - “service integration”” on page 227. Everything needed to transform data is done inside programs, and routing is typically done in a very static way.

A limited degree of location transparency for logic and data is present. Job initiation is managed by a scheduler. The steps and their interrelations are described by JCL and processed accordingly. The physical representation and location of data is typically determined by data and queue definitions, and only indirectly referenced from the program logic.

Partner Services

Data is interchanged with business partners through:

- WebSphere MQ
- EDI
- FTP
- And, possibly, proprietary protocols

Interchange is handled in large batches with multiple entities included, not as individual records or messages.

Business Application Services

There may be a very limited interaction with existing service-enabled functions.

Access Services

Access Services are provided by the data and database access methods:

- DB2 delivers transaction (2-phase commit) support and relational data structures which may have a relatively loose coupling to the program logic.
- IMS DL/1 also delivers transaction (2-phase commit) support, but the data structures are more tightly coupled to the program logic.
- VSAM file support - data structures are very tightly coupled to the program logic.
- QSAM datasets are used for transportation of temporary data between the job steps; as storage for persistent state data or parameters; or as a container for large batches of data to be archived or sent to printing.
- WMQ delivers asynchronous persistent and non-persistent messaging between steps or jobs.

With DB2 there may be a relatively strong data structure based on an application-, department-, or even enterprise-level data model.

With the other access methods, the data structure is not likely to be on a higher level than department, and in many cases, is just at an application level.

Infrastructure Services

Infrastructure Services are provided by:

- z/OS delivering high performance, accountability, auditability, system integrity, security and so on
- Parallel Sysplex or GDPS delivering high availability, continuous operations, scalability
- A scheduling tool such as Tivoli Workload Scheduler for z/OS
- Workload balancing through WLM
- Security management through RACF® or an equivalent SAF-based product
- System Automation

Development Services

Programming tools are used for direct coding, possibly with language-sensitive editors.

Programming languages typically include COBOL, PL/I, Assembler, C/C++ and REXX™, but Java is picking up here as well.

The programming components consist of source modules, load modules, listings and others. They may be managed by dictionaries or repositories along with other development components like data description and analysis documents, and supported by version control and change systems.

IT Services Management Services

IT Services Management Services are provided by Tivoli or other third party tools.

3.4.3 Challenges when moving to an SOA

Typically, millions of records are processed in a batch jobs. The approach is that you initiate one function at a time, processing all the records in one or a few logical loops with only one instance of the initial and termination logic. This is very efficient. If all functions including the initial and termination logic would be invoked for each data record, performance would decrease by orders of magnitude.

Also, many times operations on data are grouped and a set of operations can only be considered complete and successful if all individual operations have been complete and successful. Many times, batch output contains header and trailer records, which are needed for auditing purposes.

In many cases, job steps exist before and after a program to do sorting, grouping or aggregation of records, and creating totals for auditing at the same time. In that case, hardly any business logic is executed.

The volume itself is a challenge and requires extremely high performance and high throughput. May batch service windows “just fit” and there cannot be any delay in the jobs without jeopardizing the OLTP window.

Moving batch components into an SOA will be a challenge, but as we discuss in 5.4, “SOA implementation scenarios for batch” on page 185, there are ways to integrate batch into an SOA in a “light” manner. There are different points of view here.

Depending on the transition approach and the level of SOA maturity required, batch logic may need to be refactored to achieve the right level of granularity and thus reusability. Decomposition of batch logic may not be easy. There are probably a large number of nearly identical code blocks across different batch jobs doing nearly the same functions, possibly on the same data.

The jobs run smoothly with high performance and reliability. Any type of change will most probably decrease the Quality of Service to some extent.

In general, there is risk attached to making significant changes in the z/OS batch environment. Reliability and performance may be affected, especially if the changes are of a structural or architectural nature.

3.5 Starting scenario - data access and integration

We describe here the architectural scenarios representing *data access* (from batch and transaction-oriented systems) and those representing *data integration*.

When we speak about data integration, we mean the process by which the information (stored on multiple, disparate data assets across the enterprise, but representing, for different information systems, the same piece of information, for example a customer record) is presented to the applications in an unified, trusted way and is consistently updated.

The variations of the scenario show the ways most enterprises implement data integration today.

3.5.1 Data on z/OS

Most of the enterprises have a mixture of data, accessed by z/OS-based applications. We can categorize the data storage on z/OS as follows:

- Relational Database Management System (RDBMS), in most cases this is DB2.
- Non-relational database management system, which is usually IMS DL/1.
- Data sets, which are transactionally accessible using different file access methods (sequential, indexed, non-indexed, and so on); for example, VSAM.
- Sequential MVS™ data sets (partitioned, GDG).
- UNIX files.

In most cases, XML can be stored natively. DB2 and IMS support native XML data storage. Sequential MVS data sets and UNIX files can contain XML, too.

Each of these types of data storage has a specific access method. The usual way to get to this data is through:

- The support for data access delivered in the traditional transaction servers like CICS and IMS. CICS and IMS are highly integrated with DB2, IMS DL/1, and VSAM datastores.

- A Java-based application server (WebSphere). Java provides standard APIs for relational (SQL-based) database access by means of JavaDatabase Connectivity (JDBC™) and SQLJ and UNIX sequential file access by means of Java classes. IBM also provides specific frameworks to access sequential and VSAM data sets from Java. Refer to IBM Redbook J*ava Stand-alone Applications on z/OS Volume II*, SG24-7291, for more information about this topic.
- The batch support delivered by the operating system.
- Or, through the positioning of an additional integration layer (with different depths and functions, starting with an “integrator” and ending with a “data warehouse”).

3.5.2 Data access and integration variations

In the next sections we will discuss a number of variations of the data access and integration scenario:

- Direct data access in “Direct data access” on page 81
- Extract, Transform and Load (ETL) in “Batch ETL (file transfer)” on page 82 and “Messaging ETL” on page 83
- Data replication in “Data replication” on page 84
- Data integration and data warehouse in “Integrator/Data Warehouse” on page 85

Note: The data access scenario usually exists in combination with any of the other scenarios discussed in this IBM Redbook (3270 application, multichannel, batch or homegrown SOA).

The ETL, data replication and data integration scenarios might exist standalone on z/OS. This means that only the data and eventually the infrastructure and tooling for data extraction, replication and integration are located on z/OS, but all the applications using this data are located elsewhere. This would be the case when z/OS is only used as a “data server”.

Direct data access

The scenario of direct data access is used in most enterprises today; it is shown in Figure 3-13 on page 82. The characteristic of the scenario is that the data access logic is tightly embedded within the application (this means that the application has to know, and is dependent on, the structure of the data.)

So changes in the data structure and representation (due to application requirements to change the data model) are very difficult to implement and maintain. The access method is determined by a combination of the programming language and the type of data storage being used.

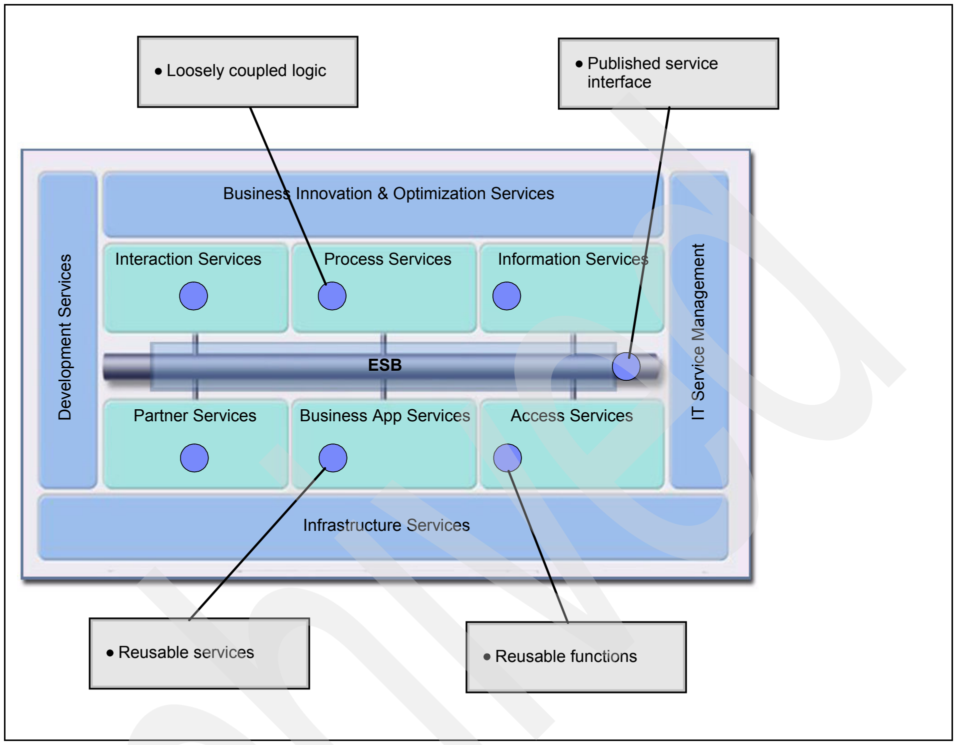


Figure 3-13 Direct access to data

Batch ETL (file transfer)

The very well-known scenario of batch ETL, or Extract Transform and Load, is used in most enterprises today. It was necessary to implement such an approach because the newer application requirements and technology changes can collide with existing legacy applications.

Since most applications are “tightly coupled” with data, ETL was the technology that allowed the applications, with no changes on the application side, to have the “consistent” view of the enterprise data at least at one point, namely at the beginning of each business day (meaning after the nightly batch runs that synchronizes all data assets). The scenario is shown in Figure 3-14 on page 83.

As you can see, in this case the task of transporting the information updates, storing the information in the correct format, and achieving consistency of the data is relegated to the integration layer that functions totally separated from the application. In fact, the integration layer usually works only when the applications do not access the data.

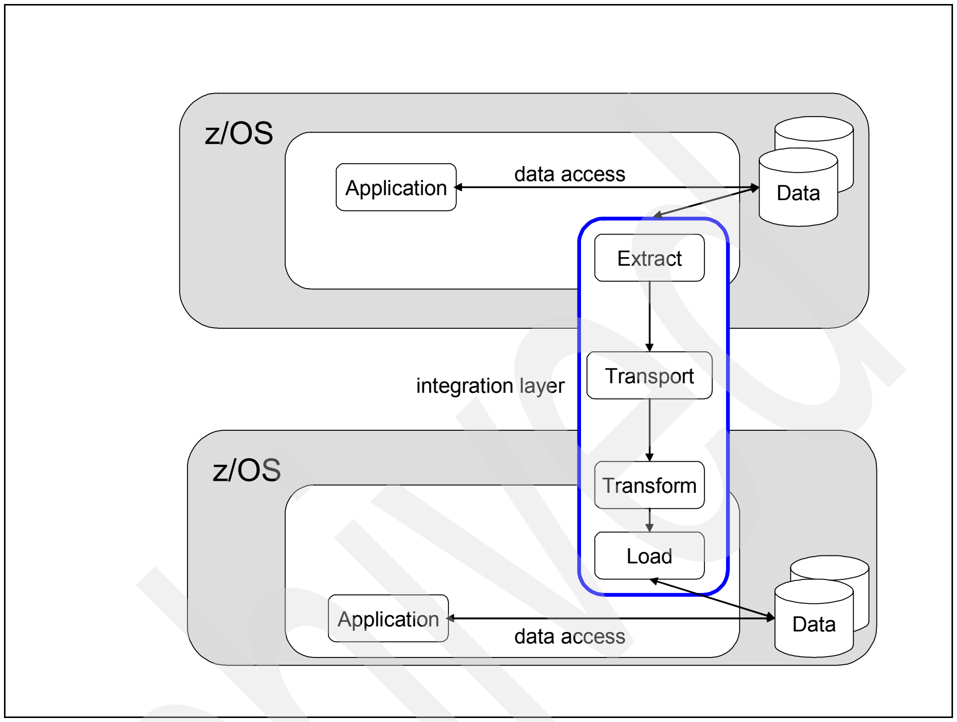


Figure 3-14 Integration through batch-oriented ETL

Messaging ETL

A variation of the ETL scenario exists when applications send the “updated view” of the information by means of a messaging infrastructure (for example, WebSphere MQ). We name this scenario *messaging ETL*, and it is illustrated in Figure 3-15 on page 84.

In this case the integration layer is used by the applications to transport the “updated information”, but the task of transforming and updating the information is now done by the applications themselves.

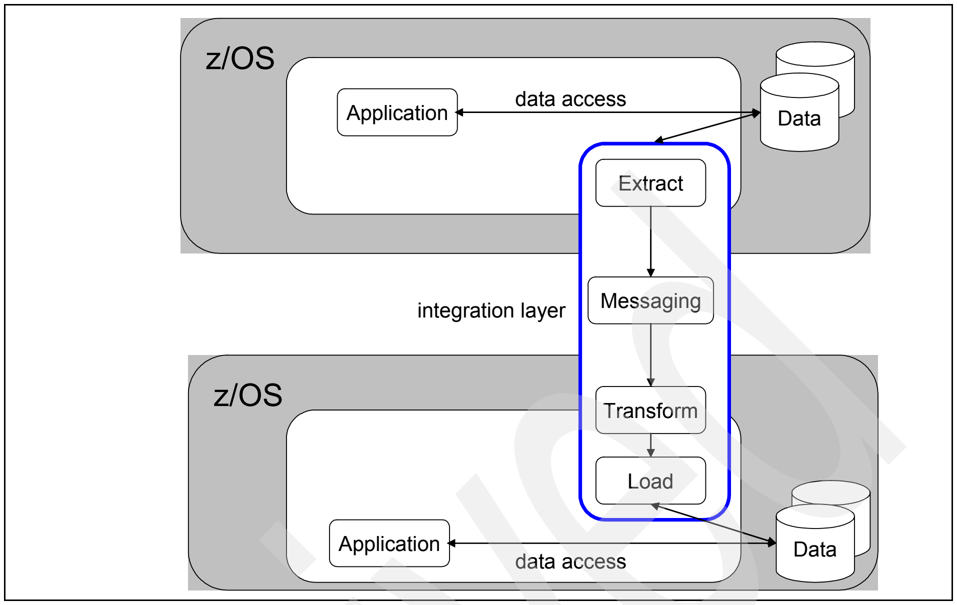


Figure 3-15 Integration through messaging ETL

Data replication

This *data replication* scenario can be found when the enterprises use data propagation technologies (for example, DB2 data propagator, but also technologies for establishing consistency for VSAM data sets). Figure 3-16 on page 85 illustrates this scenario.

This technology allows near real-time consistency of the data.

As you can see, in this case the task of transporting the information updates, storing the information in the correct format, and achieving consistency of the data is relegated to the integration layer that functions totally separated from the application.

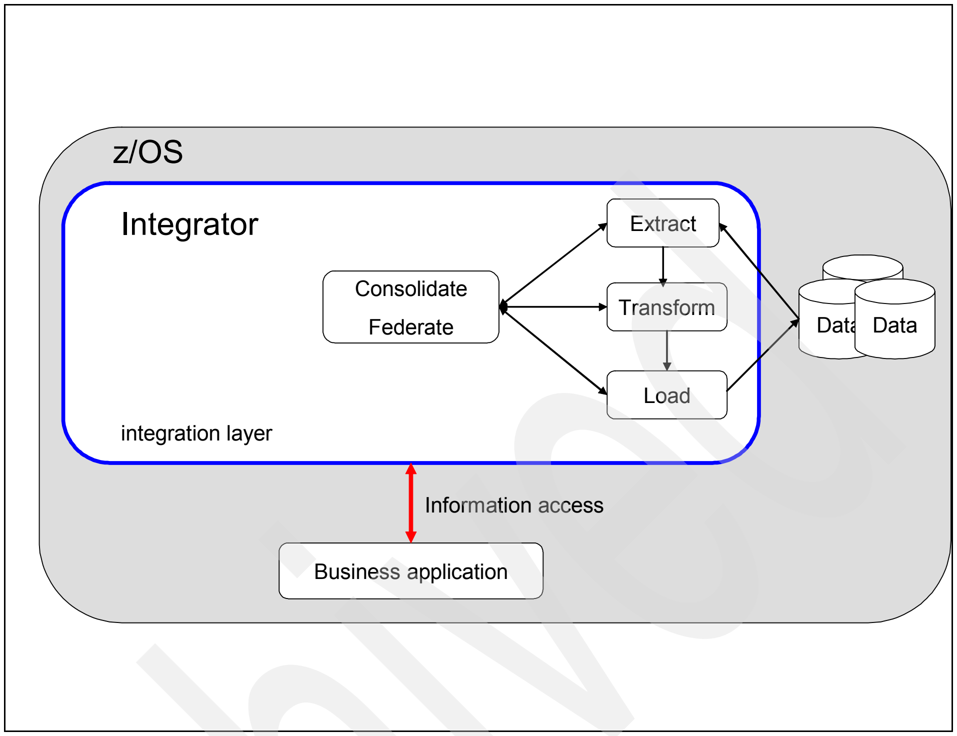


Figure 3-16 Integration through data replication

Integrator/Data Warehouse

These two variations are used by companies with a heterogeneous data infrastructure that have installed an integration layer which covers access “transparently” to this data (in addition to performing aggregation, correlation, cleansing, federation, and other activities).

The functionality depth of the solution distinguishes between Integrator and Data Warehouse. Figure 3-17 on page 86 and Figure 3-18 on page 86 show these scenarios.

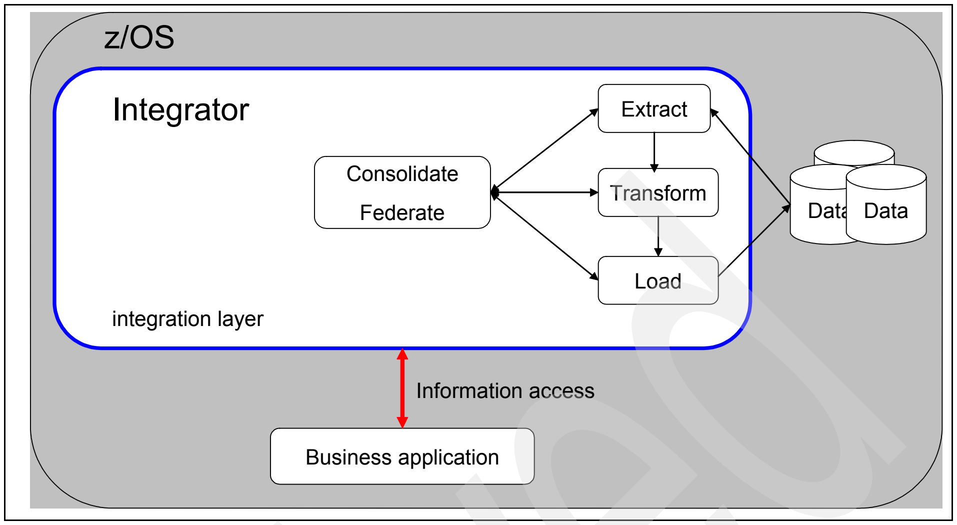


Figure 3-17 Integrator scenario

In both scenarios, all activities that are necessary for maintaining the consistency level of the information are relegated to the integration layer, and are completely transparent for the application.

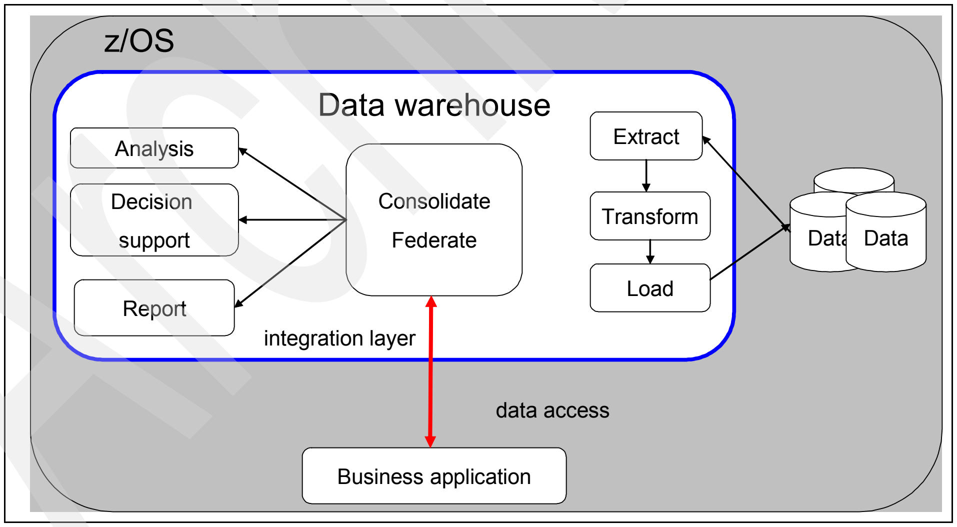


Figure 3-18 Data Warehouse

3.5.3 Characteristics

In the following sections we describe the characteristics of the data access and integration scenarios as they relate to the IBM SOA reference architecture. We also indicate possible Service interface patterns.

Enterprise Service Bus

In the batch ETL variation, the integration layer can be thought as a “mediation combined with transport services” (function of an ESB). It has a mediation character (it transforms records from one format into another, eventually enriching the records with additional information) and a transport character (it uses one of the existing file transfer products on z/OS). It is tightly coupled with the application, because the “jobs” doing the ETL function have to know everything about the application they are sending records to (they have to know such information as destination, record format, and so on).

In the messaging ETL variation, the integration layer can be thought as a “transport service” (function of an ESB). The mediation and transformation function is done inside the application, and is therefore even more tightly coupled that in the batch ETL variation.

In the data replication scenario, the integration layer can be thought as a ‘technology tool” allowing a consistent view of the data. This means that from a SOA point of view, we see no SOA-enablement here.

The Data Warehouse scenario and the Integrator scenario, shown in Figure 3-19 on page 88, can be seen as information tools that allow “information” to be presented in a consistent way, hiding all operations taking place on the underlying datastores. Both scenarios implement transformation (ESB function), federation (Information Services function), and the data access layer. The data warehouse implements much more business logic (specialized queries, multi-dimensional analysis).

We see here the potential for the implementation of SOA services.

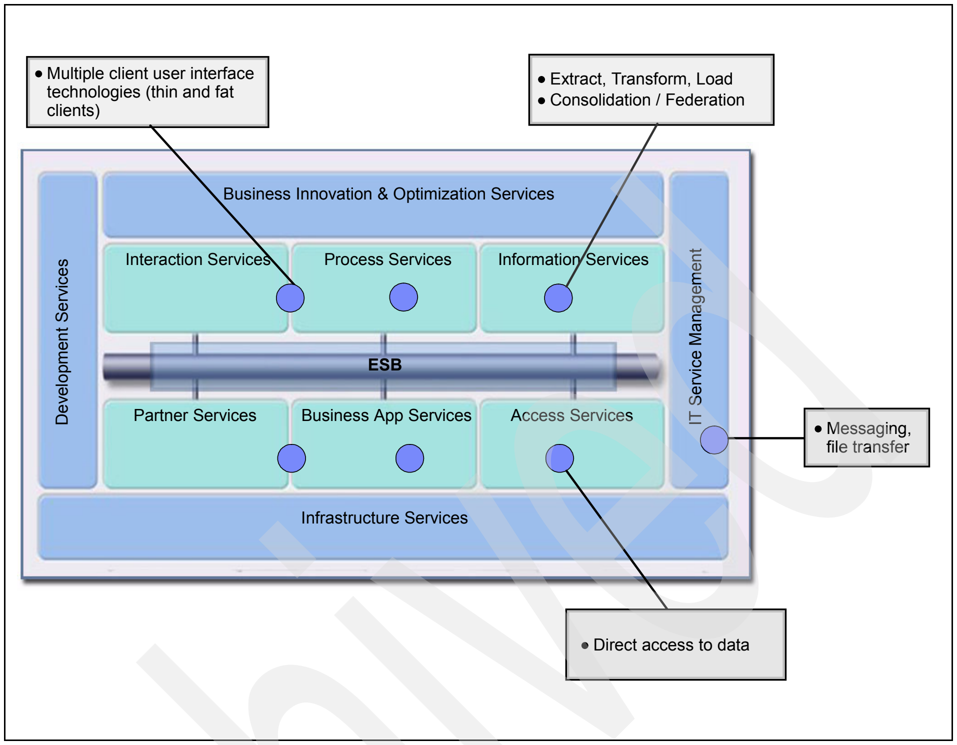


Figure 3-19 Data integration scenarios related to the IBM SOA reference architecture

Partner Services

Some of the variations presented occur also in the B2B scenarios, where applications belonging to one business interact with applications of the partners. ETL batch and messaging (where the messages respect an industry standard) are common occurrences in B2B patterns. Therefore, these scenarios can also be seen as belonging to the SOA building block “Partner Services”.

Access Services

Direct DB access is the rule (either directly through the application, or indirectly through ETL jobs), except in the variation Data Warehouse, where the information access is separated from the real database.

Infrastructure Services

All solutions work on z/OS and as such inherit the Quality of Services of the platform.

3.5.4 Challenges when moving to an SOA

The Data Warehouse/Integrator scenario can be easily integrated into an SOA, if the products that implement the scenario offer SOA services (through Web services interfaces, WebSphere MQ interface, or otherwise). We will see if this is possible when describing the solution techniques in 5.5, “SOA implementation scenarios - data access and integration” on page 199.

For the ETL batch variation, we might put an ESB in place that implements “file-drop” access points, mediation, routing, and transformation services.

For the ETL asynchronous (messaging) variation, we might try to separate the “transformation” function from the application, implement the Extract, Transform and Load as services, and let them run as sequenced mediations inside of an ESB.

Another possible solution is to encapsulate the ETL batch with a SOA-enabled wrapper and treat it as a “service batch process” (refer to 5.4, “SOA implementation scenarios for batch” on page 185). This might make sense if the encapsulated ETL batch can be designed as a reusable service.

For the scenarios that are relevant to B2B connections, we can explore the use of the WebSphere Partner Gateway[2].

These ideas are discussed in more detail in 5.5, “SOA implementation scenarios - data access and integration” on page 199.

3.6 Starting scenario - homegrown SOA

Implementing a service-based approach is not something new; some companies have been doing it for years. Achieving SOA attributes, such as location transparency, mediation, and reusability has been a goal for many IT organizations for a long time. Those situations where a “service” approach has been taken, but not necessarily following the concepts for an SOA as we define them today, is known as a *homegrown SOA*.

[2] The WebSphere Partner Gateway is not available on z/OS.

Important: We use the term "homegrown SOA" in order to distinguish between service-oriented implementations from the past, and the ideal SOA implementation as depicted in Chapter 2, "Target SOA architecture on z/OS" on page 9.

There are differences that we want to highlight, in order to make recommendations to improve the homegrown SOA.

The two principles of the homegrown SOA scenario are that the scenario is aimed at achieving some of the SOA benefits (such as location transparency and reusability), and that the scenario consists of roll your own (RYO) frameworks and abstraction layers. It has evolved during the years, and is not completely based on open standards. It has been primarily developed with the objective to meet the requirements of integrating applications in a more flexible way, but not necessarily using open standards. Many times WebSphere MQ is used as the underlying infrastructure.

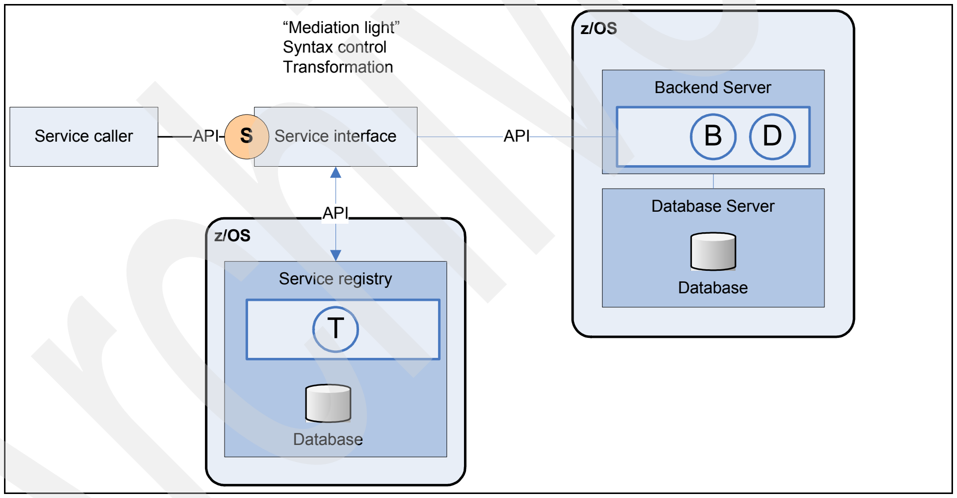


Figure 3-20 Logical view of the homegrown SOA starting scenario

In this scenario, the logic has been divided in service (interface), business and technical functions. As illustrated in Figure 3-20, the services are exposed in the "Service interface". Core business functionality is present in the back-end transaction server, and are accessed through messaging middleware like WMQ or any other type of communication feature or protocol.

Note: The service interface in this concept is an interface accessible through any type of protocol. This protocol may be high-level (MQ) or low-level (TCP/IP), and it may be very open or not. Many homegrown SOAs from the past have not had the objective to use open standards, but just standards that work to get the job done in that specific situation.

In our current SOA definitions, we require the service interface to be accessible from any type of commonly used open protocol.

Furthermore, the characteristics of this scenario are:

- The data resides in DB2 or IMS DL/I databases or in VSAM data sets.
- Integration with external systems is based on WMQ, APPC, or possibly TCP/IP sockets.
- Most commonly used languages in the transaction server are COBOL, PL/I, C and even some Assembler. In the application server, typically Java is used.
- There is a certain degree of loose coupling, especially if WMQ is used.
- A large degree of encapsulation is implemented and reuse is provided through published interfaces. However, different functions may have been implemented for similar or even identical functions.
- No particular service flow is implemented.
- A department-wide or application-wide datamodel may exist. It is possible but not likely that an enterprise-wide, consolidated datamodel exists.
- Data and function modeling tools are probably used.
- The Quality of Service (QoS) is at a high level.
- The service caller may exist inside an application server on z/OS or a distributed platform, or it may be a client program.

Some attributes of the service interface are:

- It is logically functioning as a “bus”.
- It includes light mediation and transformation.
- Interfaces are proprietary or, in some more modern homegrown SOAs, already based on SOAP.
- It uses dynamic lookup in a “service registry”, which provides location transparency. This service registry should be seen as a fairly simple datastore that contains a “binding” between the logical call from the application and the physical destination of the message or request.

- There is some level of transport protocol independence, for example, hiding the transport protocol from the application.
- Native transaction support is available in some supported protocols (APPC, J2C connectors, IMS OTMA, CICS EXCI and so on).
- There is a high level of QoS (availability, continuous operations, dynamic workload management and so on) if the entire solution runs on z/OS.

3.6.1 Homegrown SOA variations

The variations existing in this scenario are determined primarily by the extent to which functionality is implemented that mimics SOA functionality, such as an ESB, the usage of open standards, service orchestration, separation of concerns and so on. If all of this done very well and adequately, the homegrown SOA may be qualified as a real SOA that is robust and flexible enough for the future.

So, there may be a variation in which an ESB has been implemented, but not using open protocols. Routing and protocol conversion may been taken care of in the ESB, but transformation may still reside inside application programs. Thus, such a scenario has many graduations to consider.

There may also be homegrown SOA scenarios where everything is still based on traditional technology (CICS or IMS), but a “service” concept has already been implemented.

3.6.2 Homegrown SOA characteristics

The architecture in the homegrown SOA starting scenario assumes that there has been some degree of standardization and structuring around business services and communication protocols.

The infrastructure components are loosely coupled. Usually, there are different technologies and standards involved. There are also most probably still multiple implementations of similar core functions; see Figure 3-21 on page 93.

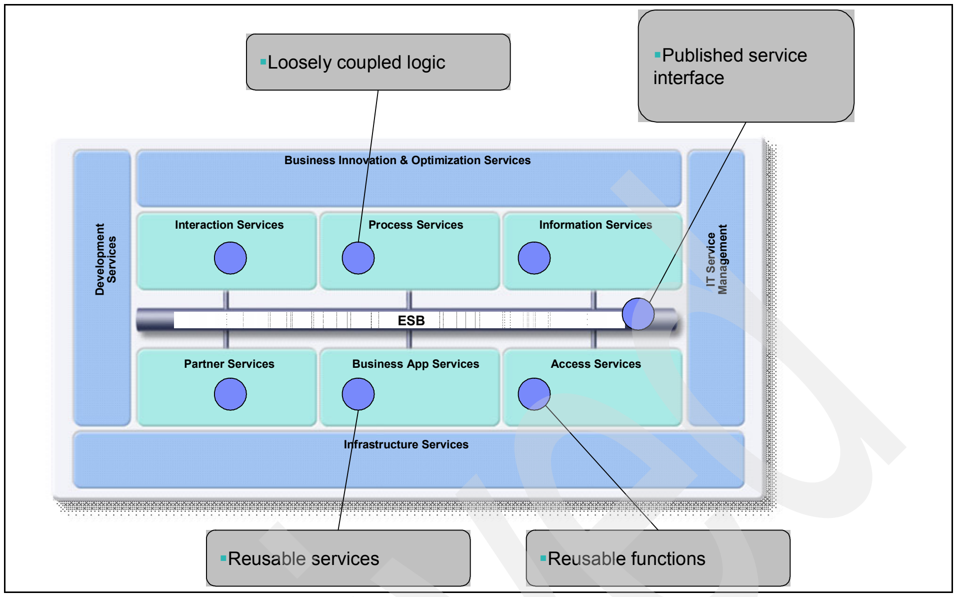


Figure 3-21 Homegrown SOA scenario fit into the IBM SOA reference architecture

Some characteristics of the homegrown SOA scenario, in the context of the IBM SOA reference architecture, are covered in the following sections.

Interaction Services

In the homegrown SOA scenario, the interaction (user interface) has usually not been designed as a set of reusable service components with open standards and connected to an ESB. Instead, any type of user interface technology is used for each specific situation. Quite a few homegrown SOAs have adopted the "portal" concept, but are still not using a service concept in the (user) interaction layer.

The predominant communication protocol used between the user interface device and the interaction layer is HTTP. What is between the interaction layer and the back-end business logic and data access logic could be anything, depending on where the interaction layer and the back-end components are implemented. If both the interaction layer and business/data access logic are implemented in a J2EE application server, the communication will be J2EE as well.

Process Services

Services can be used as atomic services or components. There may be some level of service choreography implemented, using frameworks or tools. The concept of a "process engine" is fairly new and may be found in some recent homegrown SOAs.

Information Services

Many homegrown SOAs have a certain abstraction in accessing data. A common data access layer is often used and application programs do not all go directly to data, but do this through this data access layer by means of abstract calls. However, accessing data as a service is less common and may only be found in more recent homegrown SOAs.

Enterprise Service Bus

The ESB functionality provided in the homegrown SOA is usually related to the area of transport services. Homegrown SOAs, in most cases, have their mediation, if any, hand-coded inside the application layer or inside the “bus” (which is hand-coded as well, in most cases). Note the following points:

- Protocol independence is implemented to a certain degree or not at all, and is not necessarily based on open standards.
- There is a standardized middleware for accessing the back-end systems, such as CICS and IMS.
- Routing is provided by the bus, which is hand-coded in many cases.
- Mediation, including transformation (as we define it in the IBM SOA reference architecture) is done in the application layer or in the bus, if required.
- Event handling infrastructure is most probably not used. There might be an implementation using pub/sub with MQ.

Partner Services

There may be call-outs to partners, but they are usually not SOA-enabled themselves.

Business Application Services

Adapters or connectors for core business applications are provided by the homegrown SOA, sometimes using its own code and sometimes using products from vendors.

Access Services

Access Services are heavily used for accessing the back-end core functions. There is support for:

- WebSphere MQ
- CICS
- IMS
- Proprietary middleware may be implemented

The back-end core functions need support to access data in:

- IMS DB2
- DL/I
- VSAM

Infrastructure Services

The infrastructure in this scenario is mostly based on z/OS and the qualities that this environment provides.

Development Services

There is no specific tooling used for a homegrown SOA. Homegrown SOAs are usually based on J2EE and the use of messaging (WMQ).

On the technical level, support is needed to modify the back-end transactions so they can provide standardized access through the chosen middleware interface.

Some kind of a dictionary is required to keep definitions and requirements of the services provided by the transaction server.

IT Services Management Services

As described in "Infrastructure Services" on page 63, z/OS provides the functionality for security, automation, provisioning, and so on.

3.6.3 Challenges when moving to an SOA

In the homegrown SOA scenario, there has been some level of decomposition of the presentation logic and the business logic. Also, homegrown SOAs have been implemented with loose coupling and reuse in mind. But usually, there are still overlapping functions deployed on different platforms.

Also, homegrown SOAs are not, by definition, based on open standards, which sometimes makes it difficult to open up services for other consumers.

Key questions to consider when migrating to an SOA according to the IBM SOA reference architecture are:

- How to keep the QoS at a high level.
- How to implement open standards.
- How to abstract mediation (especially transformation) out of the application layer or the self-written bus.
- How to implement the interaction layer as services.

In 5.6, “SOA implementation scenarios for homegrown SOA” on page 216, we examine different approaches to improve a homegrown SOA in order to realize more of the SOA benefits.

4

The SOA transition process

Now that the “starting scenarios” have been identified and described, we examine the process of transitioning from existing applications and transactions to services, ready to participate in a full SOA.

The topics covered in this chapter are:

- Methodologies to analyze the existing business and application environment
- Tools used to inventory and examine existing applications for eventual reuse and transformation
- A “pattern-driven” approach to moving from “core” applications to SOA-centric services

4.1 Methodologies for analyzing the business and application environment

In this section we list different methodologies which assist in developing an SOA.

4.1.1 Service Oriented Modeling and Architecture (SOMA)

A key recommendation for developing an SOA is to adopt and adapt a solution development methodology to identify, design, and build SOA components. The Service-Oriented Modeling and Architecture (SOMA) describes a set of product and technology-agnostic modeling, analysis, and design activities and techniques to build a SOA.

The SOMA process is comprised of three major steps, as depicted in Figure 4-1:

- ► Identification
- ► Specification
- ► Realization

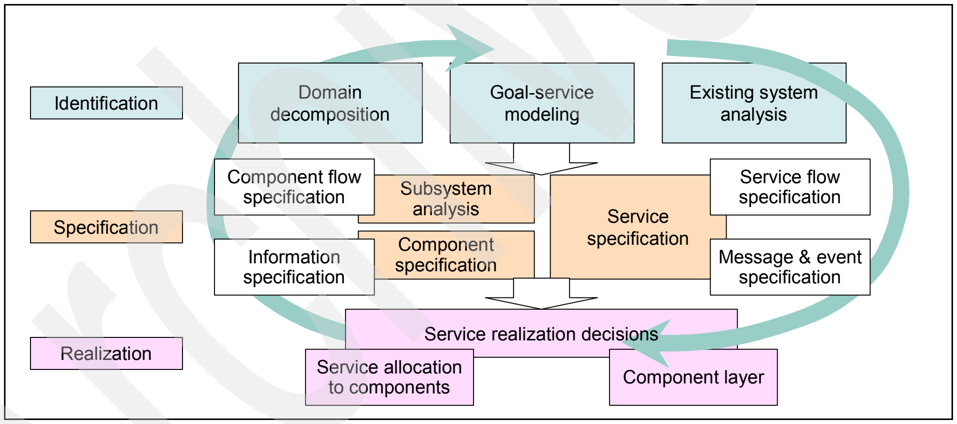


Figure 4-1 Service-Oriented Modeling and Architecture (SOMA)

Through its methods, activities and techniques, SOMA addresses a number of antipatterns that have been encountered by practitioners on engagements involving identification and design of services. Activities and techniques within each of the three steps provides guidelines and solutions to avoid occurrences of these antipatterns. As we review each of the SOMA steps, we identify and describe the associated antipatterns.

Process and methodology: RUP, SOA, and SOMA

Rational Unified Process® (RUP®) is based on software engineering best practices. It offers a configurable framework and is scalable to support enterprise initiatives. Therefore, all aspects of RUP can also be applied to the development of an SOA. RUP provides a systematic approach to bridge the gap between business and IT to support a major area of concern, which is the identification of services and how business processes are realized through the execution of services.

RUP also provides support for both the bottom-up and top-down approaches by acknowledging existing design elements, as well as through activities such as architectural analysis to identify architectural elements like services. Figure 4-2 illustrates the position of SOMA within the RUP lifecycle.

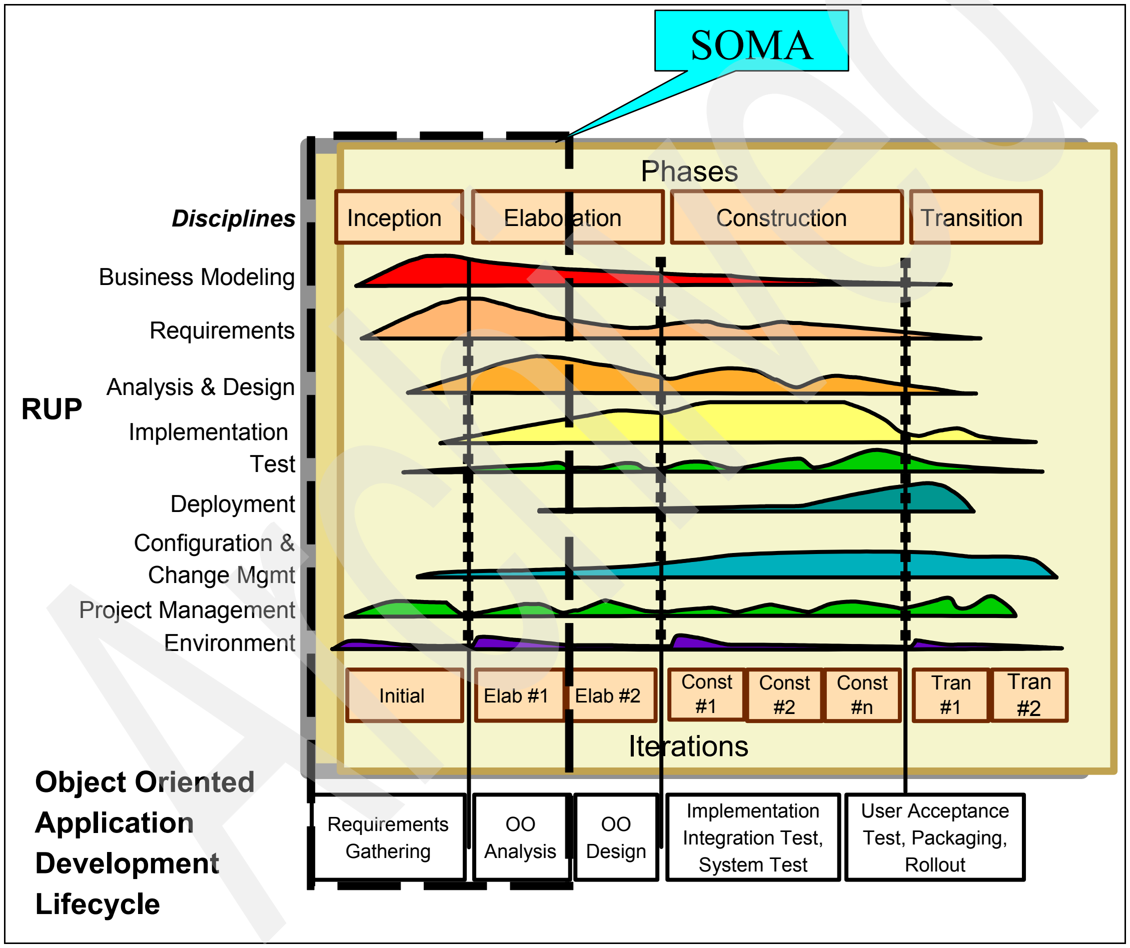


Figure 4-2 Position of SOMA within RUP life cycle

There is work in progress to provide additional support within RUP, such as incorporating content for describing SOMA techniques and artifacts. Extensions are required, such as introduction of the service model as an artifact and some supporting activities.

Service identification

Service identification begins by applying three complimentary techniques including domain decomposition, existing asset analysis, and goal to service modeling, in order to identify candidate services, candidate enterprise components, and flows.

The most important outcome of these activities is the *service model*. The service model is comprised of candidate services that, ultimately, support business services, processes, and goals of the enterprise.

A key aspect of the identification step is that it employs a *meet-in-the-middle* approach that includes a combination of top-down, bottom-up, and middle-out analysis techniques. In many cases, a purely bottom-up approach is taken. However, this approach typically leads to poor definition of services that are driven mainly by the architecture of legacy application interfaces, and not by a business perspective.

Domain decomposition represents the top-down approach, where business domains are decomposed into functional areas across the value net. Through this technique, you can establish the scope of the effort. After domains have been decomposed into functional areas, each area can then be further decomposed into processes and sub-processes and high-level business use cases. Experience shows that the business use cases are considered good candidates fto be exposed as a service.

Existing asset analysis represents the bottom-up approach, where you analyze and leverage APIs, transactions, and models from legacy and packaged applications as possible candidate services.

Goal-service modeling provides a middle-out approach that relates services to goals, subgoals, KPIs, and metrics of the enterprise. This technique provides a certain level of validation in the form of a completeness check in that it may reveal candidate services that were not identified through the top-down and bottom-up activities.

Finally, *subsystem analysis* expands on subystems identified during domain decomposition, and it specifies interdependencies and flows between them.

Antipatterns

Techniques described within this step provide best practices that can be applied to avoid some very common antipatterns related to identification of services. We summarize two key antipatterns:

- Service Proliferation Syndrome

  There is a strong tendency to equate Web services with SOA where, in reality, Web services is an *entry point* towards SOA adoption. It is possible to create an SOA that does not use Web services—and it is also possible to use Web services in a way that cannot really be considered service-oriented.

  The consequences of this viewpoint manifest themselves in a proliferation of services, commonly referred to as the Service Proliferation Syndrome. This antipattern often results in the inappropriate exposure of services that are not business-aligned.

  Determining the most appropriate level of service granularity is one of the most challenging aspects of service-oriented modeling. The rule of thumb is to model as coarse-grained as possible. Although fine-grained services are also possible, ultimately the challenge is to find the balance between coarse-grained and fine-grained services that meets business needs. The techniques described here help to determine the appropriate granularity of services and minimize proliferation of services that are too fine-grained.

- Silo approach

  The second antipattern involves what is commonly referred to as the *silo approach*, in which services are identified based on isolated applications rather than by applying a more holistic, enterprise focus. In addition to the recommendation previously mentioned to establish a governance framework that ensures cross-tower service identification and communications, the meet-in-the-middle approach emphasized within SOMA promotes exploration and identification of common services, and helps to shift consideration toward modeling of services at the enterprise level.

Service specification

In the service specification step, we identify and specify components that will be required to realize services. Some major activities might include:

- Identification of rules, services, attributes, dependencies and variation points for each component.
- Exploration of non-functional requirements required by consumers of the services
- Specification of messaging, event specifications, and management definition
- State management decisions

One of the most important activities within this step is to make crucial decisions to determine which services should be exposed. Some high-level questions related to service design analysis and principles can provide guidance in making these determinations, yet there are many more aspects to take into consideration:

- traceable

  Can the service be traced back to goals and objectives of the organization?

- stateless

  Does the service require information or state between requests?

- discoverable

  Can the service be exposed externally to the enterprise?

  Does the service have a well-defined interface and externalized service description?

- reusable

  Does the service serve the interest of other processes?

  Can this service be reused to realize many higher-level business processes?

Service allocation

In the service allocation step, we assign services to subsystems identified during previous activities. In addition, we assign services and components that realize them to layers in the SOA, as depicted in Figure 4-3 on page 103.

A key activity within this step is documenting architectural decisions that relate to both application and technical operational architecture designed and used to support the SOA realization at runtime.

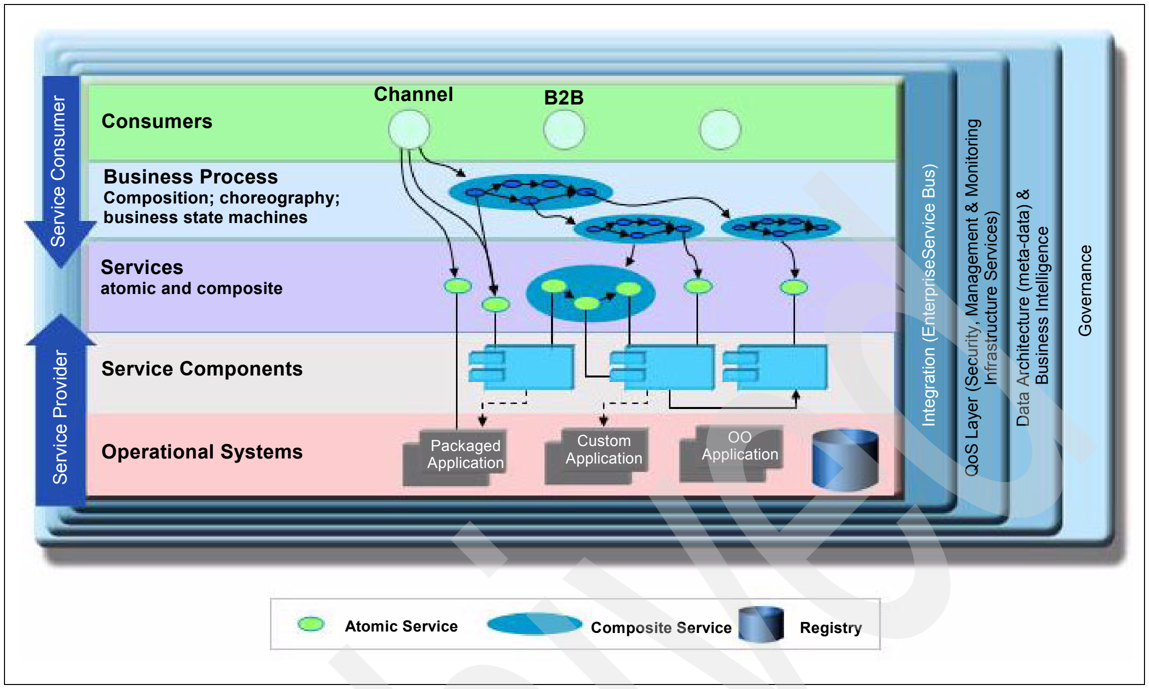


Figure 4-3 Layers of SOA

Through using these techniques, you ensure that you find a place for all services and that they can be traced back to business goals and components.

Antipattern: componentless services

There is a tendency to jump directly into development and implementation of Web services without a clear association with the owning components. This antipattern typically occurs in projects where there is a lack of architectural discipline. Architecture patterns are neither considered nor applied.

Once again, lack of good service modeling and design techniques ultimately result in serious violations of basic principles such as modular design, information hiding, encapsulation, and layering. These issues can lead to significant cost and effort related to potential reengineering.

In addition to leveraging J2EE and general EAD best practices, the application of SOMA techniques such as service allocation will help you to avoid occurrences of this antipattern.

Service realization

Realization is a key architectural step that involves the exploration of alternatives to realize the implementation of services. In addition, we identify and assess technical constraints to ensure technical feasibility of realization of services specifically for those identified during existing asset analysis

Alternatives for implementation of services goes beyond “buy versus build”. Some realization alternatives are:

- Building new component functionality (custom build).
- Transforming legacy to enable reuse of functionality exposed as services.
- Integrating by wrapping existing systems.
- Buying and integrating with third party products.
- Subscribing and outsourcing parts of the functionality, especially with Web interfaces. Subscription assumes that an enterprise application integration model has been implemented and there are services to subscribe to, in a hub and spokes architecture.

Transformation considerations

A service’s implementation can be realized by wrapping an existing system with a message queue service or a Web service. However, in many cases, the mere exposure of existing functionality is not sufficient. Componentization of the existing system or a small subset of the system must take place in order to properly expose the functionality required.

A key factor is the scope of the componentization. Avoid a common tendency to break the entire existing system down into parts. Select an appropriate subset and transform it through componentization.

Antipattern: chatty services

Similar to the identification and specification steps, there are antipatterns related to the realization of a SOA. Though all three steps prescribed within SOMA provide techniques to avoid occurrence of these antipatterns, the consequences of this particular pattern are more related to realization.

In many cases, developers are asked to begin direct replacement of existing APIs with Web services without much thought being given to the benefits of SOA and conformance to SOA design and architecture principles. This antipattern, referred to as *chatty services* stemming from a chatty dialog communicating small pieces of information, may result in severe degradation in performance.

In addition, significant development costs may be incurred to aggregate the fine-grained services into a service model that can actually realize benefits of

SOA. Guidance and techniques to avoid this antipattern span all three steps of SOMA.

- At the identification step, the meet-in-the-middle approach can help to ensure completeness of the model, attain an appropriate level of service granularity, and ensure that there is traceability back from the service to the business objectives and goals of the enterprise.
- At the specification step, application of a “litmus test” considering key service design principles can help to make the appropriate decisions involving service exposure.
- At the realization step, we assess the technical feasibility of services identified through existing asset analysis to further validate the decision of services to be exposed.

Summary

In summary, experience shows that service-oriented modeling, analysis, and design is necessary to build an SOA. It is important to reiterate some of the key aspects and benefits of SOMA:

- Techniques are designed to enable target business processes through identification, specification, and realization of business-aligned services forming the foundation of a SOA
- It builds SOAs that align the business goals of clients and directly ties business processes to underlying applications through services, thus helping businesses realize benefits more rapidly.
- This approach helps to ensure that goals set by business process modeling can actually be implemented, in order to generate the greatest result in an efficient manner.

Application of these best practices, guidelines, and techniques in identifying services and solutions can help to realize the many benefits offered through SOA.

For additional information about the identification of services and solutions, refer to the following sources:

- IBM Redbook *Patterns: SOA Foundation Service Creation Scenario,* SG24-7240, which is available at this site:

  http://www.redbooks.ibm.com/abstracts/sg247240.html
- *Service Oriented Modeling and Architecture*, which is available at this site:

  http://www.ibm.com/developerworks/webservices/library/ws-soa-design1/

- *Elements of Service-Oriented Analysis and Design*, which is available at this site:

  http://www.ibm.com/developerworks/webservices/library/ws-soad1/
- *SOA realization: Service design principles*, which is available at this site:

  http://www.ibm.com/developerworks/webservices/library/ws-soa-design/
- IBM SOMA and/or IBM SOA:

  http://www.ibm.com/services/soa

4.1.2 Service Integration Maturity Model (SIMM)

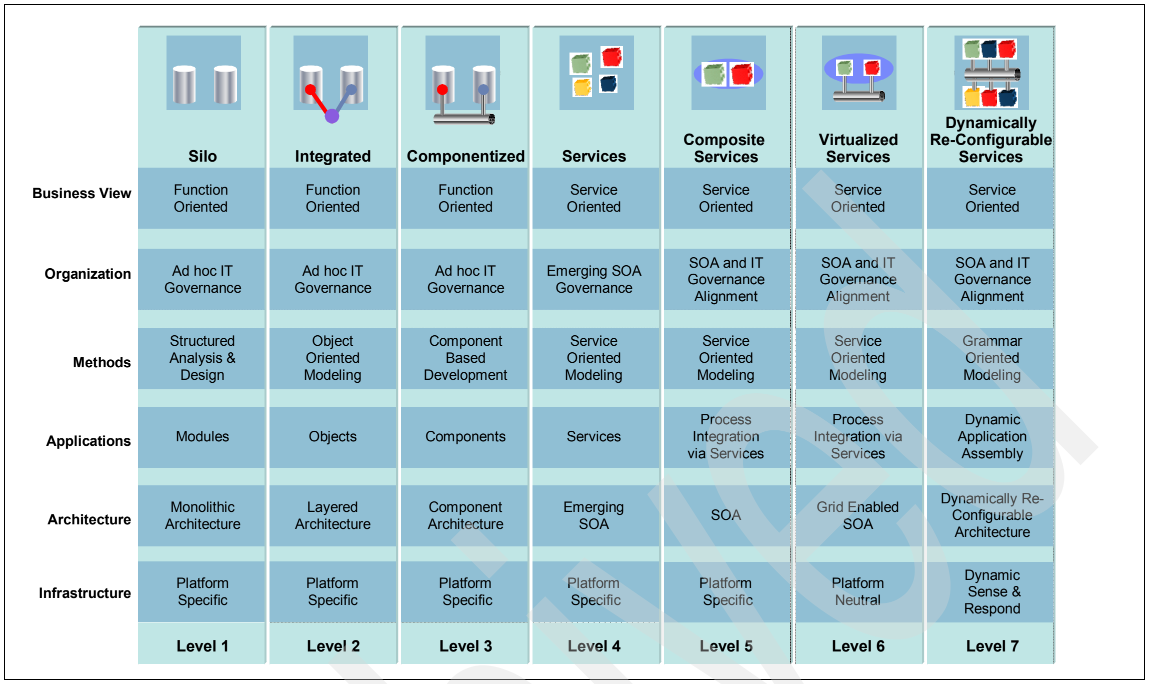
Service Integration Maturity Model (SIMM) was originally created as a way to judge the maturity (or readiness) of an organization and their business environment to move toward a SOA. The SIMM engagement or workshop is conducted at a fairly high level with facilitators, along with business and technical Subject Matter Experts (SME) from the organization being reviewed.

A SIMM engagement may involve many steps, but may be reduced to a set of key steps, for example, to identify key pain points and therefore places where the most return for minimal work may be obtained. It is also a good way for groups to get started with SOA by helping to identify a project that may be a particularly good candidate.

A *pain point* is a way to identify problem areas in the business unit that prevent alignment with business goals. Pain points come in many forms, including business process problems, legacy application problems, staffing, funding, capacity, or skills. In addition, pain points may have emerged from rapid changes in the business environment. SIMM uses pain points to begin to identify opportunities to improve the business unit processes and applications, while aligning with an SOA+ approach.

SIMM helps you to define a roadmap for incremental IT transformation linked to business transformation.

Service Integration maturity is assessed using different views, as illustrated in Figure 4-4 on page 107.



	Silo	Integrated	Componentized	Services	Composite Services	Virtualized Services	Dynamically Re-Configurable Services
Business View	Function Oriented	Function Oriented	Function Oriented	Service Oriented	Service Oriented	Service Oriented	Service Oriented
Organization	Ad hoc IT Governance	Ad hoc IT Governance	Ad hoc IT Governance	Emerging SOA Governance	SOA and IT Governance Alignment	SOA and IT Governance Alignment	SOA and IT Governance Alignment
Methods	Structured Analysis & Design	Object Oriented Modeling	Component Based Development	Service Oriented Modeling	Service Oriented Modeling	Service Oriented Modeling	Grammar Oriented Modeling
Applications	Modules	Objects	Components	Services	Process Integration via Services	Process Integration via Services	Dynamic Application Assembly
Architecture	Monolithic Architecture	Layered Architecture	Component Architecture	Emerging SOA	SOA	Grid Enabled SOA	Dynamically Re-Configurable Architecture
Infrastructure	Platform Specific	Platform Specific	Platform Specific	Platform Specific	Platform Specific	Platform Neutral	Dynamic Sense & Respond
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7

Figure 4-4 The Service Integration Maturity Model (SIMM)

Views assessed in SIMM are:

- Business

  How well does the business understand, design, implement and execute its business processes?

- Organization

  How effective is the Business/IT organization?

- Methods

  How well are business goals understood by IT?

- Application

  How well can the IT team perform its mission?

- Architecture

  How advanced is IT thinking?

- Information

  How are the core data operations performed and transformed, and how is the data managed within the enterprise?

- Infrastructure

  How capable is the IT plant?

Current maturity and the future “to be” state is assessed by working through the model; see Figure 4-5.

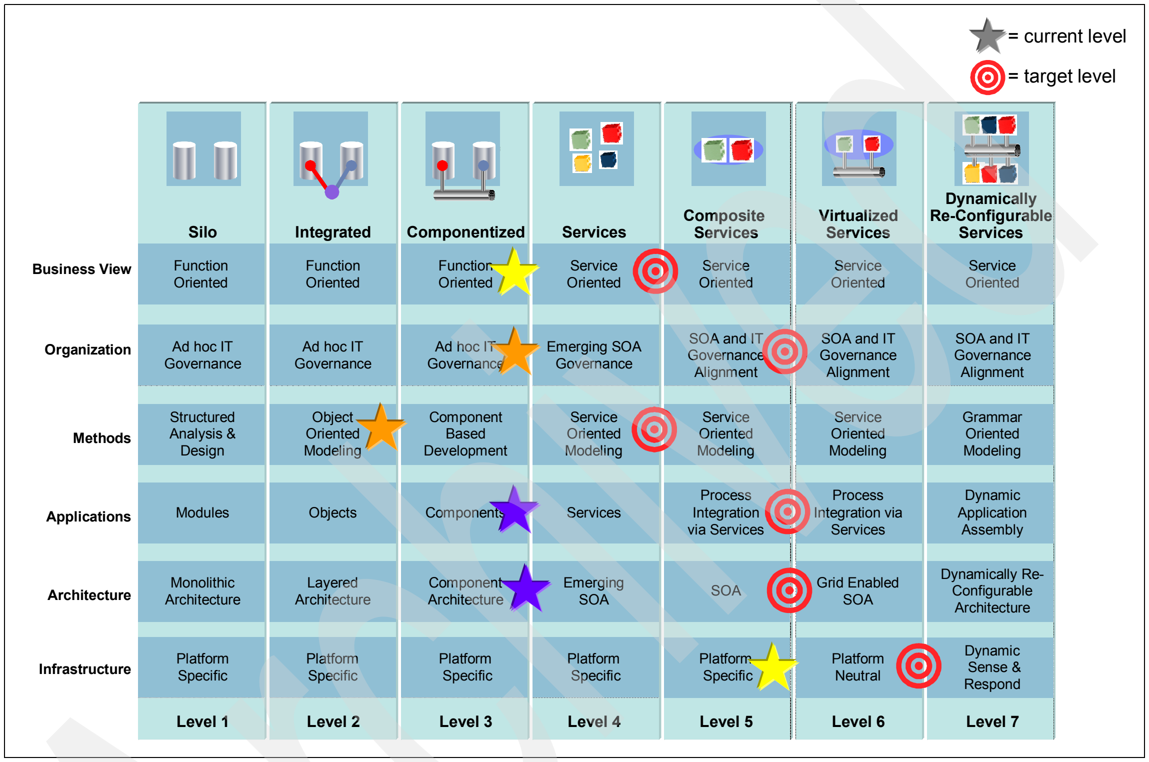


Figure 4-5 Service Integration Maturity Model Assessment

Using the gap between the to-be state and the current state, action items are developed, as illustrated in Figure 4-6 on page 109.

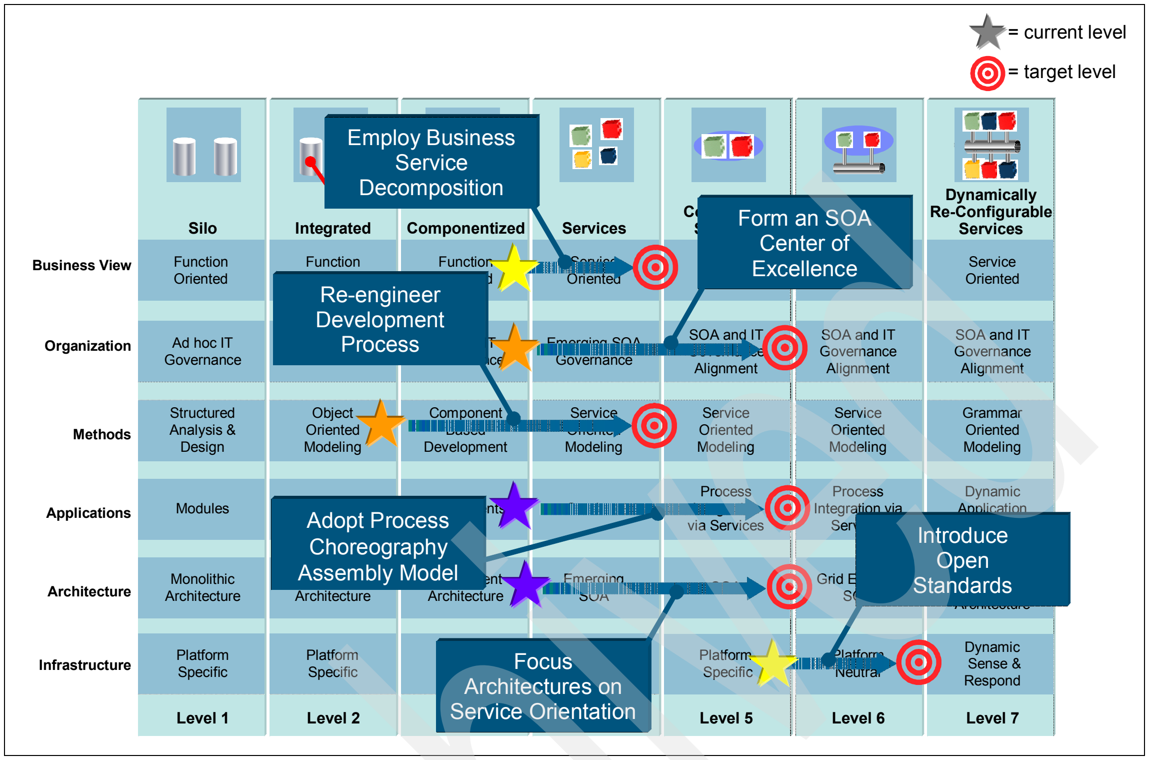


Figure 4-6 Service Integration Maturity Model with illustrating actions

4.1.3 SOA Readiness Assessment

The *SOA Readiness Assessment* is a questionnaire tool based on the SOA maturity model. SOA capabilities are assessed in the area where a company stands, when it comes to adopting SOA.

With targeted recommendations for improving the maturity level, the IBM SOA assessment tool can help unlock the full value of SOA.

For additional information

Refer to the following sources for more information:

- IBM SOA homepage

  `http://www.ibm.com/soa/`

- SOA Readiness Assessment

  `http://www.ibm.com/software/solutions/soa/soaassessment/index.html`

4.2 Tools to assist in the SOA transformation process

Many efforts to move from the core system “starting scenario” to a target scenario involve some amount of analysis of existing source code and possibly extraction of business logic and rewrite of the existing code to create SOA-compliant services.

IBM has defined the “SOA Lifecycle” as four stages in a closed loop process: *Model, Assemble, Deploy*, and *Manage* (see 2.3.4, “IBM SOA lifecycle” on page 18 for more details on the SOA Lifecycle). The SOA Lifecycle defines most of the key tasks necessary to create new SOA-compliant services *and* to service-enable existing core applications.

The process of core system modernization (also known as “enterprise transformation” or “legacy modernization”) falls primarily in the Assemble stage of the SOA Lifecycle. That process involves a number of key steps:

- Discovery of existing code modules and other assets (JCL, system definition files and so on)
- Discovery of interrelationships between artifacts
- Deep investigation of existing code and data structures to identify service definitions and business rules
- Refactoring of code structure to “clean up” source code for efficiency, performance, reuse, and readability purposes
- Programming work to make modifications to discovered or refactored source code
- Version control and storage of application artifacts before, during, and after the re-engineering process

These application development-specific activities within the SOA Lifecycle fall within a Business-Driven Development (BDD) process, as illustrated in Figure 4-7 on page 111.

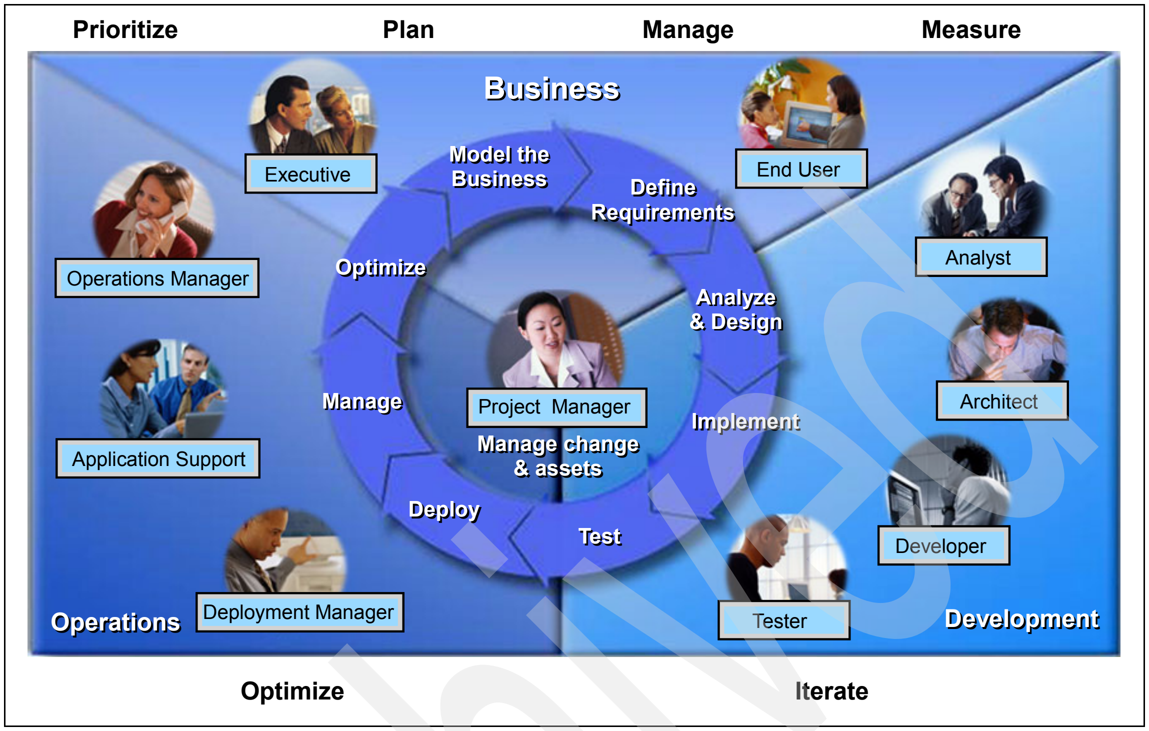


Figure 4-7 The Business-Driven Development process

In this section we concentrate on the development and re-engineering aspects of the BDD process (which is illustrated in the lower right side of Figure 4-7). Later we discuss what is needed for the Deploy and Manage stages of the SOA Lifecycle and the associated aspects of this Business-Driven Development process.

4.2.1 Tools used in the Model stage

Over the last several years, a number of tools have been developed to assist the architect and application developer in modeling, coding, and assembling applications. There has been much attention paid to object-oriented (OO) design and modeling. Tools that work with the Unified Modeling Language (UML)[1] have been used for OO-based application analysis and design, data modeling, defining object relationships, and describing the overall structure of the application.

[1] http://www.uml.org/

Although UML is still in use for these purposes, other, more coarse-grained and business-focused modeling tools are now in use for business modeling in SOA. WebSphere Business Modeler is the IBM key product for creating models of business processes and coarse-grained composite transactions.

WebSphere Integration Developer (WID) also assists in transforming the business processes defined using the WebSphere Business Modeler into a Business Process Execution Language (BPEL) representation. This BPEL-defined process can later be run and managed using a run-time engine such as the WebSphere Process Server (WPS).

Because this chapter concentrates on the underpinnings for core system service enablement, we do not examine those tools in detail here. Tools such as the WebSphere Business Modeler are used primarily in "top-down" application designs, where the process or composite application is defined first, and this design drives the underlying service granularity. In this chapter, we are looking at service enablement from the "bottom-up," where existing applications are migrated to an SOA-compliant form using several transformation techniques, discussed in 4.3.3, "Transition approaches" on page 124.

In addition to modeling processes and applications, the developer and architect must also manage requirements.The IBM Rational RequisitePro® tool can be used for requirements gathering and management, to feed the process of re-engineering existing code assets or for the construction of new services.

4.2.2 Discovery and refactoring tools used in the Assemble stage

From an application modernization and transformation perspective, the artifacts that are produced from the Model stage of the SOA Lifecycle are primarily process models and service definitions that come from the modeling tools such as WebSphere Business Modeler, WebSphere Integration Developer (WID), and Rational Software Architect (RSA). In "Service identification" on page 100, the concept of "bottom-up" versus "top-down" versus "meet-in-the-middle" development is discussed.

The Assemble stage is where the "meet-in-the-middle" occurs. Models created during the Model stage are combined with the services created during the Assemble stage to form composite applications. But in order to create those services, much discovery and analysis of existing assets must take place to harvest source code and business rules, and to maximize reuse of those existing assets.

WebSphere Studio Asset Analyzer

WebSphere Studio Asset Analyzer (WSAA) is a static analysis tool that provides a developer or an architect with a high level view of the application inventory, and optionally allows them to drill down into the application to examine its structure and determine component interrelationships. Dependencies between the application artifacts can be observed, and those dependencies can be used to determine the level of effort needed to make appropriate modifications or rewrites to the application for SOA enablement.

WSAA is referred to as a "static analysis" tool because it only analyzes what the administrator tells it to; there is no awareness of running applications. If a partitioned data set filled with source code is fed into WSAA, it will analyze it, even if that code has not actually executed in decades.

In contrast, dynamic tools such as the CICS Interdependency Analyzer collect data on running systems and provide information on components actually in use. However, this information is not as complete as that provided by WSAA (because source and other related artifacts are not available at run-time). In addition, dynamic tools may not catch information on programs that run only on occasion, such as monthly or year-end jobs.

The high-level architecture of WSAA is shown in Figure 4-8.

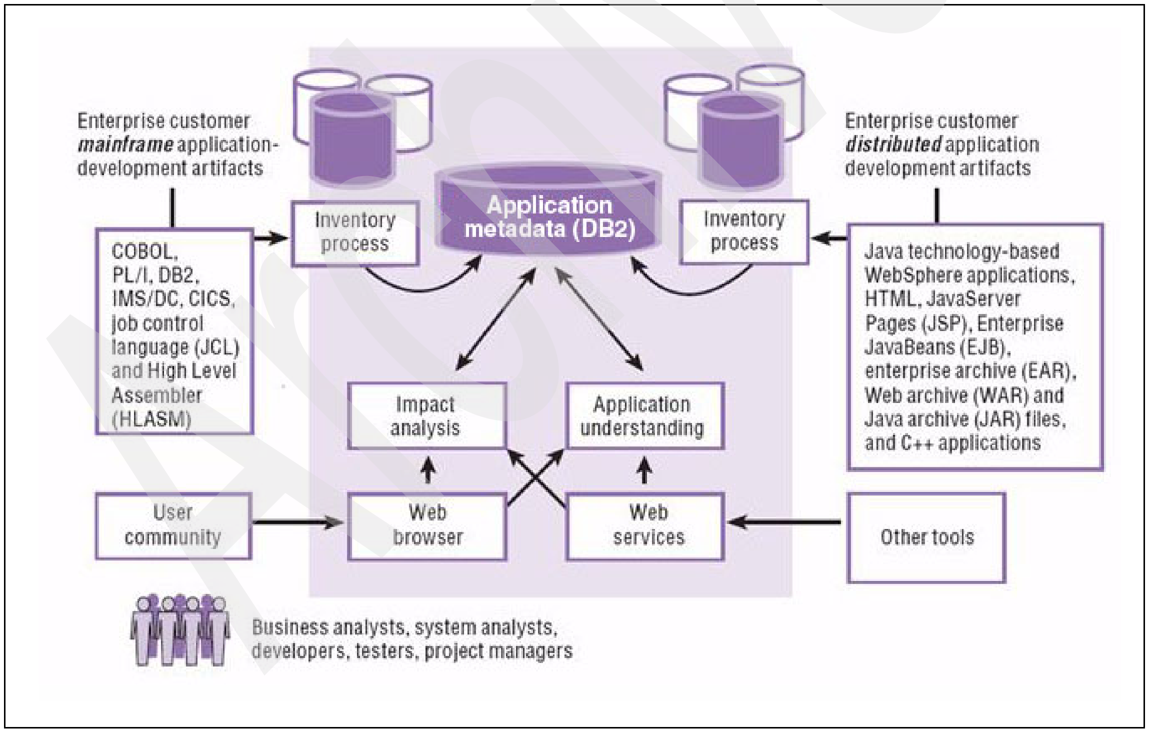

Enterprise customer *mainframe* application-development artifacts
COBOL, PL/I, DB2, IMS/DC, CICS, job control language (JCL) and High Level Assembler (HLASM)
Inventory process
Application metadata (DB2)
Inventory process
Enterprise customer *distributed* application development artifacts
Java technology-based WebSphere applications, HTML, JavaServer Pages (JSP), Enterprise JavaBeans (EJB), enterprise archive (EAR), Web archive (WAR) and Java archive (JAR) files, and C++ applications
Impact analysis
Application understanding
User community
Web browser
Web services
Other tools
Business analysts, system analysts, developers, testers, project managers

Figure 4-8 WebSphere Studio Asset Analyzer (WSAA) overview

Note that WSAA is not restricted to host assets; it can also examine and report on artifacts from Java, C++, and other Web and distributed applications. The artifacts are fed to the WSAA inventory process engine. WSAA adds the artifacts to the DB2-based repository, and then the user, either via a Web or Web services (used by other non-browser tools) interface, can perform inquiries and analysis on those artifacts added to the repository.

The results of a typical WSAA query are shown in Figure 4-9 on page 114. Here, a batch job is decomposed, showing the job steps and the DD names (files) used by the job. If possible, the sub-components are hot-linked so the user can drill down and examine the various parts of the job (programs, files, databases, and so on).

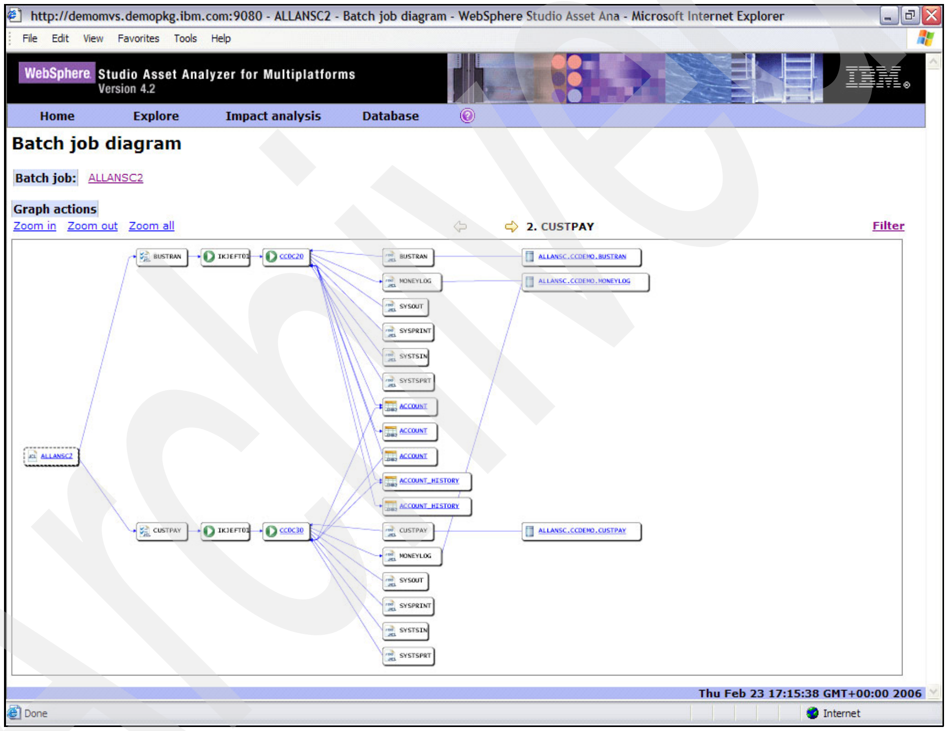


Figure 4-9 Batch job analysis in WebSphere Studio Asset Analyzer

A moderate amount of detail about program content, including the ability to browse source code, is available through WSAA, which is intended to provide a high-level view of the application structure and interdependencies between components. However, detailed analysis and decomposition of program assets is better accomplished in the Asset Transformation Workbench, which is discussed in the next section.

Asset Transformation Workbench

The Asset Transformation Workbench[2] (ATW) provides detailed reports, metrics and visualizations of existing mainframe applications. The foundation of ATW is a knowledge base that contains information describing the applications.

Surrounding the knowledge base are a number of key capabilities and features[3], as described here:

- Detailed reports, metrics, documentation, and visualizations of the enterprise applications are readily accessible to project leaders and architects using the workbench.
- A browser-based module allows team members to use ATW-generated reports.
- Integration with IBM WebSphere Studio Asset Analyzer allows users to perform high level analysis in WebSphere Studio Asset Analyzer and pass the application insight through a software bridge for use in Asset Transformation Workbench.
- Powerful analysis and assessment tools help accelerate ongoing maintenance and enhancements.
- Tools expose and help manage business rules, which can simplify application reuse for SOA initiatives.
- Re-architecting tools help increase the productivity of teams restructuring and componentizing applications.
- A Reuse Analyzer for ATW (technical preview) helps quickly assess an application's suitability for reuse in a SOA.

There are several main components of ATW (see Figure 4-10 on page 117) that use the knowledge base:

- Application Analyzer

  The Application Analyzer is a non-invasive interactive module that creates a comprehensive repository of system relationships including source code, system files, data definition language (DDL), screen maps, and more.

  It can help perform impact analysis, generate interactive graphical system diagrams, create system documentation, and browse source code in context-sensitive mode.

[2] ATW is provided by Relativity Technologies and is resold by IBM under the "Asset Transformation Workbench" name.
[3] Feature descriptions for ATW can be found at
http://www-306.ibm.com/software/awdtools/atw/features/

- Application Profiler

  The Application Profiler provides technical and business users with information to effectively understand and plan enterprise applications, without impacting the source code. It is a browser-based tool and provides users such as support, quality assurance, and business analysts insight into systems without requiring specialized knowledge or skills.

  Technical users that are unfamiliar with their enterprise applications can use Application Profiler to access documentation, understand system structure, and determine the impact of code changes. Non-technical or business users can use Application Profiler to examine system-level reports and to assess where to direct resources in order to enhance or renovate the application portfolio.

  When used with the Business Rules Extension, the Application Profiler module can help organize and annotate business rules without disturbing development.

- Business Rules Extension

  The Business Rules feature is an *optional* extension that helps navigate complex code and identify, document, and organize business rules. It identifies candidate rules using developer-driven sophisticated search algorithms.

  This process generates a list of rules for the targeted application, allowing analysts to view each rule and verify its inclusion. After rules have been found they can be documented and organized, allowing future users to understand the use of each rule. And because the rules are tagged, analysts can locate the rules within the code and modify them to respond to business process changes.

- Application Architect

  The Application Architect feature is an *optional* extension that uses sophisticated algorithms to partition code into new components. The componentization of logic results in a structured architecture that can reduce complexity and facilitate modernization.

  By componentizing enterprise code, developers are able to greatly increase the performance of frequently used programs. Application Architect can help to ensure that the components created are complete, working programs in accordance with the functionality of the original application.

- Reuse Analyzer

  The Reuse Analyzer extension (in ATW Version 2.1, a “technology preview”) can:

  – Categorize CICS and IMS programs written in COBOL by the type of work they do (screen, business logic, data access, hybrid, and so on).

– Identify some potential architectural “traps” that would require remediation before making a particular program or program call hierarchy available as a Web service.

– Create Web Services Description Language (WSDL) files corresponding to selected data elements in your program that you want to make available in a Web service. (A WSDL file can then be used with XML Services for the Enterprise, which is a feature of WebSphere Developer for zSeries.)

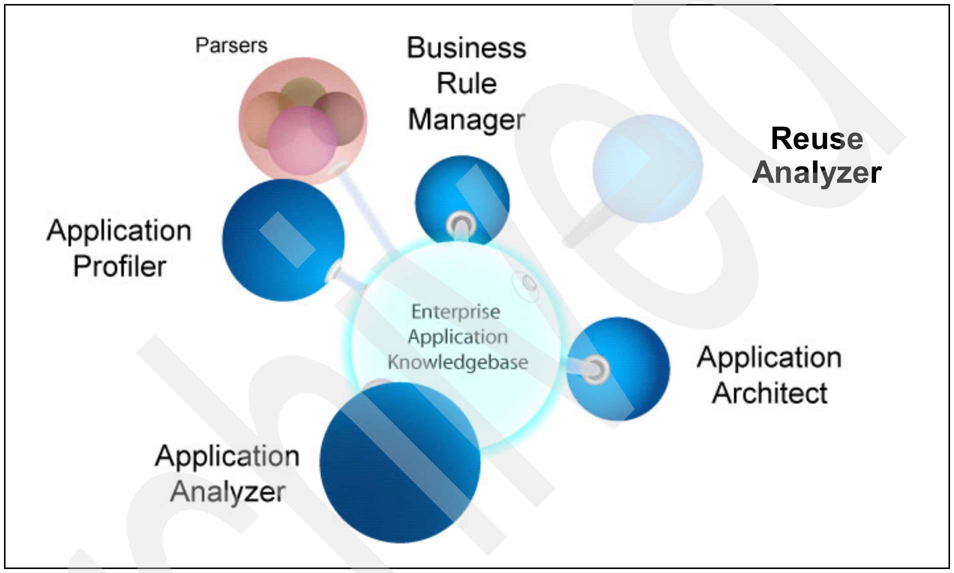


Figure 4-10 Asset Transformation Workbench features

The Asset Transformation Workbench is used when a detailed view of the application is needed for work on reengineering an application. The WebSphere Studio Asset Analyzer is used when a higher level view of the application assets is needed.

ATW is a participant in the Model stage of the SOA Lifecycle, but it also has some participation in the Assemble stage, because it provides key features (such as the Application Architect and Reuse Analyzer) that assist in the actual code creation.

4.2.3 Code development tools used in the Assemble stage

After discovery has been conducted and the appropriate code resources have been identified for reuse or redevelopment, business rules have been isolated, and data structures have been determined, you arrive at the “Analyze and design” portion of the Business Driven Development model (see Figure 4-7 on page 111). The next step is the actual service creation, which is referred to as “Implement” in the BDD model.

The Asset Transformation Workbench, discussed in “Asset Transformation Workbench” on page 115, can be thought of as a partial participant in this stage, because there is some modification of code that can be done with ATW. The Application Architect component permits the developer to refactor the existing code by partitioning it into better structured components. But it is not an Integrated Development Environment (IDE) intended for writing code.

WebSphere Developer for zSeries

The IBM WebSphere Developer for zSeries (WDz) is a superset of the Rational Application Developer IDE for Java development. WDz adds the ability to build applications and services using traditional programming languages, including COBOL, PL/I, and Assembler.

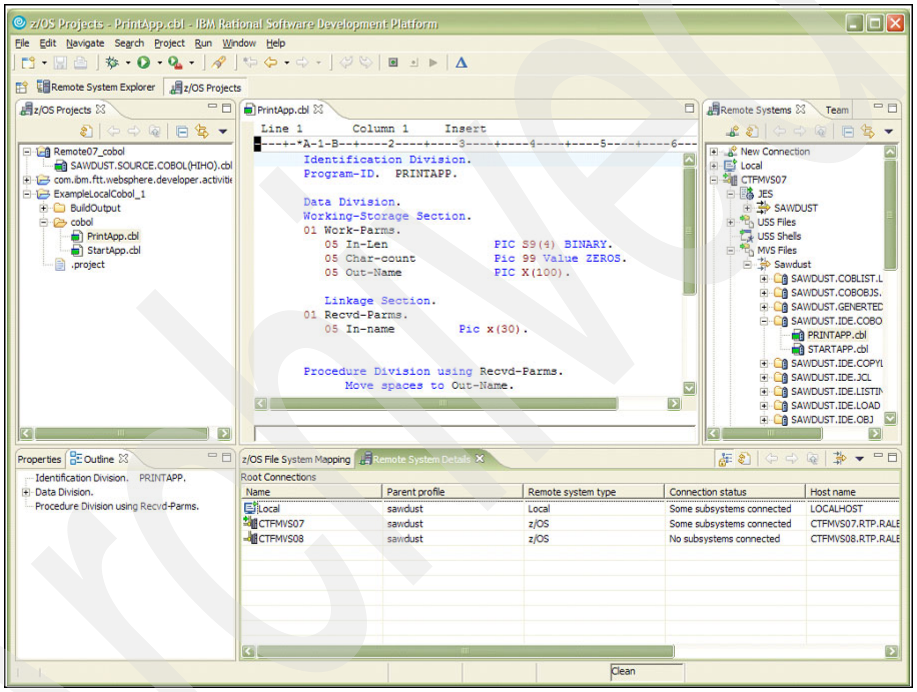
WDz enables the host developer with the same kind of tools that have traditionally been available only to distributed system developers. It can be used to build new SOA-compliant services and to reengineer existing host programs to participate in an SOA. It is ideal for equipping traditional host developers with new tooling that will improve their productivity, while equipping them to transition to a Java-based development model—or to equip Java developers with the ability to work with mainframe code assets.

Key features that WDz provides for the host developer include:

- Local or remote edit, syntax check and compile of COBOL, PL/I and Assembler programs.
- Features including programming language “code assist” and automatic generation of JCL (based on standardized skeletons) to reduce complexity for inexperienced host developers.
- Interactive debugging of traditional language programs using the same kind of debugger that workstation developers use, and with live code running on z/OS.
- XML Services for the Enterprise (XSE), a feature that permits the developer to generate service definitions from existing host applications or to generate code for the mainframe using existing service definitions in WSDL.
- Enterprise Generation Language (EGL), a fourth-generation language (4GL) that greatly simplifies development by enabling the developer to code services using EGL and generate the executables either in COBOL or Java (COBOL generation is unique to WDz).

- Job control and monitoring using the Remote System view to provide functions similar to the SDSF function found under TSO.
- Support for the creation of CICS Web Services (CICS Transaction Server V3.1).
- CICS Service Flow Modeler for creation of services and transaction flows that execute under the CICS Transaction Server V3.1 Service Flow Feature (see “Variation 2: CICS Service Flow Feature (CICS Transaction Server V3.1)” on page 142 for more details).

Figure 4-11 shows what a typical WDz session might look like.



```
Line 1          Column 1      Insert
----+-*A-1-B--+----2----+----3----+----4----+----5----+----6---
       Identification Division.
       Program-ID.  PRINTAPP.

       Data Division.
       Working-Storage Section.
       01 Work-Parms.
          05 In-Len                    PIC S9(4) BINARY.
          05 Char-count                Pic 99 Value ZEROS.
          05 Out-Name                  PIC X(100).

          Linkage Section.
       01 Recvd-Parms.
          05 In-name              Pic x(30).


       Procedure Division using Recvd-Parms.
             Move spaces to Out-Name.
```

```
Remote07_cobol
    SAWDUST.SOURCE.COBOL(HIHO).cbl
com.ibm.ftt.websphere.developer.activitie
ExampleLocalCobol_1
    BuildOutput
    cobol
        PrintApp.cbl
        StartApp.cbl
    .project
```

```
Identification Division.   PRINTAPP.
Data Division.
Procedure Division using Recvd-Parms.
```

```
New Connection
Local
CTFMVS07
    JES
        SAWDUST
    USS Files
    USS Shells
    MVS Files
        Sawdust
            SAWDUST.COBLIST.L
            SAWDUST.COBOBJS.
            SAWDUST.GENERTEC
            SAWDUST.IDE.COBO
                PRINTAPP.cbl
                STARTAPP.cbl
            SAWDUST.IDE.COPYL
            SAWDUST.IDE.JCL
            SAWDUST.IDE.LISTIN
            SAWDUST.IDE.LOAD
            SAWDUST.IDE.OBJ
```

Root Connections

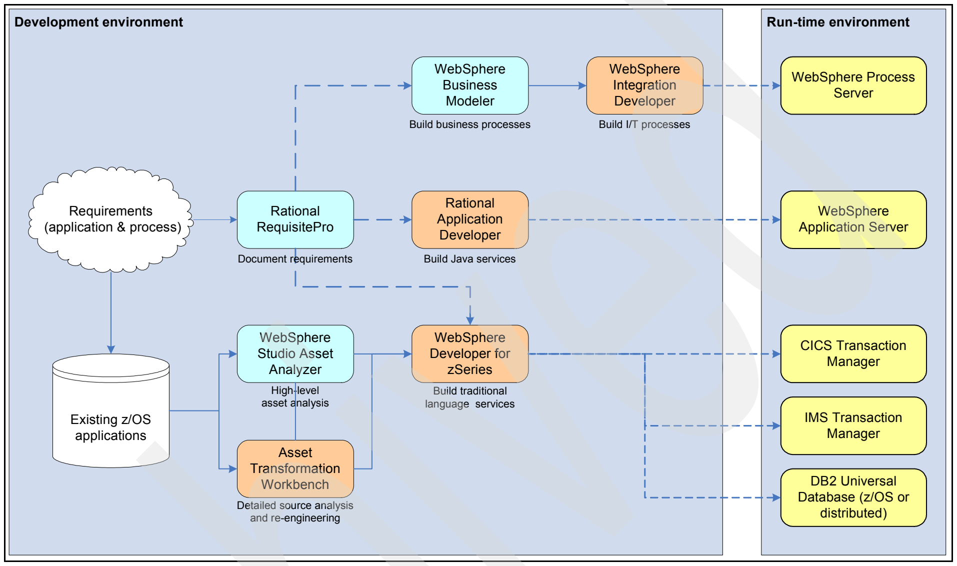
Name	Parent profile	Remote system type	Connection status	Host name
Local	sawdust	Local	Some subsystems connected	LOCALHOST
CTFMVS07	sawdust	z/OS	Some subsystems connected	CTFMVS07.RTP.RALE
CTFMVS08	sawdust	z/OS	No subsystems connected	CTFMVS08.RTP.RALE

Figure 4-11 WebSphere Developer for zSeries

WebSphere Developer for zSeries users can concentrate solely on service-based development, or they can use WDz to build a complete, end-to-end composite application. WDz includes the entire Rational Application Developer toolset, so a developer can use frameworks such as Struts to develop a front-end user interface and tie it to host services, written in traditional programming languages, and coded using the z/OS Project or EGL perspectives.

4.2.4 Interrelationships between tools

The tools detailed in this section all work together within the SOA Lifecycle to model, assemble, deploy, and manage SOA-compliant composite applications. Figure 4-12 on page 120 illustrates the interrelationship between the tools described here.



Development environment
Run-time environment
WebSphere Business Modeler
Build business processes
WebSphere Integration Developer
Build I/T processes
WebSphere Process Server
Requirements (application & process)
Rational RequisitePro
Document requirements
Rational Application Developer
Build Java services
WebSphere Application Server
WebSphere Studio Asset Analyzer
High-level asset analysis
WebSphere Developer for zSeries
Build traditional language services
CICS Transaction Manager
Existing z/OS applications
IMS Transaction Manager
Asset Transformation Workbench
Detailed source analysis and re-engineering
DB2 Universal Database (z/OS or distributed)

Figure 4-12 An overview of the SOA development tools

4.3 Pattern-driven approach - transition from "core" applications to services

IBM has established a methodology for designing IT systems that is based on "patterns." This methodology, under the umbrella of "Patterns for e-business"[4], analyzes a problem in the following sequence:

1. Examine *customer requirements* for the business problem.
2. Identify a *business pattern* that matches requirements.
3. Select an *Integration or Composite pattern* that narrows how the business problem is to be solved.
4. Select the appropriate *application pattern* that will determine how the application logic is partitioned.
5. Select a corresponding *runtime pattern* for the IT infrastructure.

[4] http://www-128.ibm.com/developerworks/patterns/

6. Use the *product mapping* for the runtime pattern to construct the specified operational infrastructure.

This pattern-driven approach accelerates the analysis and design of a solution by leveraging prior experiences and the similarities between those and the new business problem.

Similar to the approach used with the Patterns for e-business, it is appropriate to use such a process for examining existing core system assets and designing a solution based upon commonly-used “transition scenarios.”

Through our collective experiences and those of other organizations in IBM (such as IBM Global Business Services), we have identified the “starting scenarios” described in Chapter 3, “Starting scenarios” on page 55, the “SOA implementation scenarios” that we examine in Chapter 5, “SOA implementation scenarios” on page 131, and the sequence of events necessary to move from one to the other.

The transition approaches target different SOA “ambition” levels, or different levels of desired SOA maturity.

The use of techniques to move from “starting scenarios” to “implementation scenarios” is an IT-centric technique. It does not necessarily take into account the functional requirements of the application. It does, however, require consideration of the needs of the business, because there are non-functional requirements (NFRs) that must be considered, including performance, scalability, reliability, security, and so on. These will drive the selection of particular implementation technologies that fall within the end-point migration scenarios.

4.3.1 Starting scenarios

The starting scenarios are identified and described in Chapter 3, “Starting scenarios” on page 55. They require no further examination here.

4.3.2 Service interface patterns

When analyzing the various core system transformation projects in the IT world today, we see four basic service interface patterns[5] emerge; we identify each of them with a single letter (N, A, R, and B).

Note: In the associated diagrams, P represents presentation logic, B represents business logic, and D represents data access logic.

[5] The Legacy Transformation Practice of IBM Global Services has documented these four patterns as native, adapter, modularized, and brokered.

Native service interface (N)

The native service interface solution enables a core system for SOA by utilizing SOA features that are native to the transaction server, database manager, or whichever infrastructure component hosts the application component.

Frequently, support for protocols such as SOAP, JMS or WebSphere MQ are built in to those systems. An example of this is the CICS Web Services support included with CICS Transaction Server Version 3.1. In this new feature, existing CICS transactions may be accessed directly in CICS using Web services protocols (SOAP, WS-Security, and so on).

The native service interface pattern is shown in Figure 4-13.

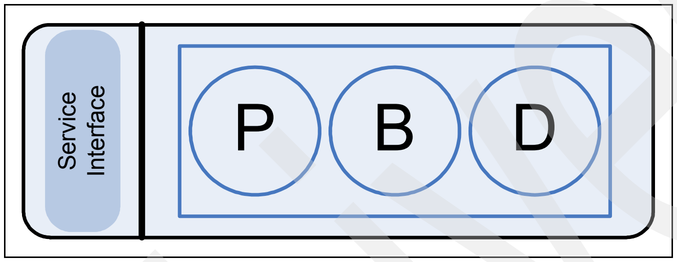


Figure 4-13 The native service interface pattern

Adapter-provided service interface (A)

In many cases, a core system is unable to communicate via service-oriented protocols, as in the native service interface pattern. In these situations, an adapter may be employed, if available, to translate between the proprietary interface to the system and SOA-compliant protocols.

The adapter usually "lives" outside the infrastructure component that hosts the application component to be service-enabled. Adapters have been employed in the past to provide integration with middleware such as Web application servers. In this pattern, the adapter provides an interface to SOA-based calling services.

The adapter pattern is illustrated in Figure 4-14.

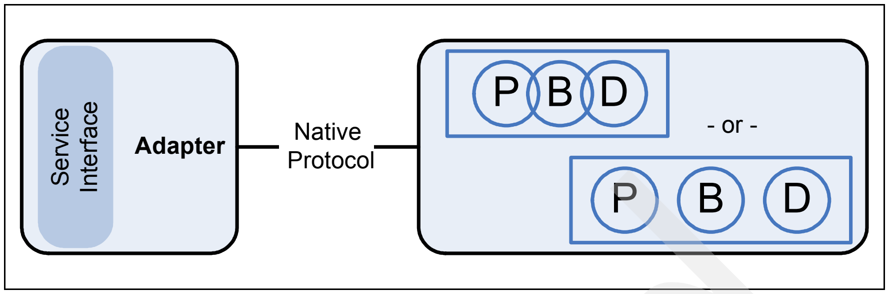


Figure 4-14 The adapter-provided service interface pattern

Brokered/mediated service interface (B)

It is often easier to employ an intermediary Enterprise Service Bus, or “broker,” to provide the service interface to the transitioned core application. The ESB can insulate the core application from the need to comply with new protocols, and it can transform the message content so it can be processed by other services that connect through the ESB.

Often, this brokered/mediated pattern involves the use of WebSphere MQ or JMS as a message transport. However, most message broker and ESB products can support multiple transport protocols, inbound and outbound.

The brokered/mediated service interface pattern is illustrated in Figure 4-15.

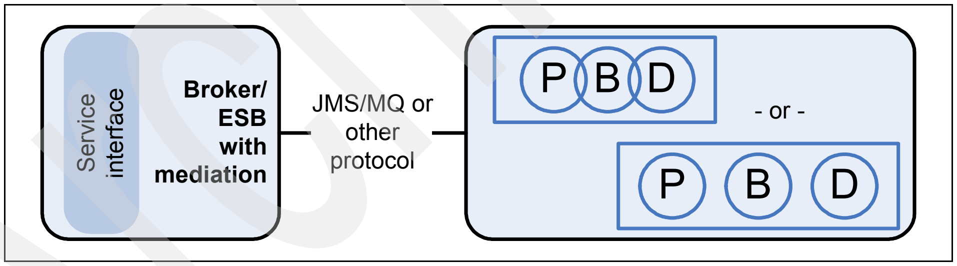


Figure 4-15 The brokered/mediated service interface pattern

Redeveloped code with native service interface (R)

The redeveloped code with native service interface pattern involves taking existing core system code and re-writing it to conform to SOA-compliant structure and protocols. This often involves refactoring the source code so it has a more “SOA-friendly” service structure. The newly-modularized code would then be invokable directly via SOA-compliant protocols, usually SOAP-over-HTTP or SOAP-over-JMS/MQ.

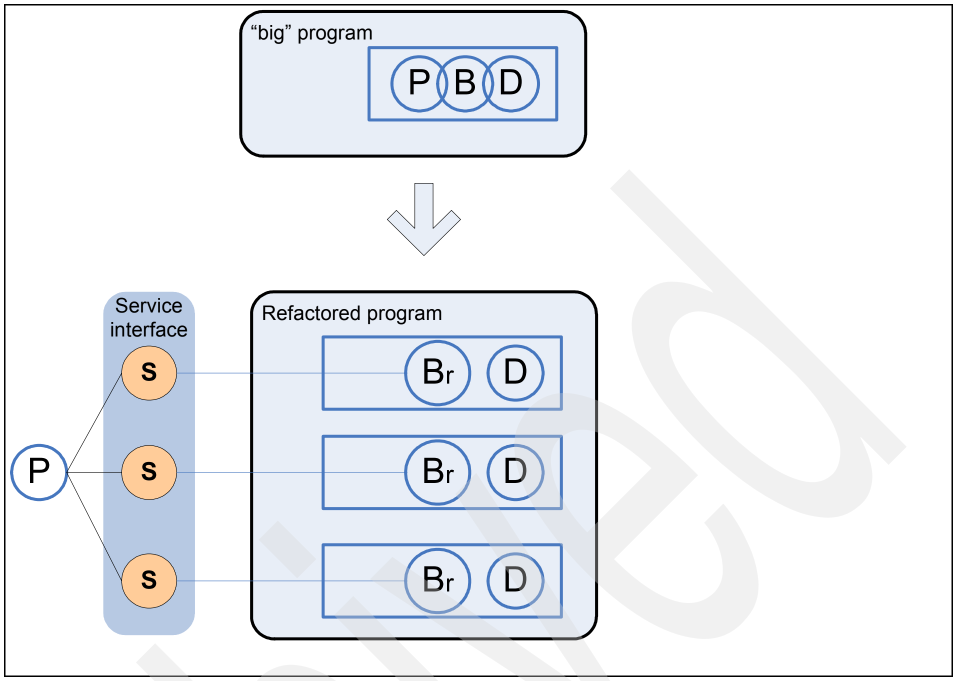


Figure 4-16 Refactoring of "big" program

Figure 4-16 illustrates how an application with presentation code and data logic that are highly dependent on each other is refactored into a clear separation of concerns. Presentation logic is completely taken out of from the refactored program, and is here considered to be a service consumer.

The refactoring pattern also covers how to find the right level of granularity on the services that are exposed.

4.3.3 Transition approaches

As architects examine the existing core system and determines its current implementation, they must determine which transition approach to use for service enablement. This will be driven largely by the technique chosen to perform the migration.

Inside each stage of maturity (Improve, Adapt, Innovate), we can apply different service interface patterns (native, adapter, brokered/mediated and redeveloped, as discussed previously). There are different levels of ambitions and cost associated with each step.

There are three primary approaches for transforming an existing core application, as discussed in “Improve the application” on page 125 through “Innovate by re-designing and re-developing the application” on page 126.

Improve the application

Using the Improve approach, we can distinguish between a flavor that involves a user interface and a flavor that does not involve a user interface.

Improve approach with a user interface

In this approach, the user interface, usually a 3270 interface, is wrappered inside a Web application server environment, and at the same time the application component is made callable as a service.

A common example is the wrapping of 3270 applications using middleware such as IBM Host Access Transformation Services (HATS). HATS can be used to wrap a native 3270 application as a Web Service, or to expose that 3270 application as a Web server application.

Improve approach without a user interface

In this scenario, we do not have an existing (3270) user interface and we only need to “wrapper” the call to the business logic. The wrapper communicates with the calling service using a standardized interface, and communicates with the wrapped application using that application’s native protocol.

The use of the Improve approach usually leads to the adoption of the N (native service interface) or A (Adapter-provided service interface) service interface pattern, as discussed in “Native service interface (N)” on page 122 and “Adapter-provided service interface (A)” on page 122, respectively.

Adapt the application connectivity

This approach is a bit more intrusive to the existing application than Improve.

To Adapt the connectivity implies separating business logic from the presentation and data logic. After this is done, the business logic can be accessed as a separate component and reused appropriately. Sometimes, an existing core application is already “componentized” so that the business logic can be accessed directly.

IBM has recommended this separation-of-concerns practice for CICS and IMS developers for many years. But older code often has all tiers of logic intertwined, making it difficult to split the logic. In this case, either a less invasive approach must be taken (Improve), or the application must undergo significant change and redesign (Innovate; see “Innovate by re-designing and re-developing the application” on page 126).

Use of the Adapt transition approach often leads to the adoption of the N, A, or B service interface patterns, since it usually requires the partitioning of the application logic.

Innovate by re-designing and re-developing the application

The Innovate approach is the most invasive to the application.

In this approach, the end result is a restructured, rewritten application that natively conforms to SOA-compliant standards and protocols. However, it is possible that the application may simply be partitioned and refactored, with all mediation and connectivity logic left to the mediation layer (Enterprise Service Bus).

The Innovated application is fully modularized, so that it can be more easily reused in the future. Use of the Innovate approach usually leads to the adoption of the R or B service interface patterns.

4.3.4 Service interface patterns and transition approaches - characteristics

The transition approaches and associated service interface patterns offer a number of advantages, disadvantages, and differentiating characteristics, as listed in Table 4-1.

Table 4-1 Characteristics of the service interface patterns and transition approaches

Service interface pattern	Common transition approach	Complexity	Relative cost	Relative performance
Native service interface	Improve	Low Create a native service interface for existing code code "as-is"	Low Requires no extra middleware, but uses either a "wrapper" or built-in Web services support	Medium
Native service interface	Adapt	Medium Frequently requires small amount of code modification to access partitioned business logic	Medium Requires no extra middleware, but does require more human interaction to modify code	Medium to High No intermediate middleware, but native transaction manager must translate between SOA protocol and native interface

Service interface pattern	**Common transition approach**	**Complexity**	**Relative cost**	**Relative performance**
Adapter-provided service interface	Improve or Adapt	Low to Medium If Improve, no changes to code Tooling and middleware accesses 3270 presentation logic directly If Adapt, potential need to partition code into business and presentation logic Additional middleware is required in both cases	Medium Requires additional middleware Code changes are not significant, particularly if an Improve migration technique is used	Low to Medium Middleware layer adds additional overhead, but can be mitigated if middleware is placed on same OS instance with application Improve solutions incur more overhead, as original user interface is still in use, invoked by adapter middleware
Brokered	Adapt	Medium Usually requires little code change if broker supports native application protocol or if adapters are used	Medium to High Although small amount of code change necessary, more middleware infrastructure required Required infrastructure can mitigate code changes and may be required for full SOA, regardless	Medium Intermediate middleware infrastructure required, adding some overhead, but usually uses native protocol between broker and application

Service interface pattern	**Common transition approach**	**Complexity**	**Relative cost**	**Relative performance**
Redeveloped	Innovate	High Involves significant re-engineering and rewrite of application code	High Personnel cost for code modification is high Tool cost can be high, but good tooling is critical to success of redevelopment High redevelopment cost can be offset in the long run by more efficient development for future SOA applications	Medium to High Modernization can result in more efficient code and modularization that maximizes efficiency of composite SOA applications

4.3.5 Applying transition approaches and service interface patterns

Similar to the Patterns for e-business, the use of starting and transition scenarios for core system transformation dictates a sequence of events that guide the migration from an identified starting pattern to a SOA-compliant system.

These steps describe a high level view of the transition process:

1. Identify a starting scenario, based upon the existing core system attributes.

   Chapter 3, “Starting scenarios” on page 55 provides a number of common starting scenarios.

2. Determine non-functional requirements (NFRs) and Quality of Service (QoS) requirements for the migrated system.

   The Service Level Agreements (SLAs) play an important role here.

3. Based upon NFRs, QoS requirements, and the desired SOA maturity level, select the appropriate transition approach (Improve, Adapt or Innovate).

   We discussed the Improve, Adapt, and Innovate approaches earlier in this chapter.

4. Decide on the desired service interface pattern, as discussed earlier in this chapter.

   The choices are native service interface, adapter-provided service interface, brokered/mediated service interface and redeveloped code with native service interface.

5. Choose the desired SOA implementation scenario(s).

   Refer to Chapter 5, “SOA implementation scenarios” on page 131 for a catalogue of the most useful scenarios.

6. Select the solution techniques that fit the technological environment.
7. Use appropriate core system modernization tools to perform the transition.

Important: These steps may have different outcomes for different applications that need to be SOA-enabled. However, one of the things to keep in mind is to try to focus on a common runtime for most of the new SOA applications.

5

SOA implementation scenarios

In this chapter we examine the process of moving from a certain starting scenario (as discussed in Chapter 3, “Starting scenarios” on page 55) to different levels of SOA enablement. We cover the following topics:

- A general process for making architectural decisions, discussed in 5.1, “The architectural decision process” on page 132.
- An analysis of how the three transition approaches (Improve, Adapt, Innovate) can be used to accomplish the SOA enablement. We provide runtime topologies for each SOA implementation scenario. In some cases, the tools needed to accomplish the migration are also discussed.
- A brief review of the advantages and disadvantages of the different options for each scenario/approach.
- A sample decision process review to illustrate how a company might select the appropriate transition approach and technologies appropriate to the SOA implementation scenario.

5.1 The architectural decision process

After an architect has identified the starting scenario for the existing application, the analysis process quickly moves to the question, “How should I make this application SOA-enabled?” The selection of a transition approach and the associated transition process is as much an art as a science. The architect must take into account many technical factors, as well as some that have nothing to do with the structure of the application or the existing IT infrastructure.

There are many architectural methodologies in the IT world. IBM uses several design methods, including the IBM Global Services Method, TeAMethod, Rational Unified Process (RUP), and a number of others originating inside and outside IBM. In general, a methodology for creating a solution architecture involves several basic steps:

1. Examine the existing IT environment.
2. Analyze the customer requirements, both functional and non-functional.
3. Study use cases to ensure that requirements are met.
4. Define the system context.
5. Develop the architectural overview, based upon architectural decisions.
6. Develop an operational (physical) architecture.

There are several key areas of the architectural methodology that are of interest, as described next.

5.1.1 The existing IT environment

Many aspects of the existing IT environment will drive the selection of a particular transition approach (Improve, Adapt, Innovate), service interface pattern (native service interface, adapter-provided service interface, brokered/mediated service interface or redeveloped code) and SOA implementation scenario; for example:

- What are the current release and maintenance levels of the z/OS-based transaction and database managers (IMS, CICS, DB2, WebSphere, other non-IBM systems)?
- What products are installed?
- What existing “SOA infrastructure” products are installed (such as WebSphere Application Server, WebSphere MQ, WebSphere Process Server, and so on)?
- What languages and compilers are in use?
- What languages were used to create the application in question?

- What IT architecture and product standards are in place?
- And so on.

Most of the transition approaches have multiple options for implementation, and several of the solution techniques require certain products or releases to be present. The presence (or lack) of a required product will often drive the decision to a particular variation.

5.1.2 Functional and non-functional requirements

Functional requirements describe *what* a solution does. Non-functional requirements (NFRs) describe *how* a solution does what it does. An example of a functional requirement is “the solution must present a window with the customer’s name, address and phone number”. An example of a non-functional requirement is “the solution must provide one second response time to the end user.”

Note: We discuss the QoS of the z/OS platform associated to the NFRs discussed in this section in more detail in Chapter 8, “SOA and z/OS Quality of Service” on page 273.

When selecting a transition approach to enable an application for SOA, the non-functional requirements tend to be the most important to making decisions. The non-functional requirements that are of greatest interest include:

- Performance

  How “fast” must the solution function? Is the measurement of end-user response time or internal? The use of Service Level Agreements (SLA) is important, so is the performance of the solution meeting the requirements agreed upon by the end-user community?

  – When selecting a solution, choose the option that provides optimal performance while still fulfilling the remainder of the functional and non-functional requirements. The best-performing solution is not always the best solution overall.

- Scalability

  An application that scales is one that can provide an increased transaction load without impacting the Quality of Service provided. Different infrastructure options provide differing scalability options. For example, a message broker on a particular server model can process a certain number of messages per second. How can that number be increased (scaled)? By adding more server instances (horizontal scaling)? By increasing the capacity of the hardware (vertical scaling)?

  – When selecting a solution, ensure that the technical variation uses components that can be scaled to increase the transaction rate to meet requirements.

- Flexibility

  Flexibility is a rather nebulous concept, but an important one. One of the key aspects of SOA is to provide a more flexible environment for implementing new applications and changing existing ones. SOA introduces flexibility by abstraction of functions such as network protocols, mediation of message content, workflow, and provides separation of business logic from the other parts of the application. This allows the developer to more easily assemble composite applications from the "parts", which are the services.

  – When selecting a solution, ensure that flexibility is maximized while maintaining the other requirements. A more flexible solution may save money in the long run, even though it may introduce additional performance overhead or other "negatives."

- Reliability and availability

  Reliability and the related concept of availability define how *resilient* the application is to failures in the application itself and in the hardware and software infrastructure that supports it. Reliability and availability are impacted by the complexity of the infrastructure (points of failure) and the means by which the components recover from failure. Often, mechanisms such as server clustering and failover can improve reliability and availability by maintaining application availability even though one instance of the infrastructure component or application has failed.

  – When selecting a solution, be aware of the ways that the components maintain availability. Some variations have more complex infrastructures than others, and as a result have more potential points of failure. Be prepared to mitigate potential failure points by using the middleware facilities such as clustering. Resist the temptation to eliminate middleware simply because of availability issues; often, middleware provides value that offsets its potential for failures. Removing a component such as an ESB may slightly improve overall availability, but it can greatly reduce the flexibility of the solution, incurring additional cost.

- Security

  Security requirements usually relate to two functions: authentication and authorization. In other words, how does the solution allow for the verification of the individual's identity, and how does it authorize the user to access resources? Also, functions such as encryption and key management are important to the security of SOA-based solutions. Some computing platforms (z/OS, for example) tend to be inherently more secure than others. Platform security usually depends on the presence of operating system security managers, such as RACF, or other inherent hardware or software security features, including mainframe features such as hardware-based encryption, storage protect keys, and built-in public-key certificate infrastructures.

  – When selecting a solution, consider the security features of the platform where the services and the infrastructure will reside. Consistent with SOA principles, make sure that as many of the security functions as possible can be externalized from the services and defined in the security infrastructure.

- Skills

  The presence (or lack) of skills is often one of the main architectural decision criteria. Does the programming staff have skill in the needed programming languages? Does the proposed solution introduce new infrastructure components that will require training? How many administrators will the solution require? Does the solution introduce new operating systems? The cost of acquiring skill and the personnel with the skills must be considered when designing the solution.

  – When selecting a solution, consider the types of skills necessary, in service development and in administration of the middleware included. Although an SOA implementation is intended to reduce development time and simplify the development process, it often increases the complexity of the infrastructure, and new skills may be needed to administer the underlying SOA middleware.

- Organizational “ideology”

  The ideology (or “politics”) of an organization can be the most sensitive decision point to deal with when designing a solution. Everyone, even consultants who are supposed to be unbiased, has personal preferences. There is often an institutionalized bias against particular solutions. For example, a team may have had a bad vendor experience or dealt with a product that was particularly problematic, and therefore has a bias against that vendor or product. The corporate or IT leadership may have been hired from another company that did things a certain way, and their familiarity with that method or technology influences their decisions. There are many factors that influence organizational ideology, and not all of them are based on fact or logic. The architect must be aware of these “preferences” and design a solution that takes them into account

  – When selecting a solution, be aware of the informal preferences of the organization, particularly of those who will be approving the architectural decisions. If selecting an infrastructure component or a platform that is in jeopardy due to ideology issues, be prepared to back the selection with reasonably unbiased evidence and comparisons with other options. Using a standardized architectural decisions document is a useful approach for documenting the decision process.

5.1.3 The architectural overview and operational architecture

The IT architect is often tempted to proceed directly to the creation of the architectural overview and definition of a physical/operational architecture without performing a complete analysis and architectural decision process (a "dinner napkin" design). However, the other steps in the process mentioned earlier are critical to arriving at a working architecture that is well-documented and justifiable to the decision-makers in the enterprise.

The definition of the target architecture by using the pattern-based approach described in this IBM Redbook helps build an architecture overview and a physical architecture by using established patterns, rather than by "building from scratch." The patterns described here do not represent the complete solution, but are starting points for building the architectures that enable migration to an SOA-based architecture from the starting scenarios described in Chapter 3, "Starting scenarios" on page 55.

5.1.4 Selecting a transition approach and solution technique

The architectural decision process detailed in 5.1, "The architectural decision process" on page 132 should be applied to the selection of the transition approach, solution technique, and SOA implementation scenario. An architect has to find answers to the following questions:

- What is the current IT infrastructure?

  Depending upon the existing IT environment, some of the solution techniques may or may not make sense. Some solution techniques require specific products or releases.
- What does the existing core application do? How is it implemented?
- What starting scenario does the existing application map to?
- What are the requirements for the new, SOA-compliant service that is being designed?

  In particular, the non-functional requirements will drive the selection of a solution technique.

- How much time and effort can you expend on this solution; that is, it a “quick-fix” project, or are you building a service that is expected to have a long lifespan?

  The answer to this question will provide a great deal of insight into determining whether to use an Improve, Adapt, or Innovate transition approach to modernization and service enablement.

- What resources and skills are available to perform the work?

  If developer resources are scarce, for example, then a transition approach or solution technique that depends upon code changes may not be a good idea. Or, if an organization has no Java resources and the solution is based on WebSphere Application Server and Java, then that solution may not be a good choice.

- How much funding is available?

  If funding is unavailable, then a solution technique that requires new infrastructure may not make sense.

Given the answers to these and other questions, the architect can examine the transition approaches and solution techniques and determine which approach and solution technique is best for the organization. The architect should evaluate each option with those questions and the NFRs in mind.

5.2 SOA implementation scenarios for a 3270 application

In 3.2, “Starting scenario - 3270 application” on page 56, we describe the typical 3270 application as a starting scenario. Here, we describe *variations* of the SOA implementation scenarios for 3270 applications.

Table 5-1 lists the variations discussed throughout this section.

Table 5-1 Summary of 3270 transition variations

Transition approach	Variation	Described in
Improve	Variation 1: service enablement of 3270 programs using IBM Host Access Transformation Services (HATS)	“Variation 1: IBM Host Access Transformation Services (HATS)” on page 140

Transition approach	Variation	Described in
Improve	Variation 2: service enablement of CICS transactions using the CICS Service Flow Feature (CICS Transaction Server V3.1)	“Variation 2: CICS Service Flow Feature (CICS Transaction Server V3.1)” on page 142
Improve	Variation 3: service enablement of IMS 3270 transactions using the IMS MFS Web Services Support feature	“Variation 3: IMS using MFS Web Support” on page 144
Adapt	Variation 1: service enablement using Web Services support in CICS	“Variation 1: Native Web services access to CICS transactions” on page 148
Adapt	Variation 2: service enablement using J2C connector (CICS TG) to CICS	“Variation 2: J2EE Connector Architecture access to CICS” on page 150
Adapt	Variation 3: service enablement using WebSphere MQ/JMS access to CICS	“Variation 3: WebSphere MQ access to CICS” on page 152
Adapt	Variation 4: service enablement using J2C connector (IMS Connect) to IMS	“Variation 4: Using IMS Connect” on page 154
Adapt	Variation 5: service enablement using IMS SOAP Gateway to access IMS	“Variation 5: Using the IMS SOAP Gateway” on page 156
Adapt	Variation 6: service enablement using WebSphere MQ/JMS access to IMS	“Variation 6: Using the WebSphere MQIMS Bridge” on page 159
Adapt	Variation 7: service enablement and integration using an ESB	“Using the Adapt approach with a broker/ESB” on page 161

Transition approach	Variation	Described in
Innovate	Redeveloped code with a clear separation of concerns and high reusability.	5.2.3, “Using the Innovate transition approach” on page 162

5.2.1 Using the Improve transition approach

Following the Improve transition approach for 3270 applications generally involves providing a new front-end interface. Many customers simply choose to implement a HTML/Web front-end on the 3270 application. However, this does not provide a SOA-compliant service interface.

Because improving the application addresses the problem at the user interface, an Improve solution interacts with the existing application via the 3270 data stream. All input and output messages to the 3270 application are done via the 3270 native protocol, and no changes are made to the underlying application

The logical architecture for an Improve approach is shown in Figure .

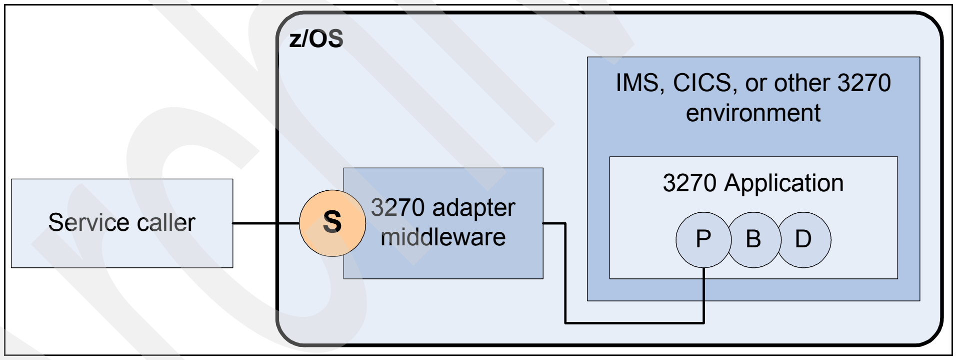


Figure 5-1 Logical architecture for Improve approach

Note: In the diagrams in this chapter, the service interface is represented by the circle with a letter S. The placement of the service interface is important to the architecture of the SOA-enabled host solution, and the solution technique used for the solution dictates the location of that service interface.

Solution techniques for Improve approach

When using an Improve transition approach against a 3270 starting scenario, all of the solution techniques follow the adapter-provided service interface pattern (refer to "Adapter-provided service interface (A)" on page 122). A 3270 presentation adapter is used to translate between the incoming Web Services messages and the 3270 data stream. The variations discussed differ from the rest of the adapter patterns in their native access to 3270 presentation logic.

The remainder of the adapter-provided service interface pattern variations, described in "Adapter-provided service interface (A)" on page 122, are derived from the Adapt transition approach. They access the 3270 application's business logic directly, bypassing the 3270 layer.

We now look at three solution techniques for the Improve approach and the adapter-provided service interface pattern:

- IBM Host Access Transformation Services (HATS)
- CICS Service Flow Feature (SFF)
- IMS MFS Web Services support

Variation 1: IBM Host Access Transformation Services (HATS)

A common approach to Improve is the use of the Host Access Transformation Services (HATS) product. HATS is a WebSphere application that performs two main functions:

- Translate a 3270 application into a Web interface
- Translate a 3270 application into a Web Services interface

This is accomplished with a combination of the HATS runtime and tooling running under Rational Application Developer (RAD). The HATS developer uses the HATS "perspective" in RAD to navigate through the 3270 application and capture the various inputs, outputs, and record the interactions needed to communicate with the 3270 application.

The process generates a series of integration objects, that is, Java beans that can subsequently be used in either a Web server interface or to generate a SOA/Web services interface. These Java beans are deployed to the WebSphere Application Server and run using WebSphere and the HATS runtime. HATS can be used to service-enable *any* 3270 (or 5250 or VT-based) transaction, including CICS, IMS, TSO, and so on.

Solution technique implementation

The HATS variation is an implementation of the adapter-provided service interface pattern. HATS, running in WebSphere, is the "adapter" that transforms the inbound Web Services protocol into a 3270 data stream that is understood by the host application. In a HATS solution, the service interface is provided by WebSphere Application Server, because the services are running inside WebSphere Application Server.

Process overview

SOA-enabling a 3270 application using HATS involves several steps:

1. The developer uses the HATS perspective in RAD to navigate through the 3270 application and records the user interactions, input and output fields, etc.
2. The developer creates Java beans from the HATS artifacts.
3. The developer uses Web services wizards in RAD to create services from the HATS Java beans.
4. The developer deploys Java artifacts to WebSphere Application Server.
5. The Java artifacts may be exposed as services.

Figure 5-2 shows the HATS (running on z/OS) Web services solution.

Note: This is only one topology for running HATS. The HATS server is also supported on distributed platforms, including Linux and Windows.

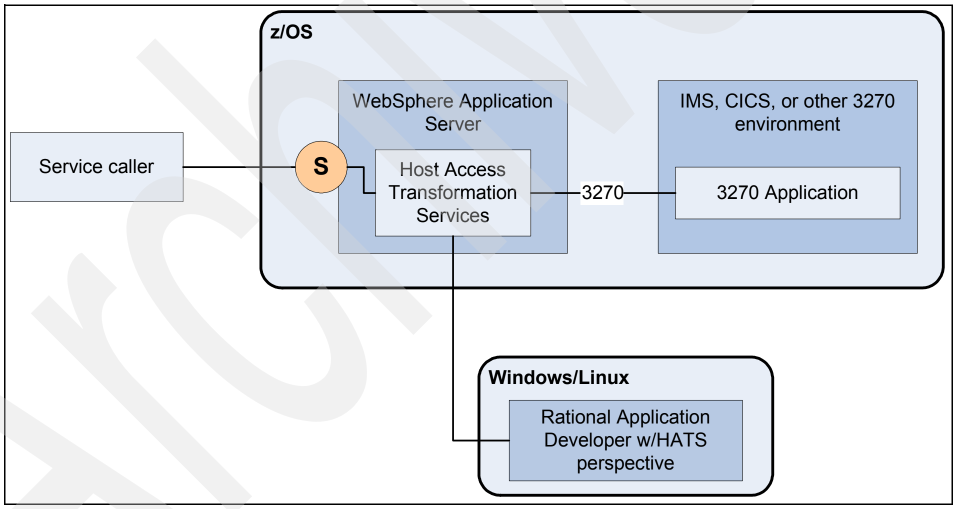

z/OS
WebSphere Application Server
IMS, CICS, or other 3270 environment
Service caller
S
Host Access Transformation Services
3270
3270 Application
Windows/Linux
Rational Application Developer w/HATS perspective

Figure 5-2 Improve using IBM Host Access Transformation Services (HATS)

For detailed information

- *Host Access Transformation Server Concepts and Architecture*, REDP-3706

  `http://www.redbooks.ibm.com/abstracts/redp3706.html`
- *Using IBM WebSphere Host Access Transformation Services* V5, SG24-6099

  `http://www.redbooks.ibm.com/abstracts/sg246099.html`

- Online InfoCenter

  http://publib.boulder.ibm.com/infocenter/hatshelp/v60/index.jsp

Variation 2: CICS Service Flow Feature (CICS Transaction Server V3.1)

In CICS Transaction Server V3.1, a new feature is available to Improve CICS applications. The Service Flow Feature, announced in November 2005 (Announcement Letter 205-303) is a no-charge, separately-orderable feature that allows the developer to create CICS business services that are composed of a sequence of CICS application interactions. These applications may be 3270 applications or other CICS applications that do not use the 3270 interface.

Service Flow Feature is comprised of two components, the Service Flow Modeler (SFM) and the Service Flow Runtime (SFR), which are explained here:

- Service Flow Modeler (SFM) is used to model the flow between CICS services, create the interactions with the CICS applications (3270 and non-3270 COMMAREA-accessible), and expose these services as a Web service.
- Service Flow Runtime (SFR) delivers the adapters and other supporting code to execute the flows and 3270 interactions created using the Service Flow Modeler.

The Service Flow Modeler (SFM) is a feature of WebSphere Developer for zSeries (WDz), an Eclipse-based development tool built on top of the Rational Application Developer base. CICS Service Flow Feature ships with a number of limited-use licenses of WDz, specifically for use with Service Flow Feature and the CICS Web Services feature. If a customer wants to use WDz for purposes other than the creation of CICS Web services or SFM flows, the customer must purchase a license for the full WDz product.

In a Service Flow Feature solution, the service interface is provided by CICS itself, because the CICS Transaction Server has its own SOAP listeners, provided by the CICS Web Support or the WebSphere MQ Trigger Monitor.

Solution technique implementation

Although the CICS Service Flow Feature solution is generally considered to fit an adapter-provided service interface pattern, it could also be considered a “native service interface” pattern, because the adapter function and the Web service interface are entirely self-contained within the CICS transaction manager.

Process overview

SOA-enabling a 3270 CICS application using the Service Flow Feature solution involves the following parts of the process:

1. The developer uses the CICS Service Flow Modeler in WDz to define the 3270 interactions and flows between 3270 programs (if required).
2. The developer generates artifacts to be deployed to CICS (message adapters, server adapters, JCL to create RDO definitions and properties files, and so on).
3. The artifacts are transferred to CICS.
4. Service is ready for use.

Figure 5-3 shows the physical architecture for a CICS Service Flow Feature SOA solution technique.

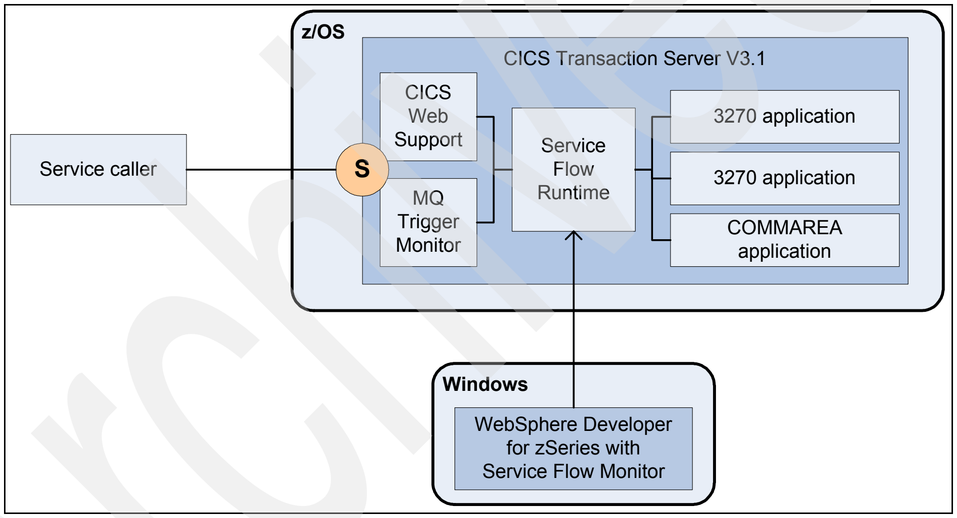


Figure 5-3 Improve CICS applications using CICS Service Flow Feature

For detailed information

- *Application Development for CICS Web Services*, SG24-7126 (refer to Chapter 7):

  http://www.redbooks.ibm.com/abstracts/sg247126.html

- *CICS Service Flow Feature for CICS TS for z/OS V3.1 Run Time User's Guide*, SC34-5899

  http://www-306.ibm.com/software/htp/cics/tserver/v31/library/

- Online InfoCenter (refer to “CICS Service Flow Runtime V3.1”):

  http://publib.boulder.ibm.com/infocenter/cicsts/v3r1/index.jsp

Variation 3: IMS using MFS Web Support

Message Formatting Services (MFS) is an IMS facility that formats messages to and from terminal devices and IMS application programs. It is used to separate the application logic from the device logic, and is illustrated in Figure 3-4 on page 59.

IMS MFS Web Support is a solution that enables IMS MFS applications to be published as Web services, EJBs or Java Beans. It consists of two parts, IMS MFS Web Services support, and IMS MFS Web enablement, as explained here:

- IMS MFS Web services support

  Figure 5-4 illustrates IMS MFS applications being exposed as a service using IMS MFS Web services support.

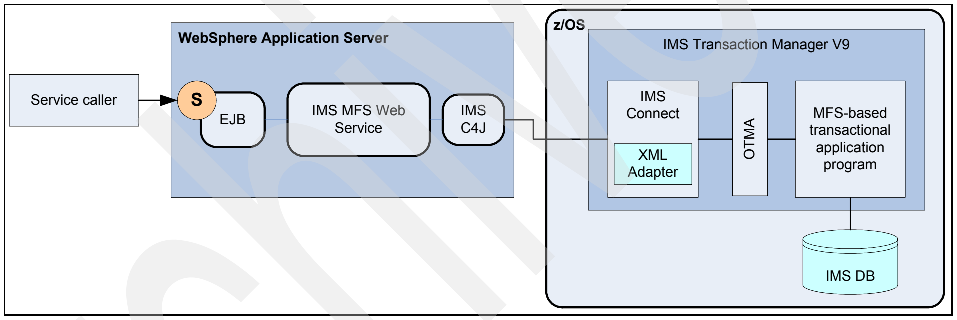
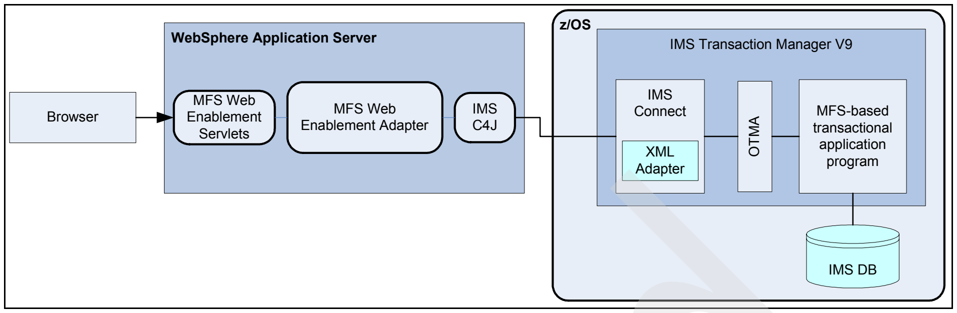

Service caller
WebSphere Application Server
S
EJB
IMS MFS Web Service
IMS C4J
z/OS
IMS Transaction Manager V9
IMS Connect
XML Adapter
OTMA
MFS-based transactional application program
IMS DB

Figure 5-4 Overview of IMS MFS Web services support

- IMS MFS Web enablement

  Figure 5-5 on page 145 shows IMS MFS applications being reused as a Web application. In this case, there is no service interface. This is called the IMS MFS Web Enablement support, which is also part of IMS MFS Web Support.



WebSphere Application Server
Browser
MFS Web Enablement Servlets
MFS Web Enablement Adapter
IMS C4J
z/OS
IMS Transaction Manager V9
IMS Connect
XML Adapter
OTMA
MFS-based transactional application program
IMS DB

Figure 5-5 Overview of IMS MFS Web enablement

Solution technique implementation

Both IMS MFS Web services and IMS MFS Web enablement implement the adapter-provided service interface pattern because they translate between a proprietary protocol and an SOA-compliant protocol.

Process overview

There are the process steps for the IMS MFS Web services solution:

1. A developer uses the IMS MFS Web services tooling that is included in WebSphere Integration Developer (WID), and imports the required MFS source files.
2. The service is defined from the MFS source file, and the following artifacts are generated:
   - XMI files
   - MID/DIF
   - MOD/DOF
   - MFS table
   - WSDL
3. From WSDL files, the following are generated:
   - Input/Output Beans
   - Format Handlers
   - Service Proxies
4. Service is published and deployed to WebSphere Application Server, which makes it available as a Web service, EJB, or Java bean.

For the IMS MFS Web enablement solution, the process is more or less the same, except that there is no WSDL or EJBs generated. Instead, there are Java servlets and stylesheets generated, that will be deployed in WebSphere Application Server.

Observations about using the Improve transition approach with the SOA implementation scenario for a 3270 application

Advantages:

- It offers quick implementation, including simple tooling and deployment and quick time-to-market.
- There is no impact on existing applications.
- It offers low complexity.
- HATS is a generalized 3270 adapter (a “universal 3270 adapter”) that functions with *any* 3270 application.
- With the CICS Service Flow Feature variation, no additional software required, other than CICS Transaction Server V3.1
- CICS Service Flow Feature performs the service enablement inside CICS, reducing points of failure and overhead.

Disadvantages:

- The HATS variation requires additional software (HATS, WebSphere Application Server).
- There is additional overhead incurred at the 3270 translation layer.
- Modifications to the 3270 user interface can impact the functionality of integration.
- Service granularity is impacted. IMS 3270 transactions are not designed for participating in an SOA, and may not have the right granularity for being invoked as a service.

  Thus, it may be necessary to perform service modeling techniques in order to achieve the right level of granularity and reuse.

5.2.2 Using the Adapt transition approach

An Adapt transition approach for transforming a 3270 application to SOA requires *direct* access to the business logic of the application, and it bypasses the 3270 presentation layer. This may be a relatively easy task, depending upon the structure of the existing application code.

For example, some CICS applications have been partitioned to separate the presentation interface from the business and data logic. Older CICS applications often have the presentation and BMS code interspersed within the business logic. In programs where the logic is partitioned, a COMMAREA construct is often used to pass parameters between the calling programs and the called programs.

In CICS, this calling approach is known as Distributed Program Link (DPL). Most of the variations to those solution techniques which use an Adapt transition approach require a COMMAREA (or a similar construct in IMS) to function.

The logical architecture for the solutions based on an Adapt transition approach is shown in Figure 5-6.

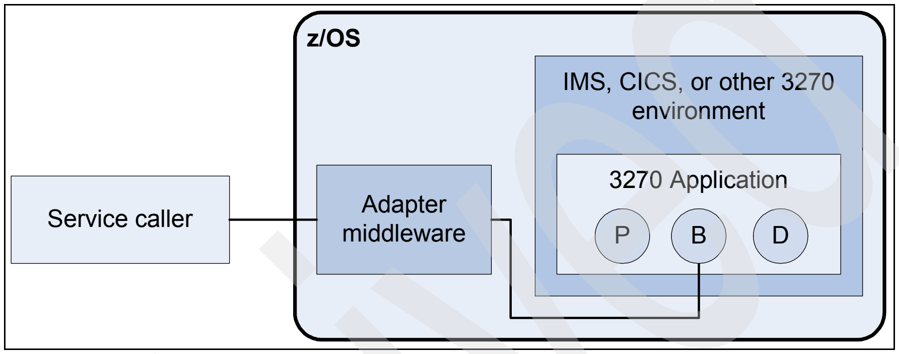


Figure 5-6 Logical architecture for the Adapt transition approach

Solution techniques for Adapt transition approach

Solutions derived from the Adapt transition approach all access the business logic directly, with no “reuse” of the 3270 business logic. There are three service interface patterns (refer to 4.3.2, “Service interface patterns” on page 121) that are the end result of an Adapt transition approach:

- Native service interface

  Application code is partitioned and business logic is accessed directly within the bounds of the transaction manager or database server. The “adapter middleware” and the service interface are provided natively, inside the transaction manager or database server and not by an external software product or component.

- Adapter-provided service interface

  Application code is partitioned within the transaction manager or database server, making business logic directly accessible. The service interface is placed in the “adapter.” External middleware is used to provide the adapter functionality.

- Brokered/mediated service interface

  Application code is partitioned in the transaction manager or database server, making business logic directly accessible. The service interface is provided by a broker or ESB. Applications are often accessed via a messaging protocol (JMS or WebSphere MQ). The support for those protocols can either be native to the application, or provided by the transaction manager or database server. Modern brokers, now referred to as the Enterprise Service Bus (ESB), can integrate with existing transactions using other protocols, such as SOAP or native interfaces to transaction systems.

Variation 1: Native Web services access to CICS transactions

Beginning with CICS Transaction Server Version 2.3, a native SOAP interface to CICS transactions became available. In Version 2, this was known as the SOAP for CICS feature and it was a separately orderable CICS feature.

As of CICS Transaction Server Version 3.1, the support for SOAP has been enhanced and is now known as the CICS Web Services feature. In the Version 3.1 feature, the new WS-I standards[1] such as WS-Security, WS-Basic Profile, and WS-Transaction are supported. In addition, the creation of COMMAREA-to-XML mappings and other related "adapter code" creation tasks have been simplified.

The CICS Web Services feature provides a SOAP interface to existing CICS transactions. SOAP can flow via either HTTP or JMS/MQ, and there is support for either inbound (CICS as a service provider) or outbound (CICS as a service consumer) requests. Inbound/outbound SOAP messages are processed by a CICS BTS pipeline which removes the payload from the SOAP message and parses the XML contents to produce a COMMAREA or a CONTAINER to be passed to (or from) the CICS program that is being called (or that is calling out).

Solution technique implementation

The CICS Web Services feature is an implementation of the native service interface pattern. SOA-compliant connectivity to the CICS application is provided natively by CICS Transaction Server via the Web Services feature. All connectivity and processing of the inbound and outbound Web services protocols is handled by CICS. The service interface is located inside CICS, and is provided by the CICS Web Services feature.

Process overview

SOA-enabling a 3270 CICS application using the CICS Web Services feature is known as a "bottom-up" implementation. It involves these steps:

1. Obtain the CICS application language structures (COPYBOOKs) and modify or simplify them if necessary.

[1] Details on the Web Services Interoperability Organization and its standards can be found at `http://www.ws-i.org`

2. Using the language structures as input, run the CICS Web Services Assistant to generate the WSDL, WSBind files, and other artifacts to be deployed to CICS, and deploy them to the z/OS HFS.
3. Define the necessary resources to CICS, including the transport (HTTP or MQ) PIPELINE, URIMAP and WEBSERVICE definitions.
4. Test and use the service.

Figure 5-7 shows the physical architecture for an SOA solution based on CICS Web Services.

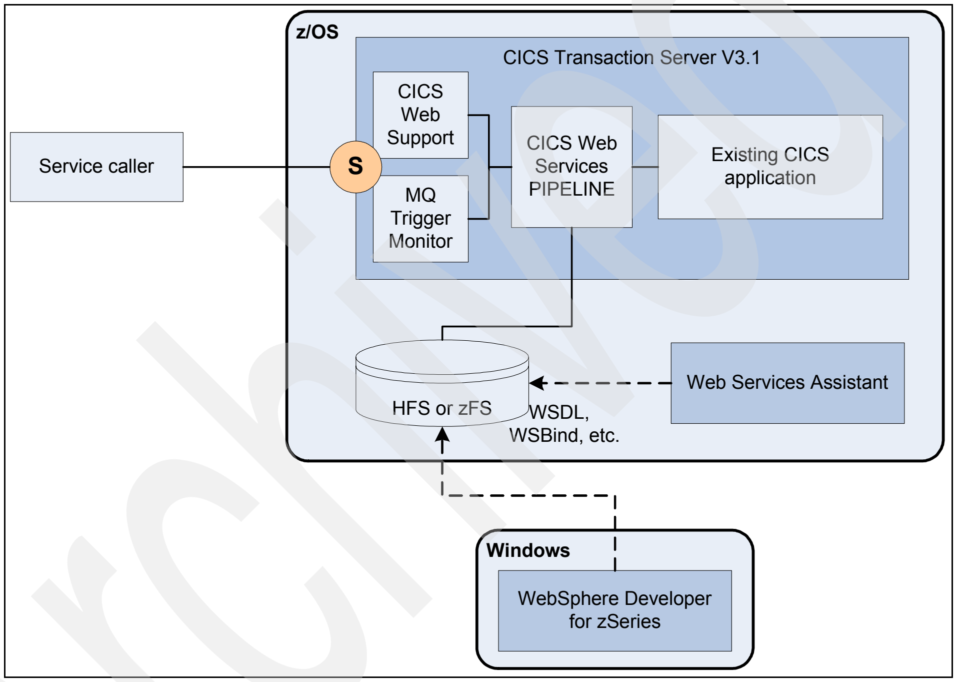

z/OS
CICS Transaction Server V3.1
CICS Web Support
S
MQ Trigger Monitor
CICS Web Services PIPELINE
Existing CICS application
Service caller
HFS or zFS
WSDL, WSBind, etc.
Web Services Assistant
Windows
WebSphere Developer for zSeries

Figure 5-7 Adapt CICS applications using CICS Web Services

For detailed information

- *Application Development for CICS Web Services*, SG24-7126

  http://www.redbooks.ibm.com/abstracts/sg247126.html

- *Implementing CICS Web Services*, SG24-7206

  http://www.redbooks.ibm.com/abstracts/sg247206.html

- *CICS Web Services Guide*, SC34-6458

  http://www-306.ibm.com/software/htp/cics/tserver/v31/library/

- Online InfoCenter

  http://publib.boulder.ibm.com/infocenter/cicsts/v3r1/index.jsp

Variation 2: J2EE Connector Architecture access to CICS

CICS provides the ability to invoke a transaction from a Java2 Enterprise Edition (J2EE) application program. The J2EE Connector Architecture (J2C, or J2CA) is the standard mechanism for calling applications from a J2EE program synchronously. It is used to invoke applications running in IBM transaction managers including IMS and CICS, and other “Enterprise Information Systems” such as PeopleSoft®, SAP®, Oracle® ERP, and others.

An overview of the J2EE Connector Architecture is shown in Figure 5-8.

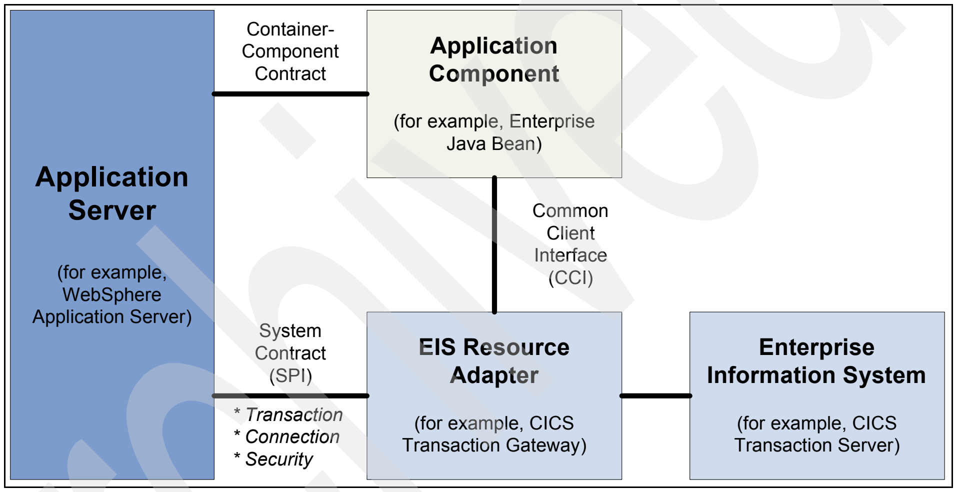

Application Server
(for example, WebSphere Application Server)
Container-Component Contract
Application Component
(for example, Enterprise Java Bean)
Common Client Interface (CCI)
System Contract (SPI)
* Transaction
* Connection
* Security
EIS Resource Adapter
(for example, CICS Transaction Gateway)
Enterprise Information System
(for example, CICS Transaction Server)

Figure 5-8 J2EE Connector Architecture

CICS transactions can be invoked via the J2C API from within a J2EE program. A J2EE application running in an application server that supports J2C, such as the WebSphere Application Server, can use the J2C classes to call a transaction.

The EIS Resource Adapter, as shown in Figure 5-8, is an “intermediary” that transforms the J2C syntax into a form that the EIS understands. To access CICS Transaction Server applications, the IBM implementation of the EIS Resource Adapter is the CICS Transaction Gateway (CICS TG). CICS TG transforms the native Java J2C API into calls to the CICS transactions.

As with the other Adapt solutions, the CICS program’s business logic must be separate from the presentation logic and DPL-accessible through a COMMAREA. CICS TG takes the input parameters from the J2EE program, formats them into a CICS-acceptable COMMAREA, invokes the program, and passes the response back to the J2EE caller.

The Rational Application Developer tool and its J2EE Connector Tools feature provide wizards and Java classes to assist the developer in building J2EE applications that use J2C to access a CICS program. Chapter 6 of IBM Redbook *WebSphere for z/OS Version 6 Connectivity Handbook*, SG24-7064, provides details on the development process.

Solution technique implementation

The J2C access to CICS variation is an implementation of the adapter-provided service interface pattern. The J2EE application running in the Web application server (WebSphere Application Server or other compatible server), combined with the CICS Transaction Gateway, provide an “adapter” that is external to CICS. The service interface is located in the Web application server.

Process overview

The major steps for developing a service that uses J2C access to CICS are as follows:

1. Install and customize the CICS Transaction Gateway.
2. Obtain the CICS application language structures (COPYBOOKs) and modify or simplify them, if necessary.
3. Use Rational Application Developer and the appropriate wizards to generate Java classes that populate the fields in the COMMAREA to be passed to the CICS transaction and call the transaction.
4. Use RAD’s Web services wizards to define the service interface to the J2C application and produce the WSDL.
5. Deploy the resulting EAR file and other artifacts to WebSphere Application Server.
6. Access the service.

Figure 5-9 on page 152 shows the physical architecture for a SOA solution based on J2C access to CICS.

Note: There are several different topology implementation options for WebSphere Application Server and CICS Transaction Gateway. For example, both the WebSphere Application Server and the CICS Transaction Gateway can run “off platform” on distributed servers. IBM Redbook *ICS Transaction Gateway for z/OS Version 6.1*, SG24-7161, describes the topology options and their implementation processes. Figure 5-9 shows the “z/OS-centric” topology.

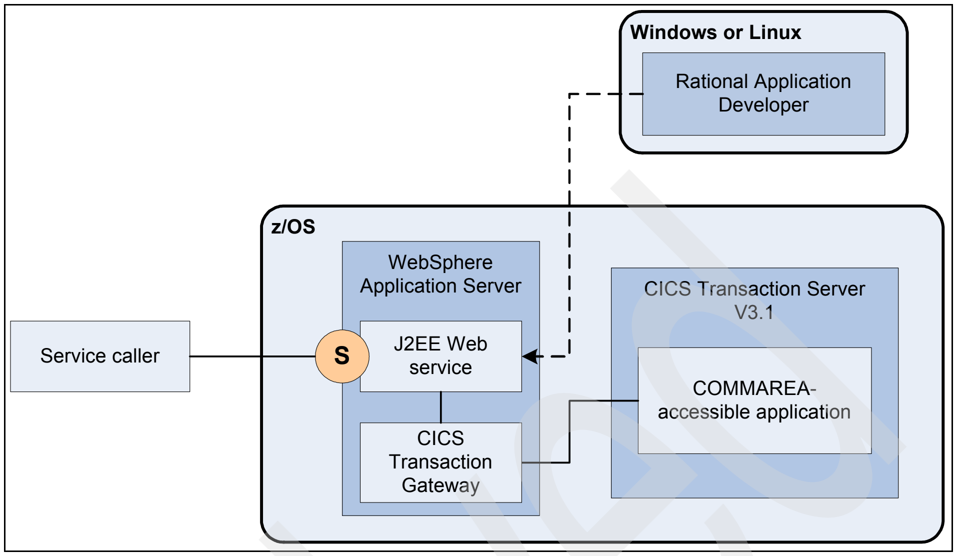

Windows or Linux
Rational Application Developer
z/OS
WebSphere Application Server
Service caller
S
J2EE Web service
CICS Transaction Gateway
CICS Transaction Server V3.1
COMMAREA-accessible application

Figure 5-9 Adapt CICS applications using the J2EE Connector Architecture

For detailed information:

- *CICS Transaction Gateway for z/OS Version 6.1*, SG24-7161

  `http://www.redbooks.ibm.com/abstracts/sg247161.html`
- *Revealed! Architecting e-business Access to CICS*, SG24-5466

  `http://www.redbooks.ibm.com/abstracts/sg245466.html`
- *WebSphere for z/OS V6 Connectivity Handbook*, SG24-7064

  `http://www.redbooks.ibm.com/abstracts/sg247064.html`
- *WebSphere for z/OS to CICS and IMS Connectivity Performance*, REDP-3959

  `http://www.redbooks.ibm.com/abstracts/redp3959.html`
- Online InfoCenter (see "CICS Transaction Gateway")

  `http://publib.boulder.ibm.com/infocenter/cicsts/v3r1/index.jsp`

Variation 3: WebSphere MQ access to CICS

CICS transactions can be invoked via a message received on a message queue. This function is provided by a combination of WebSphere MQ and either the WebSphere MQ CICS Bridge (shipped with WebSphere MQ) or the WebSphere MQ Trigger Monitor task. In both cases, the "service caller" invokes the program by using the MQ API to place a message on a queue that is monitored either by the Bridge or the Trigger monitor.

The MQ message payload is the COMMAREA to be passed to the CICS program. When the Bridge or the Trigger Monitor receives the inbound message, they invoke the CICS program and optionally place the response COMMAREA in a message on a REPLY-TO queue. A REPLY-TO queue is also used for error conditions that result from the call.

The CICS Link3270 Bridge or the older CICS 3270 Bridge component can also be used with the WebSphere MQ CICS Bridge to invoke a 3270 program that does not have a COMMAREA interface.

Neither the WebSphere MQ CICS Bridge nor the WebSphere MQ Trigger Monitor provide a WSDL-described Web services interface. SOAP is not used as the message forma; it is “native” MQ. This is a different scenario than using MQ or JMS as a SOAP transport. If a Web services-compliant solution is needed, an Enterprise Service Bus (ESB) can be used to place a SOAP-compliant layer between the service caller and the Bridge or Trigger Monitor. This will mean a brokered/mediated service interface pattern.

Solution technique implementation

The WebSphere MQ access to CICS variation is an implementation of the adapter-provided service interface pattern. The WebSphere MQ middleware and the Bridge and Trigger Monitor features act as the “adapter” between the service requester and the CICS application. While these applications are not represented as Web services, they still are services which are enabled for use within a composite application.

Process overview

There are several key steps to implement a WebSphere MQ interface to a CICS application:

1. Install and configure either the WebSphere MQ CICS Bridge or the WebSphere MQ Trigger Monitor.
2. Code the service requester program to create a COMMAREA-compatible data area to pass to the service.
3. Add MQ API calls to place a message containing the COMMAREA and appropriate MQ headers onto a queue that is monitored by the WebSphere MQ-CICS Bridge or the Trigger Monitor.

Figure 5-10 on page 154 shows the physical architecture for WebSphere MQ access to CICS transactions via the WebSphere MQ-CICS Bridge.

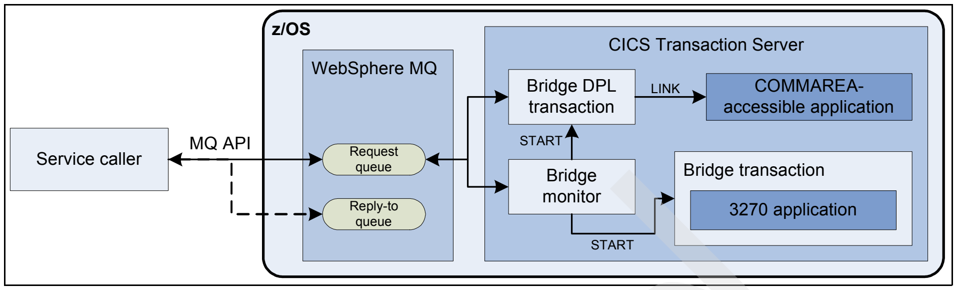


Figure 5-10   Adapt CICS applications using the WebSphere MQ-CICS Bridge

For detailed information

- *Revealed! Architecting e-business Access to CICS*, SG24-5466

  `http://www.redbooks.ibm.com/abstracts/sg245466.html`

- *WebSphere for z/OS to CICS and IMS Connectivity Performance*, REDP-3959

  `http://www.redbooks.ibm.com/abstracts/redp3959.html`

- “Using a message-based approach to integrate your CICS system with your entire IT infrastructure”, G325-2113

  `http://www.elink.ibmlink.ibm.com/public/applications/publications/cgibin/pbi.cgi?CTY=US&FNC=SRX&PBL=G325-2113-00`

Variation 4: Using IMS Connect

The Adapt scenarios for IMS illustrate how back-end functions can be exposed as services. This is done by creating a new layer with service interfaces based on EJB components, which in turn, call the back-end IMS transaction. These EJB components will enrich the functionality and be able to provide logic that will increase the value and ease of reuse in a modern SOA.

IMS Connect enables TCP/IP connectivity to IMS. A client can be any kind of client, as long as it has TCP/IP connectivity. In the example shown in Figure 5-11, the caller is an EJB.

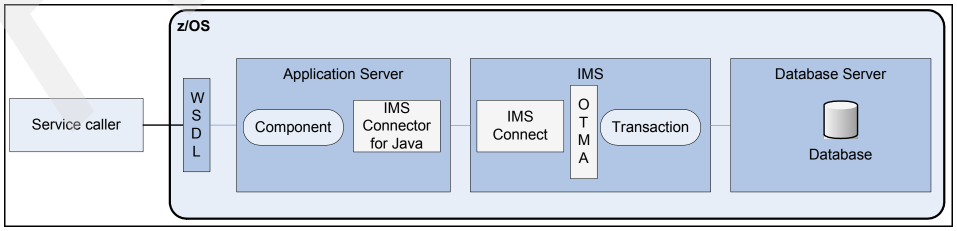


Figure 5-11   Overview of the IMS Connect scenario

In this scenario, the client to IMS is a J2EE application server, already running on z/OS. Logic is implemented in EJBs. Based on these EJBs there are service definitions published using WSDL and accessible from different channels, for example, through SOAP. The EJBs use the J2EE Connector Architecture (J2C) to call IMS Connect. JCA is discussed in “Variation 2: J2EE Connector Architecture access to CICS” on page 150.

Example of the flow of a message using IMS Connect

Next, we discuss the flow of a request, as shown in Figure 5-12.

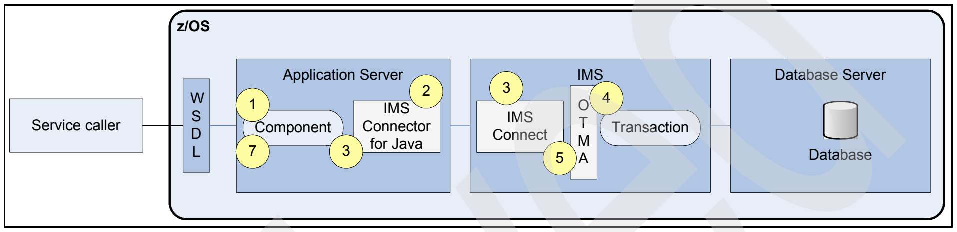


Figure 5-12 Walkthrough of the IMS Connect example

1. The application server receives the SOAP message from the client application. It processes the SOAP header and calls the EJB that matches the input request.
2. The EJB uses the J2EE Connector Architecture (J2C) to obtain a connection to IMS Connect, and builds the required structures for the call. Then it executes the call.
3. IMS Connect receives data from the application server (TCP/IP) client, performs basic editing and translation, invokes security, and prepares the message in the OTMA format.
4. OTMA gets the message, and passes it on to the receiving transaction.
5. Response from the transaction is passed to OTMA, and IMS Connect.
6. IMS connect formats the response in a way that the application understands, and the control is returned to the EJB.
7. The EJB processes the reply and returns a reply to the service caller.

Solution technique implementation

The IMS Connect scenario is an implementation of the Adapter-provided service interface pattern. The J2EE application running in the Web application server (WebSphere Application Server or other compatible server), combined with the IMS Connector for Java, provide an “adapter” that is external to IMS. The service interface is located in the Web application server.

Process overview

1. Install and configure IMS Connect. Open Transaction Manager Access (OTMA) is already part of IMS.
2. Install and configure WebSphere Application Server. Configure connection management to IMS.
3. You can choose to code the logic yourself in order to use IMS Connector for Java. Or you can use a tool, such as WebSphere Integration Developer or Rational Application Developer, to generate the necessary structures and beans.
4. Deploy the application to the application server.

For detailed information

- *IMS Connectivity in an On Demand Environment: A Practical Guide to IMS Connectivity*, SG24-6794

  http://www.redbooks.ibm.com/abstracts/sg246794.html
- *IMS Connect* product documentation

  http://www-306.ibm.com/software/data/db2imstools/html/imsconnectv12.html
- WebSphere Integration Developer

  http://publib.boulder.ibm.com/infocenter/dmndhelp/v6rxmx/index.jsp

Variation 5: Using the IMS SOAP Gateway

One way to open up existing IMS transactions, and to make them easily accessible from different service callers, is to expose them as Web services.

IMS SOAP Gateway is a Web services solution that enables IMS applications to interoperate outside of the IMS environment through Simple Object Access Protocol (SOAP); refer to Figure 5-13. By doing this, the IMS transaction can easily be reused from different channels through the IMS SOAP Gateway.

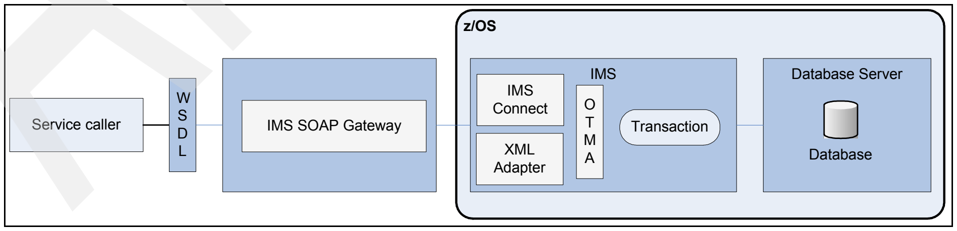


Figure 5-13 Overview of the IMS SOAP Gateway

Solution technique implementation

IMS SOAP Gateway fits the adapter-provided service interface pattern because it translates between a proprietary protocol and an SOA-compliant protocol.

IMS SOAP Gateway consists of two main components:

- IMS SOAP Gateway server, which is the node that provides the SOAP service and the WSDL interface.
- IMS SOAP Gateway deployment utility, which is a utility that enables you to set up properties and create runtime code for the IMS SOAP Gateway.

Process overview

1. Create a Web Service Description Language (WSDL) file for the IMS application.
2. Deploy the Web service interface to IMS SOAP Gateway and define the connection and correlation information by using the deployment utility.
3. After you deploy the WSDL file, the IMS application is available as a Web service.
4. You can create your desired client application to send SOAP messages to your IMS application through IMS SOAP Gateway.

Tools used to create the WSDL for the IMS SOAP Gateway

IBM WebSphere Developer for zSeries is an application development tool that helps with the development of traditional mainframe applications. It helps you to easily generate the artifacts needed to transform your IMS application into a Web service to be used with the IMS SOAP Gateway runtime.

By simply taking a COBOL copybook for your IMS application that describes the input and output message format, it generates the following Web service artifacts:

- Web Services Description Language (WSDL) file, which provides a Web service interface of the IMS application so that the client can communicate with the Web service.
- COBOL converters and driver file, which help you to transform the XML message from the client into COBOL bytes for the IMS application and then back to XML.
- Correlator file, which contains information that enables IMS SOAP Gateway to set IMS properties and call the IMS application.

Example of the flow of a message using IMS SOAP Gateway

Next, we discuss the flow of a request, as shown in Figure 5-14 on page 158.

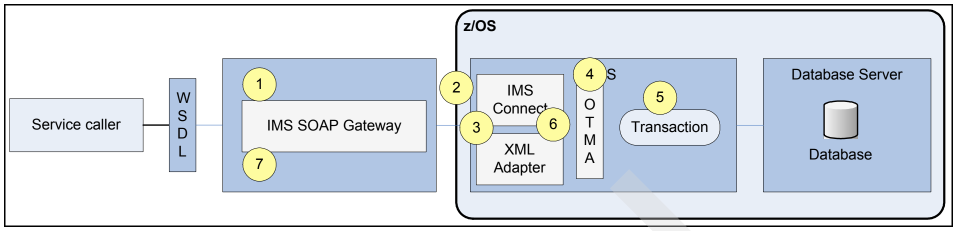


Figure 5-14 Walkthrough of the IMS SOAP Gateway example

The numbers shown in Figure 5-14 correspond to these steps:

1. The IMS SOAP Gateway server receives the SOAP message from the client application. It processes the SOAP header (XML) and retrieves the appropriate correlation and connection information for the input request.
2. The IMS SOAP Gateway sends the input XML data to IMS Connect using TCP/IP after adding the appropriate IMS Connect header.
3. IMS Connect calls the XML Adapter, which in turn calls the XML Converter to perform the XML-to-IMS application format transformation.
4. It then calls the transaction using OTMA. From this point on, the processing is the same as a normal transaction flow.
5. The transaction gets executed and the output is queued.
6. The output message from IMS is then transferred back to IMS Connect, which calls the XML Adapter in order to perform the transformation of the IMS application format to XML. IMS Connect sends the output XML message back to IMS SOAP Gateway using TCP/IP.
7. IMS SOAP Gateway server wraps a SOAP header on the output message and sends it back to the client.

A few words about XML transformation

In the scenario, we have assumed that all XML transformation is done by the XML Adapter in IMS.

If you instead choose to handle the XML transformation in your application without utilizing the IMS Connect XML Adapter, you obviously do not need to invoke the XML Adapter.

In this case, the incoming XML message is sent directly to IMS Connect and then to the IMS application and the same is true in reverse. The IMS application creates an XML output message which is sent to IMS Connect, IMS SOAP Gateway and finally to the Web service client.

For detailed information

- *IMS Connectivity in an On Demand Environment: A Practical Guide to IMS Connectivity*, SG24-6794

  http://www.redbooks.ibm.com/abstracts/sg246794.html

- IMS SOAP Gateway product documentation

  http://www-306.ibm.com/software/data/ims/soap/index.html

- "WebSphere Developer for zSeries" on page 118

Variation 6: Using the WebSphere MQIMS Bridge

The WebSphere MQ IMS Bridge provides MQ connectivity to IMS back-end transactions; see Figure 5-15. A "client" can therefore be any kind of client that can put messages on an MQ queue.

In this scenario, the client is a J2EE application server, already running on z/OS. Logic is implemented in EJBs. Based on these EJBs there are service definitions published using WSDL and accessible from different channels, for example, through SOAP. The EJBs use the JMS Provider for WebSphere MQ to access queues in a WebSphere MQ queue manager. Messages are forwarded by WebSphere MQ to the bridge, based on the queue settings in the WebSphere MQ queue manager.

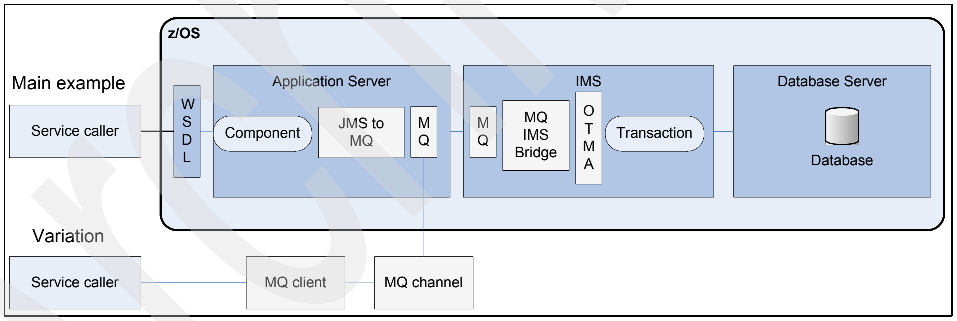


Figure 5-15 Overview of the WebSphere MQ IMS Bridge

Example of the flow of a message

1. The application server receives the SOAP message from the client application. It processes the SOAP header and calls the EJB that matches the input request.
2. The EJB uses JMS calls to obtain a connection to WebSphere MQ, and builds the required structures for the call. Then it executes the call.

3. WebSphere MQ receives the message from the application server, and forwards it to the receiving queue manager. The WebSphere MQ IMS Bridge retrieves the message, and prepares the message in the OTMA format.
4. OTMA gets the message, and passes it on to the receiving transaction.
5. Response from the transaction is passed to OTMA, and MQ IMS Bridge.
6. A message is returned to the reply queue, and is fetched again by the EJB.
7. The EJB processes the reply and returns a reply to the service caller.

Note: Asynchronous retrieval of the reply message in the Web application server requires the usage of Message-Driven Beans and the configuration of so-called Listener Ports (JMS 1.0) or Activation Specifications (JMS 1.1) in the application server.

Solution technique implementation

The WebSphere MQ IMS Bridge example is an implementation of the adapter-provided service interface pattern. The J2EE application running in the Web application server (WebSphere Application Server or other compatible server), combined with WebSphere MQ, provide an “adapter” that is external to IMS. The service interface is located in the Web application server.

Process overview

1. Configure WebSphere MQ, including a queue manager and queues.
2. Install and configure the WebSphere MQ IMS Bridge.
3. Define the WebSphere MQ queue and its queues to the application server.
4. Open Transaction Manager Access (OTMA) is already part of the IMS installation.
5. Develop the (Web service) application running in the application server using the JMS APIs. Eventually, develop MDBs for the reply messages.
6. Deploy the application to the application server.

For detailed information

- *IMS Connectivity in an On Demand Environment: A Practical Guide to IMS Connectivity*, SG246794

  http://www.redbooks.ibm.com/abstracts/sg246794.html

- *WMQ IMS Bridge*

  http://publib.boulder.ibm.com/infocenter/wmqv6/v6r0/index.jsp?topic=/com.ibm.mq.csqsat.doc/csq826y.htm

- WebSphere Integration Developer

  http://publib.boulder.ibm.com/infocenter/dmndhelp/v6rxmx/index.jsp

Using the Adapt approach with a broker/ESB

All of the technology variations in 5.2, “SOA implementation scenarios for a 3270 application” on page 137 address the problem of enabling an existing 3270 transaction as a service and accessing it directly.

As an organization moves forward in the maturity of its SOA implementation, it will probably employ a message broker or Enterprise Service Bus as a mediation layer between the service requesters and service providers. 2.4.3, “The Enterprise Service Bus (ESB)” on page 22 discusses the basic functions of the ESB.

One of the major functions of an ESB is to translate protocols between the requester and provider. Most of the service enablement technologies used with the Improve and Adapt transition approaches can be used in conjunction with an ESB. The ESB becomes the service interface for all of the services under its control. This scenario implements the brokered/mediated service interface pattern. The ESB provides the service interface and leverages the appropriate service enablement technology to invoke the called service.

Figure 5-16 on page 162 illustrates the relationship between the ESB and the service enablement options. The service requester calls a service. Then the broker intercepts that call, routes the message to the proper endpoint service provider, and in the process, converts the transport protocol to the one supported by the service provider. Optionally, the ESB will transform the message content into a format acceptable to the service provider or service requester.

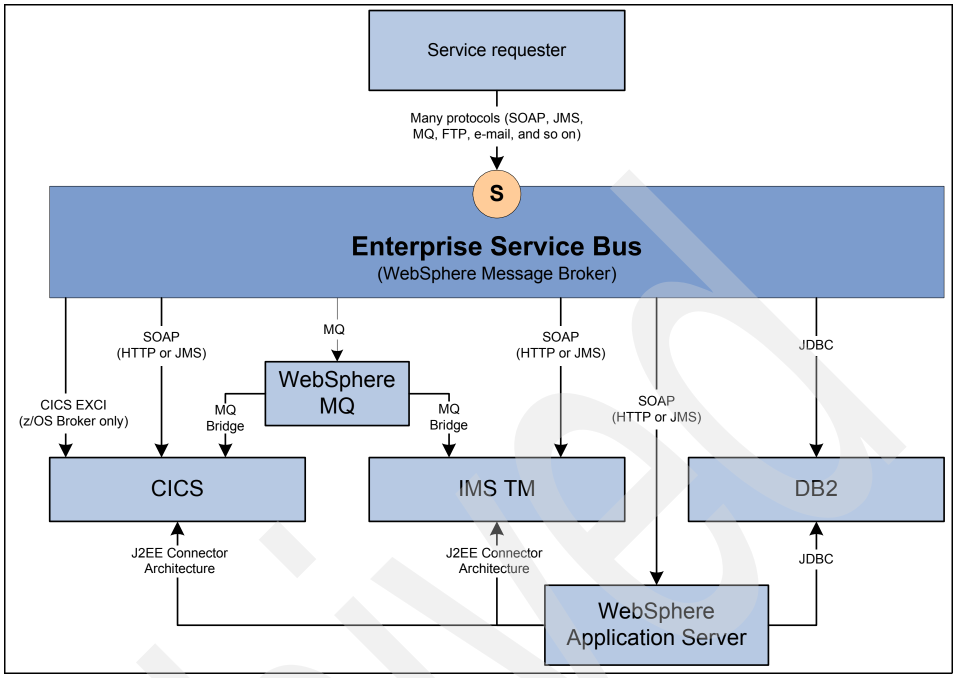

Service requester
Many protocols (SOAP, JMS, MQ, FTP, e-mail, and so on)
S
Enterprise Service Bus
(WebSphere Message Broker)
CICS EXCI (z/OS Broker only)
SOAP (HTTP or JMS)
MQ
WebSphere MQ
MQ Bridge
MQ Bridge
SOAP (HTTP or JMS)
SOAP (HTTP or JMS)
JDBC
CICS
IMS TM
DB2
J2EE Connector Architecture
J2EE Connector Architecture
JDBC
WebSphere Application Server

Figure 5-16 Overview of a brokered/mediated service interface architecture

For more information on ESB and service integration, refer to Chapter 6, “Towards service integration and process integration” on page 223;

5.2.3 Using the Innovate transition approach

Sometimes, an organization working on service enablement of a 3270 transaction may find that the code is so complex and unworkable that it requires a complete rewrite. This can be a very costly and involved process, and it negates some of the cost savings that are provided by reuse of assets. If appropriate tools are used to harvest and reuse business rules and existing business logic, savings can still be realized, and the resulting code is better structured for reuse and may provide better performance or reliability as a by-product of the effort.

The Innovate transition approach can allow an organization to do a better job of structuring the services with the appropriate level of granularity. In 4.1, “Methodologies for analyzing the business and application environment” on page 98, the concepts of top-down versus bottom-up SOA implementation and modeling approaches such as SOMA is discussed. The use of these techniques becomes more applicable in a situation where code is being rewritten, since the service granularity and appropriate levels of modularity can be implemented more easily in rewritten code than when using programs that do not necessarily match the requirements identified in the top-down analysis using the modeling tools.

A key question in the innovation effort is, “Is the 3270 interface still needed?” Many organizations are restructuring their applications to be accessed by Web interfaces, but there is still a requirement for 3270 access. This may be a matter of “dual use” by users who are accustomed to the 3270 interface and do not wish to change, and by new users or those who prefer a browser interface. Not all applications lend themselves to a browser UI. In some cases, using a keyboard is a more efficient way to enter data than using “point-and-click”.

Other decisions must be made when undertaking an Innovate project; for example:

- What programming language should be used?

  This decision is driven by a number of factors, but in an Innovate effort, a key factor is the amount of existing business logic that can be extracted from the existing programs.

- What transaction manager should be used?

  For example, a program may be redeveloped using Java, but that does not mean the application cannot continue to run on IMS or CICS, which both support transactions coded in Java.

- Does the re-engineered application conform to the proper level of granularity and provide the appropriate service interface?

The other architecture decision questions must be considered also, including Quality of Service requirements, skills, funding, and so on. Architects should make sure they employ a methodology for architectural decisions when reviewing these items.

The logical architecture for an Innovate-based transition approach to service enabling a 3270 transaction is shown in Figure 5-17 on page 164.

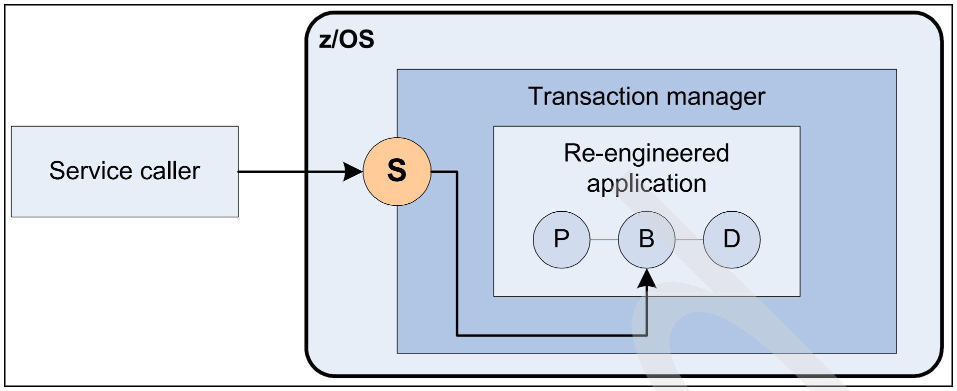


Figure 5-17 Logical architecture for the Innovate transition approach

Solution techniques and the Innovate transition approach

When using an Innovate approach to service enablement, the solution technique used is the redeveloped service interface pattern. However, using this technique also results in an application that takes on the appearance of an application that is service-enabled using the native service interface pattern, because the service interface is ideally, though not necessarily, natively provided by the transaction manager or database server for the re-developed programs.

5.3 SOA implementation scenarios for multichannel

As described in 3.3, “Starting scenario - multichannel” on page 64, the multichannel architecture may already consist of reusable components, and to some degree also reusable services.

There are many variations of multichannel applications possible and we discuss a few, very common ones in this chapter. Note that this does not represent an exclusive list. Common to all variations is that there is a middle tier implemented between the channel and the back-end, using components based on Java or J2EE. The scenarios discussed in this chapter are listed in Table 5-2 on page 165.

In the variations examined in this chapter, we only deal with changes in the J2EE application server layer, and not with changes in the core back-end functions. For changes in the core back-end, refer to 5.2, “SOA implementation scenarios for a 3270 application” on page 137. The multichannel and 3270 application scenarios can be combined in order to provide a more complete picture of the transition process.

Table 5-2 Summary of multichannel variations

Transition approach	Variation	Described in
Improve	Variation 1: service-enable an existing Java servlet/JSP-based Web application	"Variation 1: Service-enabled Web application" on page 166
Improve	Variation 2: service-enable an existing J2EE application	"Variation 2: Service-enabled J2EE application" on page 168
Improve	Variation 3: service-enable an existing JMS-based application	"Variation 3: Service-enabled J2EE application using JMS and Message Driven Beans" on page 169
Adapt	Variation 1: service integration using WebSphere ESB	"Variation 1: The Adapt approach using WebSphere ESB as broker" on page 173
Adapt	Variation 2: service integration using WebSphere Message Broker	"Variation 2: The Adapt approach using WebSphere Message Broker as broker" on page 175
Innovate	Variation 1: service enablement and integration of a client/server application	"Variation 1: SOA enablement of a fat client (client/server) application" on page 179
Innovate	Variation 2: Using WebSphere Portal to provide interaction services	"Variation 2: Using portal" on page 182

5.3.1 Using the Improve transition approach

Just to refresh what we mean with the Improve transition approach, we have defined it as an approach that exposes application functions as a service. It usually involves a piece of new technology which adds a standardized interface to be used by a calling application; see Figure 5-18 on page 166.

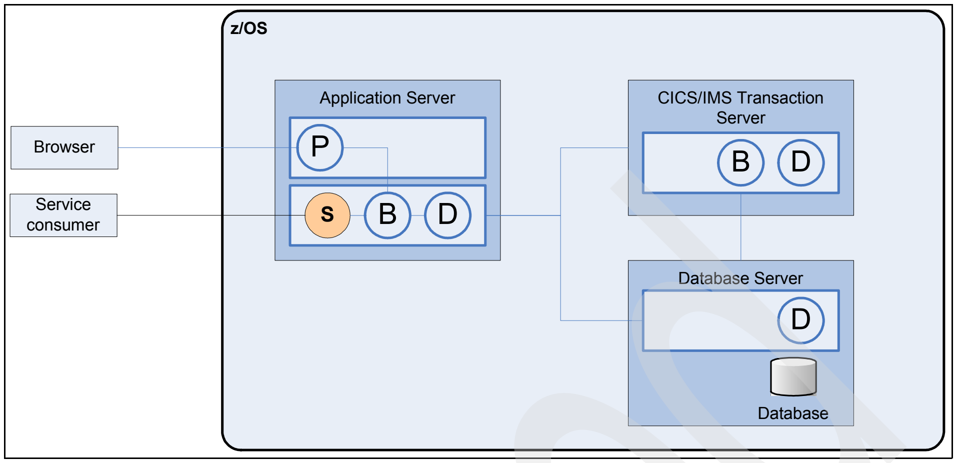


Figure 5-18 Logical overview of the Multichannel Improve transition approach

Solution techniques for Improve transition approach

The use of the Improve transition approach usually leads to the adoption of the adapter-provided service interface pattern. In the multichannel scenario, we might also see some pieces of the native service interface pattern, because there might be slight modifications to the components in the application server layer.

The core functions in the back-end transaction server remain untouched.

Variation 1: Service-enabled Web application

Many existing Web applications are based on Java Server Pages (JSP) or servlet technology. In the early days when there was no EJB support, the application logic was built using standard Java Beans. Those applications have had the primary objective of adding a better user interface to an existing (legacy) application. We also called this approach “Web enablement”. There was not much focus on separation of concerns and reusability.

For this scenario, we assume that the back-end functions in CICS and IMS will remain the same, and be called via the same interface as before; refer to Figure 5-19 on page 167. The changes are in the Java layer and have the objective of making encapsulated business functions (which are usually implemented in the Web applications by means of Java Beans) accessible as Web services.

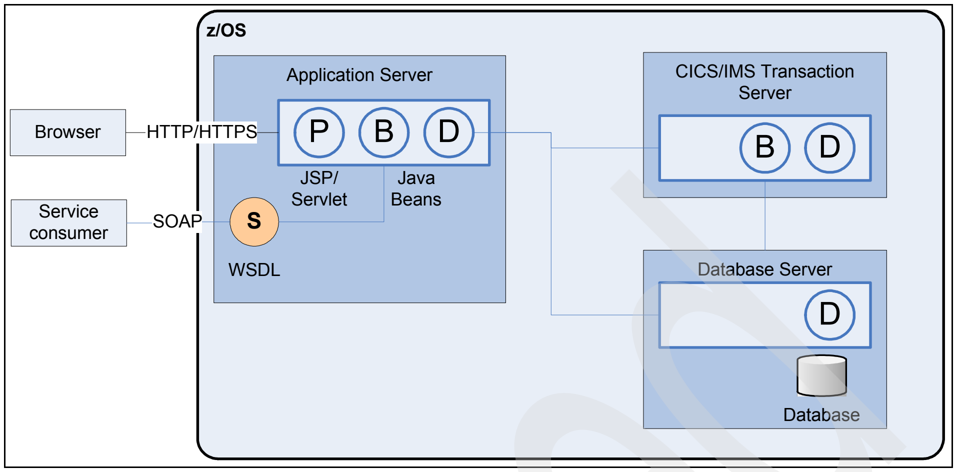


Figure 5-19 Target architecture of the service-enabled Web application variation

When transformed, this architecture may be viewed as the starting point for "Variation 2: Service-enabled J2EE application" on page 168.

Solution technique implementation

The solution technique in this scenario could best be described as a native service interface pattern technique, because the service interface will be implemented in the same runtime component as where the service itself is implemented.

Process overview

Web service-enabling a Web application involves the following steps:

1. The developer uses the Rational Application Developer or equivalent tool to create a service interface from the servlet or Java Bean, using the provided wizards.
2. Eventually, a Java service proxy can be created to be included in a Java service consumer.
3. The WSDL created in the first step can be used by the developer of any service consumer, and the Java service proxy created in the second step can be used by a Java service consumer.

For detailed information

- *Rational Application Developer V6 Programming Guide*, SG24-6449

  http://www.redbooks.ibm.com/abstracts/sg246449.html

Variation 2: Service-enabled J2EE application

The starting point for this variation is that the application architecture is based on J2EE, including EJBs. Compared to the Java servlet enablement variation, EJB technology brings added functionality for transactions and security.

This variation illustrates how the EJB components can be enabled for reuse, and called by other channels. In this case, via the SOAP protocol.

For this scenario, we assume that the back-end functions in CICS and IMS will remain the same, and called via the same interface as before. The changes we apply are in the J2EE layer, implemented in the application server.

This scenario, like the "Variation 1: Service-enabled Web application" on page 166, shows that it is the J2EE application server that provides the technology enhancements to add support for new protocols and channels.

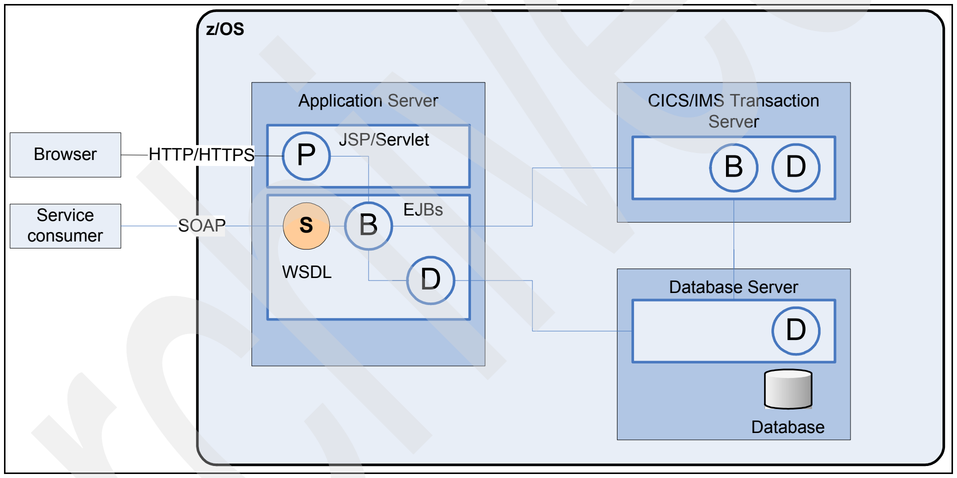


Figure 5-20 Overview of the service-enabled J2EE application

Figure 5-20 shows the enablement of a WSDL interface to the existing EJBs. After your component architecture is based on EJBs, it is not a major task to add support for additional standards, such as SOAP.

WSDL is generated by the Rational Application Developer tool, and the EJBs and WSDL are deployed to the WebSphere Application Server.

Solution technique implementation

The service-enabled J2EE application variation is an implementation of the native service interface pattern. The J2EE application is Web services-enabled using functionality in the J2EE application server (WebSphere Application Server or equivalent). The service interface is located inside the J2EE application server.

Process overview

Service-enabling an EJB-based application involves the following steps:

1. The developer uses the Web Service wizards in Rational Application Developer to create WSDL from the stateless session EJB.
2. Eventually, a Java service proxy can be created to be included in a Java service consumer.
3. The WSDL created in the first step can be used by the developer of any service consumer, and the Java service proxy created in the second step can be used by a Java service consumer.

For detailed information

- *Rational Application Developer V6 Programming Guide*, SG24-6449

  http://www.redbooks.ibm.com/abstracts/sg246449.html

Variation 3: Service-enabled J2EE application using JMS and Message Driven Beans

The starting point is an application architecture that is based on EJBs and JMS as asynchronous communication protocol, opposed to the variation discussed in "Variation 2: Service-enabled J2EE application" on page 168 where HTTP or RMI-IIOP were the primary protocols used.

This variation illustrates how the EJB components can be reused better from other channels by service-enabling the MDB- and EJB-based functions.

For this scenario, we assume as in the previous variations that the back-end functions in CICS and IMS will remain the same, and are called via the same interface as before. The changes we apply are in the J2EE layer, implemented in the application server.

This scenario shows that the runtime functionality for Message Driven Beans (MDB) will be provided by the J2EE Application Server.

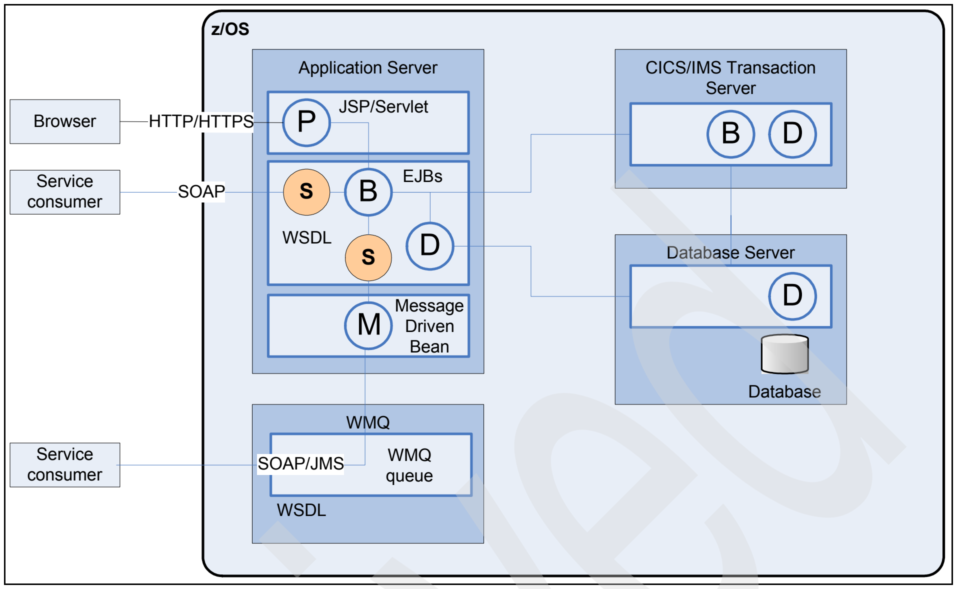


Figure 5-21 Overview of service-enabled J2EE application using JMS and Message Driven Beans

Solution technique implementation

The service-enabled J2EE application using the JMS and Message Driven Beans variation is an implementation of the native service interface pattern. The J2EE application is Web services enabled using functionality in the J2EE application server (WebSphere Application Server or equivalent) combined with the usage of Message Driven Beans. The service interface is located inside the J2EE application server.

The wizards in Rational Application Developer can be can be used to create an EJB with a bean type of Message Driven Bean. The wizard creates appropriate methods for the type of bean.

Process overview

1. The WebSphere MQ administrator creates any additional necessary queues and connections to be used by the new solution, if not already there.
2. The developer uses the Enterprise Bean wizard in Rational Application Developer to create the enterprise bean with the type of Message-Driven Bean. All necessary methods are automatically created.
3. One reason for creating a new Message Driven Bean is to separate the business logic from the interface. The Message Driven Bean can easily call

the target EJB, so the MDB can be thin, and implement most logic in the *onMessage*() method.

4. The EJBs are configured for deployment, packaged into EAR files, and deployed in the WebSphere Application server.
5. Client code is created using the technology of choice. The client needs to be configured to use the appropriate queue name, which triggers the MDB.

For detailed information

- Using message-driven beans in applications - technical documentation

  `http://publib.boulder.ibm.com/infocenter/wasinfo/v5r1//topic/com.ibm.websphere.zseries.doc/info/zseries/ae/tmb_ep.html`

5.3.2 Using the Adapt transition approach

The Adapt transition approach is more intrusive than the Improve transition approach. As a result, there are more changes in the original code and functions than in the previous examples; Figure 5-22 illustrates an overview.

There is a need for a more clear separation of presentation, business and data access logic. There may also be a need to change the core functions in the back-end applications.

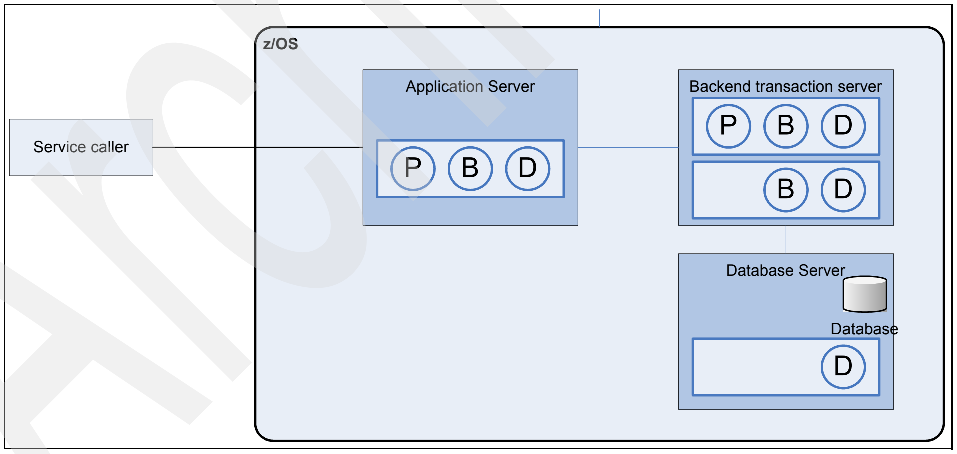


Figure 5-22 Overview of the Multichannel Adapt transition scenario

Solution techniques for the Adapt transition approach

The Adapt variations for the multichannel SOA implementation scenarios will involve the adapter-provided service interface pattern and the brokered/mediated service interface pattern.

Using the Adapt approach with a broker/ESB

The starting point for this variation is that the application architecture is service-enabled, but services are not being called over an ESB yet. Thus, any routing, mediation, or event services logic (if this exists) is still manually implemented in the application. There may be different types of service bindings used, and the service consumers need to be able to support the bindings of the service provider.

For this scenario, we assume that the back-end functions in CICS and IMS will remain the same, and are called via the same interface as before; that is, through one of the protocols supported by the application server. Usually, this is either a J2C connector or JMS. Typically, the service interface is in the application server.

This variation introduces a common bus between the service requesters and service providers. Instead of calling a service in the application server directly over HTTP or JMS, the call will now go logically through the ESB. This variation is illustrated in Figure 5-23.

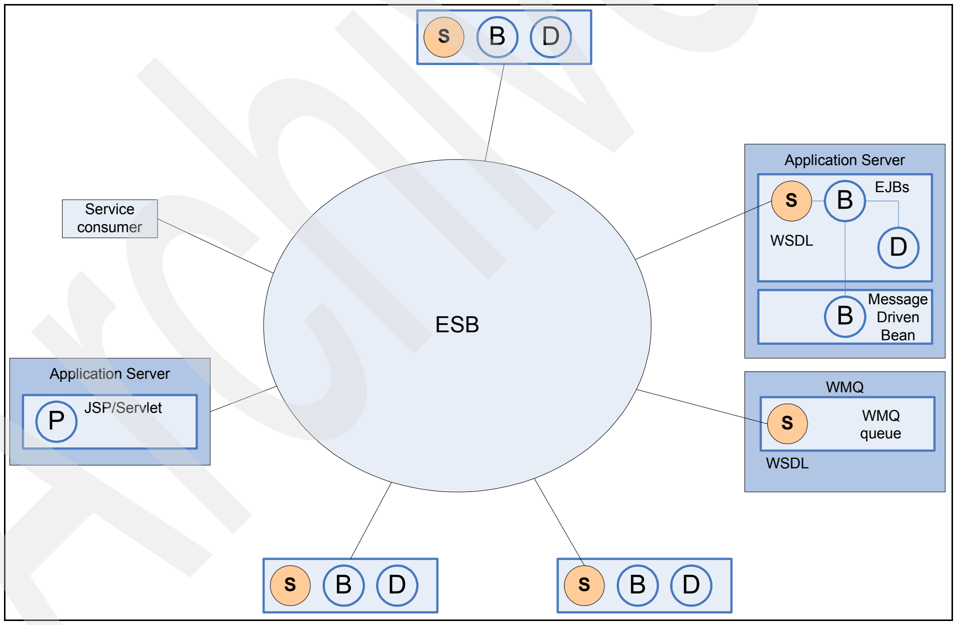


Figure 5-23 Overview of the Adapt transition approach with a broker/ESB

For more information about the ESB architecture, refer to “The capabilities of an ESB” on page 232.

Variation 1: The Adapt approach using WebSphere ESB as broker

In this variation we instantiate the generic ESB described previously with the product WebSphere ESB. From the description of the starting point we know that the applications are enabled as services, but the routing, mediation, and event services logic is still manually implemented in the application. We also know that there may be different types of service bindings used, and the service consumers need to be able to support the bindings of the service provider.

An example, with an application containing mediation, is shown in Figure 5-24.

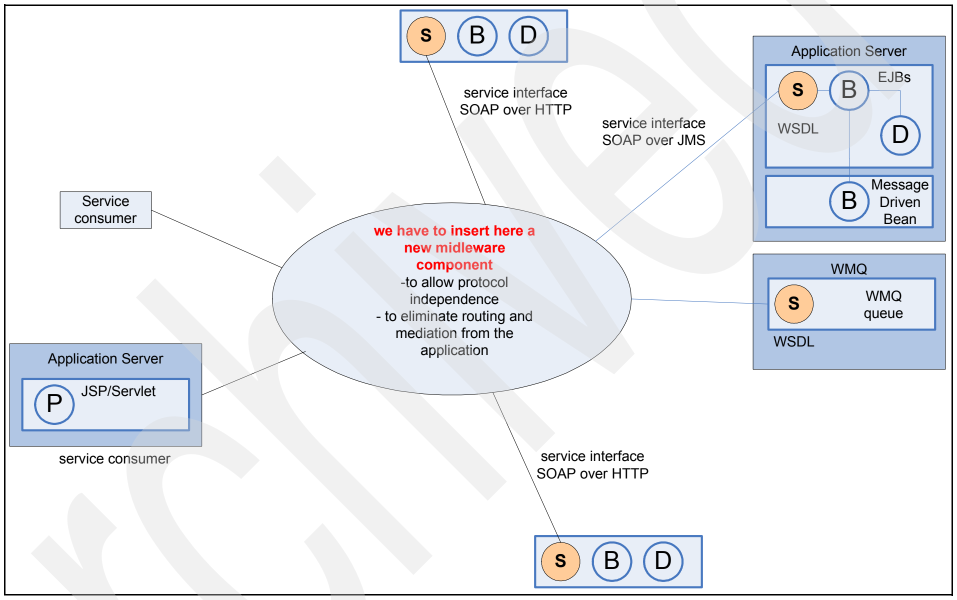


Figure 5-24 Example of the Adapt approach using WebSphere ESB

The first task is to identify the application parts that implement routing, mediation, and event processing, and then position these inside the WebSphere ESB. So some amount of analysis, decomposition and restructuring work is necessary.

The second activity concerns the service bindings used: we will leave the service binding untouched, but eliminate the necessity for the service consumer to know that a particular service can be called only with a specific service binding. We are also creating, in the process of restructuring, new services (named S1).

Consider this example: the service, implemented in the application server, can be called using SOAP over JMS. Because we do not want to put restrictions on the service consumer, we use the flexibility provided by WebSphere ESB to mediate between the call of the service consumer and the service, translating (in the ESB language this is called “mediating”) as necessary.

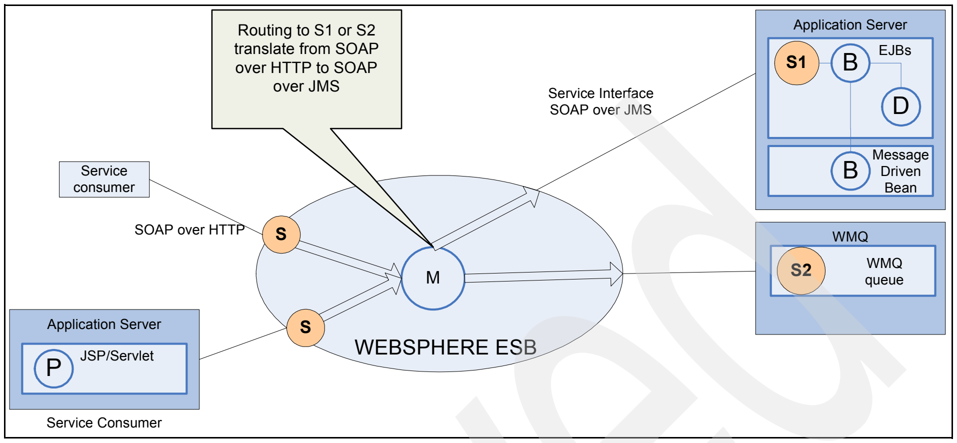


Figure 5-25 Implementation of routing and mediation for Adapt approach with WebSphere ESB

Solution technique implementation

The solution technique in this scenario could best be described as a brokered/mediated service interface pattern, because the service interface accessed by the consumer will be implemented in the ESB.

The best scenario to implement WebSphere ESB is when the applications support the interaction pattern called Web Services. In the simplest case, all services are co-located inside the WebSphere Application Server. The collocation produces improvements in performance (such as reducing path length and eliminating some network traffic).

Process overview

1. The developer restructures the application by decomposing the routing/mediation parts, and creating eventually more service implementations.
2. The developer uses the wizards in WebSphere Integration Developer[2] to create the SCA components (with their imports and exports) that represent, to the outer world, the services. The initial WSDL is known from the application (we said that the prerequisite was that all applications are service-enabled); the WSDL can be imported and used in the SCA. The SCA components will have the bindings used by the clients. Note here that the ESB (the central

[2] WebSphere Integration Developer (WID) is the IBM tool to develop SCA components and mediation for WebSphere ESB.

middleware) adapts to the bindings supported by the clients, and not vice versa.

3. The developer uses the wizards in WebSphere Integration Developer to create the mediations and routing components.
4. The WebSphere ESB administrator deploys the mediation and routing components in the WebSphere Application Server runtime (where the ESB itself runs).

Variation 2: The Adapt approach using WebSphere Message Broker as broker

In this variation we instantiate the generic ESB described previously with the product WebSphere Message Broker (WMB). From the description of the starting point we know that the applications are enabled as services, but the routing, mediation and event services logic is still manually implemented in the application. We also know that there may be different types of service bindings used, and the service consumers need to be able to support the bindings of the service provider.

When we speak here about the applications enabled as services, we do not mean Web services; there is a mixture of applications, some have standard (Web Services) service interfaces, and some have non-standard service interfaces, accessed over different protocols and different interaction patterns. The situation is shown in Figure 5-26 on page 176.

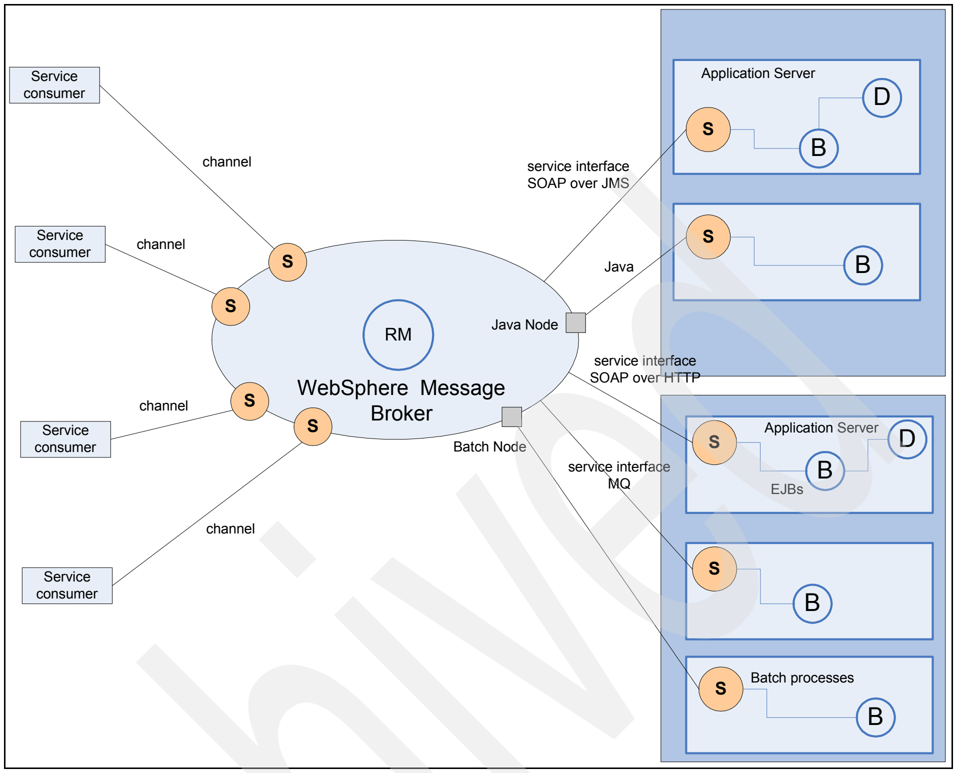


Figure 5-26 Logical design for the Adapt approach with WebSphere Message Broker

Again we position, between the service consumer and this multitude of service providers (with a varied array of protocols and interface patterns), a piece of middleware to simplify the connectivity, centralize routing, mediate protocols and content. This piece of middleware, in this case, is the Websphere Message Broker.

The words “different protocols and a multitude of protocols and interaction patterns” represent the “power” feature of the WebSphere Message Broker, so we know that from the point of view of connectivity we are on the right path to solving the problem. WebSphere Message Broker makes available numerous message processing nodes, like Database node, Compute node (with the speciality Java), Filter node, Batch node, MQ node. JMS node, Web Services nodes (HTTP(s) request and reply nodes), Aggregation node, XSLT node and many others. These nodes allow us to implement the necessary translations, routing, and mediations.

Solution technique implementation

The solution technique in this scenario could best be described as a brokered/mediated service interface pattern, because the service interface accessed by the consumer will be implemented in the WebSphere Message Broker.

Process overview

1. The developer restructures the application by decomposing the routing/mediation parts, and creating eventually more service implementations. The bindings and interaction pattern of the service interfaces can be created based on the business requirements; WebSphere Message Broker will take care of the necessary translation between the service consumer and the service providers
2. The developer uses the WebSphere Message Broker Toolkit to create the message flows. The initial WSDL is known from the application (we said that the prerequisite was that all applications are service-enabled); the WSDL can be created or imported, and then used in the Web Services nodes. WMB makes available, for the Web Services nodes, a WSDL generator and a WSDL import wizard, with high flexibility for modelling SOA messages, WDSL types, and interaction patterns.

   As an example, the message flow for defining a Web Service might look like in Figure 5-27 on page 178. The nodes Implementation, Implementation1, and Implementation2 are the places where the developer, using the nodes available, implements the processing, and part of the processing is the call of existing services. We see that the developer has a high flexibility in implementing the Web service both in the area of connectivity (multiple transports) and interaction patterns, and in the access to back-end services (multiple node types).

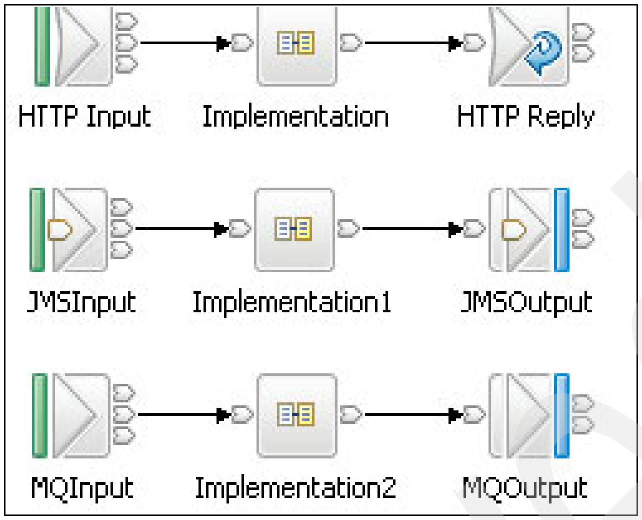


Figure 5-27 Example of implementation of a Web service in the WebSphere Message Broker

3. The WebSphere Message Broker administrator deploys the message flows to the runtime.

5.3.3 Using the Innovate transition approach

The Innovate transition approach is even more intrusive than the Adapt transition approach. In the Innovate approach, an existing multichannel application will need to be changed to meet a fairly high SOA maturity level. In any case this includes a full "separation of concerns" and a high reusability level of services.

At this point we would want to have the presentation logic in the various channels clearly separated from the rest of the application. Also, standards-based service interfaces should be in place and an ESB must be implemented for mediation, routing, and event services.

It is likely that the back-end functions will also need to be integrated using Web services standards and through an ESB. This, however, may lead to the implementation of one or several scenarios as discussed in 5.2, "SOA implementation scenarios for a 3270 application" on page 137.

Variation 1: SOA enablement of a fat client (client/server) application

Simplified, a *fat client* application has a combination of presentation and business logic implemented on the client device. It is not unusual to have this presentation and business logic very tightly integrated. In some cases, even data access logic is implemented on the client.

Note: Today, a client can be a variety of devices, such as a Windows workstation, personal digital assistant (PDA) device, smartphone, ATM, kiosk or any other device that can communicate with a server.

The communication protocol with the server can be any protocol, HTTP, TCP/IP, MQ, or RMI/IIOP, and even SNA-based communication is not impossible. This is illustrated in Figure 5-28. The most commonly used languages for a fat client are Java, C, C++ or Visual Basic®.

The back-end server could provide a service interface based on, for example, CORBA, or it could be as simple as providing connectivity to data.

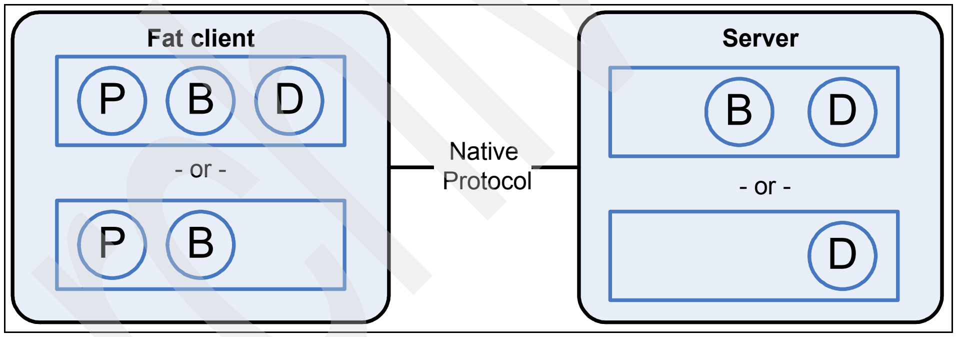


Figure 5-28 Logical overview of the fat client scenario

The fat client starting point

The starting point for the scenario is the example in Figure 5-29 on page 180 that is labeled "Fat client". The examples labeled "Rich client" and "Thin client" are evolutionary steps towards an SOA, but could also be the starting points.

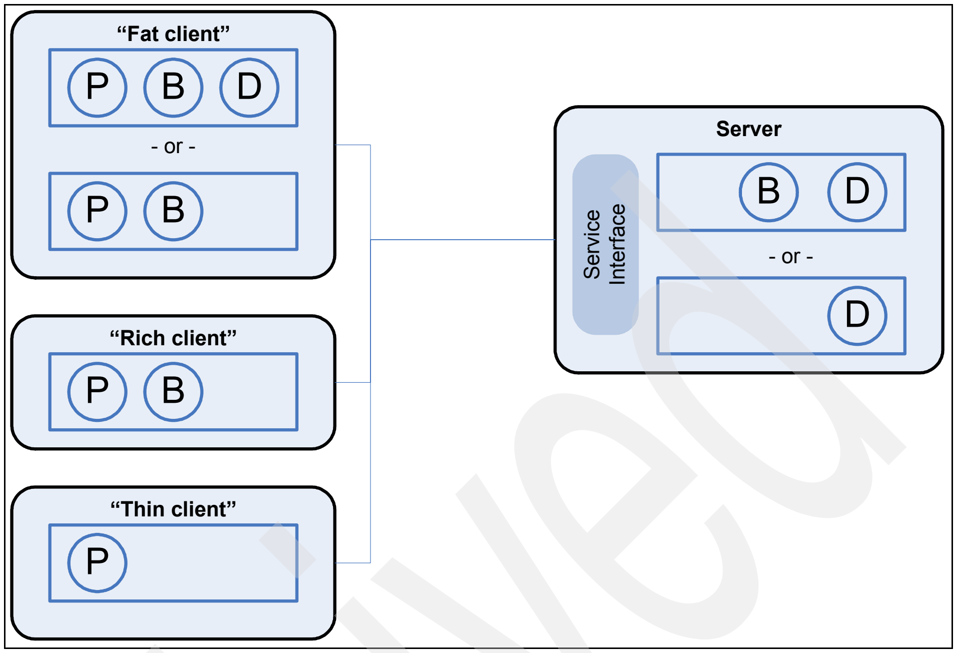


Figure 5-29 Possible evolution towards the innovate approach of the migration of a fat client

Solution technique implementation

The solution technique in this scenario could best be described as a mix of the adapter-provided service interface pattern and the native service interface pattern.

- Adapter, because there will be a standard service interface in front of the core back-end functions. However, there is a possibility that the core functions need to be changed to fit into the new architecture.

  The service interface is located in the core transaction server.

- Native, in case back-end services are called directly using native SOAP calls.

Process overview

To apply the Adapt transition approach to this example, the following needs to be considered.

Server tier

- Can an adapter-provided service interface pattern be applied?
  - What can be done to standardize the native protocol between the client and the server?

  - Is the protocol based on proprietary communication, and how can that be opened up?
  - What platform is the server running on? If it is CICS or IMS, maybe the techniques that are described in the 3270 transition scenario chapter could be applied.
- Can a native service interface pattern be applied?
  - What about the application architecture? Are the services structured in a way so they can be packaged and used by another protocol than they originally are built for.
- Can the a broker/mediated service interface pattern be applied?
  - Could messaging, such as WebSphere MQ, be used?

Client tier

- Can the presentation logic be separated from the business logic?
  - Is the application layered in a 3-tier model?
  - How about data access? Is it clearly separated in the code?
  - Are new requirements on the client platform introduced? User interaction, security, role-based interactions, and so on?
- Can the business logic from the fat client be reused and packaged as server-side components? Or is it necessary to rewrite using another technology?

One possible method is to migrate to a "rich client" (illustrated in Figure 5-29 on page 180), with most business logic deployed on the server, perhaps callable via SOAP, or as EJBs through RMI/IIOP.

Some client applications require the speed and input validation functions provided by the fat client or rich client, that may be the target. Other applications might provide the right functionality running in a portal, with role-based interactions.

There are many considerations in this scenario, with no single answer to these questions. Instead, your focus should be on deciding which strategic and tactical steps to use for the migration.

The rich client starting point

If the application already is at the level of a rich client, it is probably much easier to migrate to an SOA and a thin client-based solution, because there is a clearer distinction between presentation logic, business logic, and data logic.

The platform of the rich client provides access to an open standards-based protocol for communication with the services on the back-end server.

For detailed information

- *Patterns: SOA Client - Access Integration Solutions*, SG24-6775

  `http://www.redbooks.ibm.com/abstracts/sg246775.html`

Variation 2: Using portal

A variation of the Innovate transition approach consists of the possibility of redeveloping the presentation part of the application, positioning it on a portal, and using standard interfaces to access the services. This solution opens an additional channel (we are in the multi-channel case) for the application. There are many sub-variations in the portal use.

The portal solution can be implemented only if we have a clear separation of the presentation from the business part of the application.

The portal solution capability for composing applications takes advantage of the functions available in the WebSphere Portal Server; these are placed into the category “on the glass” and “under the covers”. In the category of on the glass, we have:

- Portlet technology
- Web services technology
- Web clipping technology
- Java Server Faces (JSF) technology

In the category of under the covers we have:

- Adapters technology
- Broker technology (in its two possible instances WebSphere ESB and WebSphere Message Broker)
- Web services technology
- Service Data Objects (SDO) technology
- Information services technology (such as XQuery and SQL)

The simplest implementation of a portal integrates access to services using these technologies. The existing services can be Web services located in application servers, information services, or even “green screen” applications that can be accessed by the HATS portlet. Figure 5-30 on page 183 shows the logical architecture of such a portal solution. This shows the portlets accessing directly services (through their Web services capability, for example) or using the mediator implemented by the ESB.

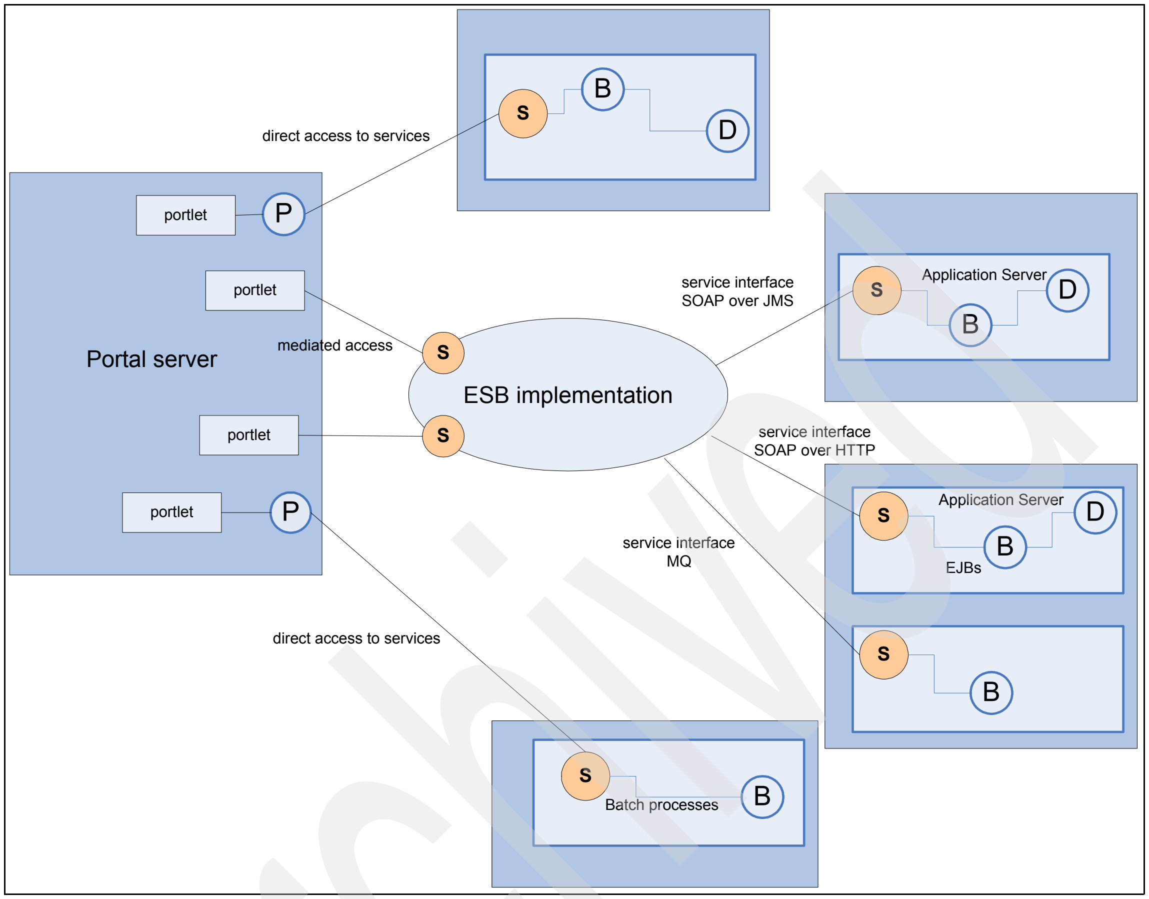


Figure 5-30 Logical architecture for a simple portal implementation

A more sophisticated portal solution (and the one that allows you to create composite applications) is the one in which the portlets themselves are part of new business logic. In this case we use the capability of the portlets to interchange data and messages, the BPEL-based choreography engine and human-task list, and the possibility of specifying business rules for composing applications.

The portlets are not only available to exchange data and messages, but they can also be automatically triggered when changes occur in other portlets. The interface between WebSphere Portal and WebSphere Process Server contributes to complete the solution.

The logical architecture of this implementation is shown Figure 5-31 on page 184.

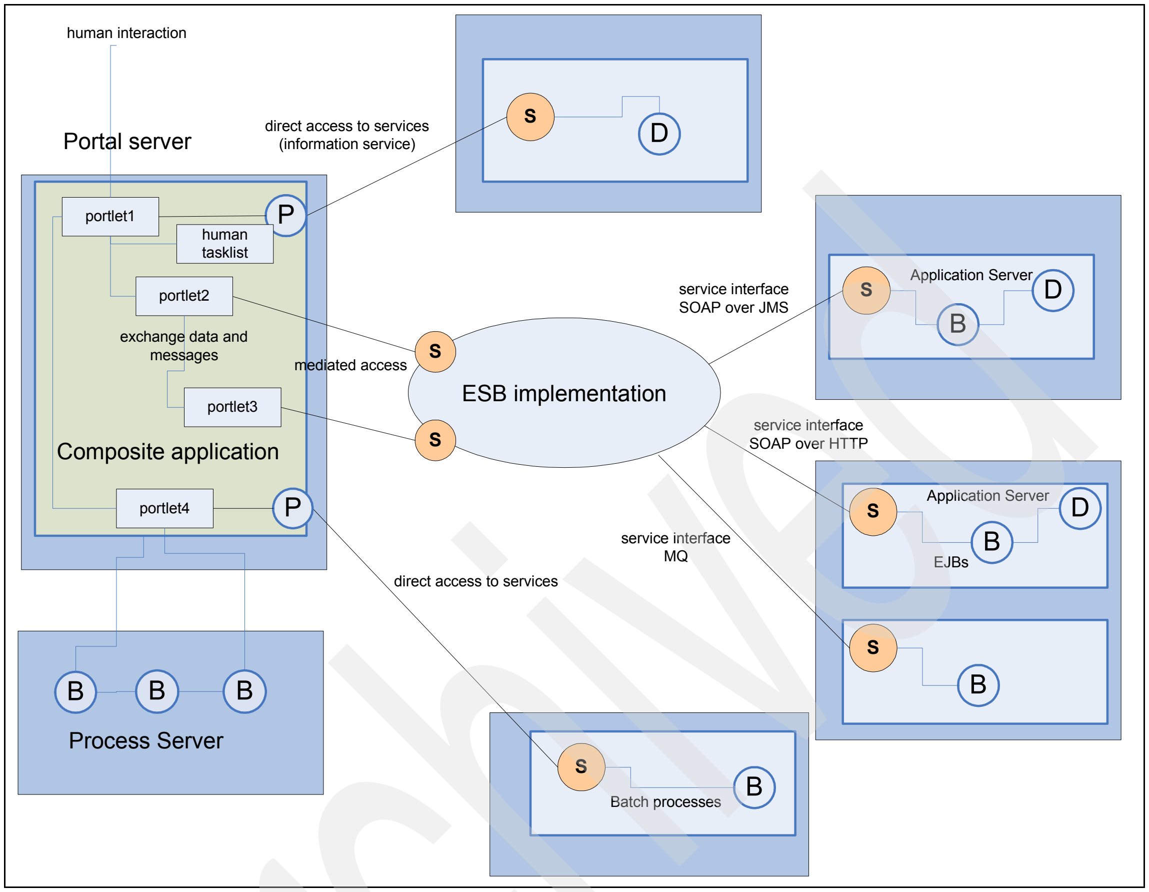


Figure 5-31 Logical architecture for a composite portlet application

Solution technique implementation

The solution technique in this scenario could best be described as a mix of the adapter-provided service interface pattern and the native service interface pattern.

- Adapter, because there will be a standard service interface in front of the core back-end functions. There is though a possibility that the core functions need to be changed to fit into the new architecture.
- Native, in case back-end services are called directly using native SOAP calls.

Process overview

1. The portal designer uses the tooling to produce the page layout and the portlet design.

2. The administrator deploys the produced artifacts in the runtime.

5.4 SOA implementation scenarios for batch

Service-enabling batch applications involves establishing new interfaces to initiate or invoke batch components as services. A batch job may be considered as one probably large component. Or, it may be considered as consisting of several minor components exposed by steps—or perhaps even more granulated by individual programs or subroutines inside one step.

The flow of batch jobs or the flow of steps within a batch job can be considered a workflow, that is, a composite service consisting of several atomic services implemented by the individual jobs or job steps.

Figure 5-32 shows how batch is invoked.

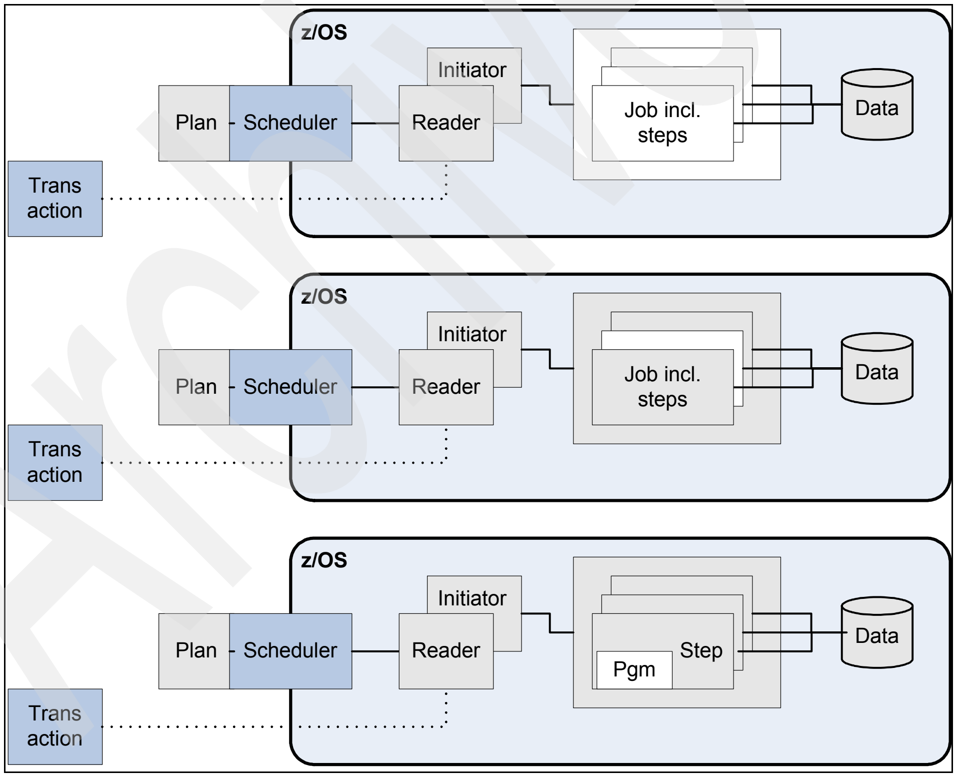


Figure 5-32 Overview of a batch invocation

Based on a plan, the scheduler invokes the batch job involving the reader and the initiators. Batch jobs may also be invoked from TSO or a transaction server by writing directly to the internal reader. With WebSphere MQ (WMQ), batch jobs can be triggered by messages arriving on a queue.

The batch job consists of one or more steps, including one or more programs. It receives input in the form of parameters, sysin, datasets, messages or database rows. And it delivers output in the form of condition codes, sysout, sysprint, datasets, messages and database rows.

Furthermore, the batch job can be considered a workflow consisting of one or more automatically invoked activities.

In this chapter we will look at batch from both a consumer perspective, and a provider perspective.

Table 5-3 lists a summary of the variations of the SOA implementation scenarios for batch jobs that are discussed in this chapter. We will see that service-enabling of batch clearly still provides fewer options than in the previously-discussed OLTP scenarios.

In addition to the traditional approaches, a very pragmatic “leave be” approach is described. It is not a real transition approach because no existing code is reused, but it may turn out to be a very popular solution in many organizations.

Table 5-3 Summary of batch variations

Transition approach	Variation	Discussed in
Improve	Making a job or job step reusable as a service without changing any code	5.4.2, “Using the Improve transition approach” on page 188
Adapt	Variation 1: Improve the granularity of the services in batch and integrate them	5.4.3, “Using the Adapt transition approach with batch as service provider” on page 191
Adapt	Variation 2: Call reusable Web services from batch programs, eventually through an ESB	5.4.4, “Using the Adapt transition approach with batch as service caller” on page 193
Innovate	Fully reuse functions inside batch from anywhere	5.4.5, “Using the Innovate transition approach” on page 194
“Leave be”	Special case: Leave batch be and develop new SOA	5.4.6, “A practical, mixed approach” on page 198

5.4.1 Multi-entity handling in batch services

Before moving to the individual transition approaches, a batch characteristic should be taken into account. Regardless of which transition approach you choose, you are probably facing the challenge that large amounts of data and data entities are processed in each program invocation.

As shown in Figure 5-33, a batch program needs a service to process several records or messages.

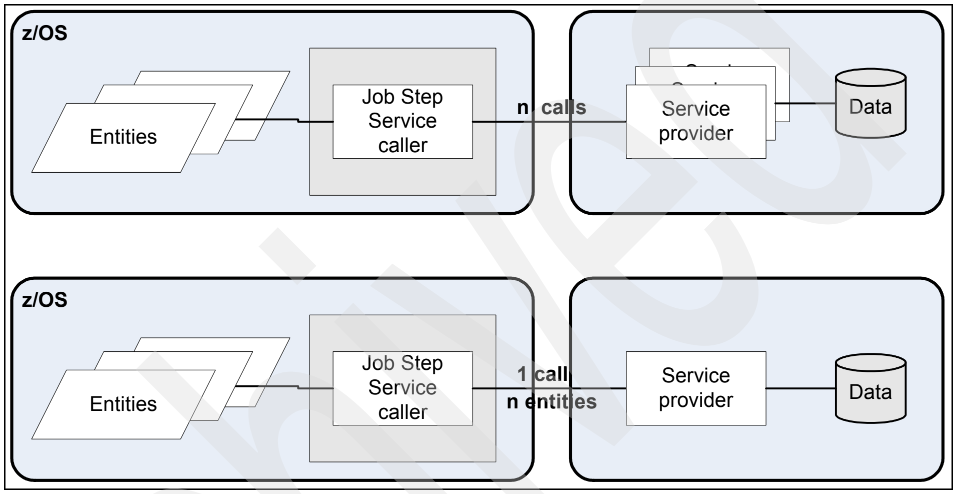


Figure 5-33 Multi-entity handling in batch

Logically, it can be done in either of two ways:

1. The service caller invokes the service provider once for each entity to be processed.
2. The service caller invokes the service provider once and expects the provider to process all entities in the same instance.

We explain these ways in more detail:

Service call per entity

This is a purer SOA approach, and data can easily be exchanged as parameters (for instance, as XML in a SOAP message). A natural consequence is considerable resource consumption due to a corresponding number of external calls, including housekeeping.

Service call once for all entities

This may be a “less pure” SOA approach, but a more pragmatic one. With this approach you can achieve a higher lever of performance, because the overhead of invoking a service many times individually can be avoided. It works like a kind of caching.

But how can the large number of data entities be exchanged? WMQ gives a good answer to that. Messages can be exchanged between reusable services in a platform- and location-independent manner. Using WebSphere Message Broker (WMB), it may even be possible to achieve protocol transparency.

In case of WMQ, “pipelining” can be exploited to achieve a level of parallelism. The service provider can start processing the messages while the caller is still producing messages. This naturally depends on the demands for transaction support and units of work.

With WMQ, even further parallelism can be achieved by asynchronously triggering more services.

The multi-entity call approach also provides means for accumulations and other cross-entity information and calculations usually seen in batch.

Call approach determination

In order to determine which approach is the most appropriate, some factors should be considered:

- What is the intended use of the service provider?
- Can it be determined whether it is expected to be invoked with one entity at a time, or with large numbers of entities? The transition approach selection may be dependent on that.
- Can the service be deployed in two implementations with controlled redundancy?
- With parallel processing of multiple entities provided by WMQ, batch job duration can be reduced thereby narrowing the batch window.

Under any circumstance, it is likely, and recommended, that changing the existing well-running batch jobs could and should be questioned.

5.4.2 Using the Improve transition approach

The logical architecture for an “Improve” solution is shown in Figure 5-34 on page 189.

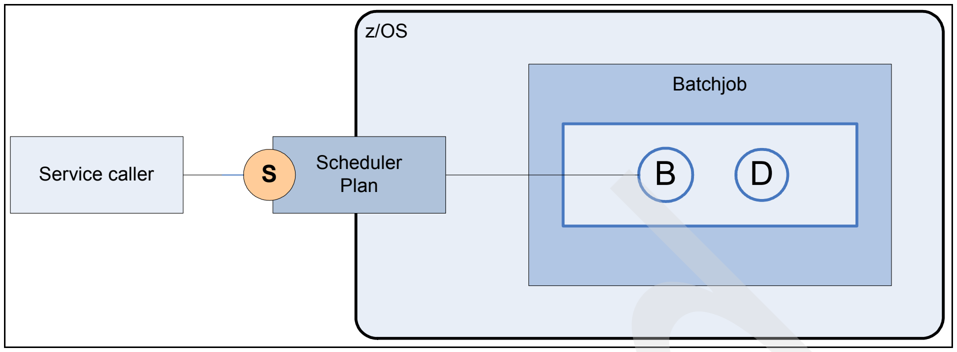


Figure 5-34 Logical architecture for the Improve batch variations

Considering the batch job as a service, it may be invoked in its complete state. It can be invoked by the scheduler as a main service, or it can be invoked from an external service caller as a Web service[3].

Solution technique implementation

The original batch job may be split into several batch jobs in order to make each of these service callable in the desired granularity. Or it may be considered a service including all the original steps. In the Improve solution, the batch job may be considered a sort of workflow, but it will not be considered a composite service because the individual steps are not invoked as services.

In order to invoke a batch job as a service, a service interface has to be provided. Tivoli Workload Scheduler provides support for Web services interfaces, so any scheduling function can be accessed. Otherwise, a separate interface to the scheduler involved must be developed to access information in the scheduling plan, and have the job initiated and controlled.

Invoking the reader directly is not considered a good idea. If a job scheduler is implemented, you will probably want to manage all jobs through this scheduler and do not accept direct write to internal reader. In any case, you cannot call batch programs directly without a job or a started task.

The existing program logic can remain unchanged.

- If the complete batch job is intended to be exposed as a service, then no changes are needed at all, either in the logic or in the flow (JCL).
- If one or more steps are intended to be exposed as services, no changes are needed in the logic, but new flows must be created. It must be ensured that the service receives all the input it needs to execute the service function, and that it can provide a proper response and output to the service caller.

[3] This depends on the capabilities of the scheduler product being used.

If a subprogram or a subroutine is intended to be exposed as a service, this cannot be done by using the Improve solution. Some level of reprogramming is required and it will fall into one of the two subsequent transition approaches, Adapt or Innovate.

In any case, when the service is implemented as a batch job (which is, by nature, an asynchronous process), then no synchronous response will be provided to the caller. An asynchronous response may be provided via WMQ or a mailing service indicating the batch job completion or progress.

Process overview

SOA-enabling a batch application with the improve approach involves the following steps:

1. Identify and select service candidates among jobs and jobsteps.
2. Establish new JCL flows if necessary.
3. Establish the Web service components to interface to the scheduler. Exploit a standard Web services interface if available, or write your own.

For detailed information

- IBM Tivoli Workload Scheduler homepage:

  `http://www.ibm.com/software/tivoli/products/scheduler/`

- Tivoli Workload Scheduler Reference Guide product documentation

  `http://publib.boulder.ibm.com/infocenter/tivihelp/v3r1/topic/com.ibm.tivoli.itws.doc/srf_mst323.htm`

Observations when using an Improve transition approach with the batch scenario

Advantages:

- It offers a quick implementation.
- There is no impact on existing applications. It can run unchanged. There is low risk.
- There is low complexity in implementation.

Disadvantages:

- The real value of reusable logic may not be exploited.
- Business services are not really exposed.

5.4.3 Using the Adapt transition approach with batch as service provider

The logical architecture for the Adapt transition approach is shown in Figure 5-35.

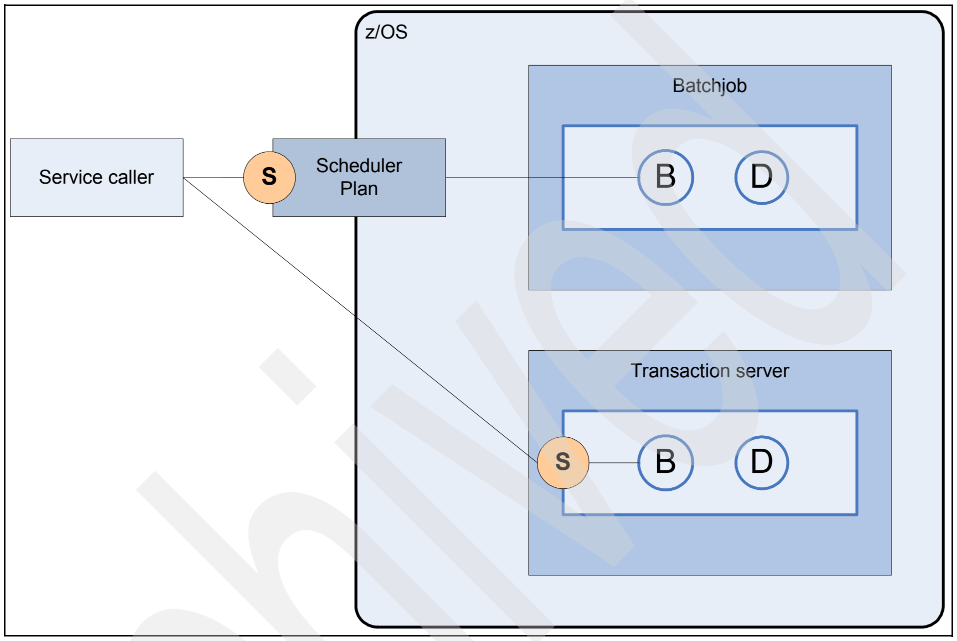


Figure 5-35 Logical overview of the batch Adapt transition approach

Two variations are available:

1. Batch-to-batch, in which batch is kept as the runtime environment.
2. Batch-to-transaction, in which reusable programs or subroutines are refined and redeployed in a transaction server.

We explain these variations in more detail:

Batch-to-batch solution

The batch-to-batch solution can be considered an extension to the Improve transition approach. Reusable subprograms and subroutines may be put in separate steps and service-enabled in the same way as in the Improve solutions. This implies that they cannot be invoked directly, but always through the scheduler.

In this solution, too, a SOA interface must exist in order to access the scheduler plan and have the job initiated and controlled.

In this case, changes to program logic is necessary. It requires some code analysis to ensure that the service gets all the input information it needs to execute the desired action, and that it can provide a proper response and output to the service caller. The SOA interface itself, however, is provided by the job scheduler as a Web service or by a homegrown component.

Batch-to-transaction solution

In the batch-to-transaction solution, reusable subprograms and subroutines are adjusted to run as services in a transaction server like CICS or IMS. This is probably not the case in WebSphere Application Server, because they are not written in Java.

The services are deployed as standard business services, but they have not been implemented based on a real methodological approach.

Process overview

SOA-enabling a batch application using the batch-to-batch solution involves the following steps:

1. Identify and select service candidates among jobs, steps, subprograms, subroutines.
2. Establish new JCL flows.
3. Establish the Web service components to interface with the scheduler. Exploit standard Web services interface if available, or write your own.

SOA-enabling a batch application using the batch-to-transaction solution involves the following steps:

1. Identify and select service candidates among jobs, steps, subprograms, subroutines.
2. Prepare and deploy the services in a transaction server.
3. Establish the Web service components to interface the transactions.

For detailed information

- IBM Tivoli Workload Scheduler homepage

  http://www.ibm.com/software/tivoli/products/scheduler/

- Tivoli Workload Scheduler Reference Guide product documentation

  http://publib.boulder.ibm.com/infocenter/tivihelp/v3r1/topic/com.ibm.tivoli.itws.doc/srf_mst323.htm

- *Application Development for CICS Web Services*, SG24-7126

  http://www.redbooks.ibm.com/abstracts/sg247126.html

- *Implementing CICS Web Services*, SG24-7206

  http://www.redbooks.ibm.com/abstracts/sg247206.html
- *IMS Connectivity in an On Demand Environment: A Practical Guide to IMS Connectivity*, SG24-6794

  http://www.redbooks.ibm.com/abstracts/sg246794.html

Observations when using an Adapt transition approach with the batch starting scenario

Advantages:

- It offers relatively quick implementation. There is some coding needed.
- The value of reusable logic exploited, to a certain extent.
- It offers relatively low complexity in implementation.

Disadvantages:

- There is a risk of getting redundant code. Existing batch jobs may not be changed.
- Business services are exposed only to a certain extent.
- It may represent a “too-quick” solution, and does not really implement SOA.

  A genuine methodological approach should probably be taken instead.

5.4.4 Using the Adapt transition approach with batch as service caller

The logical architecture for batch as the service caller is shown in Figure 5-36.

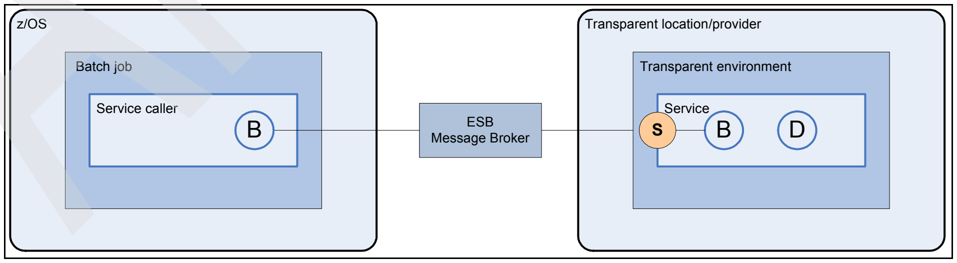


Figure 5-36 Logical overview of the batch as a service caller variation

A batch program can act as a service caller. It may invoke SOA-compliant services through an ESB. It may even invoke services in batch through a native or another SOA interface, as described in the Improve solution section.

Considerations concerning invoking services from batch as compared with other invocation methods are:

- Calling sub-programs natively provides better performance than service invocation.
- It can create unwanted wait situations for the batch job; for example, waiting for online transactions to complete and waiting for synchronous or pseudo-synchronous partner processes to complete.
- It may be used in connection with asynchronous WMQ-based communication with partners. This implies dependences to Message Broker availability and responsiveness.

Process overview

Preparing a batch application to act as a service consumer involves exploitation of standard interfaces to the ESB installed.

Observations when using the Adapt transition approach with the batch starting scenario

Advantages:

- It offers the reuse of real business services from batch.

Disadvantages:

- There is a significant performance impact if there are high volume calls.
- Delays or instability may occur as a result of external callouts.

5.4.5 Using the Innovate transition approach

The logical architecture for an Innovate solution is shown in Figure 5-37 on page 195.

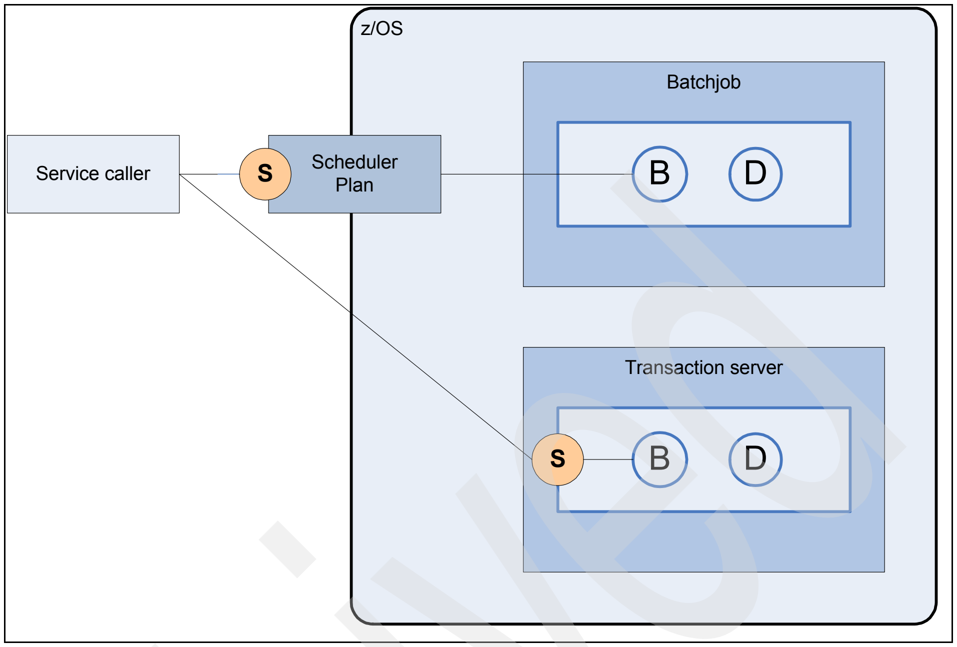


Figure 5-37 Logical overview of the batch Innovate variation

Solution technique implementation

The logical architecture for the innovate transition approach looks similar to the Adapt transition approach. The core logic could be used unchanged, but it is likely that re-engineering is needed and that new business services appear as a result of a methodological approach. The most probable deployment destination is a transaction server like WebSphere Application Server, CICS, or IMS.

It is possible that some re-engineered services can be deployed in batch.

The differences by enabling a service in an application server and a batch job are as follows:

- If the service is deployed in an application or transaction server, the service caller can have a synchronous response, as opposed to the batch implementation, where no direct response back is created.
- In a transaction server, the services can be invoked synchronously or asynchronously.
- With the use of message protocols in a transaction server, even pseudo-synchronous invocation is possible. Pseudo-synchronous invocation provides the opportunity to call several services asynchronously, in parallel, and correlate the responses (reply-messages) in the caller.

- In the transaction server implementation, the service interface is directly connected to the service code itself. In the batch implementation, the interface is connected (indirectly) to the scheduler.

From batch job to process flow

A batch job can be considered a flow of activities in a process; see Figure 5-38.

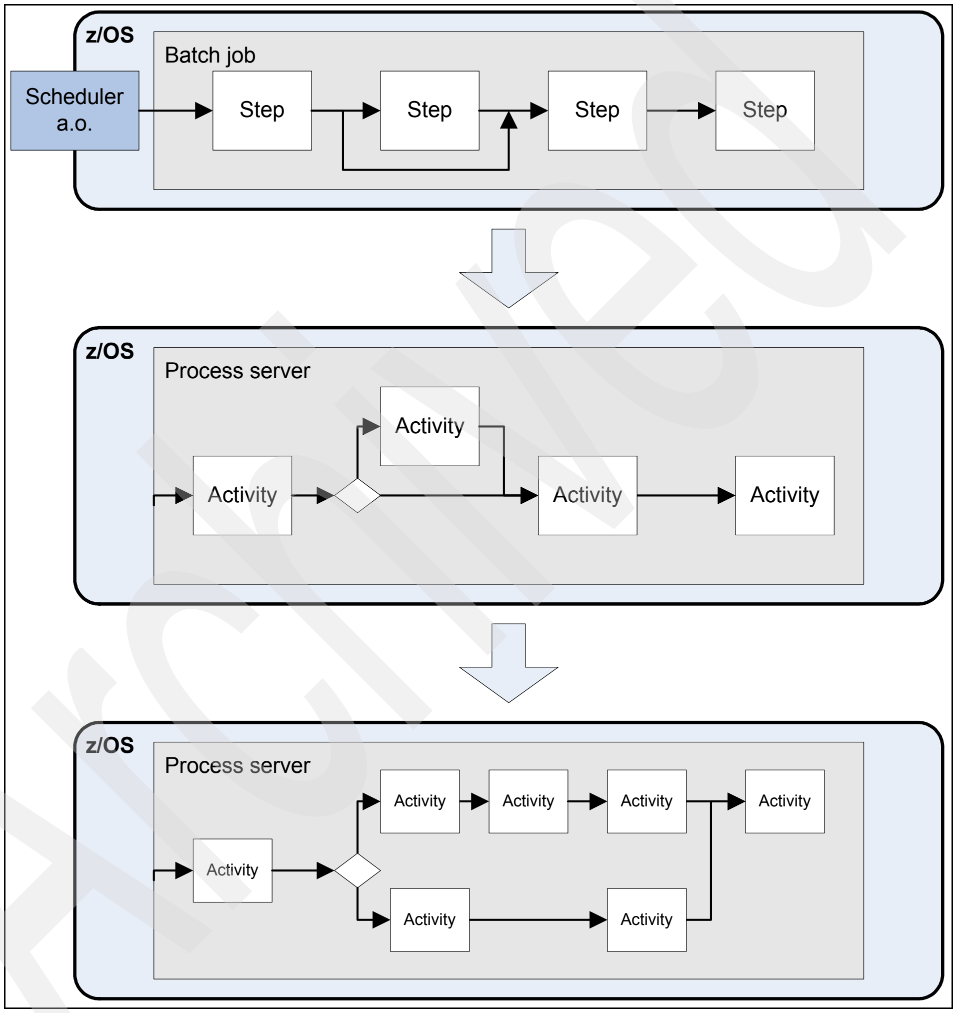


Figure 5-38 Illustration of a batch job as a sequence of activities

The flow of logic in a batch job expressed in steps, programs, and embedded sub-programs may be considered a composite service consisting of separate atomic services. The navigation between the activities is based on a binary determination of whether a step in the predefined sequence will be executed or not, managed by condition codes.

In this Innovate transition approach:

- The atomic services must be identified as a result of a structured methodology. A decomposition based on the step structure may not reflect the basic logical service structure.
- Business rules may be extracted from the code and implemented in the process flow, making the atomic activities more granular and reusable.
- When a proper decomposition has been produced, atomic services can be developed and deployed.
- A composite service can be implemented including several atomic services. It may be deployed in a message broker or a process server.
- Even if it may be technically possible to implement it as a batch job, it may not be a good idea. Batch jobs must run unattended with no manual interference. Callouts from batch can also affect the batch operation. There may be external interrupts or delays causing stops or exceeded batch durations, which may result in extended batch windows.

Process overview

SOA-enabling a batch application with the Innovate transition approach involves the following steps:

1. Identify and select candidate code.
2. Redevelop the code observing standard SOA methodologies.
3. Prepare and deploy the resulting services as standard services in a transaction server.
4. Establish the Web service components to invoke these standard services.
5. If applicable, create and exploit composite services.

For detailed information

- *Application Development for CICS Web Services*, SG24-7126

  http://www.redbooks.ibm.com/abstracts/sg247126.html
- *Implementing CICS Web Services*, SG24-7206

  http://www.redbooks.ibm.com/abstracts/sg247206.html
- *IMS Connectivity in an On Demand Environment: A Practical Guide to IMS Connectivity*, SG24-6794

  http://www.redbooks.ibm.com/abstracts/sg246794.html

Observations when using the Innovate approach with the batch starting scenario

Advantages:

- Real business services are produced and exposed according to standards.
- It offers a significant level of reuse.

Disadvantages:

- There is a significant impact on existing applications.
- Change introduces risk.
- It requires skills and experience, in both existing and new technology.

5.4.6 A practical, mixed approach

A practical and feasible approach in many companies could be the following:

1. Keep existing batch jobs unchanged.
2. Follow the evolution and implement new code as standard services.
3. As a consequence, live with the resulting redundancy for some time.

This approach may imply a greater effort in maintaining the applications, but it is certainly much easier to implement. And it may turn out to be the only possible approach, considering the scarcity of skills in these disciplines.

Observations when using this mixed approach with the batch starting scenario

Advantages:

- It offers very fast implementation and involves no effort at all.
- There are no operational risks.
- It offers the ultimate (existing) level of Quality of Service.
- New real business services can be produced and exposed according to standards.
- Some level of code reuse may be exploited.
- There is a low level of skill dependencies in the short term.

Disadvantages:

- Redundant code to be maintained for a long time.
- It requires skills and experience in both existing and new technology, and in the long run.

5.5 SOA implementation scenarios - data access and integration

Here we describe SOA implementation scenarios for all variations described in the "data access and integration" starting scenario. These variations are:

- Data access
- Integrator
- Batch ETL
- Messaging ETL

When discussing the SOA implementation scenario for Integrator, we examine the idea of "information as a service". We describe which IBM products are available on the z/OS platform to enable the concept of information as a service, looking at them in the context of the IBM SOA reference architecture. We do not discuss here the functionality available in the areas of aggregation, replication, consolidation, analytics, special queries, and so on. Instead, we discuss the *functionality* that enables the concept of information as a service.

Table 5-4 on page 200 lists a summary of the variations that we examine here.

Table 5-4 Summary of data access and integration variations

Transition approach	Variation	Described in
Improve	Variation 1: Data access	"Data access using the Improve transition approach" on page 200
Adapt	Variation 1: Data access	"Data access using the Adapt transition approach" on page 203
Adapt	Variation 2: Integrator	"Integrator using the Adapt transition approach" on page 205
Adapt	Variation 3: Batch and messaging ETL	"ETL using the Adapt transition approach" on page 212

We structure the sections based on the targeted level of SOA enablement maturity (Improve, Adapt, Innovate), as with the other SOA implementation scenarios.

5.5.1 Variation 1: Data access

In the following sections we discuss SOA enablement using an Improve and Adapt transition approach of data access.

Data access using the Improve transition approach

The Improve transition approach looks at the way data access is taking place, and will provide a SOA-enabler for the access. Considering the starting scenario, access usually takes place from CICS/IMS transactions or batch programs, and these components either:

- Access data directly, using native data interfaces made available by z/OS and the database subsystems
- Or use (in case of DB2) stored procedures to encapsulate business logic and get data

The logical architecture for the Improve transition approach for data access is shown in Figure 5-39 on page 201.

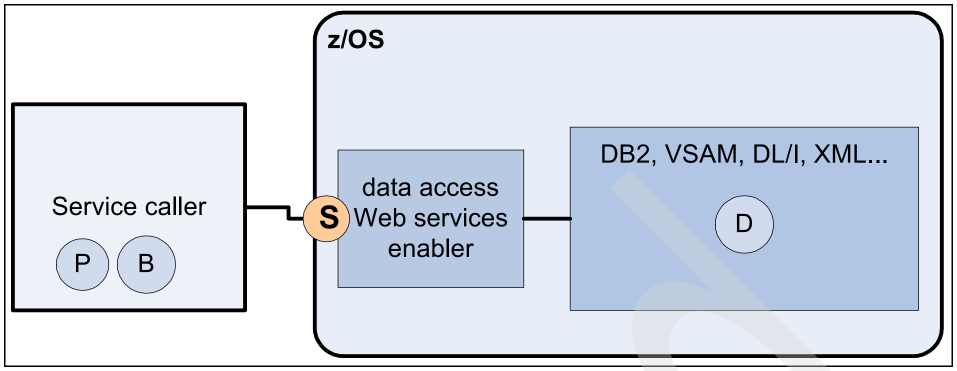


Figure 5-39 Logical architecture for SOA enablement of data access

In the case of DB2 and its stored procedures functionality, we can devise another logical architecture for the Improve transition approach, shown in Figure 5-40. As seen, the business part of the application is split between the service caller and DB2.

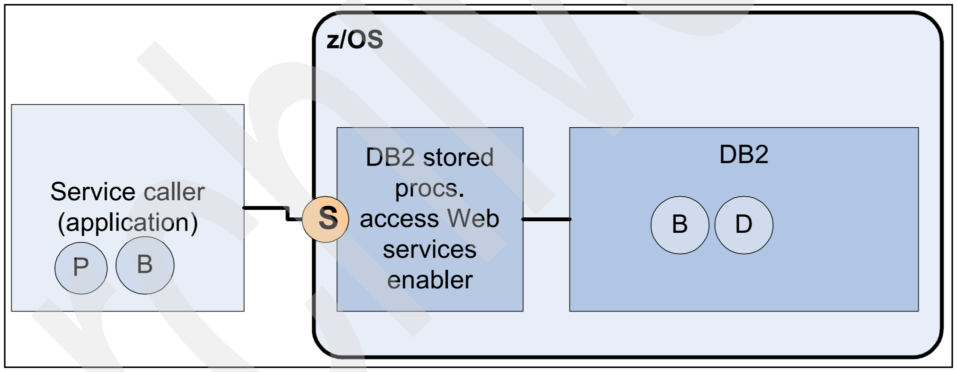

z/OS
Service caller (application)
P
B
S
DB2 stored procs. access Web services enabler
DB2
B
D

Figure 5-40 Logical architecture for SOA enablement of stored procedures access

Products used

DB2 for z/OS allows enabling DB2 data and stored procedures as Web services through the Web Services Object Runtime Framework (WORF). So, DB2 becomes a service provider in SOA terminology, a SOAP-enabled service provider.

WORF runs inside WebSphere Application Server, and provides an environment to create XML-based Web services that access DB2.

A Web service is defined by using a Document Access Definition Extension (DADX) file. In the DADX file, we define Web services based on SQL statements and stored procedures.

Based on the definitions in the DADX file, WORF performs the following actions:

- Resource-based deployment and invocation.
- Automatic service redeployment at development time when defining resources change.
- HTTP GET and POST bindings in addition to SOAP.
- Handling the generation of any Web Services Definition Language (WSDL) and UDDI information that the client application needs.
- Providing DB2 JDBC connection information for the target database.
- Can be easily generated via WSED/RAD tooling.
- Formatting the result into XML, converting types as necessary.
- The URL to invoke the Web service specifies the DADX file as well as the SQL operation (method) that has to be invoked.

Figure 5-41 shows the implementation of this solution.

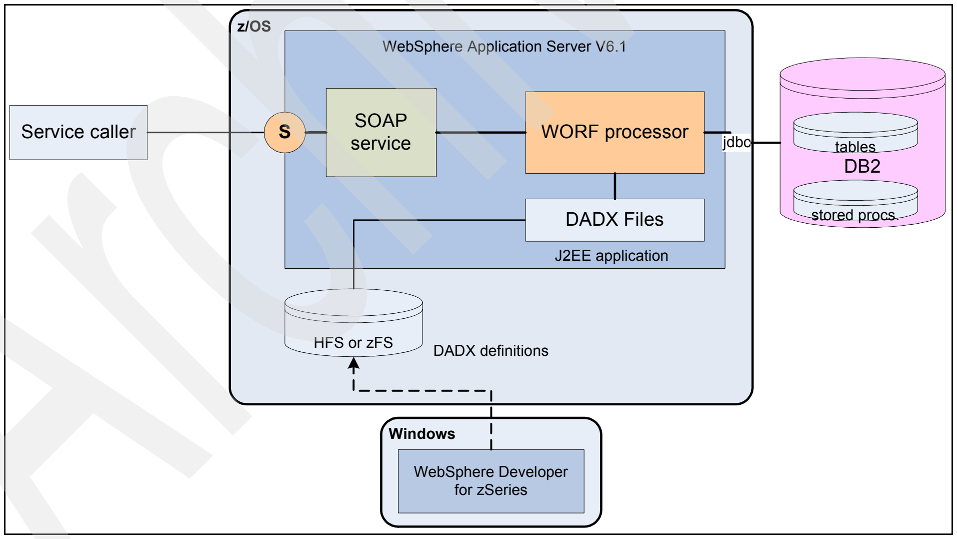


Figure 5-41 DB2 access enabled through WORF

Observations when using the Improve transition approach with the DB2 access/stored procedures variation

Advantages:

- It offers fast implementation; there is simple tooling and deployment, thus quick time to market.
- There is low complexity.
- There is no change in the business logic (stored procedures).
- It can be used to encapsulate stored procedures as SOA-enabled services and improve reusability (can be called as a Web service from anywhere in the SOA implementation).

Disadvantages:

- It requires WebSphere to position WORF.
- It involves additional overhead, as compared to native data access.

Data access using the Adapt transition approach

In the Adapt transition approach, we take a look at business logic positioned in DB2 (stored procedures) and the way it can behave in a SOA-enabled environment. This business logic can not only access data in DB2 but also, through user-defined extensions, access external Web services. Therefore we have a new logical architecture, which is shown in Figure 5-42. In this case the logical architecture is at the same time the product implementation architecture.

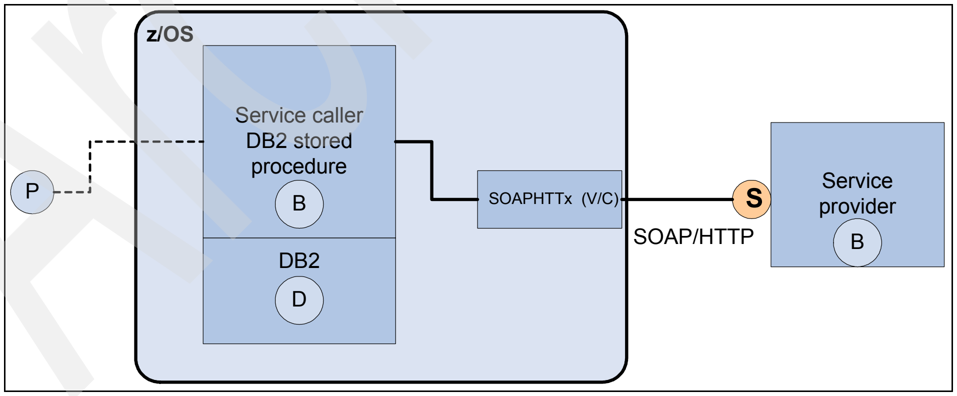


Figure 5-42 Logical architecture of Adapt transition approach using DB2 stored procedures

Products used

IBM DB2 for z/OS has made available User-Defined Functions (UDFs) for implementing Web services consumers in DB2. These new Web service consumer UDFs enable the database system to directly invoke SOAP-based Web services using SQL statements. This eliminates the need to transfer data between Web services and the database. The Web services consumer converts the results obtained by calling WSDL interfaces into DB2 table or scalar functions.

When a service consumer receives the result of a Web services request, the SOAP envelope is stripped and the XML document is returned. An application program can process the result data and perform a variety of operations, including inserting or updating a table with the result data.

Internally, DB2 provides these actions using a SOAP UDF:

- Receiving input parameters from the SQL statement.
- Composing an HTTP/SOAP request based on the input to the UDF.
- Invoking a TCP/IP socket call via z/OS USS APIs and sending an HTTP/POST request.
- Receiving a reply back from the Web service provider.
- Validating HTTP headers.
- Stripping the SOAP envelope and returning the SOAP Body (including the namespace referenced in the SOAP envelope) to the DB2 client application.

This DB2 feature presents us with an interesting new architecture (shown in Figure 5-43). In this architecture we see the possibility to indirectly SOAP-enable batch COBOL programs as Web services consumers. We also see the participation of DB2 services (provider and consumer) in an ESB (either WebSphere ESB or WebSphere Message Broker).

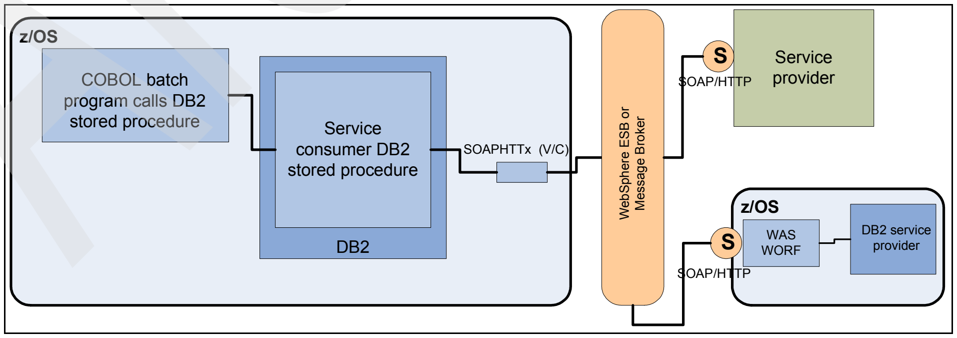

z/OS
COBOL batch program calls DB2 stored procedure
Service consumer DB2 stored procedure
DB2
SOAPHTTx (V/C)
WebSphere ESB or Message Broker
S
SOAP/HTTP
Service provider
z/OS
S
SOAP/HTTP
WAS WORF
DB2 service provider

Figure 5-43 DB2 stored procedures as service consumer and service provider in SOA

Observations when using the Adapt transition approach with the DB2 consumer variation

Advantages:

- It is relatively easy to implement; there is some tooling support.
- It offers the full participation of DB2 in an ESB.
- It can be used to indirectly SOA-enable COBOL batch programs.

Disadvantages:

- It requires changes in the DB2 and stored procedures business logic.
- It involves additional overhead as compared to a native data access.

5.5.2 Variation 2: Integrator

In the following sections we discuss SOA enablement using an Adapt transition approach of data/information integration.

Integrator using the Adapt transition approach

Here we describe the SOA implementation scenarios for SOA-enablement of the integrator scenario. Generally speaking, with the integrator scenario we ask, “What is being delivered by the integrator”? The answer is: information. Therefore, we must find a way to describe and enable the discovery of information in the SOA world, and in this way the concept of “information as a service” appears.

Why “information as a service”?

In today’s large organizations—which are built over time through evolving technology, and which use different product capabilities and experience changing application requirements and expansions and mergers—different parts of the enterprise use different information management systems to store and search their critical data. Each of these disparate systems carry overlapping information, managed using various technologies and data formats. As these information systems become more complex, they become more difficult to change and increasingly expensive to maintain or develop.

The same problems that are experienced with application systems also exist in the data integration area (for example, multiple interfaces, “spaghetti” connectivity, high complexity, redundant data positioned in different databases, and no or little governance). In contrast, the position we seek to be in is illustrated in Figure 5-44 on page 206.

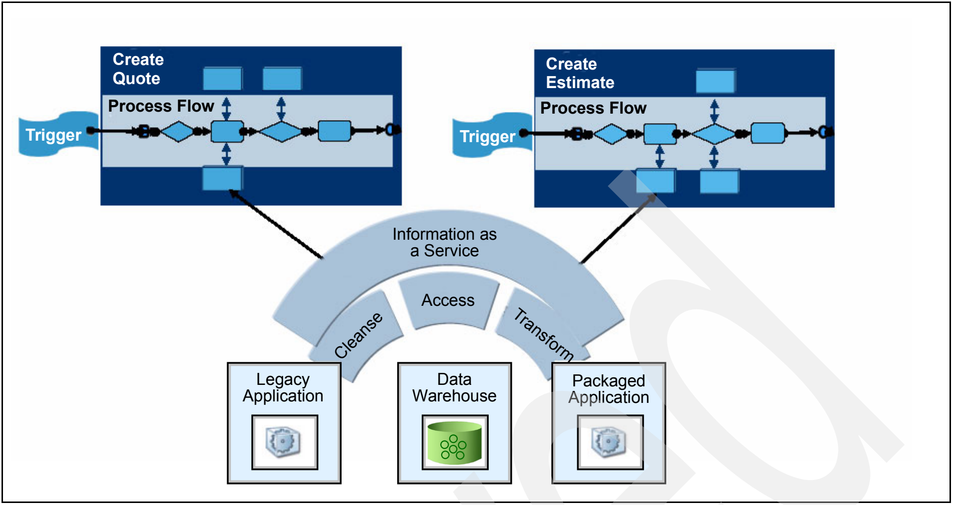


Figure 5-44 Information as a service presented as an layer separating the applications from data

The SOA building block Information Services

The discussion in this section revolves around the content of the Information Services SOA building block. The building block contains a number of disciplines, out of which we will focus on information integration services.

We define a new type of service for the information, and we apply the SOA criteria for this service. The information service as defined will be reusable, have an implementation-independent interface, be location-transparent and transport-neutral; it will behave like any other SOA service.

An *information service* allows the managers of shared information assets (such as customer information or product descriptions) a consistent, auditable and secure way to share this asset, while maintaining control over how it is used. For the service consumer, the information service is a trusted information source provisioned by people who understand the meaning of the data and have responsibility for maintaining it.

And now we see one of the SOA principles at work: by separating the interface from the implementation, service providers are free to change how and where the data is produced and managed internally. For example, new application requirements might prompt an enterprise decision to store some of the information assets as XML native inside DB2. Having an interface above the service provider (in this case, DB2 with XML) allows the service consumer to retrieve its data without being aware of the internal change that has taken place.

Invoking an information service is one of many ways of programmatically accessing data. It is not appropriate for all types of data access.

A typical information service will have one or more of the following characteristics:

- It will deliver *information*.

  This means there is a process that prepares pieces of data from (possible different sources) and delivers it.

- Data preparation might include *aggregation, synchronization, standardization, duplication, reformatting, conversion*, and so on.

  These combinations of data preparation tasks form data integration patterns. Choosing the right pattern depends on the amounts of data, where the data came from, when it needs to be delivered and in what form.

- It will integrate multiple data sources.

  Many business processes require information that results from processing large sets of data, often from multiple sources. Bringing together this data can be a data intensive process that calls for specialized data management tools.

- It will provide virtualized views.

  Virtualization provides transparency that masks the differences and implementations of underlying data sources from users. Ideally, it allows data from multiple heterogeneous sources to appear to the user as a single system.

  The service consumer does not have to be aware of where the data is stored (location transparency; again, a SOA criteria), what language or programming interface is supported by the data source (invocation transparency), whether SQL is used, what dialect of SQL the source supports (dialect transparency), how the data is physically stored, whether it is partitioned and/or replicated (physical data independence, fragmentation and replication transparency) or what networking protocols are used (transport neutrality).

  The user should see a single uniform interface, complete with a single set of error codes (error code transparency).

- It will provide Reusability.

  To be reusable, information services must be at the right level of granularity to encapsulate an information need that is repeatable. An information service should be designed in such a flexible way that it allows future changes, without the need for changing the interface (extension of the interface should be possible, so the service consumers that use the older interface do not need to change).

IBM product that can be used to create “information as a service” components

The only IBM product available on z/OS is WebSphere Information Integrator in several flavors (classic federation, replication, Event Publisher for DB2/IMS/VSAM). We will address only the SOA-relevant elements, not the detailed functionality of the product. We refer to the product in the remaining of this section as WebSphere Information Integrator.

Websphere Information Integrator

WebSphere Information Integrator (WebSphere II) allows users to write applications as if all of the data were in a single database, when in fact the data may be stored in a heterogeneous collection of data sources.

By providing an SOA interface to these capabilities, the information server gives users real-time access to integrated business information across and beyond the enterprise by publishing reusable services.

These operations include the ability to:

- *Connect* to any data or content, wherever it resides. Direct, native access is provided to relevant information sources (that is, access to information, not to data).
- *Understand* and *analyze* information, including its meanings, relationships, and lineage.
- *Cleanse* information, to ensure its quality and consistency.
- *Transform* information, to provide enrichment and tailoring for its specific purposes.
- *Federate* information, to provide a unified view to people, processes, and applications.

WebSphere Application Server II delivers information services using an SOA framework known as the IBM WebSphere Information Services Director (WISD). WISD facilitates reuse of the information service by ensuring consistent definitions, packaging, and rules applied to the data. WISD facilitates governance by centralizing control and management.

WISD uses open standards, and it is deployed on a J2EE-based foundation framework that provides flexible, distributable, and configurable interconnections among the many parts of the architecture through accepted SOA standards. WISD allows the same service to support multiple protocol bindings, all defined within the WSDL file. This improves the utility of services (they can be used by different client types), and it therefore increases the likelihood of reuse and adoption across the enterprise.

An information service can be invoked over the following bindings:

- Web service

  Web services-compliant consumers can access the information services.

- SOAP over JMS

  In a messaging environment, the Information Services Director can automatically generate an asynchronous JMS queue listener (Message Driven Bean) and route incoming messages into information services. It can adapt the output of an information service into a SOAP message that can be posted to one or more JMS queues or topics.

- EJB

  For Java-centric development, the Information Services Director can generate a J2EE-compliant EJB (stateless session bean) where each information service is instantiated as a separate synchronous EJB method call.

- Service Component Architecture (SCA)

  This binding provides a client programming model and a consistent way of describing components as services available the WebSphere Enterprise Service Bus product.

Now we return to the Adapt transition approach. We want to use the functionality delivered by the IBM products (previously described) in an SOA-enabled architecture. Therefore we explain the "information as a service" components, as shown in Figure 5-45 on page 210.

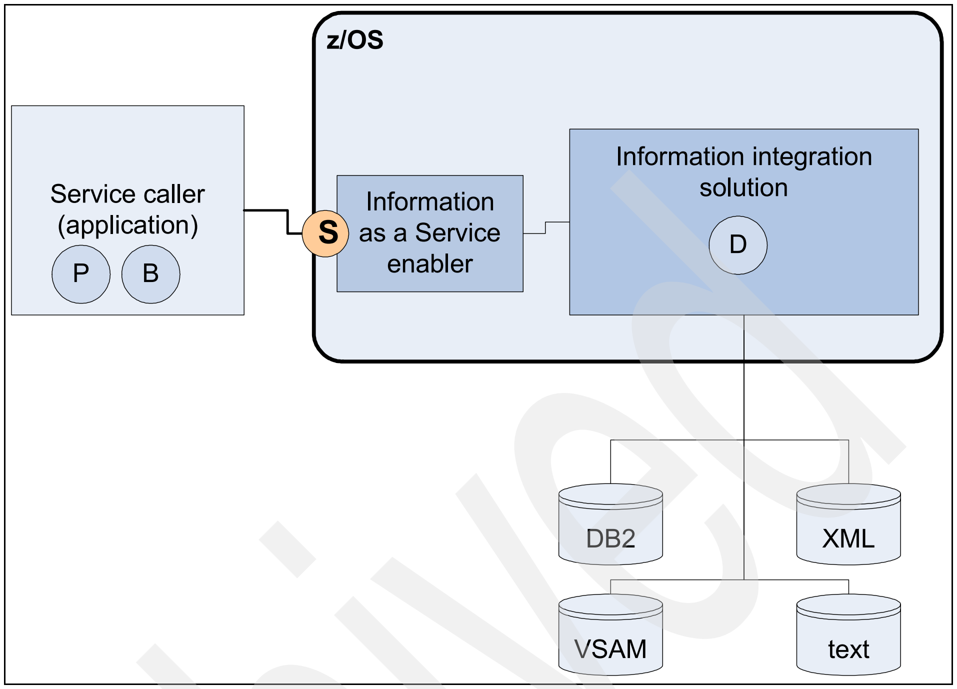

z/OS
Service caller (application)
P
B
S
Information as a Service enabler
Information integration solution
D
DB2
XML
VSAM
text

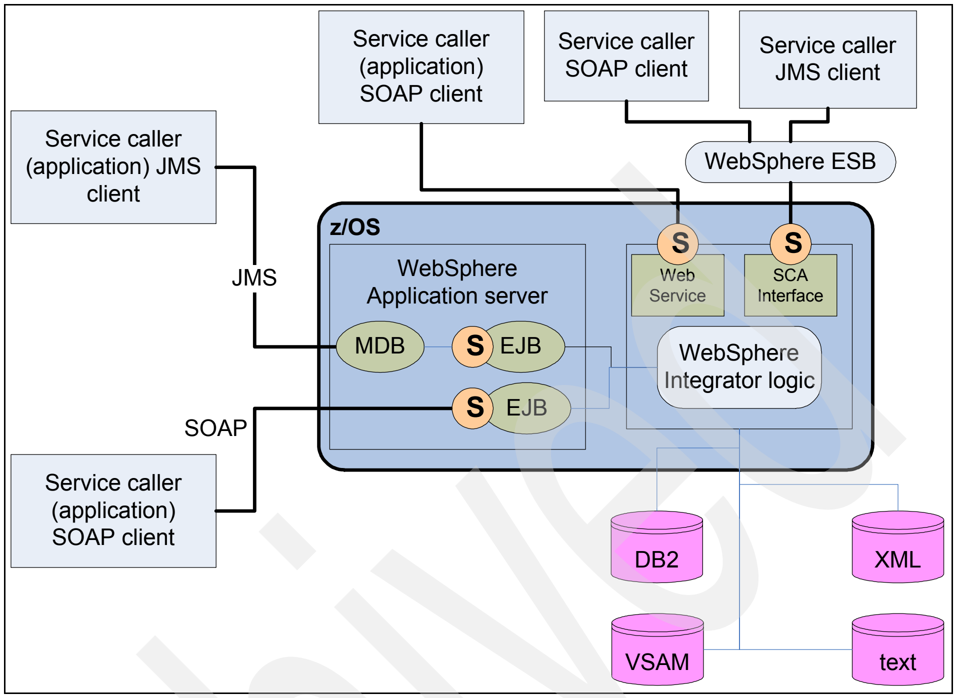
Figure 5-45 Logical architecture for the Integrator scenario

Products used

For the purposes of this discussion, we use the IBM WebSphere Information Integrator. We saw previously that this product can deliver its information service over several bindings. Therefore we can envision several implementations of the logical architecture.

Figure 5-46 on page 211 shows some possible implementations, which are described here:

- An implementation where the SOAP-enabled service consumer accesses WebSphere II over the provided Web services binding.
- An implementation where the access is over an MDB (generated by WebSphere II), placed on the WebSphere Application Server, enabling it to receive JMS messages while being able to call the back-end integrator.
- An implementation where WebSphere II generates an EJB with back-end methods, and places the EJB on the WebSphere Application Server. This means any Web services-enabled client can now (over the WebSphere Application Server) access the EJB and therefore the back-end integrator.
- An implementation in which the “information as a service” is reached using the SCA binding over the WebSphere ESB bus.



Service caller (application) SOAP client
Service caller SOAP client
Service caller JMS client
Service caller (application) JMS client
WebSphere ESB
z/OS
JMS
WebSphere Application server
MDB
S
EJB
S
EJB
SOAP
S
Web Service
S
SCA Interface
WebSphere Integrator logic
Service caller (application) SOAP client
DB2
XML
VSAM
text

Figure 5-46 Different implementations of WebSphere II SOA-enabled

Which of the several possible implementations can be implemented in a specific enterprise depends on many factors (including the complexity of the landscape, the availability of the IBM products that will run the SOA-enabler interfaces, and the level of performance required).

Observations when using the Adapt approach with the Integrator starting scenario

Advantages:

- It provides for the implementation of the SOA-enabled “information as a service”.
- All derived services inherit SOA characteristics and benefits.
- It allows new and innovative use of the information service, decoupling business logic from data positioning, structure, and representation.
- It allows the easy creation of new data models and their access as information services.
- No changes in data implementation are required.
- It offers all of the advantages of the Integrator that are related to data management and access.

Disadvantages:

- It requires WebSphere Information Integrator, and possibly other WebSphere products, for more flexible SOA-enablement (WebSphere Application Server and WebSphere ESB).
- It incurs additional overhead, as compared to a native data access.

5.5.3 Variation 3: batch and messaging ETL

In the following sections, we discuss SOA enablement using an Adapt transition approach of batch and messaging Extract Transform and Load (ETL).

ETL using the Adapt transition approach

From the logical point of view, the batch ETL and messaging ETL look the same, as shown in Figure 5-47 on page 213. As you can see, we interpret the ETL layer as an ESB. In case of the batch ETL, the ESB will contain file-drop attachments, and the mediations are taking place inside the bus. In the case of a messaging ETL, the ESB will contain messaging attachments.

We can implement the ETL functionality as mediation flows inside the ESB and allow the bus to be concerned with the reliable transport of the data; the business rules that control the flow can also be implemented in the ESB. Because the business rules that govern the ETL process are implemented inside the ESB, we have a dynamic and easily changeable application architecture.

If we implement this SOA concept, we will have reduced considerably, for an enterprise that has many file transfers, the number of connections (each application connects to the ESB, instead of any-to-any between applications).

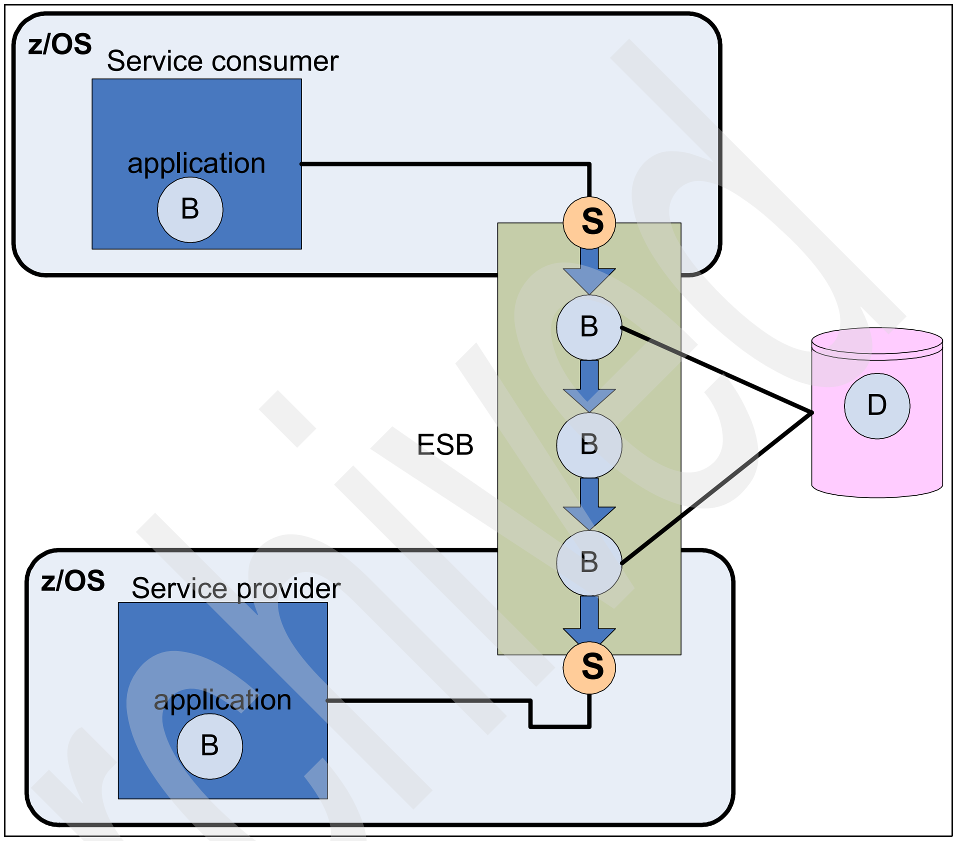


Figure 5-47 Logical architecture for batch ETL and messaging ETL

The logical structure that we create for all applications in the enterprise is shown in Figure 5-48 on page 214.

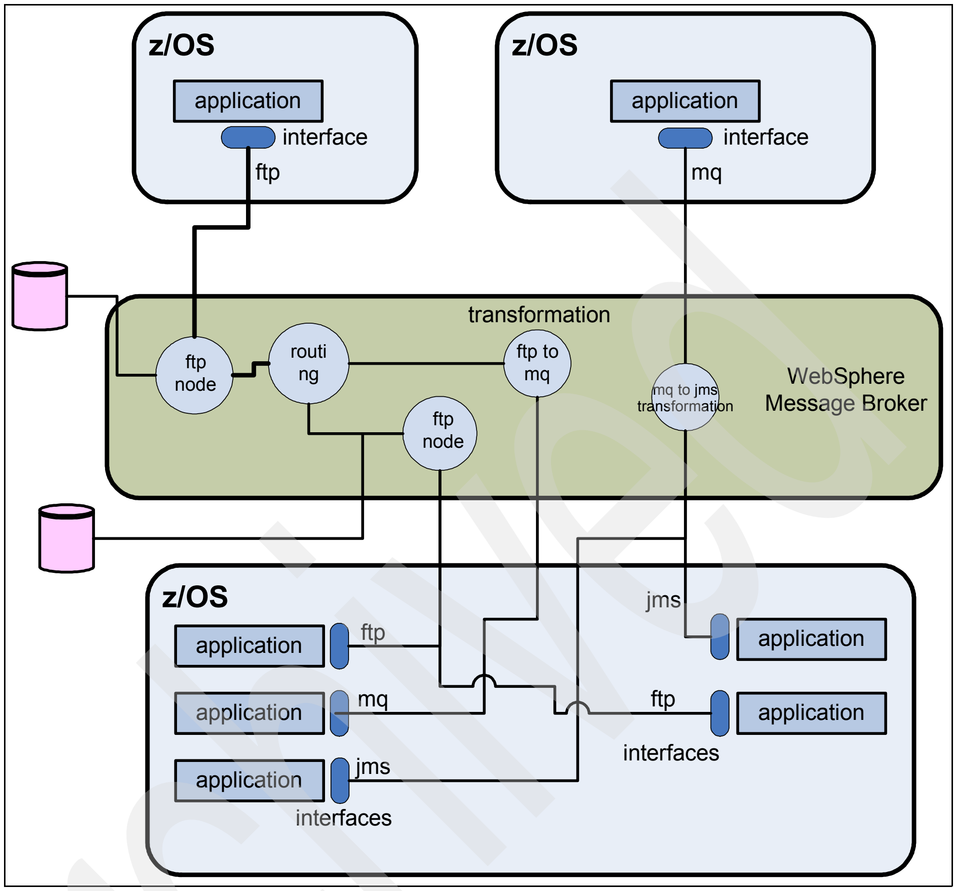


Figure 5-48 Enterprise SOA-enabled batch ETL and messaging ETL

Products used

In the case of batch and messaging ETL, we could use IBM WebSphere Message Broker with the necessary nodes and mediations. The physical implementation might look as shown in Figure 5-49 on page 215.

This implementation results in, among others, the following consequences:

- The application (as a service consumer or provider) has only one attachment point to the WebSphere Message Broker. There is no any-to-any configuration necessary.
- The mediations and transformations are implemented as services inside the WebSphere Message Broker, and as such can be written as reusable components. They run in a controlled way and can be managed. The flow of

mediations can be designed with existing tooling and deployed to the ESB runtime.

Because of the many interfaces (and node implementations) supported by WebSphere Message Broker, it is possible to establish communication relationships between service consumers and providers that have different interfaces (for example, a JMS/MQ service provider can receive FTP files as sequences of JMS/MQ messages).

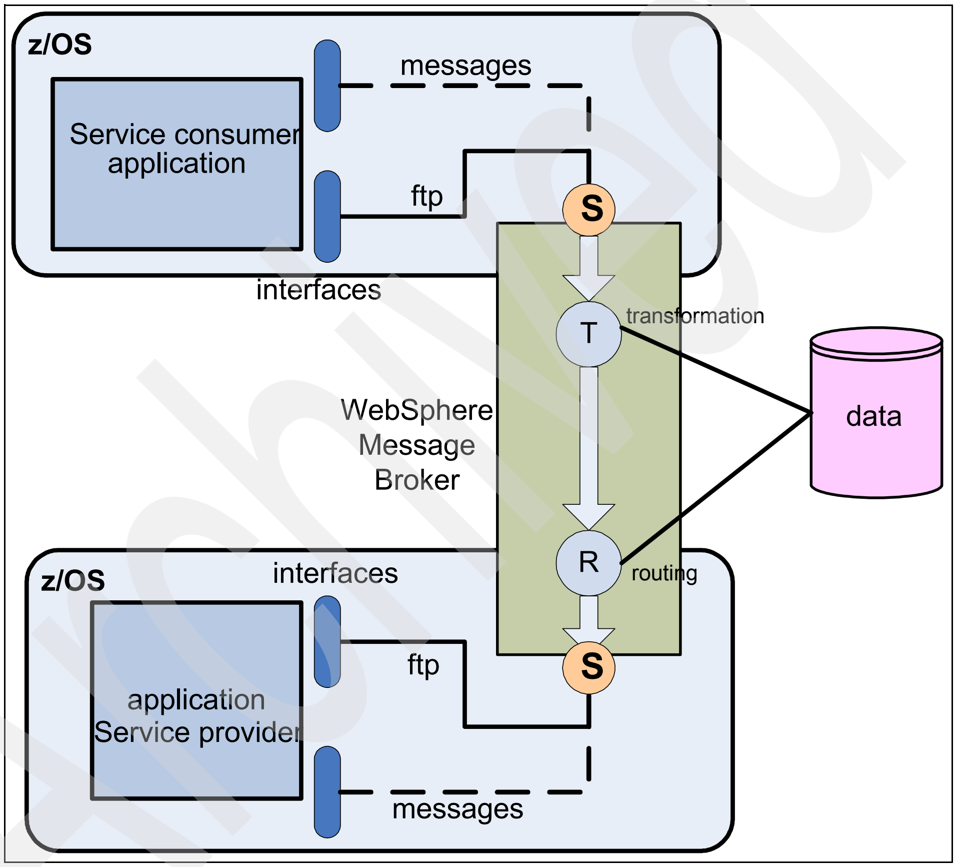


Figure 5-49 Implementation solution for batch and messaging ETL with WebSphere Message Broker

Observations when using the Adapt transition approach with batch and messaging ETL starting scenario

Advantages:

- ► It can simplify the configuration of middleware and connectivity (enterprise-wide).
- ► It can result in increased flexibility for the applications.
- ► It is interface-independent.
- ► It makes possible a publish and subscribe model for "ftp"-based integration.
- ► It offers controlled transformation through configurable business rules.

Disadvantages:

- ► It is necessary to install an ESB.
- ► It incurs performance overhead as compared with native messaging and native FTP.

5.6 SOA implementation scenarios for homegrown SOA

In 3.6, "Starting scenario - homegrown SOA" on page 89, we discuss the scenario in which companies have tried to implement some kind of Service Oriented Architecture, with the objective of increasing reusability and implementing transparency.

We mentioned that there are many variants of this scenario, and it is impossible to discuss them all. However, most of those existing Service Oriented Architectures do have a few things in common:

- ► There is an abstraction layer, before accessing the real business logic, that is implemented in a J2EE application server, a back-end transaction manager, or a database server.
- ► In most cases, the service interface is more a "wrapper" than a native service interface.
- ► The transport between different servers or containers usually takes place using JMS or WebSphere MQ. In some cases, when the application environment is all J2EE, you may also see RMI-IIOP as a transport mechanism.

Many of the “homegrown” SOAs do not comply to the SOA definitions as we have them today and the maturity level is relatively low. In the homegrown SOAs, however, we do see the use of standards-based protocols as well as some form of location transparency, although implemented with homegrown frameworks.

Reusability is often not ideal yet, as a major refactoring effort to improve service granularity in the business logic has not taken place. “Spaghetti” logic is still being invoked as “spaghetti”, but using a standards-protocol and a self-built mechanism to provide location transparency. So, in most homegrown SOAs there is work to do to actually achieve the promised benefits of a modern SOA.

Table 5-5 provides a summary of the variations discussed in this chapter.

Table 5-5 Summary of homegrown SOA implementation variations

Approach	Scenario	Summary
Improve	Introducing open standards	“Open standards-based SOA Interface” on page 218
Adapt	Using an open standards-based service registry	“Open standards-based Service Registry” on page 220
Innovate	Various scenarios possible, based on maturity level	

The SOA implementation scenarios are based on the starting scenarios as described in 3.6, “Starting scenario - homegrown SOA” on page 89.

5.6.1 Using the Improve transition approach

Based on our starting scenarios, there is at least one option where the Improve transition approach can be used; that is, how to make the SOA Interface callable via open standard- based protocols, if that is not already the case. Refer to Figure 5-50 on page 218.

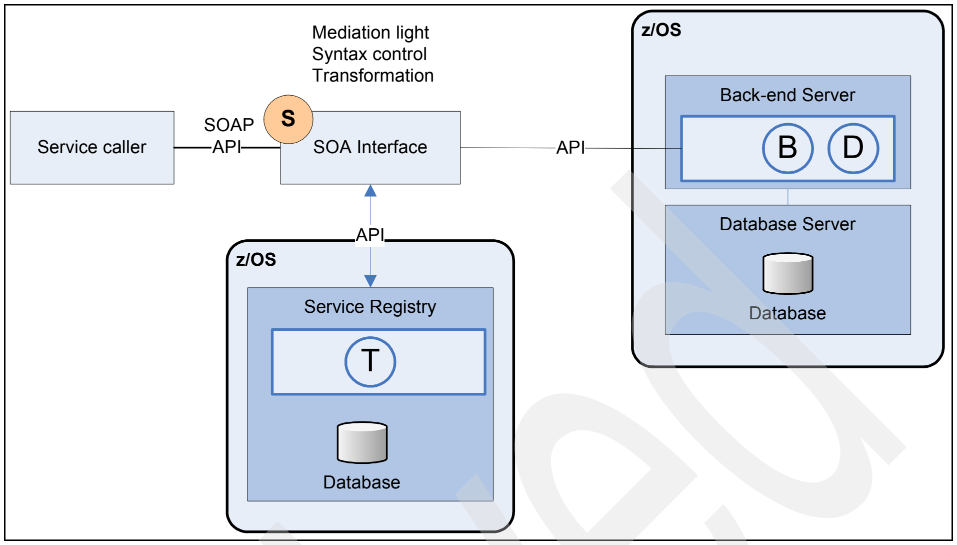


Figure 5-50 Overview of the homegrown SOA Improve transition scenario

Solution techniques for Improve approach

The use of the Improve transition approach usually leads to the adoption of the adapter-provided service interface pattern. In this scenario, we illustrate how the in-house developed standard interfaces can be exposed via open standards-based protocols.

The core functions in the back-end transaction server remain untouched in this migration scenario.

Open standards-based SOA Interface

Many homegrown SOA solutions use WebSphere MQ as the transport protocol. On top of WMQ, there is logic implemented that masks some of the functionality typically available in a broker or ESB (shown as `SOA Interface` in Figure 5-50). It is the SOA interface that is the entry point for the call to the service.

The SOA interface provides functions to provide some level of location transparency, such as correlating a queue to a service name. There may also be some level of support for mediation, syntax control and transformation. The Service Registry is located in DB2 or another datastore, exposed through a technical API (developed in-house).

For this scenario, we assume that the back-end functions in CICS and IMS will remain the same, and will be called via the same interface as before. The changes we apply are in the area of *how* the services are called.

Solution technique implementation

The solution technique in this scenario can best be described as an adapter-provided service interface pattern, because we implement an “adapter” in front of the Service Registry.

Process overview

Considerations when moving a homegrown SOA to an open standards-based service interface are as follows:

- What can be done to standardize the native protocol between the caller and the provider?
  - Is the protocol based on proprietary communication, and in that case, how can that be opened up?
  - Can the techniques that are described in 5.2, “SOA implementation scenarios for a 3270 application” on page 137 be applied?
- What about the application architecture—are the services structured in such a way that they can be packaged and used by a protocol other than the one they were originally built for?

There are many considerations in this scenario, and there is no single answer to these questions. Instead, your focus should be on deciding which strategic and tactical steps to use for the migration.

We have illustrated a way to enable the SOA Interface, to be accessible via an open standards-based API and protocol (for example, SOAP).

For detailed information

- *Patterns: Extended Enterprise SOA and Web Services*, SG24-7135

  `http://www.redbooks.ibm.com/abstracts/sg247135.html`

5.6.2 Using Adapt transition approach

The purpose of this scenario is to illustrate how to:

- Create a loose coupling between the caller and the homegrown SOA interface.
- Enable a service caller to use open standards based protocols to access the Service Registry in order to find a service.
- The Service Registry can be accessed via Open Standards based protocols, and in that case, how the core back-end functions can be exposed as services.

We assume that the SOA interface is callable via SOAP, as described in the 5.6.1, “Using the Improve transition approach” on page 217.

Open standards-based Service Registry

Figure 5-51 depicts how the Service Registry is used in calling a service. Note that in this example we do not focus on how services are published, but only how they are looked up.

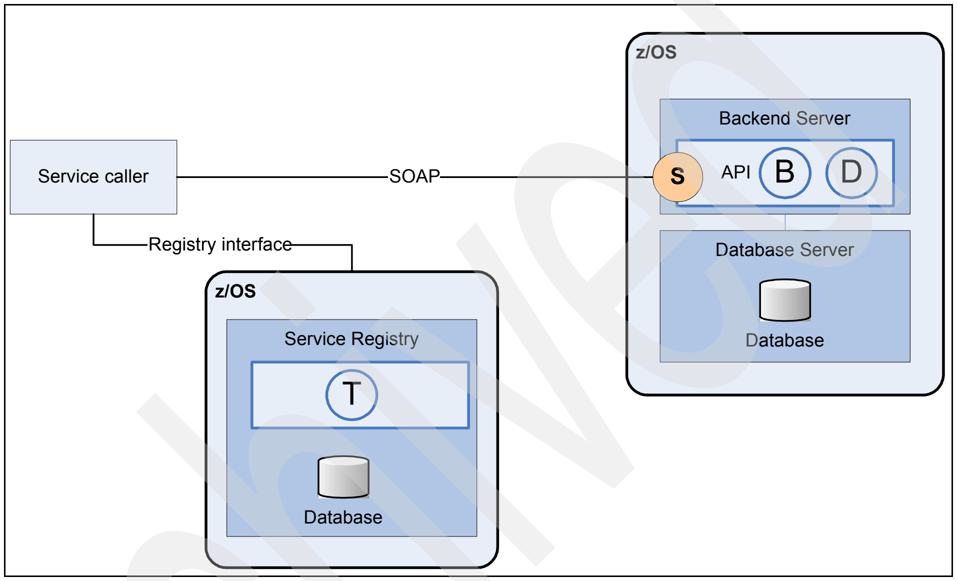


Figure 5-51 Overview of homegrown SOA Adapt transition approach

Process overview

Considerations when moving a home grown SOA to an open standards based service registry are the following:

- What can be done to standardize the protocol between the client and the service registry?
  - Should the service registry at all be in-house developed? Or is there a product available that provides the functionality?
  - Which protocol should be used?
  - Maybe the techniques that are described in the 3270 transition scenario chapter could be applied.
- What about the application architecture? Are the services structured in a way so they can be packaged and used by another protocol than they originally are built for?

There are many considerations in this scenario, and no single answer to these questions. Instead, your focus should be on deciding which strategic and tactical steps to use for the migration.

We have illustrated a way to enable the SOA Interface, to be accessible via an open standards-based API and protocol (for example, SOAP).

For detailed information

- *Patterns: Extended Enterprise SOA and Web Services*, SG24-7135

  http://www.redbooks.ibm.com/abstracts/sg247135.html

5.6.3 Using the Innovate transition approach

An Innovate transition approach for a homegrown SOA could be, for example, refactoring business logic to achieve a better granularity of the services, or the implementation of a full ESB, if not already implemented.

The extent to which an Innovate transition approach is necessary will depend on the maturity of the homegrown SOA and the ambition level.

6

Towards service integration and process integration

In this chapter we discuss the following topics:

- Defining the transition stages towards service integration and process integration (by defining SOA implementation blocks) and presenting the SOA-related activities to be implemented during these stages
- Describing the reasons for moving from stage to stage
- Describing the status of the enterprise after undertaking the transition scenarios described in Chapter 5, “SOA implementation scenarios” on page 131
- Indicating which IBM products will be positioned from stage to stage, and how their features are exploited

6.1 The SOA implementation block approach

The approach called “SOA implementation blocks” allows an enterprise to select individual elements of the SOA architecture to implement. Blocks can be implemented one at a time, or in groups designed to meet an immediate business need. Some organizations will start by adding one block at a time as they build a full SOA architecture. These organizations will achieve significant business value with each block they add. Other organizations may design a solution that initially requires multiple blocks to implement. Still others may start off with a design that does not pause until all the SOA blocks are in place. The process has then the following steps:

1. Select blocks specific to the requirements.
2. Implement an immediate solution.
3. Execute a simple quick start.
4. Extend to more complex requirements.
5. Add additional blocks “as needed”.

There are many ways to define the implementation blocks and their content and granularity. Of course each enterprise will apply the activities defined in the block according to its own requirements; this is not a “one size fits all” solution. Instead, it is a process by which an enterprise can see what has to be done generally in a building block, and then select the parts relevant for it.

We chose an approach favored in other IBM documents, which defines the SOA implementation blocks in the following ways.

6.1.1 Stage one - “service enablement” implementation block

The following implementation block and its associated tasks leads to a stage of being “service enabled”.

- Basic Web services

  This implementation block contains activities from the following list:

  – Create services from tasks in new or existing systems.
  – Enable external Web Services using a gateway.
  – Integrate using “point to point”.
  – Implement different technologies (J2EE, .NET, CICS, IMS, and so on).
  – Implement static SOAP binding.
  – Build client stubs using WSDL.
  – Position internal Web services.
  – Use wrappers or adaptors.
  – Enable connectivity to packaged applications (CRM, ERP, Supply Chain).
  – Enable connectivity to legacy systems and data.

6.1.2 Stage two - “service integration” implementation blocks

The following implementation blocks and their associated tasks lead to a stage of being “service integrated”.

- Enterprise Service Bus exploitation

  This implementation block contains activities from the following list:

  – Enable integration of applications and business processes across the enterprise.
  – Introduce routing and transformation capabilities.
  – Introduce more advanced security and mediation.
  – Use message brokering and ESB.
  – Implement portal exploitation and page aggregation.

- Advanced services adoption

  This implementation block contains activities from the following list:

  – Use Service Gateways.
  – Introduce more complex aggregations of services exposed across multiple applications.
  – Include transactional semantics.

6.1.3 Stage three - “process integration” implementation blocks

The following implementation blocks and their associated tasks lead to a stage of being “process integrated”.

- Business services exploitation

  This implementation block contains activities from the following list:

  – Implement service-oriented integration of business functions.
  – Expose coarse-grained business services.
  – Implement provisioning and lifecycle.
  – Implement policy-based business services.

- Business process orchestration

  This implementation block contains activities from the following list:

  – Introduce business process modeling.
  – Begin process choreography.
  – Implement external business rules.
  – Introduce flow and event management.
  – Implement compensation.

- Discovery and dynamic binding

  This implementation block contains activities from the following list:

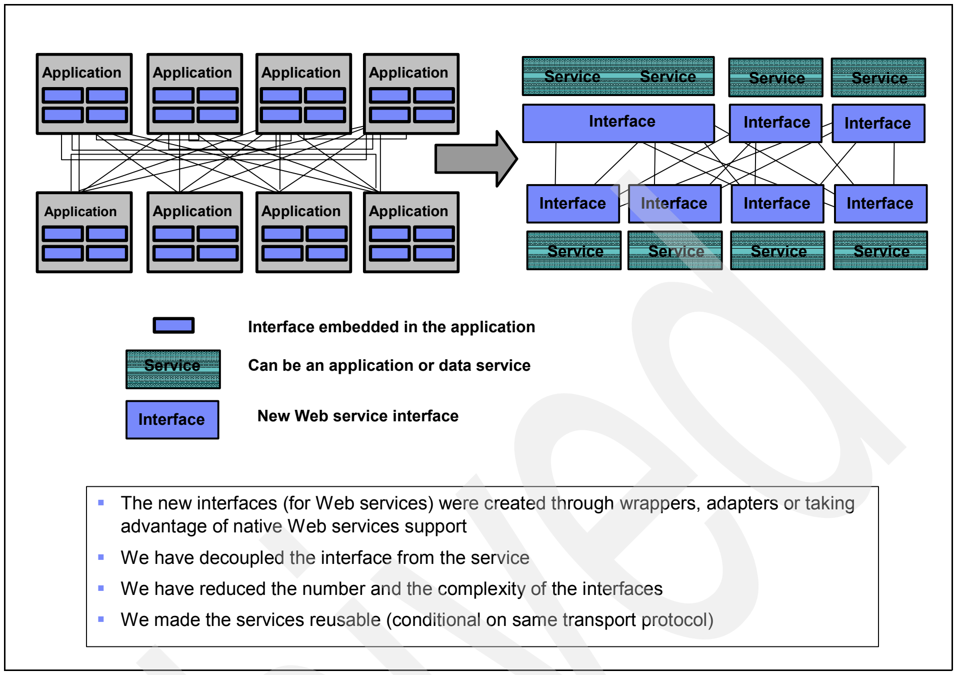
  – Locating services exposed on the ESB - use a service registry for discovery.
  – Introduce “consumer discovers supplier” patterns.
  – Implement dynamic consumption of WSDL.
  – Implement dynamic Invocation of service.

These implementation blocks determine the level of SOA maturity being achieved. Moving from one implementation block to the next one improves SOA maturity and brings the enterprise close to the full SOA benefits, such as agility, flexibility, business-IT alignment, and time to market.

6.2 Stage one - “service enablement”

Most of the activities described under “basic Web services” must have been completed before moving into “service integration” and “process integration”.

To resume, in this stage we created many services out of existing tasks, packaged and legacy applications, and also used wrappers and adapters to improve them. We created client stubs out of WSDL definitions and integrated the client stubs into the service containers. We integrated “point-to-point” between consumers and providers to use (and reuse) the just-created services. And we arrived at the following status, depicted in Figure 6-1 on page 227.


Application
Service
Interface
Interface embedded in the application
Can be an application or data service
New Web service interface

- The new interfaces (for Web services) were created through wrappers, adapters or taking advantage of native Web services support
- We have decoupled the interface from the service
- We have reduced the number and the complexity of the interfaces
- We made the services reusable (conditional on same transport protocol)

Figure 6-1 Status of the enterprise after undergoing service enablement

6.3 Stage two - "service integration"

For the purpose of this book, we define service integration as consisting of the following implementation blocks: Enterprise Service Bus exploitation and Advanced Web Services Adoption.

Note: Enterprise Service Bus exploitation is further discussed in 6.3.1, "Implementing the block "ESB exploitation"" on page 230, and Advanced Web Services Adoption is further discussed in 6.3.2, "Implementing the block "Advanced Services Adoption"" on page 240.

We want to reach the loose coupling situation, therefore we have to break the point-to-point integration. We also want to increase reusability, but we cannot afford to continue to build an unmanageable number of logical and physical connections. There is no common place to store the definitions of these connections, so each application will have to have an increasingly bigger configuration file with static definitions for service providers.

Of course, if we continue this way, we increase the administrative overhead. There is also no dynamics available, so it will not benefit the business. Figure 6-2 shows the architecture we have at this moment.

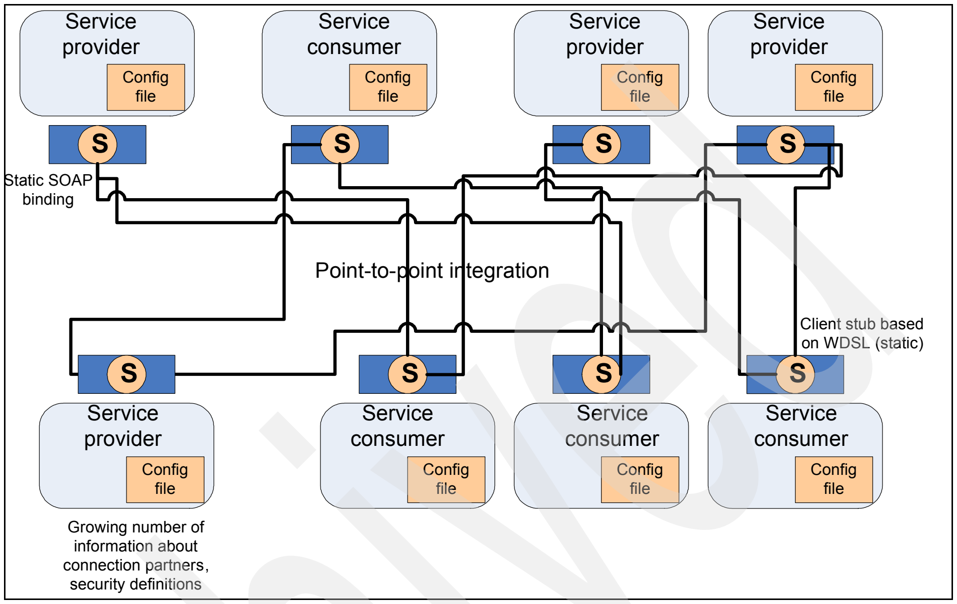


Figure 6-2 Services are there, but limitations abound

Note: Several figures contain the letter S in a circle. This represents a piece of service implementation, which can be either a stub (proxy) on the client side, or a binding on the service provider side.

We want to also start aligning the IT services created in the previous stage with the business services. We have already seen that the Improve and Adapt transition approaches produce services (SOA-style), but they are very seldom aligned with the real business services. Since we are considering future needs, we want to put at the disposal of the business analysts as many business services as possible, which they can manipulate at will in a secured environment.

That means we have to identify these business services, and see that these are either newly created or composed out of existing IT services and some other pieces of infrastructure. Figure 6-3 on page 229 shows a business service (called "Service provider D") that contains pre-existing service primitives or parts of them (it contains the business logic of Service A, part of Service B, and part of Service C, all connected in a flow).

We want to put the service interface on the business service so that it can be used (called) by processes (another future consideration). Thus, we begin to reuse our “primitive” services in an intelligent way.

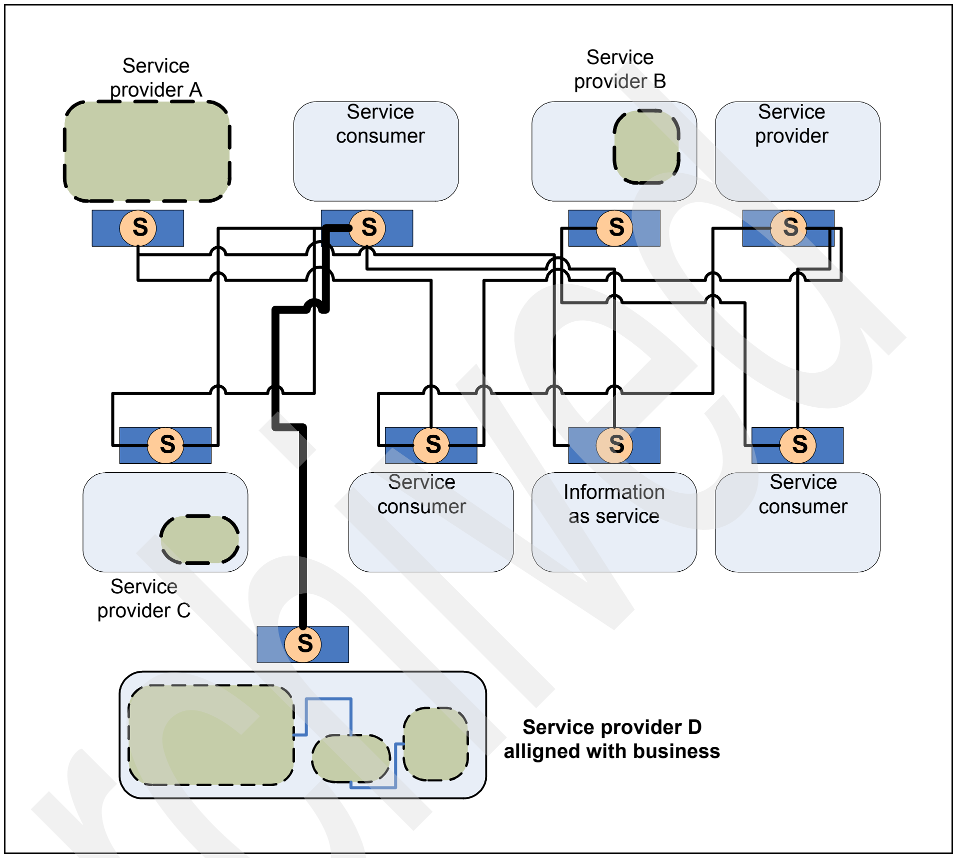


Figure 6-3 Service aligned with the business

We also keep in mind the data considerations (data is the “forgotten” child of SOA). Data should be exploited as “information”, so we put federation structures in place. The obvious conclusion is that we have to put in place a sort of ESB, like the one shown on Figure 6-4 on page 230.

All service consumers see the ESB as the “proxy” for the services they might request. That’s why we have the S (for service) positioned on the contour of the ESB. All applications have now a very thin configuration file (containing the information about where to find the ESB). The ESB is taking care of “calling” the right service. We just concentrated all connectivity logic in one place. At this early ESB stage, all configurations entries are statically coded inside the ESB (through administrative tools).

Note: Figure 6-4 illustrates a “generalized” ESB; keep in mind that some interfaces might not be supported by certain ESB products.

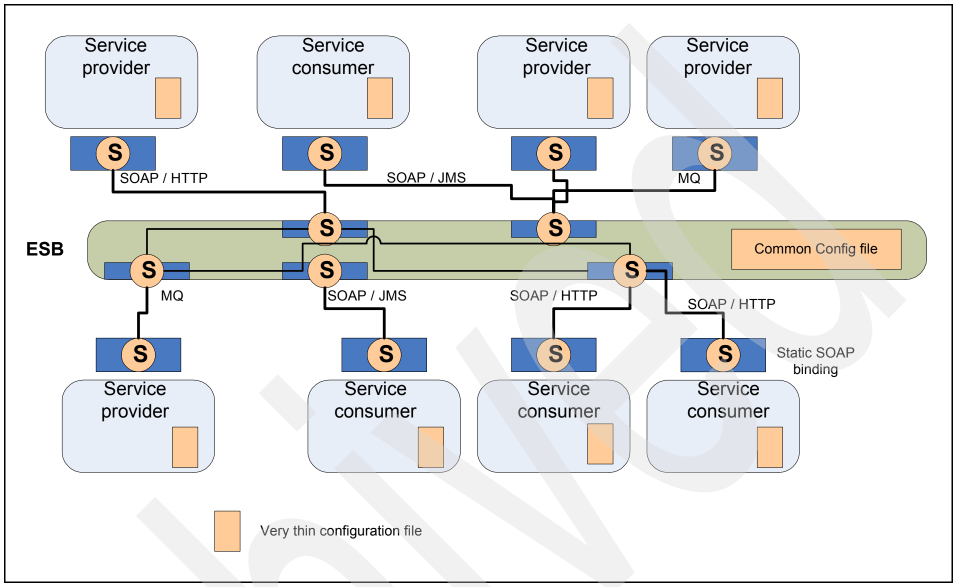
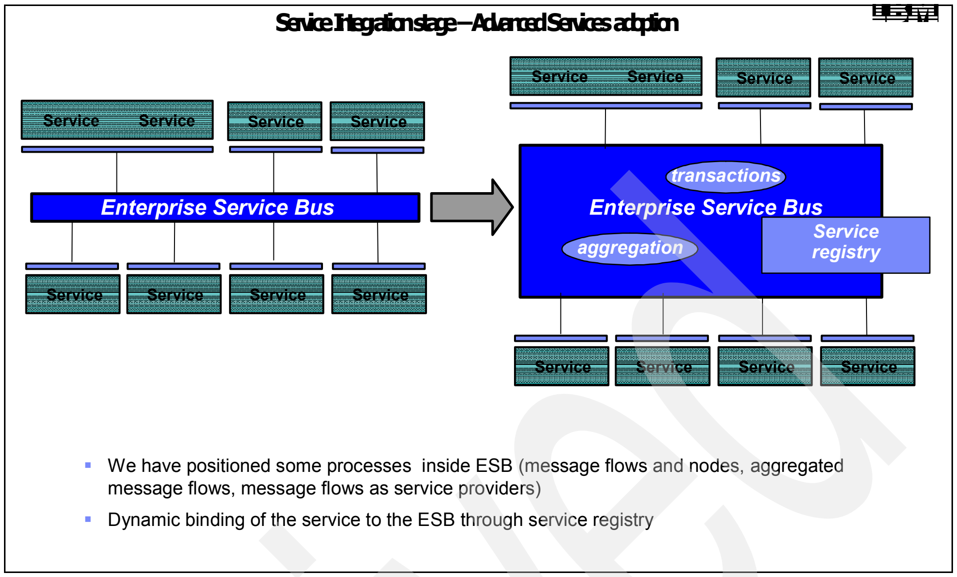


Figure 6-4 The ESB has really become part of the infrastructure

6.3.1 Implementing the block “ESB exploitation”

In this building block, the main objective is to start exploiting an ESB. All applications that play on the “ESB” ground will need to reach loose coupling. The ESB will need to provide for support of multiple integration patterns, multiple transport protocols, usage of mediations, transformations and routing. Service consumers and producers should be able to speak different protocols, and we should be no longer restricted to the SOAP protocol, both for the service consumer and requester. Our architecture is now illustrated in Figure 6-5 on page 231.



- We have positioned some processes inside ESB (message flows and nodes, aggregated message flows, message flows as service providers)
- Dynamic binding of the service to the ESB through service registry

Figure 6-5 Status at the end of the "exploitation of ESB"

By installing an ESB, we implemented all the activities required by this building block. The degree of implementation can be seen in Table 6-1 on page 236; this is of course highly dependent of the features delivered by the ESB chosen.

The only activity left is the *portal exploitation* and *page aggregation*. The reasoning behind this (in addition to the advantages provided by a portal itself) is to allow the portlets, as service consumers, to be integrated into the SOA architecture and to make the services available to the portlets. Now, with the advent of the ESB, we can see the architecture illustrated in Figure 6-6 on page 232.

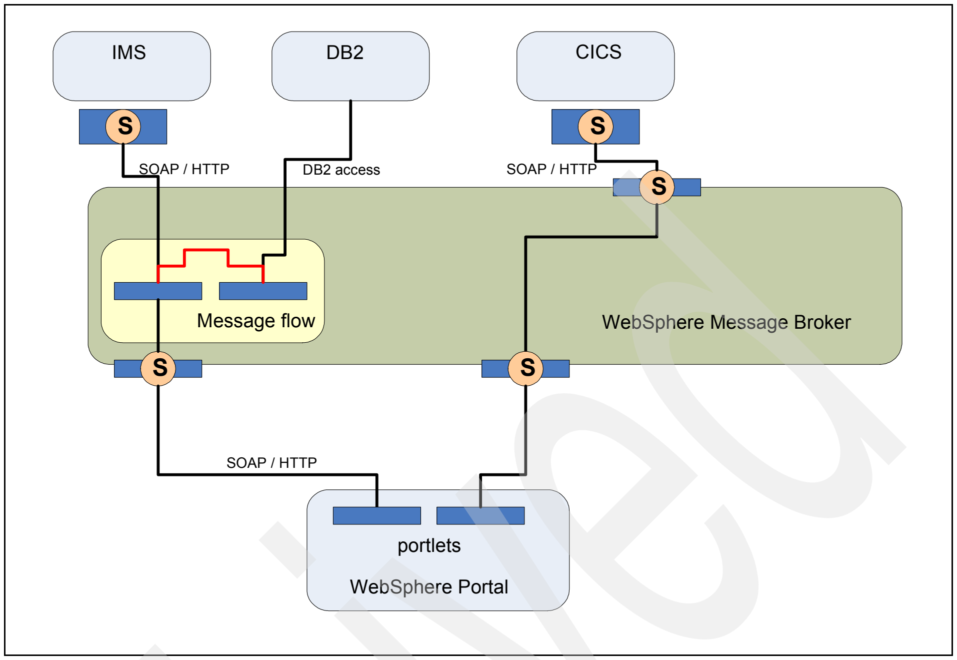


Figure 6-6 Portlets enable presentation integration through ESB

As you can see in Figure 6-6, portlets can access the message flows running inside WebSphere Message Broker (through SOAP/HTTP), but can also reach directly all SOA-enabled services (through the broker function). The architecture enables the portal (located in the IBM SOA reference architecture Interactive Services) to aggregate information coming from different services.

The capabilities of an ESB

First we describe what an ESB should be able to do. There are many opinions about what an ESB should contain and which features are required at which stage. The main functions are, of course, *routing, transformation, transport* and *switching*. But there are degrees of detail. We decided to use the terms ESB basic and ESB advanced, which we define here.

The *ESB basic* capabilities should be:

- Support high volumes of interactions.
- Allow for centralized management, administration and control.
- Support various interaction patterns (message-oriented, event-driven, synchronous request/response, asynchronous fire and forget, and so on).
- Provide for mediations (resolve differences between the applications attached to it).
- Allow connection independence (transport neutrality).

- Handle routing requests.
- Perform protocol transformations.

The *ESP advanced* capabilities should be:

- Implement a service directory (in order to allow consumers to locate services exposed on the ESB).
- Support multiple networks and protocols.
- Integrate databases.
- Support application adapters.
- Support language Interfaces (Java, C++, and so on).
- Implement security (authentication, authorization, encryption) for the services exposed on ESB.
- Provide message transformations, message enrichment, message and service aggregation.
- Support logging.
- Implement advanced management, monitoring, administration and policy-driven service-level management.
- Implement business rules.

All these functions are differentiating elements between products. Some of the functions will be implemented in an ESB-type of product, some in other layers (for example, business rules are implemented in IBM WebSphere Process Server).

Available ESB options

There are several options for building an ESB on the z/OS platform, as described here.

Option 1 - a "minimal" ESB based on WebSphere MQ

In this case, the ESB only has the possibility of connecting services that "speak" MQ or that have adapters that "speak" MQ. Any service consumer that produces SOAP messages will have to put them inside MQ messages in order to be transported through the ESB. At the other end, a service provider will retrieve the MQ message and separate and process the SOAP envelope.

Any mediation, data transformation, or routing function must be specifically coded by the developer (without specific tooling) and deployed in the runtime (as triggers and exits). There is no support for protocol transformation.
Services are called "implicitly" by consumers by dropping messages on their corresponding input queue; the replies are picked from the output queue.

This type of implementation does not fulfill the basic ESB characteristics.

Option 2 - A "light" ESB based on WebSphere Application Server Service Integration Bus (SIB)

The Service Integration Bus (SIB or SIBus) can be seen as a communication structure inside of WebSphere Application Server that can be used by J2EE applications to exchange messages using the JMS APIs. The SIB has been part of WebSphere Application Server since Version 6. The features of the SIB are:

- It provides managed communication for synchronous, asynchronous, and event-based messaging.
- It can be expanded through a "link" (which is simply a connection definition to a messaging engine on another SIB, or an external WebSphere MQ Queue Manager).
- This ESB will deliver, for the service consumers, a reduced amount of connectivity options, specifically those allowed by the J2EE platform. Supported application attachments are:
  - Web services
    - Requestors can use JAX-RPC API.
    - Providers run in WebSphere Application Server as stateless session beans and servlets (JSR-109).
    - Requestors or providers can attach via SOAP/HTTP or SOAP/JMS.
  - Messaging applications
    - Inbound messaging using JFAP-TCP/IP (or wrapped in SSL for secure messaging). JFAP is a proprietary format and protocol used for service integration bus messaging providers.
    - MQ application in an MQ network using MQ channel protocol.
    - JMS applications in WebSphere Application Server V5 and V6.1.
    - MQ client protocol.
  - Message Driven Beans (MDBs):
    - With EJB 2.1, Message Driven Beans (MDB) in the application server that listen to queues and topics are linked to the appropriate destinations on the service integration bus using JCA connectors.

The service providers themselves can be reached through the connectivity allowed by WebSphere Application Server, either internally as Web services, or externally as CICS/IMS/MQ SOAP-enabled services (through the SOA enablements described in Chapter 5, "SOA implementation scenarios" on page 131), or through WebSphere Adapters to packaged applications.

Any mediation, protocol/data transformation, or routing function must be specifically coded by the developer and deployed in the runtime (mediation handlers). This means that if a service consumer speaks SOAP/HTTP, and the service provider MQ, a protocol transformation piece of code has to be written and deployed. The same is valid if some data transformation is necessary between incompatible formats. The “wiring” between service consumer, mediations, and service provider is static (administrative configuration).

This ESB fulfills some basic characteristics. We see in this “light” ESB some limitations, but it might be a valid option for an enterprise that does not need the features delivered by WebSphere ESB or WebSphere Message Broker “out of the box”.

Option 3 - a “full service ESB”

There are two implementations: WebSphere ESB (WESB), and WebSphere Message Broker (WMB). They are both full service ESBs because they implement the basic functionality (transport services, mediation services, routing services, event services) and much more.

WebSphere ESB has a limited amount of connectivity options, which impact the types of service consumers and providers that can participate. This limitation, though, might be irrelevant in an enterprise that has mostly J2EE applications. The WebSphere Message Broker has its strong points in the areas of universal connectivity and data transformation.

Table 6-1 on page 236 compares WebSphere ESB and WebSphere Message Broker, among others, from the point of view of connectivity and data transformations.

Selection criteria for an ESB

Table 6-1 on page 236 compares the two IBM ESB products on several SOA-related criteria.

Important: The specifications of the IBM ESB products are very time-sensitive. Functions and levels of specifications may change rapidly. We recommend that you always confirm the latest specifications on the Web sites when making a decision.

Table 6-1 Comparison between WebSphere ESB and WebSphere Message Broker

Function	WebSphere Enterprise Service Bus V6.0	WebSphere Message Broker V6.0
Connectivity	► TCP/IP, SSL, HTTP(S), IIOP ► JMS V1.1 (point-to-point, pub/sub) ► JMS/MQ (using MQLINK configuration)	► TCP/IP, SSL, HTTP(S) ► JMS V1.1 (point-to-point, pub/sub) ► Native WebSphere MQ ► Supports WebSphere MQ Transport, WebSphere MQ Everyplace Transport, Multicast Transport, Real-time Transport, SCADA Transport, Web Services Transport, JMS Transport ► CICS, VSAM using SupportPacs ► Files using WebSphere Message Broker File Extender
Web services support	► SOAP/HTTP(S), SOAP/JMS, WSDL 1.1 ► Supports WS-I Basic Profile V1.1 ► UDDI V3.0 Service Registry ► WS-Security, WS-Atomic Transactions ► Client support: J2EE client, Message client for C/C++ and .NET, Web services client	► SOAP/HTTP(S), SOAP/JMS, WSDL 1.1 ► Supports WS-I Basic Profile V1.0 ► Client support: JMS client, Message client for C/C++ and .NET, Web services client, MQI client
Adapter support	► WebSphere Adapters and WebSphere Business Integration Adapters[a]	► WebSphere Business Integration Adapters[b]
Mediation programming model	► WebSphere ESB has a programming model based on Service Component Architecture (SCA) and SMO (SDO plus message header plus context)	► WebSphere Message Broker supports the use of ESQL, numerous Nodes (Compute Node, Database Node, Filter node, JavaCompute node, native JMS Input/Output node, HTTP Node, File transfer node, and so on) and flows
Message logging	► Provides prebuilt mediation primitives for message logging	► Provides prebuilt message flow nodes for message logging

Function	WebSphere Enterprise Service Bus V6.0	WebSphere Message Broker V6.0
Message transformation	► Protocol transformation between HTTP, JMS, IIOP ► Custom transformation logic can be implemented in Java, XSLT ► Supports transformation of XML, SOAP, JMS message data format (many more if used with adapters)	► Protocol transformation between any protocols available as input or output nodes (HTTP, JMS, MQ, and more) ► Custom transformation logic can be implemented in Java, ESQL, or XSLT ► Supports transformation of self-defined messages (XML), built-in predefined messages (SOAP, MIME, and more), and custom predefined messages (MRM)
Message routing	► Content and transport/protocol-based routing ► Provides prebuilt mediation primitive for message routing, or custom build mediation using Java ► Supported through SCA	► Content and transport/protocol based routing ► Custom routing logic can be implemented in Java or ESQL
Database access	► Built-in database lookup mediation primitive	► Built-in nodes for database access (Datanode ESQL, Java, graphical mapping)
Validation	► Validation of the input message against its schema by configuration of primitives	► Validation of input and output message against its schema definition
Event-driven processing	► Supports event-driven processing by leverage adapters for capture and dissemination of business events	► Supports complex event processing (processing of events formed by several earlier ones)
Security	► HTTPS support ► Authentication and authorization as part of J2EE ► Support for WS-Security	► HTTPS support ► Authentication and authorization by the operating system environment
Quality of service	► Assured delivery support by service integration bus ► Transaction support provided by WebSphere Application Server ► Configurative within SCA module components	► Assured delivery support by WebSphere MQ ► Transaction support by WebSphere MQ (limited for JDBC connections) ► Configurative within node properties

Function	WebSphere Enterprise Service Bus V6.0	WebSphere Message Broker V6.0
Integration styles supported	► Request/reply, Publish/subscribe	► Multiple integration styles (request/reply, publish/subscribe and others)
Management	► High availability and scalability provided by WebSphere Application Server environment ► Built-in administration tools as part of the WebSphere Admin Console ► Import bindings can be modified using the WebSphere Administration Console ► Common Event Infrastructure (CEI) support. Entry, exit and failure events can be activated on all SCA components within the mediation modules ► Common Base Event browser for viewing events from the CEI	► A high level of availability can be achieved using multiple brokers in combination with WebSphere MQ clustering and WebSphere MQ queue sharing. Queue sharing is a unique feature of WebSphere MQ on z/OS ► Built-in administration tools

a. Not all adapters are available for the z/OS platform.
b. Not all adapters are available for the z/OS platform.

If we consider the two full ESB implementations, and we have the task of selecting, we can use following brief comparison.

WebSphere Enterprise Service Bus

WebSphere Enterprise Service Bus (WESB) is designed to provide the core functionality of an ESB for a predominantly Web services-based environment. It is built on WebSphere Application Server, which provides the foundation for the transport layer.

If the user has numerous Web services in its environment and applications are primarily J2EE-based, then WebSphere Enterprise Service Bus is likely to be the better product to use. Building an ESB that is based entirely on WebSphere Enterprise Service Bus is an option when Web services support is critical and the service provider and consumer environment is predominantly built on open standards.

However, if integration with non-Web service standards-based services is a major requirement, or there is a very heterogeneous landscape of applications, then WebSphere Enterprise Service Bus might not be the right choice.

WebSphere Message Broker

WebSphere Message Broker (WMB) provides a more advanced ESB solution with advanced integration capabilities such as universal connectivity and any-to-any transformation for data-centric deployments. It can handle services integration as well as integration with non-services applications. WebSphere MQ provides the transport backbone for messaging applications. Typically, customers who need a higher performance and throughput product in a message-centric environment would use WebSphere Message Broker.

One interesting benefit available with WebSphere Message Broker is the possibility of exposing Message Flows as Web services (therefore functioning as service provider), as well as Message Flows calling Web services (as service consumer). The implementation is done through the combination HTTP input node/HTTP reply node. This architecture is shown in Figure 6-7.

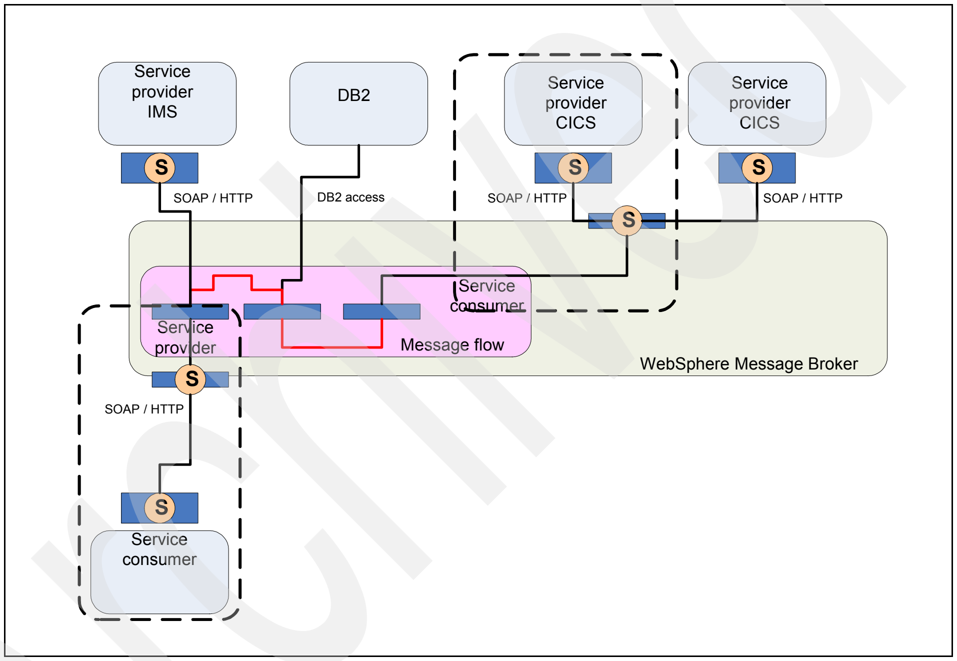


Figure 6-7 Message flow with two roles: service provider (towards client) and service consumer (towards IMS, DB2)

Here are a few typical WebSphere Message Broker Web services scenarios; notice the role played by WMB:

- Make use of a Web service (consumer role)
  - Message Flow invokes a Web service to retrieve data or perform a function (for example, it can invoke a CICS Web service).

- Provide a Web services “front-end” to an existing application (which service-enables, indirectly, the application).
  - Message Flow called by the Web services client invokes an MQ-enabled COBOL program and returns the result to the client.
- Route a Web services request (just as a proxy)
  - Message Flow forwards the client request to the service provider based on message content. The reply from the provider is returned to the flow and passed back to the client.
- Serve as Web services aggregator (consumer and business logic implementation)
  - Message Flow makes requests to other Web services and aggregates their replies into a single response.

For more information about WebSphere ESB on z/OS, visit this site:

`http://publib.boulder.ibm.com/infocenter/dmndhelp/v6rxmx/index.jsp?topic=/com.ibm.wsps.ovw.doc/welcome_wps_ovw.html`

For more information about WebSphere Message Broker, visit this site:

`http://publib.boulder.ibm.com/infocenter/dmndhelp/v6rxmx/index.jsp?topic=/com.ibm.websphere.wesb.doc/tasks/twesb_inst.html`

6.3.2 Implementing the block “Advanced Services Adoption”

In this section we discuss the activities contained in the SOA implementation block Advanced Services Adoption, and show how to implement them.

Use of a Web Service Gateway

In our SOA infrastructure, we want to have a point of control where all service requests arrive and get mapped to service providers. We would also like to be extremely flexible, and this can be reached if the target location, message format, and transport protocol are shielded from the service consumer.

Some usages for a Web Services Gateway are:

- Externalize an internal Web service (making it available for external service consumers, and in the process, secure it).
- Internalize an external Web service (making an external Web service accessible to service consumers as if were an internal Web service).
- Protocol transformation.
- SOAP Proxy service.

- Process abstraction: the service invocation approach must be flexible enough to cope with events such as switching frequently between external providers of a similar service without requiring changes to the application.
- Increased flexibility: a service provider needs the flexibility to change the deployment infrastructure without notifying all the service requestors.
- Single deployment of a Web service to multiple end-point listeners.
- Configurable intermediation through mediations.
- Authentication and authorization support (per service or operation) using basic user ID/password and SSL support.

The IBM Web Services Gateway is a runtime component that provides configurable mapping between Web service providers and requesters. Services defined with WSDL can be mapped to available end-point listeners. The IBM Web Services Gateway is included with IBM WebSphere Application Server Network Deployment V6. It is based on the Service Integrated Bus (SIB), and is tightly integrated with WebSphere Application Server.

The basic components of the Web Services Gateway are:

- End-point listeners that define the entry-points into the gateway and carry the Web service request and response through the gateway
- Mediations that are used to intercept service invocations which come into the gateway and act upon the services
- Services that are described with the help of a Web Services Description Language (WSDL) document
- UDDI references to manage the publishing of an exposed Web service to a private or public UDDI registry

Figure 6-8 illustrates the basic components of the Web Services Gateway.

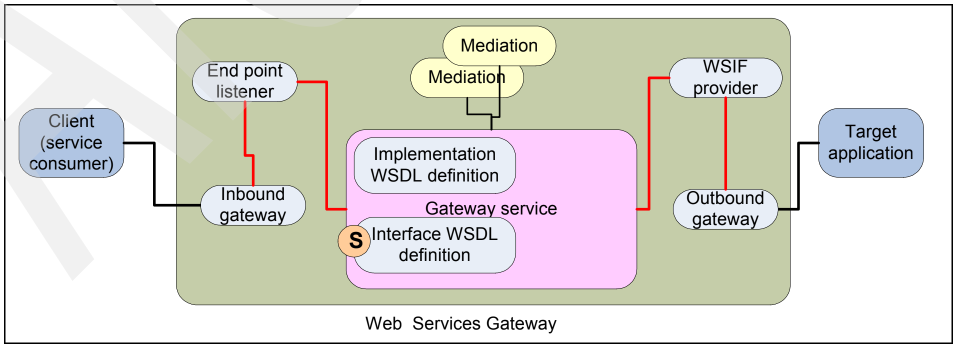


Figure 6-8 Basic structure of the Web Services Gateway

The entry point to the gateway is defined by an End Point Listener (EPL). An EPL is a piece of software that defines the protocol you can use to access the gateway. The incoming message is assessed on arrival through the EPL to determine which service is required.

Each service (defined in a WSDL document) has to be bound to one or more EPLs. One or more mediations can be bound to a service for manipulating both request and response messages. The WSDL service definition specifies the provider service interface and implementation used to access the target service.

A request to the Web Services Gateway arrives through an EPL and is translated into an internal representation of the service. With the help of mediations for the request, a request can be logged, intercepted, or generally manipulated. After this an appropriate provider is used to communicate with the target service. The provider in the gateway acts as a client for the target Web service. The response from the target service flows along the exact same path back to the provider.

The process of deploying a target service into a gateway EPL generates two different *external* WSDL files: an implementation definition, and an interface definition. These new WSDL files can be exported for use by client applications, and are the externalization of the service capabilities offered by the *internal* target service.

The implementation WSDL definition is used to simplify the connection process for a client, particularly when dynamic invocation is being used. Having obtained the implementation definition, the client can then access the WSDL interface definition produced by gateway, which provides full information about the target service (as presented externally by the gateway).

The IBM Web Services Gateway uses the Web Services Invocation Framework (WSIF) API from Apache to decouple invocation from deployment within the Web Services Gateway.

The following features can be configured at runtime:

- End-point listeners (EPLs)
- JAX-RPC handlers
- SIBus mediations
- Gateway and proxy services
- UDDI lookup and publishing
- WebSphere Application Server and Web services security

For more information about these topics, refer to the following sources:

- "An introduction to Web Services Gateway", by Chandra Venkatapathy and Simon Holdsworth

  http://www-128.ibm.com/developerworks/library/ws-gateway

- Web services gateway at InfoCenter

  http://publib.boulder.ibm.com/infocenter/wasinfo/v6r0/index.jsp?topic=/com.ibm.websphere.pmc.express.doc/sibuswsgw/index.html

Complex aggregation of services across multiple applications

Aggregation is the ability to decompose a service request into multiple outbound requests and re-assemble the replies to send an aggregated response. Aggregation is supported in the WebSphere Message Broker through built-in *nodes* (`AggregateControl`, `AggregateReply`, `AggregateRequest`, `MQGet`).

Currently, aggregation is not supported in WebSphere ESB.

Aggregation of Web services is supported through the BPEL runtime in WebSphere Process Server. A discussion of the powerful control flow features offered by BPEL is beyond the scope of this book. The implementation of the BPEL language in the WebSphere Process Server is described in WebSphere Process Server V6.0 Business Process Choreographer Programming Model:

  http://www-306.ibm.com/software/integration/wps/library/infocenter/

For more information, you can refer to the following document:

- "Business Process Choreography in WebSphere: Combining the power of BPEL and J2EE", by M. Kloppmann et al.

  http://researchweb.watson.ibm.com/journal/sj/432/kloppmann.pdf

Transactional capabilities

Here we discuss the transactional capabilities in the WebSphere Message Broker and in the WebSphere Process Server.

WebSphere Message Broker supports transactional message flows. The *Transaction* property can be set for specific nodes, with different consequences. The Transaction property can be set to automatic or commit, as explained here:

- Automatic

  This means that any updates, deletions, and additions performed by the node are committed or rolled back when the message flow processing completes. If the message flow completes successfully, all changes are committed. If the message flow does not complete successfully, all changes are rolled back. In order to coordinate all processing done by the message flow, we select this value.

- Commit

The action taken depends on the system to which the message flow has been deployed.

 – On distributed systems, any work that has been done to this data source in this message flow to date (including any actions taken in this node) is committed, regardless of the subsequent success or failure of the message flow.
 – On z/OS, actions taken in this node only are committed, regardless of the subsequent success or failure of the message flow. Any actions taken before this node under automatic transactionality are not committed, but instead remain within a unit of work and might either be committed or rolled back, depending on the success of the message flow.

There are a number of nodes where we can set the Transaction property. Among them are: `Compute` Node, `Database` Node, `DataDelete` Node, `DataInsert` Node, `MQInput` Node, `MQOutput` Node, `MQReplay` Node, `JMSInput` Node, `JMSOutput` Node.

For WebSphere Message Broker on z/OS, transactions are always globally coordinated (that means the property *coordinatedTransaction* is always on). Coordination is provided by Resource Recovery Services (RRS).

WebSphere Process Server supports transactional process flows. The interaction between a service client and a service is governed in the runtime by *service qualifiers*. Service qualifiers are quality of service specifications that define a set of communication characteristics required by an application (including transaction management and security level).

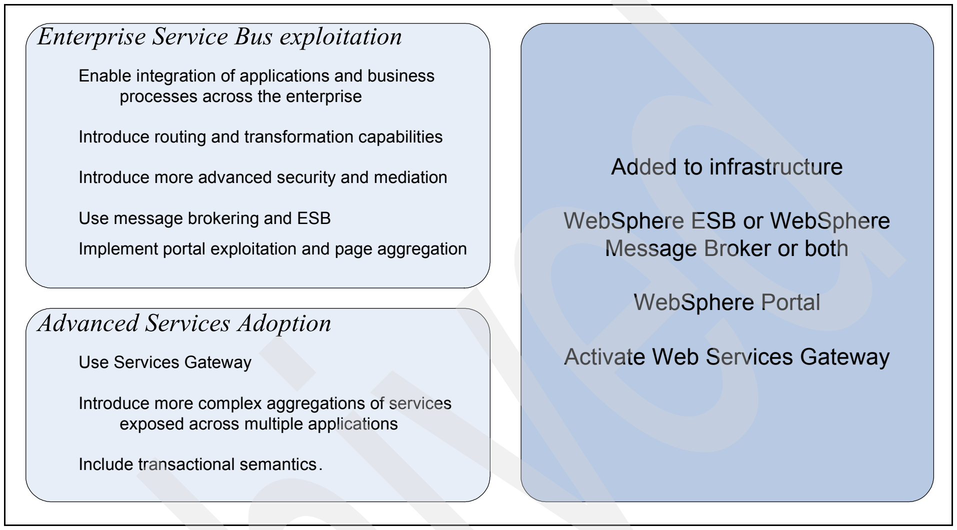
An application communicates its quality of service needs to the runtime environment by specifying service qualifiers (as metadata to the service). Quality of Service qualifiers can be specified on a SCA reference, interfaces and implementation.

WebSphere Process Server processes rely upon the underlying WebSphere Application Server capabilities for transaction, security, and workload management. For business processes, WebSphere Process Server supports transactions involving multiple resource managers using the two-phase commit process to ensure atomic, consistent, isolated, and durable (ACID) properties.

This capability is available for both short-running flows (single transaction) and long-running flows (multiple transactions). Inside a business process, multiple steps can be grouped into one transaction by modifying transaction boundaries in WebSphere Integration Developer.

6.4 Stage 3 - “process integration”

At this point, we have finished the two stages that encompass “service enablement” and “service integration”. Figure 6-9 shows the activities completed and the new pieces added to the SOA infrastructure.

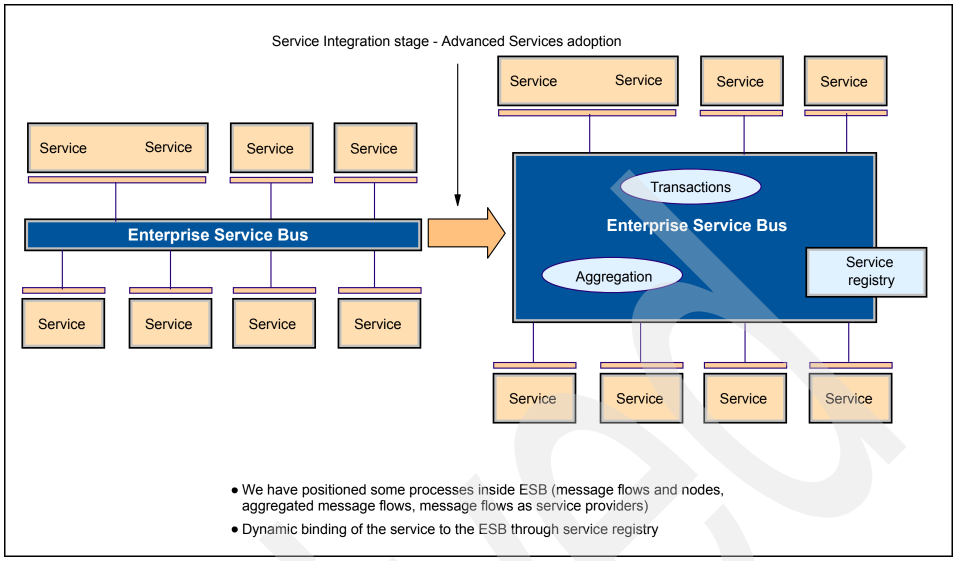


Enterprise Service Bus exploitation
Enable integration of applications and business processes across the enterprise
Introduce routing and transformation capabilities
Introduce more advanced security and mediation
Use message brokering and ESB
Implement portal exploitation and page aggregation
Advanced Services Adoption
Use Services Gateway
Introduce more complex aggregations of services exposed across multiple applications
Include transactional semantics.
Added to infrastructure
WebSphere ESB or WebSphere Message Broker or both
WebSphere Portal
Activate Web Services Gateway

Figure 6-9 End of the “service integration” stage

Our architecture is shown in Figure 6-10 on page 246. It is now time to take advantage of the SOA-enabled services and of the architecture that enables their transparent communication, start aligning IT services to the business and start creating new business processes.

But first, we define *process integration* as the creation and management of the logic that links applications and services together to implement a business function.



Service Integration stage - Advanced Services adoption
Service
Service
Service
Service
Enterprise Service Bus
Service
Service
Service
Service
Service
Service
Service
Service
Transactions
Enterprise Service Bus
Aggregation
Service registry
Service
Service
Service
Service
• We have positioned some processes inside ESB (message flows and nodes, aggregated message flows, message flows as service providers)
• Dynamic binding of the service to the ESB through service registry

Figure 6-10 Status after the second stage of "service integration"

6.4.1 Implementing the block "Business Services Exploitation"

In the following sections we discuss the implementation of the building blocks associated to process integration.

Implement service-oriented integration of business functions

One possibility is illustrated in Figure 6-7 on page 239, with Message Flows functioning as service providers. In this example a business service was created using existing "primitive" services (with some business logic located in CICS, IMS, and with some data access from DB2). Considering the numbers of nodes of different types made available by WebSphere Message Broker (for example, Java Compute Node, JMS Nodes, CICS Node, Database Node, HTTP node and many File Nodes), we have a flexible way of creating business services.

Another possibility is to use the decomposition tools (such as WebSphere Studio Asset Analyzer) to identify pieces of the existing applications that fit the service definition, and chain them together in Message Flows, thus creating business services.

A third possibility is to use process choreography and orchestration tools and technologies to link services into composite applications, fully aligned with the business; this option is possible when installing the WebSphere Process Server and using WebSphere Integration Developer (WID). The functionality of the

WebSphere Process Server will be described in “6.4.2, “Implementing the block “Business Process Orchestration”” on page 248 “.

Expose coarse-grained business services

Using either WebSphere Message Broker or WebSphere Process Server, we can create new business services (either completely new, or a combination with existing services). From a business point of view, it makes sense to model most processes as coarse-grained services, which happens to correspond with the slight technological advantage they enjoy over the fine-grained services (that is, they involve fewer calls, less network traffic, and less object marshalling and demarschalling).

Implement policy-based business services

Policies are sets of “if-then” business decisions that can be simply expressed and can be used by several applications in an enterprise. The idea behind this activity is to increase the agility of an application by separating the business rules from the application. This “decoupling” allows easy changes in the behavior of the application, through changes in the business rules.

One possibility is to use the ESB and place the policies inside a Message Flow (for example, as a Java node). The other option is to implement the policies through WebSphere Process Server. In the WebSphere Process Sever, business rules are assembled into Business Rules groups. They are exposed in the runtime as an SCA component. The SCA component can be accessed by multiple processes.

Implement provisioning and lifecycle

Provisioning and *lifecycle* refer to the activities necessary for the management of a Web service starting with the development phase, over deployment and usage, and concluding with retirement. These activities are strongly related to the service registry and repository.

WebSphere Service Registry and Repository (WSRR)

The registry and repository contains information that is used during the whole lifeycle of the service. The IBM product offering this functionality is the WebSphere Service Registry and Repository (WSRR), and the strategy is that, for all phases of the service lifecycle, IBM products will be integrating with WSRR.

During the lifecycle of the service, there are several interaction points with WSRR. During creation of the service, there is a need for the developer to know what services are available and how to call them. Therefore the development tools need integrated access to WSRR (repository function).

At runtime, the mediation components of the ESB (both WebSphere ESB and WebSphere Message Broker) will need interaction to WSRR in order to perform service selection, enforce service policies, and so on (registry function).

Figure 6-11 illustrates how different components of the IBM SOA reference architecture (and from all lifecycle parts) interact with WSRR.

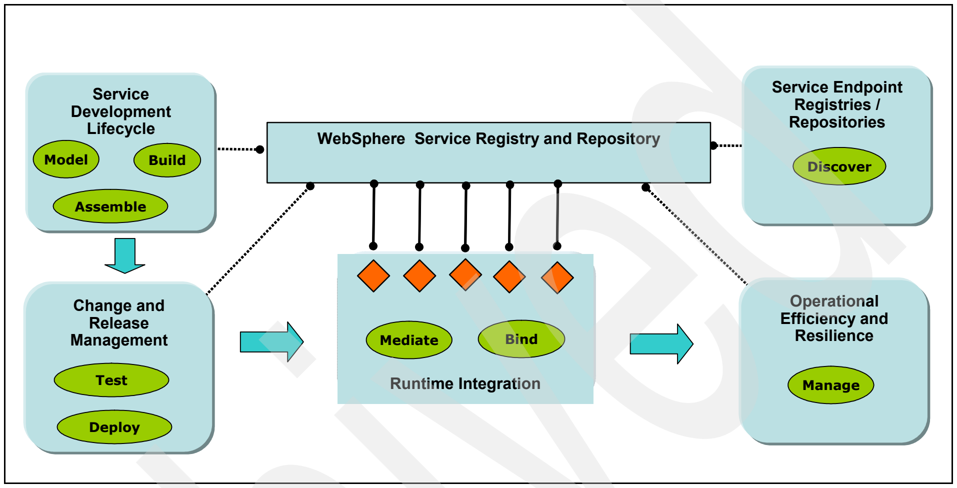

Service Development Lifecycle
Model
Build
Assemble
WebSphere Service Registry and Repository
Service Endpoint Registries / Repositories
Discover
Change and Release Management
Test
Deploy
Mediate
Bind
Runtime Integration
Operational Efficiency and Resilience
Manage

Figure 6-11 SOA service lifecycle and interactions with WSRR

6.4.2 Implementing the block "Business Process Orchestration"

As defined, the implementation block "Business Process Orchestration" contains the following activities:

- Introducing business process modeling
- Beginning process choreography
- Implementing external business rules
- Introducing flow and event management
- Implementing compensation

All these activities can be implemented on z/OS through the installation of WebSphere Process Server (as runtime), WebSphere Business Modeler and WebSphere Integration Developer (both as development tools) and WebSphere Business Monitor as a management tool.

We start by examining the structure of the WebSphere Process Server; see Figure 6-12 on page 249.

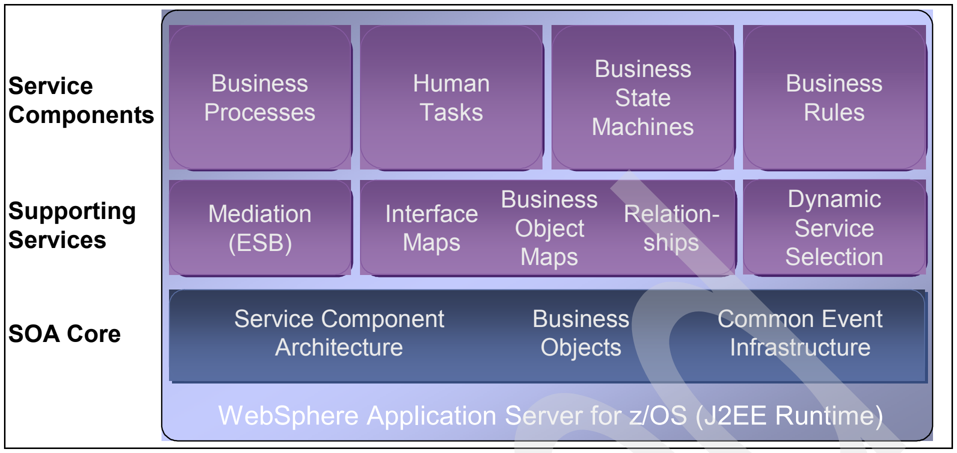


Figure 6-12 Architectural model of WebSphere Process Server

WebSphere Process Server is implemented on top of WebSphere Application Server and WebSphere ESB. WebSphere Application Server provides the J2EE and Web services runtime, and WebSphere ESB provides the ESB functionality. The SOA core layer in WebSphere Process Server consists of:

- Service Component Architecture (SCA)
- Business Objects
- Common Event Infrastructure (CEI)

On top of this SOA core layer lies the service components and supporting services layers. WebSphere Process Server implements a number of components and services that can be used in an integration solution. In the service components layer, you find the following:

- Business processes

  The business process component in WebSphere Process Server implements a WS-BPEL-compliant *process engine*. WS-BPEL is a language that allows specifying the behavior of business services, as described here:

  – Behavior between Web services
  – Behavior as a Web service

- Human tasks

  Human tasks in WebSphere Process Server are standalone components that can be used to assign work to employees.

- Business state machines

  A *business state machine* provides a way of modeling a business process by representing them based on states and events.

- Business rules

  Business rules are a means of implementing and enforcing business policies through externalizing business functions. This enables dynamic changes of a business process.

These components can use the features of a number of supporting services in WebSphere Process Server. Most of these can be classified as some form of *transformation*. There are a number of transformation challenges when connecting components and external services, each of which is being addressed by a component of WebSphere Process Server, as described here:

- Interface maps

  Very often interfaces of existing components match semantically, but not syntactically. *Interface maps* allow the invocation of these components by translating these calls. Additionally, business object maps can be used to translate the actual business object parameters of a service invocation.

- Business object maps

  A *business object map* is used to translate one type of business object into another type of business object.

- Relationships

  In business integration scenarios, it is often necessary to access the same data in various back-end systems (for example, an ERP system and a CRM system). A common problem for keeping business objects in sync is that different back-end systems use different keys to represent the same objects.

  The *relationship* service in WebSphere Process Server can be used to establish relationship instances between objects in these disparate back-end systems. These relationships are accessed from a business object map when translating one business object format into another.

- Dynamic service selection

  A selector component allows dynamic selection and invocation of different services, which all share the same interface.

- Mediation

  This component is inherited from WebSphere Enterprise Service Bus.

The primary development tool for WebSphere Process Server is WebSphere Integration Developer (WID). This is the same tool used for WebSphere Enterprise Service Bus development tasks.

You can find more information about IBM WebSphere Process Server V6 at:

http://www.ibm.com/software/integration/wps/

The important points are that both WebSphere Process Server and WebSphere ESB share the same programming model, based on data representation as *Service Data Objects (SDO)*, invocation based on *Service Component Architecture (SCA)*, and composition based on BPEL+ extensions.

The focus of the programming model is on assembling solutions, rather than on implementation details. A number of adapters are available to enable communication with EIS and non SOA-enabled legacy systems. Supported by tooling, it is clear that the two products deliver, based on the common basis, a coherent part of the SOA infrastructure.

Because WebSphere ESB is the routing and transformation basis for WPS, it is obvious that the SCA components will communicate without problems with SOA-enabled services reachable over WESB. These are mostly Web services, so if the business process requires just these, we can stay with the combination WPS and WMB.

Figure 6-13 shows the connectivity available to SCA components running in WebSphere Process Server and WebSphere ESB.

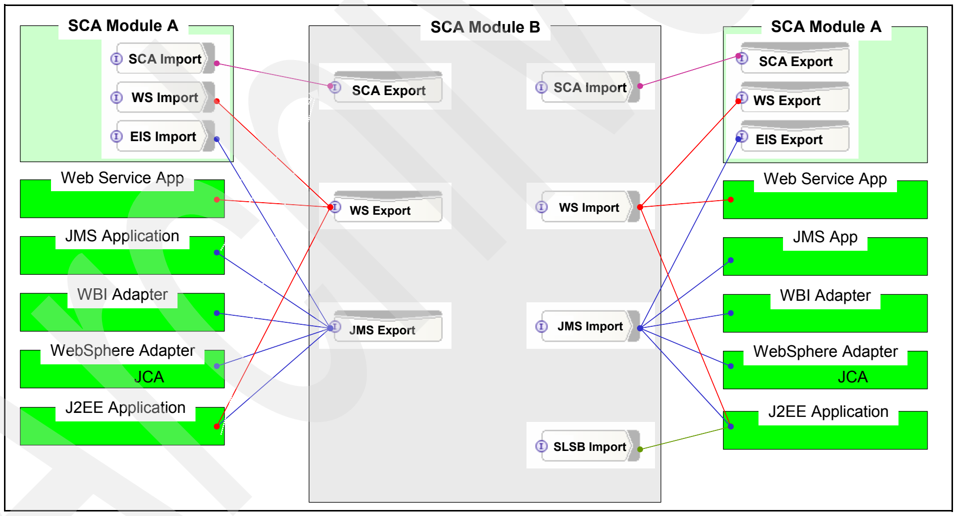


Figure 6-13 SCA connectivity to other components and services

The WebSphere adapters supported by the SCA components are:

- WebSphere Flat File adapter
- WebSphere JDBC Adapter
- WebSphere PeopleSoft Enterprise adapter
- WebSphere Siebel® Business adapter
- WebSphere SAP adapter

A more interesting aspect is the integration between WebSphere Process Server and WebSphere Message Broker. WMB can consume WPS XML-generated messages and can generate WPS-consumable messages, using several interfaces. The integration is illustrated in Figure 6-14.

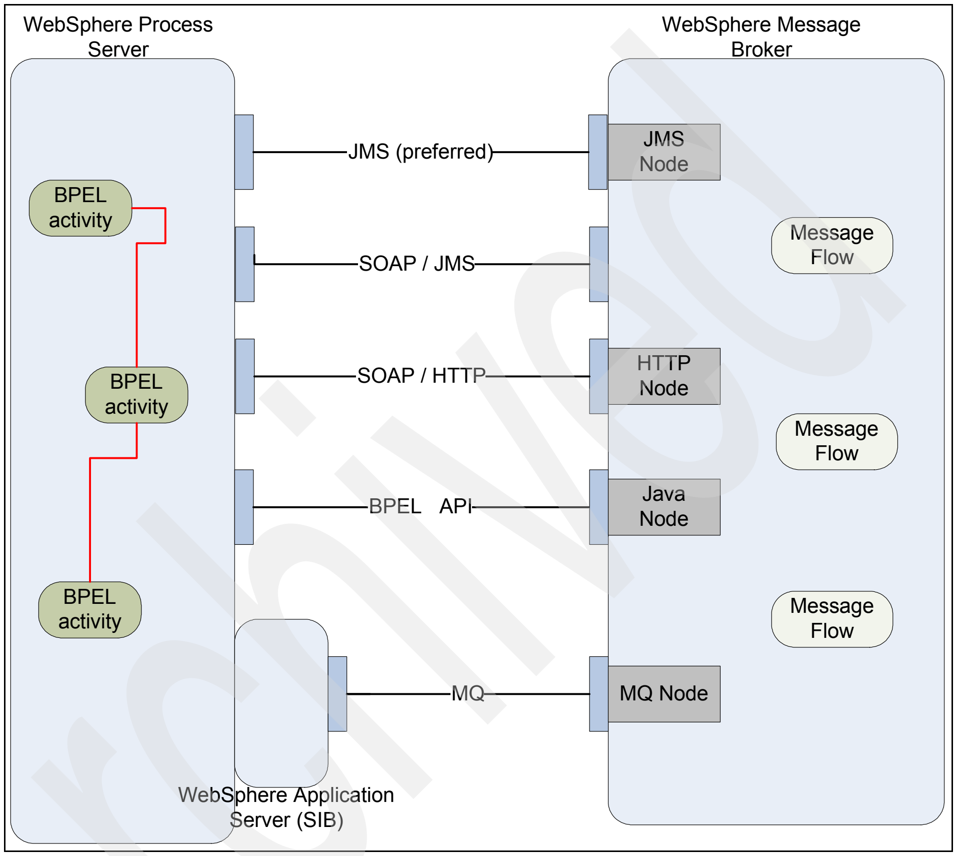


Figure 6-14 Integration between WebSphere Process Server and WebSphere Message Broker

Because WebSphere Message Broker supports numerous interfaces for non-Web services applications, we present scenarios here in which each product applies its strength to implement the solution.

The first scenario is shown in Figure 6-15 on page 253. In this scenario, a WebSphere MQ service consumer accesses WMB, where the necessary routing and transformation takes place (the strengths of WMB). When a human interaction is necessary, the message flow reaches for WPS, which does its part. In this scenario, WebSphere Message Broker controls the flow.

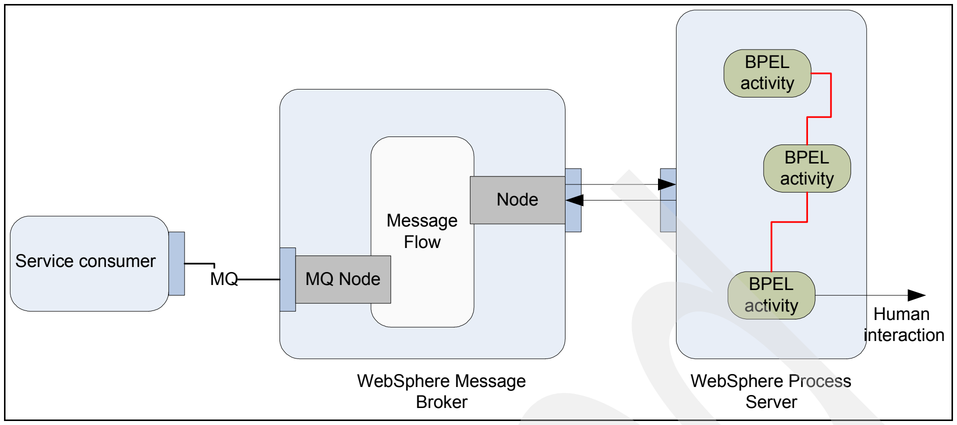


Figure 6-15 WebSphere Message Broker controlling the flow

The second scenario, shown in Figure 6-16, presents a situation where the WebSphere Message Broker has to handle multiple transports, transformations, and message splitting (which it can do very well), and then start a process with several threads. This is better done by WebSphere Process Server.

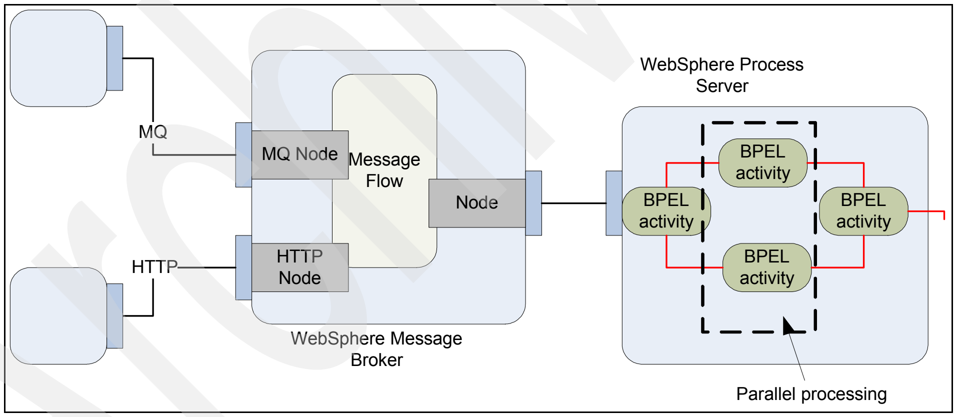


Figure 6-16 WMB gives control to WPS for simultaneous processes

The last scenario, shown in Figure 6-17 on page 254, describes a situation where WPS executes the business process, choreographs the Web services, and drives WMB to access messaging applications. WMB then brokers the reply message to WPS, which continues to run the process.

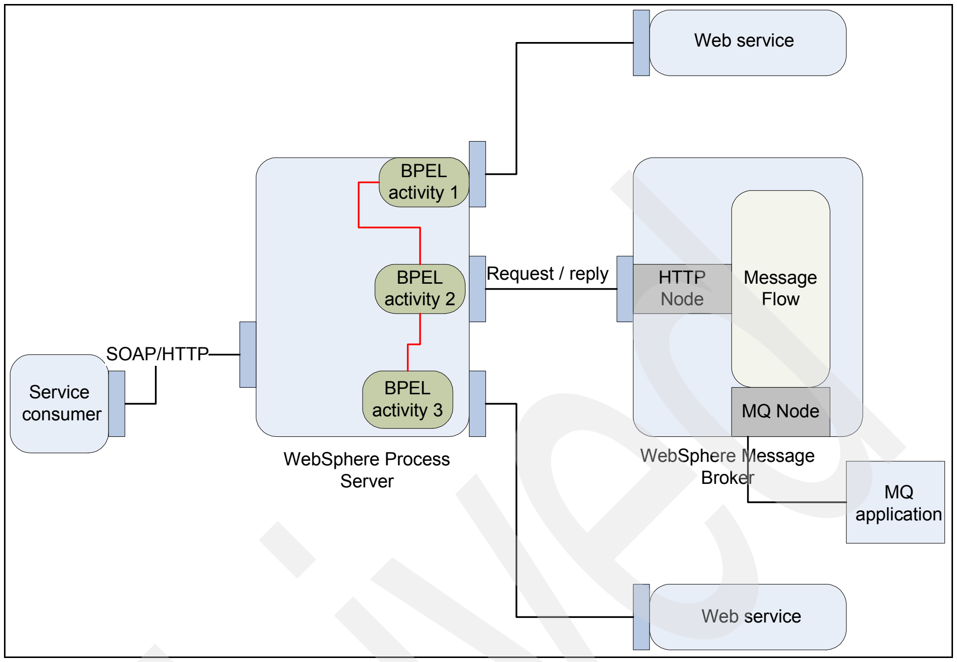


Figure 6-17 WPS as choreographer of services, using WMB for access to messaging application

We can generally recommend using WebSphere Process Server when the business process:

- Orchestrates multiple processes
- Needs human intervention
- Has parallel processes in the same flow
- Makes almost exclusive use of Web services (WPS is strong in accessing Web services)

Use WebSphere Message Broker when the business process:

- Needs extensive routing and transformations
- Uses stored procedures
- Accesses applications needing industry-standard format
- Needs high performance
- Has multiple transports in the same flow
- Has a complex publish/subscribe topology

Out of these recommendations, situations may arise where both products are necessary.

6.4.3 Implementing the block “Discovery and Dynamic Binding

In the following sections we explain how to implement the “Discovery and Dynamic Binding” block.

Locate services exposed on the ESB and introduce “consumer discovers supplier” patterns

These activities can be enabled by installing a service registry. For a service registry, IBM offers the product WebSphere Service Registry and Repository (WSRR). You can refer to “WebSphere Service Registry and Repository (WSRR)” on page 247 for a discussion of the general role played by WSRR in the lifecycle of the service (assembly, deployment, runtime, and management). Here, however, we are interested in the locate services and introduce “consumer discovers supplier patterns activities, so we limit our discussion to the way in which WSRR supports us in implementing them.

The location of the service is one of the most important activities, because it touches the base of SOA (loose coupling). We want our service consumers to know as little as possible about the services they will call; the best situation is when they only know the name of the service they require.

Next we examine how some of the IBM SOA runtime products interact at runtime with the WSRR. The major user of WSRR at runtime is the ESB, in the form of the mediation component. We refer to the mediation component as “the requestor”.

Several actions must be taken care of:

- Service endpoint selection

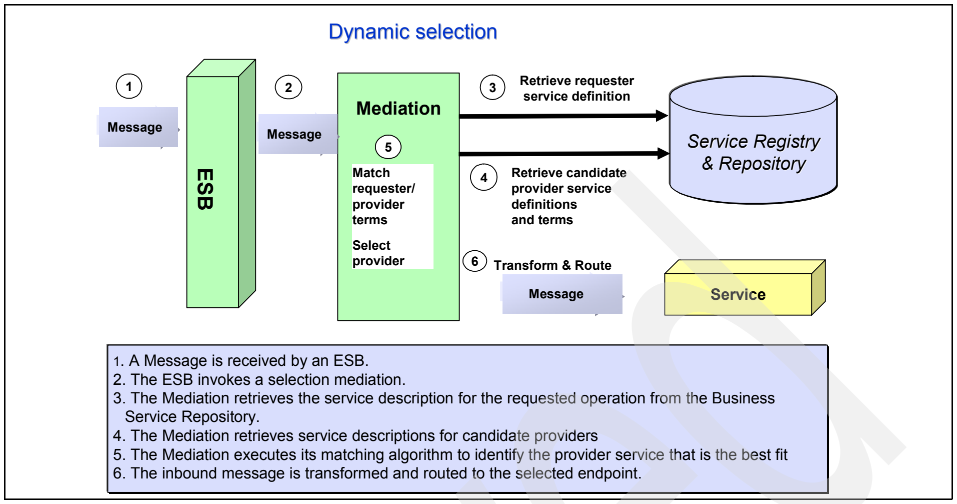
  This means finding, based on the requestor’s metadata, the candidate services, applying an algorithm to select one, and routing the request to the service (see Figure 6-18 on page 256).

- Service availability management

  This means deciding what to do in case a service is not available, selecting alternatives, and so on.

- Policy enforcement

  This means delivering, to the requestor, the policy information (the contract between consumer and provider) so that the enforcement takes place.


Dynamic selection
1
Message
ESB
2
Message
Mediation
5
Match requester/ provider terms
Select provider
3
Retrieve requester service definition
4
Retrieve candidate provider service definitions and terms
Service Registry & Repository
6
Transform & Route
Message
Service

1. A Message is received by an ESB.
2. The ESB invokes a selection mediation.
3. The Mediation retrieves the service description for the requested operation from the Business Service Repository.
4. The Mediation retrieves service descriptions for candidate providers
5. The Mediation executes its matching algorithm to identify the provider service that is the best fit
6. The inbound message is transformed and routed to the selected endpoint.

Figure 6-18 WSRR runtime selection and invocation interactions

The integration with WebSphere ESB is done through:

- A new pre-built mediation “Endpoint Lookup”
- Optional caching (to reduce interaction with WSRR)
- Dynamic end-point selection

The integration with WebSphere Message Broker is done through:

- New mediation capabilities (Nodes), for example `SRRetrieveITservice` (retrieves PortType) and `SRRetrieveEntity` (retrieves metadata)
- Optional caching

Implement dynamic invocation of service and dynamic consumption of WSDL

In the following section we describe a set of activities which, each one in turn, help to refine the loose coupling of the SOA infrastructure, by eliminating even further dependencies between service consumer and service provider.

Web Services Invocation Framework (WSIF)

There are two ways of binding to Web services: *static* and *dynamic*.

- In the *static* process, the binding is done at design time. The service consumer obtains a service interface and implementation description through a proprietary channel from the service provider (by e-mail, for example), and stores it in a local configuration file. So this means the service consumer is dependent upon the WSDL stored in its configuration.

- The *dynamic* binding occurs at runtime. While the client application is running, it dynamically locates the service using a UDDI registry and then dynamically binds to it using WSDL and SOAP. Therefore there is no dependence here between service consumer and the WSDL.

We do not want to tie the client code to a particular protocol implementation, because it is inflexible, restricts possible connectivity, and is hard to change. Therefore we are interested in a process that allows the invoking of Web services, independent of the format of the service or the transport protocol through which it is invoked.

The Apache Web Services Invocation Framework (WSIF) provides a standard Java API to invoke services, no matter how or where the service is provided, as long it is described in WSDL. WSIF enables the developer to move away from the native APIs of the underlying service, and interact with representations of the services instead. WSIF is WSDL-driven and provides a uniform interface to invoke services using WSDL documents. So, if a SOAP service you are using becomes available as an EJB, for example, you can change to RMI/IIOP by just modifying the WSDL service description, without needing to modify your service consumers.

This API is used in WebSphere Integration Developer and in the WebSphere Application Server runtime to construct and manipulate services defined in WSDL documents. The architecture allows new bindings to be added at runtime. WSIF has the following advantages:

- Multiple bindings can be offered for services, and bindings can be decided at runtime.
- Switching protocols, location, and so forth, without having to recompile the client code.
- A stubless and totally dynamic invocation of a Web service.

WSIF is an intermediary between service consumer and service provider, and as such shields the consumer from the possible bindings of the provider

WebSphere V6 on z/OS includes a UDDI Version 3 Registry that can be used to obtain this dynamic behavior.

For more information on this subject, consult the following documents:

- “Dynamic Discovery and Invocation of Web services” by Damian Hagge:

  http://www-128.ibm.com/developerworks/webservices/library/ws-udax.html?t=egrL296&p=invocationws#author

The Selector function inside WebSphere Process Server

Dynamic selection functionality is available also in WPS.

The *selector* objective is:

- Determine dynamically which implementation to invoke based on some defined set of criteria. The predefined implementation uses dates, but it is possible to specify other selection criteria via XML configuration. Custom selection algorithms can be plugged into the selector component by manual coding.
- Decouple the client application from a specific target implementation. Change of target does not require change of client.
- Allows SCA target implementations to be added to the selector dynamically without requiring a restart of the application or server.

6.4.4 The end of the journey

At the end of stage three, there will be an infrastructure and application architecture that provides process integration. Figure 6-19 on page 259 shows the activities done and the IBM products (with specific features) that have been activated.

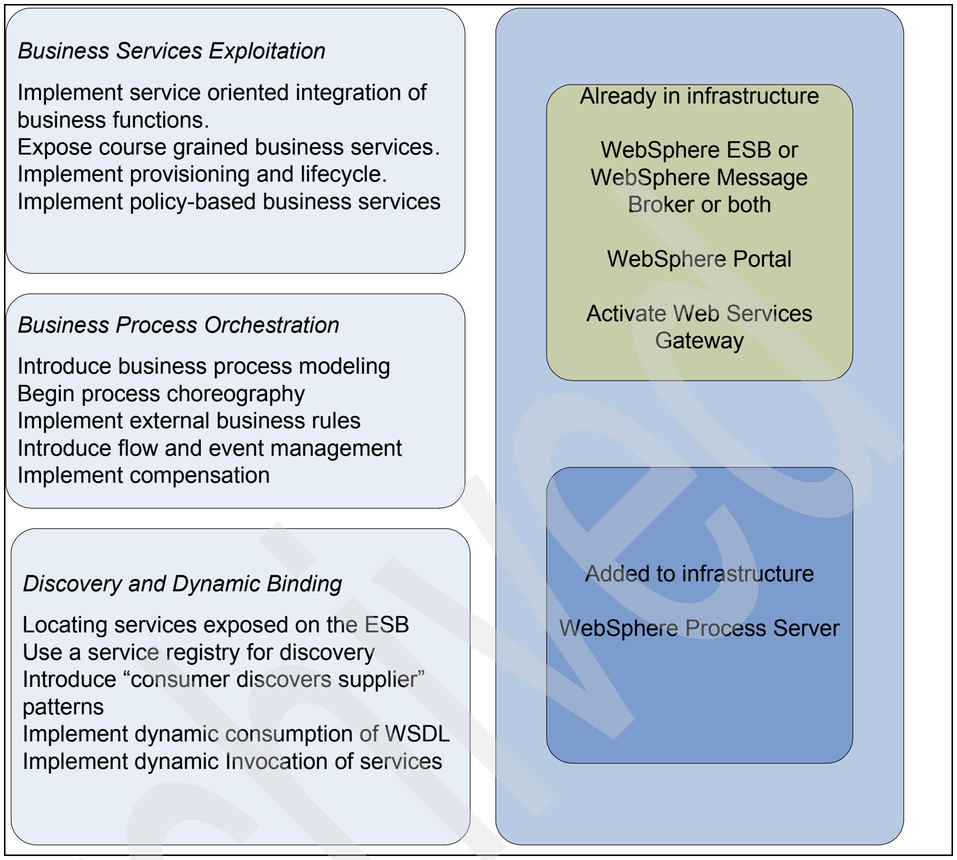

Business Services Exploitation
Implement service oriented integration of business functions.
Expose course grained business services.
Implement provisioning and lifecycle.
Implement policy-based business services
Business Process Orchestration
Introduce business process modeling
Begin process choreography
Implement external business rules
Introduce flow and event management
Implement compensation
Discovery and Dynamic Binding
Locating services exposed on the ESB
Use a service registry for discovery
Introduce “consumer discovers supplier” patterns
Implement dynamic consumption of WSDL
Implement dynamic Invocation of services
Already in infrastructure
WebSphere ESB or WebSphere Message Broker or both
WebSphere Portal
Activate Web Services Gateway
Added to infrastructure
WebSphere Process Server

Figure 6-19 Stages from Service Integration to Process Integration

7

SOA governance on z/OS

The practice of managing policy and maintaining controls over the platform and architecture is often referred to as *governance*. SOA governance consists of a number of different areas of emphasis. In this chapter we examine several of these areas in terms of how they impact an SOA implementation using resources on the mainframe.

7.1 Background - governance and the mainframe

The z/OS mainframe environment is well known for the high Quality of Service (QoS) that it delivers, including reliability, availability, security, scalability, and other characteristics. These traits derive in part from the design of the hardware, operating system, and middleware. But another key reason for the mainframe’s high level of QoS is the rigor of process, procedure, and governance that surrounds the mainframe in most customer installations.

High system reliability and availability are achieved not simply because hardware components such as the central processors can fail over, or because z/OS can trigger a functional recovery routine when an application attempts to overlay storage. Instead, reliability and availability also stem from change control, rigorous testing, application standards, and other controls that help prevent planned and unplanned outages.

As mentioned, the practice of managing policy and maintaining controls over the platform and architecture can be described as governance. The word originates from the word “govern,” implying varying degrees of control. One of the keys to governance is to control without imposing so much restraint that it constricts the functioning of the organization.

It is occasionally implied that mainframes are too slow or inflexible to respond to change. In fact, the mainframe is no different from any other platform with respect to responsiveness or flexibility. But the governance policies of the enterprise often are at issue, and in many cases those restrictions exist for good reason and greatly contribute to the superior qualities of service of the mainframe.

Because SOA implementations are, by nature, a loosely-coupled collection of services and infrastructure, a strong governance process is needed in order to balance an unconstrained proliferation of services and service providers by using governance practices to help keep things in order.

SOA uses the separation of concerns to abstract business logic from infrastructure logic (communication, mediation of data and connectivity, and so on). As a result, a more complex infrastructure of application artifacts, middleware and servers may be needed to run it. More components means more complexity, and more complexity means more controls to prevent that complexity from becoming an issue. In his paper titled “Introduction to SOA Governance,” Bobby Woolf states:

> Governance becomes more important in SOA than in general IT. In SOA, service consumers and service providers run in different processes, are developed and managed by different departments, and require a lot of

> coordination to work together successfully. For SOA to succeed, multiple applications need to share common services, which means they need to coordinate on making those services common and reusable. These are governance issues, and they're much more complex than in the days of monolithic applications or even in the days of reusable code and components.[1]

The complication that stems from the sharing of services across an enterprise makes governance more important than ever, especially considering the cross-organizational nature of the deployed services and infrastructure.

7.2 What is governed

SOA governance concentrates on policies applied to the service lifecycle. There are many other areas of governance that are not specific to SOA, such as enterprise IT standards, problem and change management, and so on. Some of these will be impacted by the SOA implementation; that is, IT governance and SOA governance are not mutually exclusive. SOA governance focuses on the design, development, and maintenance of shared business services. A key aspect is the agreements that are forged between the service providers and service consumers. And key to these agreements are the people involved and the process for governing the service lifecycle.

Woolf[2] states that, in contrast with IT governance, SOA governance:

- acts as an extension of IT governance that focuses on the life cycle of services to ensure the business value of SOA
- determines who should monitor, define, and authorize changes to existing services within an enterprise

7.3 Who governs

An enterprise that has the resources for a formal organization may form a “center of excellence” or similar team to create the governance policies and procedures. A board of knowledgeable individuals may act as the guiding body and serve to mediate agreements between the interested parties, including the service provider organizations and the development teams who are consumers of the services.

[1] http://www-128.ibm.com/developerworks/library/ar-servgov/
[2] Ibid

Governance is largely a political function. It does not determine designs, infrastructures and other technical issues; instead, it determines how those decisions are made. The IBM publication *SOA Governance Lifecycle*[3] demonstrates that SOA governance is not a technology issue. This Lifecycle consists of:

Plan	Establish the governance need
Define	Design the governance approach
Enable	Put the governance model in action
Measure	Monitor and manage the governance processes

None of these items are directly relevant to technology. The SOA Governance Lifecycle defines how to establish and maintain the governance framework, not the SOA itself.

In the mainframe environment, infrastructure, applications, and the decisions and policies that surround them tend to be highly centralized. Applications are for the most part not distributed and do not cross organizational boundaries. There are well-defined groups of architects, developers and administrators responsible for the various aspects of the system. While this centralized paradigm does not eliminate the need for governance, it does make it easier. However, the introduction of business-aligned services that are at least partially developed by business areas, and the use of distributed infrastructure for components such as an enterprise service bus or process server, all contribute to a more distributed architecture with many more people and teams having an interest in how policy is made.

7.4 Aspects of SOA governance

SOA governance consists of a number of different areas of emphasis. The key aspects of SOA governance are:

- Definition
- Development lifecycle
- Versioning
- Migration
- Registries
- Message model
- Monitoring
- Ownership
- Testing
- Security

[3] http://www-306.ibm.com/software/solutions/soa/gov/lifecycle/

In the following sections we examine several of the aspects in terms of how they impact an SOA implementation using resources on the mainframe.

7.4.1 Service definition

Definition of the service is one of the most fundamental functions in the service lifecycle. The architect/developer must determine the service's functionality, scope and granularity, and the composition of the service interface. Since a service is to be composed of business logic and is considered a "repeatable business task," this must be taken into account during the service design - how is the business logic to be partitioned in a way that maximizes the future reusability of the service?

Reflecting back upon prior sections of this book and the mainframe SOA migration patterns and strategies, it is apparent that the "bottom-up" approach of reusing mainframe assets may constrain the service definition task. Because most SOA implementations are not "green field" projects (that is, there are existing assets to be reused), there must be at least some bottom-up and meet-in-the-middle analysis and some development done to harvest the existing assets. And although many existing mainframe transactions were designed to perform "repeatable business tasks" at the user interface level (for example, functions invoked via CICS menus), the internal structure of these transactions often does not match the business granularity presented on the surface.

As the architect and developer develop a service definition, a detailed knowledge of the asset inventory that might feed that service is critical. The asset discovery tools discussed in 4.2.2, "Discovery and refactoring tools used in the Assemble stage" on page 112, including WebSphere Studio Asset Analyzer and Asset Transformation Workbench, become important in the service definition process by providing a detailed view of the application artifacts and their structure. This can help determine the suitability of the asset for reuse.

7.4.2 Service versioning and migration

After a service is created, it is unlikely to stay static forever. Business requirements and rules change, and modifications to the service will be necessary. If an adequate governance structure is in place that keeps track of service providers and consumers, it may be possible to gauge the impact of change on a service. Service definition, as described in 7.4.1, "Service definition" on page 265, should result in an interface that can "flex" with the service over time.

The z/OS environment has a long history of attention to backward compatibility and avoidance of impact of change. Consideration of the impact of service migration is closely related to the change control practices that are common in most mainframe customers. Versioning of services should be considered when designing a SOA governance model.

Service migration may become an especially significant issue for migrated z/OS transactions that are reused using the Adapter-provided service interface pattern and the Improve transition approach. Tools such as the CICS Service Flow Feature or WebSphere Host Access Transformation Services depend upon the 3270 user interface to execute the existing host transactions. Over the years, such techniques have been susceptible to breakage because of change at the user interface. However, now that organizations have started providing the UI via a Web browser, the 3270 interface has become significantly less volatile than in the past.

Theoretically, loose coupling of services from caller to provider and the infrastructure to support it (Enterprise Service Bus, service registry) can help insulate change. The ESB can route service requests to the appropriate caller or service, and the registry provides the appropriate endpoint address, depending upon the version requested (or a default).

7.4.3 Service registries

When faced with the need to create a new function for an application, many developers will build from scratch, for various reasons. For example, there may be a lack of information about the pre-existence of other assets that meet the requirements for that function. In such cases, a service registry can ease the job of finding and reusing existing services.

A service registry can increase the service reuse in an organization by providing a searchable directory of services that advertises the existence of service functions. The registry provides information on the service interface and how to invoke it, and it provides details on the location of the service for design-time or run-time resolution. As mentioned in 7.4.2, “Service versioning and migration” on page 265, a service registry can also help insulate the service caller from changes in a service or new versions that have been provisioned.

IBM’s registry solution

In September 2006, IBM announced the *WebSphere Service Registry and Repository* (WSRR).

WSRR is the master metadata repository for service descriptions, including traditional Web services implementing WSDL interfaces with SOAP/HTTP bindings as well as a broad range of SOA services that can be described using WSDL, XSD and WS-Policy decorations.

As the integration point for service metadata, WSRR establishes a central point for finding and managing service metadata acquired from a number of sources, including service application deployments and other service metadata and endpoint registries and repositories, such as UDDI. With WSRR, service visibility is controlled, service versions are managed, proposed changes are analyzed and communicated, usage is monitored and other parts of the SOA foundation can access service metadata with the confidence that they have found the copy of record.

WSRR focuses on a minimalist set of metadata-describing capabilities, requirements, and semantics of services. It interacts and federates with other metadata stores that support specific phases of the SOA lifecycle and capture more detailed information about services relevant in those lifecycle phases; examples of specialized repositories include a reusable asset manager in development or configuration management database in service management.

The product architecture of WSRR is shown in Figure 7-1.

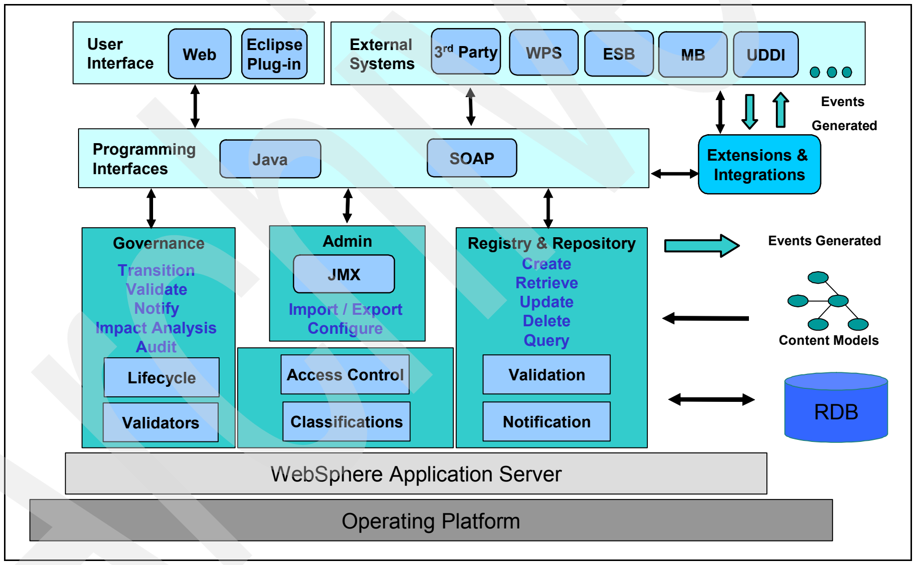


Figure 7-1 WebSphere Service Registry and Repository architecture

WSRR fulfills the requirements of a SOA service registry by providing the following major functions:

- **Service publishing and inquiry**
  Publish, retrieve, query and manage documents which describe services (a metadata repository). Documents may be XML, WSDL, XSD, WS-Policy, or other formats.

- **Service registry**
  Register services, so that information about the service, including endpoint location, interface description, and so on can be resolved at design or run time.
- **Event notification**
  Changes to WSRR content can trigger notifications to subscribers (JMS pub/sub or e-mail notification).
- **Governance model**
  WSRR facilitates governance of entities within the repository by directing the governance process by use of state machines that define the entity's lifecycle.
- **Programming interfaces**
  Both Java and SOAP interfaces are provided for CRUD operations against the metadata repository.
- **User interfaces**
  Web and Eclipse-based user interfaces are provided. The Eclipse interface is intended for use by developers and analysts; the Web interface can be used for metadata management and governance.

Figure 7-2 shows an overview of the WSRR from a solution perspective.

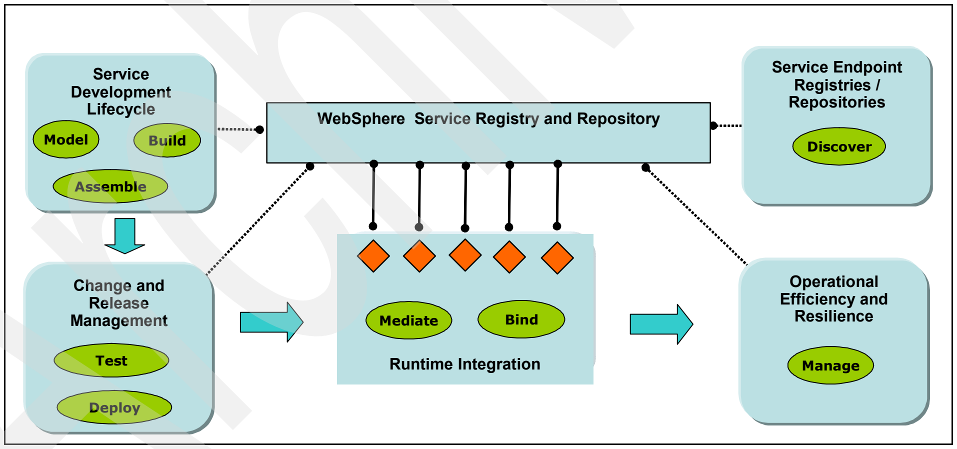

Service Development Lifecycle
Model
Build
Assemble
WebSphere Service Registry and Repository
Service Endpoint Registries / Repositories
Discover
Change and Release Management
Test
Deploy
Mediate
Bind
Runtime Integration
Operational Efficiency and Resilience
Manage

Figure 7-2 Solution view of WSRR

The WebSphere Service Registry and Repository plays a key role in completing the vision of SOA as a loosely-coupled abstraction of business logic and infrastructure. Without a registry to resolve service endpoints at runtime, it is difficult to completely disconnect the service consumer and provider, because the endpoint infrastructure must still somehow be reflected in the services. Also, WSRR helps to mitigate the other difficulties in SOA governance, including version control, migration, and tracking the development lifecycle of services.

For mainframe-based services that have been migrated using the SOA migration techniques described earlier, the WSRR provides the place to store the descriptions of the services, such as the WSDL and other XML artifacts. WSRR will provide the run-time registry for the ESB to locate and resolve service endpoint addresses to fulfill the loose coupling requirement. And while the z/OS platform will provide the optimal levels of security, reliability, and so on for the registry, WSRR can be hosted on any platform supported by the product, even if the services are located on z/OS.

7.4.4 Service monitoring

The introduction of SOA, loose coupling of services, and new infrastructure components including ESBs, process servers, and service registries pose new problems of complexity in mainframe environments that formerly consisted simply of z/OS running CICS transactions. To maintain the levels of QoS to which mainframe customers are accustomed, new and rigorous monitoring practices are needed. There are several areas of monitoring that are important, as described here.

Business monitoring

The traditional concept of “monitoring” encompasses the monitoring of IT components including CPU utilization, I/O saturation, response time, and so on. SOA’s close ties between IT and business dictate a slightly different approach to monitoring. Business people need access to metrics that show the state of business functions; a “business dashboard” is a common implementation that permits the business analyst to monitor various measurements of business operation. For example, an insurance executive may wish to monitor the number of claims being processed in a period of time by the claim processing center. Or bank managers might want to monitor the flow of funds through their branches.

The decoupling of business logic from IT logic makes it easier to monitor business-related metrics. Composite applications and workflows can be instrumented to produce statistics that are fed into business monitoring tools, and those statistics can be provided back to the modeling tools used to create the workflows and processes to further improvements. IBM provides the WebSphere Business Monitor to give business people the ability to monitor such business metrics and key performance indicators.

IT monitoring

The complexity of the SOA infrastructure dictates the need for new, end-to-end monitoring tools that can show not only the status and performance of services on their respective transaction servers, but also the availability and performance of the end-to-end process and/or transaction. End-to-end performance monitoring has been a challenge for many years, but the complexity of a SOA-based application that spans many application, database, ESB, process, directory and security servers is far greater than a CICS 3270 transaction.

Service level agreements (SLAs) are critical to the proper governance of a SOA implementation. Without an SLA, a customer may not be able to adequately provide sufficient levels of performance or scalability, because there is no benchmark by which to gauge success. How good is “good enough?” How fast is “fast enough?” Without a SLA, an IT organization may be on a never-ending quest for faster and better transaction performance.

IBM’s Tivoli software brand provides many monitoring tools that help the IT staff measure and manage an SOA-based application, provide an end-to-end picture of the application, and determine if SLAs are being met. The Tivoli Composite Application Manager for WebSphere and the Tivoli Composite Application Manager for SOA both aid the end-to-end monitoring requirement. The WebSphere monitor concentrates on the WebSphere Application Server and can give information about services executing there, including those that invoke back-end services on CICS or IMS, per the Adapter-provided service interface pattern. The SOA monitor gives a higher-level view of the SOA service at a Web services protocol level.

Accounting

One of the sometimes controversial aspects of IT governance is resource accounting (in some contexts this is referred to as “chargeback”). Organizations usually must account for resource usage, and sometimes charge the users of resources for the consumption of those resources.

In a loosely-coupled SOA implementation, it may not always be possible to accurately account for the consumption of resources. The loose coupling may not always maintain the identity of the service consumer from end to end. The need to maintain this identity can drive the architectural decisions of what migration pattern and approach to use to move a mainframe application to SOA.

Mainframe z/OS customers have always had the ability to collect vast amounts of data to use for resource accounting. The z/OS System Management Facility (SMF) is an inherent part of the operating system and can measure virtually any activity that occurs under z/OS. SMF records are created by all of the major IBM transaction managers (CICS, IMS, WebSphere, WebSphere MQ), by the database managers, and most other users of the system.

The SMF repository can be used to report on system performance, utilization, and resource consumption, all at a very granular level. Organizations wishing to charge back for resource consumption can use SMF to create the billing needed. However, the architect must design the SOA implementation so that SMF data is accurately gathered to reflect the “true user” of the service.

Some SOA enablement mechanisms may not easily transmit the identity of the service caller without custom coding. For example, J2EE Connector Architecture connections can maintain user identity from a Web application server caller back into CICS or IMS, but a WebSphere MQ connection may require extra code to populate the appropriate message headers.

8

SOA and z/OS Quality of Service

Most of the content in this IBM Redbook concerns application architecture topics.

In this chapter, however, we examine the factors that go into achieving Quality of Service (QoS). Many IT decisions are based on QoS impact, rather than simply functional matters, and questions such as the following need to be raised in an SOA implementation:

- Does a given service interface solution technique perform adequately?
- What is the throughput of a given ESB solution?
- Can the security context in a service call be propagated by using a given solution technique?
- If a given service is not available, is there an alternate that becomes automatically available?
- Does the service provider scale?

This chapter describes how to use the QoS aspects which System z hardware and the z/OS operating system bring to the implementation of an SOA on z/OS.

8.1 Overview

Many people think about QoS in terms of performance, scalability, reliability, integrity and perhaps one or two other qualities. z/OS is traditionally strong in the area of Quality of Service, and it seems that SOA requires even more QoS than traditional IT environments, because in a properly implemented SOA, assets will be increasingly shared and reused.

In this chapter we explain how to make use of the QoS aspects that are already present as part of the System z hardware and z/OS operating system when implementing SOA. Our focus is on availability, scalability, security and workload management, as well as Total Cost of Ownership (TCO) considerations.

Note: The full list of QoS characteristics includes areas as maintainability, manageability and so on, but a discussion of all QoS characteristics is beyond the scope of this IBM Redbook.

Quality of Service (QoS) is a major theme in today's IT environments. The Quality of Service of the platform and of the software products running on that platform are key factors in the decision-making processes of IT departments.

It is important to know how an SOA architecture can benefit from the strong QoS of the z/OS platform. However, each solution technique, as discussed in Chapter 5, "SOA implementation scenarios" on page 131, also has different QoS characteristics. And the QoS aspects of a certain solution technique may be more important than its functions and features.

A service (in the sense that is defined by SOA) has, in addition to the functionality it implements, qualities that describe how it delivers the business function; for example:

- Reliability of the service
- Conditions for reachability (availability)
- Security cover under which it acts
- Capacity and performance that it delivers
- Transactional capabilities

The SOA environment implemented on z/OS derives the Quality of Service features from several areas:

- The System z hardware and the physical system infrastructure on which the software products (middleware) are positioned
- The z/OS operating system, with its built-in subsystems such as Workload Manager (WLM), Resource Recovery Services (RRS), and solutions such as Parallel Sysplex and Geographically Dispersed Parallel Sysplex (GDPS)

- The features of the software products that build the underlying SOA infrastructure (that means the products from the portfolio supplied by IBM, as previously described)
- The inherent characteristics and features of the SOA architecture itself, such as the standards being used

These areas can be viewed as layers, which are positioned one over the other (layer 1 at the basis):

Layer 1	The hardware and operating system layer.
Layer 2	The layer constructed with the products that implement the SOA building blocks.
Layer 3	The layer built by positioning the application over the SOA building blocks.

Figure 8-1 illustrates this layered structure.

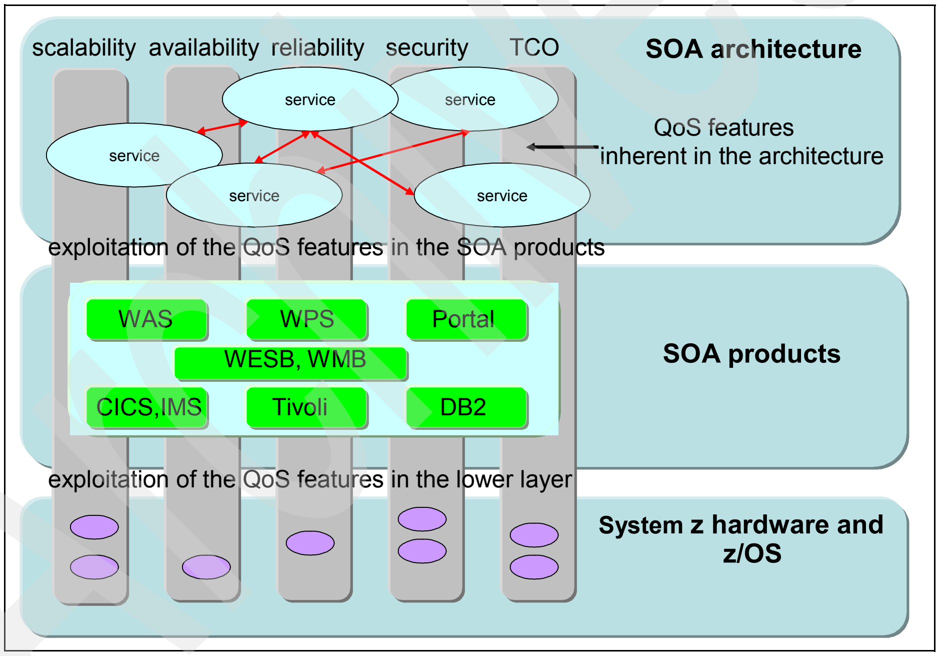


Figure 8-1 SOA QoS features - layer structure

This layer positioning, and the way in which the upper layers exploit the functionality of the lower layers, increase the QoS of the SOA solutions positioned on z/OS. In the following sections we explain how this exploitation is implemented in terms of scalability, availability, reliability, security, Total Cost of Ownership (TCO).

8.2 Quality of Service on the System z platform and inside z/OS

The Quality of Service features of the System z hardware platform, in combination with the z/OS operating system, are described in detail in several IBM Redbooks and other publications (for example, in IBM Redbook *IBM System z Strength and Values,* SG24-7333). In the following sections, we summarize the most important QoS characteristics.

8.2.1 Scalability

Scalability is the ability to accept increased workloads without degradation of service. In reality this means that an infrastructure needs to be capable of easily finding the additional resources needed for this increased workload, without running into bottlenecks. “Resources” in this sense means anything needed to run the workload, such as memory, CPU, DASD, address spaces, threads and so on.

Resources can be at a “hard” level (for example, real memory and CPU), or at a “soft” level (such as threads, address spaces or virtual memory). Hard resources will have a given limit (that is, the number of CPUs installed in the system), but soft resource maximums are configurable and tunable to accept peak workloads.

The main function available in z/OS to manage the workload in accordance with the given resources is workload management. The function of the workload management is very simple: to keep the machine busy while staying within the agreed service levels. The key features that implement this are:

- Dynamic allocation of I/O and CPU between LPARs
- A sophisticated implementation of the z/OS Workload Manager (WLM)

8.2.2 Availability

Availability comes in many flavors. The level of availability should depend on the business requirements. However, we know that in a full-blown SOA, availability is of increased importance because of the increased reuse of IT assets.

System z and z/OS are designed for high availability (HA), without having to add any additional software products; it is “part of the box”. Note, however, that some levels of availability may require multiple LPARs, or even multiple footprints.

With System z and z/OS, “silver”, “gold”, and “platinum” levels of availability can be achieved, as explained here:

Silver	This level entails one footprint (machine) with multiple LPARs (system images). This allows non-disruptive maintenance at the operating system level, planned and unplanned outages of an LPAR, and intelligent workload balancing between LPARs dynamically—with an already high level of availability.
Gold	This level entails multiple footprints in the same location with one or multiple LPARs. This allows non-disruptive maintenance at both the hardware and operating system level, planned and unplanned outages of an LPAR or an entire machine, and dynamic intelligent workload balancing between LPARs and machines—with a very high level of availability.
Platinum	This level entails multiple footprints in multiple sites. This allows non-disruptive maintenance at both the hardware and operating system level, planned and unplanned outages of an LPAR, an entire machine or an entire site, and dynamic intelligent workload balancing between LPARs and machines. This level delivers extremely (continuous) high availability at the hardware and operating system level.

The following list includes the most important technology available in the System z hardware and the z/OS operating system that enforce the high availability functionality:

- Inclusion of *self-healing* attributes in the hardware to prevent downtime caused by system crashes. The operating system takes advantage of the self-healing attributes of the hardware, and extends them by adding functions such as recovery services for all operating system code, address space isolation, and storage key protection.
- Elimination of planned outages through concurrent hardware changes.
- Elimination of planned outages through Enhanced Driver Maintenance. This allows upgrades of the Licensed Internal Code for processors of all types (CPs, IFLs, ICFs, zAAPs), memory, and I/O adapters that are transparent to the application.
- On demand capacity upgrades (CUoD and CIU are processes that allow a temporary or permanent upgrade in the CPU, memory, I/O ports).
- Removal of single point of failure (SPOF) through the Parallel Sysplex architecture (non-disruptive attachment and removal of LPARs, servers, non-disruptively installation and maintenance of hardware and software). Parallel Sysplex is discussed further in “Parallel Sysplex” on page 278.

- Business continuity solutions like Geographically Dispersed Parallel Sysplex (GDPS) with its variations GDPS/PPRC synchronous mirroring, GDPS/XRC asynchronous mirroring, GDPS/Global mirroring with asynchronous PPRC replication technology. GDPS is discussed further in "Geographically Dispersed Parallel Sysplex (GDPS)" on page 279.

Parallel Sysplex

Centralizing all components on a single system does not imply that mainframe computing is limited to one single machine or to one single operating system. On the contrary, mainframes can be partitioned into a maximum of 60 logical partitions (LPARs). Each partition has the ability to run one of the five System z operating systems. In that case, there are management tools and resource sharing at a hardware level, and at operating system level.

Figure 8-2 shows a simplified view of the Parallel Sysplex concept.

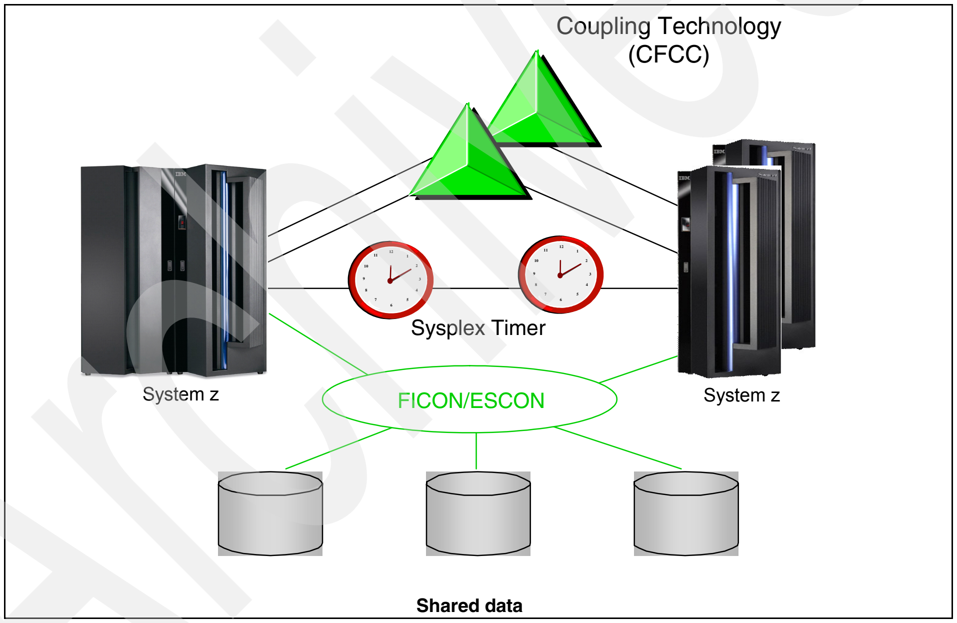


Figure 8-2 Parallel Sysplex - simplified view

The z/OS operating system provides the capability of creating a cluster of up to 32 systems known as a Parallel Sysplex, where a system can be a full system or just an LPAR. Most computing platforms today have clustering capabilities, but Parallel Sysplex is a completely different kind of clustering solution because it is able to share every resource between the elements in the cluster, and can dynamically reconfigure, add, or remove resources.

z/OS allows all members in a cluster to share all data, even up to the record level. All other cluster implementations, at best, allow you to partition data among the elements of the cluster, and each system can access just the data attached to it.

Parallel Sysplex also provides significant network optimizations for communication across its cluster members. After a client request reaches the Sysplex Distributor, there is no more external network traffic required; all traffic flows over the System z hardware. As a consequence, network latency is kept to a minimum and the typical network issues you often see in a physical decentralized infrastructure do not exist.

Even when the Parallel Sysplex is physically spread over several different machines, the communication between them flows over high speed fiber optic connections managed by the Cross Coupling Facility (XCF), a specific protocol for those connections, with a magnitude of gigabytes of transfer rate. Within a physical machine, communication between z/OS images is accomplished through memory-to-memory, and there is no network protocol faster than that.

Using Parallel Sysplex is key to achieving high availability in any of the SOA building blocks discussed later in this chapter. It is the technology that makes it possible to run the same workload on different system images, while using the same data image (if DB2 data sharing is also enabled).

Geographically Dispersed Parallel Sysplex (GDPS)

For higher availability and disaster recovery purposes, a Parallel Sysplex can be configured in a Geographically Dispersed Parallel Sysplex (GDPS) mode. There are two GDPS modes:

- GDPS/PPRC is a configuration in which a Parallel Sysplex is distributed over two sites, connected together up to 100 km, with data synchronized and shared continuously. One site (part of the sysplex) acts as a primary, and the second site acts as a secondary, in stand-by mode. GDPS controls and automates a full swap to the backup site in case of failure.
- The second mode of operation for GDPS is GDPS/XRC, in which the distance between sites can be more than 100 km (theoretically, without limitation). In GDPS/XRC, the sysplex does not span both sites, but instead a full system image is *swapped* to the alternate site in an emergency situation.

Both modes use the HiperSwap capability, which allows you to activate replicated data in the disaster recovery site without an application outage.

8.2.3 Reliability

Reliability is another Quality of Service with a broad meaning. In practice, reliability is associated with the ability to run programs with transactional attributes and ensure that data is not corrupted. In the broad sense, however, reliability also depends on the level of security on the system and other qualities of service.

The System z hardware provides built-in hardware redundancy (exemplified in continuous enhancements in hardware), and the z/OS operating system provides Resource Recovery Service (RRS) for global transactions with two-phase commit. RRS manages resources in such a way that they are registered in a global transaction only when they attempt to make changes to resources under its control.

In addition to the hardware and the operating system, CICS, IMS, and DB2 have their own built-in features for reliability, thus ensuring two-phase commit, integrity of data, and backward and forward logging mechanisms for recovery purposes.

Resource Recovery Services (RRS)

On z/OS, it is very likely that one transaction, or Unit of Recovery (UR), incorporates a number of programs and database updates. Those programs or database updates can be performed in one transaction manager or database manager respectively, but it also possible that they are performed in different transaction or database managers. In RRS terminology, a database or transaction manager making use of RRS as the coordinator is called a Resource Manager.

Whatever happens, the important thing is that the entire transaction is really managed as one transaction. This means that in case of a failure in any of the components, the entire transaction is *rolled back*. On the contrary, if all components have succeeded doing their part, the transaction as a whole will need to be *committed*.

For example, a transaction that moves money from one account to another must either complete or, in the case of any system failure, be completely backed out. For example, a debit must not be processed without the corresponding credit also being processed. This is true even if both accounts are managed by different database subsystems.

z/OS provides the Resource Recovery Services (RRS) subsystem to act as the coordinator of the transaction. RRS will keep track of each part of the transaction and initiate either a commit or a rollback, depending on the status of the overall transaction. For instance, when one part of the transaction is running in DB2 (a database update) and that part fails, RRS will initiate a rollback in all other parts of the transaction. The rollback itself is the responsibility of each Resource Manager individually using its own recovery mechanism.

The two-phase commit process

RRS uses the two-phase commit (2-PC) protocol to manage the coordination of the transaction. This process is depicted in Figure 8-3.

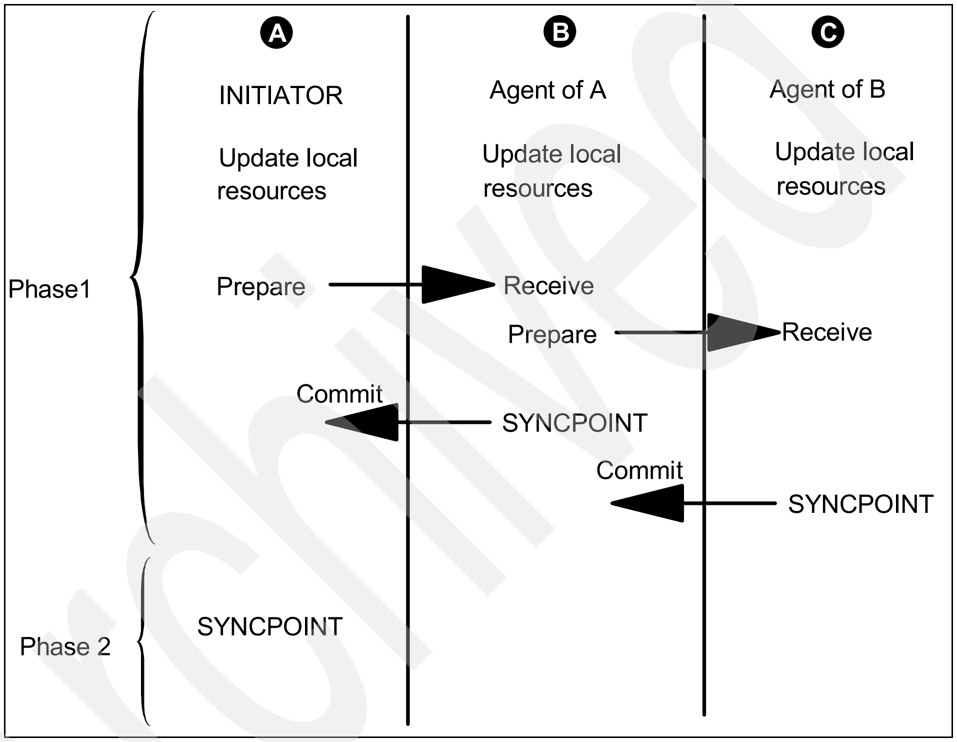


Figure 8-3 The two phase-commit process

8.2.4 Security

Security is an important and again, very broad characteristic. Security encompasses many areas, such as authentication, authorization, encryption, auditing and so on.

The System z platform, the z/OS operating system, and its security server subsystem provide a full range of security features:

- Dedicated security server (z/OS security server, including RACF, LDAP server, PKI infrastructure and much more).

- Support for a variety of *encryption standards* to keep current with industry and government security regulations - all inside the z/OS cryptographic services.
- *End-to-end data protection* that helps keep data uncorrupted and uncompromised. The generic product used is IBM Encryption Facility for z/OS, encompassing IBM Encryption Facility for z/OS, the Encryption Facility Client and the DFSMSdss™ Encryption Feature.
- Integration of security with the network with built-in technology that is resistant to hackers.
- Protection of the data in the network (encryption techniques, VPNs).
- Support for protecting of system resources and data from unauthorized access (TCP application support for RACF).
- Protection of the system from the network (IP packet filtering, traffic regulation, intrusion detection services).
- Managed access to critical data through Multiple Level Security (MLS integrated in RACF and used by different subsystems).

8.2.5 Total Cost of Ownership (TCO)

In this section we describe the System z features that have been provided over time to lower the TCO. The IBM direction is to keep on improving the TCO of the System z platform. The TCO improvements consist of the following:

- Simplifying and automating the processes running on z/OS (features in the area of systems management, reducing personnel costs through automation).
- Introducing features in the standard delivery (for example, making security features standard).
- Simplifying the disaster recovery (DR) implementation and thus reducing the DR implementation cost.
- Implementing sophisticated workload management techniques in order to use the resources on the z/OS platform in a cost-effective manner.
- Changing the commercial rules, changing the licenses, and changing the CPU usage pricing methodology. The z/OS platforms provides multiple hardware and software pricing options that suit different requirements.
- Offloading CPU loads to specialty processors, which are priced differently to make it more attractive to run new workloads on the platform.
- Introducing capacity on demand offerings.

8.3 Quality of Service of the SOA building blocks

In this section we review the software products used in the SOA building blocks and describe the Quality of Service provided by these products. First we consider the QoS features and then show, for each of them, how the products that represent the SOA building blocks implement these features.

8.3.1 Scalability

Scalability is a very important Quality of Service. It is present in all products running on z/OS, and is reflected mostly in the way these products implement workload management. In the following sections we describe how this workload management is supported in each of the products playing an important role in SOA on z/OS.

We focus on the following products:

- WebSphere Application Server as the foundation infrastructure for WebSphere ESB and WebSphere Process Server
- WebSphere ESB and WebSphere Process Server (WPS)
- WebSphere Message Broker (WMB)
- WebSphere Portal

WebSphere Application Server and workload management

We have several possibilities to scale using WebSphere Application Server on z/OS: vertical scaling and horizontal scaling. We discuss first the *vertical scaling.*

As part of the vertical scaling process within a WebSphere Application Server, the Workload Manager will start as many servant regions as required (within imposed restraints) to process the workload and meet the defined goals. If a given servant is overloaded, it is temporarily bypassed in favor of less busy servers. If a servant fails, other servants take over the work and the servant is recovered. When the servants are no longer needed, they are automatically stopped.

Horizontal scaling is especially effective in environments that contain many smaller, less powerful systems or nodes. Client requests that overwhelm a single system can be distributed over several systems.

On the z/OS platform, there are two workload managers: zWLM and eWLM. These workload managers cooperate in order to supply optimal workload management services, as described here:

- zWLM is the workload manager of z/OS, and it has an operating system view on the WebSphere Application Server.
- eWLM (enterprise WLM) is involved with application response monitoring, and feeds information back to zWLM.

The workload management is concerned with the optimal distribution of work requests to the processes (on z/OS, address spaces). In the case of WebSphere Application Server, the work requests are HTTP requests, servlet requests, messages, Web services, and EJBs.

In the following sections we discuss two aspects, namely classification of work requests and distribution of work requests.

Classification of work requests

Workload management in z/OS is based on the concept of grouping work into *service classes*. The incoming work request is classified to a service class, and the WLM schedules the resources to complete the work request according to this service class. Figure 8-4 on page 286 shows how WebSphere Application Server work requests are classified into service classes.

The following components are illustrated in Figure 8-4 on page 286:

- Work qualifier

  WebSphere Application Server for z/OS associates each work request with a work qualifier that identifies a work request to the system.
- Classification rules

  Classification rules associate a work request, as defined by its work identifier, to a WLM service class.
- Service class

  z/OS WLM organizes work into workloads and service classes. The service class for a group of work defines the performance goal and business importance.
- Performance goals

  There are three kinds of performance goals: response time, execution velocity, and discretionary. The response time goal indicates the response time goals for individual transactions; the execution velocity goals are suitable for started tasks or batch jobs; the discretionary goals are for low priority work.

- Business importance of the work

  The business importance for a service class defines how important it is to achieve the performance goal for that service class. At runtime, the workload management component manages workload distribution, and allocation of resources to competing workloads. High priority workloads get guaranteed, consistent results (for example, response time, throughput, and so on).

A few software constructs inside WebSphere Application Server are used to manage, control and deliver the classified work units to their respective servant address spaces.

- Queuing services

  The controller region queues work requests to Workload Management for execution in servant address spaces; it listens for work requests and puts them on the Workload Management queue. The Workload Management component of z/OS dispatches the work to the servant region according to the WLM policy specified by the work identifier.

- Enclaves

  Enclave services allow the performance management of a transaction across multiple address spaces and systems inside a Parallel Sysplex. The controller region creates the enclave and associates the transaction to this classified enclave. Then the transaction is queued, waiting to be served by an available thread in a servant region.

- Application Environments

  Application Environments allow WLM to start (or stop) servant address spaces in order to meet transactions performance goals, as the workload varies.

Figure 8-4 on page 286 illustrates the flow from the WebSphere controller region, through WLM, to the servant regions.

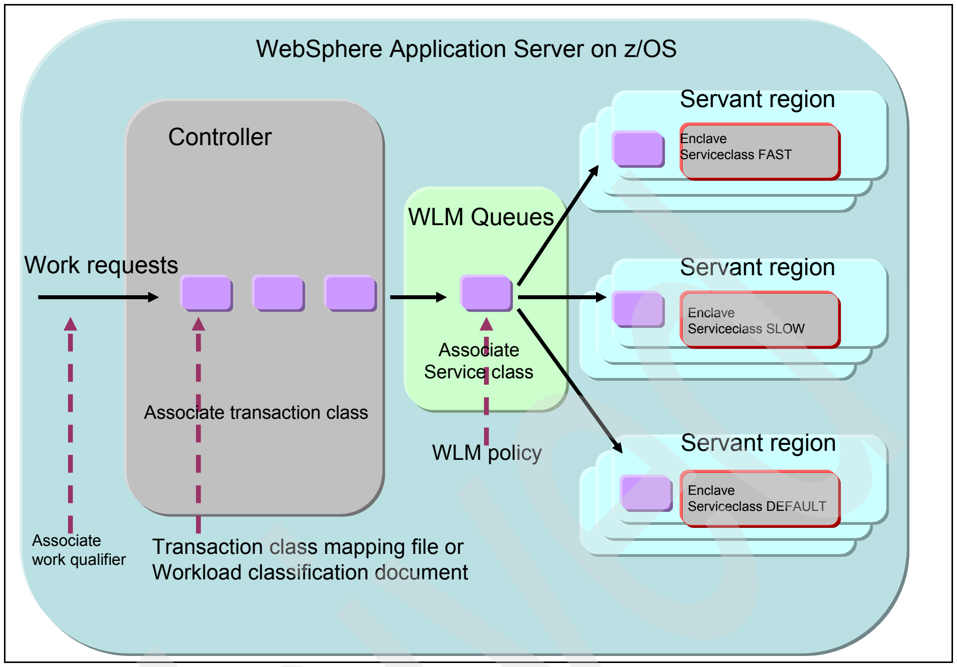


Figure 8-4 Workload management in WebSphere Application Server on z/OS

WebSphere Application Server can assign a Transaction Class (TC) to a work item by using a Transaction Class mapping file for HTTP requests, or by using a workload classification document for HTTP, IIOP, or MDB inbound requests, as described here.

- Transaction Class mapping file

  This file allows you to associate a set of URIs to a specific Transaction Class. At execution time, WLM will use the Transaction Class to associate the work request to a service class.

- Workload classification document

  This is a common .xml file for the classification of inbound HTTP, IIOP, and MDB work. The `InboundClassification` element defines the type of work that is to be classified by the type of work-specific child elements. The statement used is:

```
<InboundClassification type="iiop | http | mdb"
schema_version="1.0"
default_transaction_class="value">
```

IIOP work can be classified, in a very flexible way, based on the following J2EE application artifacts (specified through the `iiop_classification_info` element.):

Application name	This is the name of the application containing the EJBs. It is the display name of the application, which is not necessarily the name of the .ear file containing all the artifacts.
Module name	This is the name of the EJB .jar file containing one or more EJBs (there can be multiple EJB .jar files contained in an .ear file).
Component name	This is the name of the EJB contained in a module (or EJB .jar) (there can be one or more EJBs contained in an EJB .jar file).
Method name	This is the name of a remote method on an EJB.

HTTP work can be classified based on the following J2EE application artifacts:

Virtual Host Name	This is the host name in the HTTP header to which the inbound request is being sent.
Port Number	This is the port on which the HTTP catcher is listening.
URI (Uniform Resource Identifier)	This is the string that identifies the Web application.

Message Driven Beans can be associated to a transaction class. You can use the following filter elements for MDB classification:

– Listener Port (Endpoint)
– Message Selector (XML tags)

You can see that the classification of work units is very granular, because you have a flexible way of classifying the work requests. By having this granularity, WLM is able to schedule appropriately the work units and to “fill the box”.

Distribution of HTTP requests

Distribution of HTTP requests takes place through connection dispatching; we describe a solution available on z/OS, without using any external technology.

Connection dispatching is the routing of TCP connections from a dispatching (or distributing) node to a group of target servers. The dispatching node receives data from the client and forwards it to the appropriate server, which can reply directly to the client.

All systems in this cluster provide information about their workload to a dispatching entity, which is generally referred to as a *distribution manager*. This manager is responsible for distributing connection requests from clients to the target systems where the application servers are running. The distribution is based on the current workload information collected by the distribution manager.

Sysplex Distributor is a state-of-the-art connection dispatching technology that is used among z/OS IP servers. The dispatching entity in this solution is a z/OS system in a Parallel Sysplex (called the *distributing stack*), and the target servers are exclusively z/OS systems in the same Parallel Sysplex. With this technique, the client sees a traditional TCP/IP connection with a server, and is unaware of the existence of the distribution manager.

Sysplex Distributor extends the notion of automatic Virtual IP Address (VIPA) takeover to allow for load distribution among target servers in the sysplex. The Sysplex Distributor is advertising ownership of some IP address by which a particular service is known (called Distributed VIPA, or DVIPA). The Sysplex Distributor makes use of Workload Manager (WLM) and its ability to determine server load. WLM informs the distributing stack of the target server loads so that the distributing stack may make the most intelligent decision regarding where to send incoming connection requests.

Additionally, Sysplex Distributor has the ability to specify certain policies in the Policy Agent so that it may use QoS information from target stacks in addition to the WLM server load. Further, these policies can specify which target stacks are candidates for clients in particular subnetworks.

The connection routing technology of Sysplex Distributor allows a VIPA to move nondisruptively to another stack.

The limitation of the solution is that the Sysplex Distributor does not support affinity to a specific target host. The choice of the target is selected according to WLM metrics, policies, and configurations—and could possibly be a different target than in the last request.

Note: This solution works well with stateless applications. For applications that need to keep state, the WebSphere plug-in should be the one in charge of dispatching directly to the WebSphere servers.

Distribution of servlet requests

The servlet requests are dispatched by the HTTP server plug-in to one of the available application servers; the routing is *server-weighted*. These servers are known to the HTTP server plug-in by the plugin_cfg.xml configuration list; this list delivers information about the primary and backup servers, including their weight.

Distribution of messages

Messages are distributed using the partitioned messaging destination feature, which spreads the messages across multiple messaging engines.

Distribution of EJB requests

EJB requests are dispatched using a daemon which asks WLM on z/OS for a recommended endpoint, makes a decision based on the recommendation, and sends the EJB request to the selected EJB container.

The IBM Redbook *Architecting High Availability using WebSphere V6 on z/OS*, SG24-6850, provides more detailed information about this topic, as well as HTTP sessions (affinity, session management, persistence); it also offers alternative solutions.

WebSphere Message Broker and workload management

WebSphere Message Broker (WMB) supports goal-oriented resource allocation. When a Message Broker V6 execution group address space starts, it can be assigned to a Workload Manager (WLM) service class, which in turn is assigned a specific goal during the WLM configuration process. The ability to assign WLM service classes to message processing workload has two significant benefits:

- As work passes through subsystems that are WLM-enabled, the service class can be maintained (resources such as CPU and IO “follow” users’ work).
- WLM classification means that in the event of a resource constraint (at peak time, for example), high priority workloads can receive appropriate resources to ensure that critical workloads are completed at the expense of less important work.

WMB can assign threads to CPUs, assign message flows to execution groups, and assign message flows to multiple brokers deployed within the sysplex broker domain. All these reconfiguration activities are dynamic.

WebSphere Process Server, WebSphere ESB, and workload management

WebSphere Process Server (WPS) and WebSphere Enterprise Service Bus for z/OS are built on top of WebSphere Application Server for z/OS. The preceding information about WebSphere Application Server in relation to WLM is therefore relevant here, because WebSphere Process Server and WebSphere Enterprise Server Bus execute in the WebSphere Application Server address spaces.

Clustering can be employed to create a high availability Message Engine (ME) for the WebSphere Process Server. The configuration has the following features:

- It provides for multiple Message Driven Beans to utilize a common queue and a single persistent store.
- WLM decides which server will run the Message Engine.
- If the active Message Engine fails, then the HA (High Availability) manager will activate a new Message Engine on an available server.
- WLM routes the JMS clients to the currently active Message Engine.

In order to increase scalability, the logical approach is to add more Message Engines to the server cluster, and use the JMS destination partitioning to partition the messages across the Messaging Engines in the cluster. However, this feature can be used only for specific types of applications (those in which cluster affinity and stateful messages are not relevant).

As with WebSphere Process Server, topologies for WebSphere Enterprise Service Bus for z/OS are mainly imposed by those of WebSphere Application Server for z/OS: sysplex and server clustering are the main considerations when you need high availability. Internally, messages passed through mediations in WebSphere Enterprise Service Bus are persisted in the Service Integration Bus. These Service Integration Buses are made out of Messaging Engines that live inside application servers.

The configuration of Service Integration Buses is very flexible. You can have individual Messaging Engines, or clusters containing multiple Messaging Engines that can share workload, be highly available, or both.

The following options are available:

- Workload sharing configuration

  Multiple Messaging Engines (one per application server) clustered together, Message Engines are restricted to running in their application servers. The last level of workload balancing is provided by the WLM at servant level.
- High availability Message Engine configuration

  Single Messaging Engine running in a cluster. It lives in more than one application server so that there is failover to the rest of servers in the case of maintenance or a system crash. If the cluster is horizontal and sysplex-wide, WLM policies for workload through the sysplex apply.
- High availability Messaging Engines with workload sharing

  A combination of the two previous options. Multiple Messaging Engines running in a cluster with Messaging Engines being able to failover to one or more application servers in the cluster. Both the local WLM policy for servants in an application server and the sysplex-wide policy for the cluster apply here.

A comprehensive discussion of this topic is beyond the scope of this book, but you can nevertheless see that the combination of WebSphere Application Server, WebSphere Process Server, and WebSphere ESB provide high availability. For detailed information, refer to IBM Redpaper *z/OS technical Overview: WebSphere Process Server and WebSphere Enterprise Bus*, REDP-4196.

WebSphere Portal and workload management

WebSphere Portal runs in WebSphere Application Server and inherits the workload management support discussed in "WebSphere Application Server and workload management" on page 283.

8.3.2 Availability

The level of availability provided by the SOA products is determined by the clustering capabilities of the product itself, and whether the product exploits Parallel Sysplex or not.

All of the SOA products within our scope (including back-end systems such as CICS, IMS, and DB2) exploit Parallel Sysplex, meaning that multiple system images can be tied together and behave as one logical system. If one LPAR drops out, the other LPARs take over the workload.

All the WebSphere products (Application Server, MQ, Message Broker, ESB, Process Server and Portal) and CICS and IMS provide clustering techniques, and DB2 provides data sharing. Clustering means "cloning" a server that can process the same workload. This requires each "clone" to have the same program logic deployed to it, and have access to the same data.

In the following sections we discuss in more detail sysplex exploitation and clustering capabilities per SOA product.

WebSphere Application Server

To exploit Parallel Sysplex with WebSphere Application Server in a meaningful way and achieve full high availability, the following conditions must be met:

- A Parallel Sysplex must have been installed, with one or a duplicate Coupling Facility (CF).
- DB2 data sharing must be enabled.
- WebSphere Application Server must be installed in a Network Deployment (ND) topology.
- Clustering must have been configured between servers on multiple LPARs.

This allows you to run the same workloads on multiple servers in multiple LPARs having access to the same data image.

WebSphere ESB/WebSphere Process server

WebSphere ESB and WPS for z/OS can be installed and configured to run in a WebSphere Application Server Network Deployment configuration. Being able to run WESB and WPS workloads in a sysplex environment requires the same prerequisites described in “WebSphere Application Server” on page 291.

WebSphere Message Broker

WebSphere Message Broker can also exploit the sysplex, through WebSphere MQ shared queues. Input and output requests can be persisted in those shared queues, which are stored in the Coupling Facility (CF). All participating LPARs and the brokers running in those LPARs will have access to the same queue image. If an LPAR or a broker in an LPAR drops out, other brokers on other LPARs can continue processing the same workloads.

Workload scaling is also facilitated by the sysplex. Message flows can be scaled across the sysplex by deploying to multiple brokers within the sysplex broker domain. This reconfiguration process is dynamic and does not require a restart. Similarly, brokers, execution groups, and message flow instances can be removed as needed.

WebSphere Portal

WebSphere Portal for z/OS can be installed in such a way that it takes advantage of the underlying WebSphere Application Server implementation. The Portal can be installed in a WebSphere Application Server cluster for either horizontal (availability) or vertical (scalability) situations.

8.3.3 Reliability

As described in 8.2.3, “Reliability” on page 280, the System z hardware and z/OS operating system provide the underlying infrastructure for reliability. An important aspect of reliability is the ability to run transactions and apply “bulletproof” recovery mechanisms in case of failure. Even though the hardware and the operating system provide a robust infrastructure, reliability can only be achieved if the SOA core products within our scope exploit transaction and recovery mechanisms themselves, as well.

As you may expect, all IBM software products in the core SOA reference architecture and the traditional back-end systems are designed from the beginning to fully support transactionality and recoverability.

In the following sections we discuss in more detail the reliability capability for each SOA core product. (We do not discuss the back-end systems such as CICS, IMS and DB2, but there are no reliability issues with those systems.)

WebSphere Application Server

WebSphere Application Server is a transaction manager that supports the coordination of resource managers through the XAResource interface and participates in distributed global transactions with transaction managers that support the CORBA Object Transaction Service (OTS) protocol (for example, application servers) or the Web Service Atomic Transaction protocol.

For global transactions in which both WebSphere Application Server and another resource manager take part and which are both run on the same LPAR, Resource Recovery Services (RRS) is exploited to coordinate transactions.

WebSphere Application Server handles transactions with three main components:

- A *transaction manager* that supports the enlistment of recoverable XAResources and ensures that each such resource is driven to a consistent outcome, either at the end of a transaction, or after a failure and restart of the application server.
- A *container* in which the J2EE application runs. The container manages the enlistment of XAResources on behalf of the application when the application performs updates to transactional resource managers (such as databases). Optionally, the container can control the demarcation of transactions for enterprise beans that are configured for container-managed transactions.
- An *API (UserTransaction*) that is available to bean-managed enterprise beans and servlets, which enables such application components to control the demarcation of their own transactions.

WebSphere has administration tools enabling granular setting of the transaction properties; these properties are saved in the configuration files.

The transaction support delivered for access to back-end systems (EIS, databases, transaction servers) is implemented through the J2EE Connector Architecture (JCA). In this case the supplier of the back-end system delivers a JCA resource adapter with the following characteristics:

- Provides JCA-compliant connectivity between J2EE components and an EIS.
- Plugs into an application server.

- Collaborates with the application server to provide services, such as connection pooling, transaction, and security services. JCA defines the following set of *system-level contracts* between an application server and EIS:
  - A *connection management contract* lets an application server pool connect to an underlying EIS, and lets application components connect to an EIS. This leads to a scalable application environment that can support a large number of clients requiring access to EISs.
  - A *transaction management contract* between the application server transaction manager and an EIS supports transactional access to EIS resource managers. This contract allows an application server use a transaction manager to manage transactions across multiple resource managers. This contract also supports transactions that are managed internally to an EIS resource manager, without the necessity of involving an external transaction manager.
  - A *security contract* enables a secure access to an EIS. This contract provides support for a secure application environment, reducing security threats to the EIS and protecting valuable information resources managed by the EIS. The resource adapter implements the EIS-side of these system-level contracts.
- Implements the Common Client Interface (CCI) for EIS access. The CCI defines a standard client API through which a J2EE component accesses the EIS (through the JCA resource adapter). This simplifies writing code to connect to an EIS. The resource adapter provides connectivity between the EIS and the enterprise application via the CCI.
- Implements the standard Service Provider Interface (SPI). The SPI integrates the transaction, security, and connection management facilities of an application server (JCA Connection Manager) with those of a transactional resource manager.

To show a single example, we look at the implementation for DB2 access. WebSphere Application Server on z/OS implements a resource adapter as shown (for DB2 access) in Figure 8-5 on page 295.

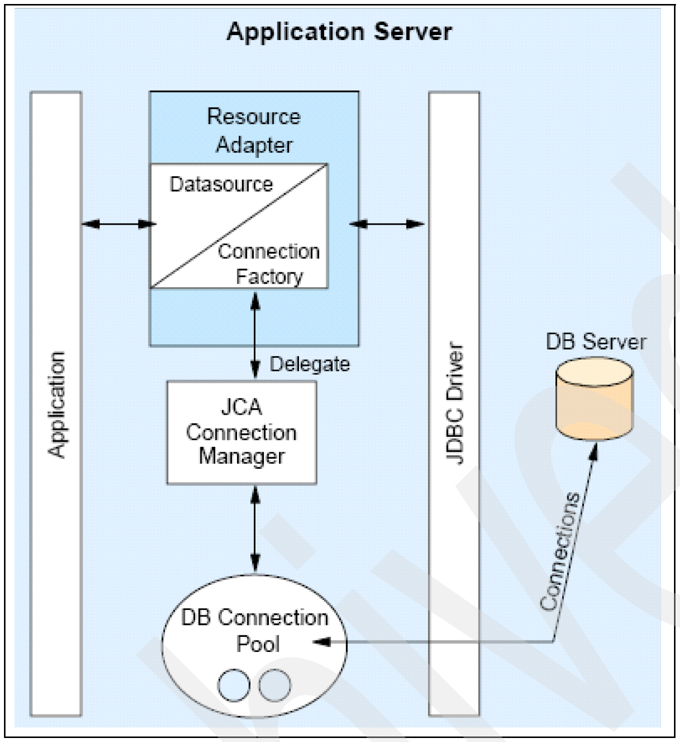


Figure 8-5 Resource adapter in J2EE connection architecture

For a detailed description of the transactional capabilities that are available when connecting to back-end systems (CICS, IMS, DB2), refer to the IBM Redbook *WebSphere z/OS connectivity Architectural Choices*, SG24-6365. That publication describes how transactions can encompass EJBs and resources available under the control of other transaction managers.

WebSphere Message Broker

WebSphere Message Broker supports transactional message flows. RRS is used for context management and commitment control between resource managers if necessary. Figure 8-6 on page 296 shows a complex example of a transactional message flow that requires such a coordinator.

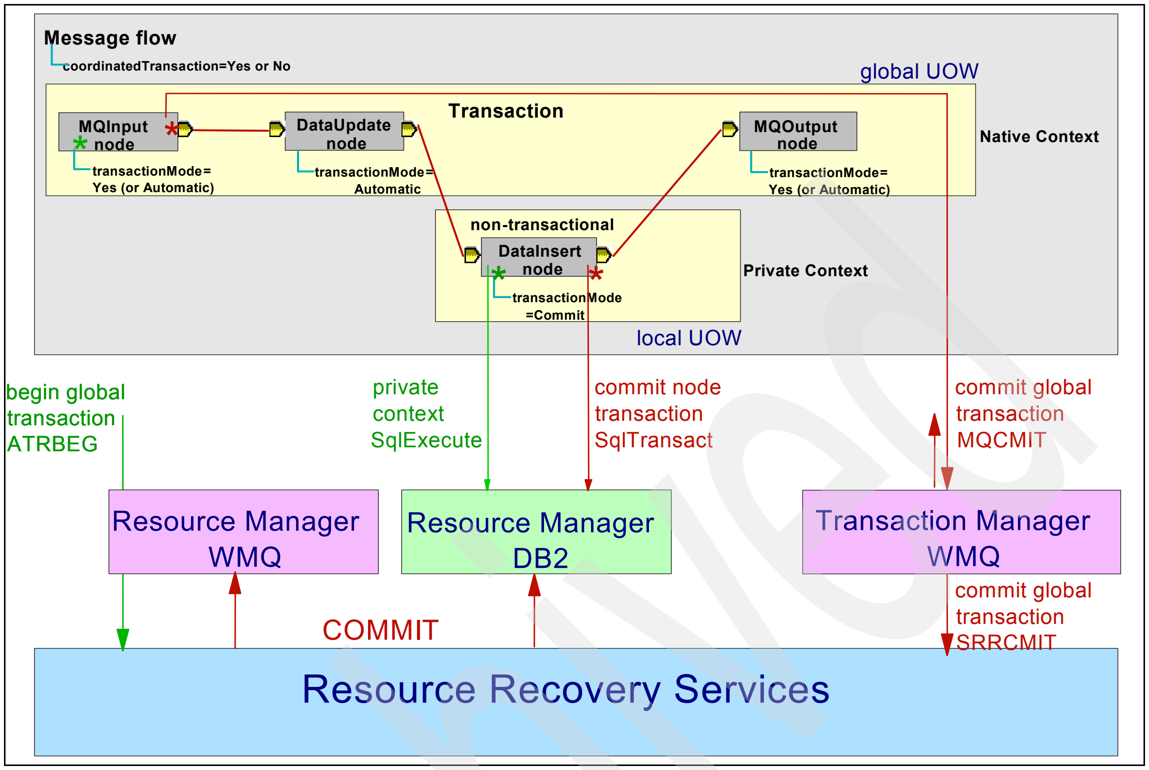

Message flow
coordinatedTransaction=Yes or No
global UOW
Transaction
Native Context
MQInput node
transactionMode= Yes (or Automatic)
DataUpdate node
transactionMode= Automatic
MQOutput node
transactionMode= Yes (or Automatic)
non-transactional
DataInsert node
transactionMode =Commit
Private Context
local UOW
begin global transaction ATRBEG
private context SqlExecute
commit node transaction SqlTransact
commit global transaction MQCMIT
Resource Manager WMQ
Resource Manager DB2
Transaction Manager WMQ
commit global transaction SRRCMIT
COMMIT
Resource Recovery Services

Figure 8-6 Example of transactional flow and coordination in WebSphere Message Broker

WebSphere Process Server

WebSphere Process Server takes advantage of the underlying z/OS RRS service. It offers support for transactions involving multiple resource managers using the two-phase commit process to ensure ACID properties. This capability is available for both short-running processes (single transaction) and long-running processes (multiple transactions). Multiple steps of a business process can be grouped into one transaction by modifying transaction boundaries in WebSphere Integration Developer.

Because not all service invocations support two-phase commit transactions, WebSphere Process Server also includes recovery capabilities. If a failure occurs in the middle of running an integration application, the server detects it and allows an administrator to manage the failed event from the failed event manager.

SCA transactions are also supported. SCA presents all elements of business transactions, including access to Web services, Enterprise Information System

(EIS) service assets, business rules, workflows, databases and so on, in a service-oriented way.

WebSphere Enterprise Service Bus

WebSphere ESB takes also advantage of the underlying z/OS RRS service. This helps to implement transactional properties in the mediations. You can configure a mediation handler to run within a global transaction. A global transaction is required when:

- Mediating and routing messages must be coordinated into a single transaction
- Several mediation handlers in a mediation handler list must be coordinated into a single transaction

Setting the global transaction property ensures transactional integrity between a mediation that accesses the resources owned by other resource managers, and the messaging engine. A global transaction encompasses all the mediation operations that are run within the bus for the duration of the mediation.

The global transaction ends when the mediation completes its processing. If a mediation transaction rolls back, all transactional changes also roll back. When the transaction rolls back, the mediated message remains on the pre-mediated part of the bus destination and becomes eligible to be mediated again. The redelivery count assigned to a message increments each time a mediation transaction rolls back. If the redelivery count exceeds the limit configured for the bus destination, then the message is sent to the exception destination.

8.3.4 Security

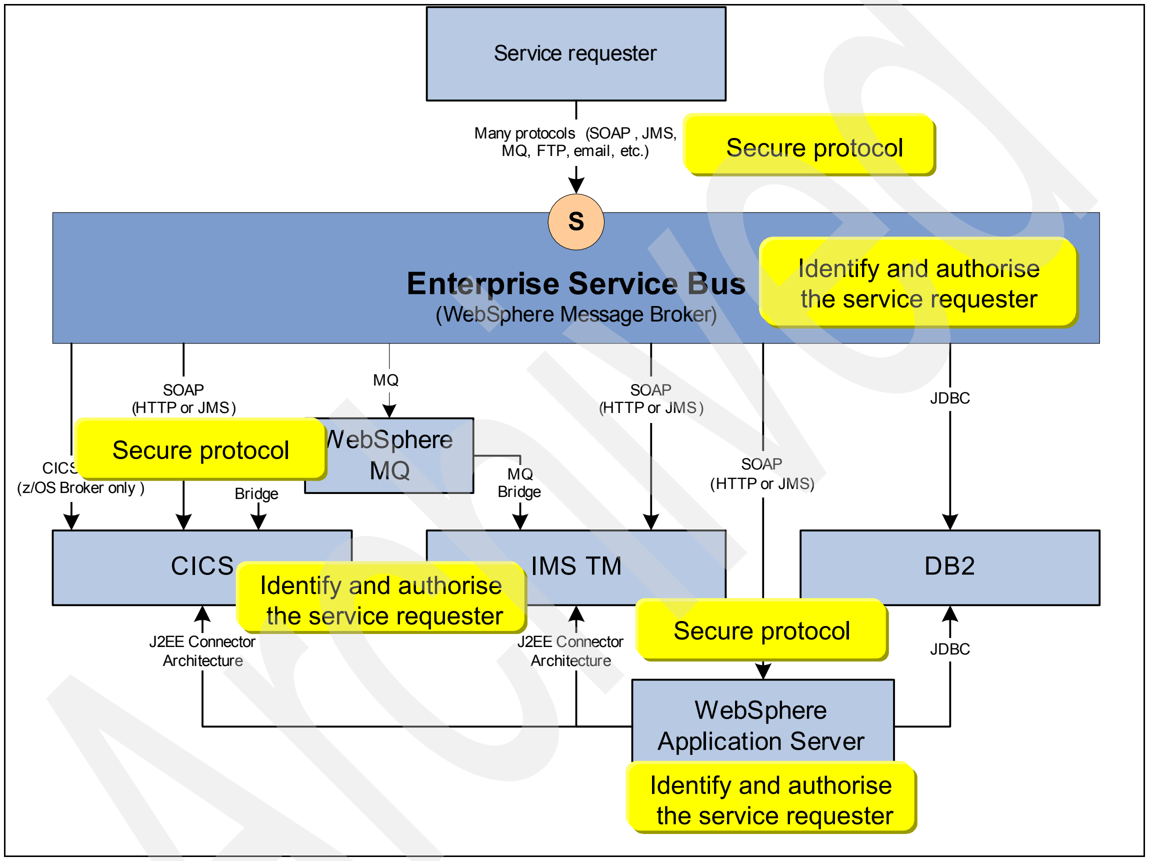
The introduction of SOA brings with it additional considerations in terms of security. The concept of SOA itself, with its principle of loosely coupled and abstracted services, means that identity validation of both consumers and providers is harder to manage. Any application plugged into an SOA architecture is likely to have different identity mechanisms and security policies. Users will most likely have different privileges for different applications, and thus they will need to be authenticated for each of the applications that are used via the SOA framework. In addition, we have to take care of the communication between the loosely-coupled elements of the new applications.

Our objectives are:

- To build an architecture that allows end-to-end identity management, namely one that is able to determine access rights for every application and user involved.

- In this context, use secure connection protocols and security features to enable data confidentiality and integrity.
- Client (service requester) authentication and authorization (via LDAP and/or

Figure 8-7 displays a diagram used earlier, but this time it shows some security interaction points. In such an architecture, with significant integration, the security design becomes particularly important.



Service requester
Many protocols (SOAP , JMS, MQ, FTP, email, etc.)
Secure protocol
S
Enterprise Service Bus
(WebSphere Message Broker)
Identify and authorise the service requester
SOAP (HTTP or JMS)
MQ
SOAP (HTTP or JMS)
JDBC
Secure protocol
WebSphere MQ
CICS (z/OS Broker only)
Bridge
MQ Bridge
SOAP (HTTP or JMS)
CICS
IMS TM
DB2
Identify and authorise the service requester
J2EE Connector Architecture
J2EE Connector Architecture
Secure protocol
JDBC
WebSphere Application Server
Identify and authorise the service requester

Figure 8-7 Example of security interaction points in a SOA architecture - WMB, WebSphere Application Server, MQ, back-end transaction servers, and DB2

As mentioned, we must introduce secure protocols and identify and authorize the requesters at specific points in the architecture. There are many options available.

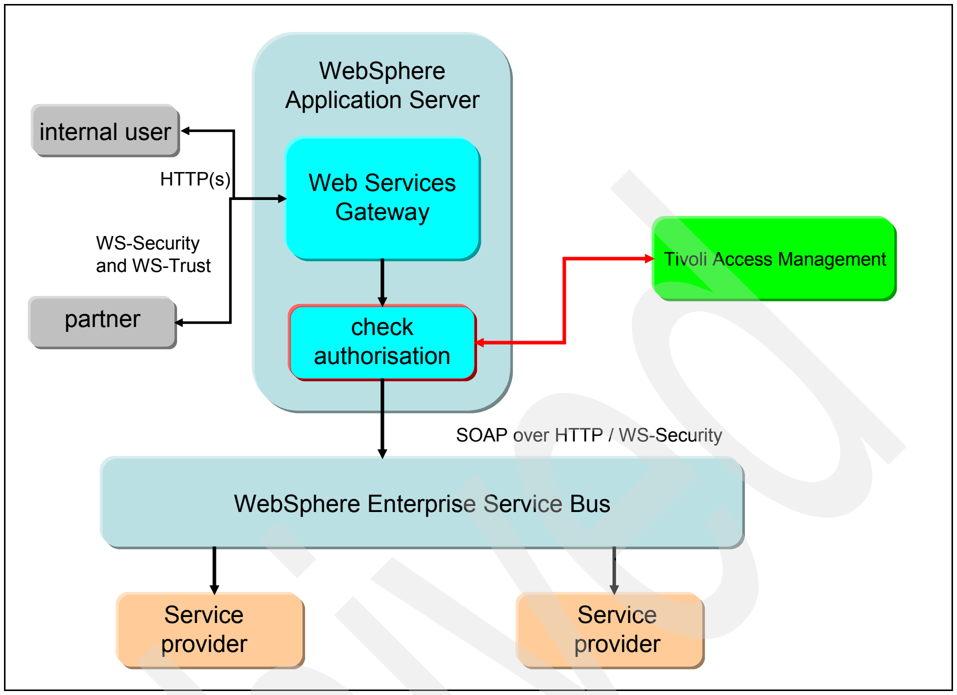


Figure 8-8 Security authorization placed in Web Services Gateway

For example, for the authorization of the service requestors, the security interaction point might be placed, depending on the architecture implemented, either in the Web Services gateway (see Figure 8-8), or in the WebSphere ESB (see Figure 8-9 on page 300).

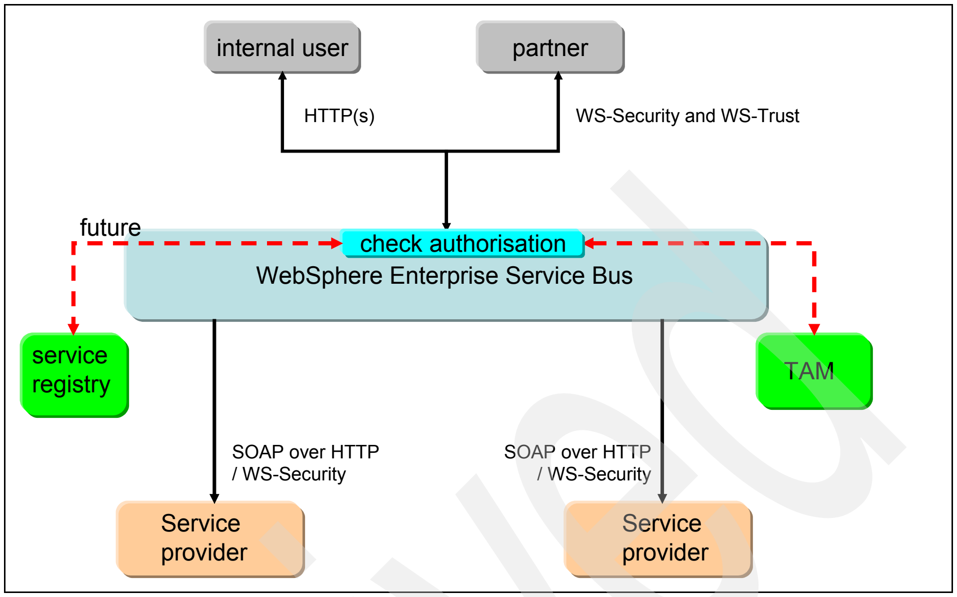


Figure 8-9 Service authorization positioned at WebSphere ESB

The scope of the security discussion here is limited. The IBM products used in the SOA architecture blocks have security interaction points and use the security infrastructure of z/OS in a consistent way, as we show in the following sections. For each product, we use the same structure:

- Show security interaction points for the components of the product, and which resources are protected at that point.
- Show the security products that are used. We show if the RACF is used, or a pluggable registry, or simply configuration files of the product.

WebSphere Application Server

z/OS security has special features that make it one of the most secure systems available. The security layers, as they are used in conjunction with WebSphere Application Server, are shown in Figure 8-10 on page 301.

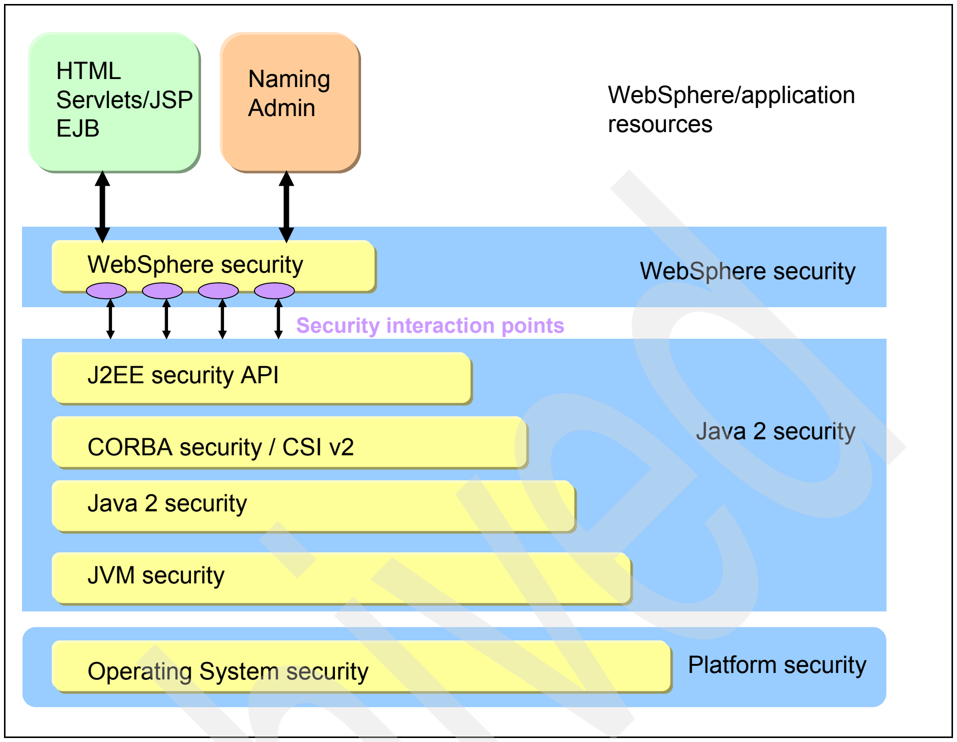


Figure 8-10 Security layers on z/OS as seen by WebSphere Application Server

Here we briefly summarize the security layers displayed in Figure 8-10.

Operating system security	At this level, RACF protects the WebSphere Application Server configuration files and many other z/OS resources used by WebSphere Application Server.
Java 2 security	At this point we protect access to J2EE application components and the J2EE runtime (Java Virtual Machine). This layer also includes the "J2EE security API", which gives control to the developer and deployer to define security (primarily authorization) on resources such as servlets/JSPs and EJB methods based on roles.

Users and groups are assigned to these roles during application deployment, using deployment descriptors.

WebSphere security At this level, WebSphere global security settings protect access to system resources such as file I/O, sockets, and properties.

A more detailed view of the security in the WebSphere environment in an end-to-end context is shown in Figure 8-11.

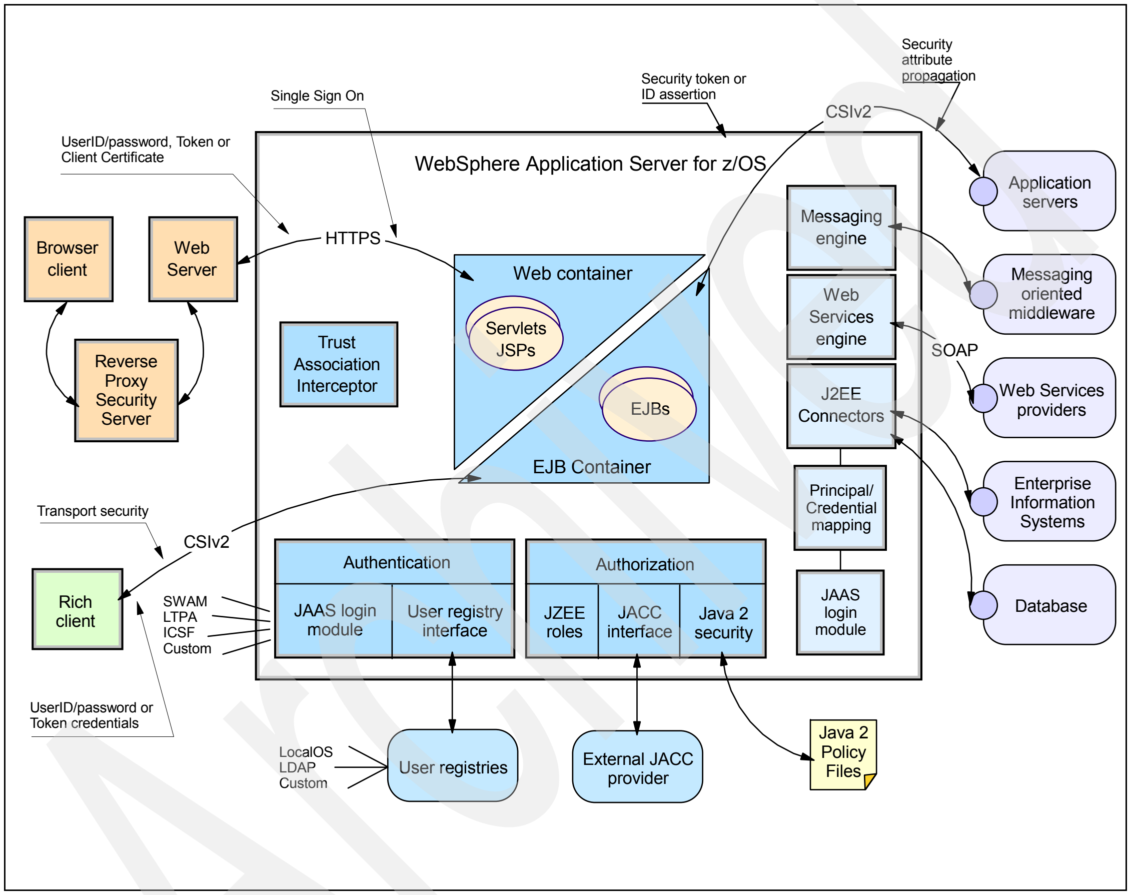


Figure 8-11   End to end security in a WebSphere Application Server for z/OS environment

Pluggable security registry

Usually the pluggable registries support specific protocols. For example, in order to access Tivoli Access Manager, WebSphere Application Server supports Java Authorization Contract for Containers (JACC), which is a specific set of APIs.

J2EE container security

At this level we use the J2EE API (as previously described), Java Authentication and Authorization Service (JAAS), and the EJB security collaborator to authenticate Java client requests to Enterprise JavaBeans (EJBs).

To secure access to resources we can use EJBROLE. Using the APPLDATA segment of the RACF EJBROLE profile for the identity to be used for the RunAs role allows RACF control.

Web Services security

When Web Services standards are used, an additional security layer may be used at the level of the SOAP message. Note that SOAP messages are sent inside JMS messages or HTTP requests, and that the security available at those levels applies, as well. For example, a SOAP message sent inside an HTTP request can be encrypted using SSL.

When we talk about "Web Services security", we refer to the security that can be applied to the SOAP message and the invocation of the Web service; we do not refer to all the security features and standards available at the JMS message or the HTTP request level.

Web services messaging relies on two protocol layers: the (SOAP) *message layer*, and the *transport layer*. Security can be implemented at both layers. WebSphere Application Server secures the message layer by implementing WS-Security specifications (these specifications are shown in Figure 8-12).

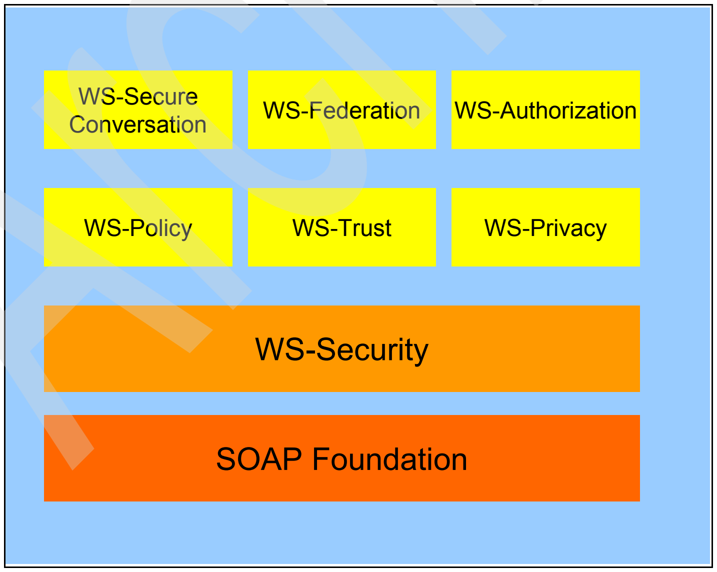


Figure 8-12 WS-Security specifications

The transport layer (HTTP, RMI/IIOP, MQ) is secured through the implementation of authentication headers and through encapsulation in the SSL/TLS.

Next, we examine the SOAP layer for a more detailed look at how WebSphere Application Server implements the WS-Security specifications. Generally, WS-Security is a message level standard that defines how to secure SOAP messages, using:

- XML Digital Signature

  Digitally sign the SOAP XML document, providing integrity, authenticity, and signer authentication (JSR 105 describes the Java programmatic implementation).
- XML Encryption

  Process for encrypting data and representing the result in XML providing confidentiality (JSR 106 describes the java programmatic implementation).
- XML Canonicalization

  Provides normalized XML document that can be digitally signed and verified.

WebSphere Application Server supports the following WS-Security authentication mechanisms via the insertion of a security token:

- Basic Authentication

  The security token includes the user name and password information, and is generated as <wsse:UsernameToken> with <wsse:Username> and <wsse:Password>.
- Signature

  The security token includes the X.509 certificate of the signer of the data and is generated as <ds:Signature> with <wsse:BinarySecurityToken>.
- ID assertion

  ID assertion includes a user name only, since the identity is asserted, and is generated as <wsse:UsernameToken> with <wsse:Username>.
- Custom

  This mechanism includes a custom-defined token.
- LTPA

  Use of an LTPA token is a WebSphere-specific customer token, generating a <wsse:UsernameToken> with <wsse:Username>.

For each option, there is extensive support available in the WebSphere Application Server configuration dialogs. The Web Services security constraints are defined in the IBM extension deployment descriptor and the binding file based on the Web Service port. At the application level this means that the Web Services configuration is stored in the two following extension deployment descriptors:

  – `ibm-webservices-ext.xml`
  – `ibm-webservices-bnd.xml`

Web container security

At this level, the Web container interacts with RACF to:

- Authenticate the Web client (granularity by URI). The behavior is specified in the WebSphere Application Server configuration file.
- Authorize the Web client. The behavior is specified in the WebSphere Application Serve configuration file.

Back-end resource access security

At this point, WebSphere Application Server makes available several options for securing access to back-end resources. We need to make sure that:

- The access to back-end resources is secured.
- The connection to back-end resources is a secure conduit.
- The identity of the requester with all its security attributes is propagated to the back-end resource.

There are some general options: we can choose whether to use common identity (JAAS aliases) for the connection pool, or to project or assert an end-user identity.

In order to secure the access to CICS, we can use CICS Identity Projection. Two methods are possible:

- *Thread Identity* support for connection identity for local connections.
- *Identity assertion* of a WebSphere provided identity to CICS.

The connection to CICS supports SSL, and the SSL parameters are defined using the J2C Connection Factory - SSL Custom Properties (configuration file in WebSphere Application Server).

In order to secure access to IMS, we can use IMS Identity Projection. Two methods are possible.

- *Thread Identity* support, for connection identity for local connections.
- *Identity assertion* of a WebSphere-provided identity to IMS (under specific conditions and under the usage of IMS Connect trusted user support).

The connection to IMS supports SSL, and the SSL parameters are defined using the IMS J2C SSL Custom Properties (configuration file in WebSphere Application Server).

In order to secure access to DB2, we can use thread identity and thread security support for local connections.

WebSphere Process Server (WPS) and WebSphere Enterprise Service Bus (WESB)

WebSphere Process Server and WebSphere Enterprise Service Bus for z/OS are built on top of WebSphere Application Server for z/OS, and therefore inherit the security capabilities of WebSphere Application Server.

SCA security

SCA provides its own capabilities for security. SCA definitions are observed by WebSphere Process Server and WebSphere Enterprise Service Bus everywhere in their architecture and development. SCA applies security by defining quality of service qualifiers. The two SCA qualifiers for security relevant to WebSphere Process Server and WebSphere Enterprise Service Bus are:

- *SecurityIdentity*

  This is the J2EE role under which a component will be executed, regardless of the invoking J2EE role.

- *SecurityPermission*

  This is the required J2EE role to invoke an operation.

Message level security

Message level security is concerned with the flow of messages in transit. There are many ways to secure these messages, including using the WS-Security specification that is supported within WebSphere Process Server, and WebSphere Enterprise Service Bus for z/OS.

The security activities are:

- *Authentication of users* when they attempt to connect to a Service Integration Bus. Users attempting to establish a connection might have to provide a user ID and password. These are authenticated against the same registry that the application server uses. Further access checks on the user name can be performed when the connection accesses a destination (to send or to receive a message), creates a temporary destination, or accesses a foreign bus.
- *Ensuring confidentiality and integrity* of the messages in transit. To ensure that communications are secure, you can set up secure transport chains and select secure transports to protect the data transmitted along the link using

SSL or HTTPS. WS-Security can also be used for SOAP messages, especially if they are asynchronous, because no handshake is needed with it.

- *Control of access to bus* for the Message Engines.

Runtime security

Security in WebSphere Process Server and WebSphere Enterprise Service Bus is controlled by definitions in the configuration files, and by access to the native or the pluggable registry. The configuration files include aliases to which default users are mapped and security roles to which users must be granted access in order to invoke these components. The components with predefined aliases and roles are:

- Business process choreographer - aliases and roles
- CEI - aliases
- SCA - aliases and roles
- Human tasks engine - roles

Application security

Securing applications is enabled by setting global security (in the configuration file). At this level we are concerned with authentication and access control.

- Authentication

  This is enabled when global security is on, then clients must be authenticated. The main authentication methods for clients are:

  - Web clients: HTTP Basic Authentication.
  - Java clients: Java Authentication and Authorization Service (JAAS.)
  - Web services: WS-Security/SOAP authentication.
  - Additionally, all of these clients can use SSL authentication, or Lightweight Third Party Authentication (LTPA). This mechanism allows you to choose between two different authentication possibilities (local user registry, or LDAP (local or remote)).

- Access control

  This is usually implemented by assigning J2EE roles to components.

Adapter security

Adapters have to be secured as well, depending on the information they process and their connections to specific Enterprise Information Systems. Within WebSphere Process Server or WebSphere Enterprise Service Bus, an adapter is an SCA import or export. This import or export can have SCA security qualifiers defined for it to determine the role under which the adapter runs and the role that is required to be authorized to access the adapter.

Enterprise information system-specific security information (such as the user ID that the transaction in the enterprise information system should run under) can usually be specified in the connection factory of the adapter.

Figure 8-13 shows the way WPS and WESB integrate in the existing security layers on z/OS and WebSphere.

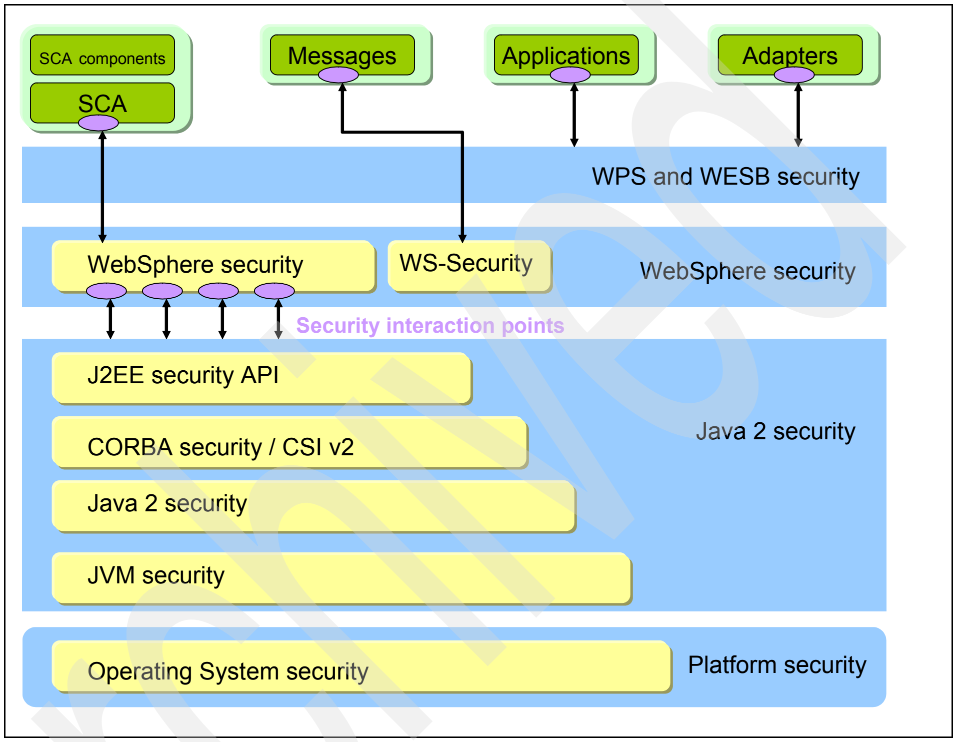


Figure 8-13 WPS and WESB security

WebSphere Portal

Security for Portal Server on z/OS is provided through the Custom User Registry (CUR) feature of WebSphere Application Server on z/OS.

Portal users can typically be a few hundred existing z/OS intranet users who probably have user IDs managed through RACF, and potentially thousands of new Internet or extranet users. The challenge is to provide these new users direct and secure access to transactions and data via the Portal. These new Portal users do not need RACF logon to the z/OS system, but do need to be authenticated and granted access to the specific application they need to run which is handled by WebSphere Portal via a portlet. This is where a separate registry using the Lightweight Directory Access Protocol (LDAP) as a Custom User Registry comes into play.

Figure 8-14 shows an overview of the security implementation of WebSphere Portal Server on z/OS.

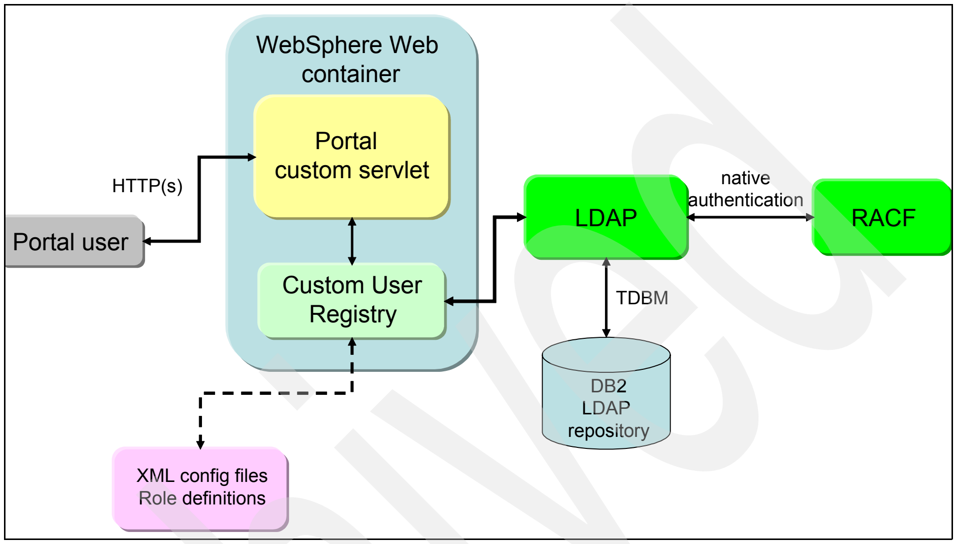


Figure 8-14 Security implementation for WebSphere portal on z/OS

Portal security

WebSphere Portal services requests from users or Web clients by authenticating a user ID and password against the Custom User Registry using the Portal Custom Servlet. It provides the first layer of protection to internal Portal resources, such as portlets, places and pages. For CUR, an authorization table is provided via an XML file.

Several files play an important role here:

- authtable.xml

  This XML file contains the authorizations for each Web application installed on the J2EE server for which the custom user registry is being used to authenticate requests. The authorizations are based on roleName and groupName definitions.

- authtablelist.xml

  This CUR authorization table XML file is used to define the applications and its authorization lists. The authorization table is managed by the administrator to grant users and groups access to the J2EE resources on a per application/portlet basis.

The native authentication feature uses LDAP with TDBM, but from a z/OS perspective, the authentication is actually performed by RACF using all its usual stringent rules. From a management perspective, there is no need for administration of multiple registries or synchronization of passwords.

More importantly, from a WebSphere Portal perspective, RACF users and non-RACF users can be defined in the same LDAP directory and Portal users are unaware of any differences from what is normally done to log into the Portal.

Native authentication allows connection between the LDAP server and RACF wherein the user ID and password that is used to authenticate to LDAP is actually passed to the System Security Server to be verified. This setup allows new Internet or extranet Portal customers to authenticate directly against the LDAP server, while existing RACF Intranet users would be authenticated using their RACF user ID and password.

WebSphere Message Broker

The following elements can be secured at this point:

- *Topic-based security*
  Access to messages on particular topics is controlled using Access Control Lists (ACLs).
- *Authentication services using real-time nodes*
  An authentication protocol is used by a broker and a client application to confirm that they are both valid participants in a session. This is done through *SSL authentication* protocol known as mutual challenge-response password authentication. This protocol is supported by Real Time nodes, HTTP listener and WebSphere MQ java client.
- *Message protection using real-time nodes*
  Message protection provides security options to prevent messages from being read or modified while in transit.

8.3.5 Total Cost of Ownership

Here we present a few examples of the way TCO for the SOA products is decreased. In 2.7, "Analysis of the IBM products available for the SOA on z/OS" on page 30, where we describe in detail the features of the products available as SOA implementation blocks, we show that each version of the product delivers the following benefits:

- Enhancements in *tooling* for development, deployment, maintenance, problem handling and resolution, and general management (for reducing personnel costs in deployment and management)

- Enhancement in *performance* (for reducing consumption, optimizing the resource usage, and improving workload management and distribution)
- Enhancements in *technology* (for improving productivity in using the products)
- Enhancements in *integration* (for reducing costs in integrating the product with the other elements of the SOA architecture; reducing the TCO for the entire SOA platform) WebSphere Message Broker

There are a number of features that improve the TCO for WMB on z/OS. Among others we mention reporting and chargeback through SMF, using zSeries Application Assist Processor (ZAAP) for the Java compute Node, XLST Node, and JMS real-time node. This means that message transformation can offload a significant percentage of its workload to the dedicated zAAP processors. Other performance improvements (in areas like parser, ESQL, aggregation implementation, and others) increase performance and thus reduce the TCO.

WebSphere Application Server

As described before, the TCO in regard to WebSphere Application Server can be reduced by several means.

One of them is by reducing the cost for development, deployment and management through the implementation of JDK 5.0 innovations, a new Automation Toolkit, tight integration with Rational tools, Application Server Toolkit (AST) enhancements, new Console command assistant, and bundle with IBM support assistant.

Another way of enhancing the TCO is by ensuring that the product is more efficient and secure, and that these capabilities are delivered “out of the box” as standard. This was accomplished, among others, through enhancements in scaling and workload prioritization, and the implementation of J2SE™ 5 and zAAP usage.

Yet another way of reducing the TCO is to enable easier integration with other products of the same family and with products of other vendors (this reduces integration costs, implicitly decreasing the TCO). This was accomplished through the implementation of new technologies (SIP servlet support), implementation of the newest Web Services standards (Web Services Notifications WS-N, Web Services Interoperability Basic profile WS-I BSP, enhancements in WS-Security, and others).

8.4 Quality of Service of the SOA architecture

In this section we review the IBM SOA reference architecture, and show which of features contribute to specific areas of QoS. The way in which an application is positioned over the SOA building blocks, and the way in which it exploits the SOA building blocks, “create” QoS features.

The nature of the IBM SOA reference architecture in itself delivers QoS in the following ways:

- Increasing flexibility, by allowing the changing, replacing and new positioning of services (remember that we are in a loose-coupled environment) without touching the other parts of the application.
- Reducing the TCO by reusing services (services have standardized interfaces and therefore the reusability is increased).
- Reducing the “time to market” by having the flexibility to react to any market developments (expand services as required without impacting existing customers; change business rules on the fly, resulting in flexible processes).
- Increasing availability of the application by “cloning” services.
- Building high availability architectures by adding service redundancy.

8.5 QoS and our implementation scenarios

In the following sections we describe how the QoS applies to the various implementation scenarios discussed in Chapter 5, “SOA implementation scenarios” on page 131.

We have defined an *implementation scenario* as a combination of a *transition approach* and one or more *solution techniques*. An example of a transition approach is “Improve” and an example of a solution technique is “CICS Service Flow Feature”.

Each of the solution techniques offers a certain level of QoS in the areas discussed earlier in this chapter, and it is fairly easy to determine those Qualities of Service for an individual solution technique. The challenge, however, is to assess the end-to-end QoS of a combination of solution techniques. For example, if two solution techniques being applied are both highly secure, it does not necessarily follow that the end-to-end solution will be highly secure. As you will see, much depends on the integration capabilities of the solution techniques in terms of QoS.

8.5.1 Scalability in our implementation scenarios

An SOA scales if the end-to-end solution scales. This means that in all layers (hardware, operating system, and middleware) and tiers, the SOA needs to be able to scale. The solution techniques being applied and the environment in which they run (if not a standalone solution) must be scalable.

We describe the scalability attributes of the SOA core products in 8.3.1, “Scalability” on page 283, and here we discuss the individual solution techniques.

Table 8-1 lists each solution technique and shows whether it runs by itself or inside a managed environment (such as WebSphere Application Server or CICS), as well as which scalability characteristics are available.

Table 8-1 Scalability in our solution techniques

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Scalability characteristics**
WebSphere Application Server	Run business application services	Standalone	► WLM enablement ► Clustering of WebSphere Application Servers (ND topology) ► WebSphere Application Server XD features (ODR)
WebSphere Portal	Run user interaction services	WebSphere Application Server	► See WebSphere Application Server
WebSphere ESB	Service integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere Process Server	Process integration	WebSphere Application Server	► See WebSphere Application Server

Solution technique	Tasks accomplished	Managed environment (runs in)	Scalability characteristics
WebSphere MQ	Service integration	Standalone	► WLM enablement ► Clustering of queues
WebSphere Message Broker	Service integration	Standalone	► WLM enablement ► Clustering of brokers within a sysplex
Host Access Transformation Services (HATS)	Service enablement of a 3270 program	WebSphere Application Server	► See WebSphere Application Server
CICS TS V3.1	Run business application services	Standalone	► WLM enablement ► Clustering of CICS servers through CICSPLEX
CICS Service Flow Feature (SFF)	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Web Services Support	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Transaction Gateway (CICS TG)	Service integration	► JCA resource adapter runs in WebSphere Application Server ► CICS TG Daemon runs standalone (only required in remote setup)	► See WebSphere Application Server ► Scalability through implementation of multiple CICS TG Daemons on one or multiple LPARs

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Scalability characteristics**
IMS V9 TM	Run business application services	Standalone	► WLM enablement ► Clustering of IMS servers through IMSPLEX ► Built-in scaling through internal prioritization and workload management
IMS Connect	Service integration	Standalone (runs in its own address space on z/OS)	► Scalability through implementation of multiple IMS Connect address spaces on one or multiple LPARs
IMS MFS Web Services Support	Service enablement	► Service interface runs in WebSphere Application Server ► Service runs in IMS ► IMS Connect used as connector	► See WebSphere Application Server ► See IMS V9 TM ► See IMS Connect
IMS SOAP Gateway	Service enablement	► IMS Soap Gateway does not run on z/OS ► Service runs in IMS ► IMS Connect used as connector	► Depends on Windows/UNIX scalability capabilities ► See IMS V9 TM ► See IMS Connect

Solution technique	Tasks accomplished	Managed environment (runs in)	Scalability characteristics
DB2 (stored procedures)	Run information services	► Service interface runs in WebSphere Application Server (WORF) ► Service runs in DB2 SP	► See WebSphere Application Server ► WLM enablement

8.5.2 Availability in our implementation scenarios

The availability of an SOA depends on the sum of the availability of all the components and services involved. As with scalability, this applies to layers (hardware, operating system, and middleware) and tiers.

The solution techniques being applied and the environment in which they run (if not a standalone solution) must be available. We describe the availability attributes of the SOA core products in 8.3.2, "Availability" on page 291, and here we discuss the individual solution techniques.

Table 8-2 on page 317 lists each solution technique and shows whether it runs by itself or inside a managed environment (such as WebSphere Application Server or CICS), as well as which availability characteristics are available.

Table 8-2 Availability in our solution techniques

Solution technique	Tasks accomplished	Managed environment (runs in)	Availability characteristics
WebSphere Application Server	Run business application services	Standalone	► Clustering of WebSphere Application Server (ND topology) ► Automatic Restart Manager (ARM) ► WebSphere Application Server XD features, such as ODR and application versioning
WebSphere Portal	Run user interaction services	WebSphere Application Server	► See WebSphere Application Server
WebSphere ESB	Service integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere Process Server	Process integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere MQ	Service integration	Standalone	► WebSphere MQ shared queues ► Clustering of queues

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Availability characteristics**
WebSphere Message Broker	Service integration	Standalone	► Clustering of brokers within a sysplex ► See WebSphere MQ for MQ-related availability features
Host Access Transformation Services (HATS)	Service enablement of a 3270 program	WebSphere Application Server	► See WebSphere Application Server
CICS TS V3.1	Run business application services	Standalone	► CICS Parallel Sysplex Manager (CPSM) ► Transaction mirroring
CICS Service Flow Feature (SFF)	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Web Services Support	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Transaction Gateway (CICS TG)	Service integration	► JCA resource adapter runs in WebSphere Application Server ► CICS TG Daemon runs standalone (only required in remote setup)	► See WebSphere Application Server ► Availability through implementation of multiple CICS TG Daemons on one or multiple LPARs
IMS V9 TM	Run business application services	Standalone	► Clustering of IMS servers through IMSPLEX

Solution technique	Tasks accomplished	Managed environment (runs in)	Availability characteristics
IMS Connect	Service integration	Standalone (runs in own address space on z/OS)	► Availability through implementation of multiple IMS Connect address spaces on one or multiple LPARs
IMS MFS Web Services Support	Service enablement	► Service interface runs in WebSphere Application Server ► Service runs in IMS ► IMS Connect used as connector	► See WebSphere Application Server ► See IMS V9 TM ► See IMS Connect
IMS SOAP Gateway	Service enablement	► IMS Soap Gateway does not run on z/OS ► Service runs in IMS ► IMS Connect used as connector	► Depends on Windows/UNIX availability capabilities ► See IMS V9 TM ► See IMS Connect

8.5.3 Reliability in our implementation scenarios

We describe the reliability attributes of the SOA core products in 8.3.3, "Reliability" on page 292, and here we discuss the individual solution techniques.

Table 8-3 on page 320 lists each solution technique and shows whether it runs by itself or inside a managed environment (such as WebSphere Application Server or CICS), as well as which reliability characteristics are available.

Table 8-3 Reliability in our solution techniques

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Reliability characteristics**
WebSphere Application Server	Run business application services	Standalone	► Built-in transaction management ► Resource Recovery Services (RRS) for global transaction coordination
WebSphere Portal	Run user interaction services	WebSphere Application Server	► See WebSphere Application Server
WebSphere ESB	Service integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere Process Server	Process integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere MQ	Service integration	Standalone	► Resource Recovery Services (RRS) for global transaction coordination ► WebSphere MQ functions to guarantee message delivery
WebSphere Message Broker	Service integration	Standalone	► See WebSphere MQ for MQ-related reliability features

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Reliability characteristics**
Host Access Transformation Services (HATS)	Service enablement of a 3270 program	WebSphere Application Server	► See WebSphere Application Server
CICS TS V3.1	Run business application services	Standalone	► Built-in CICS transaction management
CICS Service Flow Feature (SFF)	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Web Services Support	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Transaction Gateway (CICS TG)	Service integration	► JCA resource adapter runs in WebSphere Application Server ► CICS TG Daemon runs standalone (only required in remote setup)	► See WebSphere Application Server ► Reliability through 2-Phase Commit support (RRS)
IMS V9 TM	Run business application services	Standalone	► Built-in IMS transaction management
IMS Connect	Service integration	Standalone (runs in own address space on z/OS)	► Reliability through 2-Phase Commit support (RRS)

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Reliability characteristics**
IMS MFS Web Services Support	Service enablement	► Service interface runs in WebSphere Application Server ► Service runs in IMS ► IMS Connect used as connector	► See WebSphere Application Server ► See IMS V9 TM ► See IMS Connect
IMS SOAP Gateway	Service enablement	► IMS Soap Gateway does not run on z/OS ► Service runs in IMS ► IMS Connect used as connector	► Depends on Windows/UNIX availability capabilities ► See IMS V9 TM ► See IMS Connect

8.5.4 Security in our implementation scenarios

Security is a complex topic, and each solution technique has numerous security aspects, so here we can only provide the highlights for each solution technique.

Table 8-3 on page 320 lists each solution technique and shows whether it runs by itself or inside a managed environment (such as WebSphere Application Server or CICS), as well as which security characteristics are available.

Table 8-4 Security in our solution techniques

Solution technique	Tasks accomplished	Managed environment (runs in)	Security characteristics
WebSphere Application Server	Run business application services	Standalone	► Full J2EE and Java security ► Web Services security ► Authorization and authentication supported by LDAP or RACF ► Encryption supported by hardware crypto ► Thread-level security (when local) ► Single Sign On ► CSIv2 support for RMI-IIOP requests
WebSphere Portal	Run user interaction services	WebSphere Application Server	► See WebSphere Application Server
WebSphere ESB	Service integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere Process Server	Process integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere MQ	Service integration	Standalone	► Queue authorization and authentication ► Thread-level security (when local)

Solution technique	Tasks accomplished	Managed environment (runs in)	Security characteristics
WebSphere Message Broker	Service integration	Standalone	► See WebSphere MQ for MQ-related security features
Host Access Transformation Services (HATS)	Service enablement of a 3270 program	WebSphere Application Server	► See WebSphere Application Server
CICS TS V3.1	Run business application services	Standalone	► CICS security
CICS Service Flow Feature (SFF)	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Web Services Support	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Transaction Gateway (CICS TG)	Service integration	► JCA resource adapter runs in WebSphere Application Server ► CICS TG Daemon runs standalone (only required in remote setup)	► See WebSphere Application Server ► Encryption ► Authentication ► Thread-level security (when in same LPAR)
IMS V9 TM	Run business application services	Standalone	► IMS security
IMS Connect	Service integration	Standalone (runs in own address space on z/OS)	► Authentication ► Thread-level security (when in same LPAR)

Solution technique	Tasks accomplished	Managed environment (runs in)	Security characteristics
IMS MFS Web Services Support	Service enablement	► Service interface runs in WebSphere Application Server ► Service runs in IMS ► IMS Connect used as connector	► See WebSphere Application Server ► See IMS V9 TM ► See IMS Connect
IMS SOAP Gateway	Service enablement	► IMS Soap Gateway does not run on z/OS ► Service runs in IMS ► IMS Connect used as connector	► Depends on Windows/UNIX availability capabilities ► See IMS V9 TM ► See IMS Connect

8.5.5 TCO in our implementation scenarios

A realistic TCO assessment requires the examination of multiple aspects of a solution, such as hardware utilization cost, software license cost, operational cost, maintenance cost, skill maintenance and so on. It is beyond the scope of this IBM Redbook to review each solution technique using those aspects, nor would any result be accurate without benchmarking.

What we can show, however, is the usage level of specialty processors in each solution technique; see Table 8-5 on page 326. This will give you the opportunity to compare solution techniques for this aspect. For example, the usage level of specialty processors such as the zAAP will influence the TCO significantly.

Table 8-5 Total Cost of Ownership: specialty processor usage

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Specialty processor usage**
WebSphere Application Server	Run business application services	Standalone	► Most system code and application code qualifies to run on zAAP ► Average usage between 60% and 70%
WebSphere Portal	Run user interaction services	WebSphere Application Server	► See WebSphere Application Server
WebSphere ESB	Service integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere Process Server	Process integration	WebSphere Application Server	► See WebSphere Application Server
WebSphere MQ	Service integration	Standalone	► No zAAP usage
WebSphere Message Broker	Service integration	Standalone	► Java Compute Node code qualifies for zAAP.
Host Access Transformation Services (HATS)	Service enablement of a 3270 program	WebSphere Application Server	► See WebSphere Application Server
CICS TS V3.1	Run business application services	Standalone	► CICS Java programs qualify for zAAP.
CICS Service Flow Feature (SFF)	Service enablement	CICS TS V3.1	► See CICS TS V3.1

Solution technique	**Tasks accomplished**	**Managed environment (runs in)**	**Specialty processor usage**
CICS Web Services Support	Service enablement	CICS TS V3.1	► See CICS TS V3.1
CICS Transaction Gateway (CICS TG)	Service integration	► JCA resource adapter runs in WebSphere Application Server ► CICS TG Daemon runs standalone (only required in remote setup)	► No significant zAAP usage
IMS V9 TM	Run business application services	Standalone	► IMS Java transactions qualify for zAAP
IMS Connect	Service integration	Standalone (runs in its own address space on z/OS)	► No significant zAAP usage
IMS MFS Web Services Support	Service enablement	► Service interface runs in WebSphere Application Server ► Service runs in IMS ► IMS Connect used as connector	► See WebSphere Application Server ► See IMS V9 TM ► See IMS Connect
IMS SOAP Gateway	Service enablement	► IMS Soap Gateway does not run on z/OS ► Service runs in IMS ► IMS Connect used as connector	► Not applicable ► See IMS V9 TM ► See IMS Connect

8.6 Managing QoS with SOA on z/OS

The ability to manage an SOA is a Quality of Service by itself (manageability). And again, this is a QoS in which the System z platform is very strong. However, in order to manage an SOA, you need more than hardware and operating system features. You also need to be able to manage the different levels in the entire architecture, from hardware to business process.

In 2.4.11, “IT Services Management Services” on page 26, we highlight the necessity of having tools that manage the new infrastructure, and discuss some Tivoli offerings. But more than simply managing every piece of the SOA infrastructure, you can manage the application as a whole.

Using the existing tooling, you should be able to answer such questions as:

- Which services (Web services) did not fulfill the defined service level agreement (SLA)?
- How many services of a specific type were executed during a specific time interval?
- What was the workload of services during a specific time interval?
- Which security policies are implemented at this moment?
- Which users accessed a specific Web service during a specific time interval?

Figure 8-15 on page 329 shows, as an example, the way in which Tivoli products cooperate and integrate themselves in the SOA architecture in order to manage the QoS of the applications in the areas of identity management, policy management, and access management. The lower layer represents the management portal, in which all QoS information consolidation and presentation takes place.

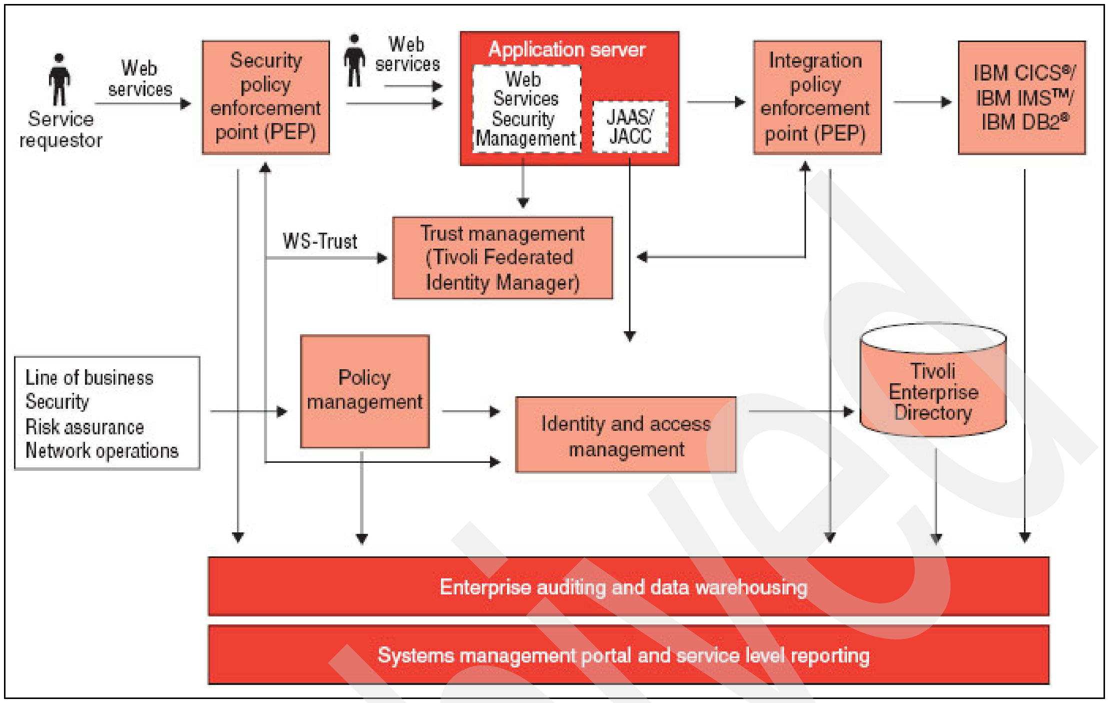

Service requestor
Web services
Security policy enforcement point (PEP)
Web services
Application server
Web Services Security Management
JAAS/ JACC
Integration policy enforcement point (PEP)
IBM CICS®/ IBM IMS™/ IBM DB2®
WS-Trust
Trust management (Tivoli Federated Identity Manager)
Line of business
Security
Risk assurance
Network operations
Policy management
Identity and access management
Tivoli Enterprise Directory
Enterprise auditing and data warehousing
Systems management portal and service level reporting

Figure 8-15 Tivoli products deliver management of Quality of Service

8.7 Conclusion

The Quality of Service delivered by a SOA architecture positioned on z/OS can be seen as a combination of features from the platform, the operating system, the products, and the SOA architecture itself.

This chapter also covered the means for managing (monitoring, administering, reporting) the Quality of Service features.

9

SOA enablement case studies

In this chapter we present two case studies of SOA enablement on z/OS. The studies involve different industries, and they each have a variety of side objectives and different solution scenarios.

In 9.1, “SOA enablement case study 1: IBM Life Insurance Solution Showcase” on page 332, we present an SOA enablement case study in the insurance industry.

In 9.2, “Case study 2: a financial institution deploying a large-scale SOA solution based on Web services” on page 366, we present an SOA enablement case study in the banking industry.

9.1 SOA enablement case study 1: IBM Life Insurance Solution Showcase

The IBM Life Insurance Solution Showcase provides a demonstration of Service Oriented Architecture in an insurance industry context. Its infrastructure integrates the functions of multiple Independent Software Vendors (ISVs) and IBM strategic software on multiple platforms.

It is implemented as a Variable Universal Life (VUL) policy sales demonstration and a production scale infrastructure demonstration running a realistic load of VUL sales plus other insurance industry background workloads. The production scale infrastructure showcase includes scenarios for capacity upgrades and outage situations, and the activity is monitored live for the audience during a briefing.

The showcase focuses on *automating the business process* of selling VUL insurance products, thereby reducing the 28-day long process to a process that can be done (for the simple case) in 30 minutes or so. There is great business value in the ability to sell and issue a policy to a client in one visit, because it results in higher sales by reducing the chance that a client will decide against buying a policy (the “not taken” rate). The showcase demonstrates that SOA technology can be applied to make business processes more efficient and flexible, and can directly result in higher revenues, faster speed to market, and lower costs.

Although this showcase demonstration involves selling variable life insurance policies, the underlying IT architectural principles are applicable to the other business scenarios, as well.

9.1.1 SOA in an insurance industry context

SOA benefits can be applied to virtually any industry setting. However, the insurance industry faces competitive and efficiency pressures, as listed here, which drive customers to give serious consideration to the architecture:

- Improved speed to market
- Competitive pressure
- Changing regulations and business processes
- Mergers and acquisitions
- Cost efficiency and outsourcing

The showcase makes the point that customers can use SOA technologies to improve speed, efficiency, and flexible change to meet increasingly demanding business environments.

9.1.2 The business problem

The VUL application in the showcase is the automation of the multiple step business process that is used to sell variable life insurance. Without automation, the process is a manually-intensive coordination of many applications via independent and different user interfaces, coupled with the requisite handling of paper between many of the steps. The manual process has the following issues that need to be addressed:

- Eliminate delays caused by postal mail between agent, customer, and main office.
- Eliminate errors caused by multiple points of data reentry and multiple user interfaces.
- Provide the means to measure the effectiveness of marketing campaigns.
- Provide the means to control and monitor process adherence.

The enterprise has the following requirements:

- Leverage/reuse/integrate existing IT capability and skills.
- Provide the infrastructure to enable the company to be agile and responsive to constantly changing business processes and market dynamics.
- Provide minimum risk (that is, preference for evolutionary versus revolutionary change, keep the business running during change, do not break the business while changing).
- Reduce the Total Cost of Ownership (TCO).

9.1.3 Enterprise view

The enterprise view of the architecture is the high level description of how the services are delivered, as shown in Figure 9-1 on page 334.

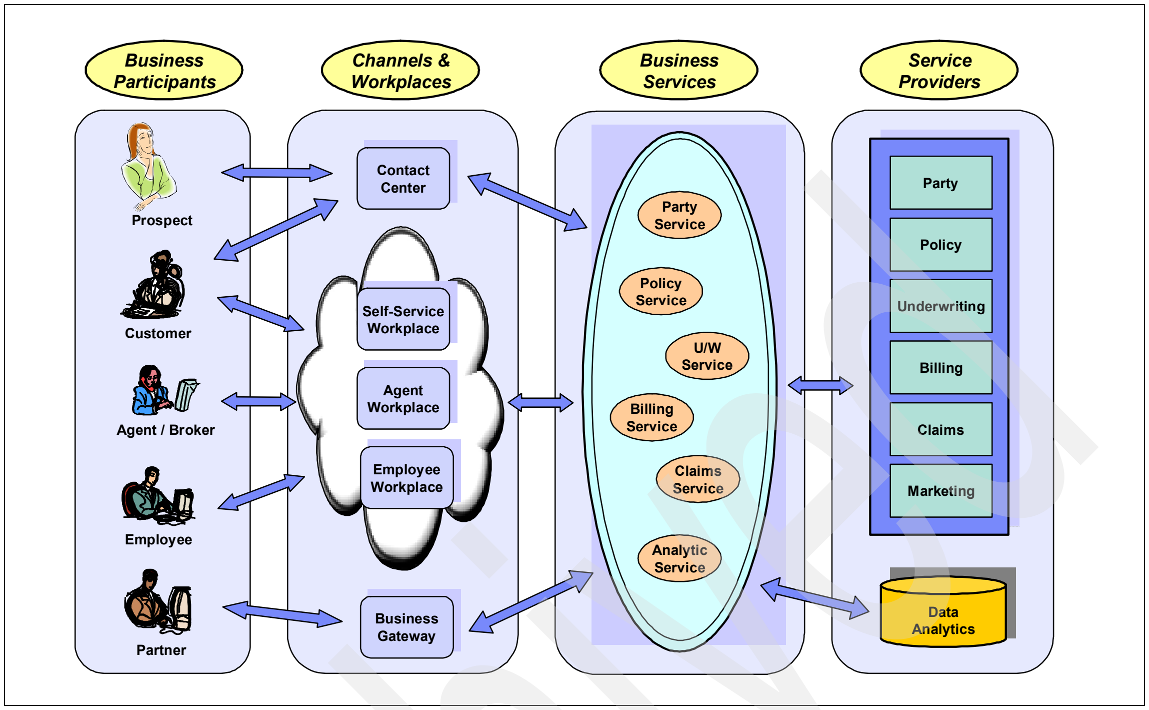


Figure 9-1 The enterprise view of the IBM Life Insurance Showcase

The enterprise view of the IBM Life Insurance Showcase blends business and application concepts with architectural aspects in a layered view including business participants, channels and workplaces, business services, and service providers.

It follows the style of a Service Oriented Architecture where an application is composed of the orchestration of a set of services, supplied by service providers.

- Business participants
  The participants can be individuals or computer systems that need to interact with the business services of the insurance carrier.
- Channels and workplaces
  The participants interact with the business services through a “channel” that is responsible for providing and controlling access appropriate to the participant's needs.
- Business devices
  Business services are grouped into sets of discrete actions that must be performed as part of working within the insurance company. Business services may be implemented by one or more service providers. A business service may be composed of interacting with one or more service provider.

- Service providers
  Service providers are applications and components that perform the “back office”-level work.

9.1.4 Application architecture

The application architecture defines and describes the application concepts and capabilities used in designing the application. These concepts and capabilities are necessary in applying technology to business design such that it supports separation of concerns, minimizes technical duplication, maximizes sharing, utilizes a common infrastructure, and supports independent construction of applications and components as well as integration. It is the application architecture that provides a solution or application to the business needs.

The application architecture provided by the IBM SOA for Insurance Reference Architecture is a slightly modified version of the layered IBM SOA Center of Excellence solution stack. In this more technical view, the application architecture firmly supports the separation of concerns through layering. It is the responsibility of the application architecture to define the application principles necessary to guide and govern enterprise application development and maintenance.

Requirements

The IBM Life Insurance Showcase use case of “Sell Variable Life Insurance” requires the following:

- Reuse of the existing party infrastructure - presume that the insurance company already has WebSphere Customer Center product installed.
- Reuse of the existing policy infrastructure - presume that the insurance company already has LiDP “The Administrator” product installed.
- Eliminate data reentry between tasks - automate the data passing between the applications.
- Enable future channels - the agent workplace is the first channel; others will come geared towards clerks, help desks, and so on.
- Enable regulatory compliance/auditing - there are regulatory requirements that must be met or proved in the selling of any investment.
- Enable rapid deployment of new offerings - the process for selling does not vary between types of offering; what changes is the offering *content*.
- Enable targeted offerings - offerings that are geared towards a given set of clients are “targeted”. A list of targets requires analysis of data against some criteria.

- Eliminate paper (and associated delays) - self-evident, unless there is a regulatory requirement for paper, or unless the use of electronic means of data transfer between parties is preferred.
- Enable measurements - provide a means to measure the process of selling insurance using a business dashboard.
- Minimize human procedural errors - humans take shortcuts, forget things, and lack knowledge.
- Minimize human interactions - eliminate mundane or repeatable tasks, maximize the time for the humans to do what cannot be automated.

Non-functional requirement (NFRs)

An internal IBM study conducted by IBM Global Business Solutions focused on insurance industry non-functional system requirements and produced 23 categories that a technical architecture must deliver. The IBM Life Insurance Solution Showcase helps to show how SOA architecture in an insurance context addresses the highest priority areas, as follows:

- Productivity
  The degree to which a system or component aids or impedes the effectiveness and efficiency of the user or business process. Productivity is typically quantified by measuring the elapsed time from start to end of a user performing a specific business process or scenario, including user talk and think time.
- Performance
  The degree to which a system or component accomplishes its designated functions within given constraints. Performance is typically quantified by averaging the elapsed times from start to end of a particular system transaction. This measurement of responsiveness can be measured from the user or component perspective.
- Capacity
  The requirement to have adequate resources available for the workload to complete in an appropriate time. Capacity is typically quantified by measuring peak utilization of system components and total throughput of a particular type of workload over a period of time.
- Scalability
  The degree to which a system or component can increase throughput capacity by adding additional resources in an effort to maintain performance objectives.
- Availability
  The system's readiness for use. Availability is typically quantified by the percent of time that the system is ready for use.

- Recoverability
  The ability to put the system back into a ready or usable state after a failure.
- Security
  The solution's ability to provide secure management of systems access and data.

With the exception of security, the workload scenarios are geared to highlight how the solution can contribute to each area.

Decisions

The SOA for Insurance Reference Architecture dictates the application architecture, as shown in Figure 9-2, for the IBM Life Insurance Solution Showcase. The design decisions for implementing these layers are noted in the text that follows.

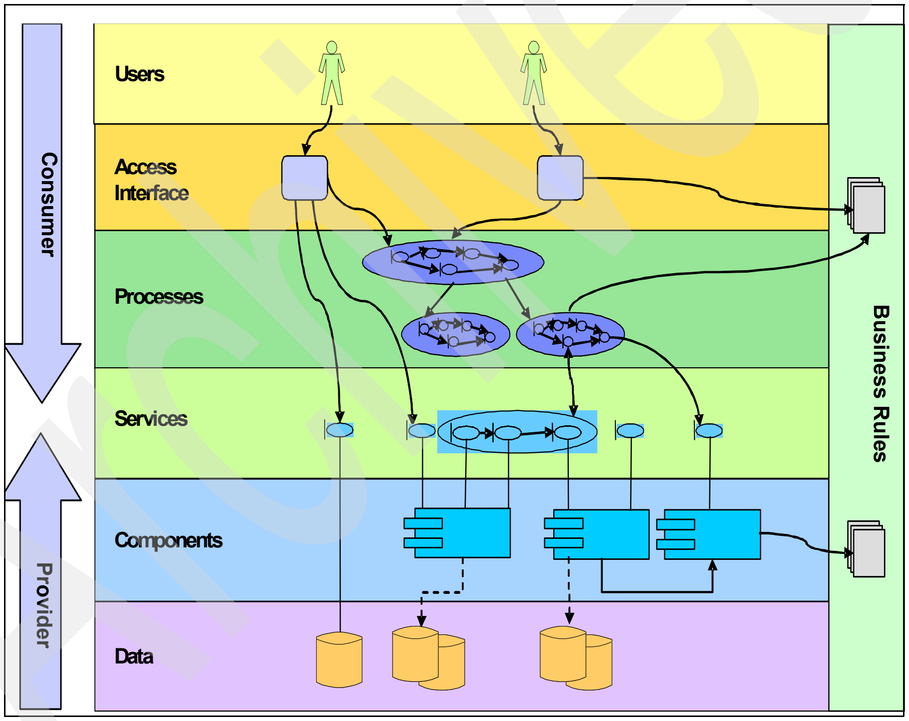


Figure 9-2 The IBM Life Insurance Solution Showcase application architecture

The IBM Life Insurance Solution Showcase application architecture follows a layered structure where applications are no longer provided by monolithic products, but by the orchestration of services.

The multiple layers shown in Figure 9-2 on page 337 create a separation of concerns that address the requirement set, as explained here.

Access interface layer
This layer provides the view into the IT systems for different users. This enables the development of different channels. The Life Solution uses the framework provided by IBM WebSphere Portal and LDAP for security.

Processes layer
This layer provides a definition of what tasks, in what order, under what conditions, need to be accomplished by what resource (user or system). This enables procedural control and monitoring. It also enables the elimination of data reentry by using a user interface to capture data once, and then “push it around” using the business process logic.

The Life Solution uses Business Process for Execution Language for Web Services (BPEL4WS) for this process modeling as provided by IBM WebSphere Business Integration Server Foundation. (In the next phase of the application, the BPEL engine will use WebSphere Process Server).

Services layer
This layer separates what needs to be done from its implementation. This enables the aggregation of existing infrastructure with new infrastructure, speeds deployment of new implementation, and standardizes interfaces to functions. ACORD[1] messages will be used as the definition of data messages that are passed around; this helps to simplify the composition of services for insurance.

The implementation of the services is a design decision; the Life Solution used Simple Object Access Protocol (SOAP) over HTTP for those services called by the business process. Other services used HTTP messages.

Component layer
This layer provides the implementation of the service which in this reference implementation provides the “home” to existing “traditional” (monolithic) products. This layer is required to provide a services interface in SOAP over HTTP, or work through a service layer provided for it.

One vender product has a proprietary socket interface that was wrapped by a service interface written by the system integration team. Other products created service layers that met the specifications of the demonstration process. Some other products already supported a service interface that accepted ACORD messages.

[1] ACORD, or the Association for Cooperative Operations Research and Development, is a global, nonprofit insurance association whose mission is to facilitate the development and use of standards for the insurance, reinsurance, and related financial services industries.

Data layer
This layer is the home to all of the data used in the organization. Data should be accessed via some sort of service layer to provide a means to enable control access and change.

The IBM Life Insurance Solution Showcase used DB2 Content Manager to serve as the electronic repository for all the binary representation of what used to be paper, Agent information in LiDP, and WebSphere Customer Center for the client database.

Business rules
This provides a codification of business level controls separate from the procedural flow. This enables the business to deploy variants to a business process, without deploying a new process.

The IBM Life Insurance Solution Showcase used several products that provided “rules”; Allfinanz xpertBridge (an underwriting product) has external XML files that define the underwriting rules; LiDP has a proprietary mechanism that defines policy rules.

Access interface (channel and workplaces)

The channel architecture includes the definition and description of enterprise-level concepts and capabilities of the channels and system interfaces that connect business participants to the business and IT systems throughout the enterprise.

A channel, used more commonly to describe access to the business, is comprised of both logical (agent or direct) as well as more physical channel mediums (in person or phone). An actor interface, used more commonly to describe IT level access, is comprised of various human interfaces as well as system-to-system interfaces.

The Life Solution was required to:

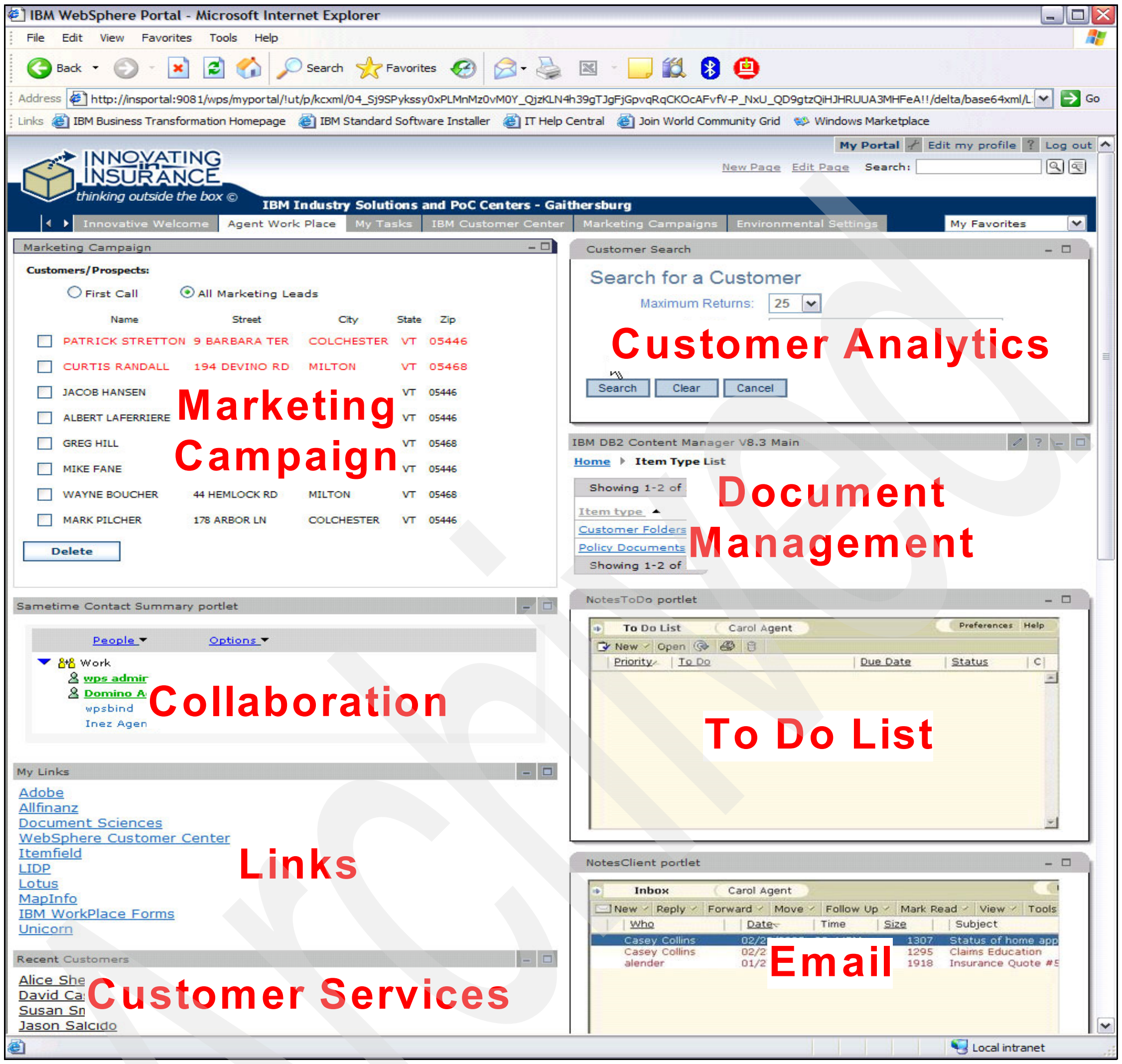
- Demonstrate that users can have a centralized environment from which to coordinate the different activities required by their role.
- Demonstrate that different users can have different views based upon different roles.
- Use Internet standard implementation (HTTP, Web browser, thin client-based solution).
- Use IBM products and selected IBM business partner ISV products.
- Use standards-based messages (ACORD).
- Provide a Web services interface.

The Showcase uses the IBM WebSphere Portal Server. This ensures that the user interface would be based on Internet standard implementations, and that it used the aggregation capabilities of a portal to provide users with a “workplace” (collection of portlets) that suits that the user's role.

When users access the system with single sign-on, the credential of the user is propagated to the business process component. The security information is stored in an LDAP server.

With this approach, the same portlet (capability) can be reused for different roles. For instance, a “view policy” portlet is the same for both insurance agents and clients; the difference is that insurance agents can use the same portlet to see the policies for any of their clients, but clients are restricted to viewing only their own policies.

The IBM Life Insurance Solution Showcase implemented the Agent Work Place, which is a single environment to be used to access the business services required to accomplish their role as insurance agent; see Figure 9-3 on page 341.



Customers/Prospects:

First Call [✓ All Marketing Leads]

Name	Street	City	State	Zip
PATRICK STRETTON	9 BARBARA TER	COLCHESTER	VT	05446
CURTIS RANDALL	194 DEVINO RD	MILTON	VT	05468
JACOB HANSEN			VT	05446
ALBERT LAFERRIERE			VT	05446
GREG HILL			VT	05468
MIKE FANE			VT	05446
WAYNE BOUCHER	44 HEMLOCK RD	MILTON	VT	05468
MARK PILCHER	178 ARBOR LN	COLCHESTER	VT	05446

My Links: Adobe, Allfinanz, Document Sciences, WebSphere Customer Center, Itemfield, LIDP, Lotus, MapInfo, IBM WorkPlace Forms, Unicorn

Figure 9-3 Agent Work Place user interface

Existing business process flow

The following is an approximation of the manual business process that the Life Insurance Solution automates:

1. The Innovating in Insurance Company uses analytic software from Mapinfo combined with client records from its client database (WebSphere Customer Center) to send out a marketing campaign letter to a set of existing clients.

2. Individual agents receive a printed list of clients to call on to sell a new Variable Life Insurance Policy - a life insurance policy backed by stocks or stock funds.
3. Either the client contacts the agent, or the agent contacts the client.
4. The agent interviews the clients to collect the parameters to generate an *illustration* (an illustration shows the potential value of an investment over a period of time and set of economic assumptions).
5. The following steps are required to generate an illustration:
    a. Enter the parameters into the policy administration system (LiDP).
    b. LiDP generates the illustration.
6. The secretary prints the illustration.
7. The secretary packages it with other required “boilerplate” documentation.
8. The agent gives it to the client for review.
9. The client reviews the illustration. If clients want to continue with the purchase, they must first sign the illustration document acceptance agreement (a regulatory requirement).
10. The agent then assists the client in completing an insurance application.
11. The insurance application is sent to the home office for processing:
    a. The secretary enters the application information into the policy administration system (LiDP).
    b. The secretary updates the client records to reflect the pending insurance sale (WebSphere Customer Center).
    c. The secretary sends the application to an underwriter for review and approval.
12. The underwriter notifies the client for any requests for clarification via mail.
13. Client provides clarification via postal mail or e-mail:
    a. This step could include arranging for medical appointments, release of medical records, and so on).
14. Iterate until the underwriter can make a determination.
15. If the underwriter does not approve; a rejection letter is sent to the client.
16. If the underwriter approves:
    a. The secretary assembles a policy package containing all the prior pieces of data, plus the requisite legal “boilerplate” and sends that to the client.
    b. The client is required to sign the policy (to enter into a contract with the Insurance company) and make the initial payment to bind the contract.

Process model of IBM Life Insurance Solution Showcase

A *process* is a standardized, coordinated set and flow of activities and sub-processes which collectively realize a business objective or policy goal. A *business process* defines the flow between business activities (the smallest unit of work meaningful to a business person).

The existing manual business process was analyzed with the help of tools like WebSphere Business Modeler. A set of processes and sub-processes are identified. BPEL4WS is used to describe the flow of activities among them. An interaction diagram is also used during the design stage to visualize the data flow between the processes; see Figure 9-4.

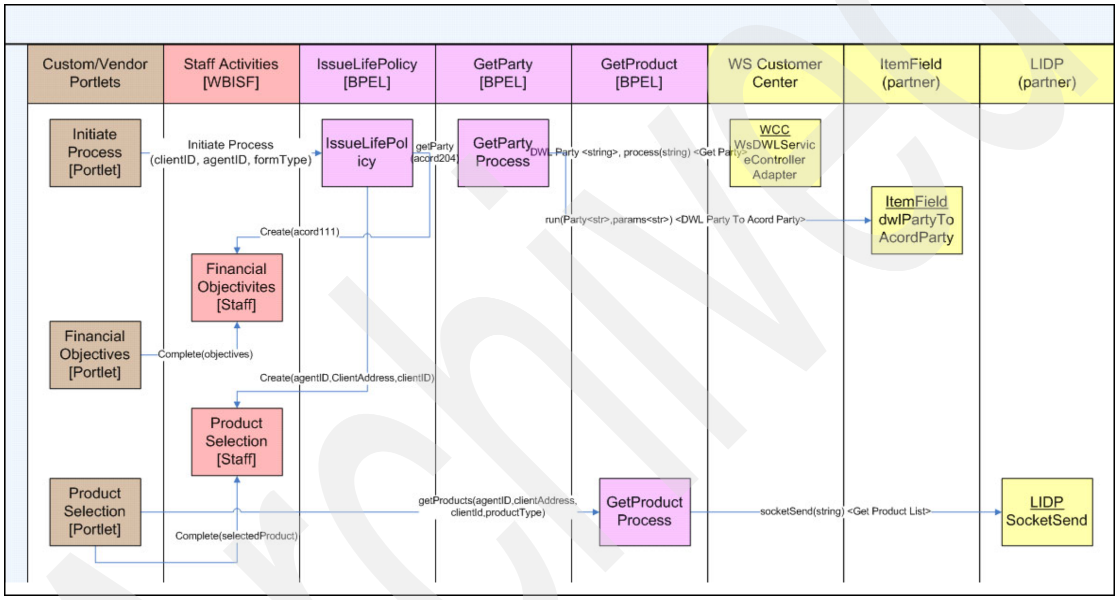

Custom/Vendor Portlets
Staff Activities [WBISF]
IssueLifePolicy [BPEL]
GetParty [BPEL]
GetProduct [BPEL]
WS Customer Center
ItemField (partner)
LIDP (partner)
Initiate Process [Portlet]
Initiate Process (clientID, agentID, formType)
IssueLifePolicy
getParty (acord204)
GetParty Process
DWL Party <string>, process(string) <Get Party>
WCC WsDWLServiceController Adapter
run(Party<str>,params<str>) <DWL Party To Acord Party>
ItemField dwlPartyToAcordParty
Create(acord111)
Financial Objectivites [Staff]
Financial Objectives [Portlet]
Complete(objectives)
Create(agentID,ClientAddress,clientID)
Product Selection [Staff]
Product Selection [Portlet]
getProducts(agentID,clientAddress, clientId,productType)
GetProduct Process
socketSend(string) <Get Product List>
LIDP SocketSend
Complete(selectedProduct)

Figure 9-4 Part of the interaction diagram for the showcase

After analysis, the following processes are identified:

- `GetParty`
- `IssueLifePolicy`
- `GetProposal`
- `GetProduct`
- `CreateIllustration`
- `UpdateApplication`
- `UnderwritePolicy`
- `ManuallyUnderWrite`
- `CreatePolicyPackage`
- `ReceivePayment`

We used WebSphere Studio Application Developer Integration Edition to design these processes, which utilize the services exposed in the service layer. In a WebSphere Process Server version of this solution, this task would have been done with WebSphere Integration Developer (WID).

Services and component model

A *service* is a software resource with an externalized specification. This service specification is available for search, bind, and invocation by a service consumer.

A *service component* is a realization of a subsystem, a logical grouping of functionally cohesive business-aligned services, which is important enough to the enterprise to be managed and governed as an enterprise asset.

Table 9-1 lists the services provided to the business process model, as well as their corresponding service components.

Table 9-1 List of services to support the business model

Services component	Services provided
Party	► `Get Party` ► `addPartyInteraction` ► `addContact` ► `updateContact`
Policy	► `getProductList` ► `generateProposal` ► `createNewBusinessRecord` ► `updateBusinessRecord` ► `issuePolicy`
Underwriting	► “simple” underwriting ► `getUWresult`
Illustration	► Create illustration
Documentation	► Compose document ► Update document ► Store document ► Creation forms ► Sign forms electronically
Geospatial	► Provide geospatial information for sales analysis
User Interaction	► Single Sign On
Data Mediation	► `DWLPartyToAcordParty` ► `Acord103toDWL` ► `DWLResponsetoUpdate`

One requirement of the showcase is to reuse the existing infrastructure provided by ISVs. For example, the Policy service component is already provided by LiDP.

The lineup of service components and their realization is as follows:

Party component
This component is used for the creation, reading, update, and deletion of the data associated with the “parties” (that is, clients, agents, and so on) who are participants in the business processes. The WebSphere Customer Center product is used to provide this functionality. Persistence is provided by DB2 hosted on zOS.

Policy service component
This component is related to insurance policies. It is realized by LiDP, but an insurance carrier can have multiple such policy service providers, each geared towards specific policy “types”. Other ISV products that manage other types of policies will be considered in the future.

Underwriting Service component
This component is used to perform (life) insurance underwriting. It is implemented by Allfinanz.

Illustration Service component
This component is used to create illustrations. It is implemented by LiDP, but can be other illustration calculators. This component relies on the documentation service for formatting and presentation.

Documentation Service component
This component is used to create, update, handle, store, and manage documents within the insurance company. It is a composite of subsystems implemented by Document Science, IBM Workplace Forms™, Adobe, and DB2 Content Manager.

The Adobe PDF format was decided upon to display to end users because of the ubiquity of the Adobe PDF viewer on most personal computers. However, using this format for form presentation and capture was not required.

Document creation and update is the responsibility of Document Sciences, which generates PDF files and requires the functionality of Adobe Form Server to help deal with the differences between how Adobe versus IBM Workplace Forms provide electronic signatures that are stored within the PDF file.

Document storage is the responsibility of DB2 Content Manager, which is used to store documents and forms used through the process. In addition, Adobe uses it to store the templates of the forms; IBM Workplace Forms opted not to deploy in this fashion for the demonstration. The document life cycle management capabilities of DB2 Content Manager were not exploited in the demonstration deployment.

There are two different approaches to human interaction, using Adobe or using IBM Workplace Forms. Each provides electronic form creation, data capture and human interaction (for example, fill in the box, sign here, and so on).

- Adobe uses a product called Adobe Document Server to assemble forms from a set of templates stored in DB2 Content Manager. For the demonstration, a custom portlet was written that presented a series of screens to do form data capture (instead of using the capabilities of the Adobe browser plug-in). The Adobe browser plug-in was only used to support electronic signature capture and for final document display.
- IBM Workplace Forms uses an XML “package” that is rendered by a browser plug-in. The demonstration portlet was responsible for creating the XML package and sending to the IBM Workplace Forms browser plug-in. The package contains everything, including MIME encoded attachments, needed to provide an audit trail of what was electronically signed for.

  (The approach also provides for offline work, but this capability was not demonstrated.) IBM Workplace forms rely on a document converter to generate the required PDF structures for electronic signatures.

Geospatial Service component
This component is used for providing geospatial information. The IBM Life Insurance Solution Showcase demonstration is predicated on geographic data, income information, and other demographics being analyzed together to select potential sales leads for a new variable life insurance offering.

Data Mediation component
This component is used for the translation of message data between components. ItemField provides this functionality. In early phases, this was embedded as a discrete step in the business process flow. In the current phase, the ItemField function was extracted and made into a separate Web service component to create a service interface for general use.

User Interaction Service component
This component is used to provide a user interface. This is implemented primarily by WebSphere Portal for the visual functions, and the WebSphere Business Integration - Server Foundation for process-related actions.

Security component
This component provides control over user access and authorization. Portal security using LDAP running on z/OS was used in this implementation to authenticate users.

Process Orchestration component
This component is used for controlling and tracking the assignment of work to a resource. IBM WebSphere Business Integration - Server Foundation, which was provided as part of the IBM WebSphere Portal Server distribution, served as the implementation. It was deployed on z/OS.

Figure 9-5 on page 348 shows the component architecture of the IBM Life Insurance Solution Showcase.

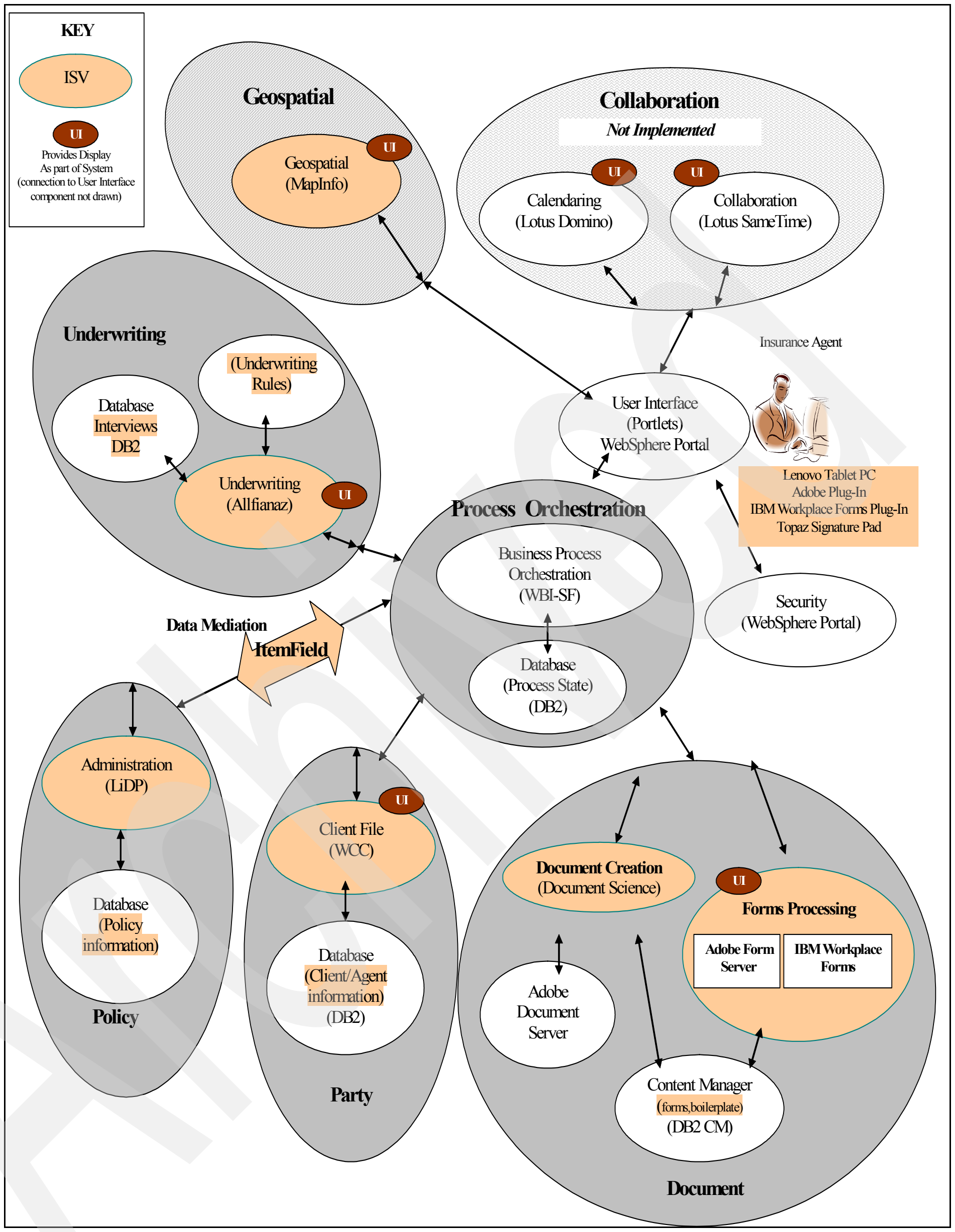

KEY
ISV
UI
Provides Display As part of System (connection to User Interface component not drawn)
Geospatial
Geospatial (MapInfo)
Collaboration
Not Implemented
Calendaring (Lotus Domino)
Collaboration (Lotus SameTime)
Underwriting
(Underwriting Rules)
Database Interviews DB2
Underwriting (Allfianaz)
Insurance Agent
User Interface (Portlets) WebSphere Portal
Lenovo Tablet PC
Adobe Plug-In
IBM Workplace Forms Plug-In
Topaz Signature Pad
Process Orchestration
Business Process Orchestration (WBI-SF)
Database (Process State) (DB2)
Security (WebSphere Portal)
Data Mediation
ItemField
Administration (LiDP)
Database (Policy information)
Policy
Client File (WCC)
Database (Client/Agent information) (DB2)
Party
Document Creation (Document Science)
Forms Processing
Adobe Form Server
IBM Workplace Forms
Adobe Document Server
Content Manager (forms,boilerplate) (DB2 CM)
Document

Figure 9-5 Component Architecture - IBM and ISV products comprising each component

Protocol between business process and service components

SOAP over HTTP was chosen since it is most widely available among the ISVs. However, one vender product supports only ACORD/TCPIP but not SOAP/HTTP. Moreover, its TCP socket implementation is not multi-threaded, so multiple ports are opened, one for each thread.

Managing which port to connect is the job of the service consumer. We developed a J2C connector with connection management so that the business process can invoke the service using SOAP/HTTP; see Figure 9-6.

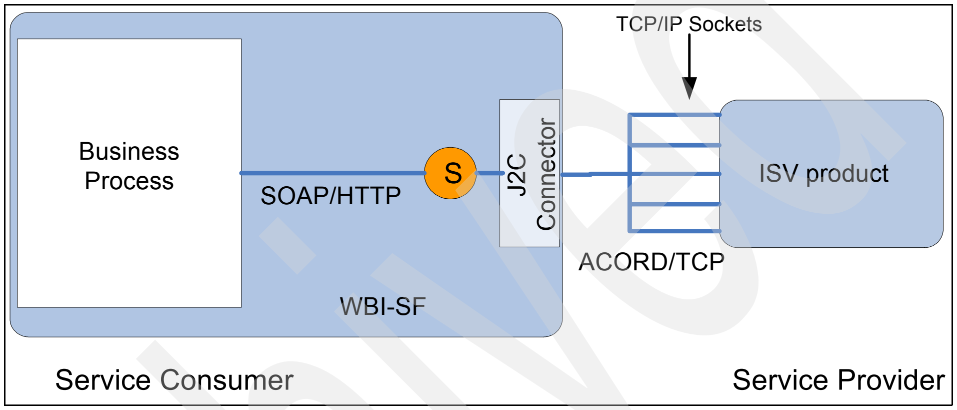


Figure 9-6 J2C Connector as a gateway between SOAP/HTTP and ACCRD/TCP

Data model

A *data model* consists of all information and data, both structured and unstructured, that represent business artifacts or aspects within the enterprise, or with which the enterprise does business.

- Structured information and data includes organized and formal data stores (both operational and analytical).
- Unstructured information and data includes images, documents, and other text-based content.

The IBM Life Insurance Solution Showcase has a “realistic” data problem; no single data repository (physical implementation) is feasible because the data is spread across multiple representations implemented by multiple products. There needs to be an enterprise-level data model that federates the disparate data sources.

In the showcase, the BPEL was built with explicit steps to keep this loose confederation of application centric databases (models) synchronized. In a production environment, these synchronization tasks should be broken out into a set of separate services that would permit all business processes to access or update the “federated data stores” in a consistent manner.

All the ISVs agreed to use ACORD messages as the means to communicate, except WebSphere Customer Center (which uses its own proprietary format).

WebSphere Customer Center and LiDP agreed to use a common key for correlating their two data models. The business process was responsible for keeping the two data models synchronized. For a production deployment, the synchronization actions used by the business process should be turned into a service.

WebSphere Customer Center did not have time to directly consume ACORD messages, and instead relied on data mediation functions provided by ItemField to convert ACORD messages to and from WebSphere Customer Center formats. This mediation was encoded as part of the business logic for early phases, and was moved to a separate data mediation service in the current implementation.

ACORD messages

Here is the list of the ACORD transaction codes (also known as ACORD messages) used:

- 103 - New Business Submission
- 111 - Illustration Request
- 204 - Party Inquiry
- 228 - Producer Inquiry
- 301 - Party Search
- 500 - Form instance request
- 503 - Denial of Risk
- 505 - Holding Status Change
- 508 - Payment
- 510 - Form instance update

The ACORD `OLifeExtension` object was used to extend each ACORD message used in the showcase with the additional data required to maintain the process session identity and state throughout the process flow.

Note that the use of the `OLifeExtension` object introduces the possibility of making the ACORD messages very specific to the enterprise that is implementing the solution. Care should be taken to avoid overusing extensions, so that messages will be more easily exchanged with other enterprises, outsourcers, and ISV products.

Rules model

The rules model includes the definition and description for the business rules that shape the activities and structure of the enterprise. Various types and levels of business rules exist, but in general a *business rule* is anything that defines or constrains one aspect of the business that is intended to assert business structure or influence behavior of the business.

The process required to sell an insurance offering does not vary significantly between offerings; the steps are similar, with variations (the addition or removal of steps) based on a criterion associated with a specific offering.

The SOA for Insurance Reference Architecture includes the concept of using rules to determine process flow control that separates the process steps from the variables that control which steps need to occur.

Some of the ISVs used in the Life Solution implemented within their products approaches that can be considered “rules”:

- Allfinanz has rules within the Underwriting Engine.
- LiDP has rules per policy that describe characteristics of the policy and the capabilities of the agents.

9.1.5 Operational model

An *operational model* contains the distribution of an IT system's components onto nodes, together with the connections necessary to support component interactions, in order to achieve the IT system functional and non-functional requirements, within the constraints of technology, skills, and budget.

Design principles and decisions

The following principles were followed to drive the design decisions:

1. All the critical data is on z/OS.

   DB2 running on z/OS can be configured to provide a quality of service to support a highly available deployment. DB2 (used by WebSphere Customer Center) will be located on z/OS; Document Manager will be located on z/OS.

2. All applications will run near the data.

   The goal was to have all products run either in z/OS or under z/VM® running with SUSE Linux. This would exploit the quality of service capabilities of z/OS and z/VM. Network security issues could also be mitigated because the network connectivity within System z configured with hipersockets and VLANs is inherently more secure than wired networks.

3. Only one service provider per machine.

   This separation may not be totally representative of production deployments. However, this project required that each IBM ISV had remote access to a machine for deployment of their product and this arrangement greatly simplified coordinating this.

   With this configuration, each ISV or IBM product installer or configurator will be capable of managing its own machine, permitting parallel development and testing activity and debugging.

4. WebSphere Application Servers other than the WBI-SF nodes and WebSphere Portal Server will be single node (no Network Deployment - ND).
5. Support remote access.

   The infrastructure must provide at least SSH access for both non-IBMers and IBMers. The solution was built in the IBM Gaithersburg center and has the following infrastructure features:

   a. Internet-facing SSH servers with managed users for non-IBMers.
   b. IBM intranet-facing SSH servers to support IBMers.
   c. The lab network is accessible from the IBM intranet, but the machines within the lab cannot access the IBM intranet.
   d. The machines in the lab can access the Internet.
6. Application security was handled by Portal security and LDAP on z/OS. Simple portal identity management was used in the form of a portal user ID and password.

Correlation to technical architecture

The diagram shown in Figure 9-7 on page 353 is logical (not a single physical instance of a single server deployment) and is physically dispersed, with each component deployment providing some part of the functionality of the “bus”.

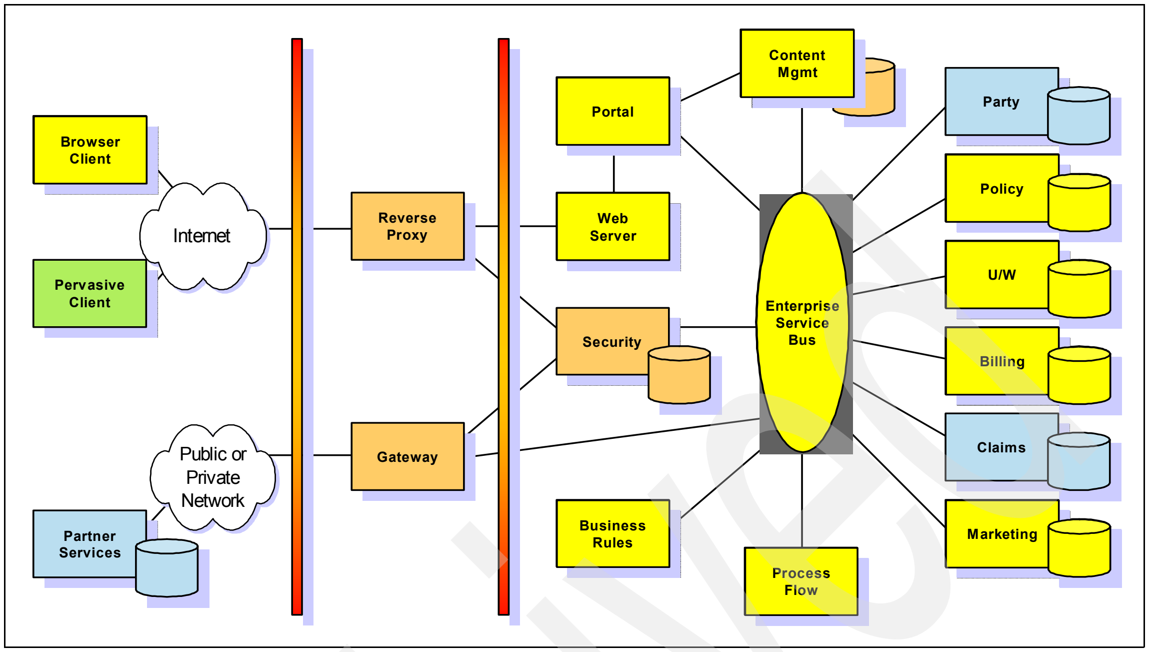


Figure 9-7 Three-tier style view - Component Architecture

The communication between components is in the form of SOAP XML messages that follow the ACORD schema sent via HTTP over TCP/IP. Each component has at least an HTTP server, and those that are J2EE-compliant have an IBM WebSphere Application Server.

File uploads and downloads to and from DB2 Content Manager used HTTP file transfer, but data updates were accomplished via a JAVA API and JDBC (Information Integration for Content (II4C) product).

9.1.6 Infrastructure (technical) architecture

An infrastructure or technical architecture defines and describes a shared infrastructure that provides the required qualities of service across the enterprise.

Requirements

Position the appropriate use of the IBM eServer™ line and STG Technologies. The insurance industry is a large System z customer but the industry ISVs are not necessarily capable of running on zOS.

- Each ISV must be deployed independently of each other and are enabled to install, configure, and support their product, but are restricted from accessing other ISV environments.
- Select platforms that ISVs can properly support or fit the ISV marketing interests.
- Create an infrastructure that will enable the follow-on iterations to build out the infrastructure to support high availability use cases.
- Follow the On Demand Operating Environment Architecture.

Decisions

In this section, we list the reasoning behind the product choices.

Rationale for using z/OS

- Within the insurance industry, z/OS is traditionally used to house mission-critical, business-vital data.
- WebSphere and DB2 data sharing on z/OS provide transactional integrity and automatic failover.
- LDAP on z/OS (which could be combined with RACF) provides the foundation for system and application security.
- Exploit the Reliability, Availability, Serviceability inherent in System z architecture and design.

Rationale for using Linux hosted by z/VM

- Exploit the existing hardware and skills.
- Provides a flexible, secure operating environment for each application.
- Ease of deployment of new images.
- Provides a virtual network:
  - Secure (cannot be tapped)
  - Speed (memory speed)
  - Reduced network infrastructure (number of wires, hubs, and switches)

Rationale for using LPARs and Parallel Sysplex

- Provides failover.
- Provides load balancing across partitions.

- Integrated Resource Director provides for dynamic provisioning of server resources.
- HiperSockets™ provides secure communication between LPARs.

The operational model shows that the spirit of the infrastructure architecture was held to, but some design decisions were based on the abilities of the ISVs and IBM products.

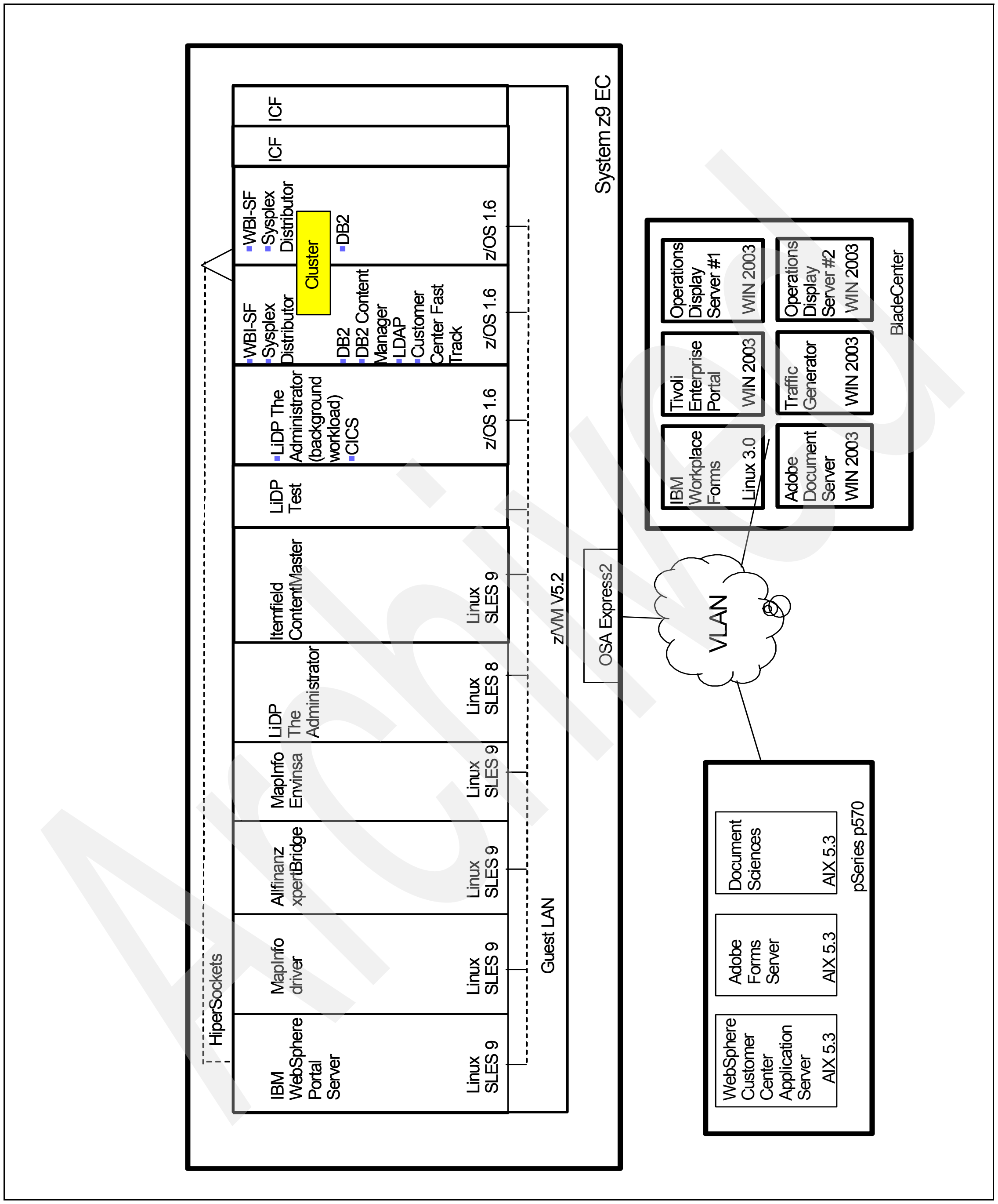


Figure 9-8 Lineup of Service Providers on physical servers

The operating environment contains 23 independent servers, 5 different operating systems (z/OS, z/VM, Linux, AIX®, Windows 2000) and 3 platforms (System z, System p™ and BladeCenter®), The resiliency of the z/OS Parallel Sysplex provides the required business data continuity, and is paired with System p LPARs management to provide failover in the AIX environment.

Correlation to the SOA Reference Architecture

The components that make up the IBM Life Insurance Solution Showcase functionality readily map to the SOA Reference Architecture; see Figure 9-9.

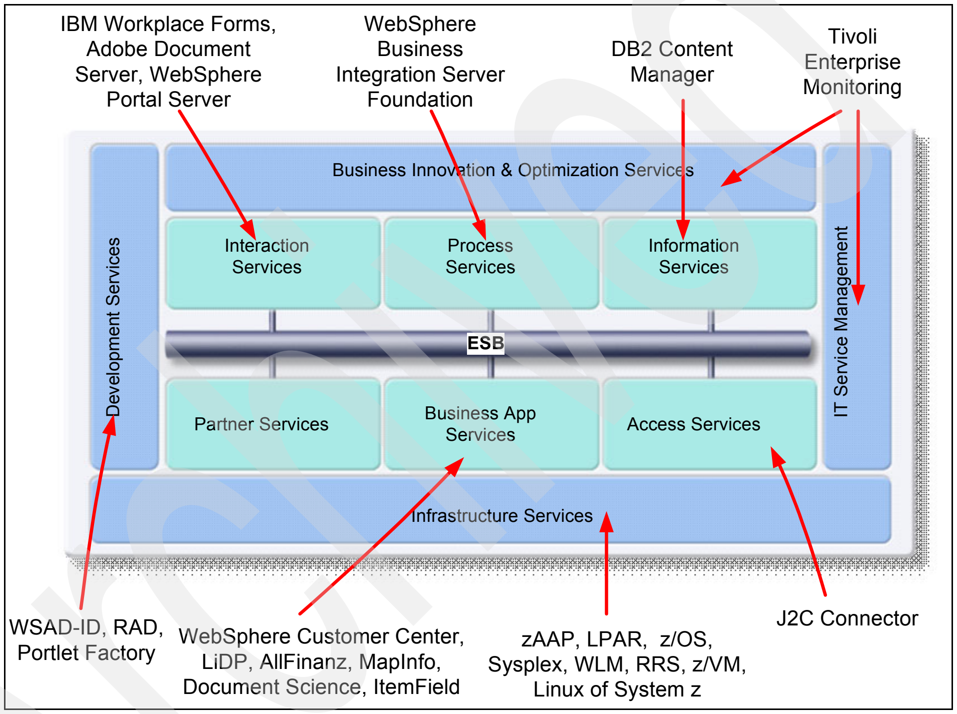

IBM Workplace Forms, Adobe Document Server, WebSphere Portal Server
WebSphere Business Integration Server Foundation
DB2 Content Manager
Tivoli Enterprise Monitoring
Business Innovation & Optimization Services
Interaction Services
Process Services
Information Services
Development Services
IT Service Management
ESB
Partner Services
Business App Services
Access Services
Infrastructure Services
WSAD-ID, RAD, Portlet Factory
WebSphere Customer Center, LiDP, AllFinanz, MapInfo, Document Science, ItemField
zAAP, LPAR, z/OS, Sysplex, WLM, RRS, z/VM, Linux of System z
J2C Connector

Figure 9-9 Products used in IBM Life Insurance Solution Showcase mapped to SOA Reference Architecture

Primary goals were to classify this mapping and identify future projects that focus on implementations of some of these components as they pertain to a broader effort of IBM Infrastructure Solutions development.

9.1.7 SOA tooling

The team used standard tools for implementing and monitoring the SOA application and system environment. The tools chosen were the most current at the time and would work with WBI-SF and the portal coding tasks that needed to be done. As the team migrates the systems to WebSphere Process Server, the tooling will change.

WebSphere Studio Application Developer - Integration Edition (WSAD-IE)

WebSphere Studio Application Developer - Integration Edition WebSphere Studio is a comprehensive integrated tool suite for dynamic e-business java application development and deployment to WebSphere Business Integration - Server Foundation systems. In particular it provides support for business process definition and development in business process execution language (BPEL).

WebSphere Integration Developer will be used when the team migrates the system to WebSphere Process Server.

Rational Application Developer Version 6

IBM Rational Application Developer helps developers to design, develop, analyze, test, profile and deploy high quality Web, Service-oriented Architecture (SOA), Java, J2EE and portal applications.

It includes full support for the J2EE programming model, integrated portal development features, Unified Modeling Language (UML) visual editing capabilities, code analysis functions, and automated test and deployment tools.

In the development of the IBM Life Insurance Solution Showcase, it was used mainly for Portal coding.

WebSphere Portlet Factory

IBM WebSphere Portlet Factory is used to extend WebSphere Portal capabilities with tools and technology to create, customize, maintain, and deploy portlets. WebSphere Portlet Factory's ease of use and development features streamline the portlet development process to speed WebSphere Portlet deployments.

In the Life Insurance Showcase, WebSphere Portlet Factory was considered as a way to show business metrics in place of Tivoli Audit records, to provide a very impressive business dashboard if implemented. The Portlet Factory team is looking at the Showcase data to see what can be done in terms of a business dashboard portlet.

Tivoli Monitoring

IBM Tivoli Monitoring is a set of products that can be used to monitor and optimize the performance and availability of the entire IT infrastructure.

Through a single customizable workspace portal (Tivoli Enterprise™ Portal Server), the products can be used to manage the health and availability of the IT infrastructure, end-to-end, including operating systems, databases and servers, across distributed and host environments.

IBM Tivoli Monitoring detects bottlenecks and potential problems in essential system resources, provides alerts, and helps to automatically recover from critical situations to ensure that business critical applications are up and running.

In this insurance implementation, IBM Tivoli Monitoring was used to:

- Isolate problems and scalability issues in the infrastructure.
- Monitor the system health.
- Bridge between business and technical monitoring.
- Provide a view of the system activity during the briefings.

The products do not provide SOA application statistics on systems running WBI-SF, so the team implemented business-critical audit records which were monitored to track and display business volumes during the briefing.

Figure 9-10 on page 360 shows an enterprise view of the servers with health indicator.

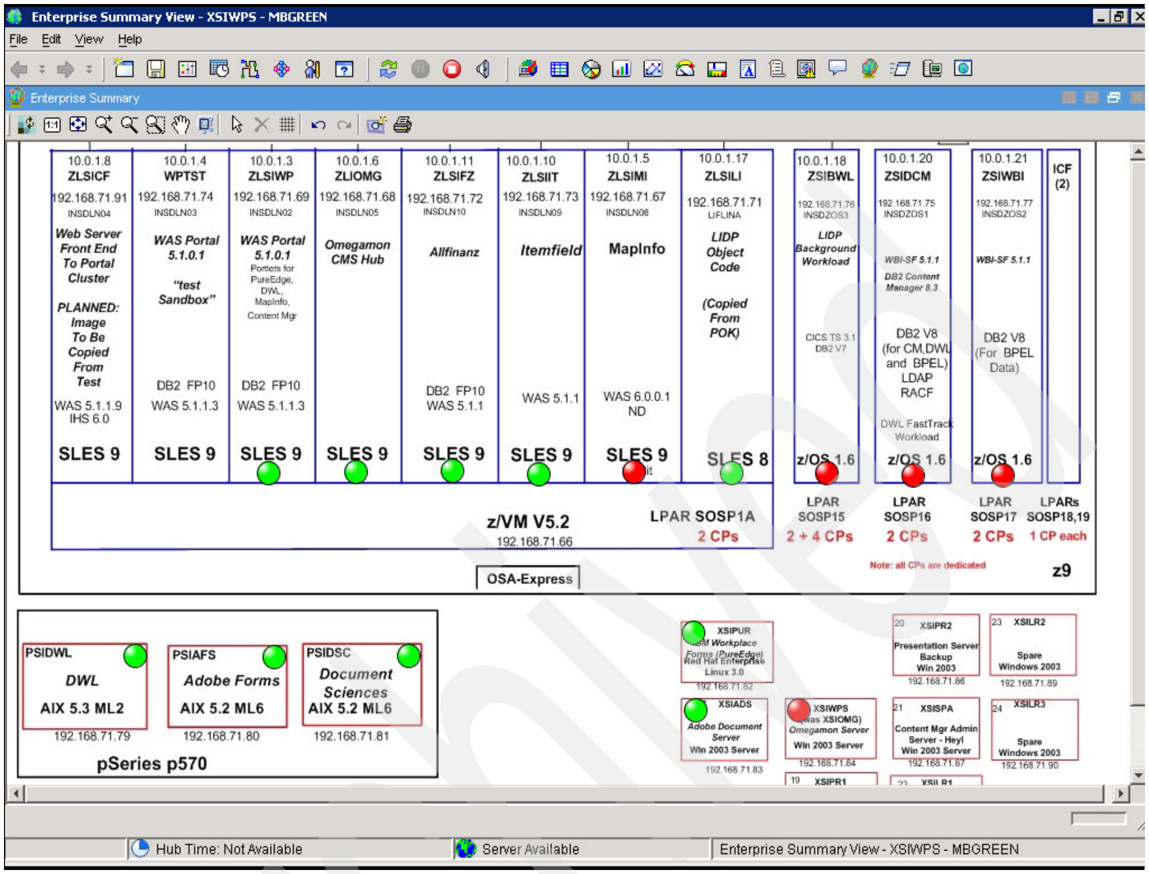

Enterprise Summary View - XSIWPS - MBGREEN
File Edit View Help
Enterprise Summary
10.0.1.8 ZLSICF 192.168.71.91 INSDLN04 Web Server Front End To Portal Cluster PLANNED: Image To Be Copied From Test WAS 5.1.1.9 IHS 6.0 SLES 9
10.0.1.4 WPTST 192.168.71.74 INSDLN03 WAS Portal 5.1.0.1 "test Sandbox" DB2 FP10 WAS 5.1.1.3 SLES 9
10.0.1.3 ZLSIWP 192.168.71.69 INSDLN02 WAS Portal 5.1.0.1 Portlets for PureEdge, DWL, MapInfo, Content Mgr DB2 FP10 WAS 5.1.1.3 SLES 9
10.0.1.6 ZLIOMG 192.168.71.68 INSDLN05 Omegamon CMS Hub SLES 9
10.0.1.11 ZLSIFZ 192.168.71.72 INSDLN10 Allfinanz DB2 FP10 WAS 5.1.1 SLES 9
10.0.1.10 ZLSIIT 192.168.71.73 INSDLN09 Itemfield WAS 5.1.1 SLES 9
10.0.1.5 ZLSIMI 192.168.71.67 INSDLN06 MapInfo WAS 6.0.0.1 ND SLES 9
10.0.1.17 ZLSILI 192.168.71.71 LIFLINA LIDP Object Code (Copied From POK) SLES 8
10.0.1.18 ZSIBWL 192.168.71.76 INSDZOS3 LIDP Background Workload CICS TS 3.1 DB2 V7 z/OS 1.6
10.0.1.20 ZSIDCM 192.168.71.75 INSDZOS1 WBI-SF 5.1.1 DB2 Content Manager 8.3 DB2 V8 (for CM,DWL and BPEL) LDAP RACF DWL FastTrack Workload z/OS 1.6
10.0.1.21 ZSIWBI 192.168.71.77 INSDZOS2 WBI-SF 5.1.1 DB2 V8 (For BPEL Data) z/OS 1.6
ICF (2)
z/VM V5.2 192.168.71.66
LPAR SOSP1A 2 CPs
LPAR SOSP15 2 + 4 CPs
LPAR SOSP16 2 CPs
LPAR SOSP17 2 CPs
LPARs SOSP18,19 1 CP each
Note: all CPs are dedicated
z9
OSA-Express
PSIDWL DWL AIX 5.3 ML2 192.168.71.79
PSIAFS Adobe Forms AIX 5.2 ML6 192.168.71.80
PSIDSC Document Sciences AIX 5.2 ML6 192.168.71.81
pSeries p570
XSIPUR IBM Workplace Forms (PureEdge) Red Hat Enterprise Linux 3.0 192.168.71.82
XSIADS Adobe Document Server Win 2003 Server 192.168.71.83
XSIWPS (was XSIOMG) Omegamon Server Win 2003 Server 192.168.71.84
19 XSIPR1
20 XSIPR2 Presentation Server Backup Win 2003 192.168.71.86
21 XSISPA Content Mgr Admin Server - Heyl Win 2003 Server 192.168.71.87
22 XSILR1
23 XSILR2 Spare Windows 2003 192.168.71.89
24 XSILR3 Spare Windows 2003 192.168.71.90
Hub Time: Not Available
Server Available
Enterprise Summary View - XSIWPS - MBGREEN

Figure 9-10 A Tivoli Enterprise Portal Server system monitoring screen

Figure 9-11 on page 361 shows the CPU utilization of each server.

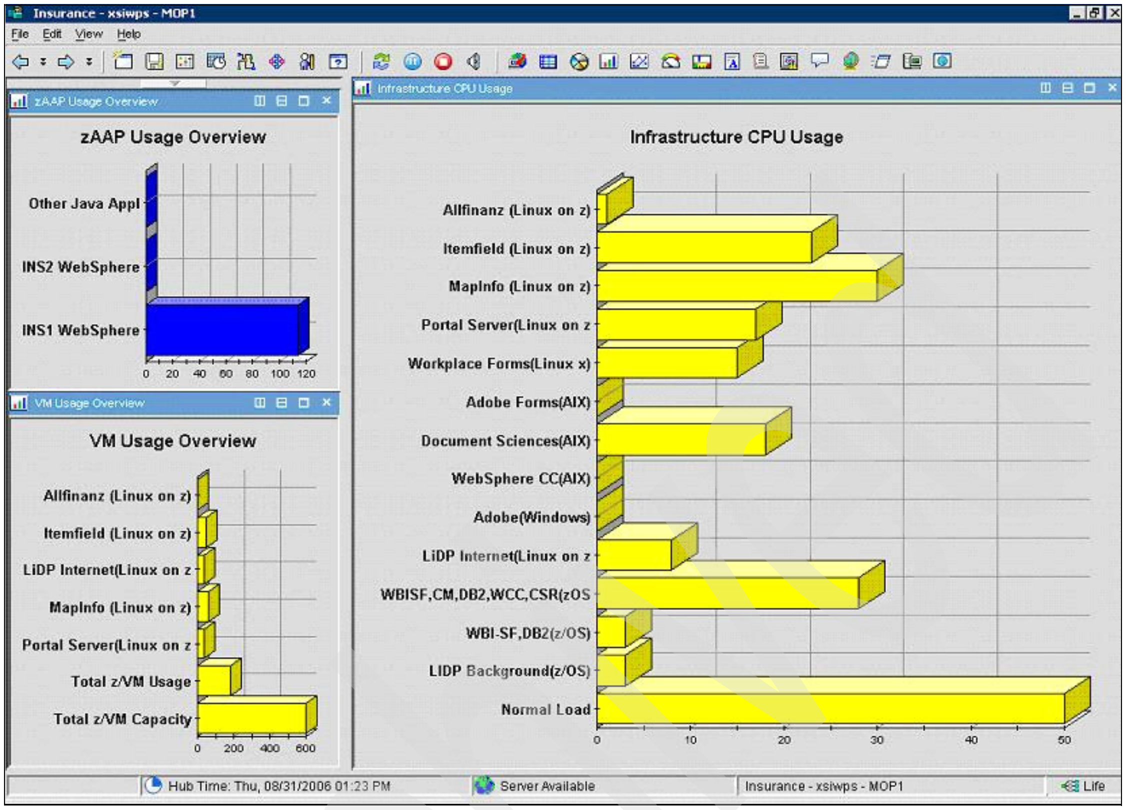
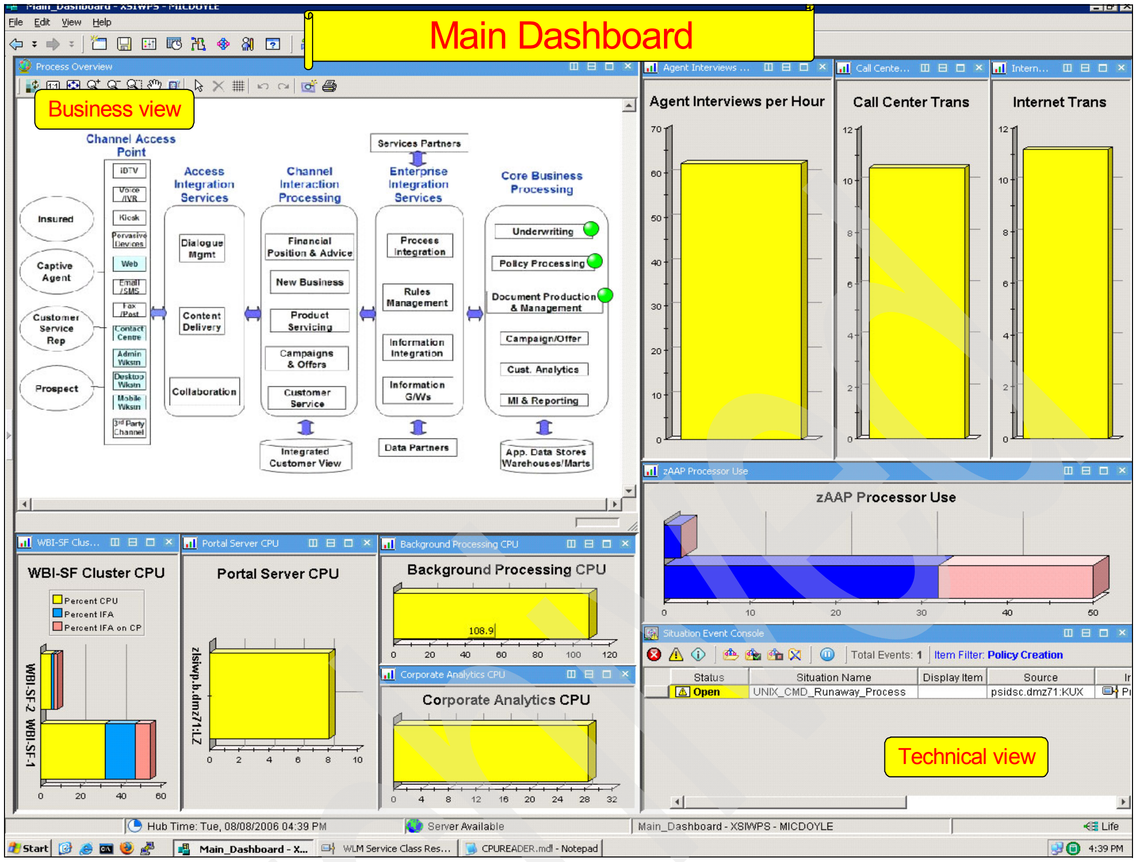


Figure 9-11 A Tivoli Enterprise Portal Server CPU utilization monitoring Screen

Figure 9-12 on page 362 shows the business transaction volume (such as agent interview per hour) and the technical resource usage (such as zAAP processor usage) on the same screen.



Status	Situation Name	Display Item	Source
Open	UNIX_CMD_Runaway_Process		psidsc.dmz71:KUX

Figure 9-12 Main dashboard to bridge business and technical volumes

Figure 9-13 on page 363 shows the IssueBindOverview display for problem drill-down.

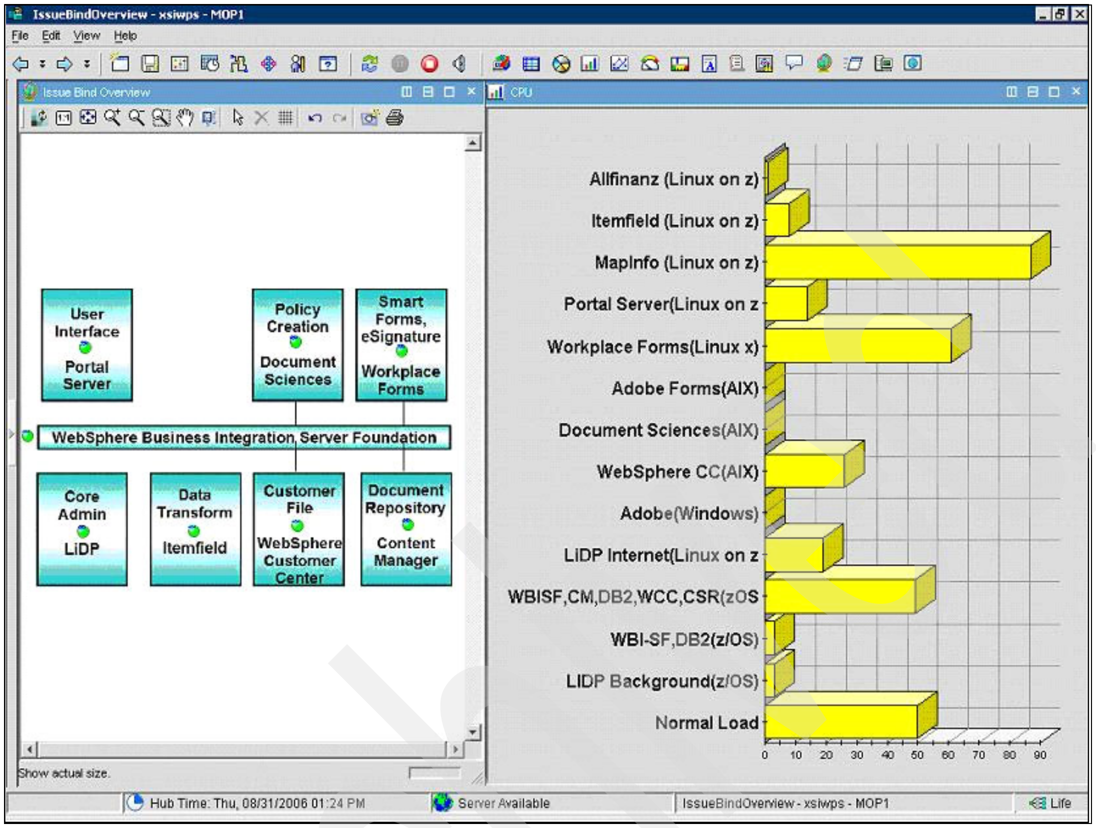
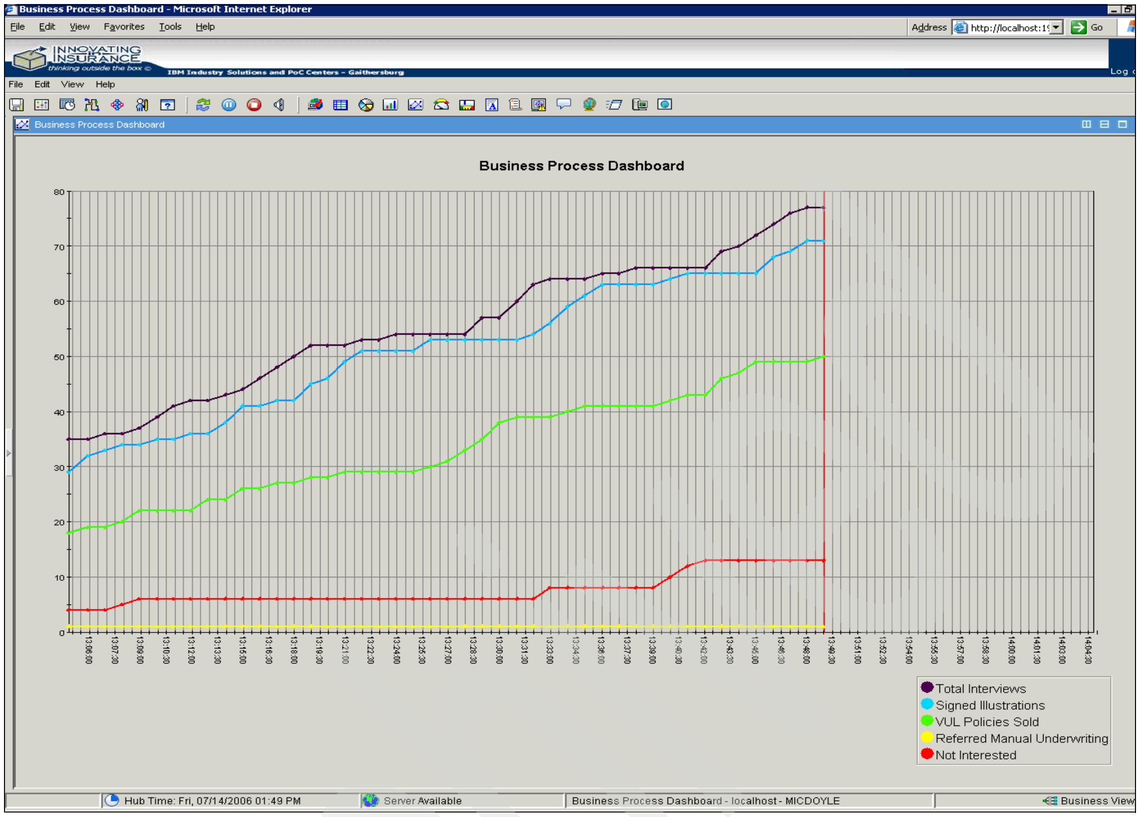


Figure 9-13 IssueBind display for problem drill-down

Tivoli Enterprise Monitor provides the drill-down feature for performance problem isolation.

Figure 9-14 on page 364 shows a different view of business process volumes. Instead of number of interviews per hour, this screen provides a cumulative view of business volume throughout the day.



Business Process Dashboard - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://localhost:1
Go
INNOVATING INSURANCE
thinking outside the box
IBM Industry Solutions and PoC Centers - Gaithersburg
File Edit View Help
Business Process Dashboard
Business Process Dashboard
Total Interviews
Signed Illustrations
VUL Policies Sold
Referred Manual Underwriting
Not Interested
Hub Time: Fri, 07/14/2006 01:49 PM
Server Available
Business Process Dashboard - localhost - MICDOYLE
Business View

Figure 9-14 Business Metric Monitoring

9.1.8 Conclusion

The main purpose of the IBM Life Insurance Solution Showcase was to provide a platform for demonstrations that prove the viability of SOA applications on System z-centric infrastructures. A secondary purpose of the development of the application and development of the infrastructure was to confirm specific proof points for scalability and resilience.

Scalability

The project clearly proved scalability. The target rate of 500 sales interviews per business day was easily met. During the full-day briefings, the team delivered a rate of 2000 sales interviews per business day, and there did not appear to be any obvious bottleneck to continuing that scalability with the current infrastructure, other than a threading issue with one of the vender software packages.

Resilience

Resilience was proven with both planned and unplanned outage scenarios. One scenario involved gracefully quiescing one of the two WBI-SF servers to apply some maintenance and then bring it back up. During the outage, the workload of scores of agents (simulated using a load driver) and one live agent continued throughout the scenario. The live agent's work was projected for the clients in the briefing while the planned outage occurs; we did not encounter any problems or response time slowing.

For the unplanned outage scenario, one of the two WSI-SF address spaces was cancelled using a z/OS operator C command. Although a number of error messages were seen, the robot agents and the live agent continued through this error without losing work, just as in the planned outage scenario. In one situation, the agent was missing some data in a portlet, but retried the step and got through it without problems.

For additional information

The IBM Life Insurance Solution Showcase Web site can be found at this site:

```
http://www.ibm.com/systems/z/solutions/showcase/
```

Further information is available at this site:

```
http://www.ibm.com/industries/financialservices/doc/content/landingd
tw/1357314103.html
```

9.2 Case study 2: a financial institution deploying a large-scale SOA solution based on Web services

Here we look at an SOA solution based on Web services for a typical banking enterprise. We identify the business scenario, design objectives, architecture decisions, design overview, and key challenges.

9.2.1 Business driver

Consider a typical large banking enterprise with 1200 branches and 5500 tellers. The teller platform, a DOS application, eventually becomes obsolete, and the check processing involves significant manual intervention. By reengineering the teller platform using SOA technology, the enterprise could save millions of dollars a year.

Apart from the cost saving, such a project would offer benefits such as platform modernization, positioning for code reuse, and enhanced business analysis as a result of consolidated transaction records of customer and teller activities.

9.2.2 Design objectives

The case study design objectives are as follows:

- Design a teller services platform to meet the CPU cost and response time objective.
- Develop services that can be reused by other lines of business (LOB).
- Design for data center independence:
  - Prepare for the possibility of data center topology change due to merging or accruing a subsidiary.
- Accommodate changing business needs with minimal impact to the design.
- Build a layered application architecture.
- Position to consolidate business logic on the J2EE platform.
- Design for “branch server” independence
  - Achieve cost saving by removing the server in every branch.

9.2.3 A typical business flow

Figure 9-15 on page 367 illustrates a typical business flow associated to teller transactions.

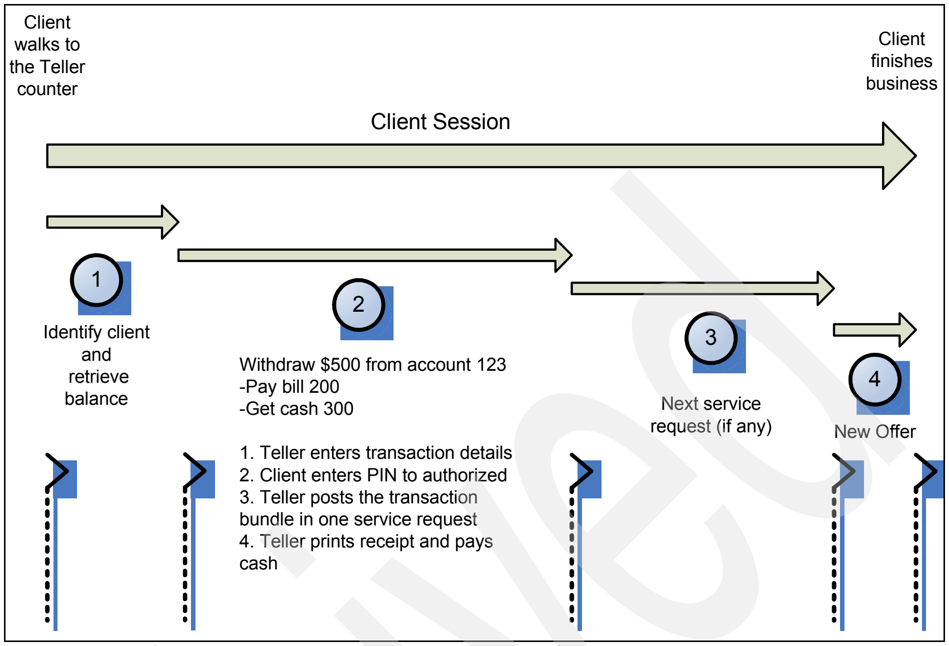

Client walks to the Teller counter
Client Session
Client finishes business
1
Identify client and retrieve balance
2
Withdraw $500 from account 123
-Pay bill 200
-Get cash 300
1. Teller enters transaction details
2. Client enters PIN to authorized
3. Teller posts the transaction bundle in one service request
4. Teller prints receipt and pays cash
3
Next service request (if any)
4
New Offer

Figure 9-15 Typical business flow

Here is the typical interaction between a teller and the customer:

1. A customer arrives at the teller counter. The teller identifies the customer using a bank card or other form of identity document, then retrieves the information about this customer, including account balance.
2. The customer wants to perform two transactions: withdraw $500 from a checking account, and make a payment of $200 towards a credit card. The teller enters this sequence of transactions via the application user interface running on the teller's workstation. This bundle of transactions is sent to the data center in *one* service request. At this point, the application performs the following tasks:
   - Decompose the request
   - Perform authorization
   - Fulfill the withdraw
   - Handle the payment
   - Update the application journal
   - Send *one* reply back to the teller

   At the teller counter, the receipts are printed and the cash is dispensed.
3. If the customer has another service request, the process will be similar to the previous request.

4. The teller has accessed the CRM application, and may use this opportunity to offer new banking services to the customer (for example, asking whether the customer is interested in applying for a new credit card).

The duration of the client session is an important indicator of how productive the teller is. The enterprise will want to keep the duration as brief as optimally possible with the help of technology.

9.2.4 Architectural decisions

In this section we describe the architectural decisions involved in this case study.

Service-oriented design and analysis

The service-oriented design and analysis can be grouped into three major steps: identification, specification, and realization decisions, as shown in Figure 9-16.

Often these steps are carried out iteratively until a satisfactory decision is reached.

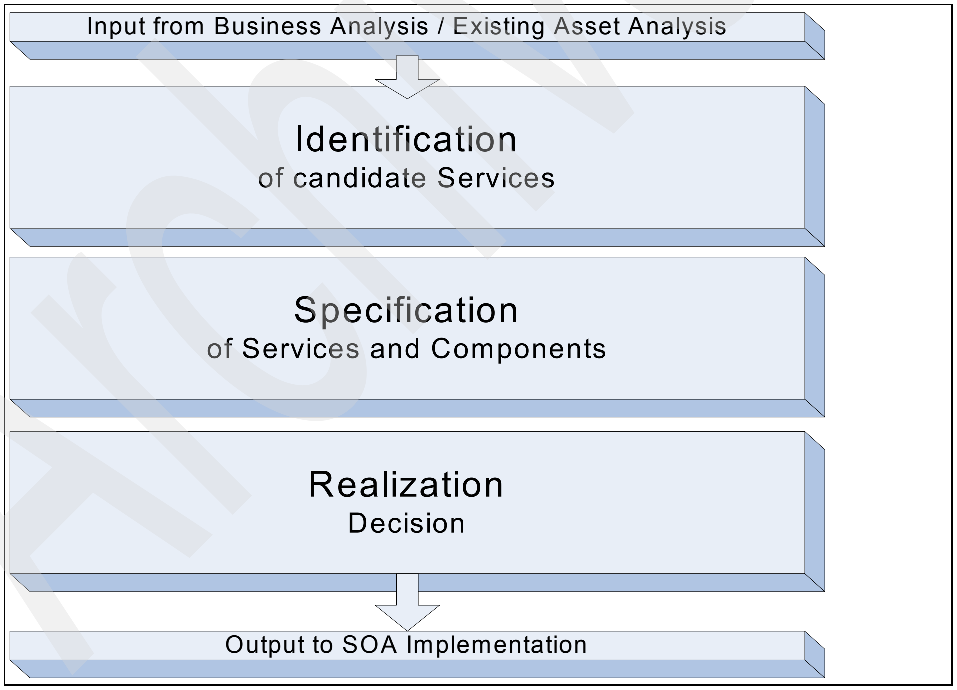

Input from Business Analysis / Existing Asset Analysis
Identification
of candidate Services
Specification
of Services and Components
Realization
Decision
Output to SOA Implementation

Figure 9-16 Service-oriented design and analysis

Identification

The objective of identification is to identify candidate services that are worth implementation. The list of candidates comes from the result of business requirement analysis (the top-down approach) or from existing asset analysis (the bottom-up approach).

Specification

For each candidate service, the following needs to be defined: dependencies, composition, exposure decisions, quality of service constraints. Also, a decision must be made regarding the management of state within a service. After this, the services components and the relationships to realize the services can be defined.

Realization decision

This phase determines in which architectural layer the services components are placed, along with rules to define how the layers interact with each other. Then, the relationship of logical runtime patterns to technical infrastructure is mapped, after an evaluation of technical constraints and Quality of Service.

Logical design of the teller service platform

Figure 9-17 shows the logical architecture for the solution. It is based on a "Adapter-provided Service interface" pattern, as discussed in "Adapter-provided service interface (A)" on page 122.

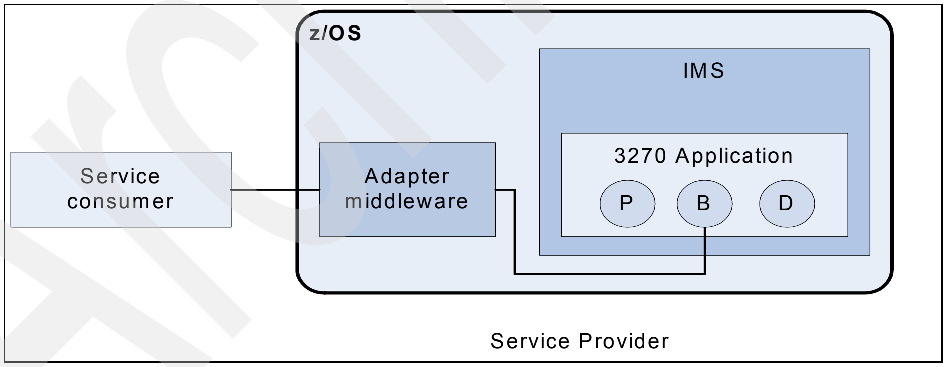


Figure 9-17 Logical runtime pattern of the new teller platform

Architecture of the services consumer

In this case study, the service consumer is the user interface (UI) running in a Windows workstation used by a teller. This workstation connects to other devices such as a passbook printer, bank card reader, and cash dispenser via existing driver programs.

Apart from the UI, this workstation also hosts other VB.NET business applications. For the implementation of the teller application UI, the following options could be considered:

- Presentation layer implementation

  The choices:

  – J2EE application client
  – VB.NET rich client
  – Browser

  In this case study, a VB.NET rich client is used.

  Typically, remote branches have a relatively low bandwidth connection to a data center, and business transactions can require several “interactions” from a teller.

  So, to keep the duration of the client session short, communication with the data center should be kept to a minimum. With a rich client, there is more flexibility on the UI. For example, it can be programmed to bundle multiple transactions into one service request and submit to the data center. It can also perform preliminary data validation without involving the host.

  Although a browser solution has the advantage of being easier to maintain and costs less, the delay imposed by the network would be unacceptable. An enterprise may also already have significant investment in skills and reusable assets in an area such as VB.NET.

- Data sharing and formatting with existing VB.NET applications in the workstation

  The choices:

  – Use existing framework for VB application
  – Develop new framework
  – Other products

  Based on the earlier VB.NET choice, using an existing framework would allow easier integration with other .NET applications.

Architecture of the services provider

J2EE is the strategic platform for the business logic and “back-end” core applications that are hosted in IMS and DB2 in z/OS, and the following options are possible.

- The protocol between the service consumer and provider

  The choices:

  – SOAP over HTTPS
  – SOAP over MQ

In this case, SOAP over HTTPS is used.

Although MQ has the advantage of guaranteed delivery, it would require an MQ queue manager at a branch. However, this contradicts one design objective of this case study, which was to remove the branch servers for cost saving.

Therefore, SOAP over MQ is ruled out. Because HTTP is inherently an unreliable protocol, there is application logic in both the service consumer and provider layers to handle the errors of lost messages.

- In the services provider layer, the services exposed to the consumer are coarse-grained and there is application logic running in the WebSphere Application Server to encapsulate fine-grained transactions provided by the back-end.

  The connection to the back-end is via J2C connectors. Our business scenarios require both synchronous and asynchronous connections to IMS. For the synchronous transactions, we use IMS Connect. For the asynchronous transactions, we use MQ.

- To connect to DB2, the Type 2 JDBC driver is used for performance.

Figure 9-18 illustrates the architecture on the service provider platform.

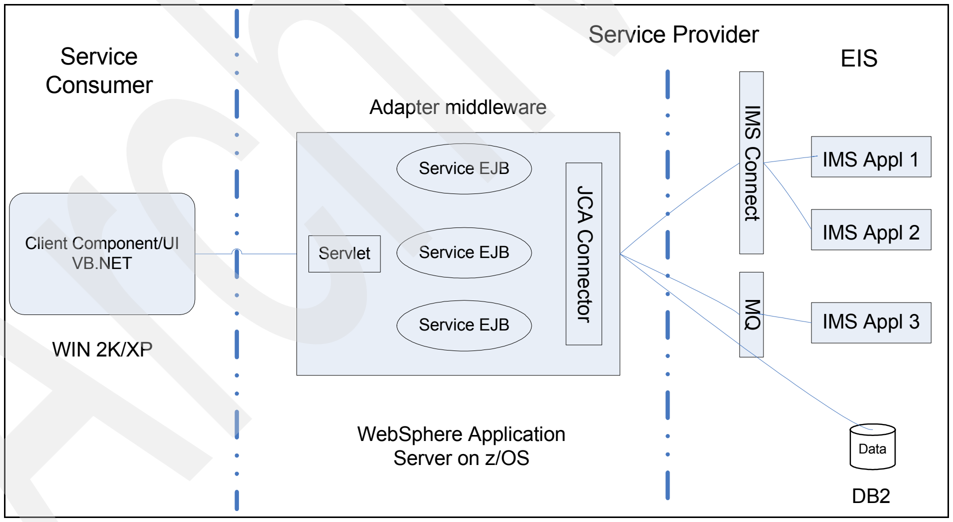


Figure 9-18 Product mapping of teller platform

9.2.5 Solution overview

In the following sections we describe the solution overview, both from a client (teller) perspective and a service provider perspective.

Teller application layers

Figure 9-19 shows the solution for the teller application.

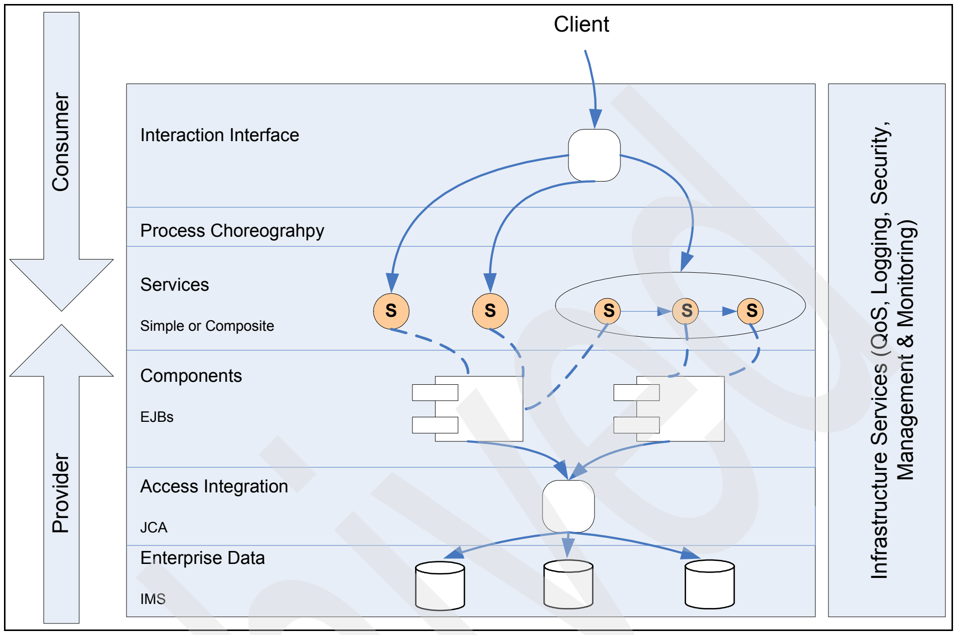


Figure 9-19 Application layers in the teller application

Interaction Interface layer

This layer routes the request to the appropriate service, while shielding the services from the message format and transport protocol. This facilitates future implementation of alternative protocols such as SOAP over MQ.

Process Choreography layer

The current release of the application does not exploit this layer.

Services layer

This layer provides the abstract service interfaces to the consumer and separates the implementation logic. It also encapsulates similar business functions supported by different Enterprise Information System (EIS) into one service. For example, “withdraw from checking”, “saving” or “loan accounts” can be handled by one common service. The services can be “atomic” or “composite”, which invokes other services.

Component layer

The layer implements the logic of the service. It containers stateless session EJBs which connect to the IMS via the Connection Integration layer.

Access integration layer

This layer decouples the IMS from the EJBs. It is a business requirement for the EJBs to connect to one of the IMS in three different centers, via IMS Connector for Java or JMS. This layer decides which protocol to use and where the request should send to, based on the rules in a configuration file.

9.2.6 Key challenges in the Services Provider layer

In the following sections we discuss some of the key issues that need to be resolved at the services provider side of the solution.

Lost messages

The connection between service consumer and provider is via HTTP(S), which is inherently unreliable. Lost messages are unacceptable in any financial institution. Here are the scenarios for a lost message:

- Lost incoming service request message to the provider
  - There is no impact; the consumer can resend the request.
- Lost outgoing response message from the service provider
  - The transactions are executed, but the service consumer is not notified of the result and may resend the same request again. To protect against re-driving the same transactions, a strategy is needed to uniquely identify each service request bundle, track the result of the individual transaction within the bundle, and reconstruct the response messages if necessary.

    This is implemented by an application journal in DB2 known as the “intent table”. Each service request bundle comes in with a unique identifier generated from the rich VB.NET client. The whole request is first stored in the journal, with this identifier as the key. As each transaction in the bundle is processed, the outcome is stored in the journal.

    If a service request ends up with a duplicate key exception when it is stored in the journal, then it means that the request has been handled previously. The response messages can be rebuilt based on the unique request identifier and the transaction records in the journal.

Transaction management

If two-phase commit support is not implemented in IMS, transactions run in “commit mode one, sync mode zero”, meaning IMS commits the transaction when it receives it. If no further response is received from IMS, the caller cannot tell whether the transaction is successful or not. So, in our case study, where a service request may be composed of multiple IMS transactions, a strategy is needed to handle situations when no response is received from IMS.

The solution is to use the application journal, which records the entire request and the outcome of each transaction in the bundle. If there is any “in doubt” situation, there is a business process of agent-assisted reconciliation of those transactions.

Multiple processing centers

Next we consider the impact of having multiple data centers serving customers in several geographic locations, with the data being unconsolidated. That is, account information in the IMS system of data center 1 differs from that of data center 2.

Now suppose a customer has an account in a location served by data center 1, and travels to the city served by data center 2. If the customer visits a branch to withdraw cash from an account, the teller should be able to complete the business transaction, regardless of where this customer comes from.

The solution is to use a router pattern in the service integration adapter layer where the routing rules are externalized in the configuration. In other words, when the account number of this customer indicates the customer’s information is stored in data center 1, the application in data center 2 should connect to the IMS in data center 1 and complete the service. Figure 9-20 on page 375 illustrates a design for IMS location independence.

And should there be a requirement to consolidate the data centers, the routing rules can be changed easily to reflect that.

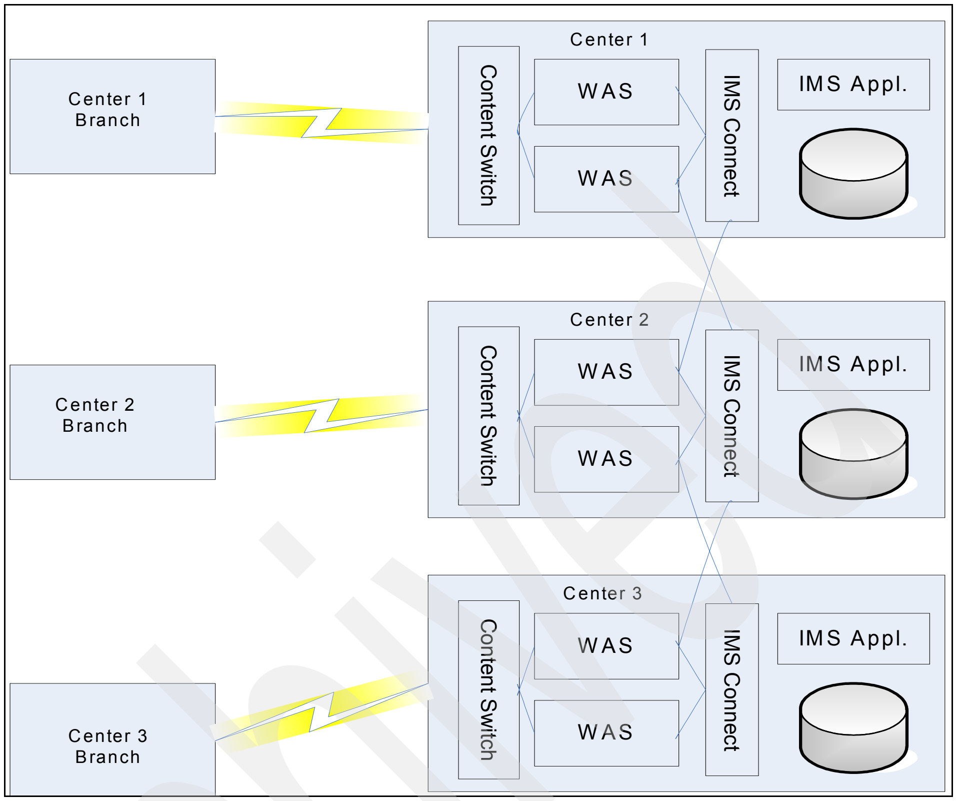


Figure 9-20 Design for IMS location independence

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this redbook.

IBM Redbooks

For information about ordering these publications, see "How to get IBM Redbooks" on page 380. Note that some of the documents referenced here may be available in softcopy only.

- *Patterns: Implementing an SOA Using an Enterprise Service Bus*, SG24-6346
- *Patterns: SOA Client - Access Integration Solutions*, SG24-6775
- *Patterns: Extended Enterprise SOA and Web Services*, SG24-7135
- *Patterns: SOA Foundation Service Creation Scenario,* SG24-7240
- *IBM System z Strength and Values,* SG24-7333
- *Implementing an Advanced ESB using WMB V6 and WESB V6 on z/OS*, SG24-7335
- *Powering SOA with IBM Data Servers*, SG24-7259
- *Java Stand-alone Applications on z/OS Volume II*, SG24-7291
- *Using IBM WebSphere Host Access Transformation Services V5*, SG24-6099
- *Application Development for CICS Web Services*, SG24-7126
- *Implementing CICS Web Services*, SG24-7206
- *WebSphere for z/OS Version 6 Connectivity Handbook*, SG24-7064
- *CICS Transaction Gateway for z/OS Version 6.1*, SG24-7161
- *Revealed! Architecting e-business Access to CICS*, SG24-5466
- *IMS Connectivity in an On Demand Environment: A Practical Guide to IMS Connectivity*, SG24-6794
- *Rational Application Developer V6 Programming Guide*, SG24-6449
- *Architecting High Availability using WebSphere V6 on z/OS*, SG24-6850
- *WebSphere z/OS connectivity Architectural Choices*, SG24-6365

- *WebSphere for z/OS to CICS and IMS Connectivity Performance*, REDP-3959
- *Host Access Transformation Server Concepts and Architecture*, REDP-3706
- *z/OS Technical Overview: WebSphere Process Server and WebSphere Enterprise Bus*, REDP-4196

Other publications

These publications are also relevant as further information sources:

- *CICS Service Flow Feature for CICS TS for z/OS V3.1 Run Time User's Guide*, SC34-5899
- *CICS Web Services Guide*, SC34-6458
- IMS SOAP Gateway product documentation

  http://www-306.ibm.com/software/data/ims/soap/index.html
- WMQ IMS Bridge product documentation

  http://publib.boulder.ibm.com/infocenter/wmqv6/v6r0/index.jsp?topic=/com.ibm.mq.csqsat.doc/csq826y.htm
- Tivoli Workload Scheduler Reference Guide product documentation

  http://publib.boulder.ibm.com/infocenter/tivihelp/v3r1/topic/com.ibm.tivoli.itws.doc/srf_mst323.htm
- White paper "Using a message-based approach to integrate your CICS system with your entire IT infrastructure", G325-2113

Online resources

- Hurwitz, "Thinking from Reuse - SOA for Renewable Business"

  ftp://ftp.software.ibm.com/software/soa/pdf/IBMThinkingfromReuse.pdf
- CBDI white paper "Business Flexibility Through SOA"

  ftp://ftp.software.ibm.com/software/soa/pdf/CBDIWhitepaperBusinessFlexibilityThroughSOA.pdf
- "An introduction to Web Services Gateway", by Chandra Venkatapathy and Simon Holdsworth

  http://www-128.ibm.com/developerworks/library/ws-gateway
- *Service-Oriented Modeling and Architecture (SOMA)*

  http://www.ibm.com/developerworks/webservices/library/ws-soa-design1/

- *Elements of Service-Oriented Analysis and Design*

  http://www.ibm.com/developerworks/webservices/library/ws-soad1/
- *SOA realization: Service design principles*

  http://www.ibm.com/developerworks/webservices/library/ws-soa-design/
- IBM SOA homepage

  http://www.ibm.com/soa/
- SOA Readiness Assessment

  http://www.ibm.com/software/solutions/soa/soaassessment/index.html
- Online InfoCenter

  http://publib.boulder.ibm.com/infocenter/hatshelp/v60/index.jsp
- Online InfoCenter (section “CICS Service Flow Runtime V3.1”)

  http://publib.boulder.ibm.com/infocenter/cicsts/v3r1/index.jsp
- Online InfoCenter (section “CICS Transaction Gateway”)

  http://publib.boulder.ibm.com/infocenter/cicsts/v3r1/index.jsp
- IMS Connect product documentation

  http://www-306.ibm.com/software/data/db2imstools/html/imsconnectv12.html
- WebSphere Integration Developer
  http://publib.boulder.ibm.com/infocenter/dmndhelp/v6rxmx/index.jsp
- “Using message-driven beans in applications”

  http://publib.boulder.ibm.com/infocenter/wasinfo/v5r1//topic/com.ibm.websphere.zseries.doc/info/zseries/ae/tmb_ep.html
- IBM Tivoli Workload Scheduler homepage

  http://www.ibm.com/software/tivoli/products/scheduler/
- IBM Patterns for e-business

  http://www-128.ibm.com/developerworks/patterns/
- WebSphere Process Server V6.0 Business Process Choreographer Programming Model

  http://www-306.ibm.com/software/integration/wps/library/infocenter/
- “Business Process Choreography in WebSphere: Combining the power of BPEL and J2EE”, by M. Kloppmann et al.

  http://researchweb.watson.ibm.com/journal/sj/432/kloppmann.pdf

- IBM WebSphere Process Server V6

  http://www.ibm.com/software/integration/wps/
- “Dynamic Discovery and Invocation of Web services” by Damian Hagge

  http://www-128.ibm.com/developerworks/webservices/library/ws-udax.html?t=egrL296&p=invocationws#author
- IBM Life Insurance Solution Showcase

  http://www.ibm.com/systems/z/solutions/showcase/
- Further IBM Life Insurance Solution Showcase information

  http://www.ibm.com/industries/financialservices/doc/content/landingdtw/1357314103.html
- Using message-driven beans in applications - technical documentation

  http://publib.boulder.ibm.com/infocenter/wasinfo/v5r1//topic/com.ibm.websphere.zseries.doc/info/zseries/ae/tmb_ep.html

How to get IBM Redbooks

You can search for, view, or download IBM Redbooks, Redpapers, Hints and Tips, draft publications and Additional materials, as well as order hardcopy IBM Redbooks or CD-ROMs, at this Web site:

ibm.com/redbooks

Help from IBM

IBM Support and downloads

ibm.com/support

IBM Global Services

ibm.com/services

Index

IBM

Redbooks

SOA Transition Scenarios for the IBM z/OS Platform

(0.5” spine)
0.475”<->0.875”
250 <-> 459 pages

SOA Transition Scenarios for the IBM z/OS Platform

Migration approaches to an SOA on z/OS

SOA technology solutions on z/OS

Quality of Service and governance of SOA on z/OS

This IBM Redbook focuses on the process of transitioning from an existing IT landscape on z/OS to an SOA-enabled landscape. So if you are a system architect or solution designer and you need to make decisions about SOA enablement or transitioning on the z/OS platform, this book offers an excellent starting point. It describes patterns, transition approaches, migration scenarios, and the features and functions of the available technology options. And specialists who are interested in technical details of the solutions will also find plenty of useful information. Service Oriented Architecture (SOA) is a hot topic on the agendas of many CIOs and architects. But the bright and shining landscape of an SOA, with all the advantages it offers, is quite different from the reality that currently exists in many IT environments; the IT is too complex, too tightly integrated, and too inflexible. The time to market of IT changes is often unacceptably long, and organizations are often not ready for an SOA. And although many IT professionals believe that SOA will make IT more flexible and significantly reduce the time to market, the challenge of how to execute toward a full-blown SOA implementation still remains.This publication will help you to meet that challenge. It helps you define an SOA strategy on z/OS, follow the appropriate implementation steps, and decide what technology to use. Much of the information is applicable to non-z/OS platforms as well.

SG24-7331-00 ISBN 0738489980