Redpaper

Mike Ebbers
Rob Culp
Frederick Niemiec, Jr.

Infrastructure Recommendations for an ESRI and IBM Geographic Information System

IBM® and ESRI have formed a global alliance to create the world's leading geographic information system (GIS) software, Web services, and hardware infrastructure. ESRI supplies the GIS software, Web services, and spatial data, and IBM provides the software, hardware, and services critical to making spatial applications enterprise-ready. Together, ESRI and IBM can provide GIS solutions for government and business, as well as system design, installation, and training services.

ESRI is the industry leader in geographic information system software technology. ESRI technology is used today to solve critical business problems for customers in industries such as government, utilities, retail, banking, insurance, oil and gas, transportation, and health.

IBM delivers innovation with leading information technology, project management, and systems integration capabilities necessary to enable complex end-to-end solutions. Enterprise GIS is fundamentally an information technology platform, and IBM is in a unique and leading position to help organizations drive growth and deliver more value with enterprise GIS technology.

After introducing GIS, ESRI, and IBM, this paper discusses the software and hardware components that are available to create a GIS system that meets the needs of a wide range of users. Reference URLs are provided for more details about these products and solutions. The paper concludes with a review of two enterprise customers where IBM and ESRI technologies were deployed.

Introduction

Geographic information systems are being used across all industries to solve complex business problems. A geographic information system is a set of information technologies that assemble, store, edit, analyze, and visualize data related by geographic location. GIS software can integrate business information, for example, determining the nearest claim center to a customer address and evaluating competitor store locations. GIS has powerful 2-D and 3-D visualization capability for seeing patterns in data, and contains complex spatial analytics for solving spatially related questions. See Figure 1. Through its mapmaking capabilities, GIS technology improves communication, increases understanding of complex problems and solutions, and drives better decision making.

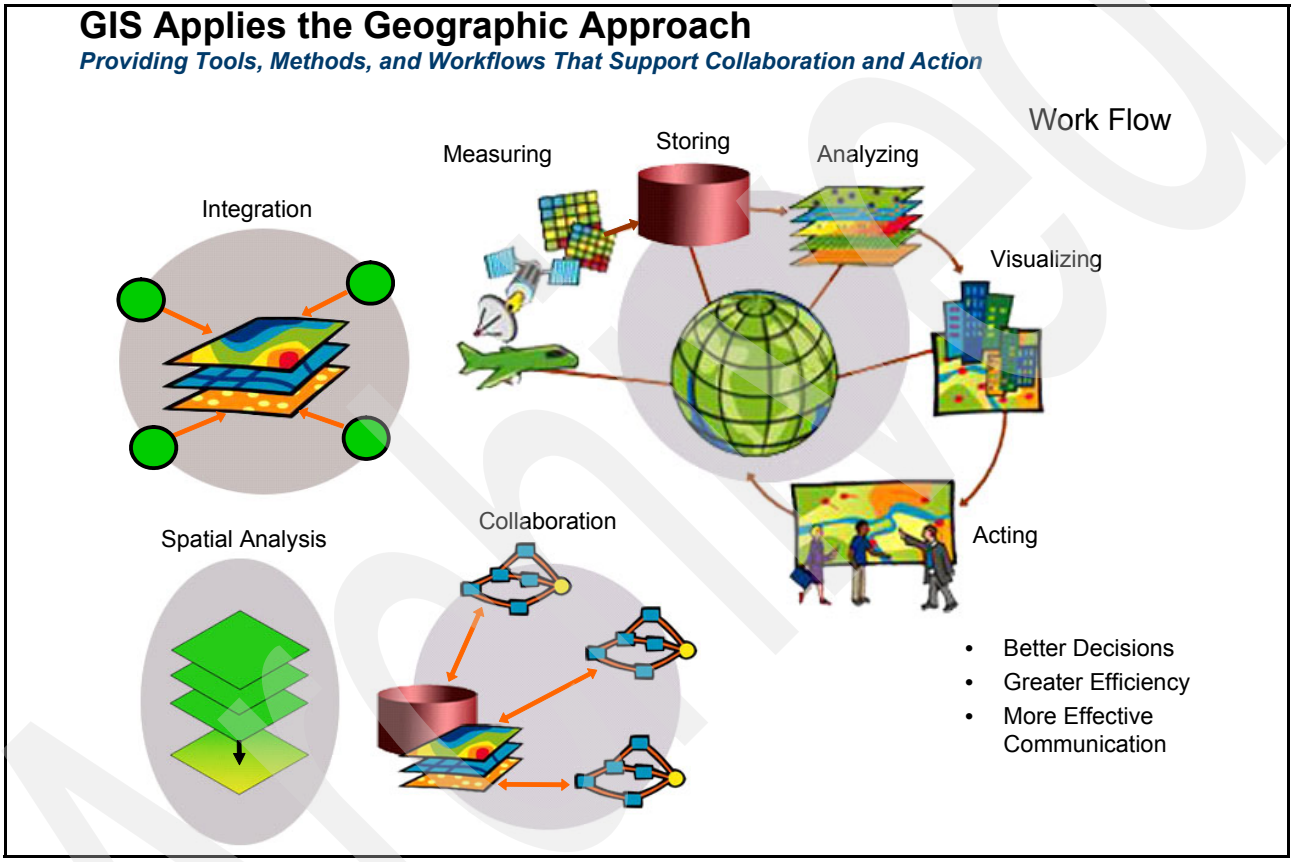

Figure 1 GIS allows users to make better decisions through modeling and mapping our world[1]

GIS overview

GIS has evolved rapidly from its traditional departmental role into a more visible and established enterprise-wide presence. IBM and ESRI are leading this evolution by providing reliable solutions with the high performance that users expect with Enterprise GIS.

GIS data

A GIS uses three common forms of data:[2]

- *Spatial data*, made up of points, lines, and areas, is at the heart of every spatial information management system. Spatial data forms the locations and shapes of map

[1] Image courtesy of ESRI.

[2] Source: http://www.gis.com

features such as customer addresses, business locations, building outlines, street centerlines, and city boundaries.

- *Tabular data* can be easily stored in tables, and contains information related to a map feature. For example, a map of customer locations may be linked to demographic information about those customers.
- *Image data* includes such diverse elements as satellite images, aerial photographs, and scanned data.

GIS technologies and applications

GIS technologies from ESRI and IBM are used to:

- Offer sophisticated spatial analysis and 2-D/3-D visualization of enterprise information.
- See, explore, and analyze an organization's entire datastore as a single asset to reveal patterns and trends in information and gain new insight.
- Run businesses better, improve supply-chain efficiency, analyze markets and competitors, see better store locations, and improve/plan business continuity.
- Support small-to-large government operations, including managing local zoning, land use, and property tax assessments, and nearly all other municipal services.
- Identify the location of an emergency call, deploy emergency vehicles, and assess public safety and health systems status in real time.
- Assess and manage coastal resources.
- Provide the public with information about real estate ownership, unpaid taxes and utility bills, housing code violations, and other data maintained by various agencies.

From the Web interface to the back-end database, IBM systems can help ensure that legacy data will integrate with new technical innovations, service-oriented architectures (SOA), and new GIS software, spatial data, and Web service solutions from ESRI. The GIS technologies from IBM and ESRI provide the infrastructure to help make data sharing among departments easier, so that organizations can work as a single enterprise.

Introduction to ESRI

Since 1969, Environmental Systems Research Institute, Inc. (ESRI) has been helping customers solve real-world geographic problems such as fighting forest fires, finding promising sites for fast-growing businesses, rebuilding infrastructures in cities around the world, supporting optimal land use planning, routing emergency vehicles, containing oil spills, and performing countless other vital tasks every day. Today, more than 300,000 organizations around the world use ESRI software because it encompasses the leading ideas in technology for geographic information management. ESRI is the leader in nearly all GIS markets, led by a 70% market share in government.

Introduction to IBM

IBM values dedication to every client's success by providing innovation that matters. IBM has been a leader in information technology (IT) products for decades. IBM has concentrated on producing IT products, including leading-edge hardware, software, and services. This has allowed IBM to serve as a premier solutions provider for their customers, often with one-stop shopping. IBM was one of the first companies to do business globally, and today operates in nearly every country in the world.

This paper features the IBM hardware and software that enables IBM and ESRI to successfully partner to provide GIS solutions for any size customer.

Project Big Green

As a special note, IBM recently announced Project Big Green[3] (a takeoff on its Big Blue nickname), highlighting the energy efficiencies of its hardware platforms: System z™ mainframes, System p™ UNIX® servers, System x™ Intel® and AMD™ servers, BladeCenter® servers, and System Storage™. Some estimates show that for every $1 of hardware in a data center, a customer may spend 50 cents just to power and cool it. Customers want new data centers that have energy efficiencies built into them. Our customers can optimize the air flow for their cabling or shift their cooling costs to off-peak hours. Actions like these can reduce energy costs and make the data center more environmentally friendly. See the IBM Energy Efficiency Initiative Web portal here:

http://www-03.ibm.com/systems/optimizeit/cost_efficiency/energy_efficiency/technology.html

IBM-ESRI partnership

ESRI supplies GIS software, Web services, and consulting services to thousands of organizations around the world. ESRI GIS solutions are deployed on IBM platforms, including System x, System p, System z, BladeCenter, System Storage, WebSphere®, DB2®, Informix® Dynamic Server, Tivoli® software, AIX®, and z/OS®, as shown in Figure 2 on page 5.

ESRI is a premier member of IBM PartnerWorld® for Developers and an IBM Strategic Alliance Partner. IBM and ESRI partner to:

- Facilitate the development, marketing, and sales of ESRI software running on strategic IBM technologies.
- Provide industry-leading, value-based programs for business, technical, marketing, sales support, and information services.
- Jointly support and promote strategic integrated IBM solutions for government, utilities, and other industries.

Solutions

IBM-ESRI integrated technology and solutions:

- Are secure, time-tested, and scalable.
- Adhere to open standards for spatial technology management.
- Are certified on IBM Systems x, p, z, BladeCenter, and IBM IntelliStation® workstations for maximum performance.
- Combine ESRI's industry-leading spatial application server, ArcGIS Server, with powerful IBM WebSphere, to provide spatially enabled applications, services, and portlets to enterprise SOA environments.
- Extend the capability of DB2 Spatial Extender and Informix Dynamic Server with advanced geodatabase functionality and spatial data administration tools.

[3] See these two Web sites: http://www.ibm.com/ibm/ideasfromibm/us/datacenter/?sa_campaign=message/ideas/leadspace/all/energyadvertisingflash and http://www-03.ibm.com/press/us/en/pressrelease/21945.wss

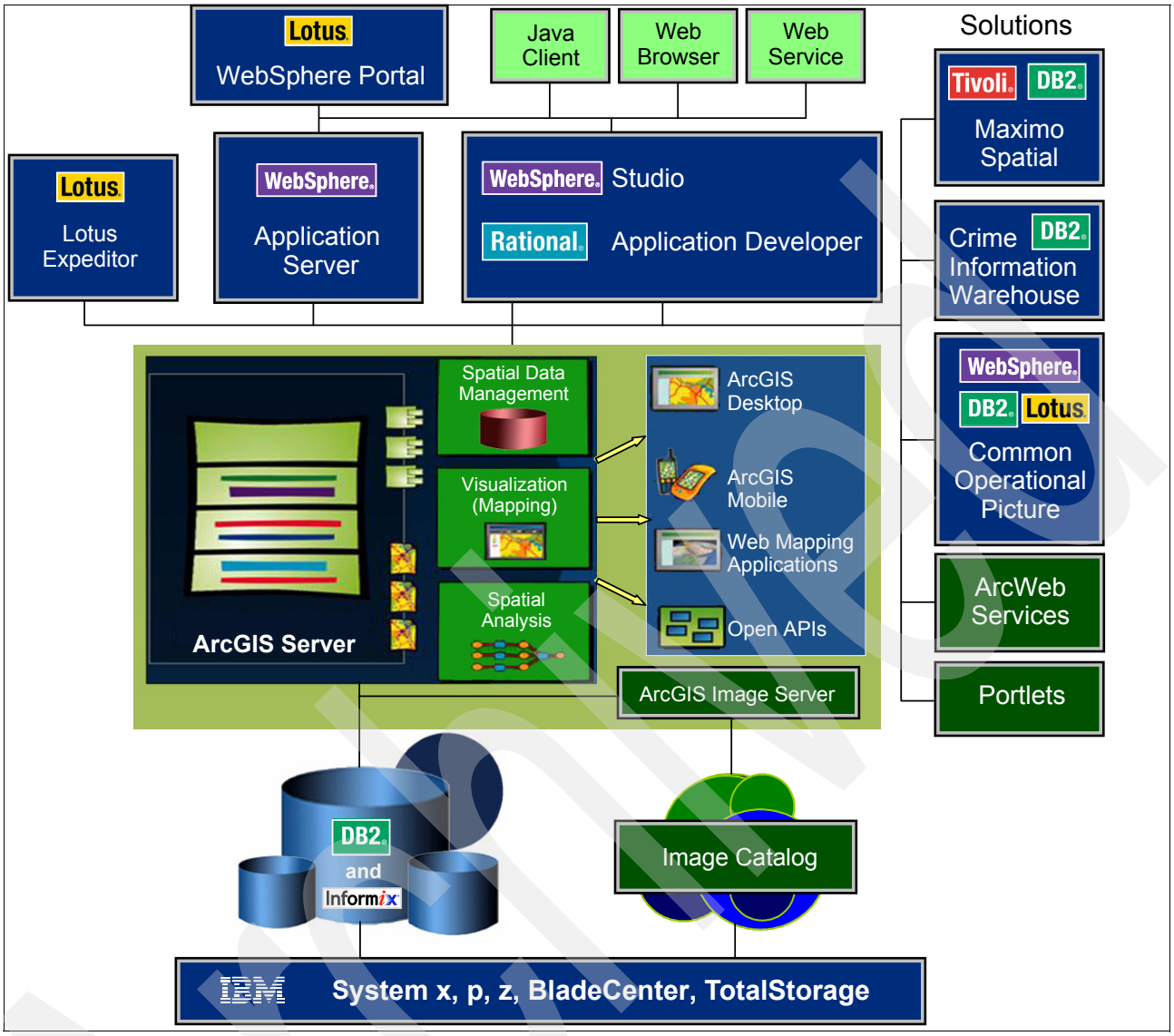

Figure 2 ESRI-IBM GIS architecture

ESRI ArcGIS software

ESRI ArcGIS is an integrated family of software products that consists of Desktop GIS, Server GIS, Mobile GIS, and Online GIS. ArcGIS is a platform for building a complete geographic information system that lets users easily author data, maps, globes, and models on the desktop; serve them to a GIS server; and use them on the desktop, on the Web, or in the field.

IBM and ESRI offer a wide range of technologies designed to meet the requirements of governments and other industries. People use the visualization, data management, and spatial analysis tools of ArcGIS on IBM infrastructure for:

- Real-time access to property appraiser map data
- High-speed notification for emergency teams
- Government boundary redistricting
- Crime data analysis

The ArcGIS system uses software components called ArcObjects, which are at the core of all the ArcGIS products: ArcGIS Desktop, ArcGIS Engine, and ArcGIS Server. The ArcGIS framework enables users to deploy GIS functionality and business logic wherever it is needed in desktops, servers (including the Web), or mobile devices. This architecture, coupled with the geodatabase, gives users the tools to assemble intelligent geographic information systems.

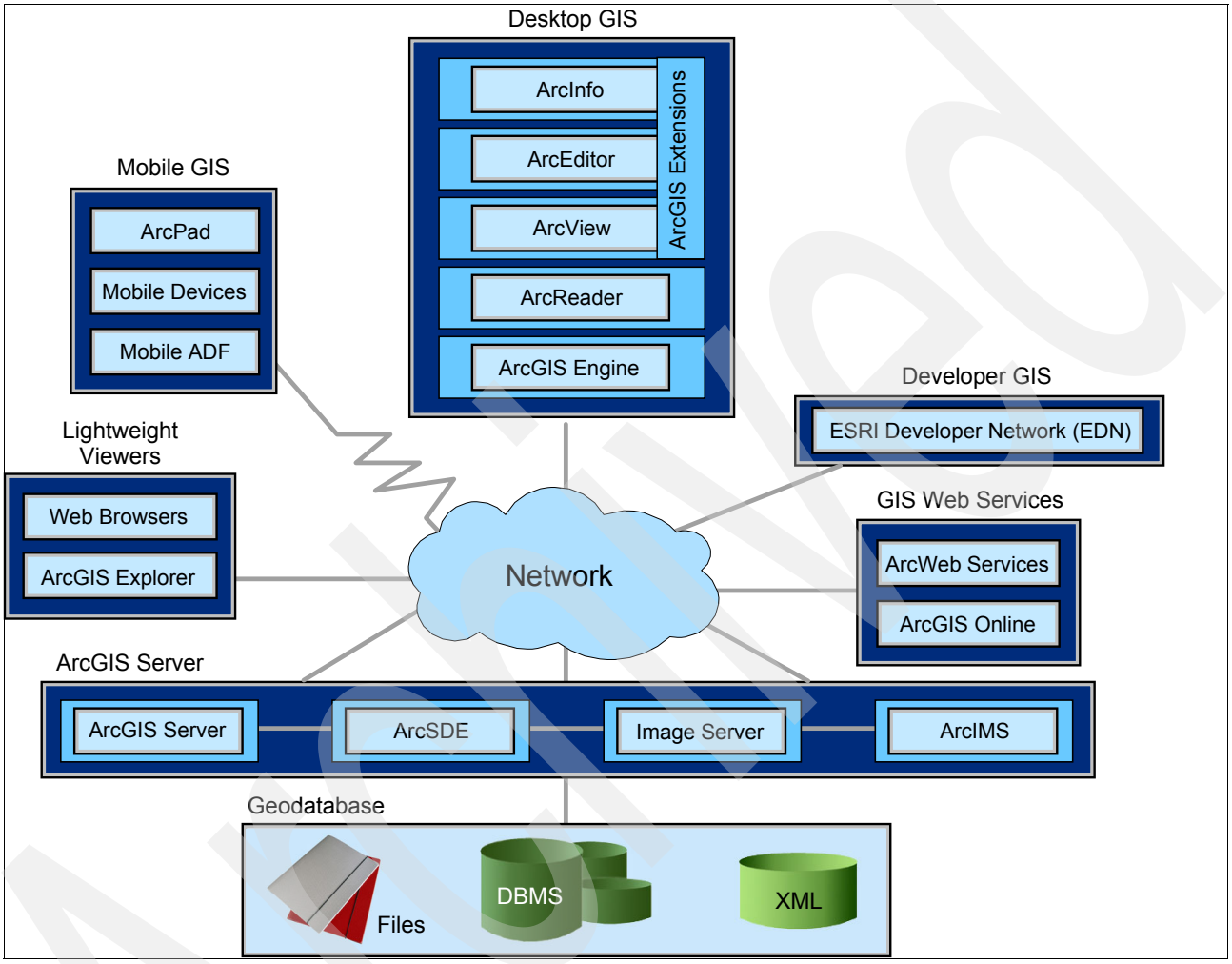

Figure 3 ESRI product family[4]

ArcGIS desktop software

Desktop GIS is the platform for creating, editing, and analyzing geographic knowledge. ESRI's Desktop GIS consists of ArcGIS Desktop, ArcGIS Engine, and ArcGIS Explorer.

ArcGIS Desktop Provides data and tools to help users create, edit, import, map, query, analyze, and publish geographic information. The ArcGIS Desktop products include ArcInfo, ArcEditor, ArcView, ArcReader, and the ArcGIS Desktop extensions.

ArcGIS Engine Allows developers to easily build focused GIS desktop applications with simple, custom interfaces.

[4] Image courtesy of ESRI

ArcGIS Explorer Is a free download that allows anyone to access and integrate various Web services and local data. ArcGIS Explorer can access the full GIS capabilities of ArcGIS Server, including geoprocessing and 3D services.

ArcGIS server software

Server GIS lets organizations share and maintain their spatially related business data created with desktop GIS tools with users across the enterprise. It enables organizations to push data, maps, models, and tools out to others in focused solutions that are tailored to business workflows.

ArcGIS Server

ArcGIS Server is designed to deploy sophisticated GIS functionality from centralized servers to support enterprise GIS implementations and applications. ArcGIS Server provides the framework for developers to create focused GIS Web applications and services that can be utilized by clients including browser-based applications, ArcGIS Desktop, and ArcGIS Engine applications.

ArcGIS Server consists of two components: a GIS Server, and an Application Developer Framework (ADF) for Java™ and .NET. The ADF enables developers to build and deploy Java or .NET Web applications and Web services that use ArcObjects running within the GIS Server.

ESRI Spatial Information Management technology

In ArcGIS Server, the ArcSDE component contains sophisticated spatial information management administration tools and functionality that extend the capabilities of DB2 and Spatial Extender, and Informix with Spatial DataBlade®.

ArcSDE technology

ArcSDE manages the differences among supported database systems so that the application can be database independent. ArcSDE technology enables multiuser read/write access to geodatabases, application of business rules to spatial data processing, and versioning capabilities to support historical archiving and GIS workflows. This enables spatial data to be fully integrated into an organization's enterprise information technology environment.

The geodatabase server provides a suite of services to enhance data management performance, extend the range of data types that can be stored in a relational database management system (RDBMS including DB2 Universal Database™ and Informix Dynamic Server), enable schema portability between RDBMSs, and offer configuration flexibility.

Online GIS

Online GIS provides ready-to-use map and data content over the Web for easy mashup with spatially related business data. Users can access 2D maps, 3D globes, and tasks from the Web to quick-start projects. Online GIS also provides developers with a comprehensive Web platform for integrating GIS content and capabilities into desktop, server, mobile, or Web applications. Online GIS includes ArcGIS^{SM} Online and ArcWeb^{SM} Services.

ArcGIS online

ArcGIS Online provides ready-to-use content and capabilities for ArcGIS users including 2D maps, 3D globes, and reference layers.

ArcWeb services

ArcWeb services provides developers with a comprehensive Web platform for integrating GIS content and capabilities into desktop, server, Web, or mobile applications. On demand content is available from leading commercial geographic data and content providers.

System platforms

ESRI's GIS solutions are deployed on the IBM System x, BladeCenter, System p, and System z platforms, including the operating systems and IBM middleware below.

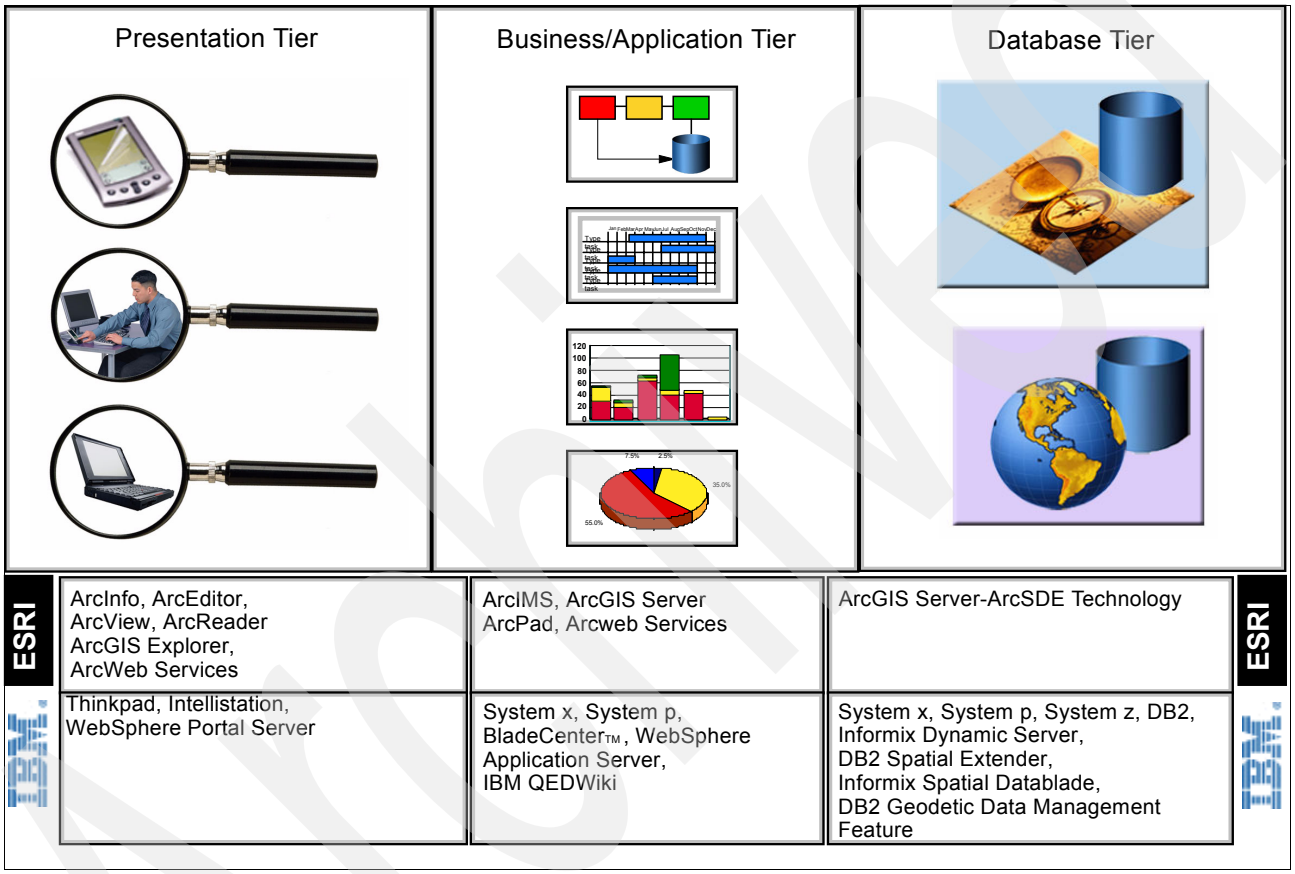

Figure 4 Platform synergy

Currently, the System p and System z platforms support only the database components, while all the other platforms listed support the ArcGIS Server components in addition to the database.

- Linux® Intel (Red Hat and SUSE) (System x)
- AIX (System p)
- Microsoft® Windows® (System x)
- z/OS (System z)
- DB2
- Informix Dynamic Server
- WebSphere Application Server

Figure 4 shows the synergy between the ESRI and IBM product lines. ESRI and IBM middleware are tightly integrated in multi-tier architectures. The database tier is separated

from the business logic and presentation tiers. The integrated middleware is open, flexible, and secure.

Recommended IBM hardware solutions for ESRI GIS

This section outlines the system requirements for the ESRI application software.

IBM hardware for server GIS

The ArcGIS Server supports published transaction-based mapping applications and services and session-based workflow applications. The ArcGIS Server applications support a thin client architecture over the Web or local network environment. Published transaction services support Web or local application clients.

The ArcGIS Server architecture includes Web applications, spatial services, and database components. The ArcGIS Server components can be deployed as a two-tier or a three-tier scale-out architecture. The two-tier architecture supports the Web applications and spatial services on the same platform tier, while the three-tier architecture includes a separate Web application tier and spatial services tier. The database is supported on a separate *scale-up* platform tier for both architecture solutions.

The ArcGIS Server Web applications and spatial services architecture is supported by multiple Intel Xeon® 5160 4 core (2 socket) 3000MHz, 4MB L2 cache, and 1333MHz FSB platform configurations. This platform can support up to 25,000 map displays per hour as a composite Web/spatial server in a two-tier configuration, and up to 32,000 map displays per hour as a spatial server in a three-tier configuration. Two-tier architecture with two composite Web/Spatial servers can support up to 51,000 map displays per hour (up to 140 concurrent clients with average productivity of six map displays per minute). Three-tier architecture with two Web servers and four spatial servers can support up to 130,000 map displays per hour (up to 365 concurrent user sessions with average productivity of six displays per minute).

IBM hardware recommendations for GIS databases

GIS databases range in size from tens of gigabytes in workgroup situations to multi-terabytes in enterprise GIS environments. The ArcGIS applications are supported by an intelligent geodatabase consisting of an object-relational database architecture that includes a variety of spatial and tabular table dependencies within a single database instance.

Spatial database queries are compute-intensive, with the server CPU being the primary technology bottleneck with fully deployed, properly configured database systems. Current geodatabase technology is deployed on standard server platform environments, with all data managed by supported commercial DBMS software, including DB2 or Informix Dynamic Server.

Roughly 10% (when using the ESRI recommended direct connect architecture) of the ArcGIS application processing workflow is supported by the geodatabase DBMS server. Ideal platform environments depend on the number of supported peak concurrent ArcGIS client workflows and include DB2 on System p (AIX), System x/Blade (Linux, Windows), and System z (z/OS, Linux). The System x server (Intel Xeon 53xx series 8 core 2 socket 3000 MHz) provides geodatabase query support for up to 700 concurrent ArcGIS Desktop users. The POWER6™ 4 core (2 socket) 4700 MHz platform can support up to 730 concurrent ArcGIS Desktop clients, providing an example of the scalability of the p6 AIX environment. System p extends the heritage of mainframe-proven reliability, availability, and serviceability, and offers extraordinary computing power and technology.

More information can be found at these Web sites:

http://www.ibm.com/systems/x/
http://www.ibm.com/servers/systems/p/

IBM hardware for desktop GIS

The ArcGIS Desktop applications include the full application tier functionality (ArcObjects). They are supported on Windows workstations with 1–2 GB memory and 256–512 MB VRAM video cards. Professional GIS power users normally replace their desktop workstations or mobile computers on a 2–3 year life cycle. Attractive options for desktop workstations are IBM Z Pro Series Intellistation Workstations. Typical mobile computer recommendations are Intel dual core 2333 MHz processors with 4MB L2 cache and 1033 MHz FSB.

Figure 5 IBM IntelliStation

This Web site has more information about IBM Intellistation:

http://www-03.ibm.com/systems/intellistation/pro/zpro/index.html

ArcGIS desktop software is supported on Window's Terminal Server (WTS) Citrix, providing a centralized computing architecture for local and remote terminal support for the ArcGIS desktop software. A popular WTS implementation architecture is a rack-mounted 1U Intel Xeon 5160 4 Core (2 chip) 3000 MHz 4MB L2 1333 FSB blade with 16 GB of memory (64-bit OS) using the Citrix presentation server and client terminal software. Each 5160 4 core server with 16 GB memory can support up to 40 concurrent users, and can be deployed in rack or blade server configurations. For larger applications, the dual processor data blade architecture (for example, BladeCenter HS21) is attractive in terms of performance reliability, hardware cost, and scalability for WTS applications and Web servers. Blade configurations are attractive for larger systems requiring more than seven servers.

Figure 6 IBM BladeCenter

See this Web site for more details.

http://www.ibm.com/systems/bladecenter/

Considerations for selecting a hardware platform

Several factors need to be considered when selecting a platform and designing the compute environment. Most important of these are performance and the total cost of ownership of the solution. For additional details, see:

http://www.esri.com/systemdesign

"IBM server and system storage platforms" on page 14 shows some of these factors and how IBM hardware is designed to provide benefits in a GIS environment.

Performance considerations

IBM and ESRI regularly analyze the latest hardware for performance recommendations. This includes using the SPEC benchmark methodology.

Spec 2006 throughput

The Standard Performance Evaluation Corporation (SPEC) was formed during the 1980s to identify and create objective sets of application-oriented tests that may serve as common reference points and be used to evaluate performance across different workstation platforms.

ESRI system design consultants have used the SPEC benchmark suite since 1992 as an independent source to identify relative performance of supported hardware platforms. The SPEC measurements have been very helpful in representing relative platform performance, and have been used with ESRI sizing models to identify appropriate platform solutions to support GIS user performance needs. Recent benchmark testing from ESRI suggests that ArcGIS applications, as well as geodatabase server queries, are primarily integer-intensive, and thus ESRI recommends the SPECrate_int2006 benchmark for sizing purposes.[5] Table 1 on page 12 shows a number of IBM server models that have been rated as best-in-class.

IBM versus competitive server test results

ESRI recommends the IBM System x models 3550 and 3650 for ArcGIS Desktop and ArcGIS Server applications. They incorporate the Intel Xeon 4 core (2 socket) 3000 MHz server, 4MB L2 cache, 1333MHz FSB. They should be equipped with 16GB memory for WTS server nodes and 8GB memory for ArcGIS Server nodes (Web servers and spatial servers, including

[5] System Design Strategies, an ESRI white paper, pages 8-7 to 8-10. http://www.esri.com/systemdesign

composite servers in two tier Web configurations). The HS21 is the blade version of these servers.

The 3650 is the Intel 8 core (2 socket) offering with the new processor technology. This would be an ideal data server since it supports up to 700 concurrent ArcGIS Desktop users. We recommend 4 GB per core memory, or 32 GB on this system. We recommend the dual core socket machines for the application servers.

Note: For GIS applications, the x3800, x3850, and x3900 models are no longer recommended because the x3550 and x3650 models are twice as fast per core.

Table 1 SPECint_rate2006 performance results

System	# Cores	# Chips	# Cores/chip	MHz	Baseline	Base/core
IBM System x 3550 (Intel Xeon 5160)	4	2	2	3000	60.8	15.2
IBM System x 3650 (Intel Xeon 5160)	4	2	2	3000	60.2	15.1
IBM BladeCenter HS21 XM (Intel Xeon 5160)	4	2	2	3000	52.9	13.2
IBM System x 3455 (AMD Opteron™ 2222SE)	4	2	2	3000	50.2	12.6
IBM System x 3650 (Intel Xeon 5365)	8	2	4	3000	96.4	12.1
IBM System x 3755 (AMD Opteron 8222SE)	8	4	2	3000	94.5	11.8
IBM System p6 570 (4.7GHz, 2 core, AIX)	2	1	2	4700	53.2	26.6[a]
IBM System p6 570 (4.7 GHz, 4 core, AIX)	4	2	2	4700	106	28.5[a]
IBM System p6 570 (4.7GHz, 8 core, AIX)	8	4	2	4700	206	25.7[a]
Sun™ Ultra™ 40 M2	4	2	2	3000	51.6	12.9
HP Integrity BL860c (1.6GHz/18MB Dual-Core Intel Itanium® 2™)	4	2	2	1600	49.7	12.4

a. This performance is a result of the Power 6 chip architecture.

These competitive benchmark results were published on:

http://www.spec.org/

Comparisons are based on the best SPEC CINT2006 rate scores for these Windows 4-way servers and 8-way servers, as well as the POWER6 servers. Total life-cycle cost and performance of the system should be the primary considerations in selecting a vendor solution. For more information see:

http://www.ibm.com/systems/p/benchmarks/
http://www.ibm.com/servers/eserver/xseries/benchmarks/

Sizing tools and guidelines

To provide a start in configuring a system, here are some general observations based on the use of sizing tools and methodologies backed by real customer implementations. The system supports up to 100 concurrent clients for every DBMS server baseline core. Baseline core has a SPECrate_int2006 baseline equal to 14, so a platform with SPECrate_int2006 baseline of 56 would support up to 400 concurrent users. Table 2 shows some general statistics for small, medium, and large configurations.

Table 2 Number of users determines size of system

User base	Number of users	Application servers	Data servers
Small	1–100	Intel Xeon 5160 4 core (2 socket) Server 1 or 2 server nodes	Intel Xeon 5160 Server 1–2 processors (2–4 core)
Medium	100-400	Intel Xeon 5160 4 core (2 socket) Server 2 to 10 server nodes	Intel Xeon 5160 Server or p570 1–2 processors (2–4 core)
Large	400+	Intel Xeon 5160 4 core (2 socket) Server 10 or more server nodes	Intel Xeon 5365 Server or p570 1–2 processors (4 core or more) Larger virtual server environments

Small

A typical small system would consist of IBM System x machines, such as the x345 or x360 models.

- Four core processors run application server software. Entry level 4 core (2 chip) servers support up to 25,000 map requests per hour. At six displays a minute, they can support up to 70 concurrent Web users. Typical enterprise solutions include two servers for high availability, which can support up to 50,000 map requests per hour (140 concurrent Web clients).
- Two processors run data server software.

Medium

A typical medium system would consist of IBM System x rack or blade servers for the application tier, and System x, System p, or System z for the database tier.

- From two to ten Intel Xeon 5160 4 core (2 socket) servers support the application tier.
- A single Intel Xeon 5160 4 core (2 socket) server or equivalent capacity System p or System z platform can support the geodatabase tier.

Large

A typical large system would consist of IBM blade servers for the application tier, and System x, System p, or System z for the database tier.

- Ten or more Intel Xeon 5160 4 core (2 socket) servers support the application tier.
- A single Intel Xeon 5365 8 core (2 socket) server or equivalent capacity System p or System z platform can support the geodatabase tier.

Additional details on IBM server and storage products follow.

Sizing resources

ESRI publishes a System Design Strategies white paper twice a year. This comprehensive document provides guidelines for selecting GIS hardware solutions to meet user performance requirements. In this document, see Chapter 8 and other useful chapters at:

http://www.esri.com/systemdesign

IBM server and system storage platforms

This section provides an overview of the hardware platforms and storage components available from IBM.

IBM System p

IT organizations in government and industries must be able to reduce costs through improved resource utilization, while responding quickly to changes in business demands and meeting service quality requirements. Performance, availability, and efficiency top the list of what is required of today's computing environments for UNIX and Linux operating systems. IBM System p models deliver through a family of 1-core to 64-core servers that support AIX and Linux on POWER5™ and POWER6 applications, all on the same system, and at the same time.

Features and benefits

Now we discuss System p benefits.

Figure 7 System p570 16 way in a rack

Performance

The performance of the 64-bit IBM POWER6, POWER5, and POWER5+™ platforms, enabled by multithreading and the AIX operating system, continues to increase with each new system generation. IBM investment in the AIX operating system and virtualization technologies, like Micro-Partitioning™ and Virtual I/O, enable AIX and Linux users alike to increase the utilization of a single system to save costs on hardware, software, energy, maintenance, and space.

Reliability

Reliability is built into every system, along with embedded autonomic security features in the AIX and Linux operating systems and the System p platform. IBM's long history of UNIX innovation, combined with investments in the Linux and open source communities, delivered through the IBM Power Architecture™ roadmap, means more function at less cost with an investment in IBM technologies.

Flexible capacity features enable quick response to changes

The IBM System p product line is equipped with a range of flexible scalability features designed to allow businesses to adjust workloads and performance dynamically — even automatically — to meet constantly shifting priorities. Dynamic LPAR, for example, allows administrators to adjust processor and storage resources across virtual servers (LPARs) by reassigning capacity from idle partitions to partitions that are experiencing high transaction volumes.

Self-managing features contribute to highly available systems

IBM System p servers are designed to help businesses build reliable, resilient computing environments without compromising system affordability. Mainframe-inspired RAS technology built into the system can help automate system monitoring to promote availability and help reduce downtime. For example, these systems can proactively alert IBM to problems, often without requiring intervention. In some cases, IBM may even be able to correct errors before an administrator spots them, greatly reducing troubleshooting time, lowering staffing costs, and limiting service interruptions.

Security features help safeguard key data and IT infrastructure

The AIX operating system offers a robust range of built-in security features to enable administrators to manage Kerberos-authenticated users and their associated principals for a high level of security. System hardening minimizes security exposures by removing unused services from the base operating system, restricting user access to the system and enforcing password restrictions.

For more information about the IBM System p, see:

`http://www-03.ibm.com/systems/p/?cm_re=masthead-_-products-_-sys-pseries`

AIX operating system

The AIX operating system is designed to deliver outstanding scalability, reliability, and manageability to enable businesses to maximize their return on investment in information technology. Business IT infrastructures should have the flexibility to quickly adjust to changing business computing requirements and scale to handle ever-expanding workloads — without adding complexity. But just providing flexibility and performance is not enough. The IT infrastructures also need to provide rock-solid security and near-continuous availability while managing energy and cooling costs.

These are just some of the reasons to choose the AIX operating system (OS) running on IBM systems designed with Power Architecture technology. With its proven scalability, advanced

virtualization, security, manageability, and reliability features, the AIX OS is an excellent choice for building an IT infrastructure. Also, AIX is the only operating system that leverages decades of IBM technology innovation designed to provide the highest level of performance and reliability of any UNIX operating system.

AIX is an open, standards-based UNIX operating system that conforms to The Open Group's Single UNIX Specification Version 3. It provides fully integrated support for 32-bit and 64-bit applications. This operating system provides binary compatible support for the entire IBM UNIX product line, and supports qualified systems offered by hardware vendors participating in the AIX Multiple Vendor Program. AIX is designed to meet the needs of client computing environments ranging from small departmental systems to enterprise class workloads such as data mining, database processing, transaction processing, and high performance computing.

AIX 6.1

AIX Version 6.1 extends the capabilities of the AIX OS to include workload partitions, a new software-based virtualization approach; live application mobility, the ability to relocate applications between systems without restarting the application; new security features to improve and simplify security administration; new availability features inspired by IBM legacy systems; and numerous features designed to make the AIX OS easier and less expensive to manage. This AIX release underscores IBM's firm commitment to long-term UNIX innovations that deliver business value.

AIX 6.1 highlights

The highlights are:

- Next generation of IBM well-proven, scalable, open standards-based UNIX operating system
- New features for virtualization, security, availability, and manageability designed to make AIX 6 even more flexible, secure, and available than previous versions
- Built on IBM POWER6 technology and virtualization to help deliver superior performance, increase system utilization and efficiency, provide for easy administration, and reduce total costs
- Binary compatible with previous versions of the AIX OS, including AIX 5L™ and earlier versions of AIX

AIX 6.1 runs on systems based on POWER4™, PPC970, POWER5, and the latest generation of the POWER™ processor, POWER6. Most of the new features of AIX 6.1 are available on the earlier POWER platforms, but the most capability is delivered on systems based on the new POWER6 processors. The AIX OS is designed for the IBM System p, System p5™, eServer™ p5, eServer pSeries®, and eServer i5 server product lines, as well as IBM BladeCenter blades based on Power Architecture technology and IBM IntelliStation POWER workstations.

For more information about the AIX operating system, see the following Web site:

http://www-03.ibm.com/systems/p/os/aix/overview/index.html

For more information about AIX 6.1, see the following Web site:

http://www-03.ibm.com/systems/p/os/aix/v61/index.html?S_TACT=105AGX12&_CMP=LP

IBM BladeCenter

IBM BladeCenter offers a comprehensive data center solution. With a wide choice of compatible chassis, blade servers, storage and networking offerings, and solution providers,

IBM delivers an innovative approach to blade design. It is an open solution that is easier to manage, uses less power, produces significantly less heat, and is easier to set up and scale compared to traditional rack systems.

BladeCenter features

Now we discuss BladeCenter features.

Chassis flexibility

The BladeCenter chassis forms an IT foundation and can be tailored to the different types of applications, environments, and performance requirements found in businesses today. BladeCenter has five chassis to provide any size, type, and performance level. With BladeCenter, blades and switches can be seamlessly moved between chassis, giving incredibly flexible mix-and-match deployment choices.

Figure 8 BladeCenter chassis and HS21 Blade

Applications run best on specific processors. BladeCenter has a choice of blades that are optimized and targeted for specific workloads. They range from single-socket Intel to four-socket AMD to high-performance IBM and Cell Broadband Engine™ processor-based blades.

Table 3 BladeCenter options

BladeCenter blade	Sockets	Processor
HS21	2	Intel Xeon
HS21 XM	2 (extended memory)	Intel Xeon
LS21	2	AMD Opteron
LS41	4	AMD Opteron
HC10	1 (workstation)	Intel Xeon
JS21	2	IBM POWER
QS20	2	Cell Broadband Engine

Storage flexibility

Clients deploying blades are building enterprise infrastructures or virtual infrastructures that require end-to-end reliability. Moving to external, shared RAID storage can help increase data and application availability and make management easier. IBM delivers a wide range of easy-to-install, external storage products to meet demanding business needs.

- Network attached storage (NAS) - provides a large capacity, highly available, and secure environment for storing mission-critical data.
- Storage area network (SAN) - offers iSCSI and Fibre Channel SANs for high-performance, block-level storage solutions. With IBM System Storage DS3000, DS4000™, DS6000™, and DS8000™, IBM can help create an easy-to-deploy storage solution for SMB or enterprise needs.
- iSCSI SAN - provides a cost-effective alternative to a Fibre Channel SAN by leveraging an existing Ethernet network.
- Fibre Channel SAN - includes integrated storage switches from vendors such as Brocade/McData, Cisco, and QLogic®, and support for industry-leading host bus adapters from QLogic and Emulex.

Availability

IBM understands that resiliency is critical when consolidating multiple servers into a single chassis. BladeCenter was designed with rock-solid availability that helps better protect against a single catastrophic fault taking down the entire system by including many redundant features.

IBM First Failure Data Capture

Tools like Predictive Failure Analysis®, Light Path Diagnostics, and First Failure Data Capture work together to help warn about problems — sometimes even before they occur. That is what is needed when everything depends on IT.

10 Gb Ethernet

10 Gb Ethernet will be the common network in the near future. IBM is a leader in the blade server industry, offering high performance, flexibility, and choice in networking options.

Power and cooling

IBM has pioneered new technologies that allow our blades to generate less heat output and use less energy to cool the system than the competition in comparable configurations. Simply put, IBM BladeCenter can run cooler to potentially deliver significant cost savings in a high-density environment. Based on IBM internal testing, IBM BladeCenter E is 11–19% more energy efficient than HP c-Class, and BladeCenter H is 5–11% more energy efficient than HP c-Class.

IBM PowerExecutive

IBM PowerExecutive™ is software and hardware included with IBM BladeCenter servers. PowerExecutive shows the actual power consumption right now, but also tracks consumption over longer periods of time such as hours, days, weeks, even months.

For more information about IBM BladeCenter systems, see:

http://www-03.ibm.com/systems/bladecenter/advantage/competitive.html

IBM System x

Adding innovation to industry standards, IBM delivers x86 servers — with X-Architecture® technology — that run faster and cooler, use less power, and make ideal platforms for

virtualization. IBM System x and solutions help reduce total costs so that the data center can run efficiently as possible.[6]

X-Architecture technology

IBM X-Architecture technology marries powerful innovation from IBM Research with 40 years of mainframe experience. The result is outstanding x86 server solutions for users. In addition to helping to improve energy management, IBM System x and BladeCenter servers help optimize performance, reliability, and manageability for a potentially lower cost of ownership. So X-Architecture technology provides a comprehensive approach to solving IT challenges today, and a forward-looking approach to designing for tomorrow's challenges.

The X-Architecture design philosophy targets five key areas, as shown in Figure 9.

Figure 9 X-Architecture key areas

Adaptive performance

The line between scale-up and scale-out servers is blurring. Performance becomes about utilization through virtualization, which is crucial to unlocking the value of multicore processors. With all these workloads running on the same server, reliability remains important, but availability becomes more critical than ever. IBM high-performance scalable x86 servers are designed to deliver the highest levels of utilization, flexibility, and availability to the data center, which provides the capability to adjust system performance as needs change.

Modular optimization

Simply put, IBM philosophy regarding rack-based servers is that *innovation comes standard*. IBM is delivering next-generation technology today that the competition cannot match. Some server vendors view uni and 2-socket servers as commodities, using off-the-shelf components to produce cookie-cutter servers with no added value. Instead, IBM X-Architecture system design begins with standard parts and adds practical innovation to create something better: outstanding dual-core and quad-core performance, high availability, scalability, power efficiency, and proactive manageability.

[6] For more information, refer to http://www-03.ibm.com/systems/x/about/index.html.

Figure 10 System x3550 server

Efficient power and cooling

X-Architecture technology helps unleash energy efficiency in IBM's arsenal of x86 rack, tower, and blade servers. Part of the Cool Blue™ portfolio, innovative tools like IBM PowerExecutive and the IBM Power Configurator can provide accurate and precise power information about systems for effective energy management.

Proactive management

Hardware and software tools with proactive, predictive capabilities that simplify deployment, monitor system health, limit power usage, and report pending problems, are crucial to keeping costs under control. With X-Architecture technology, IBM offers a number of tools to help tame the complexity of systems management and administration while managing costs.

For more information about the IBM System x, see:

`http://www-03.ibm.com/systems/x/?cm_re=masthead-_-products-_-sys-xseries`

IBM System z

More and more businesses are relying on mainframe servers. For them, IBM is the clear choice. For over four decades, the IBM mainframe has been a leader in data and transaction serving. IBM understands the cost and complexity of deploying an industry solution and maintaining IT infrastructures. In response, IBM has leveraged its wealth of skills (server, storage, software, services) and those of our partners who deliver industry-specific solution architectures that enable on demand business transformation. The IBM mainframe is central to this work.

Some of the objectives of a System z mainframe are to:

- Lower the cost of people required for maintenance and operations (economics).
- Lower the utility costs of infrastructures (energy efficiency).
- Lower the costs associated with security breaches and downtime (security).

IBM System z mainframe is designed to help businesses rationalize their IT. With over 40 years of experience in enterprise computing, the modern mainframe delivers innovative technologies, support for open and industry standards and modern programming techniques, and may help to lower the ongoing costs of ownership for large-scale computing operations.

The System z9™ models (see Figure 11 on page 21), priced to satisfy a wide range of customer needs, mean that mainframe quality of service is within reach of nearly all organizations. Highly granular upgrade options enable System z platforms to support optimum levels of system flexibility and control. Specialty processors (IFLs, zIIPs, zAAPs) that

help reduce IBM software usage costs and accelerate workload execution make the migration case even stronger. So do security certifications like EAL 5, and the intrinsic security of hipersockets and other unique features. With System z's emphasis on open and industry standards (Linux, Java, and so on), the applications and processes that customers need for a business advantage can efficiently execute.

System z provides an advanced combination of security and resiliency features to enterprises that require high levels of application availability and information processing, and the capability to reallocate resources on the fly to match changing business priorities.

Energy efficiency

System z is a good choice because of its energy efficiency. Data centers comprise racks of servers and storage systems and the connections between them. All systems consume kilowatts of energy and output thermal energy (BTUs). Power and cooling demands are becoming more important as energy prices rise and utilities restrict the amount of power some customers can use. IBM System z offers extraordinary energy efficiency capabilities to help address these issues. IBM System z platform can be configured to require a fraction of the electricity of a distributed server *farm* with equivalent processor capability.

Figure 11 IBM System z9

This is possible because System z servers can run at utilization rates as high as 100% for long periods of time. The power that is consumed is used for transaction processing. Hundreds or even thousands of smaller servers can be replaced by a single System z mainframe. That single System z mainframe does not require external networking to communicate between virtual servers. All of the servers are in a single box with huge internal I/O pathways. This may help performance of complex, interconnected applications and also save power by eliminating data center network infrastructure.

For more information about the IBM System z, see:

http://www-03.ibm.com/systems/z/?cm_re=masthead-_-products-_-sys-zseries

IBM System Storage

IBM System Storage DS™ Family is designed to simplify data migration and allow agencies to meet the rapidly changing requirements of an on demand world. And with a variety of storage options, at a range of highly competitive price levels, one can construct a fully compatible multi-tiered infrastructure that helps optimize the use of information while keeping costs under control.

IBM System Storage offers storage devices to help store, safeguard, retrieve, and share data, while helping extend the ability to be as open, as safe, and as fast as needed.

IBM System Storage DS8000 series

The IBM System Storage DS8000 series has been enhanced to include IBM System Storage DS8000 Turbo models, which offer even higher performance, higher capacity storage systems that are designed to deliver a generation-skipping leap in performance, scalability, resiliency, and total value. Created specifically for mission-critical workloads of medium and large enterprises, the DS8000 series offers powerful data backup, remote mirroring, and recovery functions that can help protect data from unforeseen events. In addition, it supports nondisruptive microcode changes, which can benefit businesses in markets where information must be accessible around the clock, every day of the year. [7]

Highlights

Characteristics of the DS8000 include:

- Designed to deliver robust, flexible, highly available, and cost-effective disk storage to support continuous operations for mission-critical workloads
- Built for outstanding performance and supports 4 Gbps FC/IBM FICON® high bandwidth connectivity for fast access to data
- Offers unique storage system logical partitions (LPAR) capability to help enable consolidation while maintaining separation for differing workloads
- Able to scale up to 512 TB of physical capacity that can be accessed by a wide variety of servers
- Can help to enable greater efficiency for IBM server environments through features such as HyperPAV, cooperative caching, and I/O priorities
- Offers a choice of Fibre Channel and Fibre Channel ATA disk drives, enabling tiered storage usage
- Enterprise Choice warranty of 1, 2, 3, or 4 years on hardware and advanced functions
- Virtualized, resilient, high-performance storage for medium to large enterprises

[7] For more information, see ftp://ftp.software.ibm.com/common/ssi/pm/br/n/tsb00624usen/

Figure 12 IBM DS8000

The DS6000 series

IBM System Storage DS6000 series is designed to provide high availability and high performance in a small, modular package. As part of IBM System Storage DS Family, the DS6800 is designed to provide medium and large businesses with a low-cost, enterprise-class storage solution to help simplify data management and to provide comprehensive data protection and recovery capabilities and easy scalability for both mainframe and open system storage needs. See Figure 13.

Figure 13 IBM DS6000

Highlights

The highlights are:

- Delivers enterprise-class functionality, with open systems and mainframe host attachment
- Supports Fibre Channel disk drives for tiered storage in a single system
- Provides low total cost of ownership by offering tiered pricing on software and a 24x7 IBM onsite repair warranty that covers both hardware and software
- Provides highly available, robust storage solution for medium and large enterprises
- Supports advanced copy services
- Includes software that supports a Web-based intuitive interface and Express Configuration Wizards for simplified system configuration and management

Other series

Other series are:

- The IBM System Storage DS4000 series is designed for mid-range applications.
- The IBM System Storage DS3000 models are for entry-level applications.

For more information about all types of IBM storage products, including software, disk, and tape products, see:

http://www-03.ibm.com/systems/storage/index.html?cm_re=masthead-_-products-_-stg-allstorage

IBM mainframe support for GIS database solutions

With the March 2007 release of DB2 V9.1 for z/OS, IBM added support for spatial data to the System z platform. The work to port DB2 Spatial Extender Linux-Unix-Windows (LUW) code (licensed from ESRI) DB2 V9.1 for z/OS was done by the IBM DB2 LUW and z/OS development teams. IBM also assisted ESRI in porting ArcSDE support for DB2 LUW to DB2 for z/OS. ESRI will certify ArcSDE DB2 Direct Connect™ support for the System z z/OS platform at ArcGIS V9.3 when it is released in 2008.

Support for DB2 9 for z/OS on System z enables ESRI and IBM to offer a spatial information management solution with scalability, multilevel security, and system reliability. It also provides a geospatially enabled solution for users who are moving toward centralization and virtualization, facilitating the move away from networked and distributed server environments, which can be hard to manage.

Eighty percent of the world's corporate data is on System z, so demand for spatial data management and spatially enabled service-oriented architectures on System z is growing. By integrating ArcGIS spatial information management, as well as ESRI ArcGIS client solutions and Web services, a reliable and secure computing platform becomes an enterprise-class application server for insurance, retail, banking, and government customers.

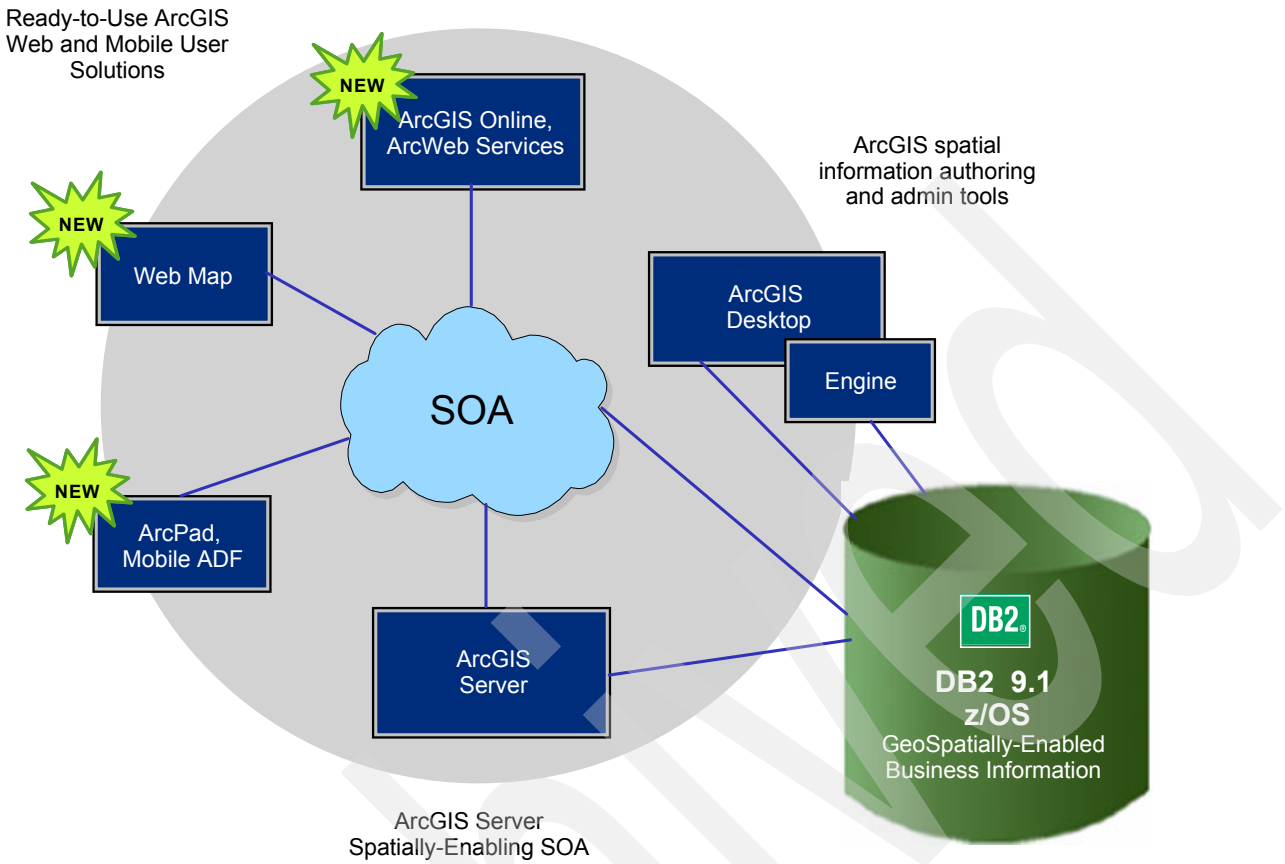

Figure 14 Enabling DB2 9.1 for z/OS for Enterprise Spatial Information Management on System z[8]

Spatial information management on System z provides a unique, high-end enterprise solution for a special group of IBM customers. IBM is experiencing significant growth in DB2 and WebSphere software as well as hardware revenue as existing and new customers embrace the trends that favor the mainframe:

- Continuous availability is more important in the Web world. Mainframe availability is often measured in years between failures.
- Security and regulatory compliance are at the top of corporate priority lists.
- Server sprawl is driving up labor and power costs.
- Total cost-of-ownership pressure is driving server consolidation and virtualization.
- Disaster recovery is becoming a core business requirement.
- The mainframe is the core of SOA.

In the commercial industry, this solution is compelling for those customers with the highest amount of spatially related data and geospatially related business operations: insurance, retail, and banking. For government, the solution is ideal for enterprise geospatial secure platforms supporting national defense and intelligence, homeland security, the nation's food supply, critical infrastructure, and cybersecurity.

[8] Image courtesy of ESRI

Mainframe database connection

For decades, mainframe platforms have been popular repositories for governmental numeric, textual, and date-time data, such as assessor's parcel records. Now, on System z, the host database can store related spatial data, such as property lines, in a format accessible to ESRI tools.

In addition, IBM DB2 Universal Database (for Linux, UNIX, and Windows) can store numeric, textual and date-time, and spatial data, supporting the ESRI geodatabase model. Using geodatabase server middleware, GIS desktop applications such as ArcInfo can connect to a DB2 geodatabase on these platforms and display spatial tables as layers in a graphic map. But related System z or System i™ host data remains isolated.

How can GIS users combine relational host data and spatial data for seamless access in a desktop, mobile, or Web application, for example, an identity-click on an assessor's parcel map that returns current attribute data from all related sources?

DB2 includes local views (called nicknames) of System z or System i tables that behave like regular local DB2 tables. Nicknames in DB2 identify the tables located on host systems. Applications such as ArcMap can connect to the DB2 database and query the data sources using nicknames as though they were tables or views in the local DB2 database, even though they actually reside on the remote system.

Users and applications send queries to the DB2 database, which retrieves necessary data from the remote system, pushing parts of the query work to the host database if this is the most efficient way to retrieve results, taking factors such as CPU, workload, and network bandwidth into account.

Overall, the architecture of this solution provides a unified datasource to any GIS client capable of connecting to a geodatabase. Once the remote system and the DB2 geodatabase are set up for nicknaming, ESRI's geodatabase server, ArcCatalog, and ArcMap will treat all tables, nicknames, or otherwise, identically.

Customer use examples

This section provides examples of the configurations of two GIS customers.

Pierce County, Washington state

Pierce County government in the state of Washington implemented GIS in 1989. They now serve 700 users in 25 county departments, including 100+ users in each of 10 subscribing agencies. Their staff has built and supported 86 business applications, including 28 on the desktop and 58 that are Web-based. ESRI products include ArcInfo, ArcView, ArcPad, and extensions. Their staff consists of a manager, six developers, two analysts, eight technicians, and one and a half server support people. Their system contains 600+ GIS data sets including orthos.

They consolidated their existing environment into a three-tier architecture consisting of four IBM BladeCenters, two x445 Database servers, and IBM Storage. Figure 15 shows Pierce County's environment.

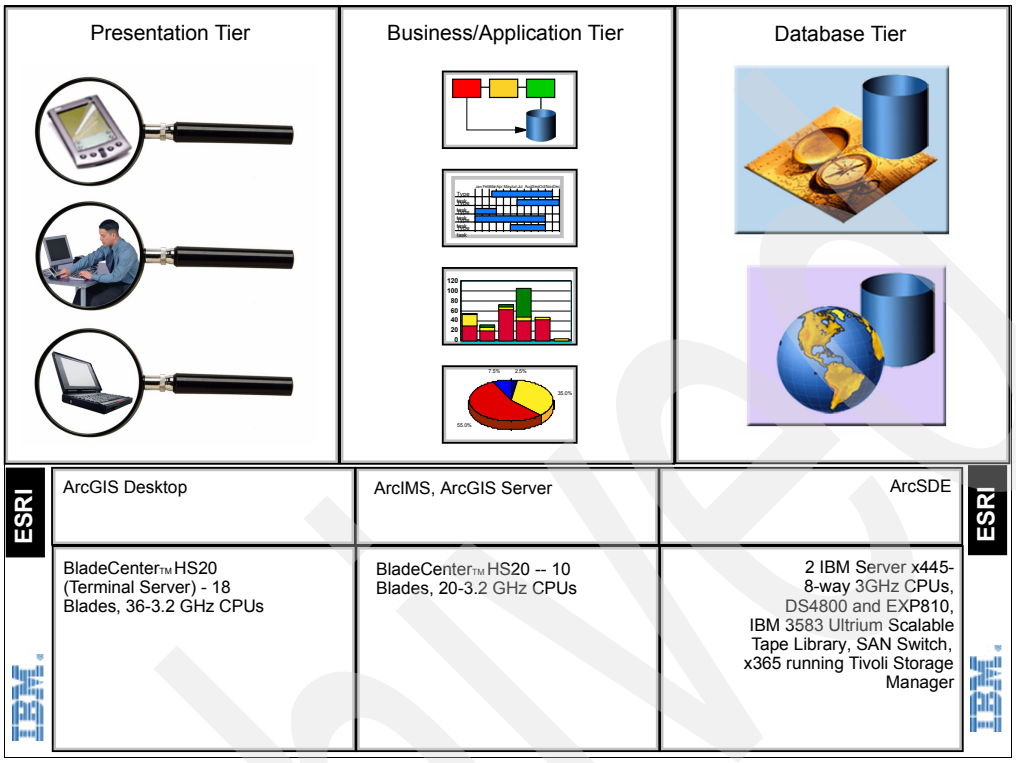

Figure 15 Pierce County configuration

Pierce County GIS at a glance

In Pierce County:

- Application

  The need to manage multiple GIS applications and GIS data sets, consolidated to a single product family

- Business benefits

  Server consolidation, providing a savings of nearly $3 million in total IT expenditures over the next four years, reduced system complexity, current level of staff support, added database redundancy and application failover, as well as incremental backup and data recovery capabilities, less power and floor space, more consistent yearly costs, reduced software licensing fees, and the lowest possible cost for capacity

- Software

  Tivoli Storage Manager Extended Edition, Tivoli Storage Manager for Databases

- Hardware
  - Servers
    - BladeCenter HS20
    - System x 335
    - System x 365
    - System x 445

– Storage

- Disk: DS4800 with EXP810
- Storage Area Network (SAN): SAN switch
- Tape and Optical: 3583 Ultrium Scalable Tape Library

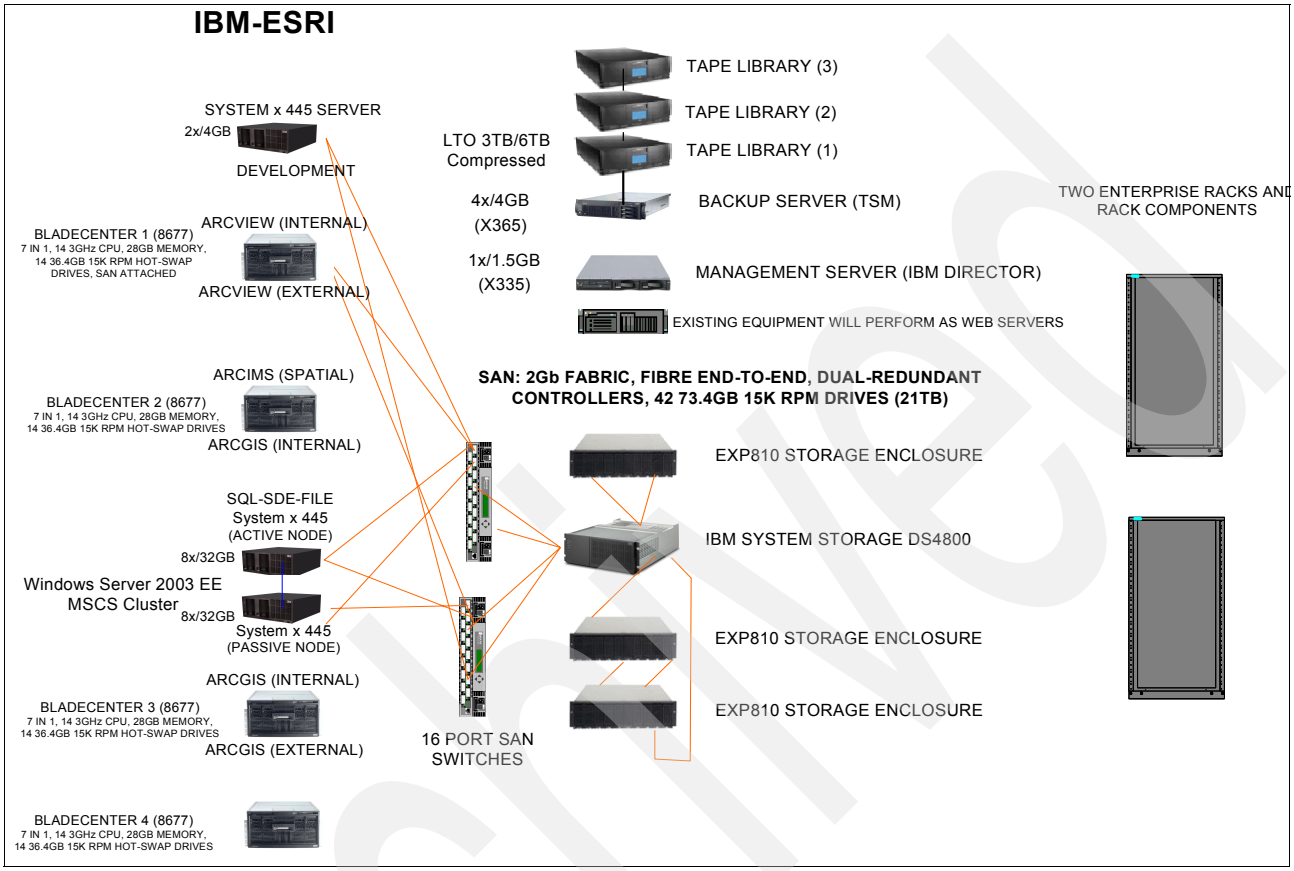

Figure 16 Pierce County configuration

FEMA

The Federal Emergency Management Agency (FEMA) implemented an automated full life-cycle mapping process to create the digital flood maps fundamental to their successful operations. Faced with the challenge of out-of-date flood maps, FEMA initiated the efforts to introduce innovations to the mapping process so that property owners and other stakeholders could accurately gauge the flood risk associated with a property parcel.

To launch the FEMA Map Modernization project, FEMA sought to enable a highly decentralized team of independent mapping contractors, giving them the mapping tools and associated training they needed online. IBM Global Business Services helped Michael Baker, Inc. to deploy the Mapping Information Platform for FEMA to provide the contractor community with:

- Mapping tools to produce and maintain digital flood hazard data and maps
- Program management tools to monitor and control map development
- Access to flood hazard data and maps via the Internet
- A state-of-the-art, secure, scalable, and reliable infrastructure

The Mapping Information Platform combines IBM information technology infrastructure and ESRI's spatial technology infrastructure to provide a fully scalable environment to support

FEMA's business requirements. IBM Global Services deployed System p and System x servers to support a software infrastructure including WebSphere Application Server, WebSphere Portal Server, WebSphere Process Choreographer, DB2, and ESRI technology.

FEMA chose to manage the required information by integrating flood hazard maps with the GIS database that makes data available via the internet. The ESRI tools deployed are based on the ESRI Production Line Tool Set (PLTS) for ArcGIS. This software was specifically developed for high-volume database production, maintenance, quality control, and cartographic production such as was required by FEMA.

Development of the required maps begins with Job Tracking for ArcGIS (JTX), a workflow management application designed to improve the efficiency of multi-user GIS projects. Through JTX, FEMA mapping partners create flood hazard products by progressing through a FEMA-defined set of best practices workflow steps. The ability of JTX to facilitate the assignment of work among users allows mapping partners to efficiently manage their mapping projects.

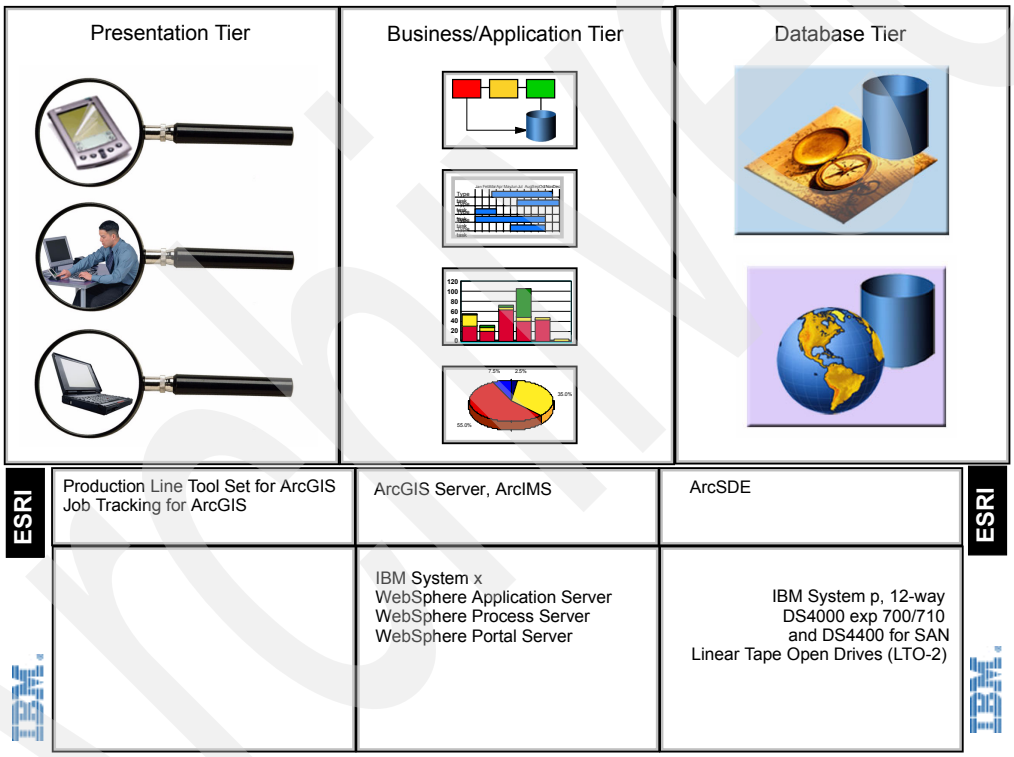

Figure 17 FEMA configuration

Summary

The ESRI and IBM alliance provides an integrated portfolio of geographic information system technologies, services, and solutions. This portfolio includes:

- ESRI's suite of GIS modeling and mapping software for a full range of customer requirements
- IBM infrastructure technology with spatial databases, middleware, servers, and storage
- Implementation, system integration, and support services

The portfolio can be purchased as components, which are assembled into custom solutions, or purchased together in bundles that provide GIS function or solutions that address specific problems.

For more information see our list of Web sites below.

Perhaps the greatest value ESRI and IBM integrated technology and solutions brings to their customers is the capability to provide the lowest total cost of ownership. This is accomplished through off-the-shelf ESRI GIS technology that is scalable, easily deployable, and all-inclusive, as well as through IBM financing options, solution design expertise and implementation tools such as server optimization technology, storage management, virtualization tools, and server consolidation.

The authors of this Redpaper

This Redpaper was produced by the International Technical Support Organization in Poughkeepsie, NY.

- **Rob Culp** is an IBM Alliance Manager for the ESRI Strategic Alliance.
- **Mike Ebbers** is a Technical Writer and Project Leader in the IBM ITSO.
- **Frederick Niemiec, Jr.** is an IBM Solutions Enablement Manager in the ISV Business Strategy and Enablement organization.

Appendix: Web sites with more information

ESRI sites

- ESRI

  http://www.esri.com/
- ESRI support

  http://support.esri.com/
- ESRI products overview

  http://www.esri.com/products.html
- ESRI ArcGIS family

  http://www.esri.com/software/arcgis
  http://www.esri.com/partners/hardware/ibm/index.html

IBM sites

- DB2

  http://www.software.ibm.com/data/db2
- DB2 Spatial Extender

  http://www.software.ibm.com/data/spatial
- WebSphere

  http://www.ibm.com/software/websphere/
- IBM solution sizing tools

  http://www.developer.ibm.com/welcome/eserver/e3/CSFServlet?mvcid=main&packageid=3000
- IBM System x

  http://www.ibm.com/systems/x/
- IBM System p

  http://www.ibm.com/systems/p/
- IBM BladeCenter

  http://www.ibm.com/systems/bladecenter/
- IBM System Storage

  http://www.ibm.com/servers/storage/disk/
- GIS from IBM and ESR

  http://www.ibm.com/industries/government/doc/content/solution/258998109.html
- IBM announcement on System z

  http://www-03.ibm.com/systems/z/energy_efficiency/
- IBM DB2 9 for z/OS system requirements (see chapter 5)

  http://publibfp.boulder.ibm.com/epubs/pdf/i1087370.pdf
- IBM DB2 9 for z/OS library

  http://www-306.ibm.com/software/data/db2/zos/v9books.html
- *Spatial Support for DB2 for z/OS User's Guide and Reference,* GC19-1145-00

Notices

This information was developed for IBM products and services offered in the U.S.A. For ESRI product availability in other countries, consult their Web site at: http://www.esri.com

IBM may not offer the products, services, or features discussed in this document in other countries. Consult r local IBM representative for information on the products and services currently available in r area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give any license to these patents. can send license inquiries, in writing, to:
IBM Director of Licensing, IBM Corporation, North Castle Drive Armonk, NY 10504-1785 U.S.A.

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at r own risk.

IBM may use or distribute any of the information supply in any way it believes appropriate without incurring any obligation to.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

COPYRIGHT LICENSE:
This information contains sample application programs in source language, which illustrates programming techniques on various operating platforms. may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs. may copy, modify, and distribute these sample programs in any form without payment to IBM for the purposes of developing, using, marketing, or distributing application programs conforming to IBM's application programming interfaces.

This document REDP-9128-01 created or updated on January 9, 2008.

Send us your comments in one of the following ways:
- Use the online **Contact us** review IBM Redbooks form found at:
  ibm.com/redbooks
- Send r comments in an e-mail to:
  redbook@us.ibm.com
- Mail r comments to:
  IBM Corporation, International Technical Support Organization
  Dept. HYTD Mail Station P099
  2455 South Road
  Poughkeepsie, NY 12601-5400 U.S.A.

Trademarks

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

Redbooks (logo) ®
eServer™
pSeries®
z/OS®
z9™
AIX 5L™
AIX®
BladeCenter®
Cool Blue™
DataBlade®
DB2 Universal Database™
DB2®
DS4000™
DS6000™
DS8000™
FICON®
Informix®
IntelliStation®
IBM®
Micro-Partitioning™
PartnerWorld®
Power Architecture™
PowerExecutive™
Predictive Failure Analysis®
POWER™
POWER4™
POWER5™
POWER5+™
POWER6™
System i™
System p™
System p5™
System x™
System z™
System z9™
System Storage™
System Storage DS™
Tivoli®
WebSphere®
X-Architecture®

The following terms are trademarks of other companies:

Cell Broadband Engine and Cell/B.E. are trademarks of Sony Computer Entertainment, Inc., in the United States, other countries, or both and is used under license therefrom.

QLogic, and the QLogic logo are registered trademarks of QLogic Corporation. SANblade is a registered trademark in the United States.

AMD, AMD Opteron, Direct Connect, the AMD Arrow logo, and combinations thereof, are trademarks of Advanced Micro Devices, Inc.

ESRI Trademarks, Registered Trademarks, and Service Marks appearing in the IBM Redpaper *Infrastructure recommendations for an ESRI and IBM Geographic Information System:* ESRI®. ArcGIS®, ArcGIS℠, ArcObjects™, ArcInfo®, ArcEditor™, ArcView®, ArcReader™, EDN℠, ADF™, ArcSDE®, ArcWeb℠, ArcCatalog™, ArcMap™, ArcPad®, PLTS™, JTX™, www.esri,com, and www.gis.com.

Java, Sun, Ultra, and all Java-based trademarks are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.

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

Intel, Intel Xeon, Itanium, Itanium 2, Intel logo, Intel Inside logo, and Intel Centrino logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries 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.

SPEC, SPECfp2000, SPECfp_rate2000, SPECint2000 and SPECint_rate2000 are registered trademarks of the Standard Performance Evaluation Corporation.

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