

Smarter Environmental Analytics Solutions: Offshore Oil and Gas Installations Example

IBM Redbooks Solution Guide

Environmental monitoring is an essential task for completing the environmental impact studies that are needed by oil and gas companies to obtain a license from the authorities to operate. Traditionally, environmental monitoring is done by sending expeditions of scientists to collect samples and measure important environmental parameters. This approach is costly and impractical, especially because oil and gas exploration is expanding into harsher environments. What is needed is an automated and real-time environmental monitoring system that is integrated with the operational systems of oil and gas companies. This is what the IBM® Environmental Analytics (EA) solution for offshore oil and gas installations is all about.

This IBM Redbooks® Solution Guide describes a solution for implementing smarter environmental monitoring and analytics for oil and gas industries. The solution implements real-time monitoring of environmental data to facilitate early detection of, and response to, operational events surrounding offshore oil and gas installations. The solution is shown in Figure 1. Although the solution that is described here is specific to the oil and gas industries, IBM Environmental Analytics solutions can be extended to other industries as well.

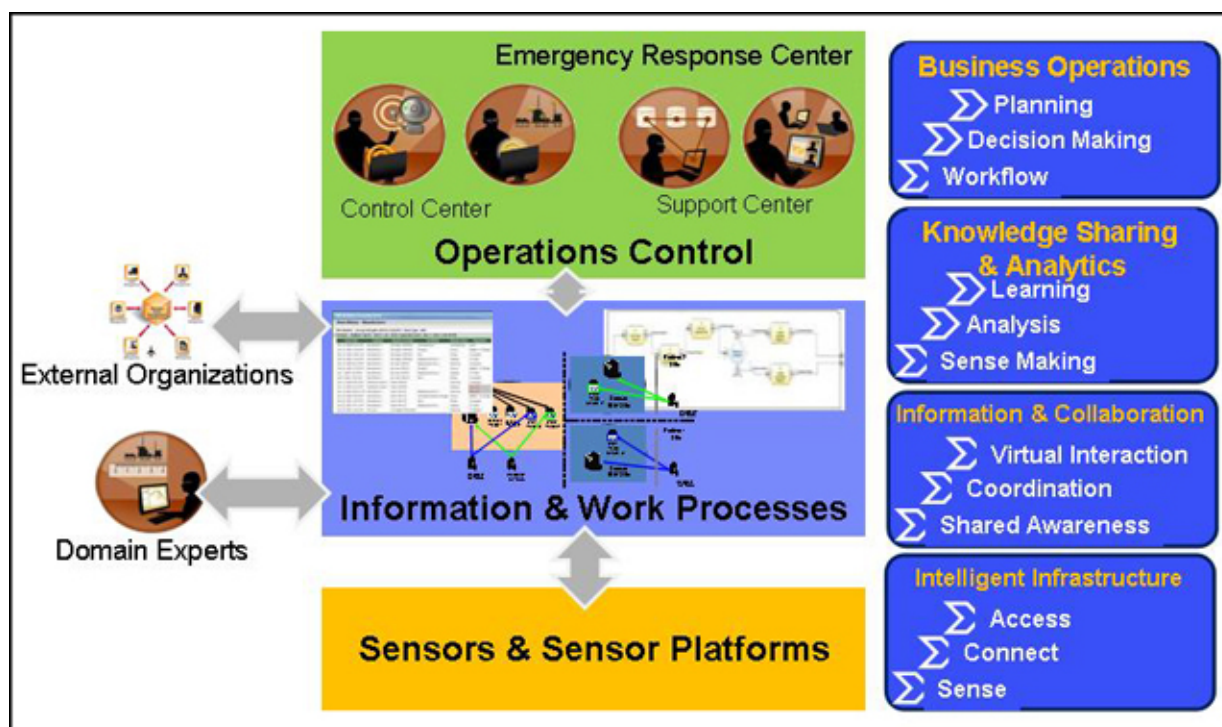


Figure 1. Environmental Analytics (EA) solution

The Environmental Analytics solution for offshore oil and gas installations (hereafter referred to as the *Environmental Analytics solution* or *EA solution*) uses various sensors and sensor platforms to monitor critical parameters of the undersea environment. These parameters are used by various stakeholders to identify and evaluate the effects of oil and gas operations on the environment. The EA solution makes this information available to the stakeholders, which include personnel in operation support centers, environmental experts centers, emergency response centers, and other external organizations. It enables the various stakeholders to collaborate on identifying and managing incidents that may negatively affect the operations and the environment. Using the EA solution, various experts can visualize and analyze the information in context to collaborate on evaluating the criticality of the information and the consequences of actions or inactions, and to make the appropriate decisions and coordinate the actions.

Did you know?

The total world consumption of energy is projected to increase by over 40% by 2030. More energy resources are coming from unconventional sources (for example, oil sands or shale), but not all. Exploration for upstream oil and gas continues to reach new and previously untapped areas (spending in this area is expected to exceed \$1.6 trillion, up from the current spending of \$1.3 trillion); as a result, conventional sources continue to increase as well. According to the U.S Geological Survey, almost one-quarter of the undiscovered, technically recoverable hydrocarbons in the world might be contained in an area north of the Arctic Circle. That source alone amounts to 90 billion barrels of undiscovered oil, 1,670 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids in 25 areas.

Concurrently, environmental regulation and concerns over operations in the oil and gas industry are escalating because of highly publicized incidents such as the Deepwater Horizon catastrophe in the Gulf of Mexico. As a result, oil and gas companies are under increasing pressure to demonstrate that their operations, especially in sensitive areas such as the arctic region, are safe and under control. This presents both a challenge, and an opportunity, for IT to provide solutions that can monitor exploration and production in such regions, providing real-time visibility and control with innovative sensors, information acquisition systems, and analytics. The EA solution that is described in this solution guide uses the power of semantic technology to address this problem.

Business value

The EA solution that is described in this solution guide has the following business benefits. Although the business benefits that are listed here are for the Chemicals & Petroleum Industry, similar benefits can be obtained for other industries when Environmental Analytics based solutions are used to solve business problems.

- Safer operations with minimized environmental impact: Oil and gas companies can monitor and reduce the environmental impact of their operations by using this solution because the EA solution integrates environmental monitoring with daily oil and gas operations systems providing early detection and faster response to remedy the potential environmental impact.
- Reduce operating costs: The solution provides real-time monitoring of environmental data, as opposed to traditional environmental monitoring techniques, which are not real-time and are done manually and are labor-intensive. It also reduces the risk of paying hefty penalties for causing environmental damages.
- Accelerate the process of obtaining a license to operate: The solution supports oil and gas companies in the process of obtaining a license from the authorities to operate in environmentally sensitive area.
- Flexibility to manage a changing world: Using semantic technology as the foundation of the solution allows customizing the solution for new concepts and relationships without changing the schema.

Solution overview

The EA solution provides an infrastructure for collecting operations data and analyzing it to observe manufacturing operations' effects on the environment. The significant use case in the Chemicals & Petroleum Industry is about collecting data during under sea drilling. The data that is collected is then analyzed to determine whether any damage is being done to the surrounding environment.

Figure 2 shows the major subsystems (functional areas) of the solution.

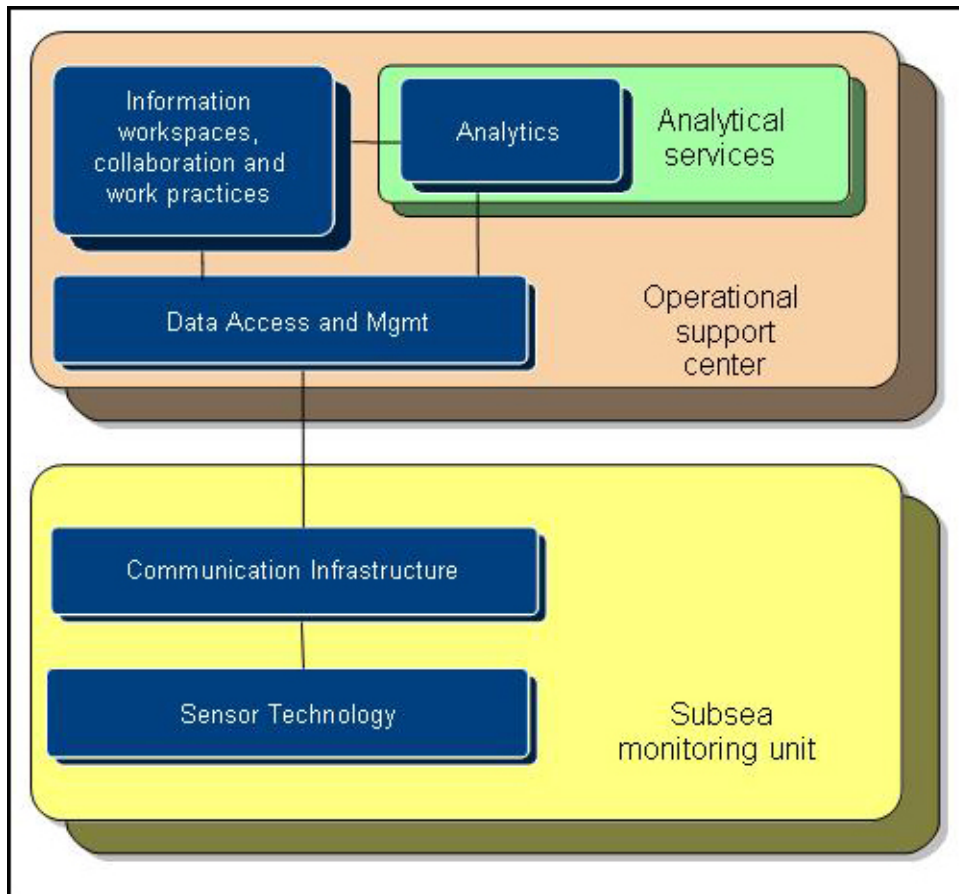


Figure 2. Solution overview

Here are descriptions of each subsystem:

- **Sensor Technology:** The Sensor Technology subsystem contains sensors for real-time monitoring of the environment. Only "Common Off The Shelf" (COTS) sensors are used. The use case decides which sensors are demonstrated.
- **Communication Infrastructure:** For subsea operations, the communication system transmits data to the surface unit. It can transmit data wirelessly and through cables. In cabled situations, optical fiber is preferred. When no infrastructure exists, an acoustic communication system is used. The surface unit receives data from the subsea unit, visualizes it, and makes it available to the Data Access and Management subsystem. It consists of a Controller PC, a data monitor, and an OPC Unified Architecture (OPC-UA) data server. OLE for Process Control (OPC) is a standard tool that is used to have Windows programs communicate with industrial hardware devices.

- **Data Access and Management:** The Data Access and Management subsystem contains databases for the storage of data that is acquired by the Sensor Technology and Communication Infrastructure subsystems, an integration framework for the delivery of this data and data from other customer systems and external systems to Information Workspaces, collaboration and work practices' and Analytics subsystems, and a semantic domain model for integration of data from the various information sources.
- **Information Workspaces, Collaboration and Work Practices:** This subsystem provides functionality for the visualization of the data that is gathered by the Sensor Technology and Communication Infrastructure subsystems, and the relevant information from the runtime systems on the oil drilling platform, other customer systems, and external systems. It also visualizes problems or events that are detected, and the results of the analysis. In addition, it contains functions for the definition and management of the actions that are identified.
- **Analytics:** The Analytics subsystem makes it possible to apply the marine environment and geographic information system (GIS) risks and advanced data analytics to the data that is provided by the Data Access and Management subsystem.

Solution architecture

The Environmental Analytics Solution architecture is shown in Figure 3.

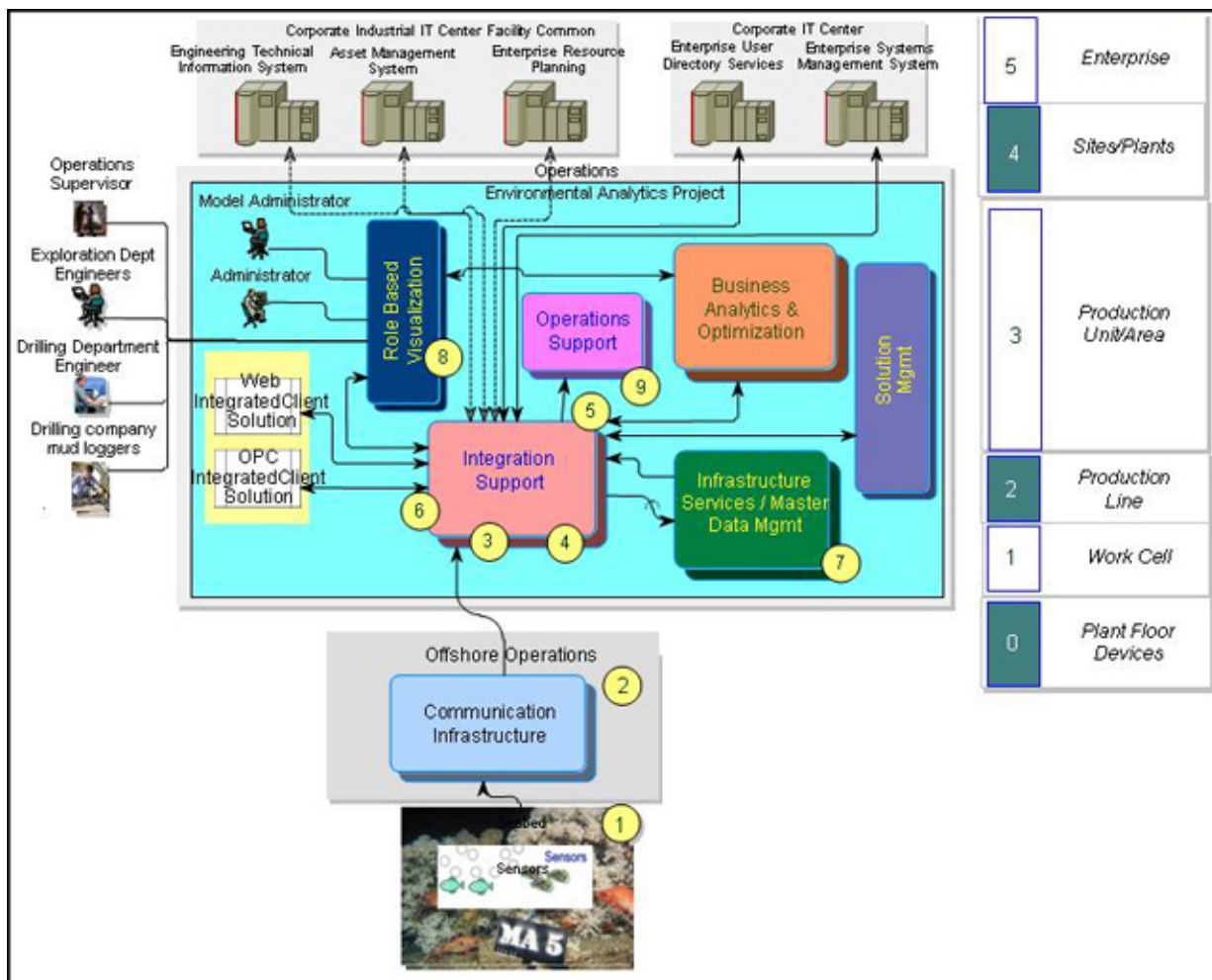


Figure 3. Environmental Analytics Solution architecture

Figure 3 shows the high-level architectural overview for the Smarter Environmental Analytics solution. The main functional areas are shown, and the actors that interact with the solution. The stacked rectangles on the right show the levels of an industrial company as defined by the ISA-95 standard. The yellow, numbered circles show a sequence of events throughout the infrastructure. Those events are:

1. Sensor signals (measurement or image) are sent from the seabed (acoustic or wired).
2. A surface transmitter stores temporary storage in the OPC-UA (OLE for Process Control -Unified Architecture) data server and publishes data.
3. The integration hub data historian application receives the subscribed data (through the OPC-UA gateway).
4. The measurement or image is stored and, for some use cases, a key performance indicator (KPI) is calculated.
5. A KPI or alert is published to Operations Center as a Common Alerting Protocol (CAP) message.
6. The KPI is written back to the data historian application.
7. The event is logged in the event log.
8. An engineer evaluates the situation.
9. For some use cases, a Standard Operating Procedure (SOP) (a set of established procedures to be followed in a given situation) workflow might be triggered.

The Environmental Analytics Solution components architecture is shown in Figure 4.

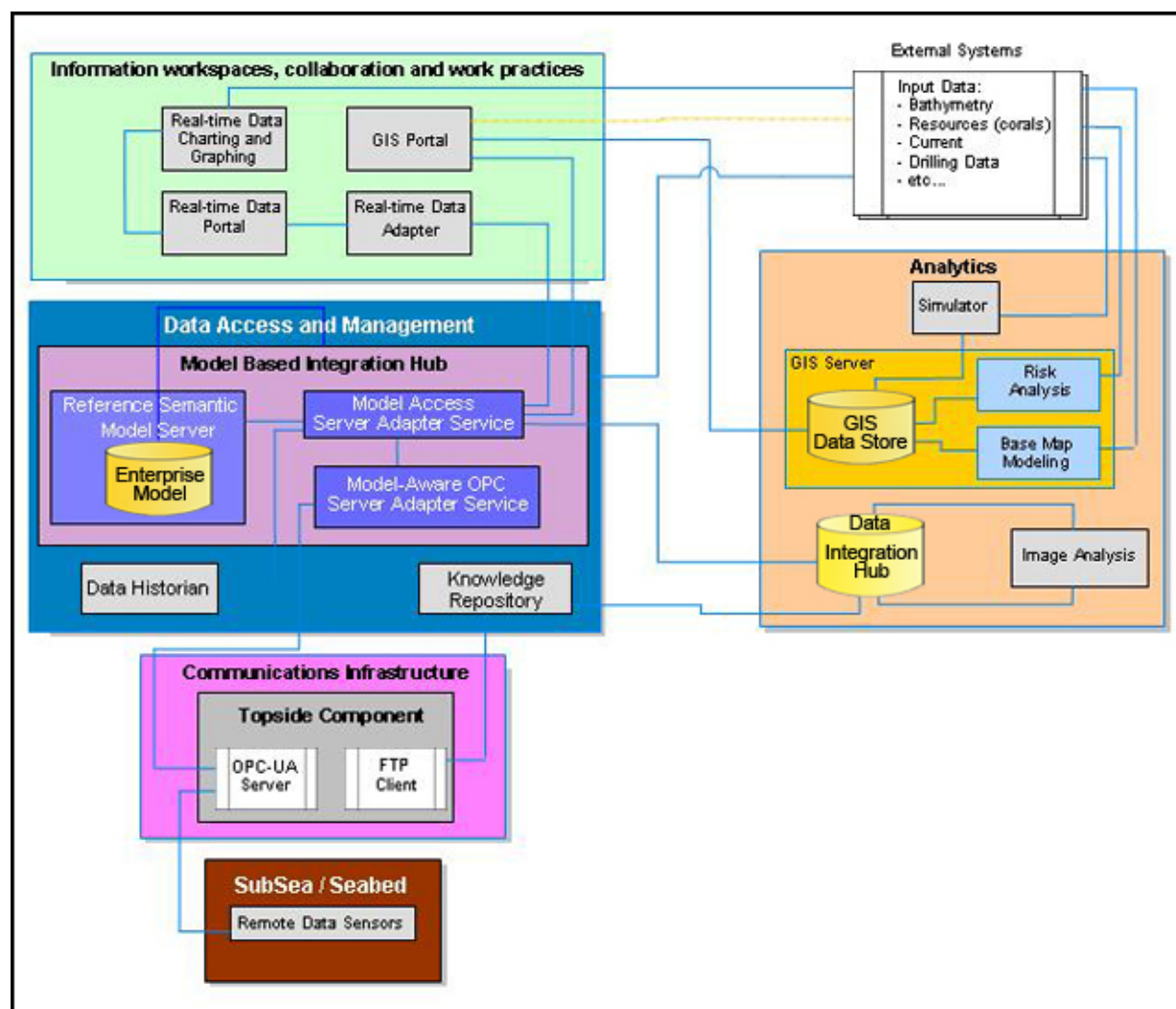


Figure 4. Environmental Analytics Solution components architecture

The components of the solution are further described here:

- The *Communication Infrastructure* component receives the data from the operations area. It is the interface between the physical manufacturing area (for example, the ocean floor oil drilling site) and the IT systems that turn manufacturing data into information for the enterprise.
- The *Model Based Integration Hub* is the main integration component of the solution. It contains the adapters to interpret the different types of data that is received from operations. It also contains the Reference Semantic Model Server, which is a standards-based information model (Enterprise Model) that is used to harmonize the enterprise domain with the operations data. For more about the Reference Semantic Model, see *Foundational Ontologies for Smarter Industries*, REDP-5081. This component also has Model Access Services, which are standard services that can be used by clients to access information in the Enterprise Model.

- The *Analytics* components are responsible for all analysis of the different types of data that is coming from the manufacturing operations area. The *geographic information system (GIS) Server* integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. Imagine Analysis determines the extent to which some aspect of the environment is being affected by operations, for example, the sedimentation level in the images of the seabed. The *Data Integration Hub* provides a single point of access to different types of information in different locations.
- The *visualization layer* consists of a four main components. The *Real-time data adapter* is responsible for the integration with the Reference Semantic Model for measurement data from operations. It also integrates with, through Wellsite Information Transfer Standard Markup Language (WITSML), the *Real-time Data Portal*, which is responsible for the visualization of maps showing sensor locations, water current, and other environment events. In addition, the *Real-time Data Charting and Graphing* component supports the visualization of data, including charting, graphing, and collaboration. Also, the *GIS Portal* component is the client side of the GIS Server component, which is used for web visualization of the GIS information.

Usage scenarios

This section shows how the EA solution is used for the environmental monitoring of drill cuttings. Drill cuttings are produced as the rock is broken by a drill bit advancing through rock or soil. Drill cuttings must be transported onshore (at a high cost) for handling if drilling takes place near environmentally sensitive locations with biological resources, such coral or sponges. If care is not taken, an environmental risk is possible where the biological resources can be buried by the drill cuttings, and the water column is left with suspended drill cuttings particles. With the EA solution, oil and gas companies can monitor the water current (speed and direction) in real time, and release drill cuttings so that the current takes them away from sensitive areas, thus obviating the need to transport them onshore. This alternative to transporting the drill cuttings may be granted by the authorities on the condition that real-time monitoring is performed to prove that no harm is done to the environment.

There are three main users of this solution for the drill cuttings use case: the environmental coordinators, the drilling operation managers, and the Health, Safety, and Environmental (HSE) experts. All of these users need to clearly identify the location and to understand the status of the environmentally sensitive resources that are found in the area where drilling is planned. The EA solution helps these users (and their associated teams) to visualize the environmental data along with the drilling information, and to collaborate to accomplish their respective tasks. The EA solution is used by support centers that consist of multidisciplinary teams that remotely monitor and analyze multiple drilling data with the associated environmental data. The support centers provide support for integrated operations to ensure the availability (and validity) of real-time data towards the overall goal of ensuring safe and efficient drilling operation.

The three main users are described in this following list:

- **Environmental Coordinator (EC):** The EC uses the EA solution portal to identify the location of environmental sensitive spots in relation to the location of the wells in the area. This information is needed both in the planning phase and in the operational phase. The EC might participate in setting the environmental monitoring strategy in the early stages and in developing and running an environmental monitoring process for certain sites. The EC uses the EA solution to get as much information as possible about the status of the sensitive environmental resources of interest to identify possible risks and to assess the environmental impact of drilling operations.
- **Drilling Operations Manager:** This user is responsible for drilling activities during planning and execution phases. The manager uses the EA solution to ensure that drilling activities are performed with no harm to the environmentally sensitive resources that are in the proximity of the drilling area.

- HSE Expert: The HSE expert uses a risk-based approach to make decisions based on their potential effects on the environment. The expert is involved in the whole lifecycle of an oil field, from project planning to operations and decommissioning.

Supported platforms

The EA solution is built on the IBM Intelligent Operation Center (IOC). IOC Version 1.6 supports the following Linux platforms:

- Red Hat Enterprise Linux (RHEL) 5 Advanced Platform x86-64
- Red Hat Enterprise Linux (RHEL) 5 Server x86-64

For detailed system requirements for IOC, go to the following website:

<http://www-01.ibm.com/support/docview.wss?uid=swg27035952>

To access the IBM information center for IOC Version 1.6, go to the following website:

<http://ibm.co/1i1RDhY>

Ordering information

Table 1 shows the ordering information for IBM Intelligent Operation Center V1.6. To order the EA solution, contact your IBM sales representative because the solution is bundled with services.

Table 1. Ordering part numbers and feature codes

Program name	PID number	Charge unit description
IBM Intelligent Operation Center V1.6	5725-D69	User Value Unit (UVU)

Related information

For more information, see the following resources:

- *Foundational Ontologies for Smarter Industries*, REDP-5081
- Press release:
<http://www-03.ibm.com/press/us/en/pressrelease/36675.wss>
- Statoil presentation on environmental analytics:
<http://bit.ly/1hly94Z>
- *The role of semantic models in smarter industrial operation*:
<http://www.ibm.com/developerworks/xml/library/x-ind-semanticmodels/index.html>
- Smarter Natural Resources:
http://w3.tap.ibm.com/medialibrary/media_view?id=163850

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