Improving Upstream Oil and Gas Operations with the IBM Integrated Operations Solution

IBM Redbooks Solution Guide

The IBM® Integrated Operations solution gives oil and gas companies direct visibility into upstream processes and delivers actionable, analytics-based insights to aid in planning, condition monitoring, production optimization, and equipment management, as well as to address health, safety, and environmental challenges. Using advanced IBM software products, the solution can ingest a wide variety of information gathered from equipment in the field, perform advanced analytics on the collected data, and provide specific maintenance and operational recommendations to keep things flowing smoothly.

With the Integrated Operations solution (see Figure 1), you can:

- Monitor wells and reservoirs and predict their performance and production
- Identify ways to optimize future production and hydrocarbon delivery
- Monitor equipment health to predict failures and improve maintenance and repair cycles
- Identify the root causes of upstream performance issues and equipment failures
- Orchestrate multi-disciplinary workflows based on a variety of analytical techniques

The solution combines some powerful IBM offerings, including IBM Integration Bus Manufacturing Pack to integrate data from sources such as field-based sensors, IBM InfoSphere® Streams to process the data in real time, and IBM Intelligent Operations Center to integrate, model, and monitor the data for of analysis. IBM Predictive Maintenance and Quality analyzes and scores the data and provides recommendations, while IBM InfoSphere BigInsights™ finds new insights in volumes of structured and unstructured data.

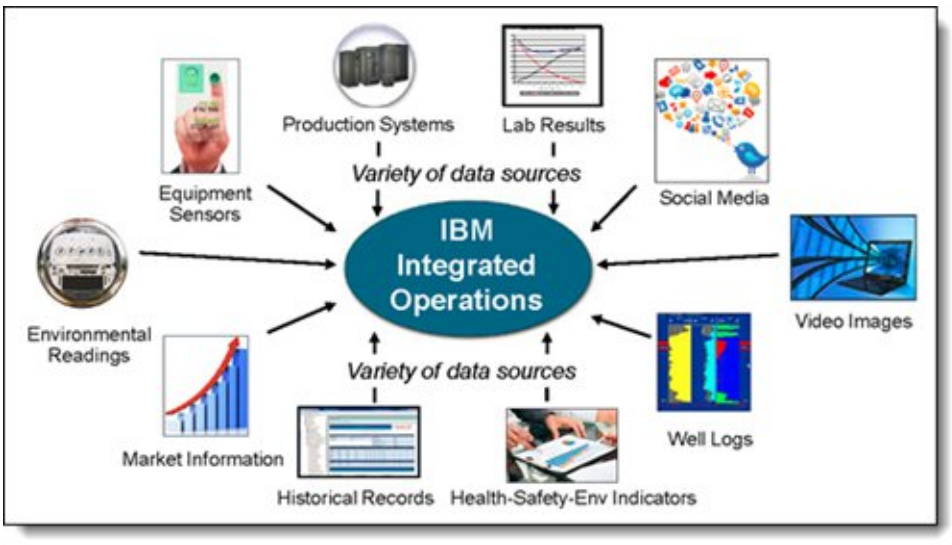

Figure 1 - The Integrated Operations solution receives data from a variety of sources

Did you know?

To implement the Integrated Operations solution in your enterprise, IBM consultants can assess your current operations issues and identify specific products and configurations that can help. Integrated Operations goes beyond simply connecting disparate oil and gas systems and data. It provides advanced predictive analytics to help optimize your day-to-day production and maintenance activities and help you develop more forward-looking strategies.

Business value

In one sense, the value of an integrated operations solution for the oil and gas industry is obvious: Greater efficiency in upstream operations can have a big impact on profit and loss. But this new IBM solution has many facets, so it is worth taking a more detailed look at how Integrated Operations can have direct, positive impacts on a variety of upstream production activities.

Benefits of the Integrated Operations solution fall into these broad categories:

- Operations

  The solution helps improve overall operations by reducing non-productive time (NPT) for production assets, optimizing equipment and plant turnarounds, and by providing timely access to upstream information to support more informed decision making. Globally, NPT is estimated to cost oil and gas companies billions of dollars annually. If you are not drilling or producing, you are not making money.

  For example, in a drilling operation, the solution can process multiple real-time data streams from the wellbore and integrate that information with measurement data from the rig. The results can then be *scored* by a predictive model (created during solution set-up and then refined as drilling goes on) to generate critical alerts for drilling managers in the field.

- Reservoir, well, and facilities efficiency

  Oil and gas companies employ numerous techniques to improve the efficiency of a reservoir and its wells. One emerging method is to integrate real-time production data from the field with higher level analytics and visualization tools. High pressures and temperatures, leaks, or other negative developments must be detected as early as possible in order to maintain the optimal performance.

  The solution enables this kind of early problem detection. One example is monitoring mud pressure, which can identify potential down-hole problems such as sudden drops in flow rate. Using the solution, engineers can see real-time data from sensors and get dashboard alerts so they can prevent a well from loading up. In addition, Integrated Operations enables predictive analytics on operations data and provides data-driven insights for making better business decisions.

- Production optimization

  Integrated Operations helps you maximize hydrocarbon output by integrating (and using) data from the operations, logistics, supply chain, environmental, and other systems.

  For example, Integrated Operations can maximize the daily production rate of wells by monitoring real time gas and oil ratios (GOR), mud and drilling fluid pressures, and so on, to confirm that the extractable resources that comply with health, safety, and environmental guidelines, all while preventing unwanted escape of pressurized hydrocarbons.

- Forecasting and allocations

  Improved forecasting of hydrocarbon production is a constant goal for oil and gas companies. You need to be able to allocate that production (by well, for example) to joint venture partners or to fulfill other allocation requirements.

  The solution allows for greater visualization and analysis of current and future operations data, so it helps enterprises to better understand and predict future production output. These predictions of future production volumes, based on current flow rates and reserves, can then be used to communicate to downstream operations and interested partners.

- Facilities maintenance

  In the oil and gas industry, it is imperative to keep equipment up and running to maintain acceptable levels of productivity. The Integrated Operations solution can greatly improve asset maintenance by helping you predict when equipment needs to be repaired. It does this by constantly analyzing incoming sensor measurements against pre-defined specifications.

  Not only does the solution analyze the performance of the equipment itself, but it can be integrated with systems governing logistics, schedules, or capacities, which helps you determine the best *times* to perform maintenance. This reduces downtime which is extremely costly.

- Cost reduction

  Data-driven analytical models such as those used in the Integrated Operations solution can serve as proxies for physical sensors, gauges, and meters. So not only can the solution save money through improved, more efficient asset maintenance, it achieves additional savings by enabling the use of these *virtual sensors* in place of more costly physical sensors.

  Consider an unconventional field with thousands of wells and electronic submersible pumps (ESPs). Rather than putting a sensor on each ESP, it may be possible to categorize the ESPs (such as by equipment type or position in the coal seam) in a way that would allow just a few physical sensors to predict failures in a field full of wells and ESPs.

Solution overview

The Integrated Operations solution builds on the fact that equipment with attached sensors generates temporal data, such as temperature, pressure, and other readings, that can be tagged with the asset or equipment ID for the item being monitored. This data can then be collected and used (together with other, pre-existing data such as maintenance schedules) in analytical models that predict field performance, hydrocarbon production, equipment failures, and other metrics. In upstream oil and gas operations, equipment that can be monitored includes platforms, risers, drills, pumps, separators, condensers, compressors, turbines, and pipelines. The data from this equipment is stored and can be augmented with data from other production systems.

The Integrated Operations solution has these main logical components or layers:

- Data Acquisition

  This layer uses a set of adapters that connect the instrumented production equipment to higher-level enterprise systems such as enterprise asset management (EAM) and enterprise resource planning (ERP) systems, portals, or dashboards. The data acquisition layer is responsible for integrating all required data into the Data Services layer.

- Data Services

  This layer stores all of the necessary data for the solution. The data can be operations data from production systems, including real time device data, historical data, master data, key performance indicators, files, maps, videos, and other structured or unstructured data. It also manages the meta data that describes the operations data and the semantics of how that data is to be interpreted by the solution.

- Advanced Analytics

  This layer is responsible for the development, training, deployment, and operational management of advanced analytical models, including statistical modeling and scoring tools. The solution provides different levels of analytics:

  - Descriptive analytics, which involves visualizing data as it is, unchanged.
  - Predictive analytics, which involves predicting what will happen based on existing and historical production data.
  - Prescriptive analytics, which involves optimizing processes and systems based on analysis of production data.

- Role-based Visualization

  This layer provides you with the relevant visualizations you need to perform your roles. Visualizations include dashboards, reports, graphs, administrator consoles, and so on.

- Business Process Management

  This layer is responsible for the development, deployment, and orchestration of business workflows or processes that combine instances of the capabilities in the above-described layers to perform end-to-end business functions. Such business processes can automate many activities that are currently done manually using spreadsheets, email, or phone calls. This, in turn, allows people to collaborate more, according to their role, to solve particular business problems.

Solution architecture

Some of IBM's most advanced products and software are responsible for enabling the Integrated Operations solution to do all that it does. This section provides a brief look at the solution architecture (Figure 2).

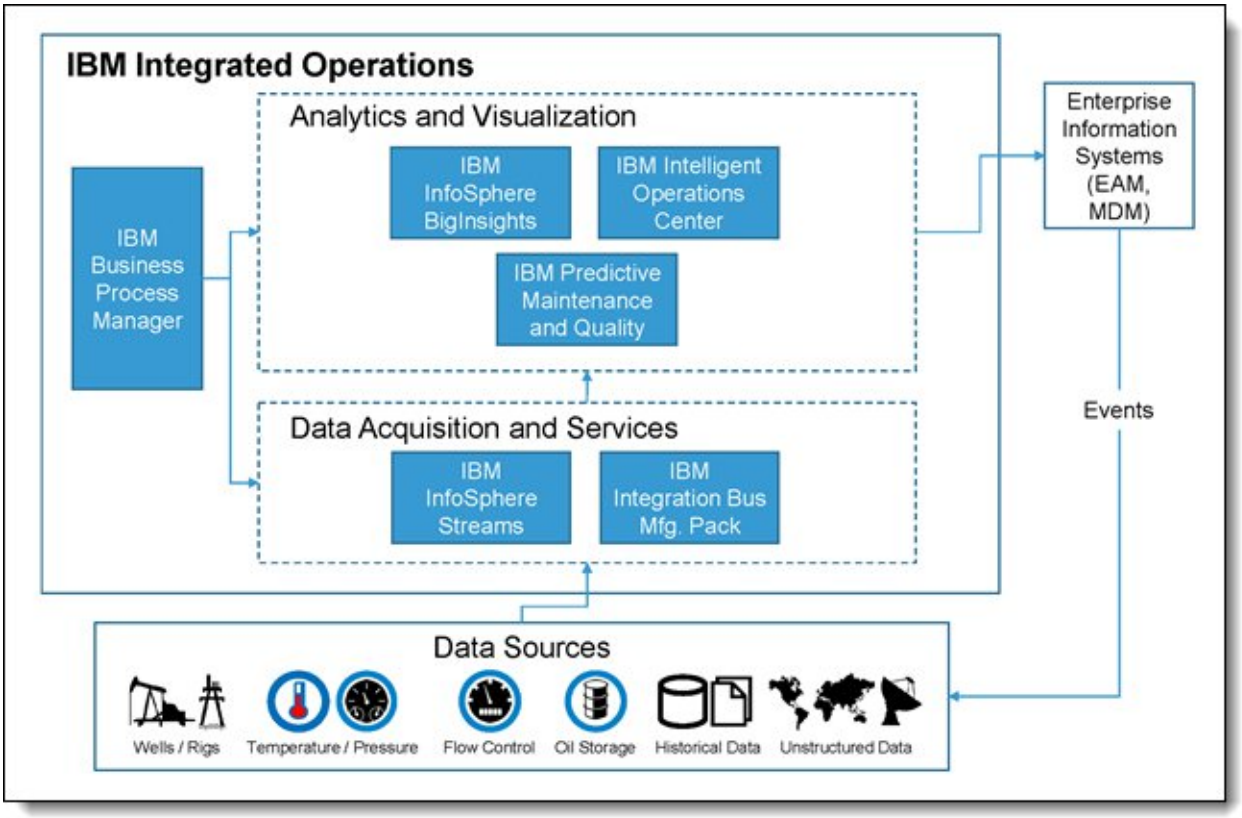

Figure 2 - High-level view of the Integrated Operations solution

The recommended topology of the Integrated Operations solution includes these IBM products.

IBM Integration Bus Manufacturing Pack

The solution uses IBM Integration Bus Manufacturing Pack to move data between production devices and enterprise systems. The Manufacturing Pack builds on existing Integration Bus technology, providing enterprise service bus capabilities (including protocol conversion, message mediation, and transformation) and support for integrating additional applications commonly used in the petroleum industry, such as OSI PI or Aspentech IP21.

In particular, Integrated Operations utilizes these features of Integration Bus Manufacturing Pack:

- Open Platform Communications (OPC) Unified Architecture connectors to read OPC data from the OPC servers
- OSIsoft PI connectors to read directly from an OSI PI Server
- MQTT connectors to read, write, publish, and subscribe to MQTT messages
- A web interface for visualizing operations data from a manufacturing point of view

IBM InfoSphere Streams

InfoSphere Streams enables real-time analytic processing of data streams such as those from a production field. These fields generate massive volumes of moving data (such as flow rates, temperatures, or tank levels) that need to be continuously analyzed in order to improve business insight and decision making.

In particular, Integrated Operations utilizes these advanced InfoSphere Streams features:

- Streams can ingest, filter, analyze and correlate (based on pre-defined rules) both structured and unstructured data such as that received from sensors or cameras in oil and gas fields.

- Streams can issue alerts to users to take appropriate action within a specific time frame. For example, Streams could detect that a pressure sensor reading is consistently too high and trigger a text or email message to the appropriate personnel.

- Streams allows cross-referencing of sensor data with maintenance schedules, closed-circuit videos, and so on to drive accurate predictions of wear and tear on an asset.

IBM Intelligent Operations Center

IBM Intelligent Operations Center (IOC) offers integrated data visualization, real-time collaboration, and deep analytics that together help oil and gas companies prepare for problems and coordinate and manage response efforts.

The following features of IOC are vital to the Integrated Operations solution:

- Integration of maps, reporting, and a rules engine to support decision making.

- A semantic model that shows contextual data relationships and allows users to access the data by reference using standard data models, schemas, or ontologies. A semantic model, for instance, can show the relationships between a well, its seismic information, its sensors and sensor measurements, its well logs, its surveillance camera video stream or images, its work order, and other related data. This ability to query a holistic view of a resource and related resources by relevancy increases operational efficiency.

- Correlation of situational awareness, emergency response standard operating procedures (SOPs), and workflows to automate and track SOPs for consistency and auditability.

- Collaboration tools for users to report issues and check resolution status, even using their mobile devices.

- An executive dashboard that presents a unified view of operations across multiple locations.

IBM Predictive Maintenance and Quality

The Predictive Maintenance and Quality solution (PMQ) provides advanced analytics and reporting capabilities of the Integrated Operations solution. The beauty of PMQ is that it can analyze large datasets, collected over time, and predict the best maintenance procedures and schedules for oil and gas production assets. In addition, PMQ provides seamless, automated, two-way integration with IBM Maximo®, an optional enterprise asset management (EAM) system.

In addition, because PMQ is a pre-configured software bundle of its own, it provides these additional analytics components that are critical to the Integrated Operations solution:

- IBM SPSS® Modeler provides many of the solution's predictive analytics capabilities. It uses sophisticated analytical models to predict when asset maintenance is needed before major and costly failures occur. It also has the ability to perform root cause analysis and discover the top reasons for failure of each asset.

- IBM SPSS Decision Management analyzes the events from IBM Maximo (or other EAM systems such as SAP Plant Maintenance) based on established rules and creates recommended actions for the responsible personnel.
- IBM Cognos® Business Intelligence provides the solution's critical visualization capabilities. It can display analytic data in a variety of standard or custom dashboards and reports, helping users visualize site overviews, asset status, product quality, material usage, and other information.

IBM InfoSphere BigInsights

IBM InfoSphere BigInsights is IBM's Hadoop engine for storing and analyzing big data. BigInsights provides vital features for discovering and analyzing valuable business information that might be hidden within large volumes of data from disparate sources. It supports big data analysis including text analytics, categorization, correlation, and data mining. This type of software can help you analyze well logs and notes, in combination with system records, to correlate unstructured and structured data in order to establish patterns and insight that will help uncover potential drilling problems.

BigInsights can analyze hundreds of petabytes of raw, loosely structured or unstructured data to identify trends and patterns in documents, emails, blogs, news reports, or social media content. BigInsights helps to bring enterprise-grade security, governance, availability, and integration into existing data stores and tools.

IBM Business Process Manager

IBM Business Process Manager is a comprehensive business process management (BPM) platform that provides deep visibility and insight to better execute and manage business processes. It provides capabilities for process design, execution, monitoring, and optimization, along with basic system integration support. Process designers of the oil and gas companies can create flexible business processes that automate operations, customized analytical process and ingest human interactions if desired. Existing business systems (including third-party systems) can be integrated with the IBM Integrated Operations solution using IBM Business Process Manager to create one succinct process and view its operations.

Usage scenarios

Several specific usage scenarios demonstrate how the Integrated Operations solution can be used to great advantage in upstream oil and gas processes. As explained above, data from various sources are either ingested into the data store or are referenced without actually being moved:

- Near real-time data visualization

  Oil and gas companies need to rapidly integrate, process, and examine near real-time production and operations data such as gas and oil ratios (GOR), well pressure, temperatures, and so on. This data can come from devices and sensors in any of the company's instrumented production areas. Once the data is integrated, it can be presented in a meaningful way using visualization tools including reports, dashboards, and role-based desktops.

  Field engineers must monitor well conditions and act immediately when a potential problem arises, such as a kick that sends an unwanted influx of gas or fluid into the wellbore. By using the Integrated Operations solution to monitor the real time data from field-based sensors, engineers can immediately shut down a well as soon as a kick is detected.

- Near real-time data visualization with advanced analytics

  Oil and gas companies often need to do more than just visualize production data. You need to perform advanced analytics on it, too. This can include both descriptive and predictive analysis,

where data is also used as input for predictive models that can help identify what is likely to occur in the future.

Advanced analytics helps oil and gas companies in areas such as asset management and maintenance. For example, companies can use statistical models to predict the equipment maintenance needs for drill rigs, pipelines, mud circulation systems, and so on based on individual wells' production rate revealed through real time sensor data.

- Model-based data integration with advanced analytics

  Hydrocarbon production requires engineers to perform some very complex operations, so they need a holistic view of all available information to make the best decisions regarding which oil or gas wells to drill, or how much of the resource to extract from each well.

  Integrated Operations supports the formation of this kind of deep knowledge base by analyzing and exploiting semantic relationships for data aggregation. Intelligent Operations Center, for example, creates semantic models from existing production data. These semantic models, in turn, link data with different formats from different sources, allowing users to access the data by relevancy and see a holistic view of resources.

- Advanced analytics only

  Even without model-based data integration, advanced analytics still helps many companies better assess how their business is doing. With PMQ, users can view inspection charts that show failure rate of equipment or view warranty charts that show absolute replacement and wear rates of equipment. When equipment, like a pump or tank, is predicted to have a high likelihood of failure, the user can view the recommended time schedule for maintenance and, if it is not soon enough, issue a work order to perform it immediately.

Integration

IBM Integrated Operations can be integrated with other systems in several broadly defined categories.

Device message hubs

IBM MessageSight is a device message hub that can be used in conjunction with InfoSphere Streams. Similar to a traffic cop, MessageSight routes massive volumes of messages and events from devices to Streams and other applications. It also provides access control to allow authorized applications to fine tune their subscriptions to certain types of messages from devices.

Enterprise asset management systems

IBM Maximo is an enterprise asset management (EAM) system that supports the creation of work orders through a self-generated web service. The PMQ solution, which is part of Integrated Operations, includes a process flow that can call the Maximo web service to create a work order when an asset or piece of equipment requires maintenance.

Incident or case management systems

When data is ingested and analyzed by the solution, InfoSphere Streams, Integration Bus Manufacturing Pack, or PMQ can each generate events and alerts. If desired, these events and alerts can be sent on to incident or case management systems, such as IBM Case Manager, for further processing and even assignment of tasks to the proper personnel. When used in this way, the solution logs these incidents with comprehensive data to help the assigned personnel to choose appropriate corrective responses and their progress can be tracked and viewed.

Modeling and simulation systems

Analytic results from the Integrated Operations solution can be used by other modeling or simulation tools to generate flow models, or to perform two-dimensional or three-dimensional simulations, or static, dynamic, or stochastic simulations, of wells and reservoirs. These simulations simplify planning and reduce risks for uncertain petroleum operations.

Supported platforms

InfoSphere Streams, Integration Bus Manufacturing Pack, Integrated Operations Center, Predictive Maintenance and Quality, BigInsights, and Business Process Manager are all supported on 64-bit Red Hat Enterprise Linux (RHEL). The hardware supporting these components can be System x servers with quad core processors.

Some components of the solution can run on other operating systems. For details about other operating systems and hardware, read the additional product information available in the “Related Information” section later in this document.

From a deployment perspective, this solution can support a cloud-based or on-premise deployment model. Contact your IBM representative for assistance in choosing the deployment model that best fits your needs.

Ordering information

The Integrated Operations solution is comprised of separate IBM products and solutions that together can provide a 360 degree view of upstream oil and gas operations. Use these hyperlinks to learn more about ordering the specific components you want to be part of your Integrated Operations implementation:

- IBM Integration Bus Manufacturing Pack:

  http://ibmurl.hursley.ibm.com/MZK1

- IBM InfoSphere Streams:

  http://ibmurl.hursley.ibm.com/MZK2

- IBM Intelligent Operations Center:

  http://www.redbooks.ibm.com/abstracts/tips1161.html?Open

- IBM Predictive Maintenance and Quality:

  http://ibmurl.hursley.ibm.com/MZK3

- IBM InfoSphere BigInsights:

  http://ibmurl.hursley.ibm.com/MZK4

- IBM Business Process Manager:

  http://ibmurl.hursley.ibm.com/MZK5

Related information

Visit these locations to learn more about the products that comprise the Integrated Operations solution:

- IBM Offering Information page (to search on announcement letters, sales manuals, or both):

  http://www.ibm.com/common/ssi/index.wss?request_locale=en

  On this page, enter <`solution name; remove angle brackets`>, select the information type, and then click Search. On the next page, narrow your search results by geography and language.

- IBM Integration Bus Manufacturing Pack
  - Product page:

    http://www-03.ibm.com/software/products/en/integration-bus-manufacturing-pack

  - IBM Knowledge Center:

    http://ibmurl.hursley.ibm.com/MZK6

- IBM InfoSphere Streams:
  - Product page:

    http://www-03.ibm.com/software/products/en/infosphere-streams

  - IBM Knowledge Center:

    http://www-01.ibm.com/support/knowledgecenter/SSCRJU/SSCRJU_welcome.html

  - *IBM InfoSphere Streams: Redefining real-time analytics processing (white paper):*

    http://public.dhe.ibm.com/common/ssi/ecm/en/imw14704usen/IMW14704USEN.PDF

- IBM Intelligent Operations Center
  - Product page:

    http://www-03.ibm.com/software/products/en/intelligent-operations-center

  - IBM Knowledge Center:

    http://ibmurl.hursley.ibm.com/MZK8

  - *IBM Intelligent Operations Center for IBM Smarter Cities® Administration Guide (IBM Redbooks® publication):*

    http://www.redbooks.ibm.com/redbooks/pdfs/sg248061.pdf

- IBM Predictive Maintenance and Quality
  - Product page:

    http://www-01.ibm.com/software/analytics/solutions/operational-analytics/predictive-maintenance

- IBM Knowledge Center:

  http://pic.dhe.ibm.com/infocenter/pmq/v1r0m0/index.jsp

- *IBM Predictive Maintenance and Quality (Version 2.0) (IBM Redbooks Solution Guide):*

  http://www.redbooks.ibm.com/abstracts/tips1130.html?Open

- IBM InfoSphere BigInsights:
  - Product page:

    http://www-01.ibm.com/software/data/infosphere/biginsights

  - IBM Knowledge Center:

    http://pic.dhe.ibm.com/infocenter/bigins/v2r0/index.jsp

  - BigInsights for Hadoop Community:

    https://developer.ibm.com/hadoop

- IBM Business Process Manager:
  - Product page:

    http://www-03.ibm.com/software/products/en/business-process-manager-family

  - IBM Knowledge Center:

    http://ibmurl.hursley.ibm.com/MZK9

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