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ISIS—A Real-Time Information Pipeline

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Abstract

BP's ISIS technology (Integrated Subsurface Information System) is changing the way BP manages reservoirs through the provision of multi-disciplinary analysis and visualisation of real-time integrated dynamic surveillance data, information and knowledge processes. The technology enables faster and integrated operational decision making, provides continuous real-time access to all digitally acquired sensor data in a well or on the platform, on a 24/7 basis, alerting users to production events which require their attention and can be acted upon. The tools developed by the ISIS Technology Program turn the vision of a real-time data pipeline into a reality by providing an innovative solution for remote visualization of information. The technology provides a robust environment for the transfer of data from the point of acquisition to the point of decision-making.

ISIS and the parallel facilities/operations project entitled D2D (data to desk) use common systems for real-time data management and visualisation. While these developments serve the distinct discipline needs of the subsurface and facilities/operations communities in terms of computational processes, there is a single collaborative system sharing technology of mutual benefit to all communities.

The ISIS system is being deployed across BP's operations as a key element of BP's FIELD OF THE FUTURE programme (1). Initial installation has been completed in seven operational assets across BP that has proven the capabilities and business benefit of the technology. Installation of the technology has been the catalyst for changing the way the field teams approach surveillance; these changes are being enhanced through use of adaptive change projects with the field teams which are changing the way BP operates its fields.

Introduction

The ISIS system arose from recognition within BP that there was an imminent need to handle large volumes of subsurface sensor data as the technology delivered by the BP's iWell project came to fruition. At the time, in 2000, BP had a limited number of fields with installed in-well sensors that had a sustained history of data acquisition. These were predominately in North Sea wells where the temperature and pressure conditions were conducive to sensor survivability. At the time the data from the in-well sensors were acquired through the production facility control systems or dedicated acquisition systems and re-evaluated on an historic basis once the data was transmitted to the office. The iWells project indicated that vendor sensor technology was moving forward with new sensor types and improving sensor survivability in harsher well bore conditions, which would deliver greater data volumes for field engineers to analyze.

The ISIS project brief was to deliver a system that would enable the subsurface user community to access and interpret in-well sensor data. Following a period of detailed review and design of potential system outcomes, the first working prototype of the ISIS system was installed in the Schiehallion field that is operated out of BP's Aberdeen office. This prototype proved the project concepts, immediately delivered value to the field, was rapidly adopted by subsurface engineers and operations engineers within the field team and provided senior BP management an indication of the potential to be gained from adopting FIELD OF THE FUTURE technology. The prototype system provides the capability for engineers to see real-time data displayed in a web browser window, which can be configured by the engineers. The system originally delivered as the ISIS prototype has been installed in a number of fields across BP.

The prototype system consisted of a number of components that were bought off the shelf comprised of data historians and processing industry web-enabled graphical components, which were integrated by the BP ISIS team into a single system.

Following on from the success of the original prototype, the ISIS program moved onto the second stage of its plan development, which provides quality-assured data to the engineer and a mechanism to alert the engineer to events in the reservoir or production system.

The installation of the ISIS technology within a field has led to the field team and individuals within the team exploring how they can work differently with the technology, with the support of the FIELD OF THE FUTURE team.

This paper will cover an overview of the ISIS technology, the design criteria and principles, some success criteria, and the challenges faced deploying the technology.

ISIS Technology Overview

ISIS provides the technology and processes required to move data from the point of acquisition through to decision makers, enabling them to make production decisions and implement the relevant actions. ISIS allows users to access and view surveillance data in real time on a web-enabled visualisation system. It automatically cleans and conditions data and alerts users to changes in the well or production system, creating a more proactive approach to reservoir performance management. Users can observe up-to-the-minute field data wherever they have access to the BP intranet network through a web browser and without the need for specialized user software.

The surveillance data are displayed through interactive web browser graphical displays comprised of time-series graphs, cross plots, tables and topological diagrams, which enable users to extract the information they require. The navigation feature enables subject area technical specialists to provide support to the fields through use of a consistent interface.

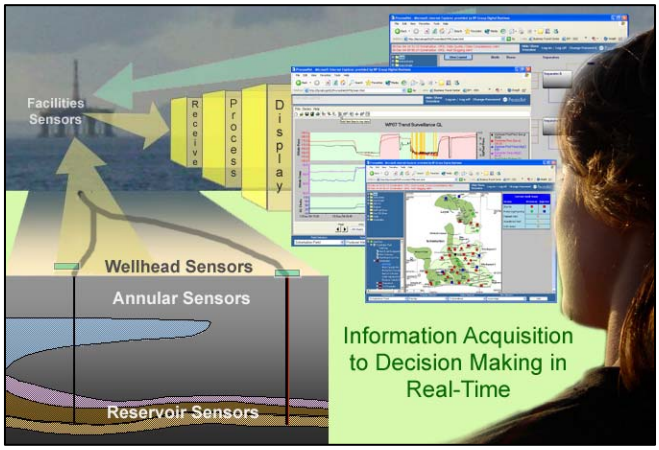

Figure 1: ISIS Web Interface

One of the challenges faced in the implementation of ISIS has been the recognition that the data acquired in a field is the responsibility of a number of engineering disciplines. Consequently the movement of data from the point of acquisition to the end users has required BP to define an "information pipeline," which consistently handles each data connection within the system until it reaches the real-time surveillance data base. Vendors supplying proprietary data acquisition systems will be required to provide interfaces to enable the "information pipeline" to transfer data into BP's database. To enable this BP supports open data interface standards such as WITSML(2) for drilling data and has encouraged POSC to publish a DTS data transfer format, both of which are based on IT web service technology.

The ease of access to the real-time surveillance data has led to greater integration between disciplines within BP's field teams, with greater cooperation between discipline teams from subsurface through to production operations. This change in behaviour has in part come about through the immediate visibility of the impact of operational decisions or actions on the field performance, and the recognition that all disciplines have a role to play in production delivery. The Schiehallion team, who were the first to receive the ISIS technology, is leading the way in changing the processes they use to operate their field.

Delivery of the continuous stream of real-time surveillance data to the field teams provided an interesting challenge. Office-based engineers who are supporting a field are now able to see events as they are happening in a field and provide operational support that is leading to improved production efficiency.

The event detection and alerting system has started to influence the way in which BP's office-based teams support field operations. For the Schiehallion team this has become an extension of the way in which they work, through a series of processes looking at how they will manage events and handle alerts that has led to significant enhancements of the event detection and alerting system in the latest version of ISIS.

ISIS Design Principles, Solutions and Process Change

From the outset the ISIS system has been designed to a set of principles that have shaped the delivered technology and continue to shape new functionality in the development stages. These design principles have insured installation flexibility that has enabled the ISIS system to be installed in 7 fields by the end of 2005, with installation in a further 20 fields by the end of 2006, and additional installations planned for 2007.

The design principles are:

- **The system must be capable of being used with existing fields and fields being developed.**

The system has been designed to work with sensor equipment; control systems and communication systems installed in existing fields and have the capability to handle new equipment and sensors which may be installed on developing fields. From the outset ISIS has been designed to work with minimal sensor requirements that provide basic functionality through to more advanced functionality and capability with the addition of more sensors. In practice, for the subsurface community the minimum requirement is for a wellhead pressure and temperature sensor installed that is

linked into a control system. As the base ISIS system is used as the platform for D2D technology delivery, the minimum requirement is for sensors that are monitoring any piece of equipment.

ISIS has been designed to be extensible and to handle any measurement that acquired in real time as a date/time data value pair. To achieve this BP is designing ISIS to use web service interfaces as part of a broader move to a Service Oriented Architecture. Sensor data will either be accessed by web services by going through an intermediate stage such as a data historian linked to the DCS or through making data directly available as a web service, as is the case with DTS using the POSC standard.

This design principle has made it possible to install the ISIS system at scale and pace throughout BP. The ISIS design, which is independent of vendor supplied sensor packaged systems, control systems, communication systems and data historians, gives BP the flexibility to install ISIS system irrespective of the equipment installed within a field. The openness of the ISIS design also means that there are no limitations, cost or technical, on what data can be stored, processed and displayed through the browser interface. At the local level, within the field teams, uses and applications of the real-time surveillance data are being prototyped, which extends the capability of the ISIS/D2D system.

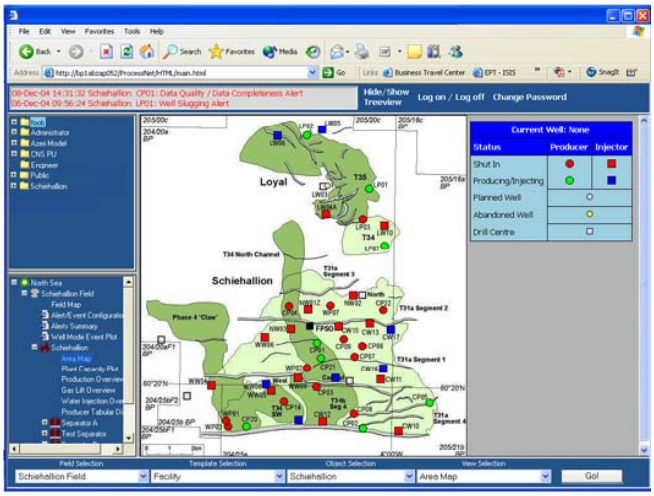

Figure 2: ISIS Schiehallion Installation

The ISIS system has also been designed to handle and store time series array-style data, for example DTS data that requires processing and storage a series of data values at single points in time. This functionality has been implemented and is being tested on the Azeri field. The ISIS DTS modules in test provide BP with the capability to observe and detect DTS temperature changes that are not an artifact of a change in the production system. The ISIS DTS implementation also illustrates BP's commitment to using web service technology, where BP has taken the lead in working with the industry, through POSC, to deliver an open data exchange format.

- **Allow unrestricted and unlimited access by all engineers supporting the field.**

This has been delivered by the use of web-enabled technology that can be accessed across the BP intranet through a Windows Explorer web browser. The use of standard browser technology makes it easy to distribute access to the system by publishing the intranet web address. The use of intranet technology has also reduced the requirement for dedicated end-user software and licenses.

While the system is open and can be accessed through the intranet, all users must be registered to use the system. Registration also allows the system to distinguish between users in the field team who will configure interpretation parameters specific to the field and those who merely browse the system.

- **Provide access to the system from any location within the company or through external access to BP's computer network.**

This is provided through use of the web browser tools accessing the BP intranet network, giving engineers access to their data from any BP office or through remote login to the network. The provision of this capability has provided engineers monitoring operational activities the freedom to monitor the operation from wherever they may be located. For example, new well performance monitoring in the Azeri field, in Azerbaijan, has been observed thousands of kilometers away in a BP offsite workshop in the London area and through remote access to the BP intranet network.

In principal this access could be provided to third parties who need to access specific data. That can be handled by the system to allow for restricted access. This is being investigated by the D2D project for use by equipment suppliers who are responsible for equipment operational performance to provide remote equipment monitoring capability and to reduce the number of trips technicians need to make to offshore production systems.

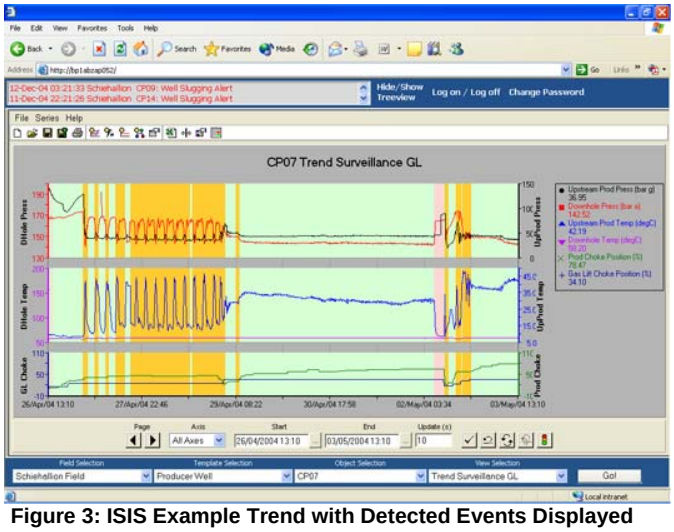

Figure 3: ISIS Example Trend with Detected Events Displayed

The ISIS event detection and alerting system has required BP field teams to think about the processes that they need to adopt to be able to handle alerts as they are received. If the ISIS system was to be taken to its extreme, engineers would

only need to look at that data when the ISIS system informed them that there is something to be investigated. This is not the case; however, the field teams need to think about how they, as a team, will respond to alerts they receive and who within the team will take responsibility for receiving and responding to the alerts. The FIELD OF THE FUTURE team have been working with a number of assets to establish processes that will be used to engage teams who are about to install the ISIS system in the development of the processes they require to handle the alerts that they will receive.

- **Use existing technology and software applications that exist in BP's application portfolio, only adopting new technology where there is a gap in the existing portfolio.**

This principle was established to ensure that ISIS was aligned with existing software standards within BP that have been established by discipline specialists, which are in line with BP's digital business directives. In practice this has made it easier to deploy the ISIS system by allowing engineers to use their familiarity with their core technical applications that are integrated within the ISIS system.

The calculation engines within the ISIS systems run continuously, on a 24-hour basis, using centrally located compute servers that are dedicated to ISIS processing. Unlike traditional applications running on compute servers, the ISIS servers are required to operate at a sustainable performance level to insure a processing cycle is complete prior to the next cycle starting. As the ISIS system has developed the designers have introduced processes to improve computational efficiency to reduce the number of compute servers required to run the system.

- **Rapid development and field testing of ISIS technology concepts.**

ISIS development is based on delivery of a series of sequentially developed modules that can be rapidly delivered for end user testing and proving the technology on completion of each module. This model has allowed engineers to see the ISIS technology as soon as the code has been developed, which has proven that there is benefit to the assets from a technology. The modular approach has had the advantage of creating a demand for the technology and feedback from early adopters has made it possible to rapidly improve the functionality, which is then released with the next module release.

Module approach has overcome the problem faced by many large software developments of taking too long to deliver something that is no longer required when it is delivered because working conditions or other technology has superseded it. Development and delivery of manageable components, which can be rapidly specified and developed, overcomes this problem by placing the technology in the engineer's hands for testing in a short time. The complexity arises through ensuring that each module, as it is developed, can leverage the functionality that exists within other modules. This is achieved by having a single point of accountability that is responsible for ensuring module development consistency.

- **Deliver a technology product that can be deployed at scale and pace across BP without requiring customization to cater for field design.**

The ISIS system has been designed so that it can be configured to meet the complexity of the bespoke field designs that are prevalent throughout the industry. This is achieved through the adoption of a simplified production facility model that allows the complexity to be mapped onto an ISIS configurable platform.

As has been alluded to above, the ISIS system has been developed independently of the data acquisition hardware, control systems, communications systems and data historians. This has removed restrictions that would necessitate the conversion of existing installed systems to a common technology. Because the ISIS system does not have this restriction it can be deployed freely across BP fields and makes it possible to deploy ISIS at pace.

In order to simplify the system, ISIS has characterized components within the system at a reasonably high level. For example within the ISIS system there are only two types of wells, producers and injectors, the details of each well type are catered for by configuration parameters. Another example is the simplification of the P&ID diagram into a series off dynamic topological displays.

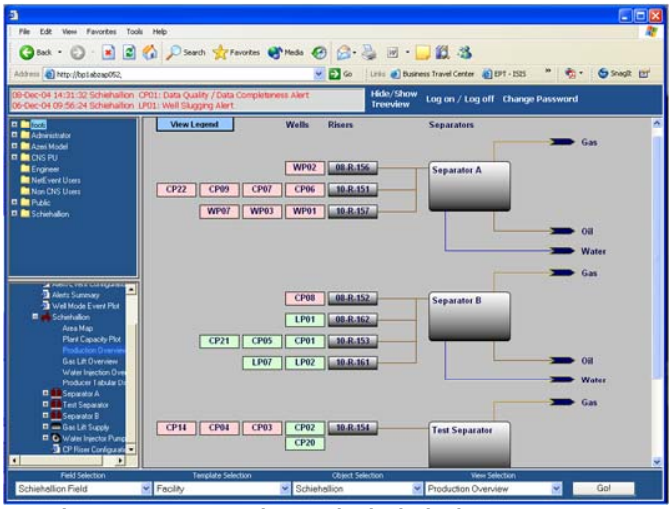

Figure 4: ISIS Example Topological Display

The implementation of simplified components within the ISIS system and the use of topological diagrams have made it possible to develop a consistent navigation schema that can be applied to all fields. In practice this means that an engineer can learn to use the system in one field and will be able to use the system to access any other field that is using ISIS technology without any further training. An advantage of this is that subject area specialists, who are often located away from the field teams, can remotely access the field data and be able to assist the asset when required.

Success Story - ISIS/D2D in Schiehallion

The Schiehallion field, located 150 km west of Shetland in 400 meters of water, was the site for both the first application of ISIS and first implementation of D2D. It is believed that this improvement in information display alone is worth up to 3,000 barrels of extra oil production per day.

Field Background and solution:

- ISIS/D2D system installed, with 20,000 tags continuously transmitted into the onshore data historian and procedures implemented to receive and handle alerts issued by the ISIS system.
- Sand erosion probes were installed in the main risers
- Use of new sand prediction and well management techniques
- Changes in business processes, organisation and behaviours

Some of the benefits of implementing ISIS/D2D in Schiehallion include:

- **Increased production:** The web-based ISIS interface has allowed the Schiehallion team to increase production and avoid losses through more efficient start-ups, more effective control of unstable wells and better communications with the offshore team. Coupling ISIS with sand detection technology has improved operation of sand prone wells. During 2005 there were no system outages caused by sanding problems. Previous years averaged around three outages per year linked to sand production problems per year. Overall, this has given Schiehallion a 5% production win.

- **Cost savings:** Considerable time and effort has been saved in the collection, quality assurance and accessibility of data. Following on the installation of the initial ISIS system the engineers based offshore who were responsible for gathering and transmitting daily production later to town were reassigned.

- **Further opportunities:** Initial indication from the rate and phase estimation functionality prototype installed in the North Sea is that it has improved the surveillance capability. ISIS has improved visibility of well and field performance data that is expected to lead to the identification of additional options for improvement. One such example recently used ISIS to look at post well turnaround well behaviour, which clearly indicated interference effects on a couple of wells following injection start-up, which could be used to re-allocate water injection to other areas of the field which require it.

Given the success of this Schiehallion implementation, the ISIS system is being systematically rolled out to extend the benefits to additional BP assets. The end of 2005 saw ISIS installed in five additional assets in the deep water Gulf of Mexico, with work started on configuration for further installations in the North Sea, Gulf of Mexico and Angola by end of year. These deployments are part of a wider rollout programme, with a dedicated ISIS deployment team and an established global support model. This is definitely a new step in the way technology is deployed simultaneously, driving standardisation and sharing best practice.

Future Direction

The ISIS technology is still in its infancy, the focus to date has been on developing technologies that are applicable to individual teams to improve field performance. The ISIS program continues to be developed along the path established in 2000 and applying the principles stated above. Alongside the key technologies being developed, the system functionality is being evolved to make it more user-friendly and processing efficient. Alongside the primary development plan there are additional areas to be considered for development:

- With a consistent look and feel to the ISIS system it is possible to consider using it to amalgamate operating field units in order to address increased resource demand as a consequence of the demographic challenge faced by the industry. This will be further supported as user confidence in the alerting system grows through experience of calibrating the event detection system, which will allow users to focus on field issues being raised by the ISIS event detection system.

- From a BP federal perspective it is possible to identify key issues across the company which reduce production efficiency. In doing this it would be possible to focus scarce resources to resolve these issues and improved overall BP production.

- Insights from using the ISIS system have indicated that it is possible to develop conditional data mining techniques which could be used to predict the onset of reservoir or production conditions which we could avoid if appropriate steps were taken early enough.

The ISIS technology is a core FIELD OF THE FUTURE technology solution, which through its development, installation and use by assets is materially changing the way in which BP operates its oil fields. ISIS technology alone cannot deliver the potential benefits it has to offer. It requires the assets to look at their processes and how they use the ISIS technology to harvest the benefits. The ISIS technology will continue to evolve and will seek greater integration with the other technologies under the FIELD OF THE FUTURE umbrella.

References

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