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Building an IT Roadmap for G&G Data:

Integration, Workflows and Interpretation Systems

About the Authors

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Intelligent Data Analysis in Oil & Gas Exploration

Recent information technology (IT) innovations have made the intelligent oil field possible. Thousands of sensors are generating massive amounts of geological and geophysical (G&G) and seismic data in the never-ending search for black gold.

Massive storage at the source reduces data transmission bottlenecks. Advanced visualization technology makes it possible to discern complex patterns in exploration and production data. Visualization, modelling, and analytics allow for improved reservoir management by decision makers. Warnings, alerts, and even suggested courses for action can be sent to offsite personnel to optimize production, reduce risk, and lower costs.

Unfortunately, the data sources come in various and increasingly complex forms (size, scope, and provenance), making it a challenge for energy firms to collect, interpret, and leverage disparate data. Integrated, sound reservoir management is a key to a successful operation throughout a reservoir's life (Satter, 1994). Furthermore, G&G data integration workflows are an essential ingredient (the exploration ingredient) of reservoir management.

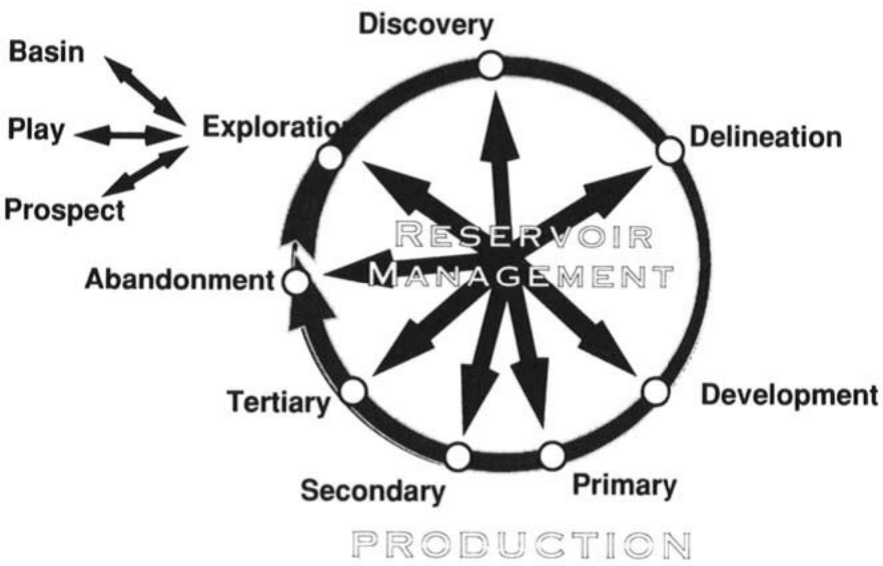

Figure 1. Reservoir Life Process (Satter et al., 1992)

Indeed this is a fascinating time to face IT challenges. Tessella engineers and scientists are ready to successfully guide you through this journey.

The Importance of G&G Data to Business Decision Making

Geological and geophysical (G&G) data and seismic data in particular are at the heart of all exploration activities from new ventures to extending the life of a field. Seismic activities allow oil and gas companies to develop a clear understanding of the subsurface rock structure and other geologic rock properties. Integration of seismic data is a key issue in geoscience and oil industry applications.

Many significant investment decisions, like determining the best locations to drill wells to achieve maximum production, are based on the interpretation of seismic data. The sums involved are considerable. A single exploration well offshore of Angola might cost anywhere from $25m to $50m. Field development costs in that region might run into the billions.

Consequently, the ability to deliver good data and its interpretation is increasingly being seen as providing competitive advantage to companies across the E&P industry, since wise business decisions depend on sound data and information. According to Dun & Bradstreet, “65% of a geophysicist’s time is spent looking for data,” and millions of dollars are spent acquiring data (a 5,000 km2 seismic survey costs in the order of $25m), and there is an ever-growing volume and diversity of G&G data available.

The result is that subsurface teams – working on a basin, a prospect, a discovery or a field – have access to very large amounts of different types of seismic data.

G&G Data and Its Uses

Exploration

1. Many basins are now assessed, and nowadays, nearly all wells are drilled, based on the results of interpreting 3D seismic surveys. Sophisticated stratigraphic and structural interpretation, tied to available well logs, results in the production of realistic 3D geologic and dynamic flow models of the subsurface (Naguib et al., 2005).

2. Beyond this, lithology and fluid prediction depend on a wide range of derivative seismic attributes - near- and far-stacks; amplitude vs offset (AVO) gradients, elastic impedance, phase, etc.

3. Non-seismic geophysics has its place, especially when such data can be understood and interpreted (integrated with) the geological framework provided by a 3D seismic interpretation from 1 & 2 above. Electro-magnetic surveys and full tensor gravity gradiometry (the study and measurement of variations in the acceleration due to gravity, http://www.gradiometry.com/gradiometry) are especially significant in this respect.

Reservoir Management

4. Most fields will now have a static reservoir description based on all available well data (logs, cores) and a sophisticated interpretation of a 3D seismic survey (see 1 and 2 above).

5. Reservoir dynamics are observed by wide-ranging production monitoring, from continuous downhole PLTs (production logging tools) to regular 4D towed-streamer seismic to 'as-often-as-you-want' permanent seismic monitoring (either on the surface or downhole).

6. These static and dynamic facts and interpretations have to be integrated into, and with, the reservoir engineers' simulators, sometimes 2D but most often (largely) 3D.

Other Sources of Data

These include passive seismic (which some would say offers, via attenuation measurements, information on reservoir permeability), micro-seismic (the observation of seismic events associated with hydraulic fracturing, see http://www.spectraseis.com/), and newer downhole methodologies such as cross-well seismic, micro-gravity, etc.

Fiber optic is also being permanently installed along pipelines and/or completion equipment to monitor pressures, temperatures, and other physical properties.

For example, the fiber optic distributed temperature sensing (DTS) method uses the Raman-effect and was developed at Southampton University in the UK in the 80s. DTS measures temperature using optical fiber instead of thermocouples or thermistors. DTS systems represent a cost-effective method for obtaining thousands of accurate, high-resolution temperature measurements.

In another application of fiber optic to record live seismic signals, 120 km of seismic cables were trenched into the seafloor in 2003 covering an area of 45 km2 above the Valhall field (GeoExpro, 2009). To illustrate this, a total of 2400 receivers, each with 4C sensors (3 geophones and one hydrophone), provide a live signal throughout each survey.

Diversity Outstrips the Ability of Systems and Workflows to Process Data

In spite of the importance of G&G data and significant IT investment, the amount and diversity of data available to sub-surface specialists has outpaced the ability of their systems and workflow processes to manage, integrate, and interpret the data. Very often each data type requires its own conditioning and analysis, before attempting to integrate these many strands into a coherent interpretation, certainly in three dimensions and possibly four. Finding integrated workflows which simplify and streamline to get more out of data and reduce cycle time is a challenge. Today's E&P businesses continuously struggle with more data compiling into more repositories and at higher levels of complexity.

To overcome this problem, companies often have a team of petrotechs working on each project. However, any one project may be unique in terms of the data available and the analyses undertaken, meaning that the work processes and software used will be chosen on a project by project basis, with every project having its own secret recipe.

Building an IT Roadmap with Tessella

Generating a comprehensive IT roadmap for the G&G data integration workflows and interpretation systems requires deep knowledge of the integration of complex scientific data for analysis and considerable IT expertise, gained across a range of industries.

To help companies assess roadmap options, we use a proven consulting process to generate IT strategies that maximize return on investment in G&G data technologies. The reward is worth the effort as individual project teams are able to provide information to support business decisions more quickly, involving less effort and cost. Project risk is reduced and outcomes are more predictable.

Key Steps

Identify Organizational & Business Needs

An important first step of Tessella's approach is to identify business and IT stakeholders and define organizational and business priorities. Once identified, the stakeholders participate in structured interviews to define the business challenges they face. Next, in consultation with the IT leadership, Tessella determines specific priorities (e.g. operational costs, business and time-to value/benefits, etc.) so business priorities are understood and subsequent efforts can be focused on achieving maximal impact.

Understand Existing Information Standards

Typically, data is held in a variety of data stores such as OpenWorks, PPDM, Seabed, etc. These data stores usually define formal catalogue controlled values to assist with enforcing standards. But the data, which is usually held in databases, has often been extended or adapted for regional circumstances. So necessary policies, standards and governance measures are frequently incomplete, and engineers find it difficult to work in a region where standard reference values are chosen from a different set than they are familiar with.

Defining complete data standards, especially metadata standards, is important to ensure that knowledge gleaned from G&G data can be easily reused. Standards facilitate integration of data with other data generated, leading to fully-informed decisions and faster generation of comprehensive data packages.

Seismic Data Integration Strategy

Data integration involves combining data from disparate sources and providing users with a unified view. There are several approaches to seismic data integration.

One approach, and historically the route companies have taken most often, is to convert the data to a common format using third-party applications such as OpenSpirit (TIBCO), EnerConnect (Volant at TGS), Informatica, ISDS (Westheimer Energy Consultants), or ProSource (Schlumberger), for example. All these vendors have similar toolkits and technologies allowing the transfer of seismic data between disparate data stores.

Another alternative is exemplified by using a federated data management approach. In iStore's offering, for example, the data are simply accessed through custom connectors and viewed from a central location rather than copied around from one data store to another. This can be a cost-effective solution when local data storage limits are limited and communication speeds have sufficient bandwidth to support interactive queries via these custom connectors. Determining which approach to use, when to use it, and which tools to use is another part of building a roadmap.

Current and Future Bottlenecks

The transfer of data between G&G applications has always been a problem in the O&G industry. With the increasing amounts of data provided by vendors, the variety of formats, and the sophistication of the software packages available to users, the problem is not likely to improve.

The following problems make the process of accessing seismic data and moving it between applications more difficult:

1. Mismatches between existing data file formats and the application input file format.
2. Having to reorder input data before an application can be run.
3. Pre-stack vs post-stack issues. Recently, using seismic data analysis requiring access to pre-stack data such as AVO has become very popular and software architectures are not capable of linking pre-stack and post-stack data sets.

Interpretation Requirements and Systems

The services offered by third parties in the data integration space may range from an open source seismic interpretation platform that can be extended with plugins to full service survey design, data acquisition, seismic data processing and interpretation. Other service providers integrate commercial tools such as ArcSDE, Oracle XML Package, and Data Transfer Manager with custom-built solutions. PGS, for example, integrates seismic data processing and visualization. Geotrace Technologies produces a full set of tools to support data integration with Tigress. Divestco and GEOSEIS offer seismic data loading, conditioning, and conversion services.

Creating the IT Roadmap

Creating IT roadmaps is difficult because of the need to balance competing business needs with priorities. The IT pain points don't always align with the needs of engineers.

Where possible, standardizing on components is preferable. It reduces licensing costs, maintenance costs, and ongoing operations costs. IT has a more simplified infrastructure to manage which in turn frees time for IT to spend on more pressing areas of the business.

Yet there is no one-size-fits-all approach, so companies have a difficult time creating enterprise-wide standards. Rather, they need to define the business needs first and then understand if existing standards are sufficient or if new standards are required.

Ultimately, the roadmap must find the right balance between competing factors (see figure 2 below):

1. When should x-project solutions be used and when should a project work locally?

2. How do we balance tactical investments supporting immediate needs against future strategic investments?

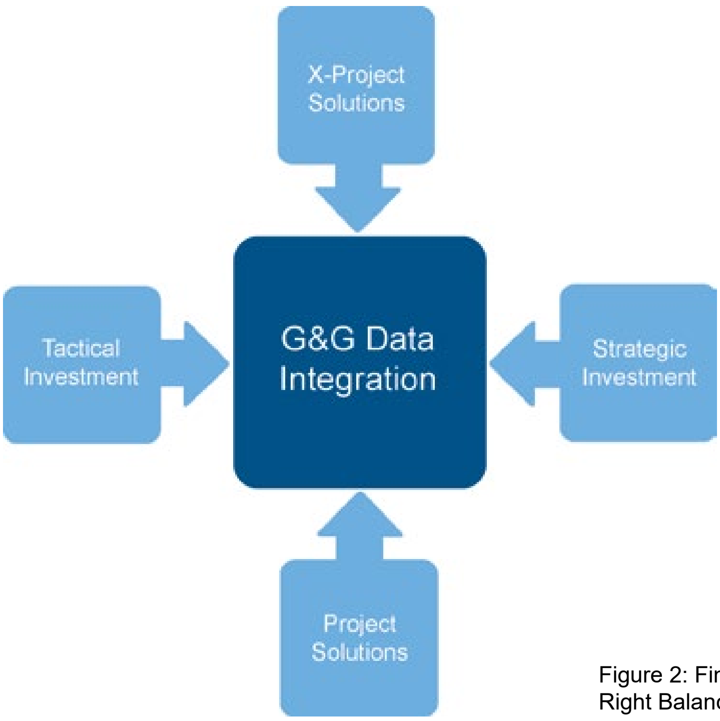

Figure 2: Finding the Right Balance

Time-to-value and cost considerations are important factors to finding the right balance. Due to the fact that integrating new data types with corporate systems is expensive and time-consuming, tactical solutions sometimes provide better value propositions for certain types of data. For example, if the content is not widely used, little value on investment is gained by physically integrating data into a standard corporate repository. In these cases it makes more sense to retain the files in a local project. Certainly, we encourage the use of standard platforms where possible, but in our experience, companies need to accept that not all data will be integrated into enterprise stores anytime soon, since the cost of doing so simply outweighs the benefits.

Tessella offers clients the opportunity to tailor a platform to specific needs, building on client IP (intellectual property) and giving competitive advantage. For example, we have extensive experience in building Petrel plugins for majors. These extensions to the Ocean-based Petrel platform are being increasingly used by oil companies to add proprietary developments not publicly available and minimize the amount of work needed to bring custom R&D modules to their user base.

Additional roadmap considerations - High-Performance Computing (HPC)

Seismic analysis is traditionally associated with HPC because it is computationally very intensive and requires parallel execution, both to achieve a reasonable computing time and to be able to process gigantic amounts of data. According to IDC (IDC, 2014) HPC adoption by the industry has been growing steadily. In particular, the O&G industry holds about 7.5% of the HPC installations in the world by processor count. Two areas of developing HPC technology are worth considering as part of your IT roadmap.

The first is the use of General-Purpose Computing on Graphics Processing Units (GPU), within an HPC environment, the adoption of GPUs is growing because it offers a potential boost in performance for a relatively small cost increase.

The second is the injection of data analytics in the HPC world. This is also growing and it is generally called High Performance Data Analysis (HPDA = HPC + Big Data). This emerging trend represents an opportunity to enter a fresh segment. Seismic processing deals with increasing quantities of data and, as sensors become more technologically advanced, intelligent management of large data related to HPC will be crucial.

Conclusions and Future Outlook

As real-world operations become increasingly expensive, it is virtually impossible to conduct modern exploration effectively without relying upon G&G data and interpretation technologies. This is driving O&G majors to make considerable investments in digital oilfield initiatives all in the objective of making more accurate business decisions in a reliable, repeatable and timely fashion. The key to the success of this endeavour is the deployment of more advanced sensors in greater numbers which provide different types of data in greater volumes, and the development of new and more sophisticated interpretation techniques to exploit this new data.

Managing the growing diversity of G&G data and its interpretation requires a clear IT roadmap. Tessella is ideally suited to help companies develop and implement such a road map. We are experts in developing IT strategies, managing projects, and designing and implementing workflows for complex scientific data integration and analytics systems.

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