Big Data & Analytics- An Upstream Oil & Gas Industry Prospective

*Swati Katewa**
Oil & Natural Gas Corporation Ltd., A&AA Basin, Jorhat, Assam

swati.drop@gmail.com

Keywords

Big Data & Analytics, Data Management, Oil & Gas Industry

Summary

The concept of big data and analytics is relatively new to the world. Big data can be defined as data sets with very large volume (normally petabyte and above), all sort of variety & high velocity at which data should be processed. Big data and analytics technology comprise of predictive analytics or other certain advanced algorithm to extract value from data to more confident decision making with greater operational efficiency, cost reductions and reduced risk.

This paper discusses about big data & analytics technology and its relevance in upstream oil & gas industry. This technology represents a new generation of technology and IT architecture. It is designed to economically extract value from very large volumes of a wide variety of data by enabling high-velocity capture, discovery, and analysis. There are a number of promising examples where big data and analytics used in exploration, development, drilling, production operations, maintenance and the enterprise for better results. There are some challenges in implementation of this technology in oil & gas industry including lack of awareness and lack of skilled business and IT personnel.

Introduction

On the earth, we generate 2.5 quintillion bytes of data every day and 90% of the data in the world today has been generated in the last two years alone. This data comes from sensors used to gather climate information, posts to social media sites, digital pictures and videos, transaction records, and GPS signals and many more to be named. All together these data is called big data.

Big data and analytics is quite new thing these days for many people, but the upstream oil and gas industry has long relation with large quantities of data. In exploration and production of hydrocarbon, we need to know what lies in sub-surface and how to bring it out. In this quest, oil companies generate millions of bytes of data to make better decision making. Oil companies are investing millions in seismic software, visualization tools and other digital technologies to facilitate this big volume data.

Today we are having more advanced affordable and fast networking systems, hardware, sensors and storage devices. These are opening more possibilities in data management and utilization of data in more effective manner. Due to latest technologies, oil producers can acquire more detailed data in real time at lower costs and from remote areas, to improve their performances. In last decades, oilfields have been turned in to digital oilfield and connected from base offices by advanced sensor technology and broadband networks. Competitive prices with improved performances of sensor technologies and the universal availability of broadband networks have added to the volume, variety, and velocity of data today. In the oil and gas industry, large amount of data being acquired but still there is enough scope of deriving more information from it.

Big data and analytics technology describes a new generation of technology and IT architectures designed to economically extract value from very large volumes of a wide variety of data by enabling high-velocity capture, discovery, and analysis. There are a number of promising examples where big data and analytics used in exploration, development, drilling, production operations, maintenance, and the enterprise for better results. There are some challenges in to implementation this technology in oil & gas industry including lack of awareness and lack of skilled business and IT personnel.

Big data – definition

Big data is an evolving term that describes any voluminous amount of structured, semi-structured and unstructured data that has the potential to be mined for information. Although big data doesn't refer to any specific quantity, the term is often used when speaking about petabytes and exaby tes of data. Big data normally can be characterized by 3Vs: the extreme volume of data, the wide variety of types of data and the velocity at which the data must be processed. Another important characteristics of big data are variability (inconsistency which can be shown by the data at times), veracity (the quality of the data being captured can vary greatly) and complexity (data management can become a very complex process). Big data usually includes data sets with sizes beyond the ability of commonly used software tools to capture, manage, and process data within a tolerable elapsed time (Fig. 1). Big data is a set of techniques and technologies that require new forms of integration to uncover large hidden values from large datasets that are diverse, complex, and of a massive scale.

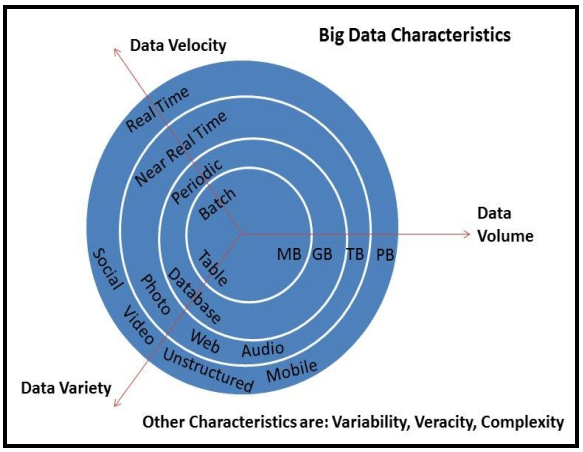

Fig. 1 – Big Data Characteristics

Big data – how it works

Big data and analytics technology requires:

- Computing Infrastructure including industry standard servers, networks, storage, and clustering software used for scale-out deployment of big data technology
- Data organization and management which includes data base software that processes and prepares all types of data to extract, arrange, label, integrate and analyze.
- Analytics and discovery includes software that supports real-time analysis and automation, algorithm based decision making.
- Decision support which includes application software with functionality required to support collaboration, scenario evaluation, risk management and decision making.

Big data require too much time and costs to load into a traditional relational database for analysis so new ways for storing and analyzing data have emerged which works well irrespective of data types and data quality. All sort of data with extended metadata is pooled in a special database for sorting, arranging & integration. Then this data has been analyzed with complex algorithms of artificial intelligence (AI) programs to look for repeatable patterns and with the help of functional application software critical decision are being made.

Although the demand for big data analytics is high, there is currently a shortage of data scientists and other analysts who have experience working with big data in a distributed, open source environment. In the enterprise, vendors have responded to this shortage by creating Hadoop applications to help companies take advantage of the semi-structured and unstructured data they own.

Big data analytics is often associated with cloud computing because the analysis of large data sets in real-time requires a platform like Hadoop to store large data sets across a distributed cluster and MapReduce to coordinate, combine and process data from multiple sources. Hadoop is an open-source framework that allows to store and process big data in a distributed environment across clusters of computers using simple programming models. MapReduce is a programming model and an associated implementation for processing and generating large data sets with a parallel, distributed algorithm on a cluster. It is designed to scale up from single servers to thousands of machines, each offering local computation and storage (Fig. 2).

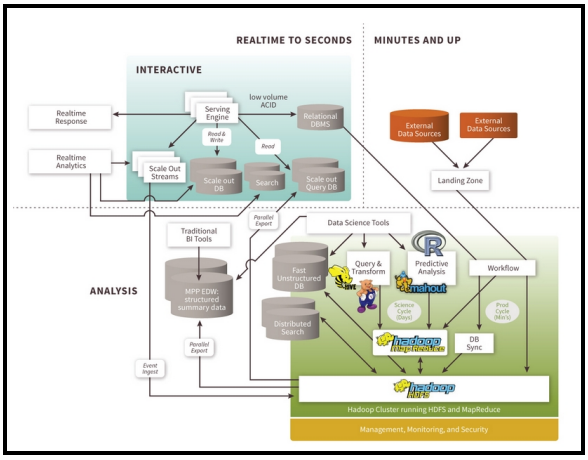

Fig. 2 – IT Architecture for Big Data Analytics (Courtesy Teradata corp.)

Big data- Relevance in oil & gas industry

Large amounts of data and superior computing capacity are not new to the oil and gas industry, which has been using high-performance computing for seismic processing and reservoir modeling for the past decade.

In oil and gas industry there is large data volumes, growing even larger, with the use of 3D Seismic data including wide azimuth (WAZ), multi component seismic, real time drilling and production data, different types of well log data, new mud pulse techniques, and sensor-embedded fiber optics, etc. There is variety, including structured (surface and subsurface data, SCADA data, drilling data, production data), semi structured (processed data), and unstructured (variety of reports, raw seismic data, specifications, raw well log or daily drilling reports in paper or PDF) data (Fig. 3). Now this huge chunk of data is

easily accessed across to different platform because of economical and fast communications channels.

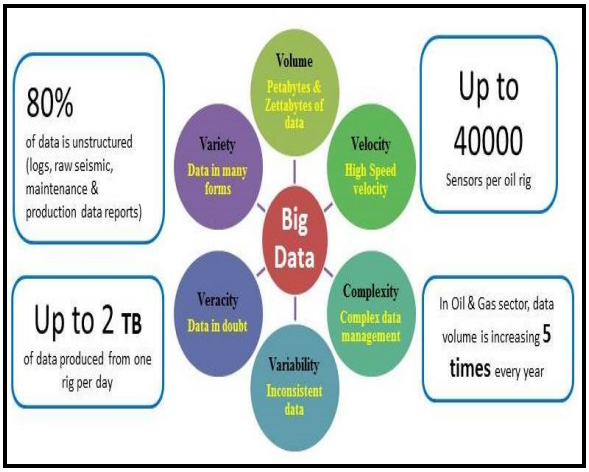

Fig. 3 – Big Data Properties

Application of big data & analytics

Big data technology has applications across the entire oil and gas value chain—from geology and exploration to production and operations, transport and refining, and retail. Possible uses of big data and analytics in the oil and gas industry are:

● **Exploration-** By applying advanced analytics, such as pattern recognition, to a more comprehensive set of data collected during seismic acquisition, geoscientists may be able to identify potentially productive seismic trace signatures that have been overlooked previously. Seismic data processing work flows can be optimized by critical analyzing historically data of these processes. Multi petro physical logs of a big field including thousands of wells can be simultaneously analyzed to draw a pattern which can give information about formation, facies and hydrocarbon bearing plays. Big data technology is also helpful in other forms of advanced exploration too like reviewing weather patterns from historical data can help analysts to make connections with operational processes, such as the impact of adverse weather conditions like storms, floods etc. on seismic surveys and rigs.

In oil & gas exploration, big data can benefit if we integrate technical, financial & enterprise data with real time production data to deliver new insights to operating groups. These analytic results can be used in assessing acreage and generating new prospects (Fig. 4).

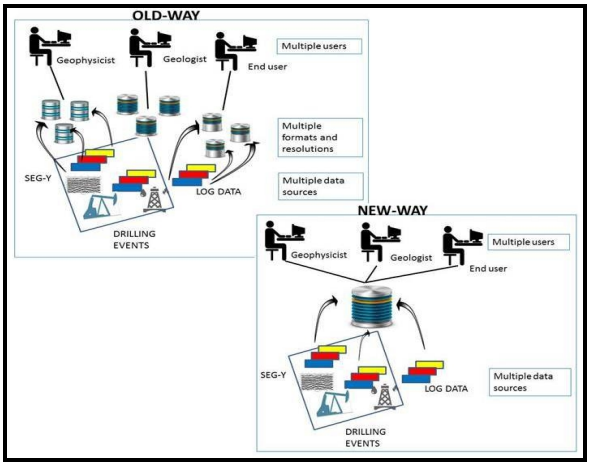

Fig. 4 – Data Integration

● **Drilling-** Beyond monitoring and alerting based on limited data, big data and analytics could be applied to real-time "big" drilling data to identify anomalies based on multiple conditions or predict the likelihood of drilling success and drilling anomalies. Real-time information returned from supervisory control and data acquisition (SCADA) systems on wellheads can be used to look for opportunities that maximize asset performance and optimize production. This can save millions in labor and equipment costs alone. For example in hydraulic fracking, Decisions are made to continue a pursuit of additional fracks at considerable cost, mainly under pressure to meet production objectives. Access to analysis of conditions could provide better decision support about fracking options and saving the cost of unproductive fracks.

This technology has been successfully used to reduce time and cost to drill. An oil and gas company created the capability to perform detailed analysis across multiple unconventional wells with similar drilling difficulties. A combination of daily drilling data from a well management application and time series drilling data from SCADA systems is used and analyzed in optimizing set points for drilling. As a result, the company has seen a 40% increase in the rate of penetration.

● **Production operations-** Big data related to production and operation work able to predict future performance based on historical results, or it can identify sub-par production zones, can be used to shift assets to more productive areas. Oil recovery rates can be improved, as well, by integrating and analysing seismic, drilling, and production data to provide self-service business intelligence to reservoir engineers. Analytics applied to a variety of big data like seismic, drilling, and production data could help reservoir engineers map changes in the reservoir over time

and provide decision support to production engineers for making changes in lifting methods.

One of successful example of implementation of big data and analytics is improving water injection strategy. An oil and gas major undertook a project to improve the speed and effectiveness of decision making in water flood surveillance processes. The project involved a reservoir with approximately 1,000 injection wells. The company used workflow, analytics, and visualization tools to identify and rectify wells where the decline curve was not as expected, thus improving estimated ultimate recovery (EUR).

- **Maintenance-** In operations, pressure, volume, and temperature (PVT) data can be collected and analyzed together and compared with the past history of equipment failure of a machine then alerts can be automated. On the basis of these data failures can be predicted on time and can be averted at big extent. This would not only reduce down time of operation but also have less impact on health, safety, and environment. This analytics is also beneficial in improving shop floor maintenance planning. It can integrate well and tool maintenance data with supply chain information to optimize scheduling of shop floor maintenance.

- **Enterprise-** Threat of cyber-attacks to secure its intellectual property in oil & gas companies can be addressed by big data analytics by proper correlating network events with metrics over time, identifying patterns. These companies are applying analytics to identify information patterns on networks and to perform more effective intrusion detection to predicting cyber-attack threats.

Another application of big data and analytics could be in performing social business scans of news, blogs and posts on social media for analyzing image and reputation of company and create a strategy to enhance its reputation as an investment destination, socially responsible corporate or a good place to work.

Conclusion

Data is a very valuable asset and efficient data management drives good business performance for a firm. E&P companies are spending vast amount of money to acquire it from years. After successful implementation of big data technology in many industries worldwide, it's proved that it can increase efficiency at lower cost for a firm. By using big data to gain new insights, oil companies can create enhanced business value that improves the bottom line and leads to true competitive advantage. Companies must create new strategies to store, analysis and manipulate this data for mining relevant and useful information for smarter decision-making. These companies need to invest in the skilled human resources which can lead and develop this analytic initiative in their organisation.

Throughout the industry, oil & gas companies are beginning to create big data initiatives. From exploration and production to oilfield services and transportation, leading companies are taking steps to design initiatives and deploy technology that can help them pursue new business opportunities, reduce costs, and streamline operations. Companies can plan and execute big data initiatives, both large and small, in ways that deliver maximum value. In next decade, big data initiatives will open new frontiers for oil & gas firms to achieve business excellence.

References

Pranaya Sangvai, 2013, Impact of Big Data in Oil and Gas Industry, SPG Conference Kochi 2013

IDC Report "Worldwide Big Data Technology and Services, 2014"

https://www.oracle.com/big-data/index.html

http://bigdata.teradata.com/

Acknowledgement

The author expresses her sincere gratitude to Shri A K Dwivedi, Director (Exploration), ONGC for his kind permission to publish the paper. Author is highly indebted to Shri C Mahapatra, Executive Director and Basin Manager, A&AA Basin, for his consistent support & motivation. Author is also highly thankful to Shri C M Jain, GM (GP), Head Geophysical Services and Shri K V Krishnan, GM (GP), in charge- RCC, A&AA Basin, for their direction and encouragement in preparing this paper.

Views expressed in this paper are that of the author(s) only and may not necessarily be of ONGC.