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Integrated Data Analytics and Visualization for Reservoir and Production Performance Management

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Abstract

ADNOC operates its onshore and offshore fields through its operating companies. In order to effectively govern and steer the operations, it is essential for ADNOC to monitor, track and measure key reservoir and production performance indicators efficiently on time. In this regard, ADNOC Upstream has established an integrated reservoir and production performance visualization environment that enables upstream departments to efficiently monitor the performance of onshore and offshore operations at different levels from the headquarter in a collaborative manner with the operating companies.

The integrated visualization environment is built on four key components, the upstream data hub, visualization, process automation and data governance which forms the common foundation for various upstream projects, enabling multi-project collaboration, reporting integrity, common business data and KPI definitions. The datawall in Thamama Collaboration Center is powered by the integrated reservoir and production performance visualization dashboards configured on objective based themes such as Reservoir Management, Production Assurance, Business Plan Assurance and others required by different departments. The visualization capability is enabling engineers and managers in the upstream directorate, to monitor key reservoir and production performance information on a daily and periodic basis, and the solution facilitates collaborative review sessions with OPCO team either on a regular or adhoc manner and to initiate and track actions.

The integrated visualization environment shall be continuously enhanced to add more themes based on business needs, and to carry out advanced data analytics to predict and forecast performance leveraging the established foundation. Business processes shall be streamline through automation of the performance measurement processes to achieve higher degree of digital transformation.

Background

Oil & Gas upstream sector is complex, data-driven business with data volumes growing exponentially (Feblowitz, 2012). Synthesizing and analyzing information across variety of data sources has become one of the biggest barriers to fast and decisive action. Between 60 percent and 73 percent of all data within an enterprise goes unused for analytics (Forrester, 2016). In order to take the decisions necessary to the

business management, managers need up-to-date, complete and correct data. In most cases, these exist but are relatively difficult to process in view of their conversion into useful information (Luminita & Magdalena, 2012). Business intelligence play an important role in improving organizational performance by identifying new opportunities, highlighting potential threats, revealing new business insights and enhancing decision making processes among many other benefits (Xia & Gong, 2014; Kowalczyk & Buxmann, 2014).

Advancement in visualization, offers deeper analytics capability where the non-experts are able to use it without the need for extensive expert consultations or scripting business strategy and decision-making (Fields, 2014). Advancement in data aggregation, data integration, data visualization techniques is enabling companies to carryout integrated data analysis in order to make better decisions on how to boost business agility and efficiency.

Visualization tools will continue to make it easier for organizations to bring data and analytical results together for newly found insights. visualization technology is considered a key integration tool for cross-discipline and cross-company collaboration, enabling the aggregation of numerous data sets into one environment. However, only 36% of the oil & gas companies have invested in big data and analytics. But only 13% of them use the insights from technology, as enhanced business intelligence solution. (Orbisresearch, 2018). The success factor is attributed to the organization maturity level and the approach taken to establish analytics.

Introduction

For ADNOC to efficiently govern and steer its operating companies, it is vital to monitor, track and measure key reservoir and production performance indicators diligently. Numerous information is delivered to ADNOC upstream directorate by operating companies across business disciplines. The information ranges from corporate, drilling, reservoir, production, operations, engineering, cost and economics, business plan and delivered through various systems and digital formats including manual reports on an adhoc, daily, monthly, quarterly and yearly basis. Each business information caters to the requirements for specific business team. However, its essential to have the collective information in an integrated manner, and transforming it to deliver actionable insights to all business levels, from senior management to upstream engineers that shall enable them to

- Gain valuable field performance awareness and operations insights to drive decisions
- Effective development and production strategies
- Consistently enhance operations efficiency now and into the future
- Better preparedness and faster response to take advantage of market opportunities

The ongoing process of digital transformation is enabling ADNOC to efficiently monitor, track the performance metrics of its onshore and offshore fields operated by its OPCOs on a daily basis and proactively drive business decisions. An integrated visualization environment has been established to unlock the value of data acquired across the business. Following sections below explain the key visualization framework components, strategy, operating model and the future roadmap.

Integrated Data Analytics and Visualization

ADNOC Upstream has established a high performance data analysis and visualization environment that provides the capability to integrate and process a wide range of field data to bring out hidden information and extract reservoir and production intelligence. The data to action framework brings together the process of information gathering, processing, analytics, insights, action and tracking.

The strategy is to bring visualization requirements from different departments, business lines, and executive management under one integrated visualization program leveraging Upstream Data Hub (one integrated single version of truth of data from OPCOs delivered commonly to all visualization), the advance data visualization (unified visualization and analytics foundation) and the business process automation capabilities to orchestrate several visualization themes (Figure-1) in an integrated manner.

Figure 1—One integrated visualization across upstream business

The integrated data visualization environment provides a panoramic view as well as granular view of key information, metrics and insights for different stakeholders from senior management to engineers across the upstream disciplines to take tactical and strategic decisions. The visualization makes it easier for the users to spot previously hidden patterns, trends and identify opportunities to analyze more deeply and have insights into past, current and future performance

The inputs for the strategic visualization for the executive team is fed by each of the visualization of the underlying tactical and operational visualization bringing tight integration and integrity of data from operational to tactical to strategic level (figure-2).

Figure 2—Visualization Levels

Thamama Center hosts the Datawall which is a large screen collaborative visualization environment facilitating continuous monitoring of reservoir and production performance as well as collaborative review sessions between disciplines and management to take informed decisions. The information can navigate the information up and down the company to field, reservoir and wells hierarchy enabling to drill down to identify the potential issues. The visualizations are accessible from the user's desktop as well.

Following are some of the key capabilities that the integrated visualization environment shall provide to the intended theme based users.

- Executive visualization quickly summarizes the latest highlights and lowlights of the fields in a single view against specific targets, measure compliance and performance.
- Integrated data delivery from OPCOs to track production and performance on a daily basis
- Quickly and efficiently understand the status of fields and carryout right communication to the OPCOs to improve performance in order to achieve targets.

- Interactive dashboards that provide the ability to monitor and track forecast performance metrics
- Reservoir and well performance, rate compliance and diagnostics plots
- Plots to analyze large data sets of data gathered from well tests, production history
- String performance (e.g. allocated vs estimated volumes)
- Present deferment breakdown that is hindering production
- Track important metrics and KPIs that align with business objectives and help assess how far or close they are to their target
- Understand the gains and shortfalls to adjust the plan to meet production targets, with the capabilities to breakdown to reservoir and well levels.
- Visual analytics enables users to group reservoir based on their capacities, identify promising opportunities
- Benchmark performance against global or regional performance
- Geospatial data integration & visualization that presents sub-surface maps (geological, Petrophysical and reservoir properties) along with spatial data such as wells, field boundaries, reservoir and sectors, OWC.
- Engineers can configure their own dashboard instantly as it does not require IT specific background to develop any visualizations

Integrated Data Analytics & Visualization Architecture

The architecture components that drives the integrated data analytics and visualization environment is presented in the figure below (figure-3). Delivering data from different data sources across the OPCOs in a streamlined way for various visualizations, orchestrating the business process are fundamental to the operations and sustenance of the integrated environment. The architecture is scalable to continuously add new data sources, build new visualizations, introduce or improve analytics,

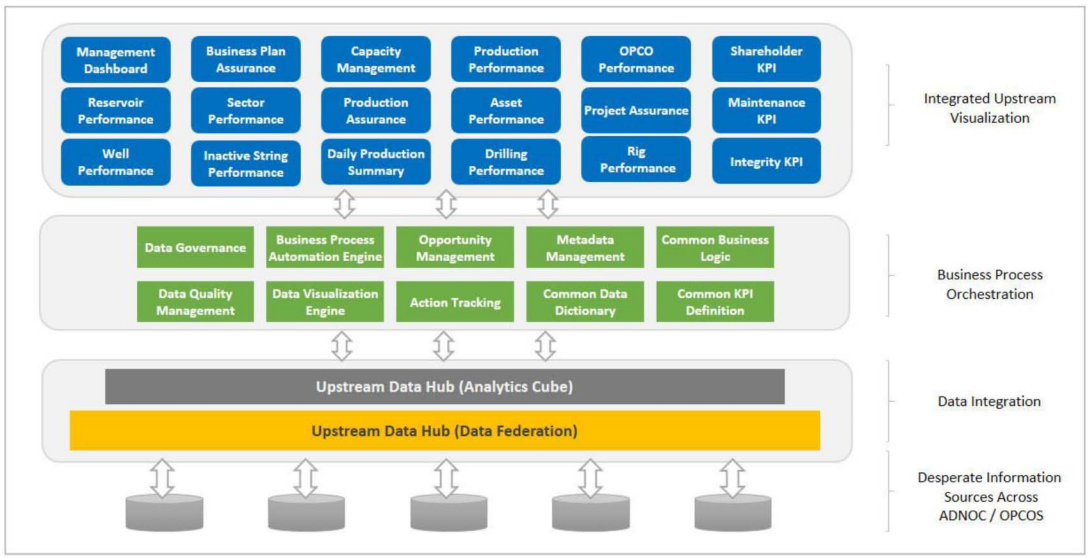

Figure-3—Integrated Data Analytics and Visualization Architecture

- It is essential to integrate and organize data in a way that makes it accessible to more users performing analysis to drive business value.

Information and Analytics Management

Analytics are only as good as the data that feeds them. A holistic data strategy has been envisaged to ensure data is efficiently managed *and* delivered in a systematic way from a variety of data sources for effective data analytics and visualization. The approach is to have one common data foundation for different visualization themes as represented in figure-3.

Efficient management of data and its integration is fundamental and a critical building block for the effective visualization, performance management and its sustenance. The challenges are tremendous when it involves multidisciplinary data covering several assets, fields, reservoirs and thousands of wells historically. This is being achieved through upstream data hub and data governance process, that streamlines the process of data collection, data validation, data delivery, data integration, data transformation, building data cubes, data analysis and visualization.

The Upstream Data governance framework ensures quality and complete data is made available on a continuous basis in a systematic manner for the visualization by establishing clear data ownership, roles and responsibilities, service level agreement, data quality metrics, monitoring and measurement.

Upstream Data Hub. The upstream data hub streamlines a variety of static and historical data including planning information across onshore and offshore assets. This includes standardizing and streamlining unstructured data available in various reports. The lack of integration deprives cross-functional decision-makers of information that can help them gain valuable insights that could dramatically improve their decisions. Upstream data hub fosters collaboration between teams by sharing cross functional information for integrated analysis and visualization. Data and KPI definitions are continuously added to the upstream data dictionary. The definitions are created by the process owners and agreed across the stakeholders for its usage in visualization.

The upstream data hub analytics cube integrates data from multiple source systems by cleansing, normalizing and organizing time oriented information to serve the visualizations themes. Common calculation and KPI definition is implemented to ensure all the visualizations use the same common definitions. The integrated analytics hub eliminates the proliferation of silos of data marts managed by multiple project teams, enables efficient data management and analytics governance

An automated process to identify data issues, reporting and tracking enables continuous improvement of data quality. Data quality issues fixed in one visualization theme fixes the quality issues for rest of the themes automatically enabling collaborative quality improvement, and ensuring data integrity between the themes.

Operating Model and Program Management

The program has a strong commitment from senior management level to establish tactical and strategic visualizations that highlights key upstream metrics and performance indicators. This ensures different upstream business functions to collaborate to ensure right information is delivered to the senior management.

The program team comprise of different stakeholders to govern, drive and operate the integrated visualization environment.

- **Steering Committee:**Drives the strategic vision and sponsoring the program.
- **Visualization Owners:** Owners of each of the visualization, provides the business requirements, drives and operates their respective visualizations to carryout performance management activities.
- **Technical Center Experts**: Enablers of process and KPI standardization, sponsor of the integrated business process and visualization environment
- **Information Management Experts**: Orchestrates the data and visualization solution in collaboration with stakeholders
- **Data Visualization Experts:** Build the upstream analytics and visualization themes.

Any visualization requirement follows the upstream data analytics cycle illustrated in figure-4. A clear business objective and purpose for each of the visualization is defined to ensure there is associated business process that shall drive the efficient usage of the visualization and the insights are actionable. Rest of the effort to understand the data, delivery of data, building analytics and visualizations follows it.

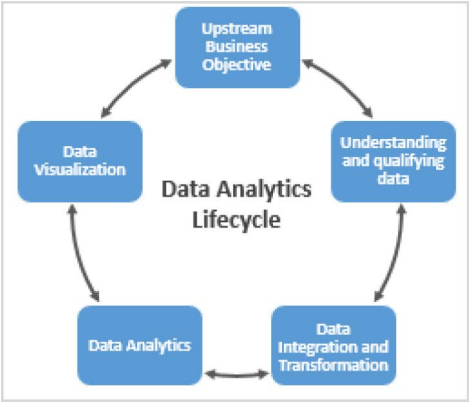

Figure 4—Upstream Data Analytics Life

Data analytics output from any technical workflows generating analytical results and model driven predictions could be integrated as required. Agile methodology is adopted to ensure rapid implementation of new themes and its continuous improvement. A shared visualization library has been established for sharing visualization between various themes which enables rapid implementation of visualization. The integrated framework accelerates the timeframe of typical visualization development from months/weeks to days with a lean team. Business users are continuously engaged along the entire process of building the visualization.

Business Process and Automation

A process driven visualization and analytics environment is established to ensure there is clear accountably for efficient use of the visualizations and the insights are actionable. Process orchestration is a key ingredient for data analytics. Process driven analytics requires ownership from the capture of the data to the publishing of a metric, tracking and actions. Visualization need to be integrated into each of the stakeholder's business processes for the effective usage, sustenance and continuous improvement of data and visualization across its lifecycle is illustrated in figure-5. Workflow automation navigates the entire visualization process from data collection, data validation, to data analysis, opportunity registration, action and tracking in a systematic manner.

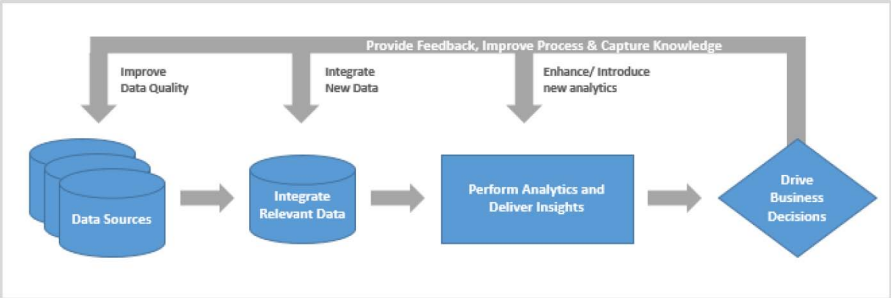

Figure-5—Data to Action Process Framework

Conclusion and way forward

An integrated upstream visualization environment has been established to exploit data to its fullest and use analytics to gain insights at strategic, tactical and operational levels to improve business and operations performance. The visualization environment has enabled better sharing of data across disciplines and cross disciplinary collaboration. Trustworthy data driven by data governance process shall paves the way for using more advanced analytic capabilities to improve planning, execution, analysis.

Associating the visualization to key business process shall be continuously achieved through business process automation. The visualization environment shall be continuously enhanced to add more themes based on business needs, and to carry out advanced data analytics to predict and forecast performance.

Nomenclature

ADNOC = Abu Dhabi National Oil Company
KPI = Key Performance Indicator
OPCO = Operating Company
OWC = Oil Water Contact

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