Tech Mahindra

DRILLING & PRODUCTION OPERATION OPTIMIZATION LEVERAGING EDGE COMPUTING

WHITEPAPER

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Connected Experiences.

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Abstract

Digitalization of upstream oil & gas industry is advancing towards providing solution at the Edge. With increasing growth of available connectivity, advent of new sensors and incorporation of AI/ML models at the Edge, Oil & Gas operator companies now have the possibility to process and get useful insights from data residing in close proximity to equipment assets. This paper will discuss on how Edge computing can be leverage for drilling and production optimization along with the pros and cons of adapting Edge, Cloud and Hybrid architecture

Key takeaways

1. ***Edge Computing***
   Understanding potential driver for Edge Computing in Oil & Gas
2. ***Drilling Optimization***
   NPT optimization in drilling operation through Edge analytics
3. ***Production Optimization***
   Edge solutioning for predicting rod pump failure and reduce production deferment
4. ***Cloud, Edge or Hybrid***
   Pros and cons of analyzing the data at the edge or on a cloud based platform or having a hybrid setup of both.

Introduction

According to most of the leading analyst reports in the field of Emerging Technologies "Edge Analytics" is at the peak of the focus areas. It is of no brainer that most of the CIO / CDO is keeping edge computing in the top priority list of their digital roadmap. With the advent of IoT (Internet of Things), industry is now bringing the power of computing at the edge itself i.e. at proximity to various equipment's/sensors. The upstream sector of oil & gas has always been sensitive to low oil prices and today with the distressed demand and oversupply, the sector is in continuous pressure to reduce its operating expenses related to drilling and production.

These days, the O&G industry has gained significant experience with IoT and the humongous data generated from various sensors is used and deployed across assets. To reduce daily operational costs and improve asset uptime, O&G industry is now looking forward to process & interpreting the data where the sensors reside. This paper will focus on the typical business challenges faced by the O&G companies that are driving them towards edge computing along with TechM's (Tech Mahindra) point of view on probable edge computing solution applicable to drilling and production operations. Also, the scope of potential opportunities of the edge and cloud computing mix, that can be leveraged by the O&G companies, will be touched upon

At the Edge

In simple term Edge Computing is processing data near the edge of the network where the data is generated, instead in a centralized data processing warehouse. IoT whose main components are people, process and technology, is the main enabler of edge analytics. The "technology" part is already being taken care by the massive ingestion of sensor data from drilling rig, well head and production gathering stations. Industry is currently focusing on integrating the vast amount of real-time data generated from sensors to specific business processes where actionable insights can be drawn from the data which demands less latency time for decision making. The potential drivers of the need of edge computing in the O&G industry are.

1. ***Lack of robust communication system (intermittent network connection) as mostly rigs and platforms are placed in remote and harsh weather condition***

2. ***Low bandwidth of satellite connection which is not suitable for transferring huge data volume***

3. ***Latency time increases in decision making as transmission and processing of data in a centralized location increases***

4. ***Data privacy / security is another point of concern when it comes to transmission of data.***

To mitigate the above challenges solution like edge computing with amalgamation of new technology like 5G & Cloud computing is being assessed and looked upon

As massive amount of real-time data is generated from various sensors used in drilling and production operations, illustrative use cases where edge computing can be leveraged are discussed further

Edge computing - Drilling sensor data

A major portion of operating cost in any oil and gas companies is spent in drilling of a well or more precisely it is being consumed by the day-rate of the rig. It has been seen that for a semi-submersible rig operating in ultra-deepwater cost can go up to $200K per day. There are instances like in case of stuck pipe or mud-pump failure when drilling operation stop which is technically termed as Non-Productive Time (NPT) and the companies ends up in paying a considerable amount of money without any drilling operations.

It is important that companies leverage real-time drilling data generated from various downhole and surface sensors efficiently to examine the breakdown of drilling operations and predict the NPT for enhancing the rig performance. A typical operational drilling rig generates ~2TB of data per day which is mostly transmitted to a centralized operating center via satellite communication having data speeds ranging from 64 Kbps to 2 Mbps. Mostly it takes 12 days to transfer one day rig data. As a result, only 1% of the data generated in the rig is being transferred to the RTOC (Real-time operation center). Hence to analyses the rest 99% unused data it's should be deal at the place where it is generated.

With the advent of micro-electronics, it is now possible to deploy Machine Learning (ML) model like multidimensional, multivariate and stochastic analysis of the downhole sensor data at the edge. As for example Rate of Penetration (ROP) optimization can be done by analyzing multiple variables like Weight on Bit (WOB), Torque, Revolution Per Minute (RPM) of drill string and bottom hole circulating pressure.

Edge gateways nowadays are designed with enhanced processing and communication capabilities. It also comes with enhanced communication layer which allows both LAN & WAN communication capabilities. LAN is generally used for communicating with local devices like Remote Telemetry Unit (RTU) and Programmable Logic Controllers (PLC). WAN is used for connectivity to the cloud platform for data transfer and remote device management.

Also, to mitigate challenges like deploying analytical platform at the edge which may hinder processing capabilities are addressed by transferring representative sample data of the complete model to the edge device. Edge architecture can be deployed on premise where results from edge gateway are used in real time for increasing operational efficiency (Fig:1). It is mainly used where there are intermittent WAN connectivity and concern of cyber security prevalent in client for data transmission to a cloud platform. Edge architecture can also be utilized via full cloud connectivity where real time data can be collected through multiple gateways and the data can be processed and interpreted in cloud platform

Benefits of edge solutioning for drilling sensor data is listed below:

1. ***Better insights:*** Faster analytics of high frequency data at the edge equates to better insights about the drilling operations in real time. This lowers the risk of steering/entering a wrong formation and better drilling performance

2. ***Lower Latency:*** Data insights at the edge helps in reducing time of decision making.

3. ***Minimize data transmission cost***.

4. ***Better communication:*** New technology like 5G will enable efficient means of communication to support real-time monitoring and mobile inspection of systems and devices, especially in remote and dangerous areas

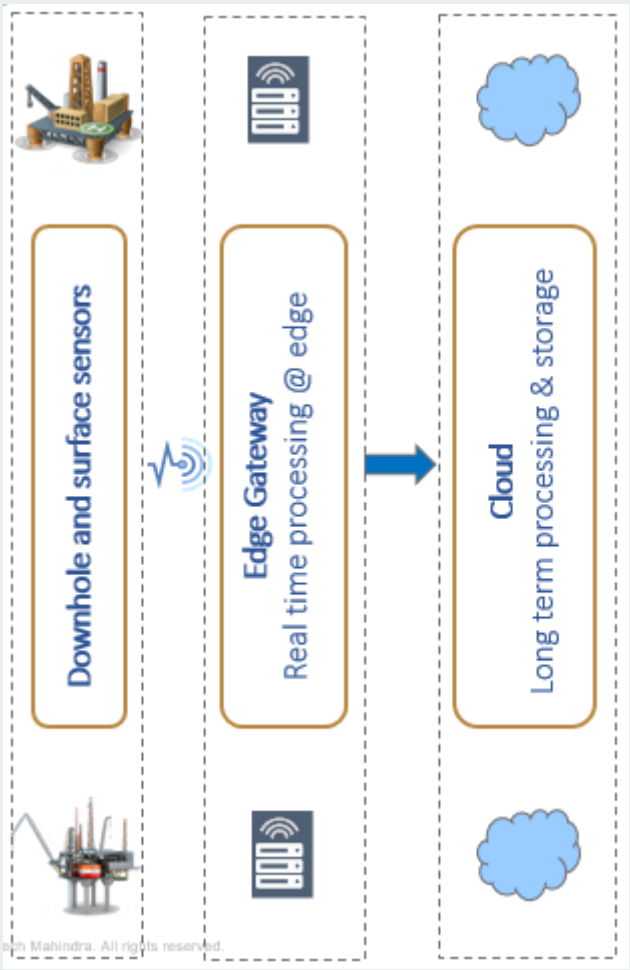

Figure 1: Edge Gateway processing the data locally at the edge before transmitting to cloud.

Edge computing - Identifying rod pump failure

Around 3-5% well are unavailable due to premature artificial lift equipment failure leading to excessive production loss. Considering failures of 10 wells in a year and shutting down period of 3 to 8 days with average production rate of 3000 barrels/day and ~ $40/ barrel oil price, revenue loss of 3 million to 9 million are estimated. Failure rates for SRPs have been substantially higher due to change in operating integrity window and parameters. Generally, in case of sucker rod pump failures are classified based on visual inspection of Dynamometer card. Dynamometer is an instrument used in sucker-rod pump to record the variation between the polished rod load and the polished rod displacement. Study of Dynamometer card disclose a defective pump, leaky tubing, inadequate balance of the pumping unit, a partially plugged mud anchor, gas locking of the pump or an undersized pumping unit. Usually the Dynamometer card is collected by RTU and transmit it to a centralized location through Supervisory Control and Data Acquisition (SCADA). In the centralized location production engineers study the Dynamometer card. The whole process is too time consuming and decision time gets increased which affects pump run time

Predictive analytics is being extensively used to proactively estimate pump failures. Machine learning is now being extensively used in studying and drawing inference of the Dynamometer card. In the training phase, supervised learning method is adopted where substantial amount of sample Dynamometer card & its results are provided as input data. The model is then trained to provide response based on set of parameters.

In inference phase already, trained model is used on new data to provide useful responses. In case of Dynamometer card recognition Convolutional Neural Network (CNN) model is used as it is the best for computer vision processing. As the model gets developed it gets deployed in Edge gateway. Edge gateway are directly connected to RTU which feeds real time Dynamometer card. Typically, container base edge architecture is use for Dynamometer card prediction (Fig:2)

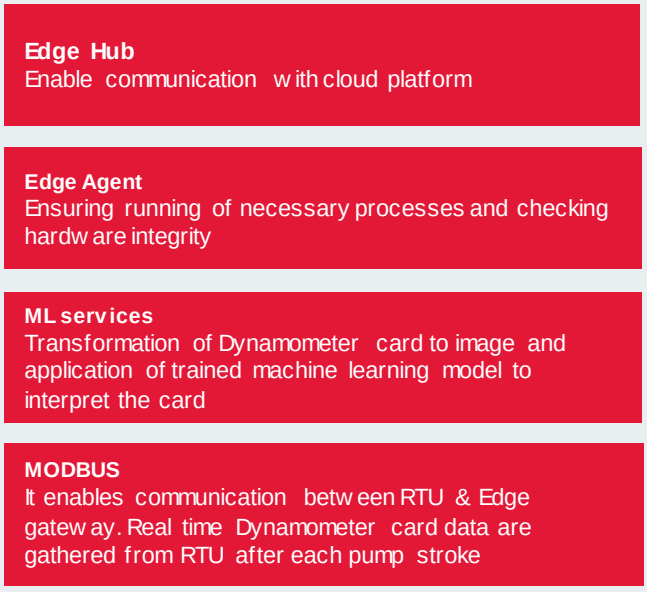

Figure 2: Container base edge architecture for Dynamometer card prediction

Benefits of edge solutioning for predicting rod pump failure is given below::

1. Proactive management of production operations and timely intervention to avoid production deferment. Reduces production deferment by 10 to 15%
2. MTTR (Mean time to repair) improves significantly and reduces cost of maintenance by 10 to 15%
3. Helps in work over rig optimization
4. Provide enough lead time for Production Engineers to plan work-over operations inspection of systems and devices, especially in remote and dangerous areas
5. Incorporation of machine learning model through effective collaboration of RTU & Edge gateway

Edge computing complementing Cloud computing

Factors Under consideration while evaluating the feasibility of edge computing or cloud computing in upstream O&G industry are:

- Data volume
- Transmission & Processing speed
- Data Transmission cost
- Cyber security

In some cases, where the data volume is huge and there is a need to store the huge volume of data and run AI/ML model at a scale i.e. enterprise wise, cloud computing is the preferred choice. It is relatively easy to apply edge computing in focus area i.e. place where it is easy to maintain highly distributed infrastructure. Usage of advanced technology such as machine learning anomaly detection at the edge is not a hindrance nowadays except for its usage in a larger scale.

With the advent of new technology like 5G having features like Enhanced Mobile Broadband, Ultra-reliable Low Latency Communications & Massive Machine Type Communications data transmission & processing speed can be significantly improved. Though in some offshore platform or drilling rig connectivity is intermittent and this is where edge computing can be thought upon

Data privacy & cybersecurity is an important issue which is of great concern for O&G operator company as it often seen that most of the sensitive data transfer is not allowed for network transmission also there are regulatory guidelines that the data needs to reside in the host country. In all these cases edge computing may be the only viable option

Are you ready to get benefit from Edge Computing

In summary we understand that edge computing and cloud computing are complementing each other. Nowadays Oil & gas companies are moving towards more of adopting a hybrid architecture where the IoT platform is open and flexible enough to support both edge & cloud infrastructure. It is quite evident that the quantity of data that the IoT sensors are generating puts pressure in the traditional storage systems. Also transmitting data to the cloud and back to the enterprise is a costly affair and requires lot of bandwidth. Edge computing helps in preprocessing the data locally and hence can filter out the unnecessary data which are not relevant to be sent to cloud.

As the future of Oil & Gas industry is moving at a fast pace to digitalization era, advanced technology like cutting-edge sensors, better connectivity (5G), economical cloud technologies, and availability of advanced data analytics model is helping O&G industry to make the next technological focus on successful deployment of Edge computing

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