LYVE™ Mobile

White Paper

OPTIMIZING HIGH-CAPACITY GEOSCIENCE DATA WORKFLOWS

SEAGATE

CONTENTS

Introduction

In the energy industry, oil and gas (O&G) companies are under constant pressure to find new and drillable carbon reserves. In this business, the first person to find oil is the first person to dig for it, which makes exploratory seismic, oceanographic, and meteorological data ten times as valuable as the oil itself. For every segment of the oil and natural gas industry—upstream, midstream, and downstream—aggregating, transporting, and analyzing more data faster is what gives O&G companies a competitive advantage.

The Importance of Data to O&G Operations

- **To mitigate the risk of environmental hazards and streamline operations** that occur throughout exploration and ongoing asset management, O&G companies utilize an array of smart sensors to capture data every step of the way.
- For *upstream* efforts—which refer to the exploration and production of oil and natural gas—**data reveals changes in rock composition to refine drilling location for faster exploration and help avoid nonproductive time (NPT).**
- For *midstream* efforts—which refer to anything related to the transportation and storage of crude oil (e.g., pipelines, pumping stations, tank trucks, rail cars, and transcontinental tankers) before it is refined, and processed into fuels and key elements—**data identifies faulty components in pipelines for repair or critical preventative indicators to avoid pipeline leaks.**
- For *downstream* efforts—which involve turning crude oil and natural gas into their final products such as gasoline, asphalt, fertilizers, plastics, dyes, fibers, hearing aids, and flame-retardant clothing—data enables smart manufacturing practices and predictive maintenance at refineries. When it comes to supporting net-zero carbon emissions (a priority at the top of every O&G producer's list), **data is vital to the carbon tracking and reporting that informs O&G operations.**

Data Movement at the Edge

Upstream (Exploring and Drilling)

- Applications: site mapping and drill monitoring
- Data types: raw, RBG, geospatial, bathymetry, and video data
- Data workflow: multistream data and image capture >10TB/day

Midstream (Production and Transport)

- Applications: asset monitoring and inspection, analytics, and predictive modeling
- Data types: sensor data files (e.g., acoustic sensors, drone video files, and carbon/pressure metrics)
- Data workflow: continuous recording greater than thousands of KB-MB files/day

Downstream (Refining and Retail)

- Applications: quality assurance, distribution, logistics, and retail
- Data types: factory metrics, performance disruption, predictive analytics
- Data workflow: factory stimulation and analytics >8-10TB/day

Data generally arrives either unstructured (e.g., well logs, written drilling reports, CAD drawings) or semi-structured (e.g., ocean-floor models and simulations). And, just like the carbon reserves, this data is of little use until it is promptly extracted, delivered, and refined. This is one reason British mathematician and entrepreneur Clive Humby coined the phrase, “data is the new oil.” O&G companies are no longer solely in the business of extracting carbon. They are also extracting the value of their company’s data.

As such, capturing, transferring, and analyzing data across upstream, midstream, and downstream applications is essential for environmentally friendly, efficient, and profitable O&G operations. More than anything else, time to insight is critical. For the large datasets that these sensors generate in real time to be of any use, customers require rugged, scalable, and affordable edge storage, and mass-capacity data transport solutions that enable frictionless data transfer to the data center or cloud.

Key Challenges to O&G Data Workflows

The biggest impediments to O&G data workflows come down to scalability, mobility, and affordability. Most prominently at the edge (where exploration and production operations generate enterprise-level datasets), if data infrastructure cannot scale up and down (affordably as operation needs change over time), upstream O&G operations simply won’t keep up.

The aim of this white paper is to explore the data workflows specific to each segment of the O&G industry, as well as the challenges each faces in the field (such as limited edge-infrastructure storage, inability to scale, limited bandwidth and network capacity, and decreased time to insight), in order to better inform and future-proof data aggregation, transportation, and activation.

Data in Upstream Operations: Drilling Use Case

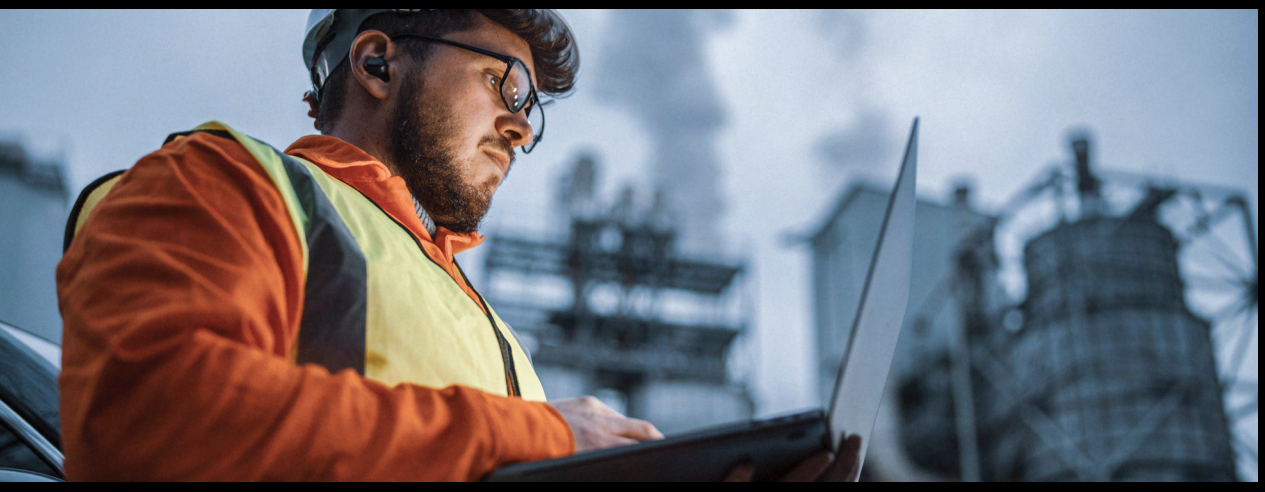
The question is, what does data collection look like at the edge? At an oil well, drilling equipment contains smart sensors that record precise geological data in order to identify subsurface rock formations to determine the amount of pressure needed to drill down into them. Many companies rely on edge analytics to interpret this data in the drilling process. This means the quicker the drilling team can interpret data generated at the edge, the sooner they can identify carbon reserves, begin extraction, and adjust ongoing operations as needed.

In modern operations, energy companies manage these processes using a supervisory control and data acquisition (SCADA) system whose operators use software to interact with various equipment—including valves, pumps, and motors—and manage flow, pressure, and temperature of product moving through the system. A typical SCADA workflow involves transferring data from the edge to a central data center or the cloud using a software-defined storage solution that streams data via Wi-Fi, 5G, LTE, or satellite communications. Considering most O&G drilling sites are remote, this presents a significant data logistics problem. These drilling operations generate high volumes of data at the edge.

Seismic Survey

- Raw acoustic data is collected from multiple sensors
- Data is aggregated in the field using fleet of Lyve Mobile Arrays
- Data plotter is used to analyze sensor data in real time, in order to make necessary adjustments

- In 2020, the global O&G industry generated five exabytes of data every two days, which is equivalent to the total amount of data created by humans until 2003. (Department of Industrial and Systems Engineering, Hong Kong Polytechnic University, Hong Kong)
- The big-data market in the O&G sector is poised to grow at a compound annual growth rate of over 19% between 2021 and 2025. (Technavio research)



Considering the steady demand for oil exploration and production, the value of this data will only increase. So, what is the simplest, most efficient way to store enterprise-level datasets in O&G operations? This is where IT personnel run into challenges. Traditional options include on-premise edge and data-center storage. However, as O&G companies know, building new data centers onsite is massively cost-prohibitive, if not physically impractical. Additionally, cloud storage gets expensive quickly, due to egress and ingress fees. As a result, operational teams in the field don't end up storing and using full datasets, only partial ones.

Moreover, to compensate for limited onsite storage, drill teams often resort to selecting limited datasets to offload and purging the rest to make room for incoming sets. Unfortunately, though purging edge data solves a temporary problem, it can create worse ones down the road. New projects that rely on retrospective insights, which analyze archived data, are hindered from the outset when those datasets have been winnowed. This means any new data-collection initiative will only cost more money, resources, and time than it would have if the old sets had not been purged. If companies efficiently and affordably move bulk datasets in their entirety, they will also be able to build legacy data archives—important for future project requirements sets—all without putting any strain on edge data storage.

The reality of leveraging some, but not all data, is not unique to O&G companies. Research indicates that numerous enterprises experience this same struggle.

- Approximately 44% of potential enterprise data is never captured, while 43% of captured data goes unused. (Seagate Rethink Data Survey, IDC, 2020)

Key Takeaway: With more digitalization at the edge–where data collection requirements will need to change to accommodate more sensors, more equipment, and more operations that generate data—O&G companies need to future-proof their edge storage infrastructure so that all data can be leveraged for business insights.)

Lyve Mobile Array

HDD and SSD Up to 96TB and 92TB

Two sets of Mobile Arrays connected to server:

- One to capture all raw data in the field
- One for processed/imaged data

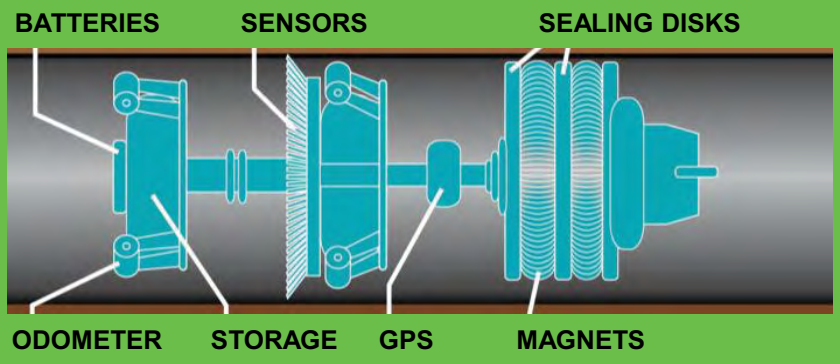
Sensor data is consolidated and processed in the field to produce dynamic visualizations of subsurface structures for client.

Data in Midstream Operations: Pipeline Integrity Use Case

Capturing data at the edge isn't limited to oil well sites. Midstream efforts utilize innovative sensors, technologies, and data as part of their planned maintenance programs. For example, energy company contractors inspect and clean oil pipelines that can stretch over 10,000 miles. To accomplish this, there are two prominent approaches—one internal and the other external.

The first method involves inserting a pipeline inspection gauge (PIG), which not only clears the pipe of debris, but also uses smart sensors to measure reverberations within the pipeline (acoustic analysis) to determine pipeline integrity.

Pipeline Inspection Gauge



Capturing and transferring the tremendous datasets PIGs generate is a feat. Typically, a PIG will travel 100 miles over the course of two days before a worker removes it, using a special trap to capture data. After that distance, PIGs typically generate up to 400GB of unstructured data. Over the course of a 10,000-mile trip, a PIG can produce as much as 41TB of data; over 2,000TB (or 2.1PB), each year.

Throughout these operations, midstream companies can typically experience up to a five-day delay before receiving data for analysis from PIG inspections. This means, if there is an issue in the pipeline such as a buildup of debris, that problem may worsen, all but guaranteeing pipeline declining efficiency and performance. The faster midstream companies can retrieve data insights, the more efficient operations will be.

Additionally, it is critical that these operators are able to process and use analytic data to make decisions in the field. Because most operations struggle to aggregate, consolidate, and activate unstructured datasets at the edge, any infrastructure that enables users to retrieve data quickly and efficiently, and run onsite analytics for immediate insights will have a powerful competitive advantage over existing solutions.

Key takeaway:

Midstream edge data is essential for pipeline, and other equipment assessment and integrity. However, delayed time to insight increases the risk of asset degradation. Midstream companies need reliable, frictionless data mobility to enable proactive maintenance and prevent asset failure.

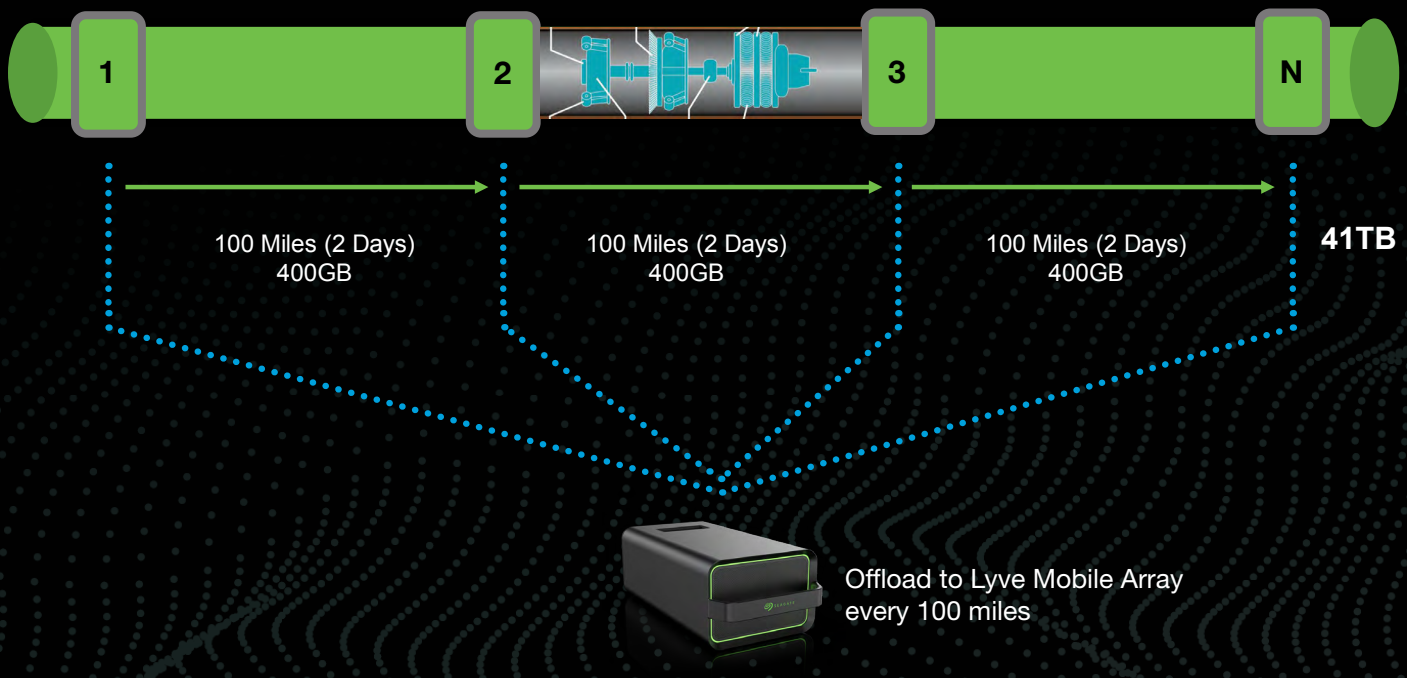
Pipeline Integrity Monitoring

- PIG clears debris from pipe and measures reverberations within pipeline
- This inspection gauge collects up to 400 GBs of unstructured data over two days
- Acoustic analysis data is collected using Lyve Mobile Arrays

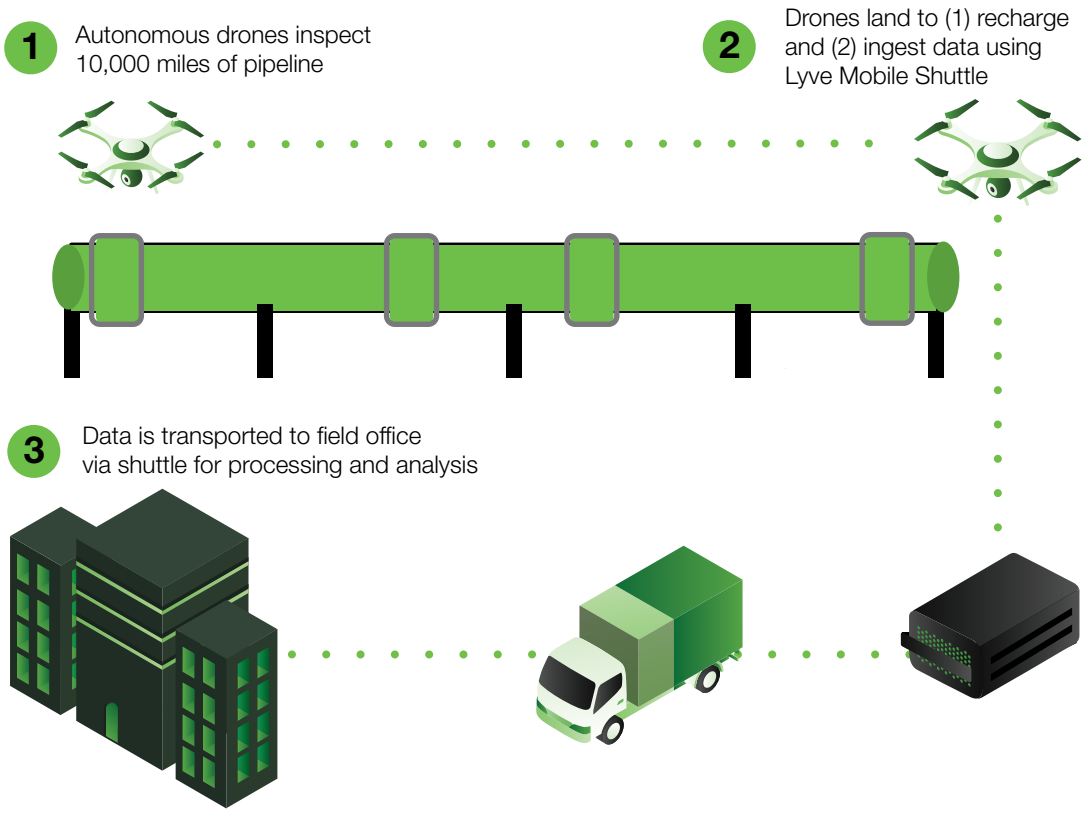
2.1PB
Per Year

41TB
Per Trip

1. The PIG is inserted at the start of the pipeline and will travel its length, often more than 10,000 miles
2. Every 100 miles, a person is deployed to offload data from the PIG to a Lyve Mobile Array
3. At the end of the pipeline, the Mobile Array is sent to a data center for review



Autonomous Drone Inspection



Thanks to advancements in asset-maintenance technologies today, midstream companies can conduct remote inspections using autonomous drones that capture high-resolution images of pipelines. Engineers can run analytics on these photographs to identify rust, corrosion, or other pipeline-integrity indicators.

Like oil well pads, these pipelines often pass through locations with limited edge infrastructure. This creates a challenge as edge locations rely on satellite connections to send imaging and data back to headquarters, even when such coverage is too limited to send substantial amounts of data. If a connection is interrupted, the upload will have to be repeated, wasting valuable time and resources.

Key takeaway:

Edge analytics are critical to detecting issues with a pipeline. However, they deliver the best results when analyzing full datasets. Midstream companies need mass-capacity data storage and transport solutions to unlock the full potential of data that leads to smarter decision-making.

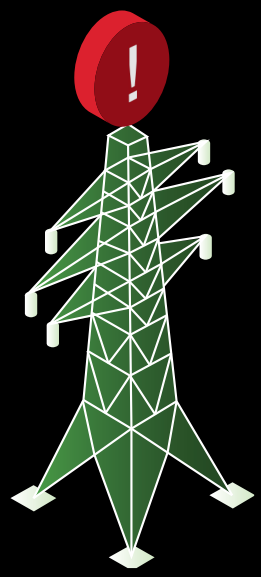
Data Management Pain Points

When looking at the upstream and midstream use cases and data workflows today, it's clear that data capture, transfer and analysis are hindered. Put simply, the critical data challenges across the O&G industry include:

- Limited physical infrastructure onsite, where today's edge infrastructure isn't suitable for tomorrow's storage needs
- Inability to scale to fit expanding and contracting data needs
- Limited bandwidth and network capacity
- Time to transfer and increased time to insight, resulting in delays in analyses that inform business decisions
- Security of data collection and transport
- Compatibility across many ecosystems
- Limited edge infrastructure storage and inability to scale

A glaring pain point across all O&G use cases is limited physical edge infrastructure that's unable to accommodate growing data needs. The rapid deployment of internet of things (IoT) devices and other sensors across O&G operations generates massive datasets. The reality is that on-premise edge storage devices and data centers have reached their limits. Due to limited storage space onsite, many operations have had to purge data to make room for new datasets, leaving valuable insights behind. Quickly scaling up or down in storage capacity to match current O&G operations is also difficult as IT teams often budget and make storage infrastructure investments designed to last for several years. These challenges are pushing O&G companies to look for data-storage alternatives.

Data Management Paint Points Continued



Limited Bandwidth and Network Capacity

Among the existing wireless communications technologies utilized by O&G companies, none present a complete solution for handling large amounts of data captured at the edge. Because of this, satellite communications have become the de facto solution for many remote operations, and it comes at significant cost. A single satellite connection can cost up to $300,000 a year.

Additionally, O&G companies face bandwidth constraints when running operations at remote sites with limited communications infrastructure. This problem is only compounded by the fact that datasets captured at the edge have become so large that they are too heavy to move over the network. This has forced O&G companies to triage data at the edge, moving essential data downstream, while troves of valuable data are purged to free up memory space onsite.

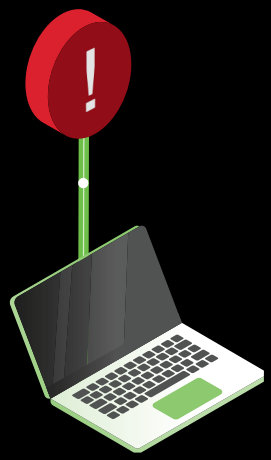
Decreased Time to Insight

With the cost of satellite data transfer, significant bandwidth limitations, and waning network capacities, O&G operations' time to insight have seen sizeable reductions. In 2018, Cisco noted that oil rigs generated over a terabyte of data each day, which takes around 12 days to transfer via satellite connection. Even at transfer speeds of 1 gigabyte per second (Gbps), fiber-optic data transmission is still 25 times slower than physical data transfers, this includes factoring in one-day shipping. Because the safety, efficiency, and sustainability of ongoing operations depend on rapid insights, O&G companies need to re-evaluate their data-transfer methods.

Data Management Paint Points (Continued)

Vendor Lock-Ins

Another hindrance to data management and mobility is being locked into vendor-specific cloud ecosystems. Many O&G companies are bound by cloud vendors that have their own proprietary systems and restrictions. As a result, O&G companies may not be able to easily access and move data across all their platforms.



Compromised Data Security

Data transfer via satellite is common in O&G operations. However, O&G companies rarely have direct authority to regulate their satellite's cybersecurity, leaving them vulnerable to ever-worsening cyberattacks. If hackers intercept satellite signals, they can access the upstream and downstream system that connects with the satellite, allowing them to breach an organization's entire network.

The cost of a data breach rose by 10% from 2020 to 2021 for energy and utilities entities, which ranks fifth in data-breach costs, according to the *Cost of a Data Breach Report*, conducted by the Ponemon Institute and published by IBM Security. Astoundingly, this report found that the average cost of a data breach in the energy industry is $4.65 million.

Imagining a Path Forward

Research suggests that, in order to employ smart oil solutions in remote settings, the industry must move with the times to future-proof its edge operations. It is vital that O&G operations embrace a truly disruptive data storage and transfer strategy. This requires bypassing bandwidth limitations, and guarantees effortless and affordable scalability at the edge. It also allows for frictionless physical data transfer from edge, to data center, to cloud, where dataset insight can continue to create value for users. Because time-to-insight for O&G analytics is such a crucial part of drilling and pipeline maintenance, simple, secure, and efficient data mobility is more important now than ever.

Finding a Solution: Lyve Mobile

The question is, how do O&G companies overcome these data challenges? One best practice is to partner with a data-storage expert that offers a different solution. Since 1979, Seagate Technology has been creating precision-engineered data-storage technologies that deliver superior capacity, speed, safety, and performance. Backed by 40 years of experience, Seagate has developed an innovative Lyve Mobile service offering that solves data-mobilization-challenges and data-logistics complexities.

Built for the edge, Seagate Lyve™ Mobile's cost-optimized, vendor-agnostic hardware, software and services enable users to consolidate and store data in any environment, and quickly move it to their landing destination of choice for immediate analysis, informed decision-making, and positive business outcomes.

Lyve Mobile is an intuitive pay-as-you-go subscription service that enables O&G companies to transfer massive amounts of edge data to high-capacity storage drives that are built to withstand the most extreme environments. Once the data is transferred, users can shuttle the drives directly to central data centers for analysis. For onshore applications, the devices can be shipped by ground or air. For remote offshore operations, companies can transport storage devices by boat or unmanned aerial vehicles to shore.

Improving O&G Operations

The value of Lyve Mobile is that it empowers O&G companies to achieve the following:

- **Quickly move data from edge to core: Getting data from the edge as efficiently as possible is critical to making timely business decisions.** Lyve Mobile enables O&G companies to aggregate, store, move, and analyze all data up to ten times faster than using wireless alternatives, ensuring no data is left behind. This enables algorithms to run on bigger datasets, producing more accurate results and leading to benefits such as improved preventative maintenance, reduced nonproductive time (NPT), and lower carbon emissions.
- **Shift storage costs from capital expenditures (CapEx) to operational expenditures (OpEx):** Because Lyve Mobile guarantees users only pay for what they need, companies don't need to incur CapEx when purchasing edge devices outright. They only need to pay per project or subscription rates on either a monthly or yearly basis. Users can order as many devices or configurations as needed, then return the edge devices once data is successfully transferred. Additionally, there is no need for maintenance fees or technology upgrades. Moving from a CapEx to OpEx, O&G companies can scale up or down using a cost-efficient subscription model—maximizing data capture and as a result, activating data insights without creating unnecessary costs. This creates storage savings and predictable storage-cost models.
- **Bypass limitations of edge infrastructure:** Lyve Mobile makes moving large datasets simple and secure, enabling companies to consolidate and physically transport data securely to their landing destination of choice. Innovative, efficient, and secure, Lyve Mobile hardware, software, and services gets data where it's needed most at best-in-class speeds, enabling customers to take back control of their data and reduce their time-to-business insights. Additionally, Lyve Mobile vendor-agnostic devices come in various storage capacities, ensuring endless customizability for every operation, on- or offshore. The Lyve Mobile Shuttle offers 16TB of HDD and 8TB of SSD. The Lyve Mobile Array is a six-bay RAID solution that boosts capacity to 96TB of HDD and 92TB of SDD. It features tamper-resistant screws and safety seals, making it ideal for secure, physical transport.
- **Activate and mobilize data simply and securely:** Outfitted with industry-standard SED AES 256-bit encryption, self-encryption, and secure user access, Lyve Mobile hardware is data secure, from the inside out. Robust, rackable, and portable, Lyve Mobile devices ensure efficient and worry-free physical transfer, even in the harshest conditions. Its vendor-agnostic and highly compatible design also ensures effortless integration into existing workflows. With the added ability to scale up, down and upgrade hardware and software depending on evolving needs, Lyve Mobile is engineered to keep pace with O&G industry needs.
- **Enable onsite analytics:** Retrieve data quickly and efficiently to enable users to make onsite analytics and calculations immediately. Lyve Mobile helps users activate their data by accelerating time to insight, optimizing workflows, and delivering a powerful competitive advantage over standard operations.

Conclusion

As data remains a critical aspect in enabling business insights and preserving assets for O&G operations, companies must evaluate their edge infrastructure and storage technologies. Upstream, midstream, and downstream companies need to rethink how they store and move data today to ensure they have a future-proof solution for tomorrow.

Here are a few recommended data assessment questions all O&G companies should consider:

- How are you moving data today? How are you moving data tomorrow or in 36 months?
- Where are you moving the data from and to?
- What are the major data bottlenecks?
- Is your cost of data movement efficient right now? How about tomorrow or in 36 months?
- What prohibits you from moving more data from edge to core?
- What are your perceived data challenges when addressing carbon-reduction initiatives?
- How are you backing up data that is being continuously collected from sensors on edge assets?
- What type of data activities are being done onsite?
- What type of data is needed for onsite processing?
- What type of data needs to be transferred ASAP to the data centers/SCADA?
- What type of data needs to be transferred online?

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