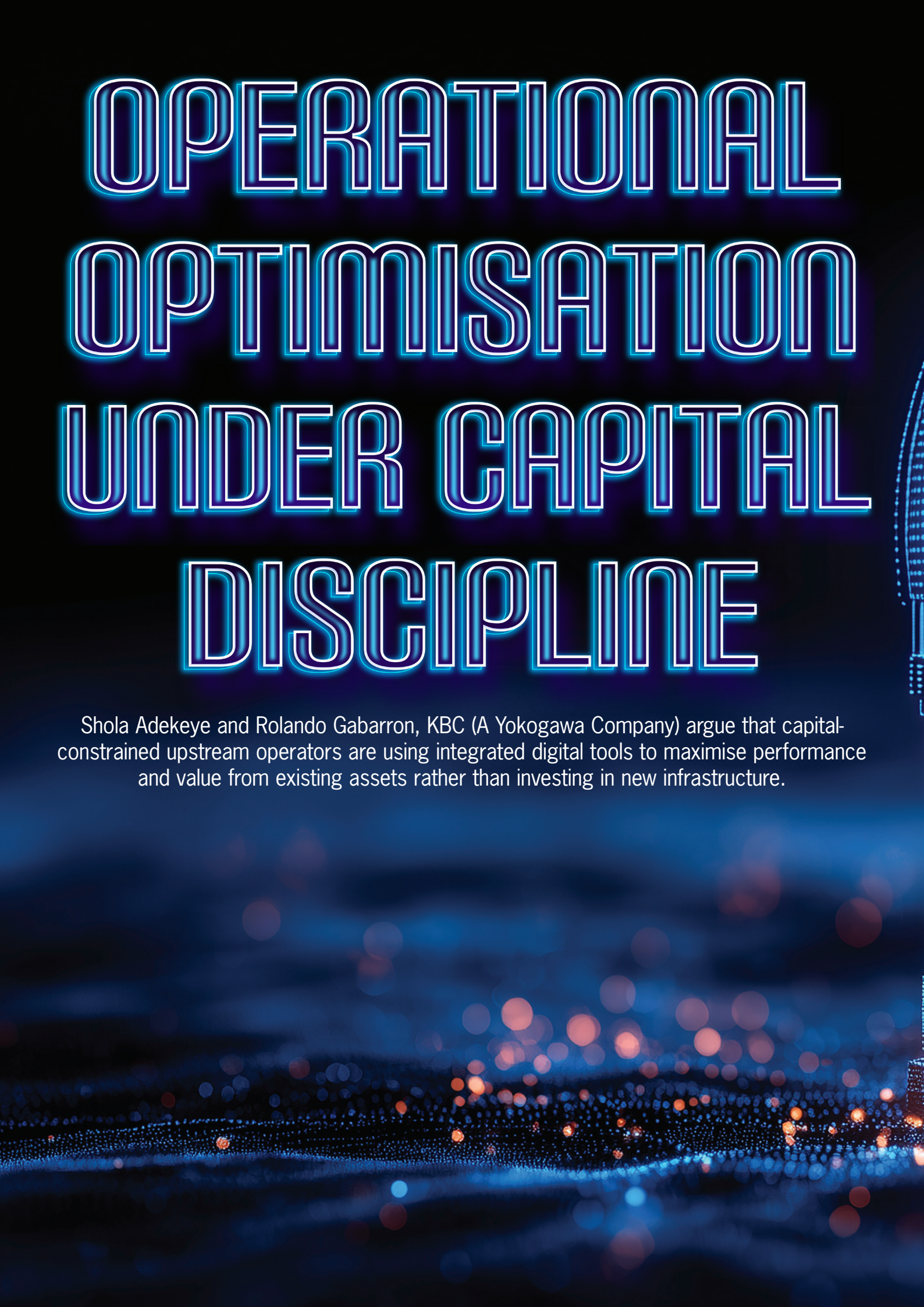
OPERATIONAL OPTIMISATION UNDER CAPITAL DISCIPLINE

Shola Adekeye and Rolando Gabarron, KBC (A Yokogawa Company) argue that capital-constrained upstream operators are using integrated digital tools to maximise performance and value from existing assets rather than investing in new infrastructure.



In upstream oil and gas, capital discipline increasingly prioritises optimising existing assets rather than adding new physical infrastructure. Capital discipline favours smaller, phased investments, fewer new projects, and deeper scrutiny of capital efficiency, reliability, and performance of existing assets using cloud-enabled tools.

At the same time, the International Energy Agency (IEA) has acknowledged that investment in oil and gas has fallen sharply, reporting that upstream capital spending declined by approximately 35% between 2015 and 2025. The IEA cautions that sustaining current production levels will require hundreds of billions of dollars in annual investment, especially as decline rates of hydrocarbon reservoirs accelerate.

In parallel, analysts now project further capital tightening. Outlooks referenced by Wood Mackenzie indicate upstream spending cuts in 2026. These projections reflect how operators must balance capital spending, commodity price risk, and portfolio diversification priorities. Together, these dynamics place renewed emphasis on capital efficiency and asset performance.

In this environment, upstream operators' early design and operating assumptions lock in cost, risk, and emissions performance. Several factors drive this renewed focus on capital efficiency:

- Energy security has returned as a strategic priority following recent geopolitical and global supply chain disruptions. Governments and operators alike are reassessing upstream resilience to ensure reliable and secure energy supplies amid heightened market volatility.
- More Artificial Intelligence (AI), Machine Learning (ML), automation and advanced production enhancement technology are increasingly being applied across Exploration and Production (E&P) operations. These tools are intended to help improve production, reduce operating costs, and manage growing asset complexity. Digital optimisation can lift production by several percentage points, directly lowering lifting costs and improving margins under capital constraints.
- Global demand for natural gas continues to rise, both as a transition fuel supporting lower-carbon energy systems and as a reliable power source for energy-intensive infrastructure such as data centres. Natural gas demand is expected to remain resilient over the medium term. This trend reinforces the

importance of efficient, well-managed upstream gas assets.

Against this backdrop, upstream operators face increasing pressure to extract greater value from assets, especially in remote environments. They must do so while maintaining safety. These challenges shift operators toward tightly integrated operating models spanning production optimisation, asset management, and facilities design.

Operational digitalisation under capital discipline

While capital discipline has become the dominant constraint shaping upstream investment decisions, it has also accelerated a shift in how operators extract value from existing assets. Rather than replace infrastructure, effective responses to capital tightening increasingly focus on integrating data, physics-based models, and operational workflows into cohesive decision systems.

Traditional approaches often treat production surveillance, allocation, asset management, and optimisation as disconnected functions. Under capital constraints, this fragmentation becomes a liability. Operators increasingly require continuous visualisation into well and network performance without new field hardware or frequent manual intervention.

Cloud-based virtual flow metering, integrated asset models, and near-real-time operational analytics have emerged as practical enablers of this shift. When embedded within daily workflows, these capabilities move teams from periodic insight to continuous decision support. This transition improves production confidence, accelerates response times, and reduces the economic impact of uncertainty, particularly in mature or remote assets with high intervention costs.

From an operational standpoint, capital discipline has therefore reframed digitalisation from a technology initiative into a core production strategy. The value lies not in any single model or dashboard, but in how measurement, optimisation, and execution are connected across the asset lifecycle.

Lifting cost reduction and asset performance

Upstream operators focus on lowering lifting costs by approximately 5 - 10%. These gains are typically achieved through improved production surveillance, asset optimisation, and digital workflows. These approaches are applied across the production system rather than any single segment of the production workflow. Together, these three areas form the primary levers operators use to improve efficiency, manage asset complexity, and strengthen field economics under capital constraints.

Operational levers for upstream performance

Production optimisation

Where can operators unlock production gains without adding capital or hardware? Production optimisation remains a central focus for upstream operators seeking to maximise throughput, stabilise operations, and reduce unplanned deferment. These objectives combine domain expertise with first-principle, physics-based simulation and near-real-time operational data.

Across a range of upstream applications, operators applying these approaches have achieved production efficiency improvements of approximately 2.5 - 10%. Figure 1 shows an integrated operational dashboard that supports production surveillance and optimisation across wells.

Rather than serving as a static reporting view, this type of dashboard supports continuous production optimisation by highlighting deviations, ranking wells by opportunity, and enabling faster operational response.

Improving production visualisation without adding hardware has become a critical optimisation lever. For example, cloud-based virtual flow metering (VFM) applies physics-based multiphase modelling and near-real-time analytics to estimate oil, gas, and water rates for back-allocation and daily production accounting. By augmenting periodic well tests and existing instrumentation, these techniques improve allocation accuracy, accelerate anomaly detection, and enable faster operational responses across brownfield and unconventional assets. When integrated into production surveillance

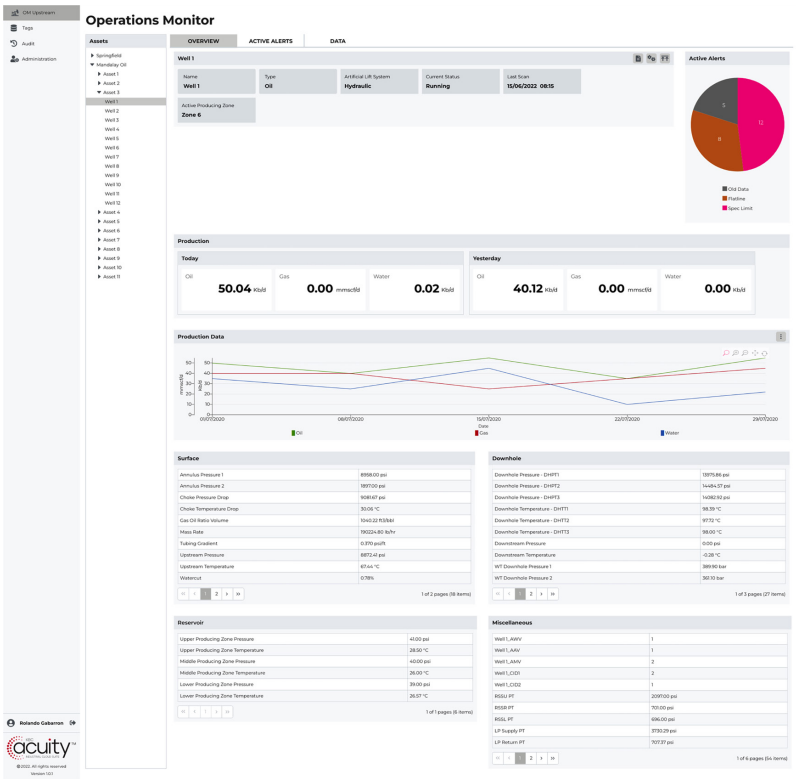


Figure 1. *Operational dashboard showing surveillance and performance monitoring across multiple wells and assets.*

dashboards, VFM helps close gaps between tests, supporting more informed day-to-day optimisation rather than waiting for the next well test cycle. These systems can operate alongside multiphase flow meters (MPFM), test separators, and well-testing units without additional instrumentation.

Beyond rate estimation, physics-based simulation tools support a wide range of upstream optimisation and flow assurance challenges, including:

- Hydrate formation risk.
- Wax deposition prediction and mitigation.
- Mercury partitioning.
- Life-of-field simulation.
- Gas lift optimisation.
- Facility debottlenecking.

These first-principle, physics-based simulations provide operators with a detailed understanding of thermodynamic and flow behaviour under real operating conditions. This insight detects risks earlier and improves confidence in decision making.

For example, these simulation insights combined with ML can detect hydrate formation risk in pipelines. Advanced analytics can then evaluate mitigation options, such as adjusting the chemical injection rates or operating parameters. These insights support earlier anomaly detection and more proactive operational response. Beyond incremental uplift, these approaches help operators build confidence under changing conditions.

Asset management

As upstream facilities age, maintenance costs rise and equipment reliability becomes increasingly critical to production efficiency and profitability. In offshore and remote environments particularly, even small production losses can have disproportionate economic impact. In the authors' experience, a 1% loss in production can exceed the annual maintenance budget of a single offshore asset.

Operators are shifting toward data-driven asset management strategies to improve reliability, predictive insight, and risk reduction. Key elements include:

- Uptime improvements of approximately 1 - 5%.
- Smart asset management where technology-augmented critical equipment reduces dependence on large onsite maintenance workforces and enables data-driven decision making.
- Enterprise asset management systems supported by subject matter expertise.
- Time-at-risk reductions of up to 30% via digitalisation and remote monitoring; task optimisation and planning, automation and robotics.
- A shift from reactive and preventive maintenance to predictive and proactive strategies.

By improving visibility into equipment health and maintenance schedules, operators can better align maintenance with production objectives while reducing operational risk.

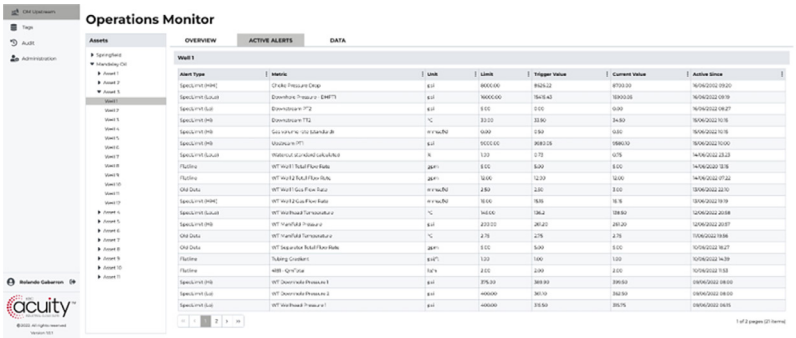


Figure 2. *Automated alerts flag deviations from expected performance.*

Facilities of the future

Most upstream assets are designed for peak production. As fields mature and production declines, operational complexities increase. These include increased water cut, changing flow regimes, and greater variability in operating conditions. Together, these factors raise the per barrel cost of sustaining production.

Facilities of the Future (FotF) concepts address this challenge via Normally Unattended Facilities (NUF) operated from a centralised Integrated Operating Centre (IOC).

The goal of the FotF is integrated optimisation across production, maintenance, and operations via:

- Reduced time-at-risk for employees.
- Reduced unplanned deferment through predictive capabilities and faster response time to operational upsets.
- Optimised production across multiple assets to maximise revenue or lower lifting costs.

While FotF programmes typically require targeted capital investment, these investments can be offset by sustained operating cost reductions. Integrated operational and digital strategies have delivered lifting-cost improvements of approximately 10%/bbl. In oil-price scenarios near US$50/bbl, upstream project models often target internal rates of return above 20% over a 10 year horizon, making sustained lifting-cost reductions strategically critical.

These integrated capabilities reflect the operating direction enabled by modern cloud-based production monitoring and digital flowmeter platforms.

Case study: real-time production monitoring and gas-lift optimisation

A large upstream operator was managing a gas-lifted production system. The operator needed to better understand how gas-lift allocation interacted across the asset. Conventional surveillance methods relied on

periodic well tests and multiphase flow meters. To address these limitations, the operator implemented a solution built around an Integrated Asset Model (IAM) and VFM.

The primary objective was to develop a VFM model capable of accurately estimating the flow rate for the chosen wells and demonstrating gas-lift optimisation for the client's wells. Success was measured by flow-rate accuracy and the effectiveness of optimisation strategies on well performance.

A comprehensive characterisation of reservoir fluids was conducted using available pressure-volume-temperature (PVT) data. The integrated model was tuned to provide accurate measurements of the flow rates and operating conditions within the wells. A Gas Lift Optimisation (GLO) module was implemented to enhance the efficiency of the gas-lift operation. VFM delivered continuous well-level flow estimates to enhance the client's existing allocation methodology, well ranking, and well test scheduling. Figure 2 illustrates the alerts used to prioritise operational response across the gas-lifted wells.

By replacing frequent physical well tests with high-accuracy virtual metering, the operator achieved:

- Approximately 2% production enhancement through gas-lift.
- US$6 million/y in incremental value.
- ≥95% accuracy in well-level flow-rate estimates using VFM.
- A 40 - 60% reduction in engineering and surveillance man-hours through automation, KPI-driven workflows, and centralised monitoring.

Integrated capabilities for upstream decision-making

When capital is constrained and operational assumptions carry greater financial consequences, upstream decision-making depends less on individual tools and more on how capabilities are integrated across the asset lifecycle.

What distinguishes upstream organisations that consistently make sound decisions under uncertainty? It is not any single model, dashboard, or workflow. It is the ability to integrate how production is measured, how assets are managed, and how decisions are executed across various fields and/or asset portfolios.

Evaluation of upstream developments highlights several characteristics that consistently support effective decision-making and value realisation:

- Production optimisation begins with visibility. Near-real-time VFM provides continuous, physics-based estimates of well and network performance. This allows operators to detect losses earlier, optimise gas-lift allocation faster, and act before deferment occurs, even when instrumentation is limited. These cloud-based digital twins provide continuous monitoring across production and processing systems to support forecasting, diagnostics, and optimisation.
- Asset management builds on that same visibility. When wells, flowlines, and facilities are monitored through a shared production model, reliability issues, flow-assurance risks, and equipment degradation can be identified earlier and addressed proactively. Modern VFM platforms integrate with sensors, historians, and SCADA systems to unify operational context across teams. This improves uptime, reduces unnecessary interventions, and lowers operating risk as assets mature.
- FotF extend these capabilities through enterprise-wide production data visibility and integrated operating workflows. By connecting production data, models, and workflows across disciplines, operators can reduce on-site exposure and streamline decision cycles across complex asset portfolios.

Together, these integrated capabilities transform how upstream assets are run. Continuous, software-based flow visibility improves decision quality and reinforces operational confidence. In capital-constrained environments, this integration is what allows operators to extract more value from existing assets while maintaining safety, reliability, and disciplined capital deployment.