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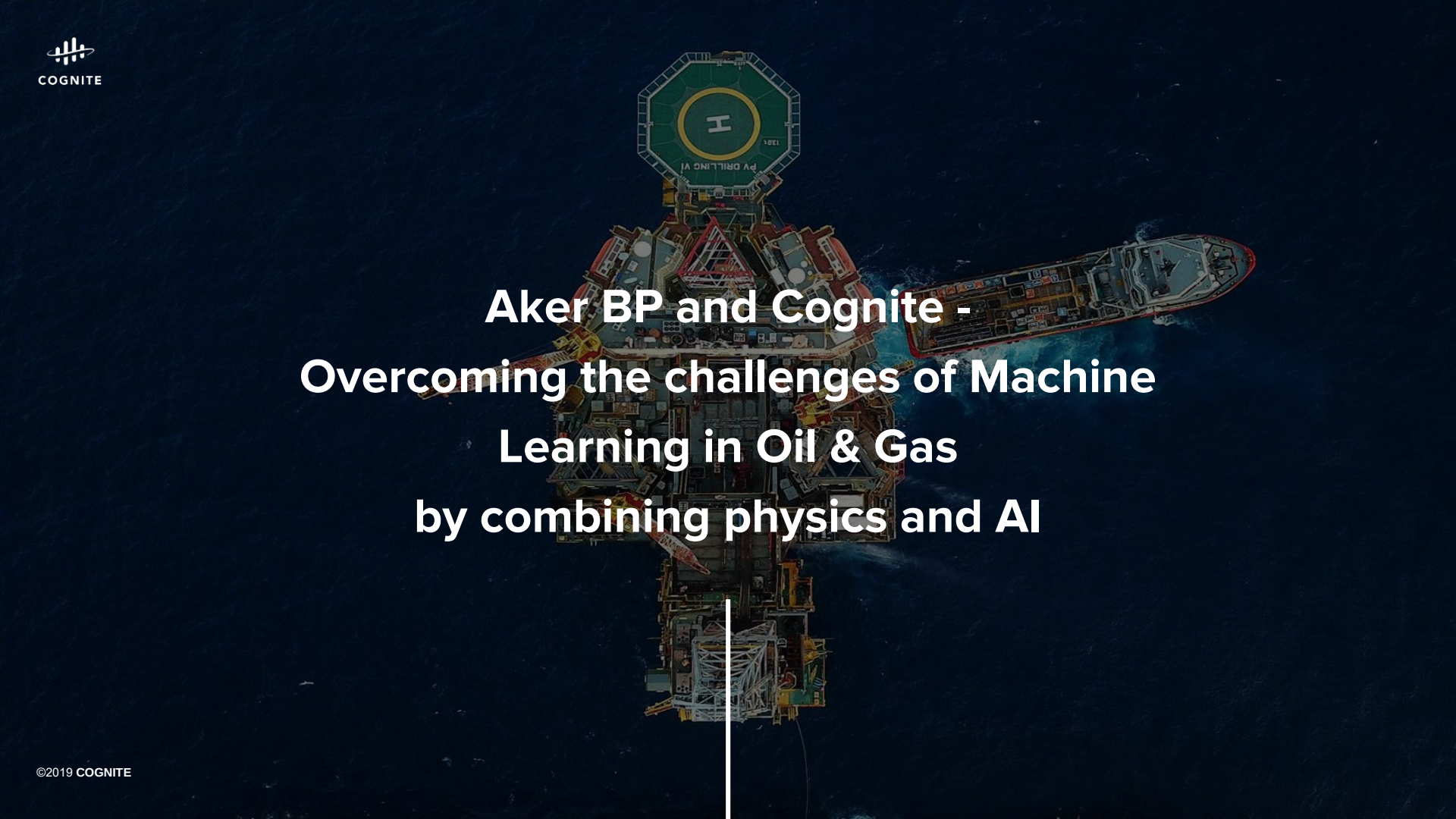

Aker BP and Cognite - Overcoming the challenges of Machine Learning in Oil & Gas by combining physics and AI

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AkerBP

Machine learning in oil and gas

ML immensely successful in areas like

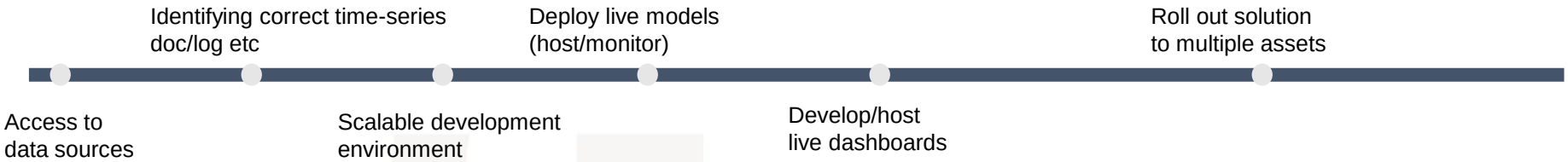
- image recognition
- optimizing ad-revenue
- recommending news feeds based on customer preferences
- product positioning

Not equally successful for O&G production

Despite the value potential being extraordinarily high.

WHY ?

Challenges when delivering Data Analytics



Access to data sources and scalability -- example

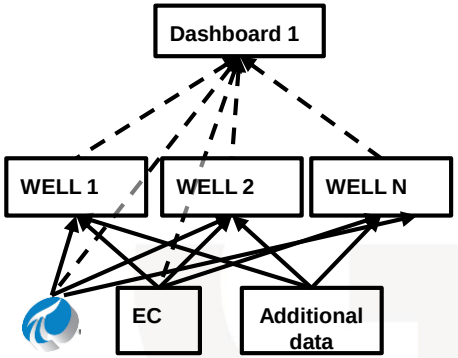
DESCRIPTION:

DATA FLOW AND STORAGE ARCHITECTURE

DATA SOURCES

PAST:

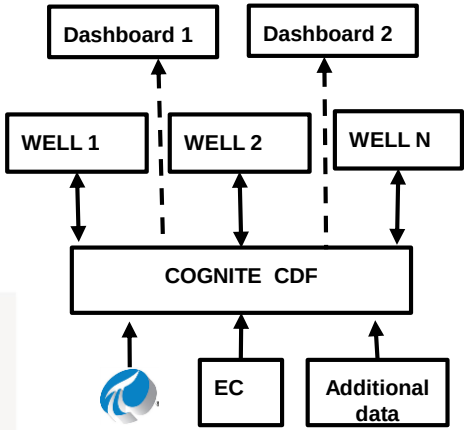
- Time-consuming point-to-point integrations
- Slow roll out to multiple wells
- Vulnerable to lock-in due to no model/visualisation separation
- Hard/impossible to reuse results on other applications



TIME ESTIMATE: >> 12 MONTHS

PRESENT:

- Fast roll out of solutions across multiple assets, leveraging the contextualization capabilities of CDF
- Results from models re-used by other models and dashboards



TIME ESTIMATE: 6 MONTHS

FUTURE:

- Query capabilities for all equipment and production data, enabled by relation based contextualization and data typing
- Automatic roll out of data analytics methods and physics simulators as a result of the query capabilities
- One click setup of common simulation scenarios (like VFM, well startup advisor etc)
- Extended tools offering
- Easy deployment and hosting

One-click setup of

- **ML models**
- **Virtual flow meters**
- **Well startup advisors**

TIME ESTIMATE: 1 WEEK

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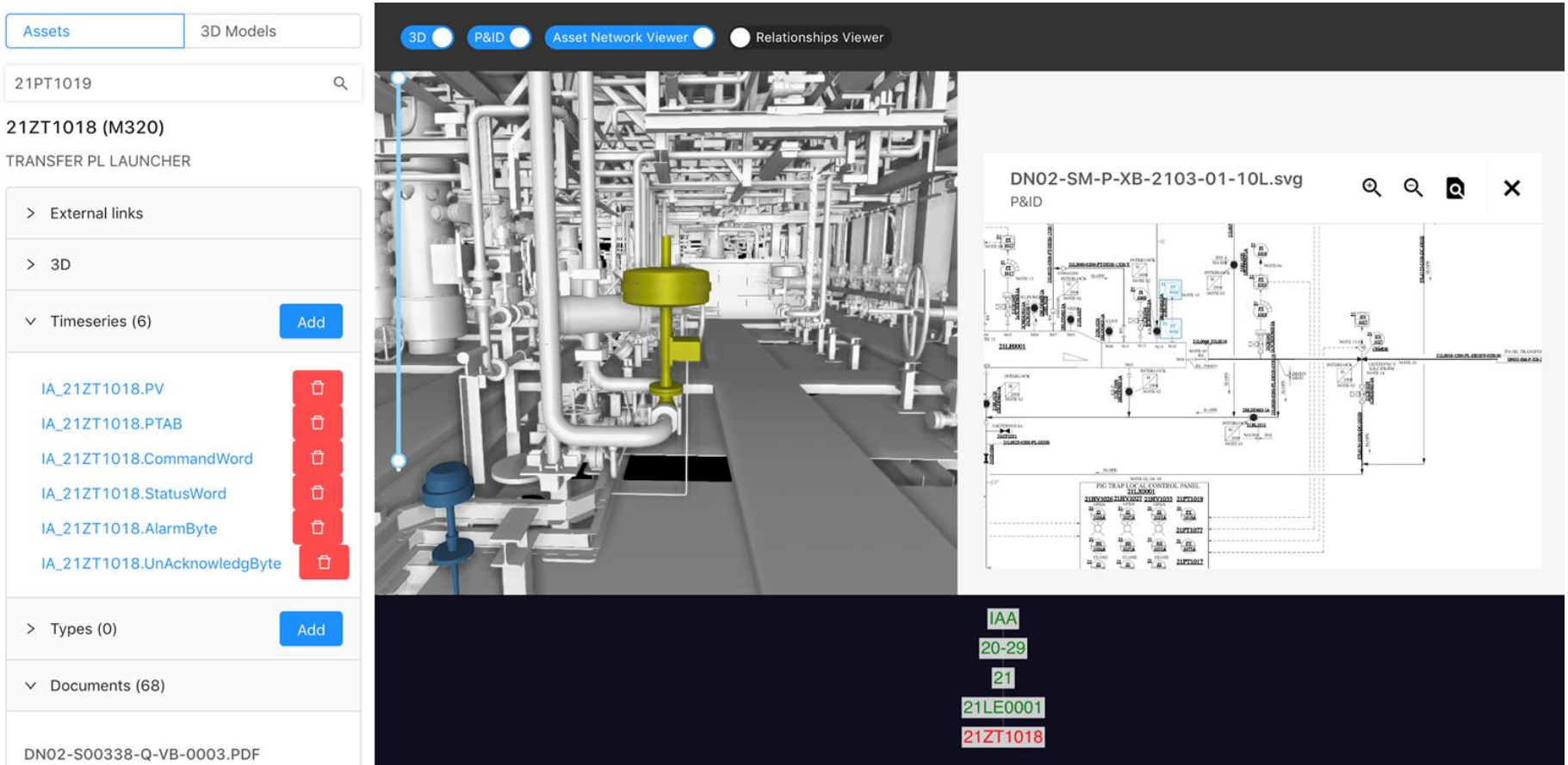
Contextualization -- Finding correct information



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FIX

Machine learning -- different requirements

Classical ML applications

- Often no alternative approach
- Large errors have usually no serious consequence
- Enormous amount of training data
- For some problems the data are *noiseless*

O&G applications

- Dynamics in oil and gas are governed by the laws of physics
- Competing against physics models
- Large errors may have serious consequences
- Few sensors measuring few properties, describing a complex problem
- Little training data (long history ≠ lot of data)
- Noise/drift in sensors
- Optimization is often about operating under conditions not previously operated in

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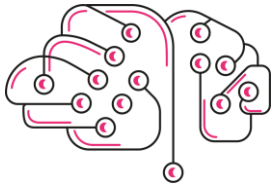
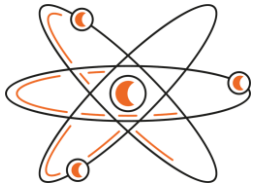
COGNITE DIFFERENTIATES FROM PURE AI COMPANIES WITH A HYBRID DATA SCIENCE MODEL UNIQUE TO INDUSTRIAL REALITY



DATA DRIVEN
MACHINE LEARNING

PHYSICS AI
HYBRID



PHYSICS DRIVEN
MODELLING AND VIRTUAL
SIMULATIONS

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Key to success -- Cross discipline team

$$\nabla \cdot \vec{V} = 0$$

$$\rho \frac{\partial \vec{V}}{\partial t} + \rho \left(\vec{V} \cdot \nabla \right) \vec{V} = -\nabla p + \mu \nabla^2 \vec{V} + \rho \vec{g}$$

- Physics
- Mathematics/Statistics
- Advanced numerical methods
- Optimization

- Multiphase flow physics
- Reservoir to topside
- Flow Assurance

- Control theory,
- Robotics
- Signal processing

- Data analytics
- AI/Machine learning

- Laboratory experiments and field measurements
- Sensor calibrations/diagnostics

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Examples from AkerBP

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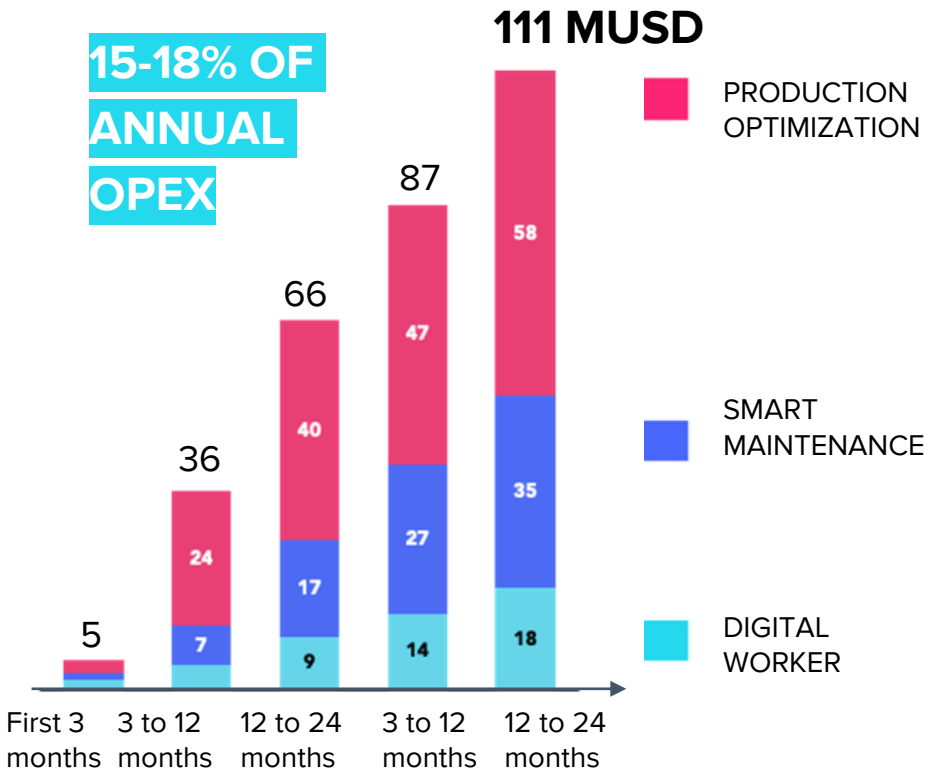
OUR CUSTOMERS ARE REALIZING SUBSTANTIAL VALUE: AKER BP EXAMPLE

Aggregated estimated value creation for known use cases in Operations alone

Production Optimization: 40-50%
Smart Maintenance: 25-35%
Digital Worker: 10-15%



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Use-case categories of increasing complexity

1 MAKE INFO AVAILABLE

Visualize existing data and put it into context.

User interpret information via graphs, dashboards etc. and make qualified decisions based on available data.

2 ACTIVE ADVISORS

Enriching the existing data and creating recommendation models with *actionable* advice.

From simple implementation of known equations to anomaly detection and machine learning. Humans evaluate output and make qualified decisions based on the recommendations.

3 AUTOMATED CONTROL

Models directly integrated with the system in question.

Closed loop integration with no human interaction.

End users need **confidence** in the recommendations! Validation of models, uncertainty estimates, data quality assessments etc.

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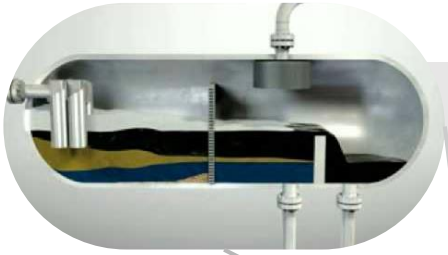
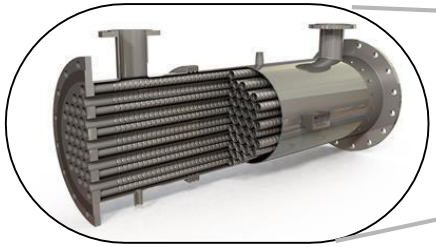
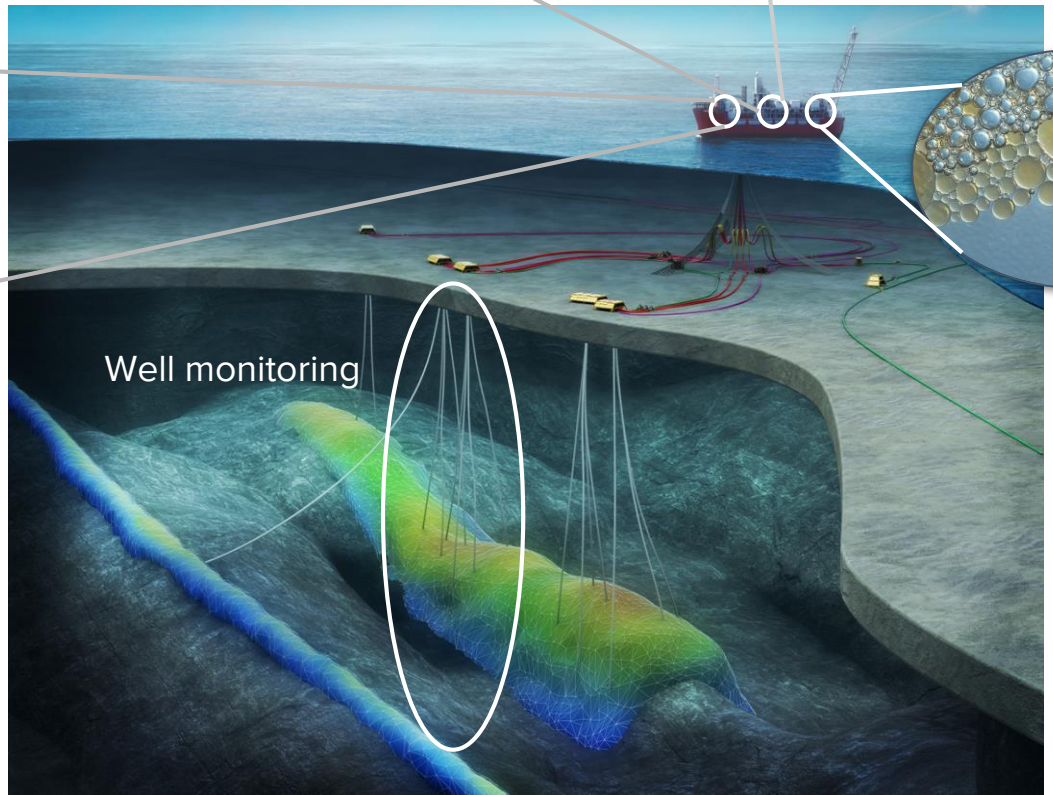
Selected Use-cases



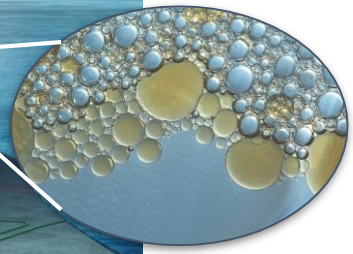
Capacity monitoring



Equipment performance monitoring



Well monitoring



Separation quality

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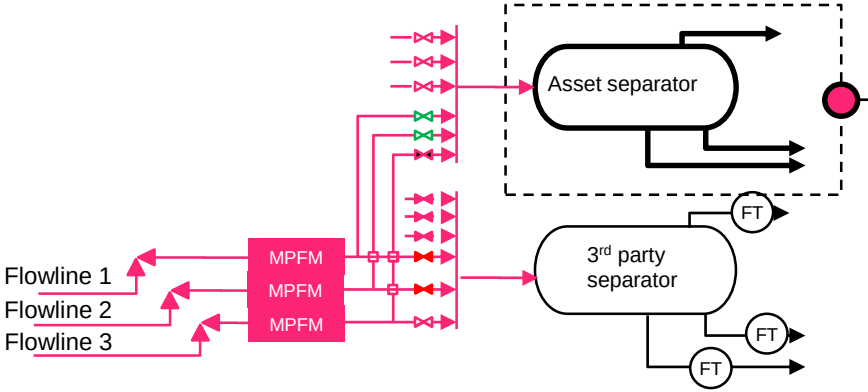
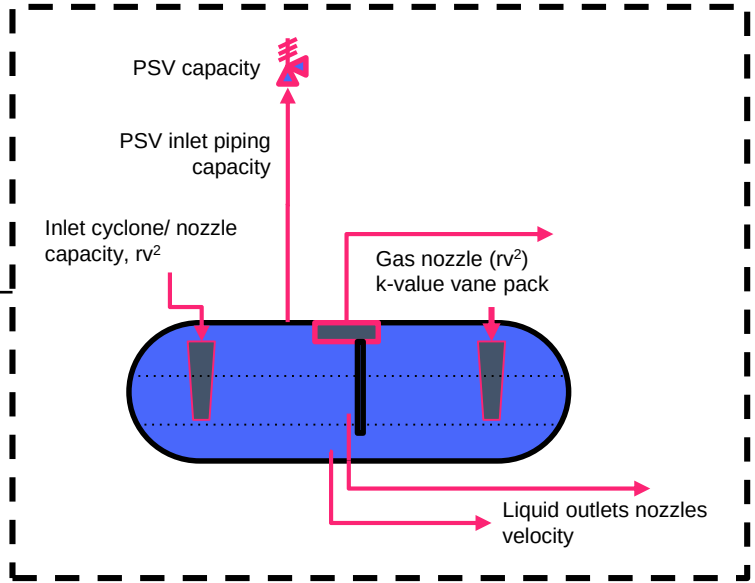
DYNAMIC MAX LIMIT OF LIQUID -AND GAS THROUGH SEPARATOR DURING CALIBRATION OF MPFM





WHAT DOES THE SOLUTION PROVIDE?

Increased insight and actionable advice to mitigate production deferral

- What is currently limiting production?

~ USD 3.5 MILLION /YR FOR ONE NCS ASSET

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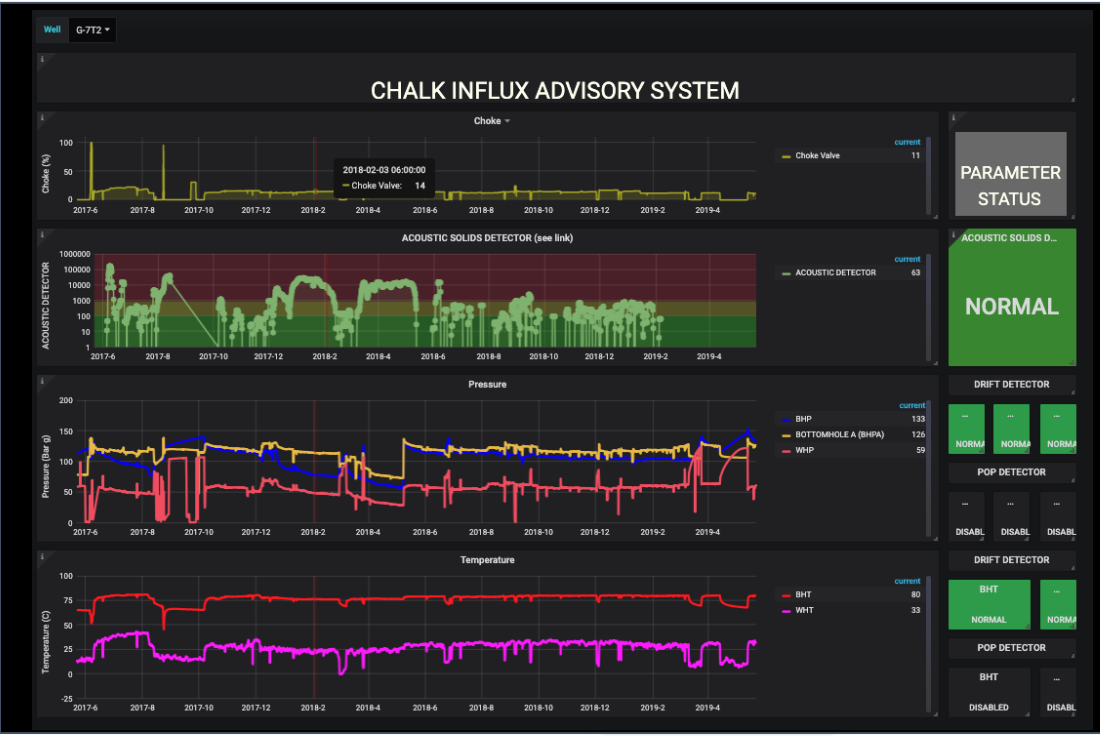
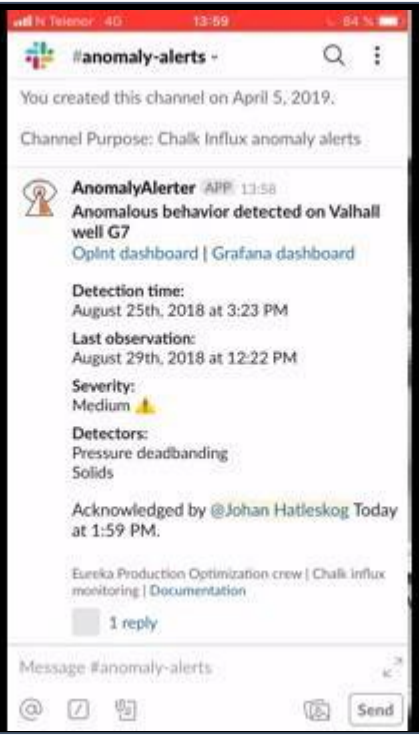
PREDICT & PREVENT CHALK INFLUX WELL PLUGGING EVENTS

Live **warning system monitoring all wells**, helping the production engineer focus his/her efforts on potential problems





ESTIMATED SAVINGS OF ~USD 10-15 MILLION/YR

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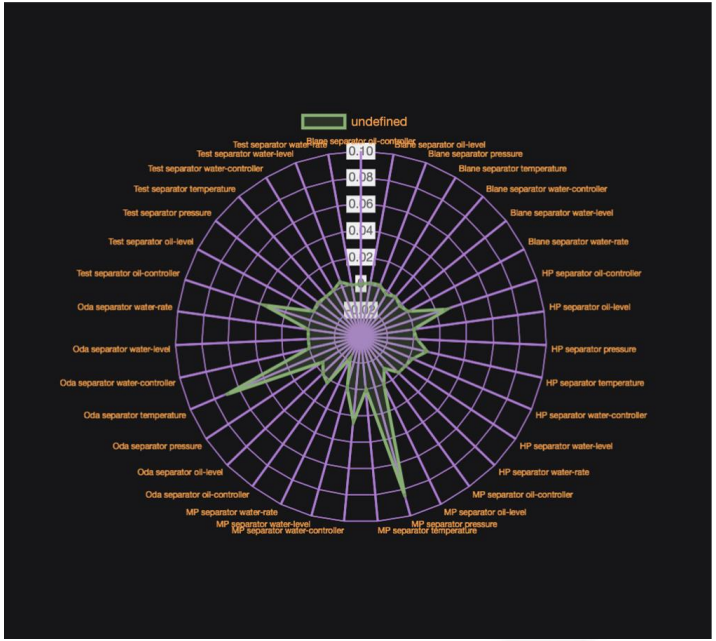
IMPROVED OIL/WATER SEPARATION

- **correlation analysis**, pinpointing the origin of poor oil/water separation in you system
- **prediction method**, forecasting oil/water separation quality based on current production settings



WHAT DOES THE SOLUTION PROVIDE?

Increased insight and actionable advice to mitigate production deferral

- Impact from each well template
- Impact by equipment type
- Which parameters are current key contributors to poor oil in water separation

NORWEGIAN OPERATOR ESTIMATES A POTENTIAL OF ~10% INCREASED PRODUCTION

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PREDICTING MAINTENANCE INTERVALS USING PHYSICS SIMULATOR COMBINED WITH DATA ANALYTICS, A HYBRID APPROACH

Data driven maintenance decision based on days to critical fouling. Here giving plenty of lead time to plan maintenance activity in advance

inprocess

Cognite product role	# of data sources	Impact
Contextualized data, Grafana integration, simulator aaS integration	3 CMMS, PI, documents	Reduced unplanned downtime from heat exchanger surprises, improved maintenance planning reducing cost

ENABLING NEW BUSINESS MODELS, ALIGNING OEM AND OPERATOR INCENTIVES THROUGH PERFORMANCE BASED CONTRACT

Pump OEM selling uptime rather than equipment enabled by the ease of CDF data sharing capabilities

Performance & remaining useful life status view

Oil monitoring view

Sharing views with operator through embedding their dashboards in Operational Intelligence

Cognite product role	# of data sources	Impact
Contextualized data & access, Grafana integration, simulator aaS integration, model hosting	6+ CMMS, PI, documents, control system events, oil data, electrical signals	Aligned incentives resulting in extended maintenance intervals

THANK YOU

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