Y&L Consulting
A YASH Technologies Company

Oil & Gas Analytics

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Challenges in Oil & Gas

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Challenges - Exploration, Production and Refining

- Strict environmental health and safety demands
- Suboptimal Refinery configurations
- Escalating competition
- Falling profitability
- Volatile market dynamics
- Difficult operating environments
- Consolidation
- Falling prices

Digital Technologies adopted by the oil & gas companies generate voluminous and a variety of data

The true value comes from the ability to draw inferences from massive data and to contextualize it to convert it into actionable intelligence and prescriptive insights

Types of Analytics

Streaming Analytics	**What is happening now?** • Real-time operations monitoring • Real-time asset performance monitoring	**Can I change parameters to impact the outcome** • Real-time inputs from well to tune drilling parameters • Cause for decline in production	
Batch Analytics	**What happened?** • Daily Drilling Reports • Daily production report • Inventory Report	**Why did it happen?** • Cause for Non-productive time • Cause for decline in production	**Can I optimize/ predict event** • Drill-pipe sticking prediction • Production pattern prediction • Optimal Spares management strategy

THE UPSTREAM ECO SYSTEM

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Upstream Value Chain

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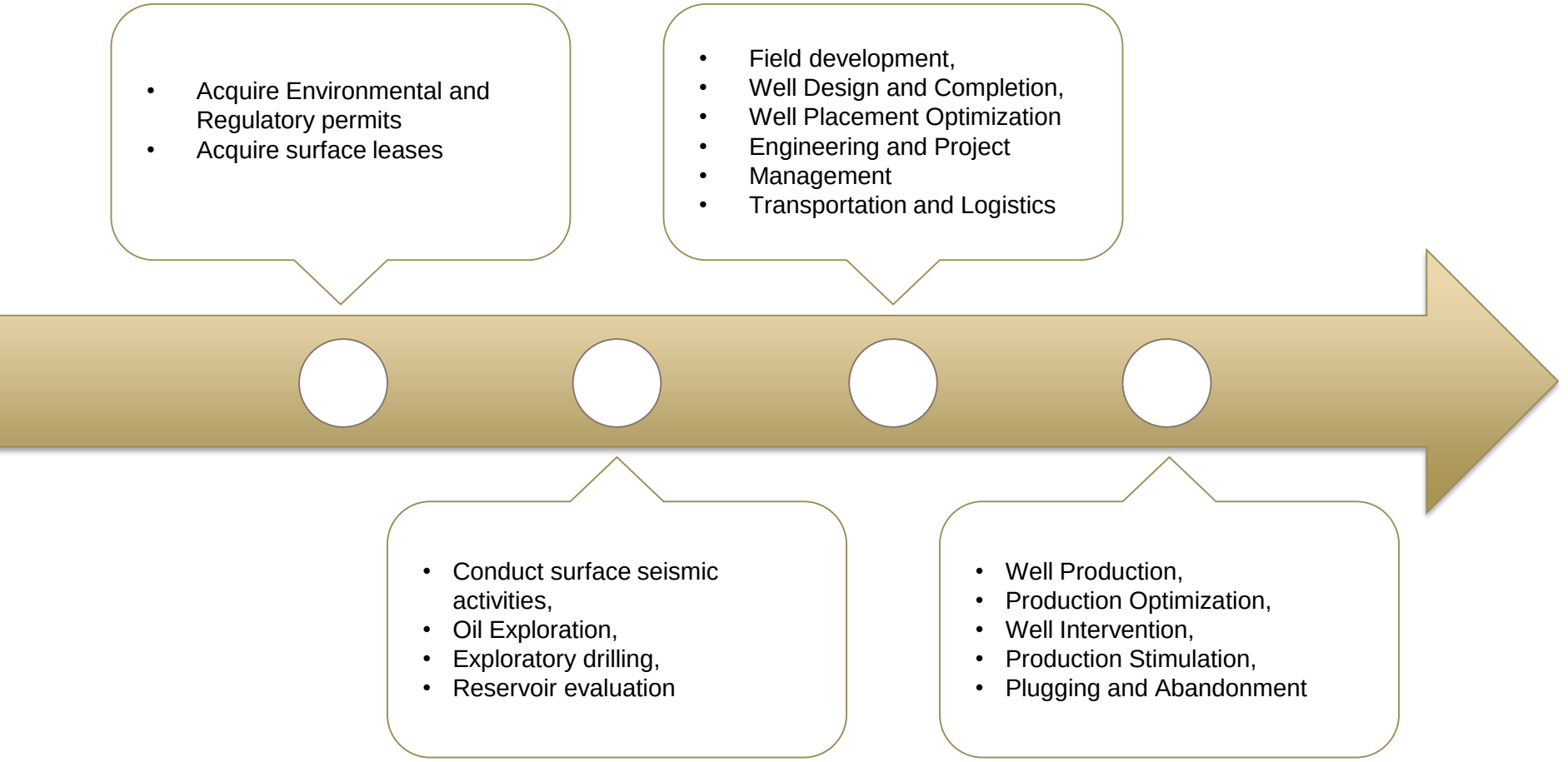

DRILLING OPERATIONS ANALYTICS

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Drilling Operations

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Drilling is one of the most critical, dangerous, complex and costly operations in the oil and gas industry.

- Drill RPM- Rotation speed
- Rotary torque
- Rotation smoothness
- Hook Load
- Weight on Drill bit
- Vibration type
- Vibration severity
- Down hole Temperature

Depth tracking sensors
- Rotation
- Depth travelled
- Rig compensator data

Decision Maker

Gas Monitor Data
- Well Id
- Sensor Id
- Date time
- Gas parts per million

Misc. Sensor Data
- H2S Gas
- CO2 Gas
- Fluid Temperature
- Density
- Conductivity

- Down hole Pressure applied/Washout
- Kick events
- Circulation loss events

Pit Monitor Sensor Data
- Mud level data
- Kick-surge in mud
- Sag in mud volume

- Mud flow volume rate
- Kick condition (surge/sag in flow rate)

Problems occur frequently and repeatedly

Correlating and analysis of problems across multiple data sources in real-time using advanced Analytics techniques requires a robust data platform which can handle wide variety of data

Challenges

In Drilling

58% of the time is wasted in

- Drilling problems
- Rig movement
- Defects
- Waiting

Drilling costs represent nearly half of well expenditures

Non-Productive Time: 20% to 22%
More than $8 billion USD in losses
70% of which is caused by wellbore instability

The most prevalent drilling problems include

- Pipe sticking – Mechanical, Differential or Key-Seating
- Lost Circulation
- Drill pipe failures - Twist off
- Mud motor failures
- Top drive failure
- BOP stack failure

It is mission critical to predict problems as we evolve towards sophisticated wellbore geometries, ultra-deep-water wells, high temperature, high pressure, and complex well geometries

Analytics Solution

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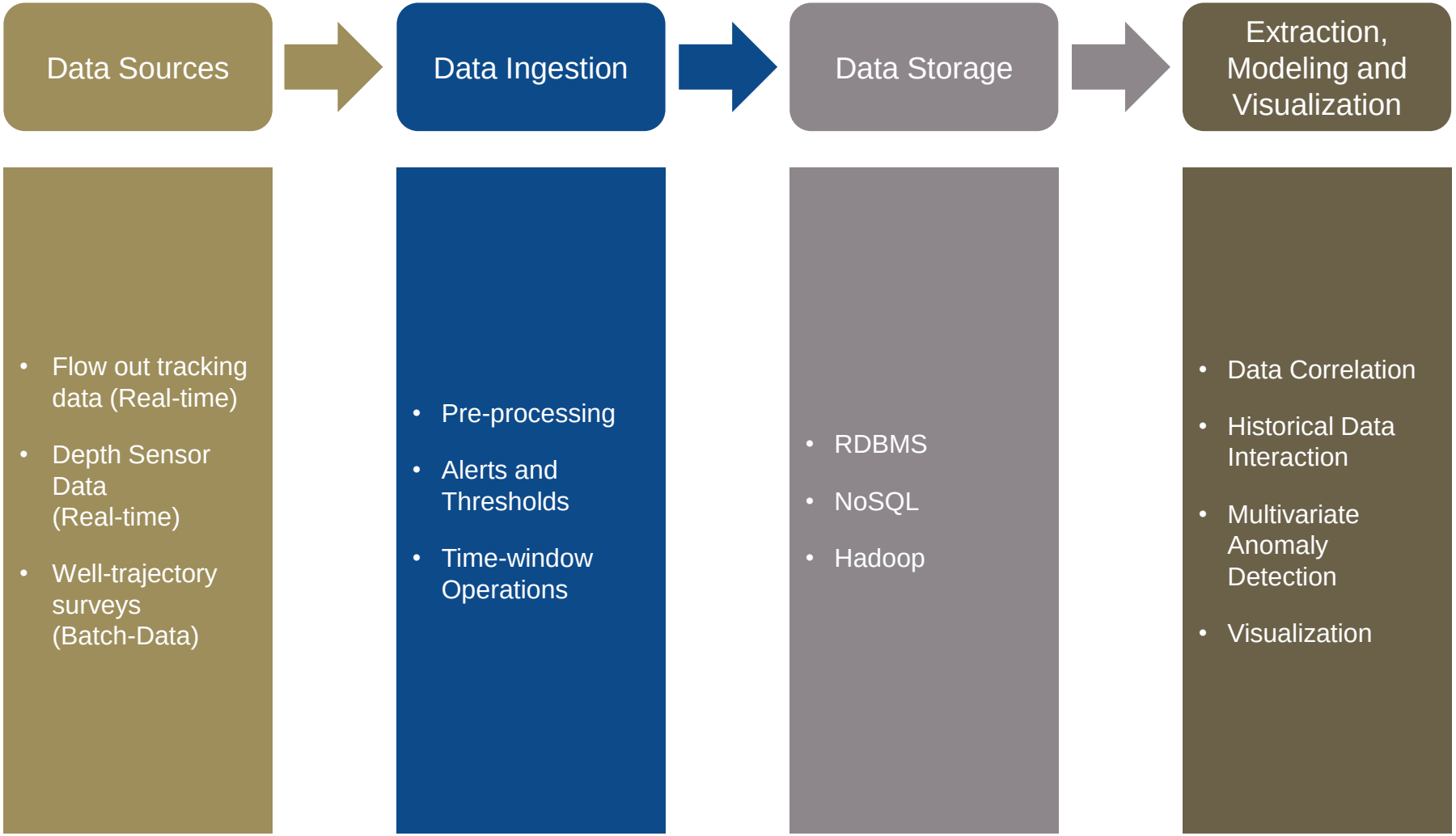

PERMEABILITY PREDICTION

Permeability Prediction

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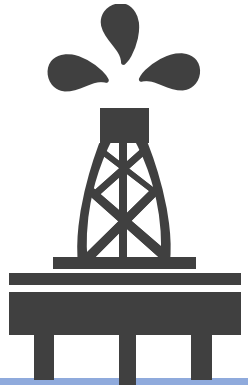
Permeability is a key parameter associated with the characterization of any hydrocarbon reservoir

Point-by-point permeability values are needed over the reservoir interval at the wellbores for developing completion strategies and computing dynamic-flow calculations

Challenges

- Both Core analysis and Well test techniques are very expensive and time consuming compared to the wire-line logging techniques.
- Establishing a series of statistical empirical correlation between permeability, porosity, water saturation, and other physical properties of rocks is successful in sandstone and carbonate reservoirs, but the accuracy suffers for well log data in heterogeneous reservoirs
- Magnetic resonance is another modern approach for the prediction of the permeability as a continuous log, but it has significant technological constrains



Determination

- The conventional methods for permeability determination are core analysis and well test techniques.

Solution

Supervised learning

Independent component analysis and Support Vector Machines can be applied to predict reservoir properties using well log data

Data Sources

Available digitized well of sonic log DT, Gamma ray log GR, Compensated Neutron Porosity log NPHI, Density log ROHB, Photoelectric factor log PEF, Micro-spherical focused Resistivity log MSFL, and Shallow and Deep laterolog resistivity LLS and LLD.

Permeability is the most important rock parameter affecting fluids flow in reservoir.

FRACKING CHEMICALS

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Fracking Chemicals - Process

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Fracking - Chemicals are injected into the ground to increase flow

The amount of chemical treatment is tied to the oil and gas production rates

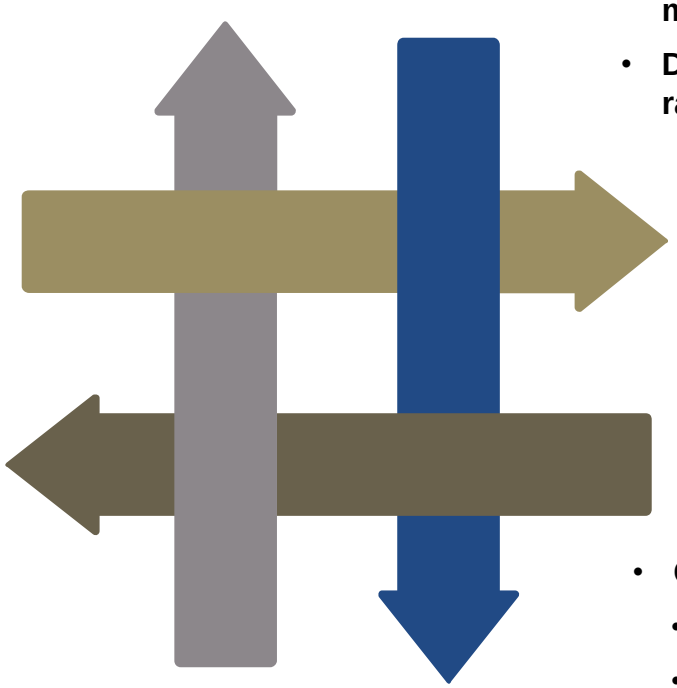
Suppliers adjust dosing rates based on production and are accountable for any out-of-stock situations.

Supplier is responsible for both Demand Forecasting and the Inventory Management.

The objective is to strengthen supply chain to optimize costs while minimizing out-of-stock situations.

Challenges – Unconventional Reservoirs

- **Suppliers need to operate on vast areas**
- **Current process is very manual with little automation.**
- **Gaugers visit each well site to**
  - check chemical stock levels
  - adjust injection rates
  - supply the chemical and
  - check current production rates.



- **Chemicals lose their effectiveness once they have passed their defined shelf life, generally a few months.**
- **Determining the correct dosing rates is also very critical.**

- **Under-dosing**
  - damages the drilling infrastructure (corrosion),
  - safety issues (hydrogen sulfide) product quality (emulsifiers).

- **Over-dosing**
  - increases cost
  - creates environmental issues (unneeded chemicals being introduced to the environment)
  - can potentially damage equipment

Solution

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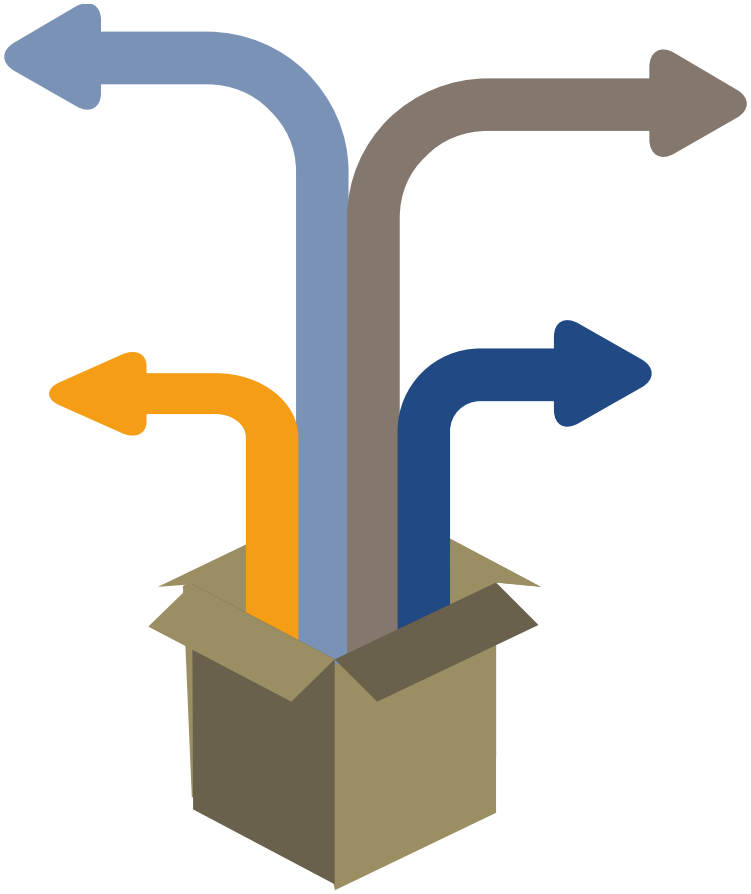
Increased Visibility

Visibility can be greatly increased by using wireless sensors to record and communicate – Production rates, chemical injection rates and chemical tank levels at the well site



Superior Planning

Collaborative planning between the operating companies and the suppliers can help them better anticipate demand and adjust production/ delivery accordingly.

IOT approach for Field force automation

Field workers could record tank levels directly into tablets or smartphones and then communicate these back to a central system to provide near-real-time tracking of well site inventories.

Predictive Analytics

Analytics based Demand Forecasting tools using the improved visibility from wireless and field force automation. inventory management be improved by more accurate demand forecasting.

THE DOWNSTREAM ECO SYSTEM

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Downstream Value Chain

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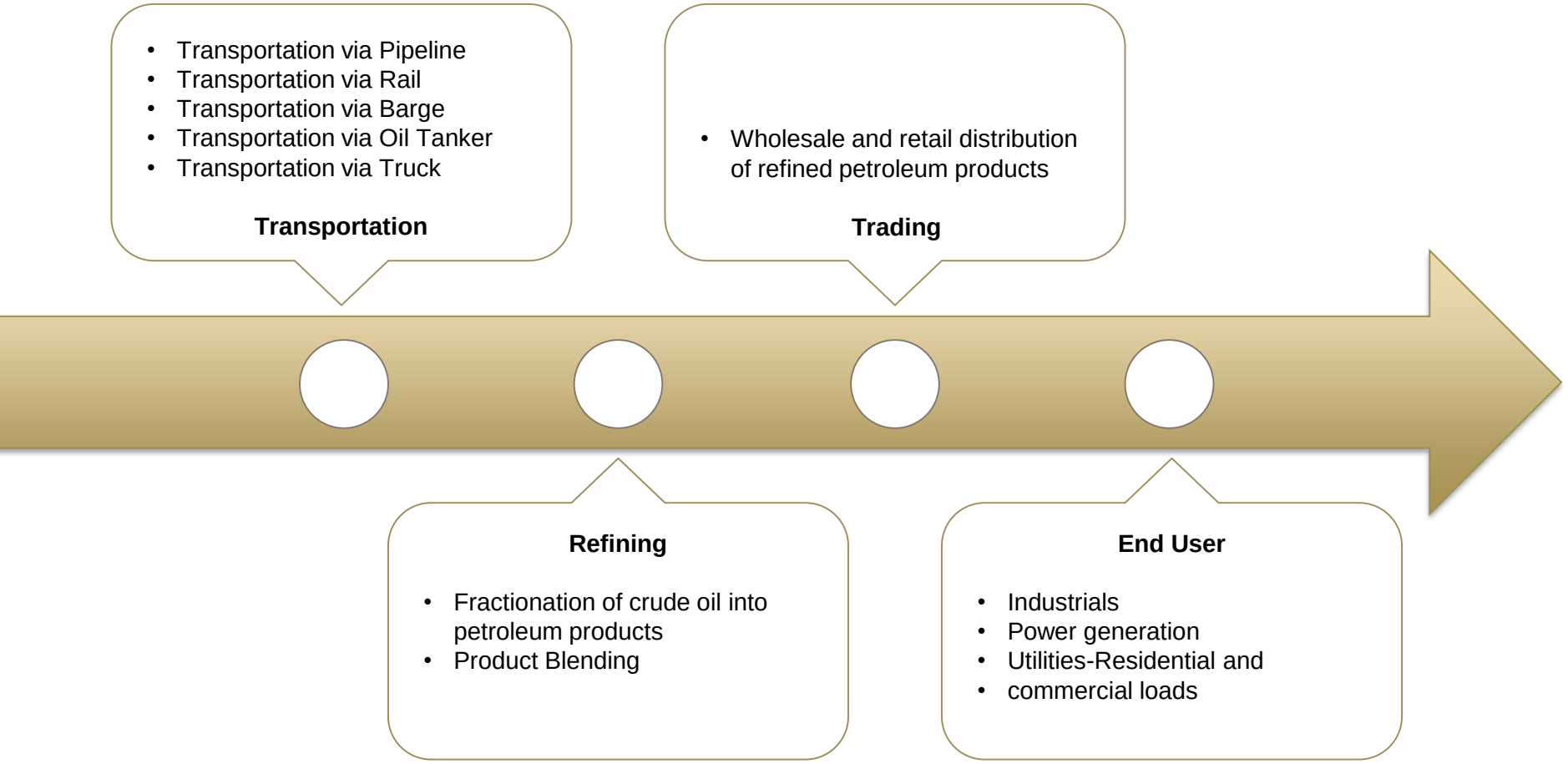

TANK FARM ANALYTICS

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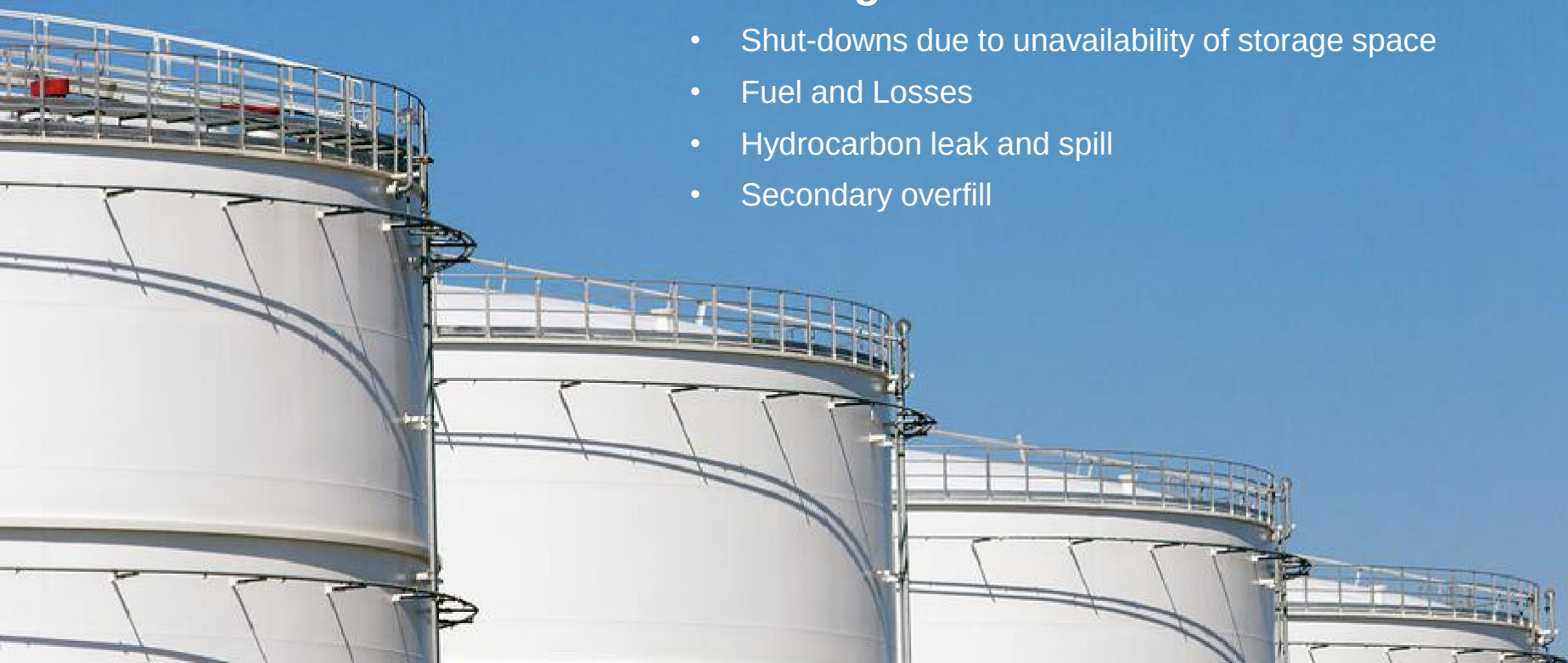
Tank farm Analytics - Challenges

- **Dedicated storage tanks are assigned to each finished product**
- **Availability of space in tank farms is highly important for finished product storage shipping**

Challenges

- Shut-downs due to unavailability of storage space
- Fuel and Losses
- Hydrocarbon leak and spill
- Secondary overfill



Solutions

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Challenge – Product-Tank Assignment

- Engineers & managers use intuition and experience to decide how to assign tanks to products, leading to overflow and errors in judgement
- Given a set of tanks, products, production lines and production schedules arrive at optimal assignment of products to tanks minimizing unsatisfied quantity. Constraints include storage and shipping

Solution – Tank Farm behavior Modelling

- Crude oil and condensate are multi-component liquids made up of a wide range of hydrocarbons that have different volatilities. Therefore, evaluating the evaporative losses from crude oil and condensate is challenging because the composition of the liquid mixture must be known and no two storage tanks carry the “same” liquid mixture.
- Evaporation in crude oil and condensate storage tanks leads to lost saleable product, air pollution, and greenhouse gas emissions.
- Objective is to minimize standing and working losses.
- Solution: Advanced ML techniques to model behavior of storage tanks using historical data and thus predicting accurately the losses, pre-empting management to institute loss control measures

PIPELINE TRACKING SYSTEM

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Pipeline tracking and Monitoring

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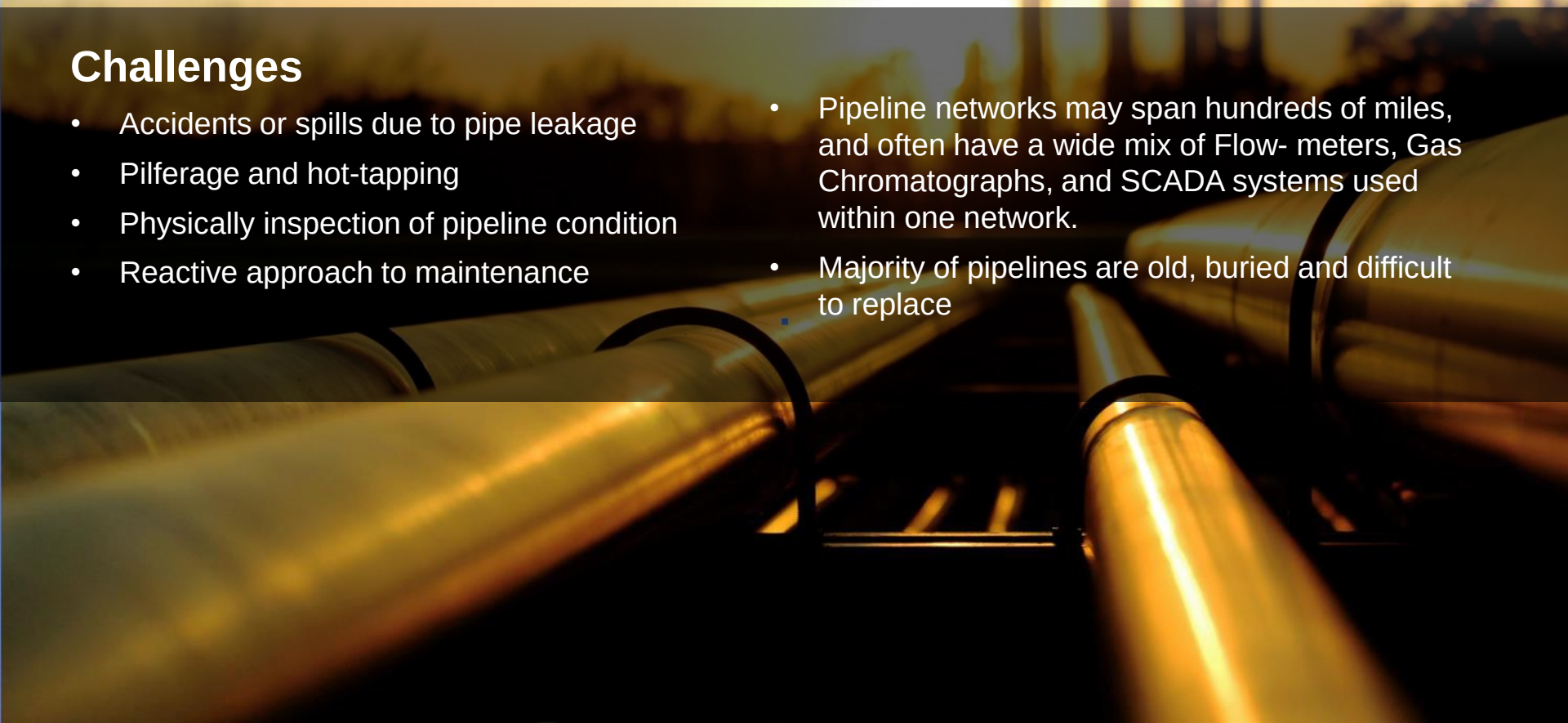
Oil pipelines transport petroleum products from refineries and crude oil from import terminals as well as domestic sources to the inland refineries in a very cost effective, energy efficient, safe and environment friendly manner



Challenges

- Accidents or spills due to pipe leakage
- Pilferage and hot-tapping
- Physically inspection of pipeline condition
- Reactive approach to maintenance
- Pipeline networks may span hundreds of miles, and often have a wide mix of Flow- meters, Gas Chromatographs, and SCADA systems used within one network.
- Majority of pipelines are old, buried and difficult to replace

Solution - Smart Pressure Monitoring

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Pressure fluctuations occur due to standard working conditions like power plants drawing fuel or chemical plants ramping up production or due to anomalous conditions, such as ruptures or leaks.

The changes are measured by automated SCADA systems that can both accurately detect and respond to anomalies, but they are not capable of interpreting these occurrences and categorizing them as either standard or anomalous fluctuations

Real time streaming analytics of the SCADA data for real-time alerts based on rules- based algorithms can enable timely actions

Gather data from multiple sources and feed it into an Analytics platform to make predictions on risk and maintenance scheduling.

Combine data from inline inspection, Enterprise asset management systems on Repairs, leak detection systems, SCADA, metering, and instrumentation

Drones can also be used to perform visual inspection, with the images being remotely monitored by SME. Image analytics can be used with Drone data

Real-time devices such as Pipelines Stress Monitors analyze pressure trend curves, determines maximum and minimum possible thresholds and calculates the impact of pressure changes

ONLINE BLENDING ANALYZER

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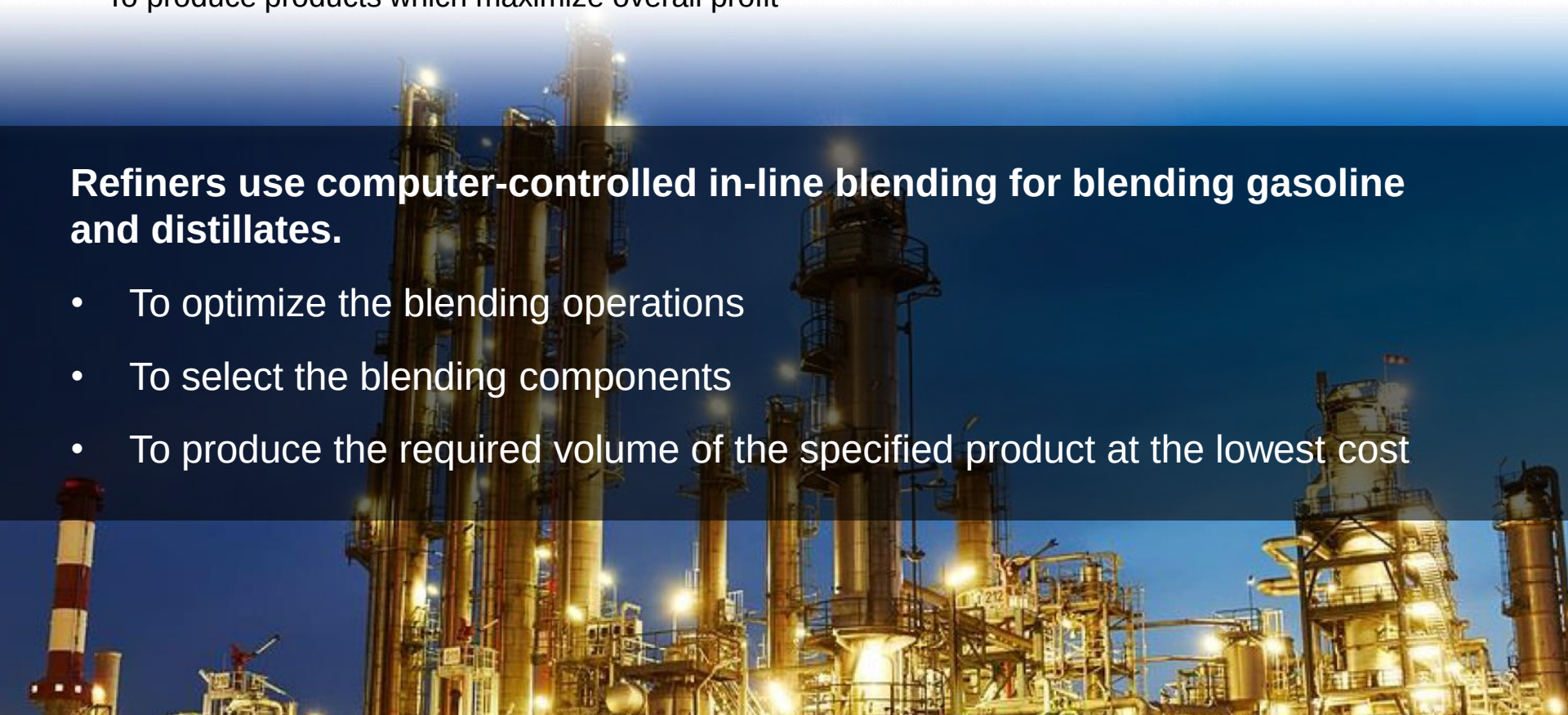
Online Blending - Overview

Gasoline blending is a refinery operation that blends different component streams into various grades of gasoline

Objective of product blending

- Allocate the available blending components to ensure all product demands are met at the least cost
- To produce products which maximize overall profit



Refiners use computer-controlled in-line blending for blending gasoline and distillates.

- To optimize the blending operations
- To select the blending components
- To produce the required volume of the specified product at the lowest cost

Solution – Online Blending Analyzer

Challenges

To Optimize blends to lower costs by reducing octane or cetane giveaway and maximizing lower cost components such as butane in gasoline.

Many of the properties of blend components are non-linear, such as octane number, so estimating final blend properties from the components can be quite complex

Regardless of how efficient the upstream process units may be, this can be invalid if poorly optimized blending produces a substandard fuel

Analytics Solution	Advance ML techniques and optimization algorithms instead of traditional linear programming methods to improve blending accuracy based on historical data.

MACHINE FAILURE PREDICTION

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Implications of Asset Failure

Assets utilized in O&G industry are capital intensive

Unplanned downtime of these critical assets negatively impacts

- Financial performance
- Operational efficiency
- Customer satisfaction

Use-Case : Frack Pump failure

Influencing factors such as

- Operating environment variables (Pressure, Flowrate, Friction)
- Frequency of preventive maintenance
- Performance efficiency
- Historical failures etc.

Multi-dimensional analysis is required to predict failure and arrive at the right maintenance strategy

Our Approach

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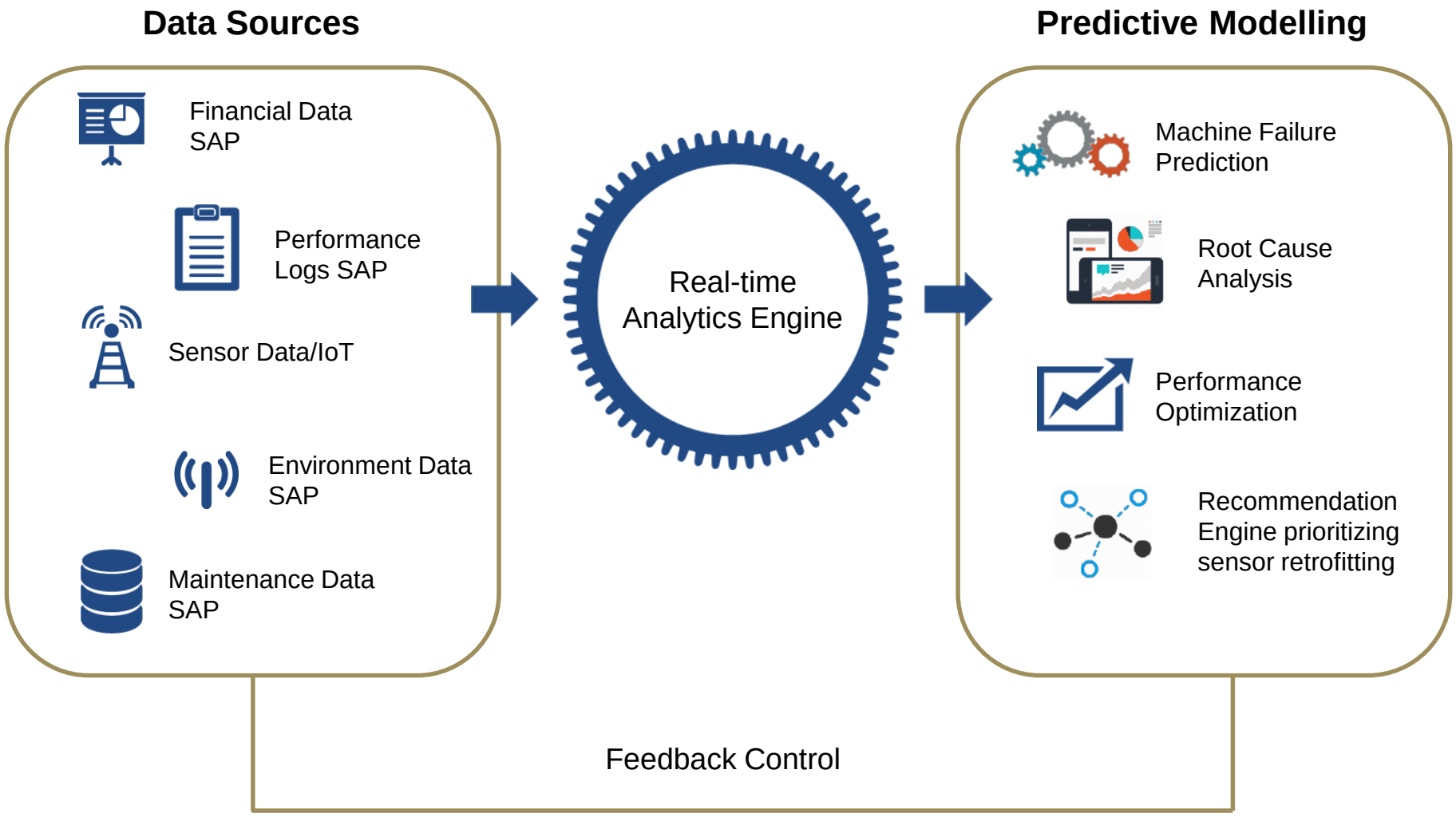

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From Fluctuating Fortunes to Anticipated Directions

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