

*Integrated solution for
Operational Metering,
Surveillance and Condition
Based Maintenance*

Luca Letizia

Subsea Processing and Flow Assurance –
OneSubsea

Agenda

- Introduction to Challenges
- Solution Requirements & Objectives
- Example Workflows
 - ✓ Virtual Flow Metering
 - ✓ Reservoir Monitoring, Management & Optimization
- Equipment Surveillance & Condition Based Maintenance
- Conclusion

Production Assurance from Pore to Process

The background of the slide is a 3D rendering of an offshore oil and gas production system. It features a large yellow platform with multiple decks situated in the middle of a dark blue sea. Several yellow subsea pipelines are visible, extending from the platform towards the bottom left and right edges of the frame. In the upper left, a red and white offshore supply vessel is partially visible. The overall scene is set against a backdrop of a clear blue sky and distant landmasses.

Concept Selection

Reservoir to Facility Optimization

Design Verification

Condition Based Maintenance

Control System Checkout

24/7 Equipment Surveillance

Operator Training

Production Optimization

Flawless Commissioning Startup

Operational Services

Reservoir to Facility Optimization

Virtual / Combined Metering

Production Assurance from Pore to Process

Concept Selection

CAPEX

Reservoir to Facility Optimization

Increase recovery and production

Design Verification

Avoid costly redesign in operation

Condition Based Maintenance

Early detection, proactive response

Control System Checkout

Save commissioning time

24/7 Equipment Surveillance

Reliable subsea installations

Operator Training

Accurate hands on training

Production Optimization

Increase production and reduce OPEX

Flawless Commissioning Startup

Safe startup

Operational Services

Handle unplanned situations

Reservoir to Facility Optimization

Increase recovery and production

Virtual / Combined Metering

Reliable and Accurate Production Data

Operational Challenges (example for gas condensate field)

Reservoir Management

- Well drawdown management
- Determine back allocation of flow
- Risk of water breakthrough/production

Hydrate control

- Hydrates can plug flowlines deferring or losing production
- Expensive chemical inhibition needed
- MEG Ops. based on predictions (affected by uncertainty)

Liquid management

- Liquid inventory (water/condensate/inhibitor) in long flow lines
- Rate changes (ramp-up surges)
- Flow instability (slugging)
- Onshore liquid handling

Low temperature management

- Wellhead and flowline shut-in pressure
- Temperature management during well restart

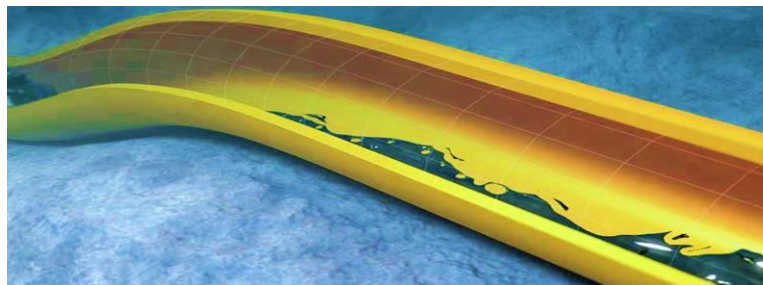
High Pressure management

- Packing / de-packing
- HIPPS activation and reset
- Shut-in pressure

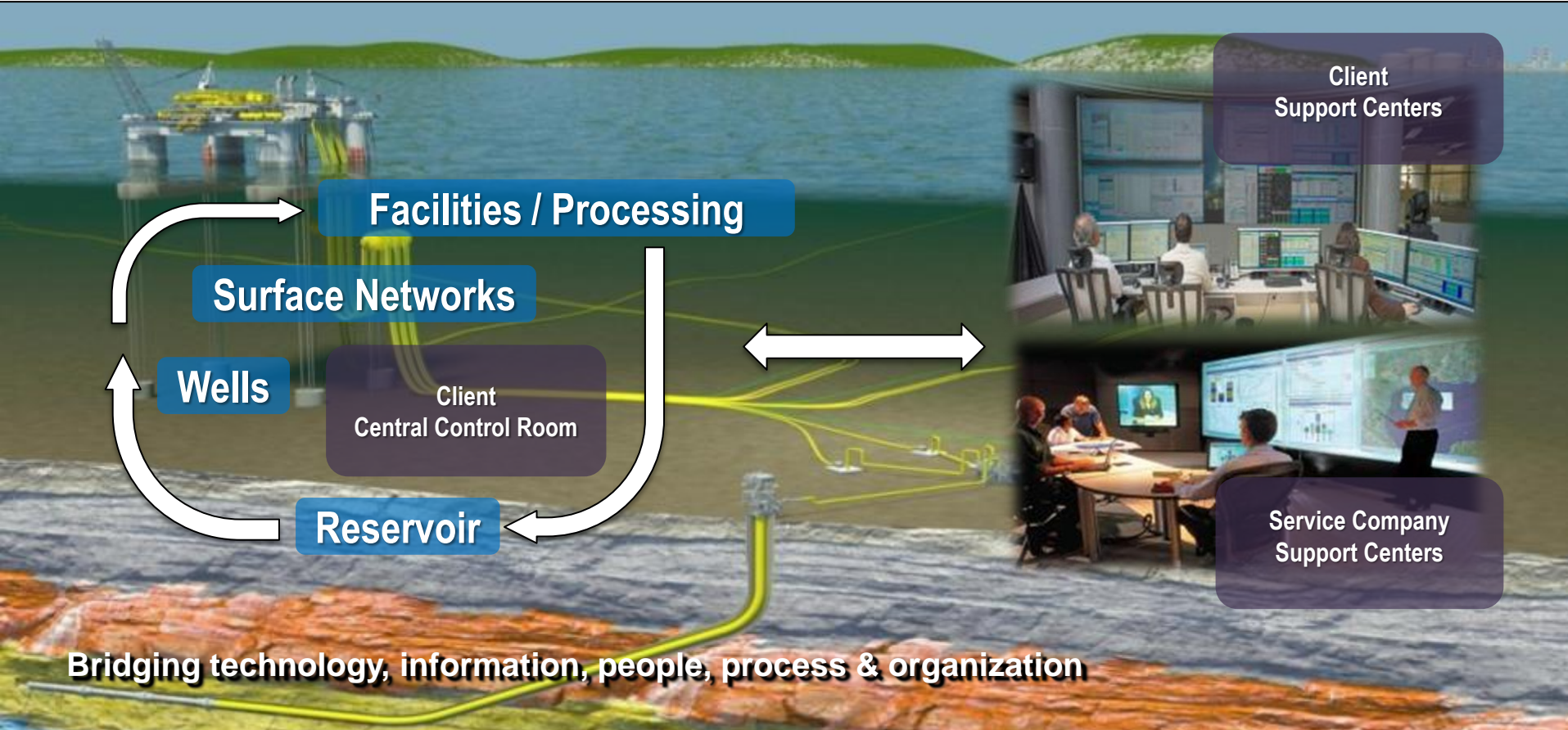
Erosion monitoring

Corrosion & Scale

Future Interventions / PLT

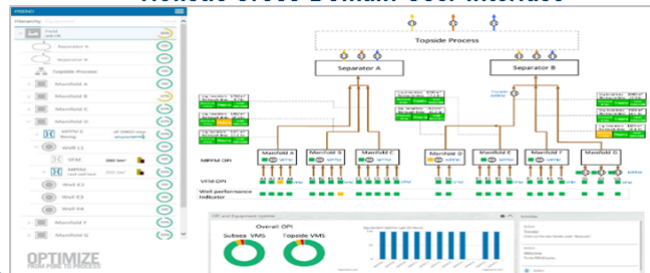


Solution Facilitating Multidiscipline Collaboration



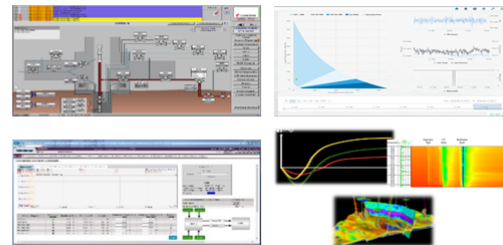
Integrated Production Management Solution (IPMS)

Holistic Cross-Domain User Interface



Schlumberger Integrated Production Management Solution

Domain Expert User Interfaces



Maintenance Planning

Operations and Production Optimization

Reservoir Management

Equipment Surveillance & Condition Based Maintenance

Virtual Flow Metering & Combined Metering

Production Management & Real Time Flow Assurance

Near Well Monitoring & Surveillance

Control System / Historian / Production Data Management System

WWFlux

SPS

Fluid Sampling

MPP

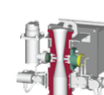
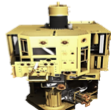
SS MPFM

Aqua Watcher

CIMV

MPFM

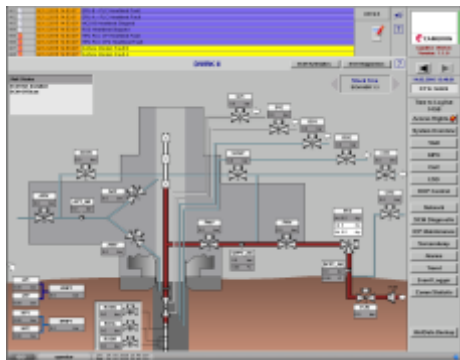
MEG Recl.



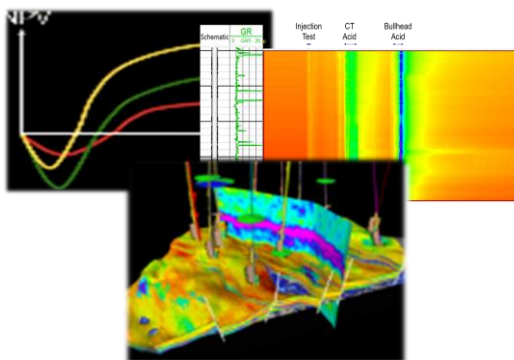
Proposed Solution – Multi-Site Collaboration

Virtual Metering

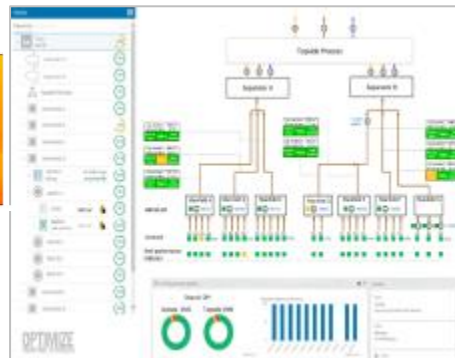
Client Control Room



Client Support Centers



SLB Support Centers



Production engineers checks virtual metering is aligned with equipment



Reservoir Engineer



Operator

Operator identifies changes in well rates from Meters



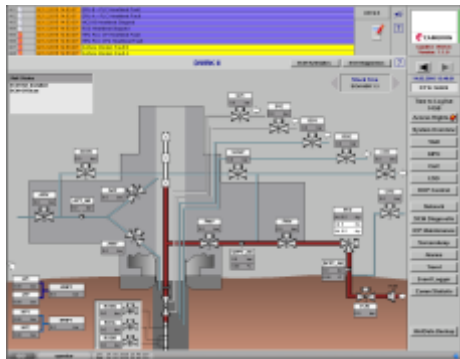
Vendor Domain Experts

Vendor ensure data reconciliation and virtual metering correctly history matched

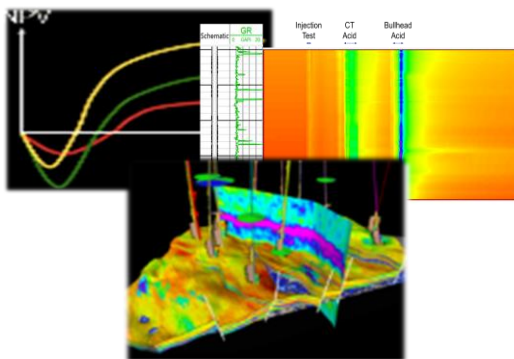
Proposed Solution – Multi-Site Collaboration

Reservoir Management

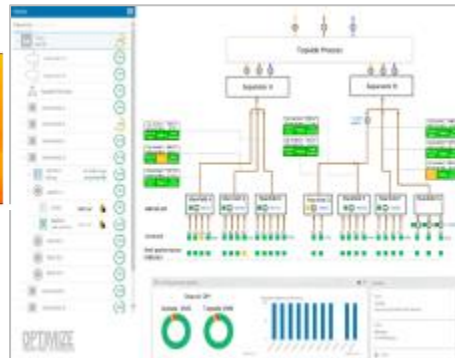
Client Control Room



Client Support Centers



SLB Support Centers



Res.Engineer uses
downhole data to run
different scenarios



Reservoir
Engineer



Operator

Operator identifies changes in
well performance and must
understand what is happening

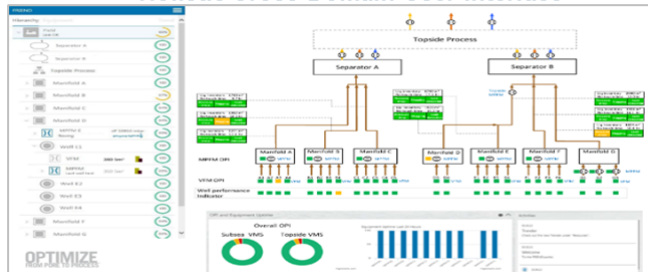


Vendor Domain Experts

Vendor ensure model
quality through
calibration and Eng.
assistance on demand

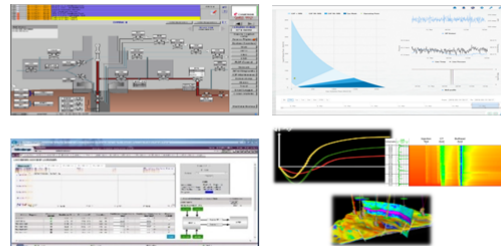
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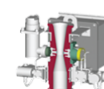
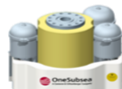
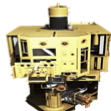
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MPFM

MEG Recl.



Virtual Flow Metering – Surveillance, Reconciliation and Calibration

▪ Short loop – Data Surveillance

–Monitor Aqua Watcher, MPFMs and VFM values to

▪ Medium loop – Data Reconciliation

–VFM uncertainty calculation

–Apply “correction” factors to the VFM flow rates as

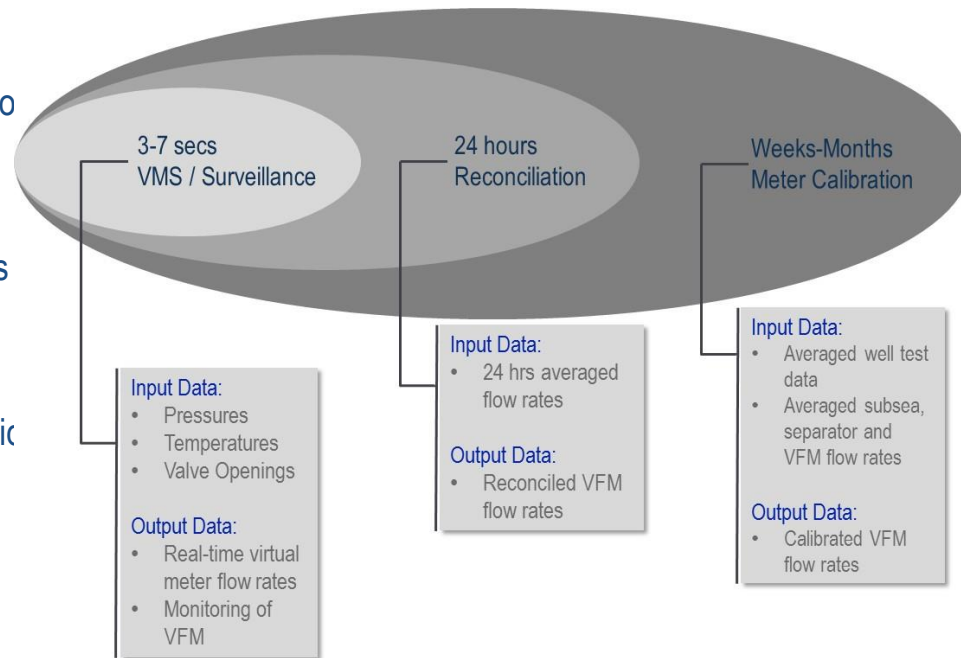
▪ Long loop – Solution Calibration

–VFM instrument failure detection / sensor drifting

–Use of well test data and historic data analysis to identify
– e.g. fluid property changes

–VFM holistic flow rate reconciliation

–Operational performance indicators (OPIs)



Virtual Flow Metering – Surveillance, Reconciliation and Calibration

- **Short loop – Data Surveillance**

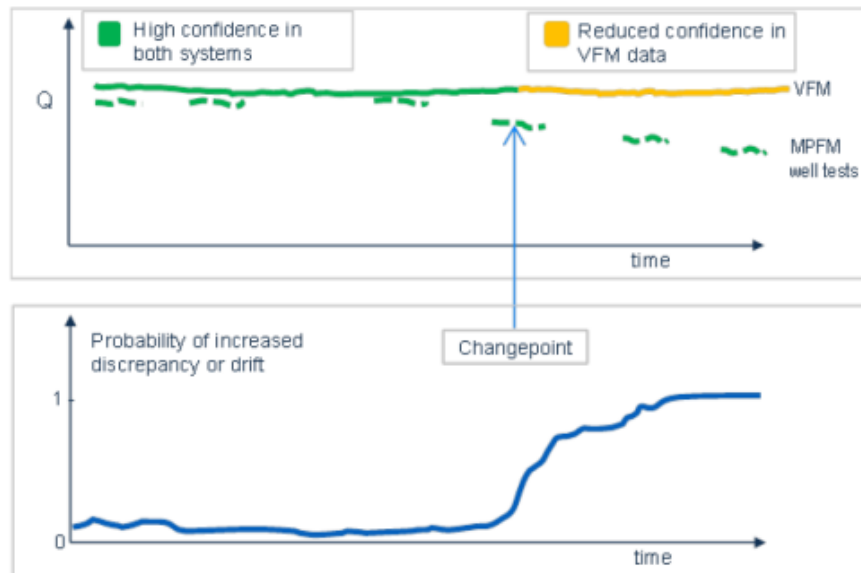
- Monitor Aqua Watcher, MPFMs and VFM values to detect changes/drift with alarms/warnings

- **Medium loop – Data Reconciliation**

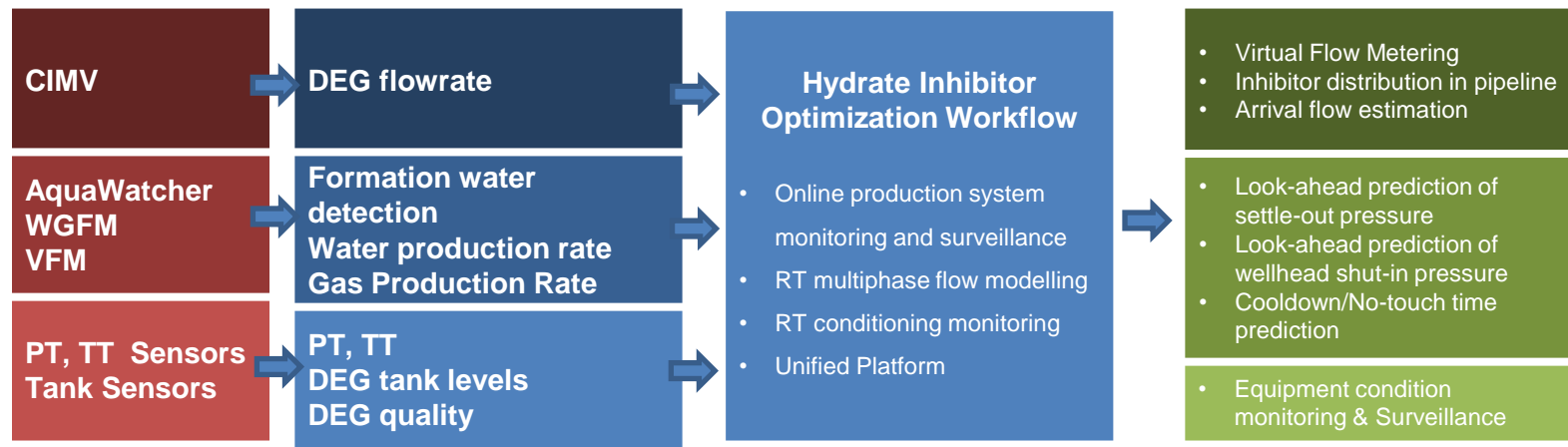
- VFM uncertainty calculation
- Apply “correction” factors to the VFM flow rates as they are compared to inlet separator metered rates

- **Long loop – Solution Calibration**

- VFM instrument failure detection / sensor drifting
- Use of well test data and historic data analysis to identify VFM quality, drift and calibration requirement
 - e.g. fluid property changes
- VFM holistic flow rate reconciliation
- Operational performance indicators (OPIs)



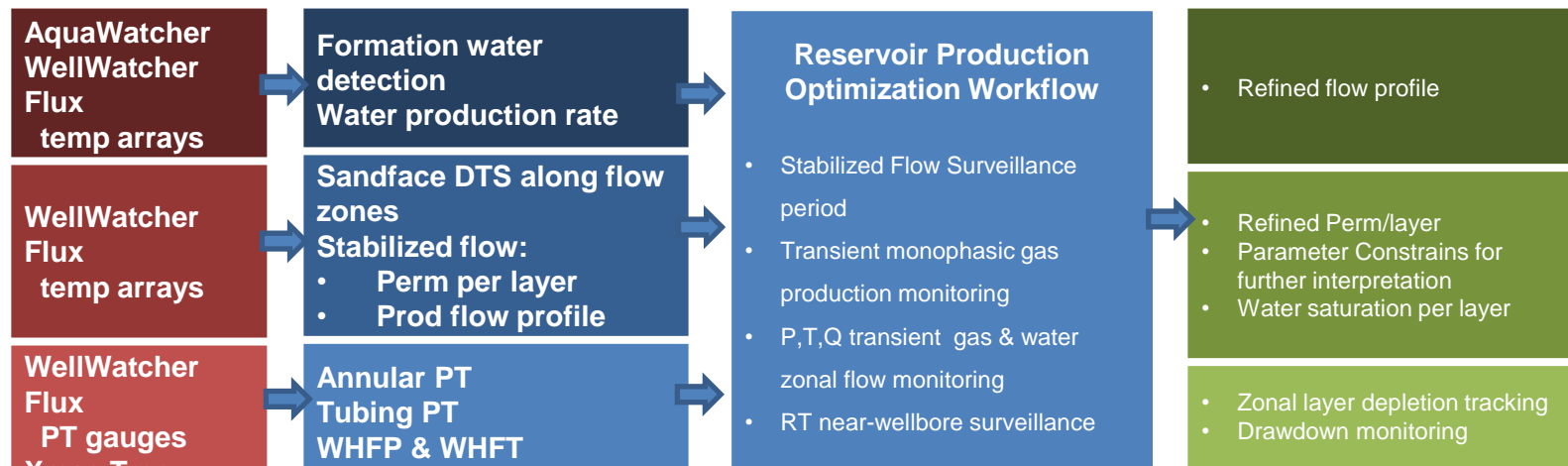
Hydrate Inhibitor Optimization Workflow



Production Management Recommendations

- ✓ **Real-time recommendations on optimum chemical injection rates**
 - ✓ Adjust dosage
 - ✓ Optimise utilities / energy consumption
 - ✓ Optimise future unit sizes or extend life
- ✓ **Inventory and consumption management**
- ✓ **Recommendation for proactive equipment maintenance**

Reservoir Monitoring, Management & Optimization - Workflow



Production Management Recommendations

- ✓ Real-time recommendations on optimum well drawdown / production rates
 - ✓ Risk of water breakthrough
 - ✓ Reduce risk of reservoir damage (avoid excessive drawdown / damage to skin)
 - ✓ Optimize production rates
- ✓ RT updates of reservoir models (perm/skin/water saturation)
- ✓ Recommendation for proactive intervention requirements
- ✓ Extend life of well / field



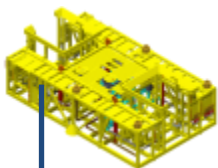
Real-time Interactive Monitoring

- Unified platform for flow assurance, reservoir and equipment condition monitoring
 - Intuitive and cross-discipline friendly GUIs
 - Data deployed back into the field's operation system
- Know the health of hardware and logical components
 - Condition and performance based monitoring leads to predictive maintenance
- Warnings and alarms issued



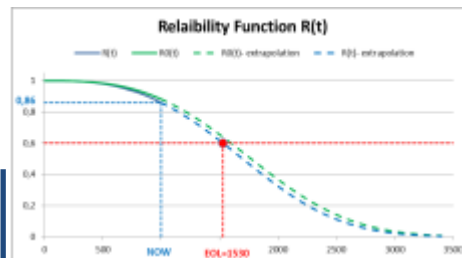
Condition Based Maintenance

Reduce OPEX cost by optimizing maintenance planning based on actual condition of system – and not run to failure



Real time condition monitoring of system

- Understand health degradation function

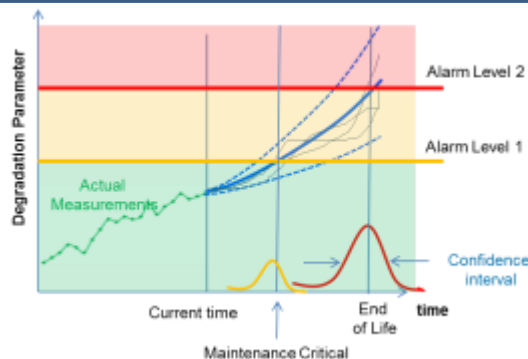


Optimize maintenance schedule

- Spare parts
- Logistics
- Personnel

Instrument system for performance evaluation

- Pressure
- Temperature
- Vibration
- Load
-

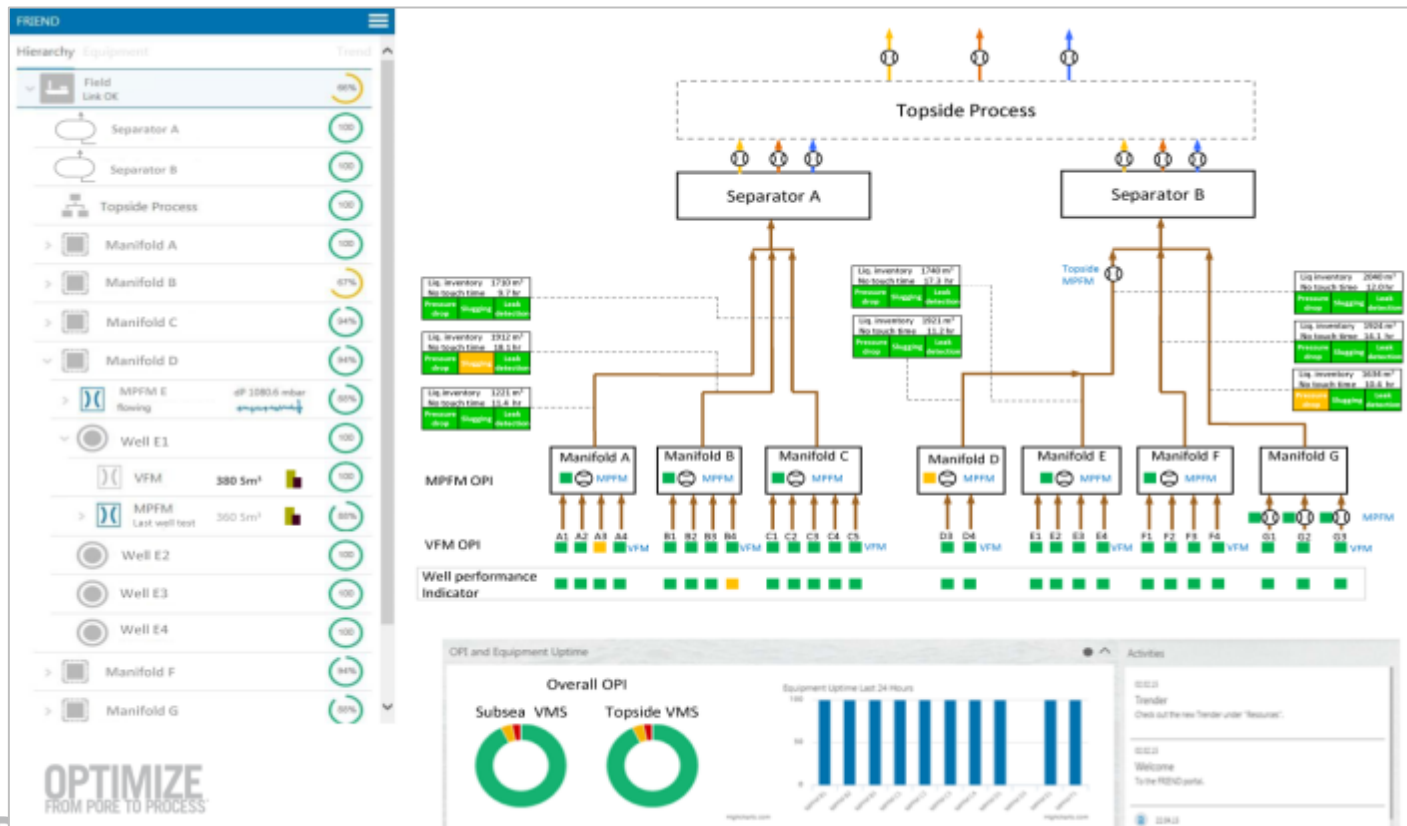


Estimate Remaining Useful Life – RUL

- Predict future health condition
- Time to maintenance critical
- Time to end of life



Example portal: WGFM, VMS and PMS with quality indicators



Conclusion

- Everything start from the reservoir and well performance;
- Equipment and software is a continuum;
- Client knowledge and supplier knowledge are complimentary;
- Supplier can support the operator if
 - Has deep knowledge over the equipment;
 - Has deep knowledge over the production systems;
 - Can reconcile both.
- Virtual system allow inherent redundancy if properly matched with real systems.