



Intelligent Asset Management

Connect Digitally to Perfect Reality

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PUBLIC

Agenda

Introduction

Intelligent Enterprise

Intelligent Asset Management

Use Case – Predictive Engineering Insights

Close

Agenda

Introduction

Intelligent Enterprise

Intelligent Asset Management

Use Case – Predictive Engineering Insights

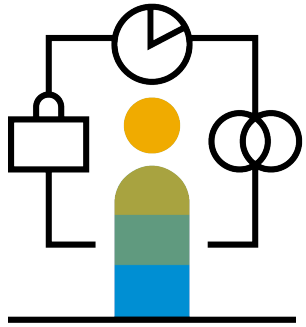
Close



**We are living
in the age of
digital disruption**

In-memory computing
Nano-technology
Big Data
cyber security
Robotics
API & Microservices
Machine learning
Cloud
Social
B2B marketplace
Artificial Intelligence
3d printing
Digital Assistants
Internet of Things
mobility
UX
Blockchain

Organizations are Transforming to Stay Ahead of the Curve...



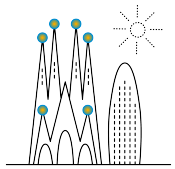
Products are moving to **services**

Outreach to customers is going **direct**

Ecosystems of partners are **collaborating** to deliver more value

...

Technologies enabling and accelerating this transformation...



City infrastructure



AI embedded
in devices



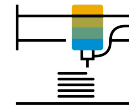
Smart vehicle



Connected fleet
management



Autonomous
vehicles



3D printing

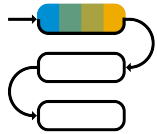


Mobility as
a Service

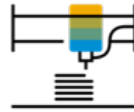


Smart home

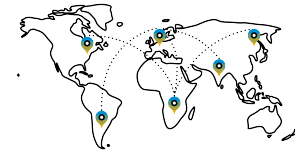
This Rapid Transformation is Putting Pressure on the Key Processes



Procure to Pay



Design to Operate



Lead to Cash

Implications on Supply Chain

- Ever increasing variability is making it critical to have a dynamic and responsive supply chain
- Need for systems which can rapidly assimilate data coming in from plethora of connected devices
- Missing ability to make intelligent decisions on the fly, that delivers the highest customer value at the lowest cost to serve

Implications on Finance

- Urgency to become a true business partner that can provide all relevant insights for decision-making
- Ability to take rapid 'go/no-go' decisions based on evolving business targets and predictive insights on probable outcomes
- Stimulate and guide business transformation with new revenue management models and financial viability insights

Implications on Core ERP

- Requirement for a robust system that can seamlessly 'extend' into the future innovations on the edge of the ERP boundary
- Necessity to free-up resources from transactional tasks in order to focus on value-added activities

Agenda

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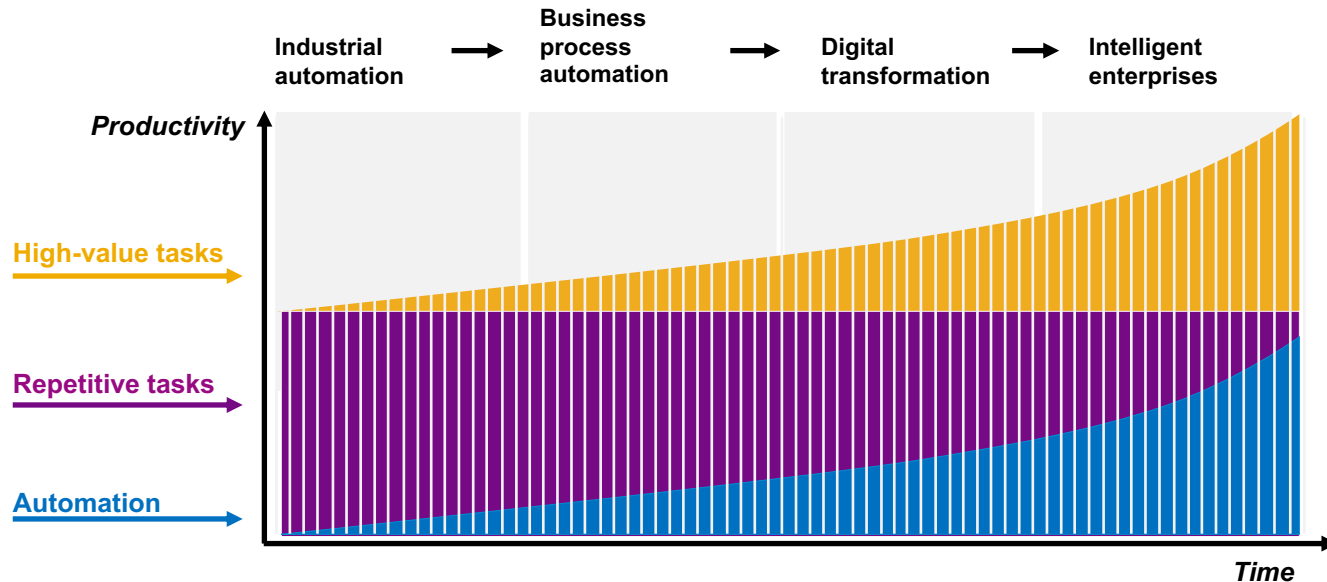
Use Case – Predictive Engineering Insights

Close

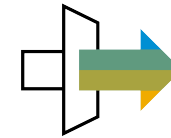
SAP Point of View:

Intelligent Enterprises are Going to Lead these Transformation Journeys

An Intelligent Enterprise should have the ability to learn from experience, anticipate problems, and use knowledge to adapt to new situations.



Optimize existing processes for more efficiency or reliability



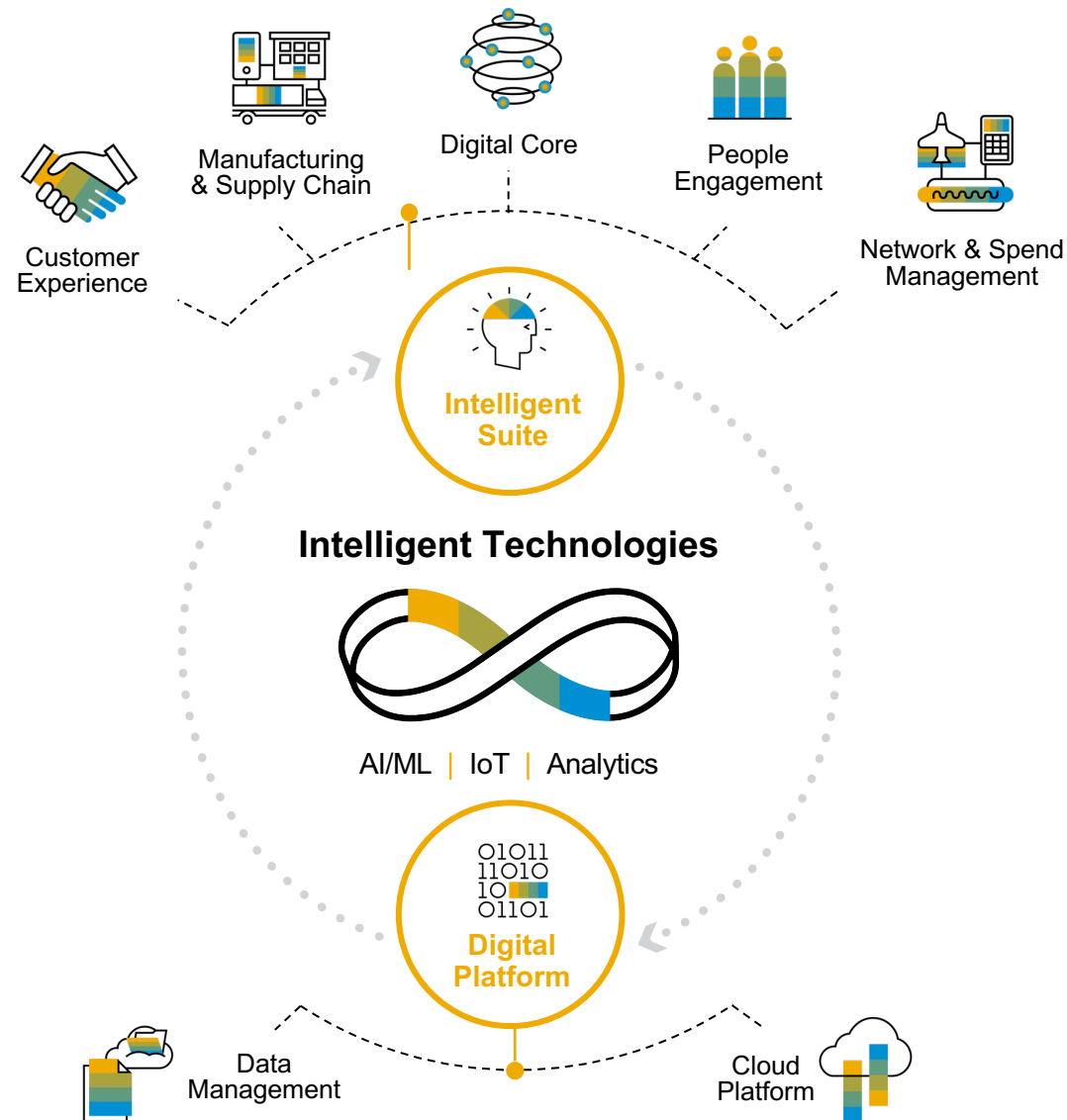
Extend current business processes beyond efficiency gains to capture new sources of value



Transform the company's value chain or business model

SAP's Intelligent Enterprise Framework

The Intelligent Enterprise features
3 key components:



1 Intelligent Suite

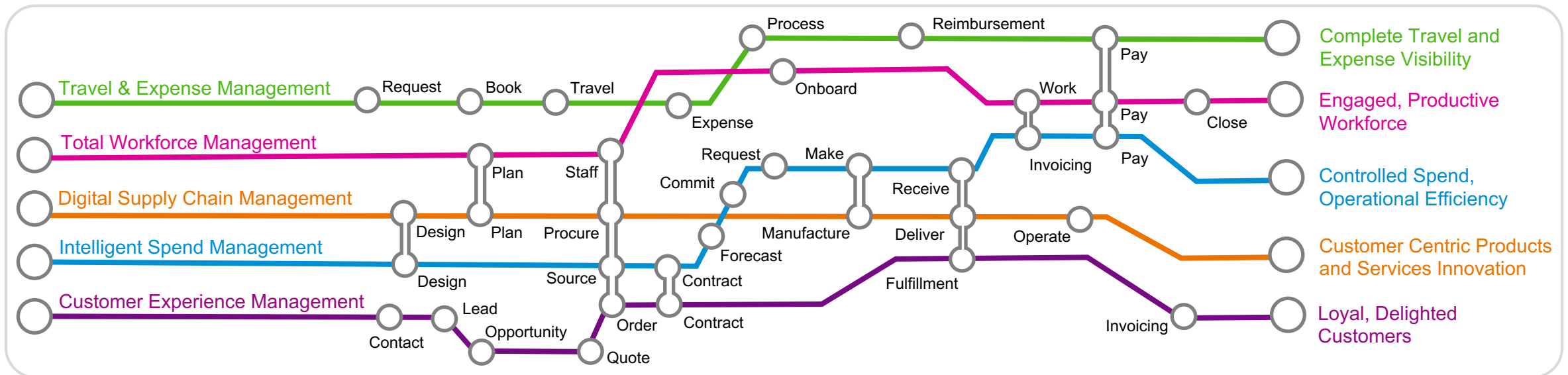
2 Intelligent Technologies

3 Digital Platform

SAP's Intelligent Enterprise Framework Helps Build Agility, Responsiveness and E2E Visibility Across the Value Chain

SAP “Metro Map” for E2E Business Processes

Seamlessly connecting your customers, partners, suppliers and employees across each end-to-end process, while providing complete enterprise-wide transparency



For an Intelligent Enterprise, SAP S/4HANA is a Foundational Requirement

SAP S/4HANA Supports the Intelligent Enterprise through Four Key Pillars



Digital Age User Experience

Digital assistance and natural language conversations for increased productivity and user satisfaction



Intelligent Automation

Artificial intelligence and robotic process automation eliminate more than half of manual tasks



New Business Models

Rapidly design and execute new business models and digital services, based on advanced end-to-end processes



End-to-end Analytics & Real-time Steering

Context aware, real time, predictive insights so you can make better decisions, adjustments, faster

Key Capabilities of SAP S/4HANA

Finance

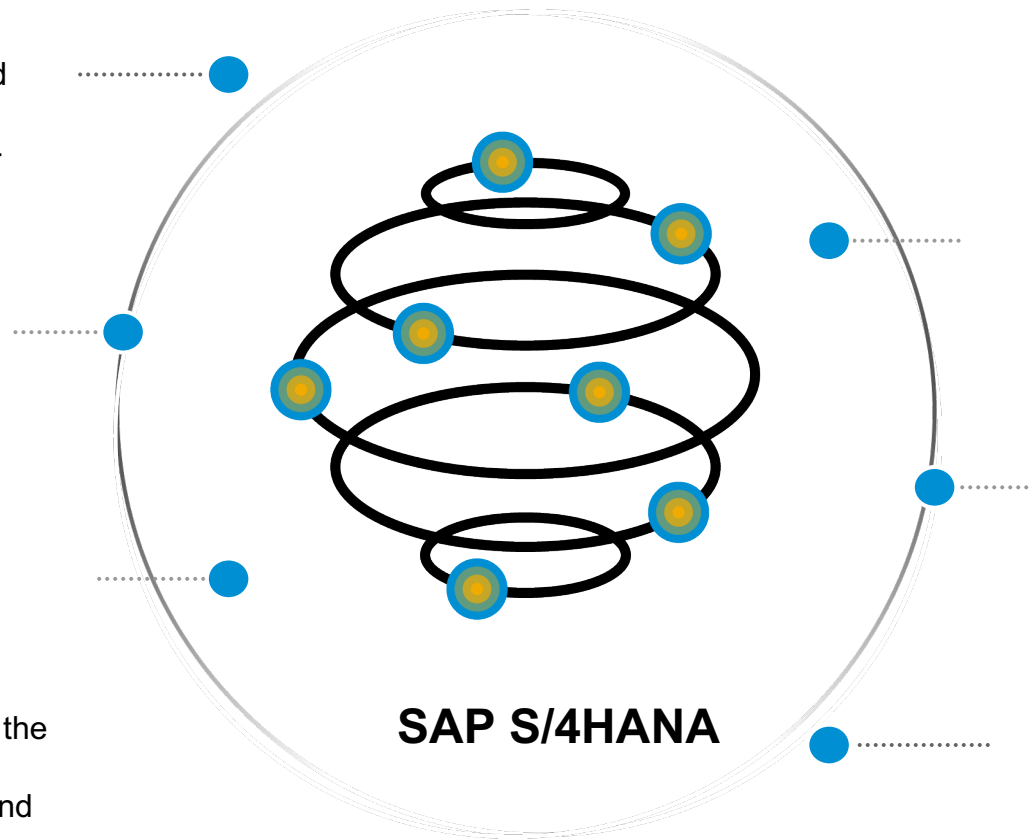
Consolidate financial, managerial, and operational data into a single source and accelerate performance with real-time processes and analytics.

Procurement

Innovate procurement processes to reduce manual tasks and increase efficiency, while improving contract renegotiation and compliance processes with predictive analytics.

Sales & Distribution

Give your marketing and sales teams the insights they need to accelerate productivity and sales performance, and have relevant conversations and interactions from anywhere.



Supply Chain Logistics

Delivering the products and services that customers want, when and where they want it. Provide total visibility to overcome complexity, by integrating customers, and partners across supply networks

Manufacturing & Asset Management

Enable Industry 4.0 through Plant Connectivity, Manufacturing Automation and Predictive Quality. Increase asset performance through predictive maintenance and service

Design & Enterprise Portfolio and Project Management

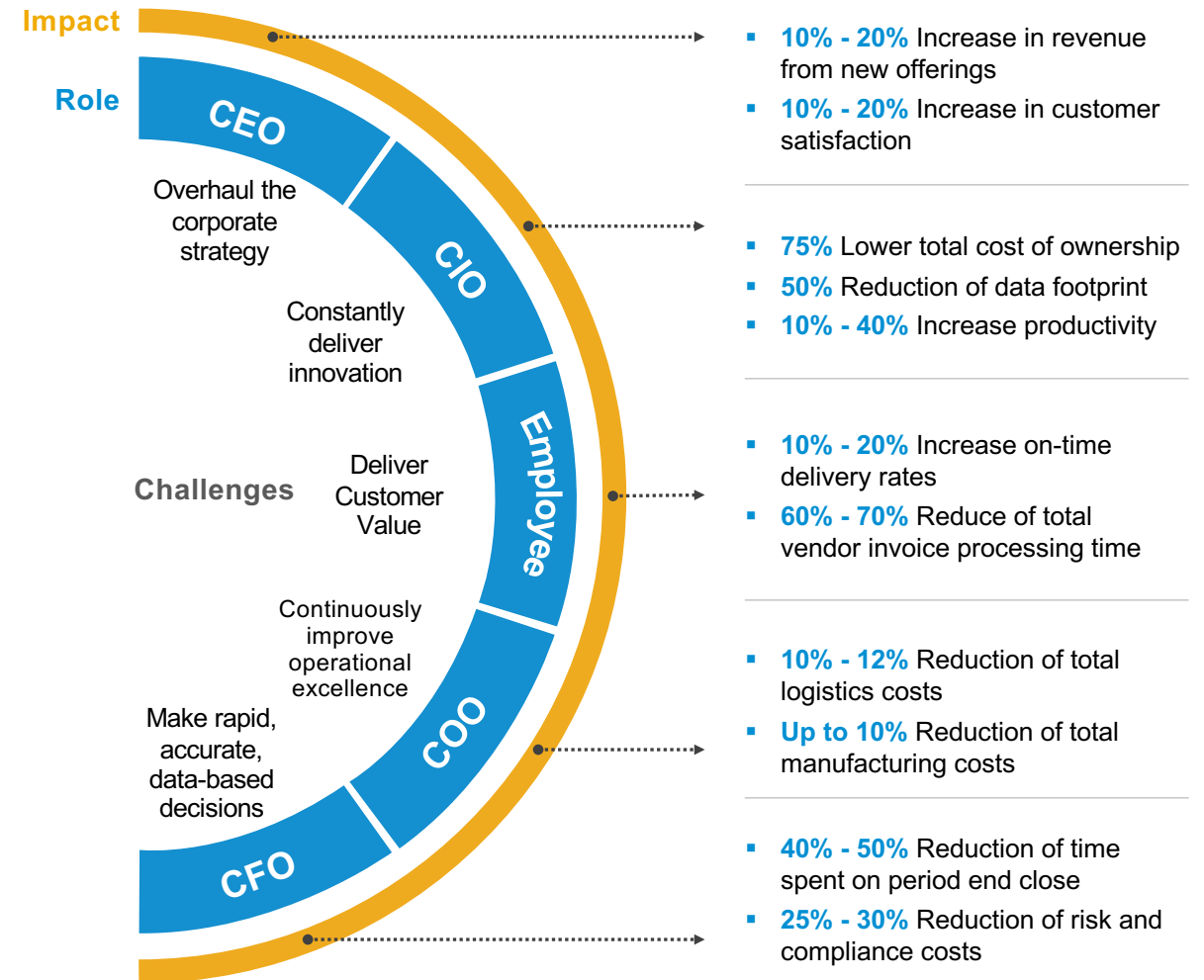
Invest in the most attractive innovations with real-time financial insights, and increase efficiency with end-to-end global project control and portfolio visibility.

Best Run Companies are already Transforming with SAP S/4HANA

Traditional Business Models

Best Run Business Models

Mass market products	> Personalized 'Smart' Products & Services
Equipment	> Service
Disconnected intermediaries	> Consumer direct/connected channel
OEM	> Recognized brand
Simple efficiency	> Resiliency
Point to point	> Multi-enterprise orchestration
Reactive Processes & Systems	> Thinking processes & systems
Latency/Obscured	> Real-time/Transparency



Leading Companies Ensure Agile and Flexible Response to Market Dynamics

A Modern

Digital Supply Chain –

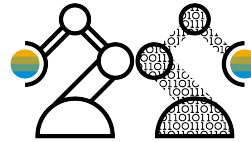
is perfecting all the experiences that lead to the final product helps you deliver the ultimate customer experience.



Digital Supply Chain is Strategic to Transforming Businesses



Customer Centricity



Total Visibility



Business Innovation

FROM...

Sales forecasting
Customer orders
Outcome focused



TO...

Demand sensing
Customer experience
Circular economy

FROM...

Mass production
Selling a product
Cost reduction



TO...

Mass customization
Delivering a service
Increase revenue

FROM...

Big data
Responsive
Linear supply chain

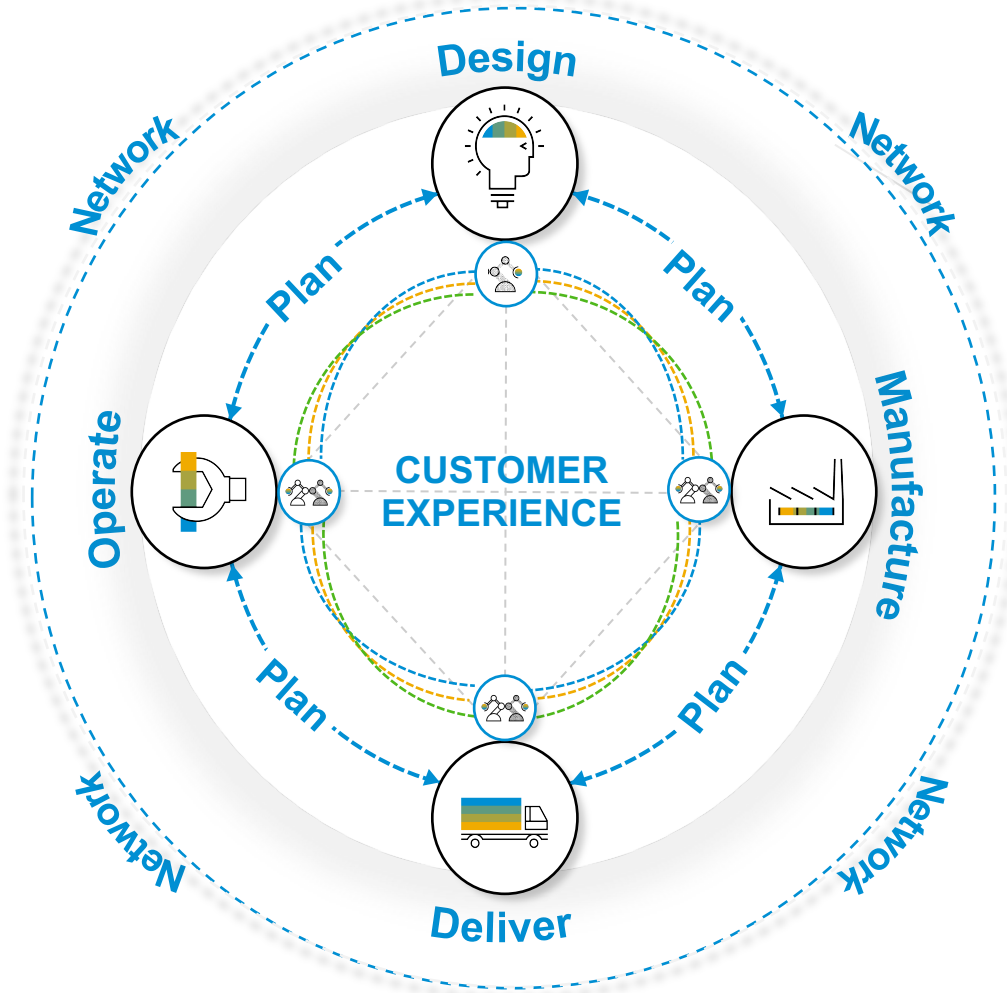


TO...

Intelligent analysis
Predictive
Agile ecosystem

SAP Digital Supply Chain – Solution Offering

From Design to Operate



Design

- Reduce time to market
- Continuously and sustainably innovate
- Deliver on customer demand



Plan

- Holistic view of demand
- Balance inventory and service levels
- Improve forecast accuracy



Manufacture

- Optimize manufacturing processes and minimize waste
- Improve collaboration with contractors
- Increase agility and responsiveness



Deliver

- Improve speed, efficiency and sustainability
- Deliver perfect orders consistently and profitably
- Increase utilization of warehouse and transportation



Operate

- Manage lifecycle of physical assets efficiently and sustainably
- Predict and simulate asset behavior
- Avoid unplanned downtime

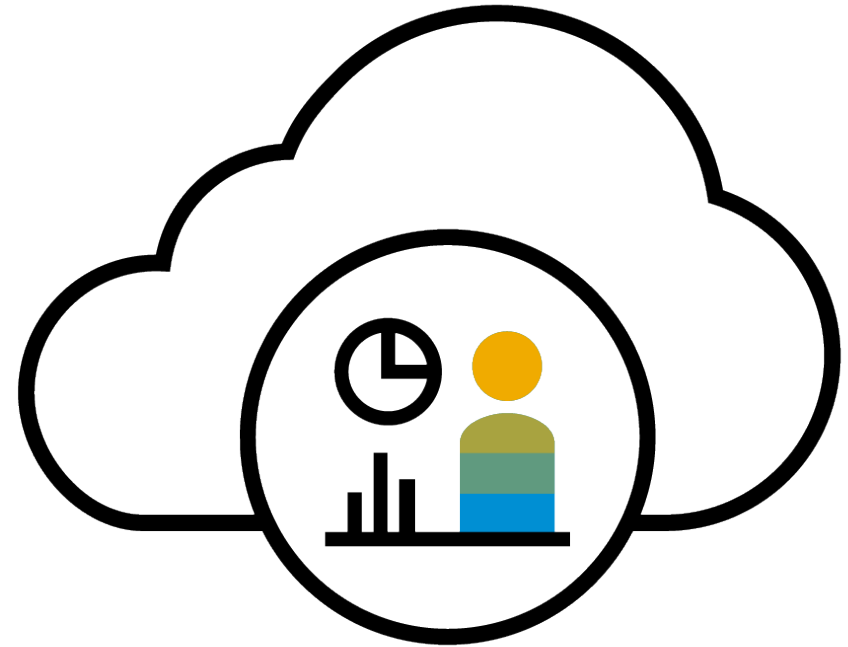


Network

- Enable better collaboration between shippers and carriers for improved process efficiency
- Improve collaboration between manufactures and operators for Asset Management

SAP S/4HANA

Strong Customer
Momentum



SAP S/4HANA Momentum

11,500+

SAP S/4HANA
Customers

3,300+

Live Customers

30%

Shorter delivery lead
time

48%

Reduction in days
sales outstanding

60%

Increase in
operational
efficiency

80%

Faster report
generation

95%

Faster material
requirements planning

100%

Visibility of
inventory across
all locations

centria

Deloitte.

ENGIE

HOERBIGER
because performance counts

Lufthansa Group



Swiss Re

Cott

Edgewell
PERSONAL CARE

FLORIDA
CRYSTALS

innogy

pladis

SIEMENS

TOYOTA

Delivery Hero

enel

HERSHEY

LaLiga

RSG
RYAN
SPECIALTY
GROUP

SONOS

VINCI

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Close

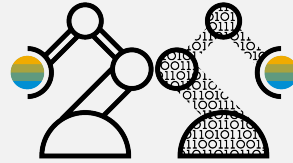
Connect Digitally to Perfect Reality for Your Asset Management



Customer, supplier,
manufacturers and
asset operator
experience



**Customer
Centricity**



**Total
Visibility**



**Business
Innovation**



Product, asset
experience

Center everything you do on your customers:

Create a collaboration hub via **Asset Central** allowing seamless data and process integration of your end-to-end supply chain and customer support.

Create a digital mirror of your end-to-end supply chain:

Full digital representation of connected assets along their lifecycle delivering an embedded, collaborative and real-time set of next generation processes and systems, e.g. health indicator of an equipment.

Refine and reinvent simultaneously:

The new ecosystems and business network enable **new business models** to buy and sell **digital services** by sharing asset information and cross-company collaboration.

Strong Momentum for Intelligent Asset Management

Digital readiness surveys show that companies clearly see the need to leverage the digital capabilities to optimize their asset management:



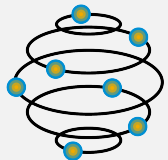
76%

of organizations consider it important to **predict potential failures** by leveraging data models



21%

Only 21% of organizations employ **predictive and preventive maintenance** effectively



83%

of organizations consider it important to have asset management processes and related metrics standardized across facilities and regularly tracked



13%

Only 13% of organizations are able to drive asset performance based on analysis of real-time sensor data, along with historical maintenance data

Production Planners and Operators Aim for the Following...

Overall equipment **effectiveness**

Return on assets

Unplanned **outages**



Maximize
asset productivity

Reduce **safety incidents**



Drive
safe operations

Annual service and maintenance **cost**

Planned maintenance budget vs. actual cost

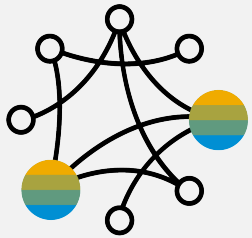
Reducing energy and input costs



Reduce
costs

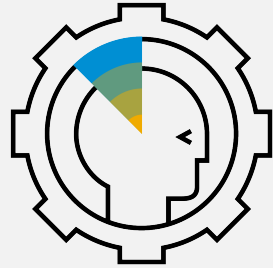


Main Technology Enablers for Intelligent Asset Management



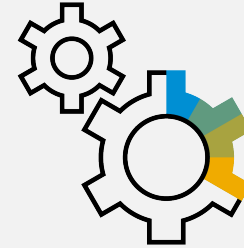
The Internet of Things (IoT)

Provides sensor-enabled condition monitoring for real time insights and new value-added services



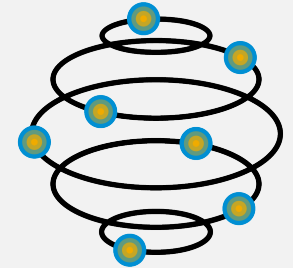
Artificial intelligence and machine learning

Bring unprecedented insights and automation of knowledge work across the enterprise



Real-time engineering simulation

Use physics-based digital twins for predictive engineering analysis in product development and operations

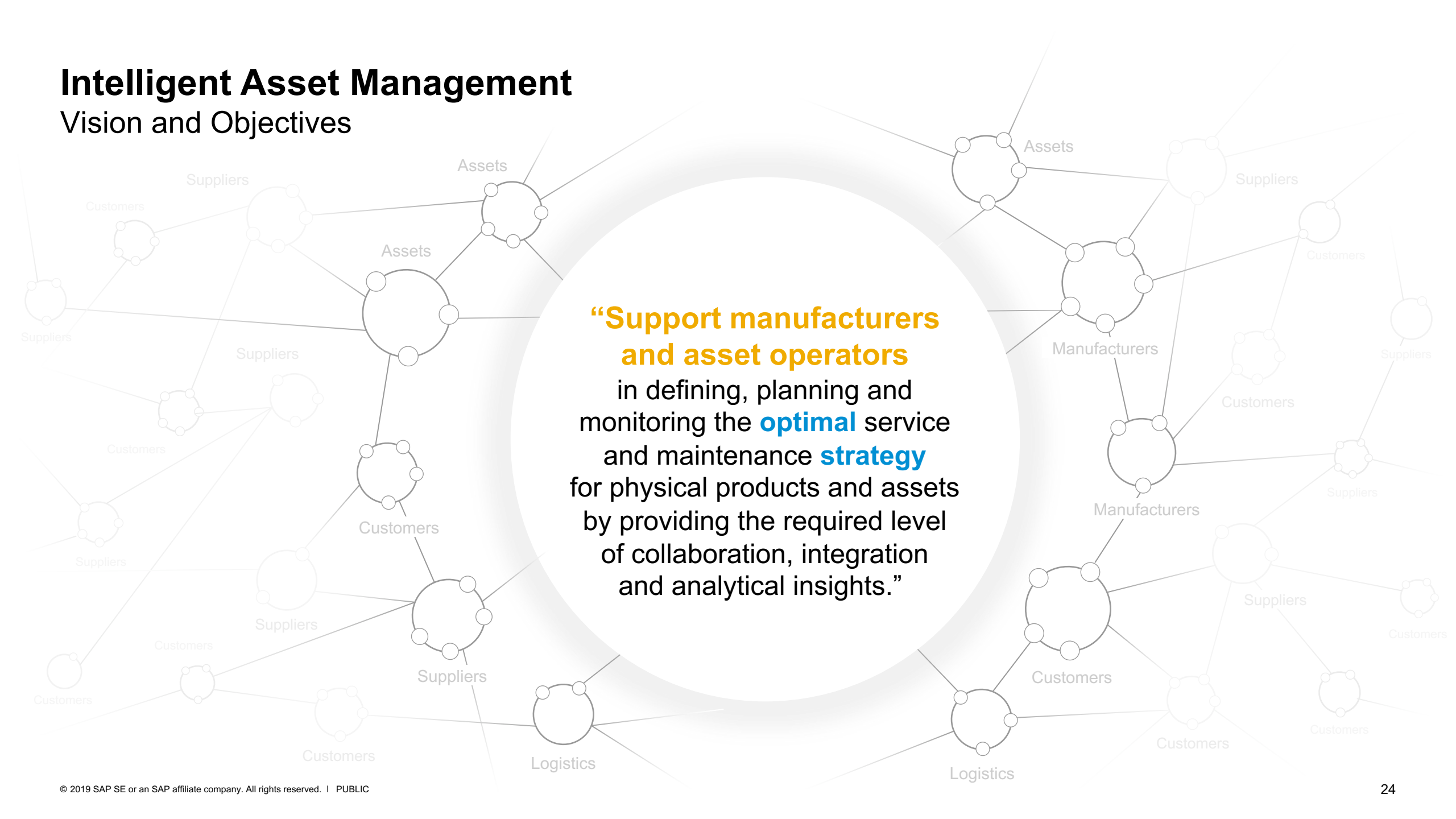


3D visualization and augmented reality

Provides unmatched situational awareness and enhanced perception for better decision making

Intelligent Asset Management

Vision and Objectives



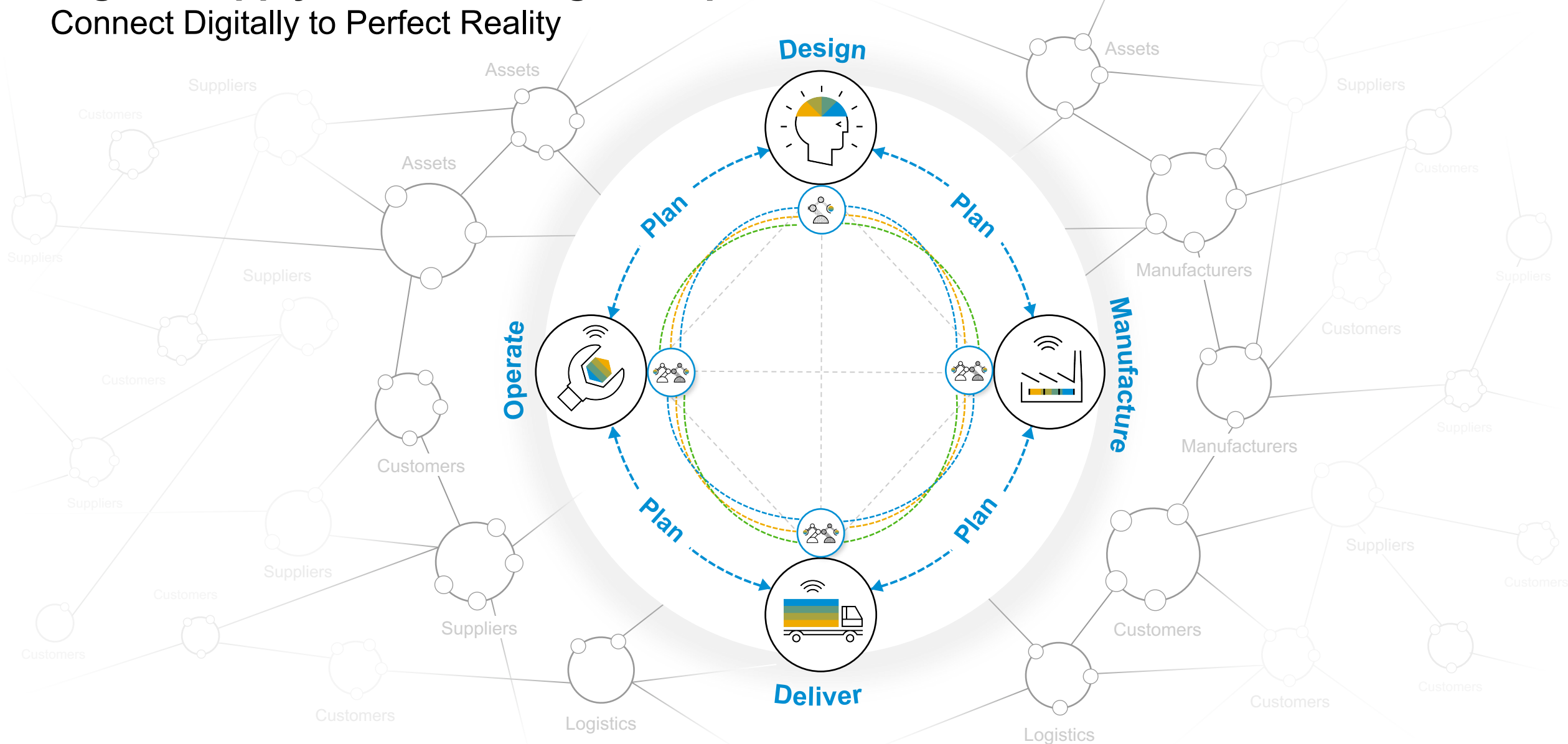
**“Support manufacturers
and asset operators**
in defining, planning and
monitoring the **optimal** service
and maintenance **strategy**
for physical products and assets
by providing the required level
of collaboration, integration
and analytical insights.”

How We Connect Digitally to Perfect Reality for Your **Asset Management**



Digital Supply Chain – Design to Operate

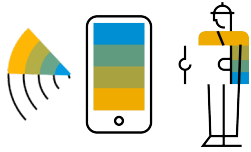
Connect Digitally to Perfect Reality



Product and Asset Lifecycle and the Digital Twin

Connect Digitally to Perfect Reality for Your Asset Management

Operator

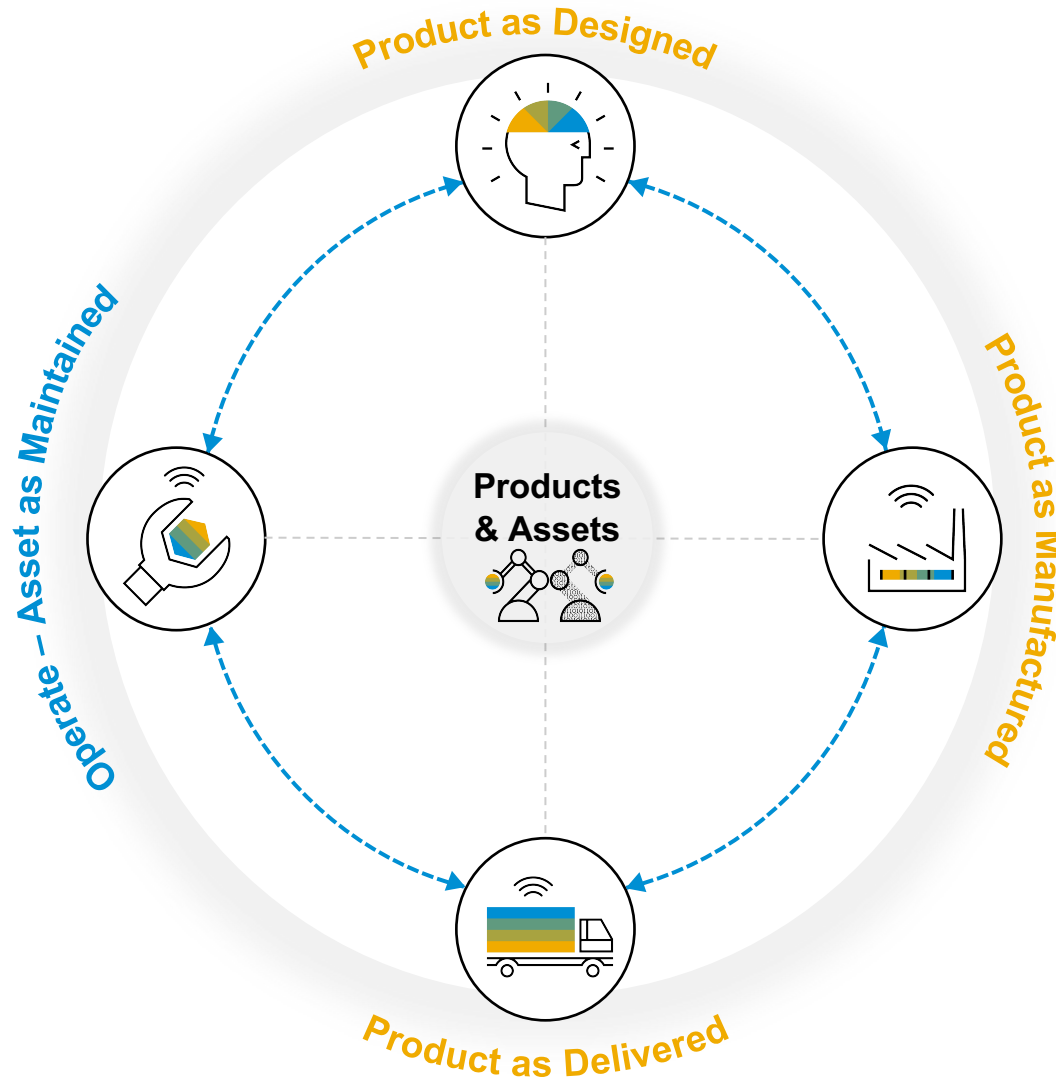


Asset Intelligence

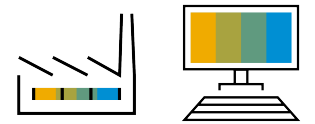
Asset Management, Predictive Maintenance and Service

Predictive Engineering Insights

As Operated – Strategic Partnership with **ANSYS**



Manufacturer

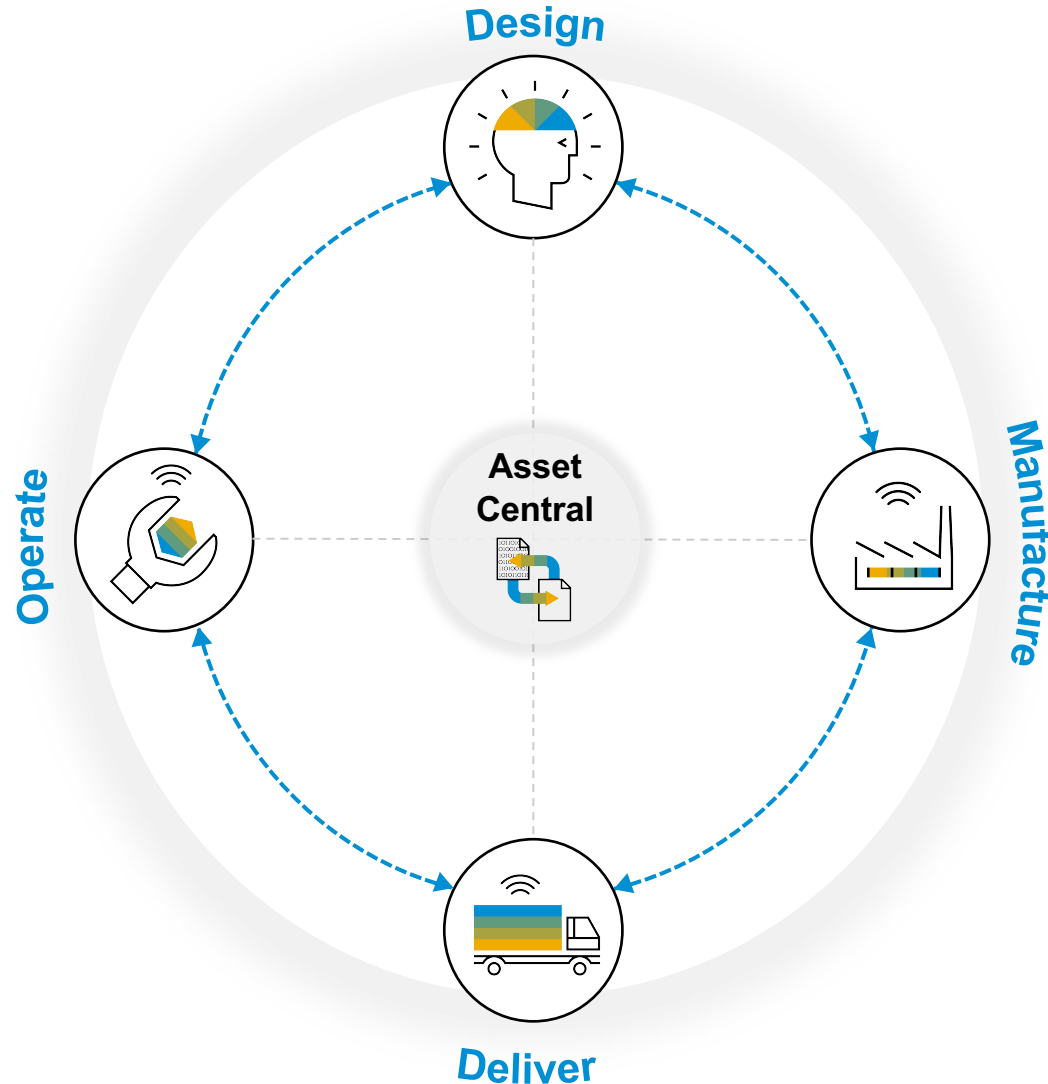


Product Intelligence

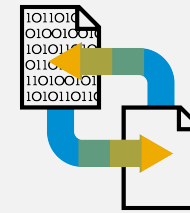
Collaborative R&D,
Engineering and
Manufacturing

Intelligent Asset Management

Asset Central as One Common Data Set



Asset Central – One Common Data Set



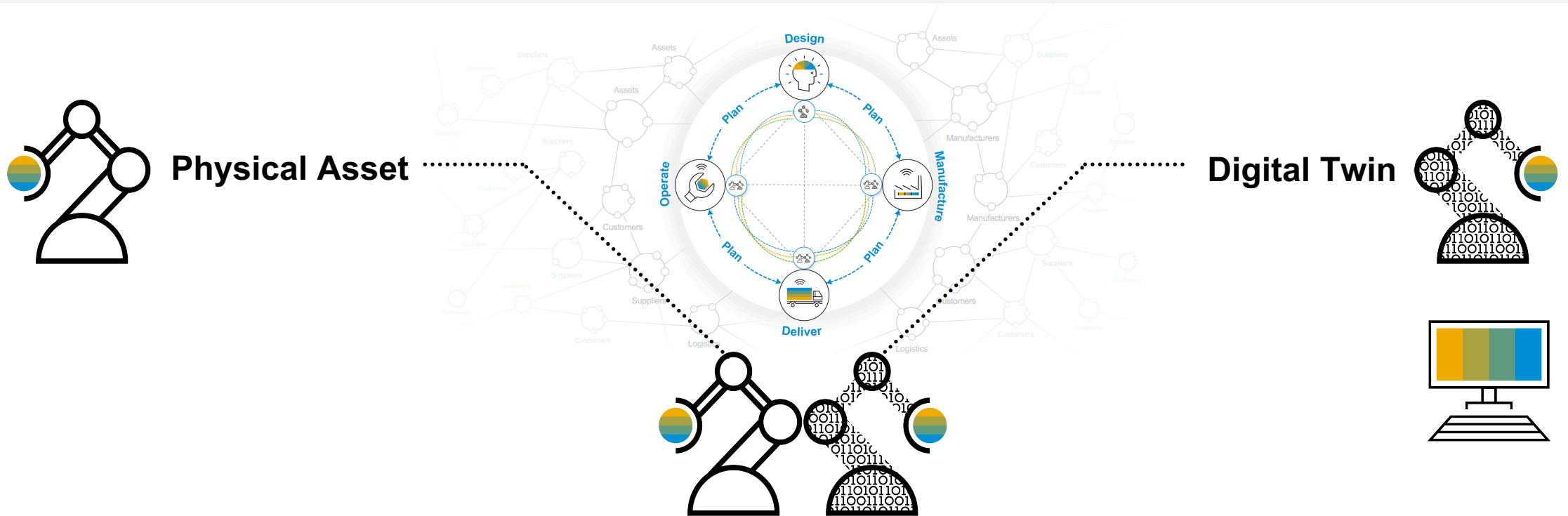
Connect to Assets

Asset Central, SAP's digital twin for physical assets, is the foundation layer across the SAP portfolio.

The Physical Asset and the Digital Twin

Connect Digitally to Perfect Reality for Your **Asset Management**

Full digital representation of connected assets along their lifecycle delivering an embedded, collaborative and real-time set of next generation processes and systems



From Preventive, Predictive to Prescriptive Maintenance

Connect Digitally to Perfect Reality for Your **Asset Management**

Today

Use of Maintenance Strategy*



TODAY

The Internet of Things is leading to increased use of **predictive** maintenance

Although still relevant, **preventative** maintenance typically results in over-maintaining assets and high cost

Future

Use of Maintenance Strategy*

Reduced Costs and Risk; Increased OEE and Service

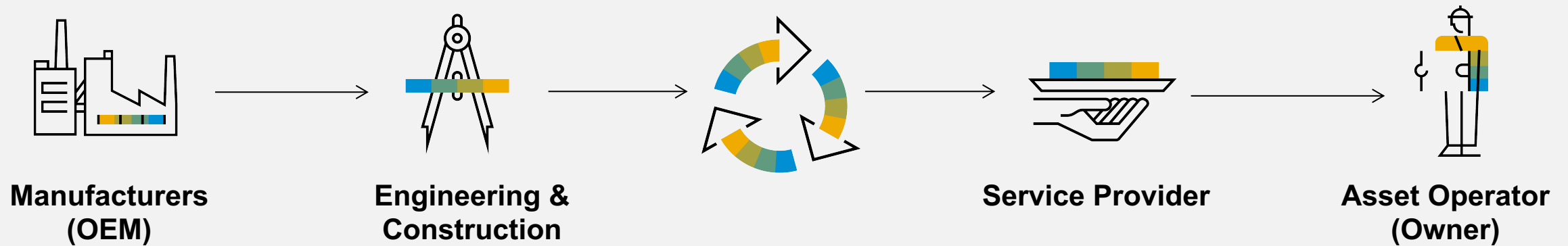


FUTURE

The goal is to enable more **IT/OT driven** approaches for **prescriptive** maintenance with machine learning and IoT-enabled engineering simulations to reduce unplanned failures and the number of maintenance actions

New Business Models – Share Asset Information and Collaborate

The new ecosystems and business network enables new business models to buy and sell **digital services** such as content packages, premium services, firmware updates and specialized asset-specific applications on top.



From...

Selling equipment

To...

Pay per use / equipment as a Service

Untrusted asset information

Collaborative Single source of truth

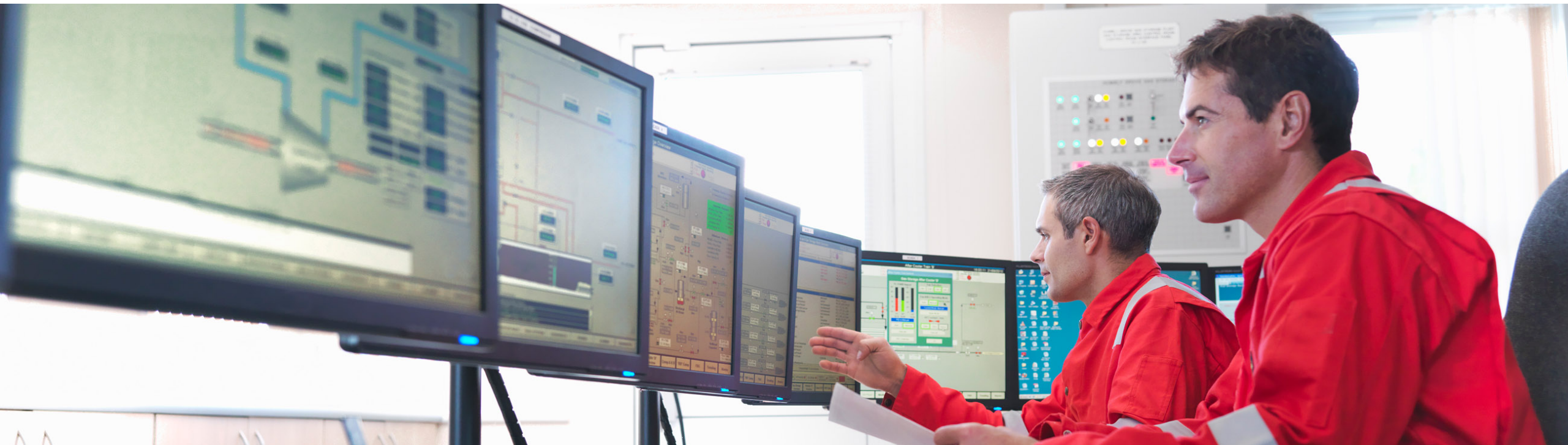
Limited analytical capabilities

Real time analytics with simulation

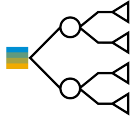
Reactive maintenance

Prescriptive maintenance

SAP Solutions

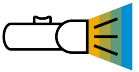


SAP Enterprise Asset Management Portfolio – Business Capabilities



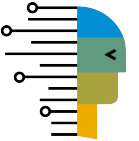
State-of-the-art business processes

Leverage new technologies to enable new asset management business processes anywhere and anytime



Real-time insights

End-to-end visibility on strategic, tactical and operational level



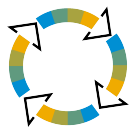
Connected assets

Bring together information from operational and business systems using IoT for scalable transparency



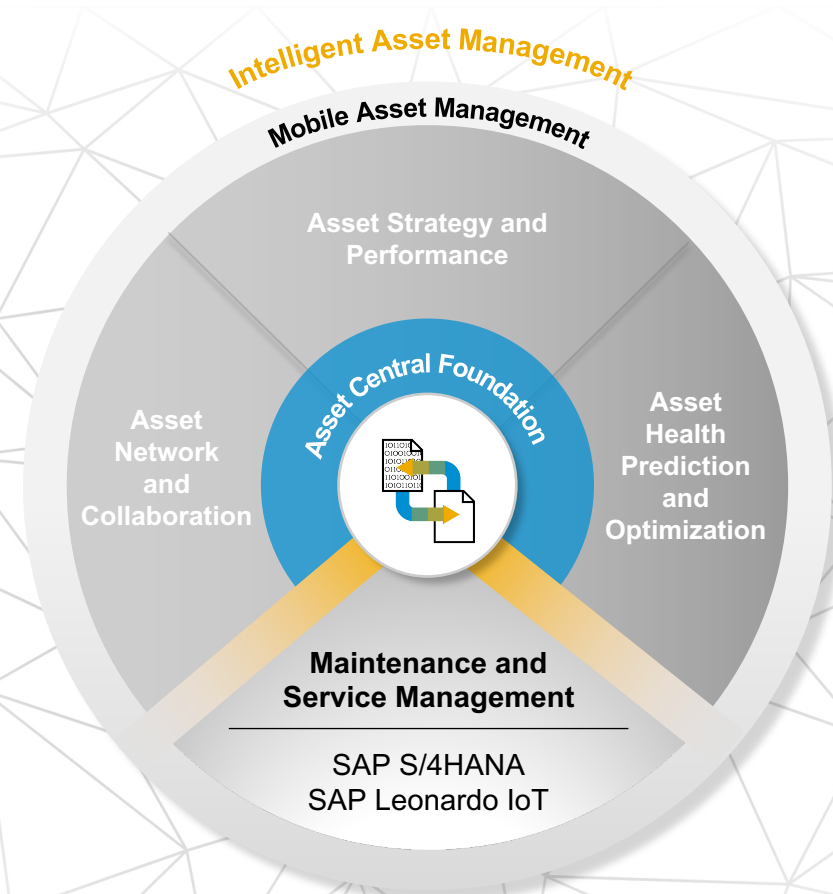
The power of prediction, optimization and simulation

Drive smarter decisions, improve reliability, and reduce outages



Collaboration throughout the asset lifecycle

Share asset information, access one version of the truth, and collaborate on a cloud-based business network with integrated processes



SAP S/4HANA Asset Management

Maintenance and Service Management



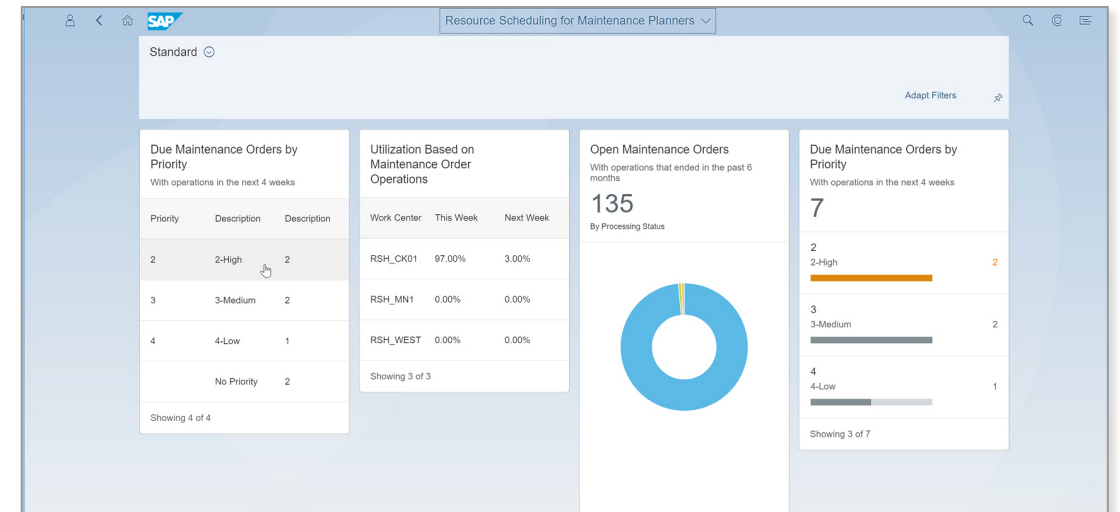
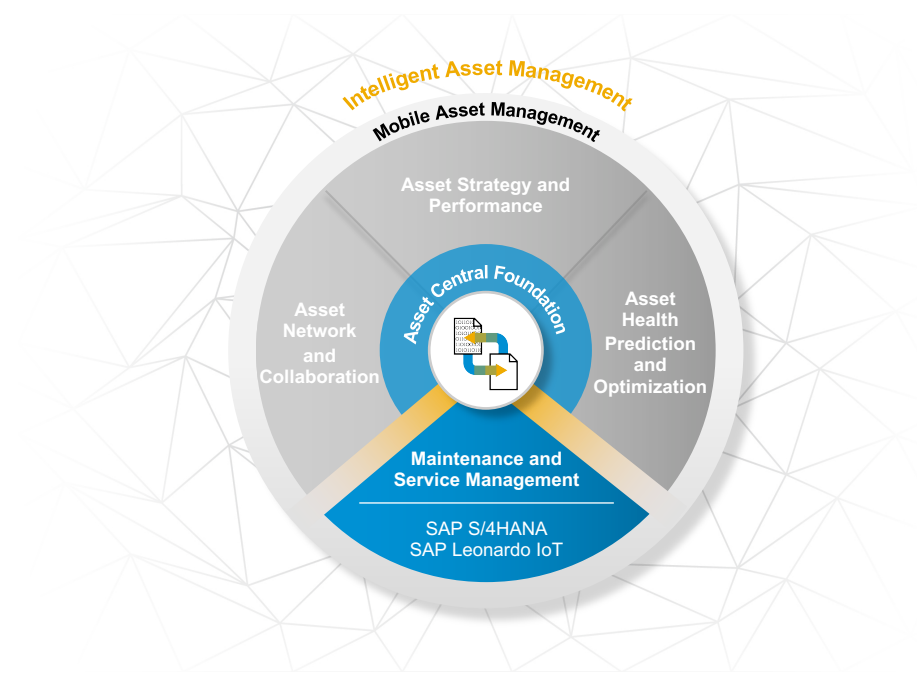
Plan maintenance activities with the right person providing the appropriate tools and resources



Schedule proactive preventive or condition-based maintenance tasks



Leverage integrated documentation for job execution and safety for a holistic view of asset status



SAP S/4HANA Asset Management

Maintenance and Service Management – Execution



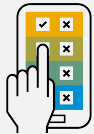
Execute planned and unplanned maintenance tasks to help ensure optimal operations



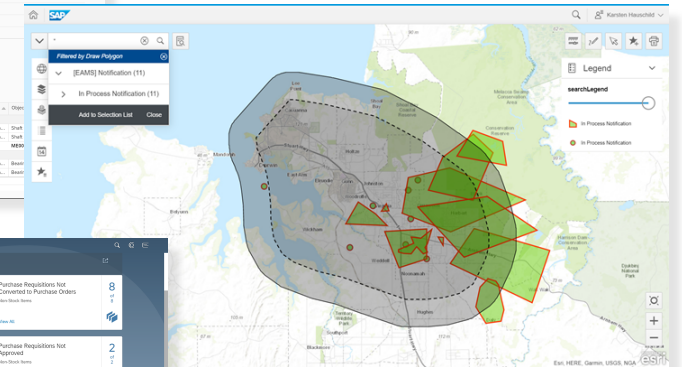
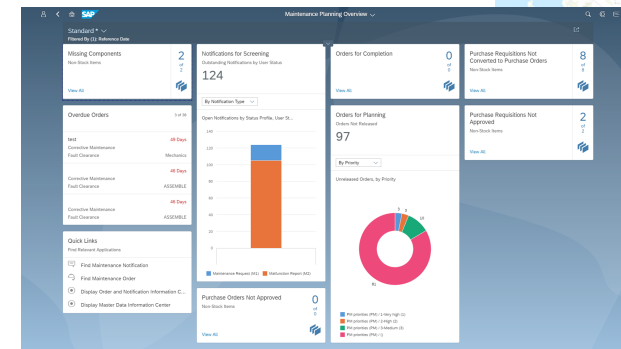
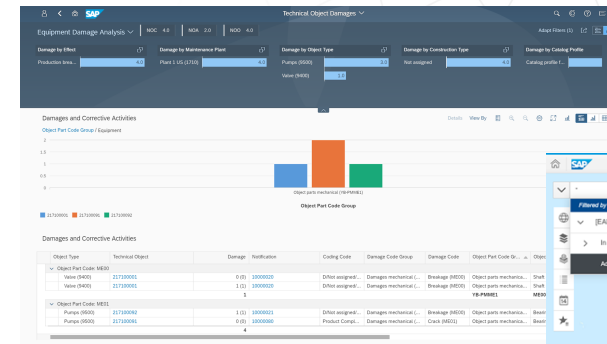
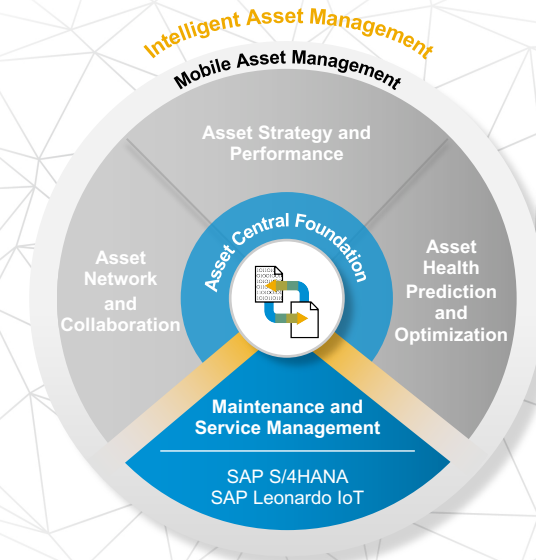
Manage preventive and condition-based maintenance proactively



Increase equipment reliability and improve asset usage as well as safer maintenance processes



Manage asset information for work orders, maintenance, measurements, inspections, metering, and inventory



SAP Intelligent Asset Management

Asset Network and Collaboration



Enable secure asset information collaboration across your business network



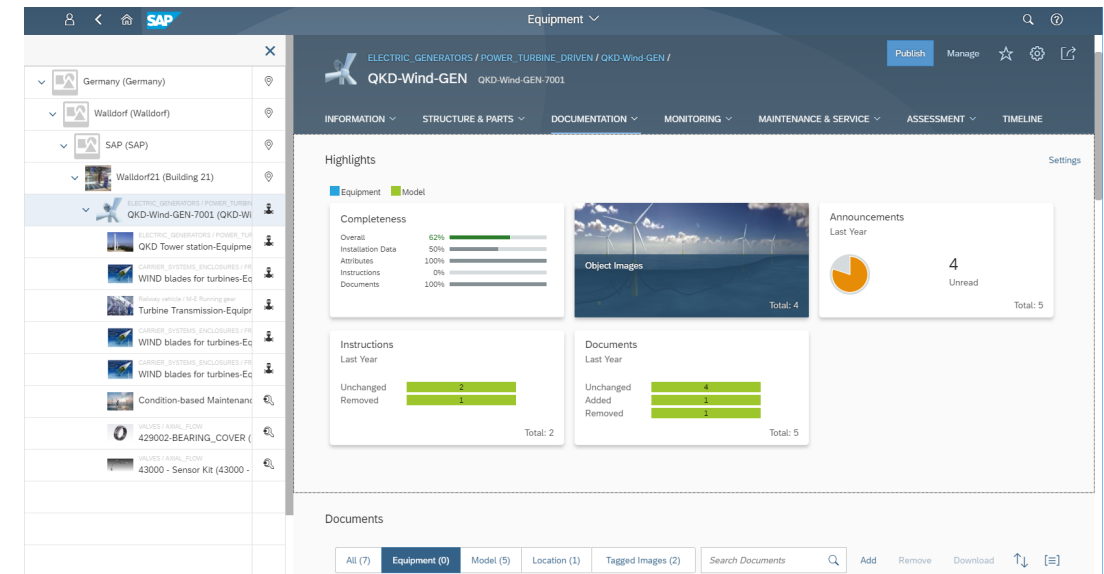
Collaborate with manufacturers, operators, service suppliers, across the network on asset information



Provide one network channel for electronic handover of technical asset and maintenance data to OEMs, service providers, and procurement vendors



Improve data reliability, reduce master data maintenance, and maintain higher asset availability



SAP Intelligent Asset Management

Asset Strategy and Performance



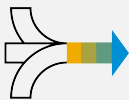
Segment assets based on risk, criticality, impact, and environmental factors to determine best maintenance strategies at lowest cost and risk



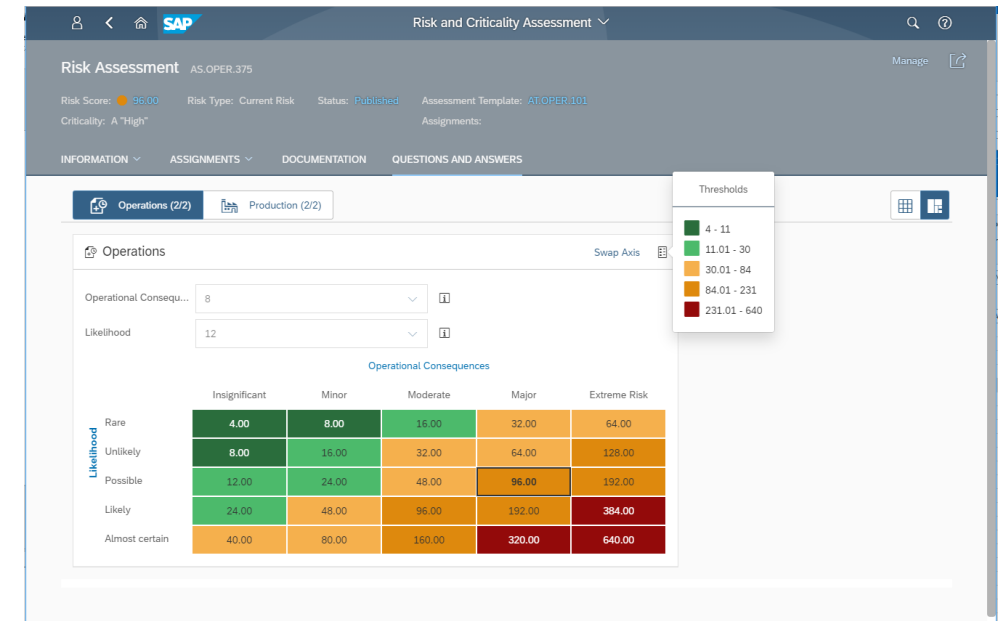
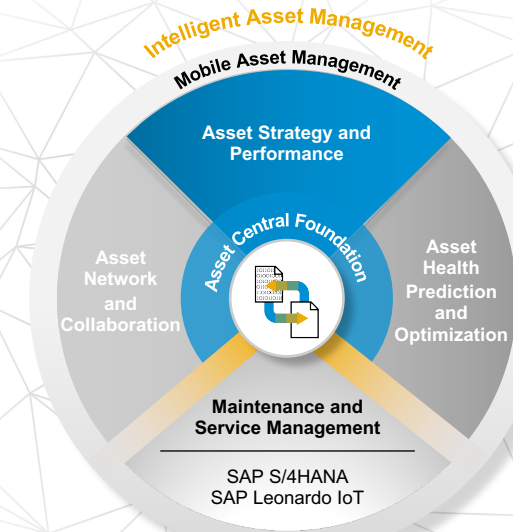
Adopt Reliability Centered Maintenance processes, considering failure modes, effect and root causes



Manage performance to optimize return on assets across lifecycles. Monitor, review, and improve maintenance plans and budgets



Reduce bottlenecks, improve decision making, and prevent incidents using a holistic view of asset types and maintenance strategies



SAP Intelligent Asset Management

Asset Health Prediction and Optimization



Optimize the availability of your assets by using predictive maintenance and service capabilities and the Internet of Things to take corrective actions early



Collect and analyze sensor data from physical assets to predict operational failure



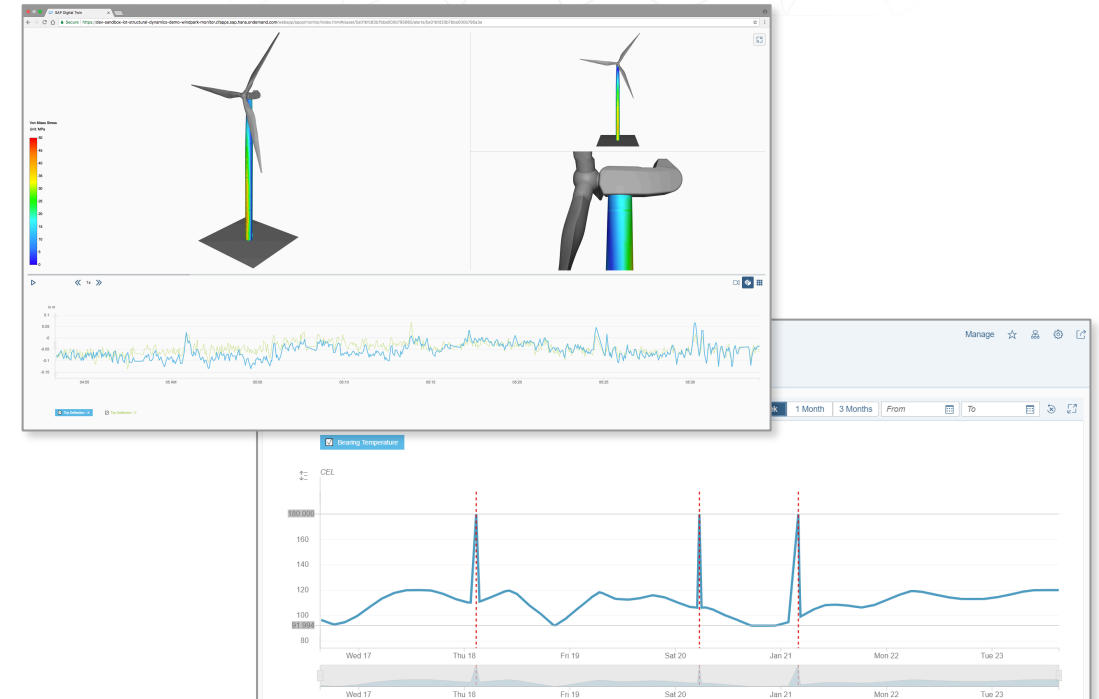
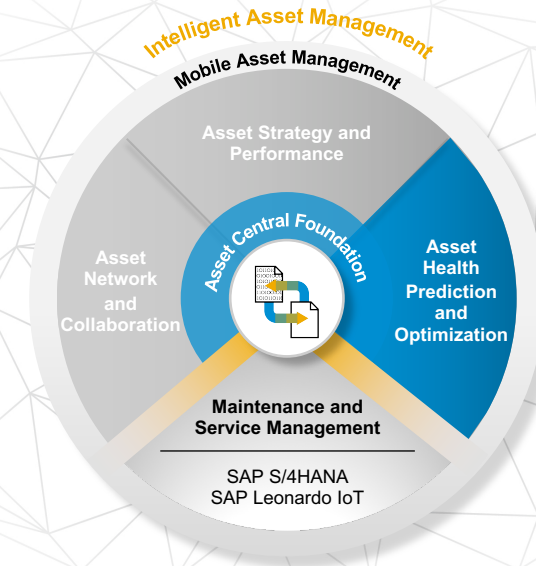
Initiate preventive countermeasures that trigger service or maintenance orders



Optimize asset performance with a closed-loop maintenance and service process



Create physics-based digital twins of industrial assets based on a real-time and predictive engineering analysis



SAP Intelligent Asset Management

Mobile Asset Management



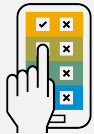
Eliminate paperwork while reducing downtime and maintenance backlog



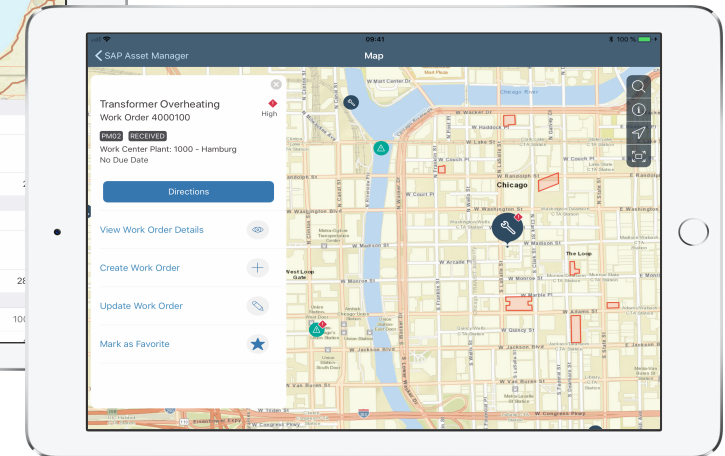
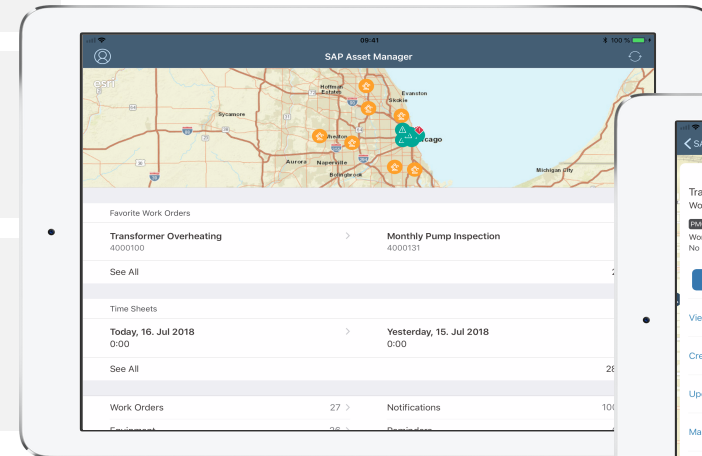
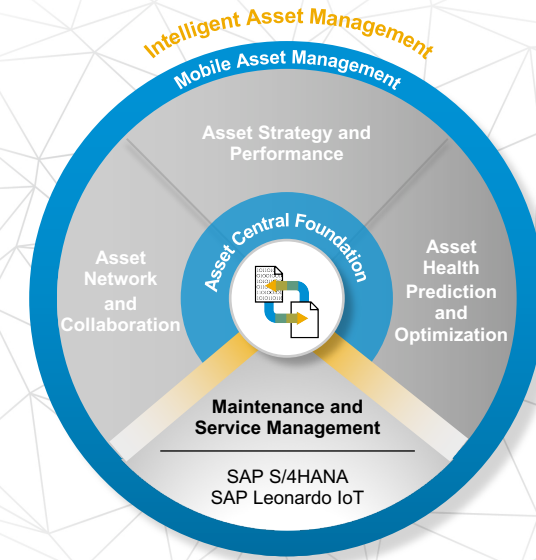
Extend and improve asset life and reliability by shortening work cycles



Turn capital spending into operational investments using cloud deployment



Manage existing work and asset data whether you're online, offline, or occasionally connected



Agenda

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Use Case – Predictive Engineering Insights

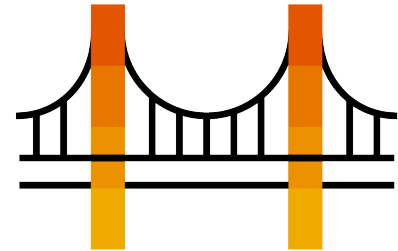
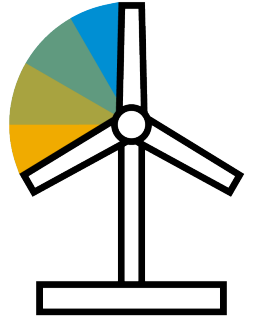
Close

Use cases: SAP Predictive Engineering Insights

Practical implementation of Simulation-based Digital Twins
SAP Norway Engineering Center of Excellence

SBN Conference
23 October 2019

PUBLIC



Case presentations: Predictive Engineering Insights

SAP Intelligent Asset Management



Statens vegvesen



Statkraft

A|S|K|O



KONGSBERG

SAP Intelligent Asset Management

Capabilities & solutions



Asset Network and Collaboration

SAP Asset Intelligence Network



Asset Strategy and Performance

SAP Asset Strategy and Performance Management



Asset Health Prediction and Optimization

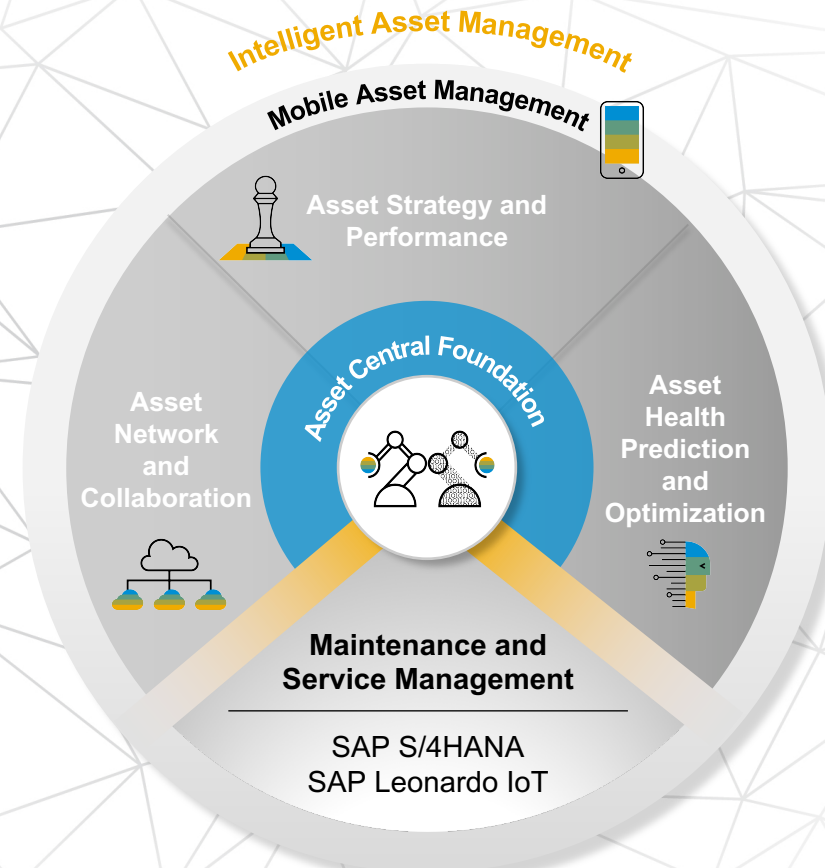
SAP Predictive Maintenance and Service

SAP Predictive Engineering Insights Enabled by ANSYS



Mobile Asset Management

SAP Asset Manager



SAP Norway Engineering Center of Excellence

DSC, P&E, PEI SAP Norway CoE

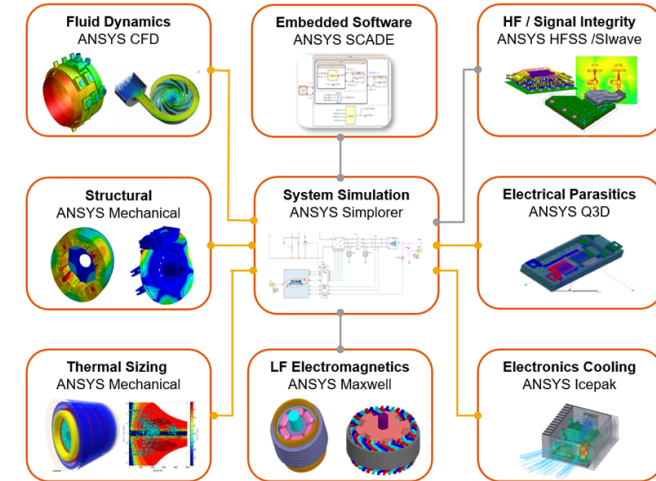
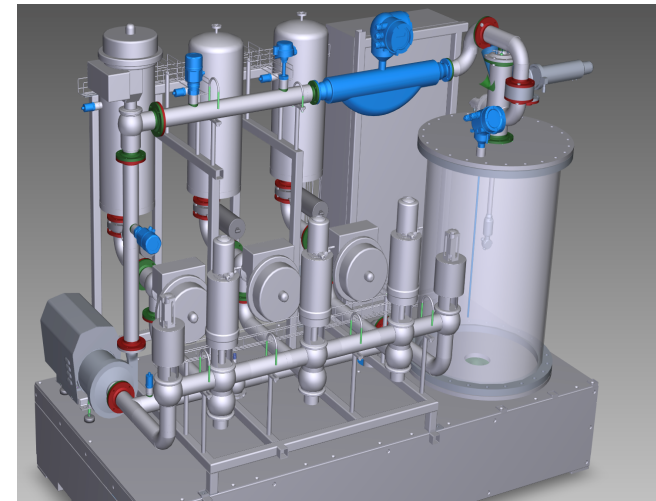
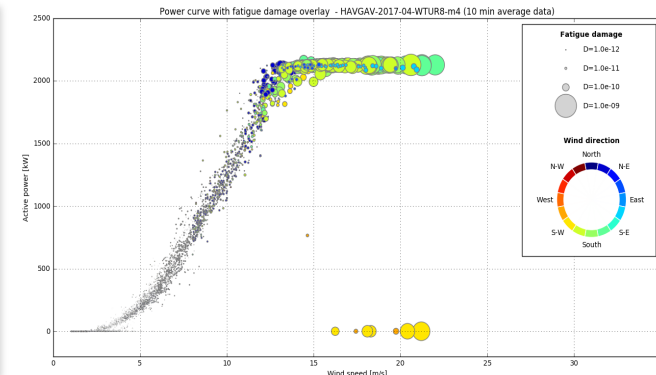
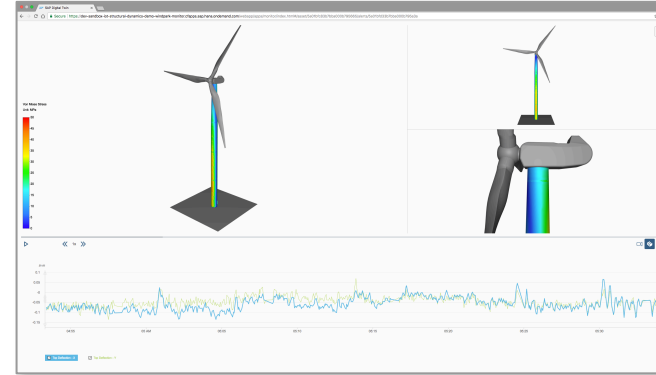
Based on the engineering and development team of Fedem (SAP acquisition 2016) in Trondheim, Norway.

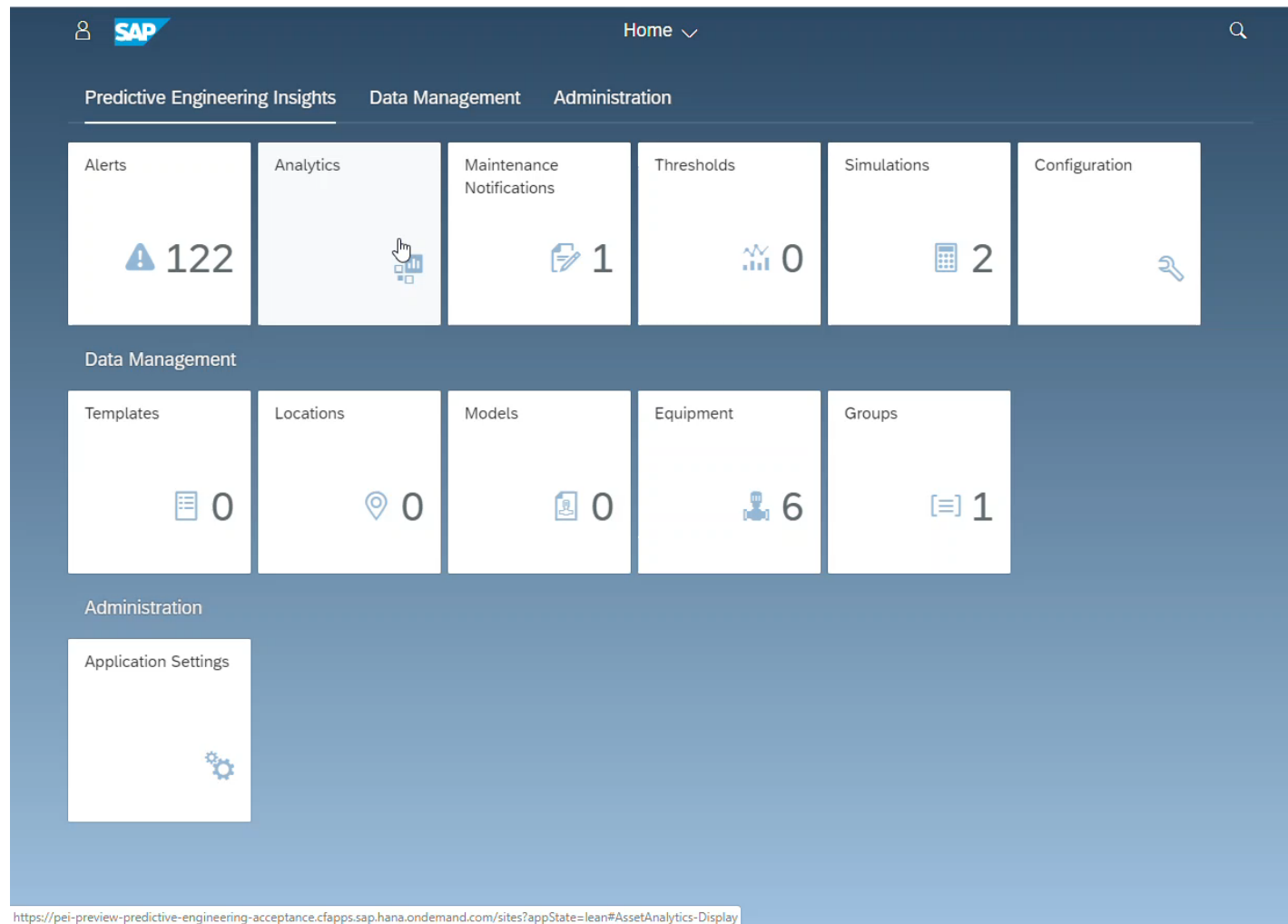
Tight relations with NTNU and UiO on R&D.

Development of physics-based Digital Twins, methodology, signal processing func., sensor applications, data visualisation, IoT data components, ...

Project delivery unit: PMs, product support, services, onboarding/training, ...

Model, implement and integrate ANSYS-based DTs in SAP Asset Management and PLM landscapes.





Statkraft: Smøla vindpark

Keywords and background:

- Abundance of data; desire to make data available for the right users on the right platforms/systems at the right time.
- SAP PM: Strategic use across the company, wish to test/extend real-time OT data availability in main maintenance solution (provided that the tech solution is mature enough)
- Objectives of the project:
 - Statkraft: Tech demonstrator for IoT data integration and CDP (OSI PI historian)
 - SAP: Data logistics (sensor data through corporate infrastructure to the cloud), compose/test HW setup, combine multiple data streams (our + external) into the cloud, develop use cases

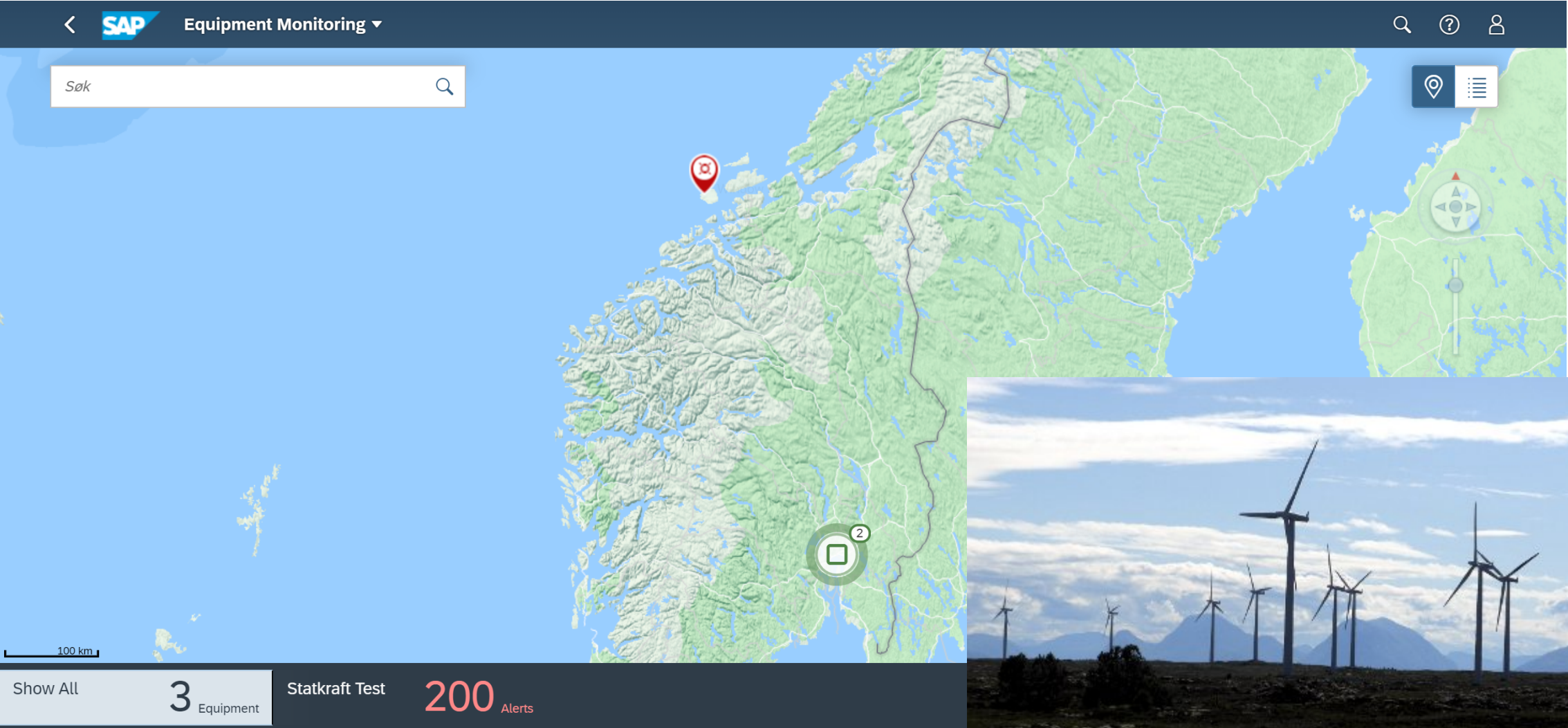


Statkraft



KONGSBERG

Statkraft, Smøla vindpark



Project tasks, approach and methodology

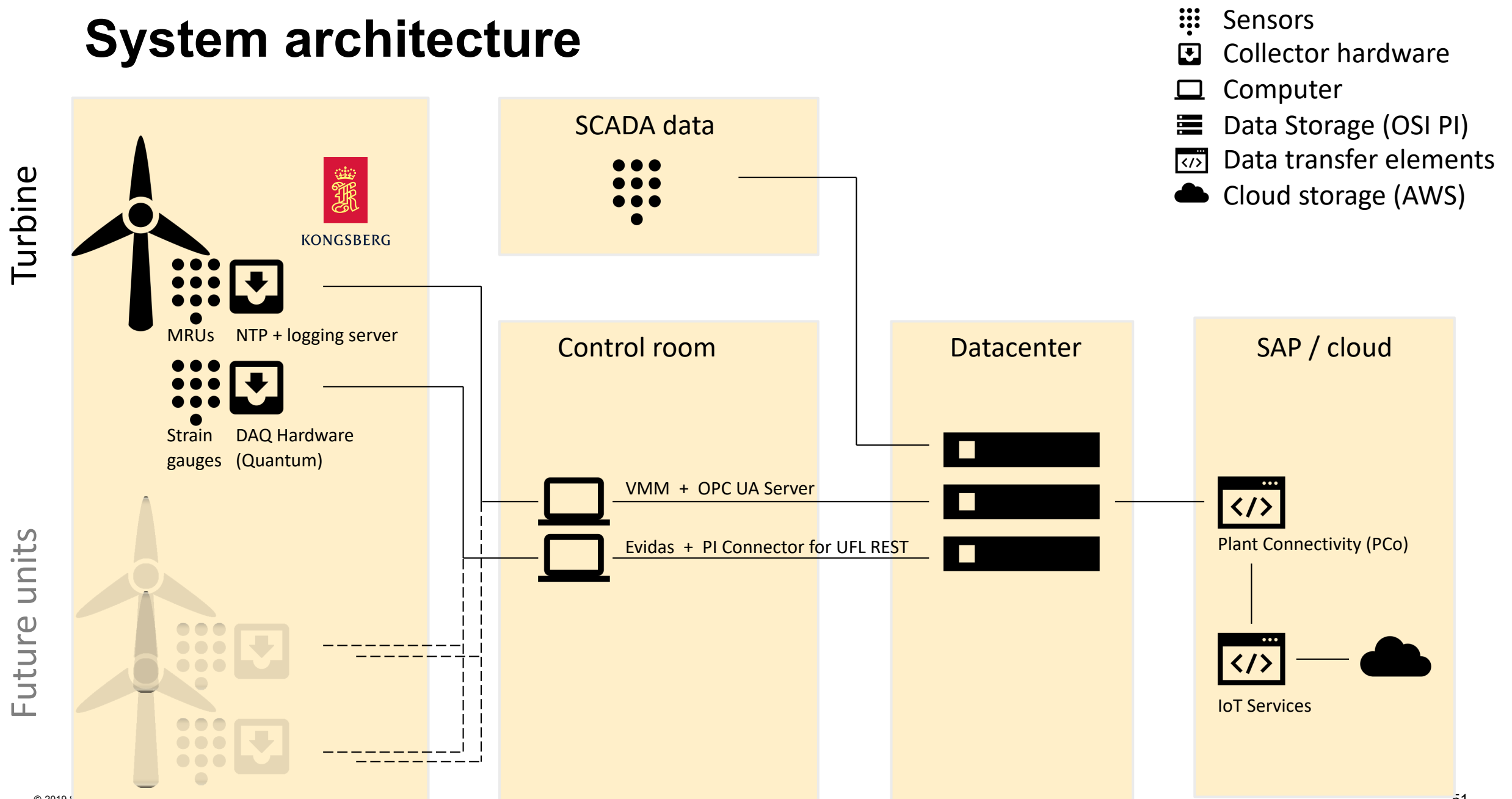
- Phased approach (with decision gates):
 - Phase 1: Technology demonstrator, operational use
 - Phase 2 (not committed): Back-end integration, functional development
- Monitoring scope
 - Structural response in tower
 - Vibrations
 - Drivetrain
- Implementation and testing scope
 - Data logistics, IoT components (SAP IoT components not necessarily made with this usage in mind), integration with corporate IT structures
 - Sensors and hardware: Approaching the limits
 - Frontend and use cases for operational experts



KONGSBERG



System architecture



Functionality, use cases

Use cases:

- As mentioned: Technology demonstrator
- Customer defined use cases:
 - UC1: Visualisation of production data and system behaviour/response metrics
 - UC2: Production / performance data
 - UC3: Fatigue life, factors affecting inspection planning and life expectancy (special events, normal production, emergency/extreme events, ...)
 - UC4: Vibration in drivetrain and nacelle structure



Status, results

Completed:

- System installation as per architecture is up and running
- Data logistics from edge through CDP to cloud (AWS S3) up and running
- New functionality and user screens developed

Remaining:

- Higher frequency data logging
- Acceptance testing





Søk



Turbine47

Smola, Norway



Alerts

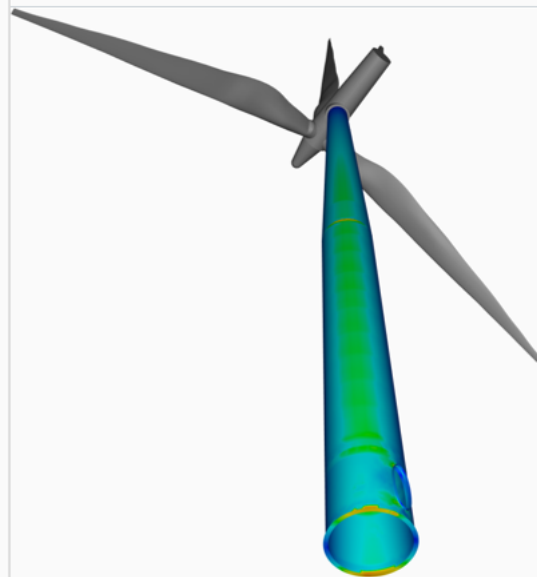


High structural load

Component: Flange 01



High



CHOOSE VIEW

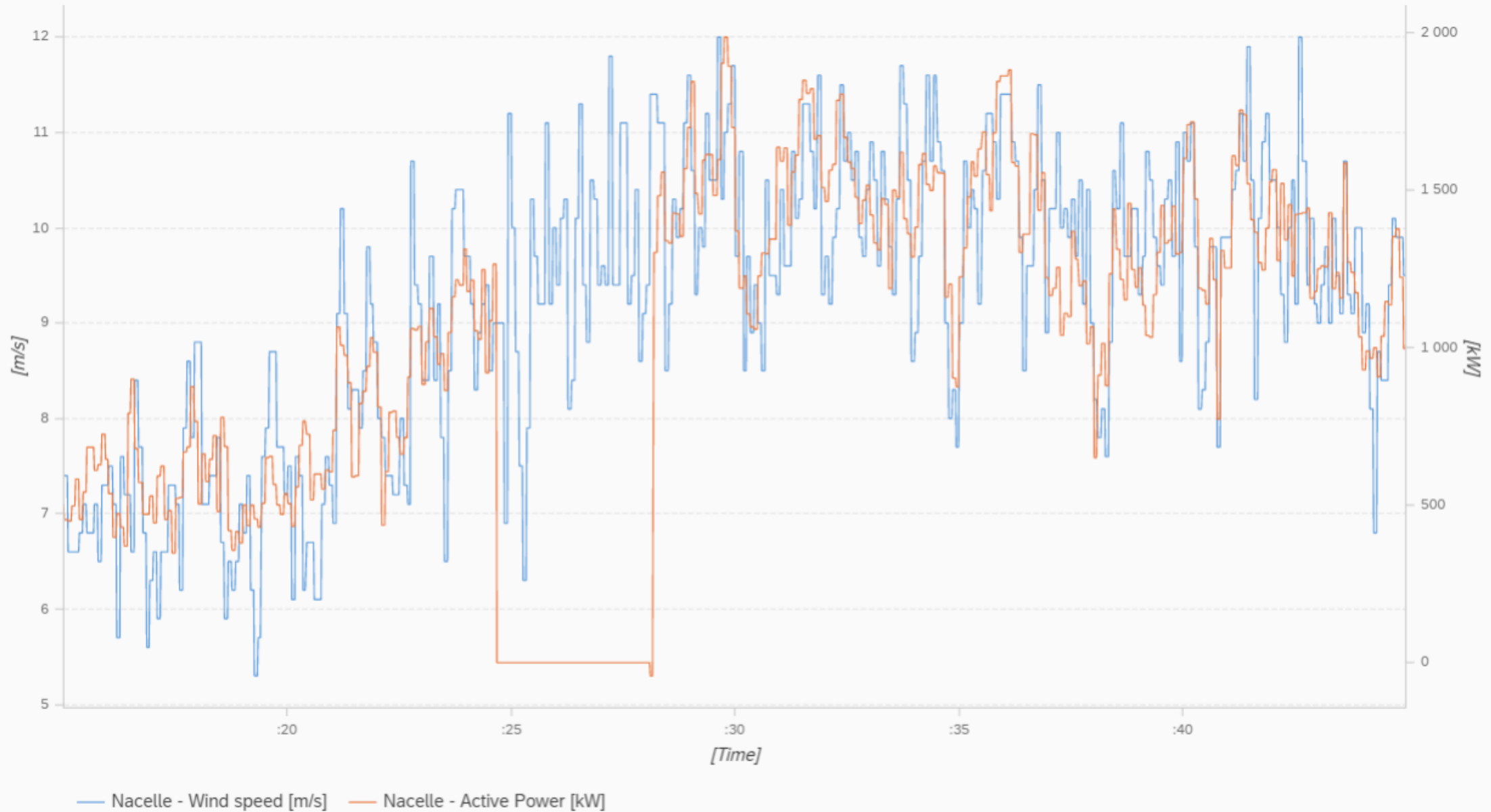
Map view

Satellite

Traffic conditions

Public transport



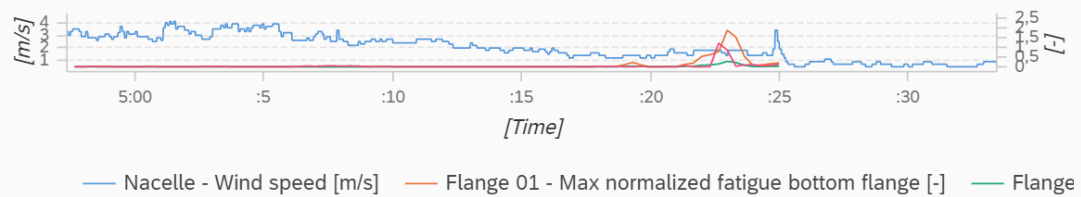


Turbine47 Statkraft Test, Smola (Norway)

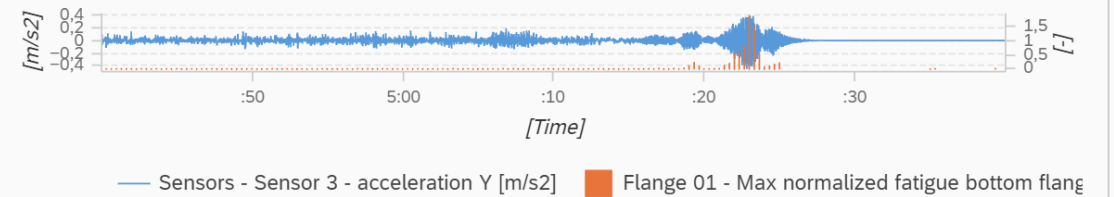
Current status (UC1) Prod wrt norm prod (UC2) Prod wrt norm prod (UC2) **Fatigue events (UC3) - Start&Stop** Fatigue events (UC3) - Start&Stop Drive train diagnostics (UC4)



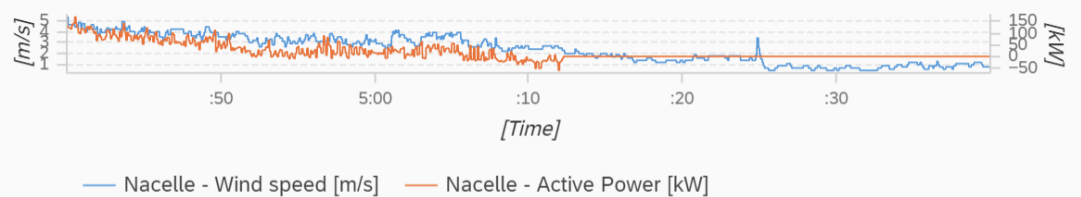
Max normalized fatigue bottom flange



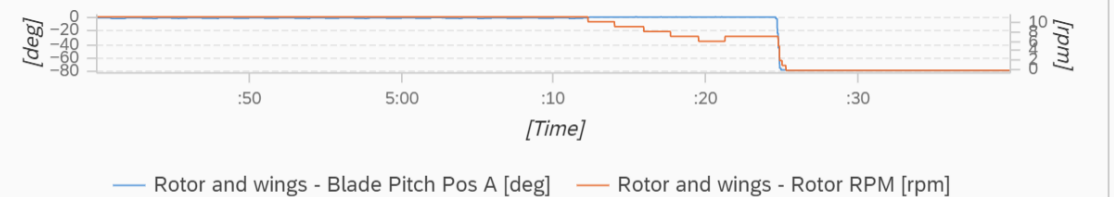
Sensor 3 - accelerations



Active Power



Blade Pitch and RPM



SAP

Situation Replay

Søk

Alerts (200)

Equipment	Alert	Date
Turbine47	Structural High structural load	for 1 måned siden
Component: Flange 01		
Severity: High		
Status: New		
Turbine47	Structural High structural load	for 1 måned siden
Component: Flange 01		
Severity: High		
Status: New		
Turbine47	Structural High structural load	for 1 måned siden
Component: Flange 01		
Severity: High		
Status: New		

High structural load

for 1 måned siden

Acknowledge

General Information

Situation Replay

Time Series

Stavå Bridge: Monitoring of structural response

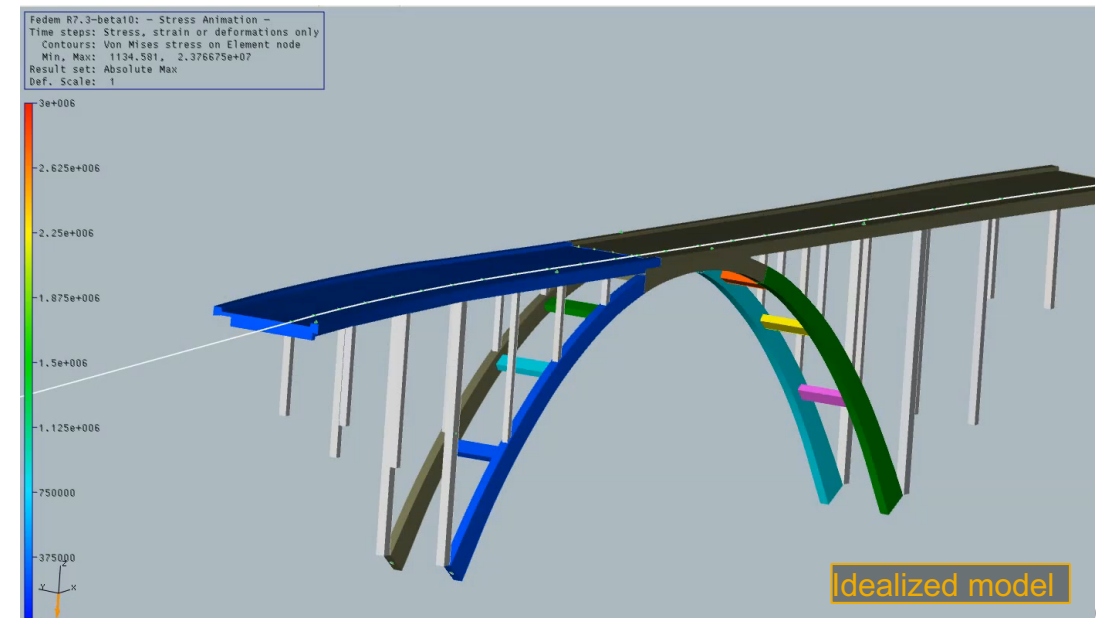
Keywords and background:

- Motivation for running a monitoring project
- Challenges: Existing structure, modelling, location, interpretation of data
- Service component more prominent (no SAP footprint)



Statens vegvesen

Stavå bridge



Description of project objectives

I januar 2018 startet SAP på eget initiativ en instrumentering av brua for å utvikle et overvåkingssystem for eksisterende bruer.

De har ved flere anledninger varslet statens vegvesen om betydelige bevegelser i brua.

Senest den i november 2018 ble det sendt varsel om en militær kolonne over brua som gav utslag på måleinstrumentene langt over forventet verdi.

Etter dette ble brua stengt for 100tonns trafikk. Dette er et betydelig inngrep for trafikken på E6 gjennom Norge.

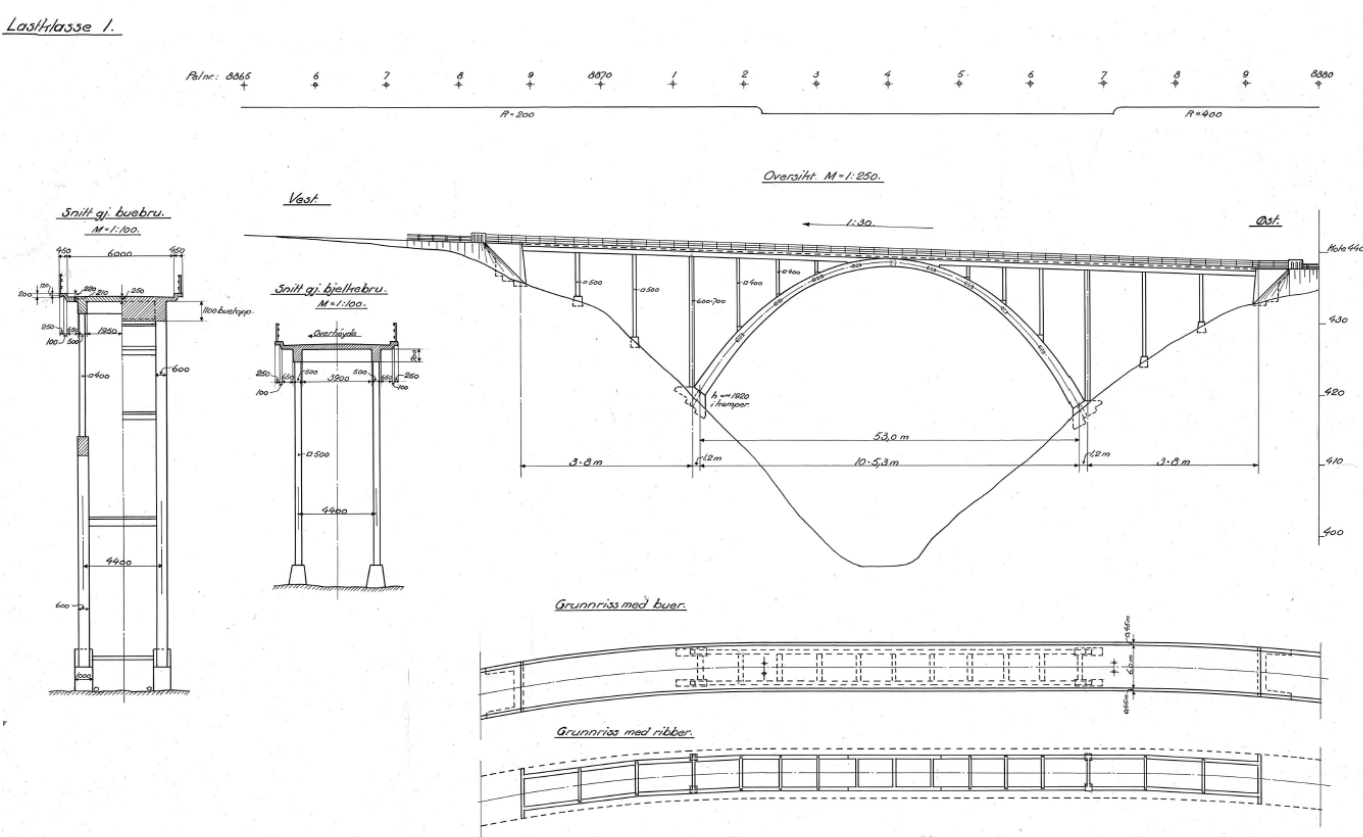
Det er derfor nå besluttet å gå videre med overvåkning av Stavåbrua med tanke på bruas tilstand, museal status og det faktum at den ligger på en viktig ferdselsåre med stor forventning til sikkerhet og bæreevne.



Statens vegvesen

Creating the model of the bridge

Loshtilasse 1.



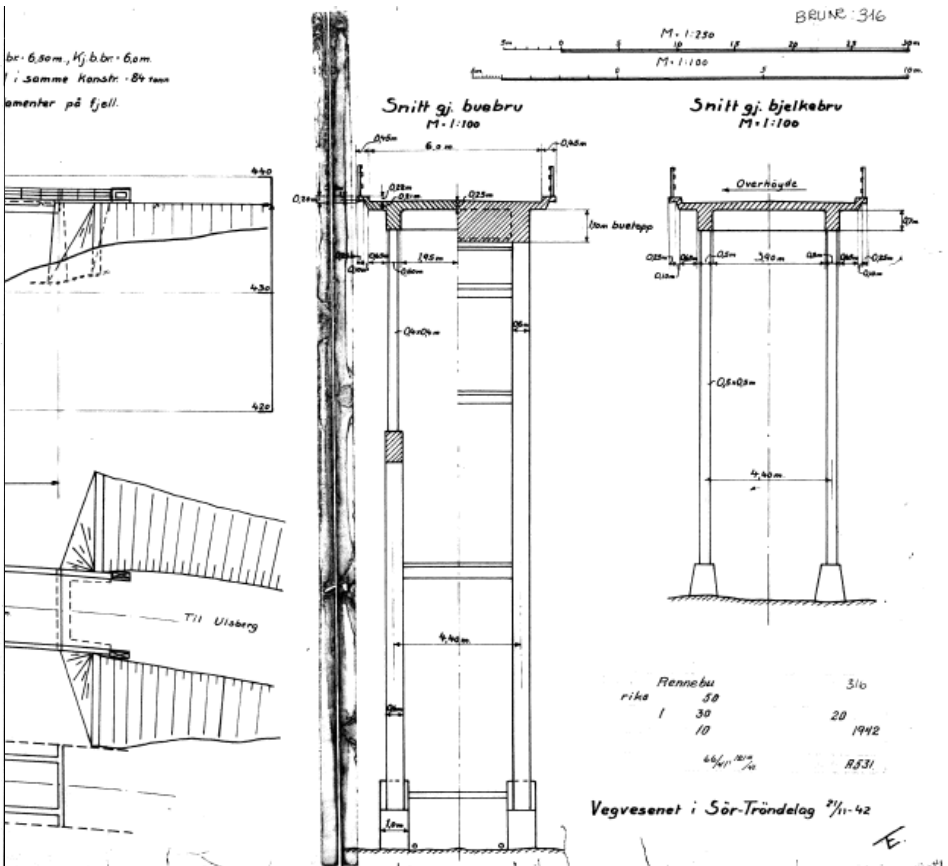
Alternativ IV.

Stavø bru.
Sør-Trøndelag fylke.

Veidirektoratet
Oslo, den 1. april 1941.

R. Dreier
for rådgivningen

M	1:250	10
1:100	2.5	—
1:50	5.0	—
1:20	10.0	—
1:10	20.0	—
1:5	100.0	—
1:2	200.0	—
1:1	400.0	—



Modelling challenges



Modelling challenges

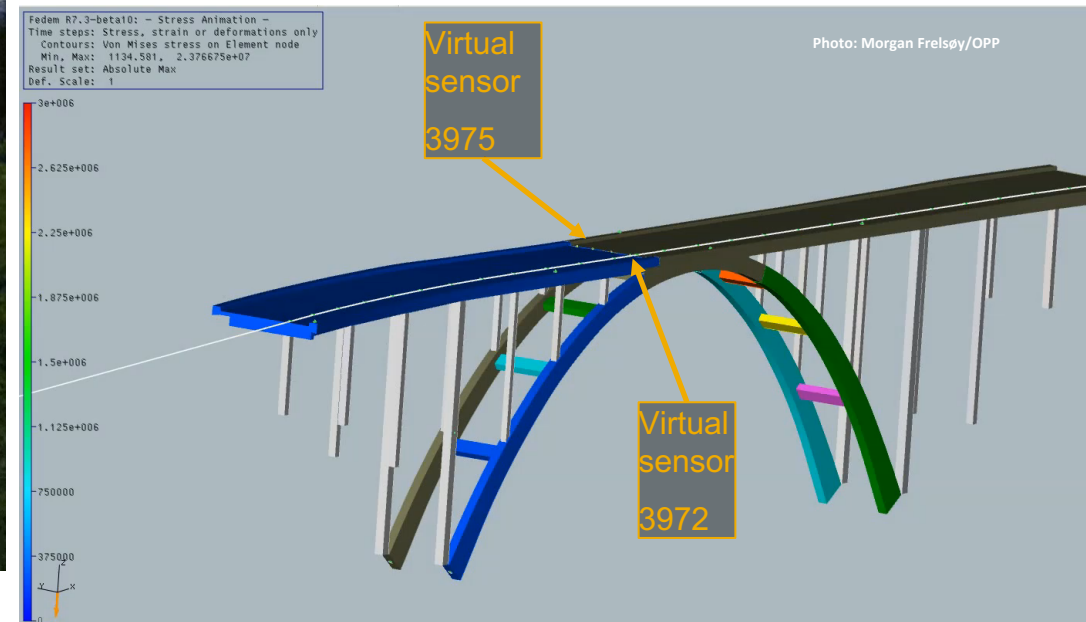
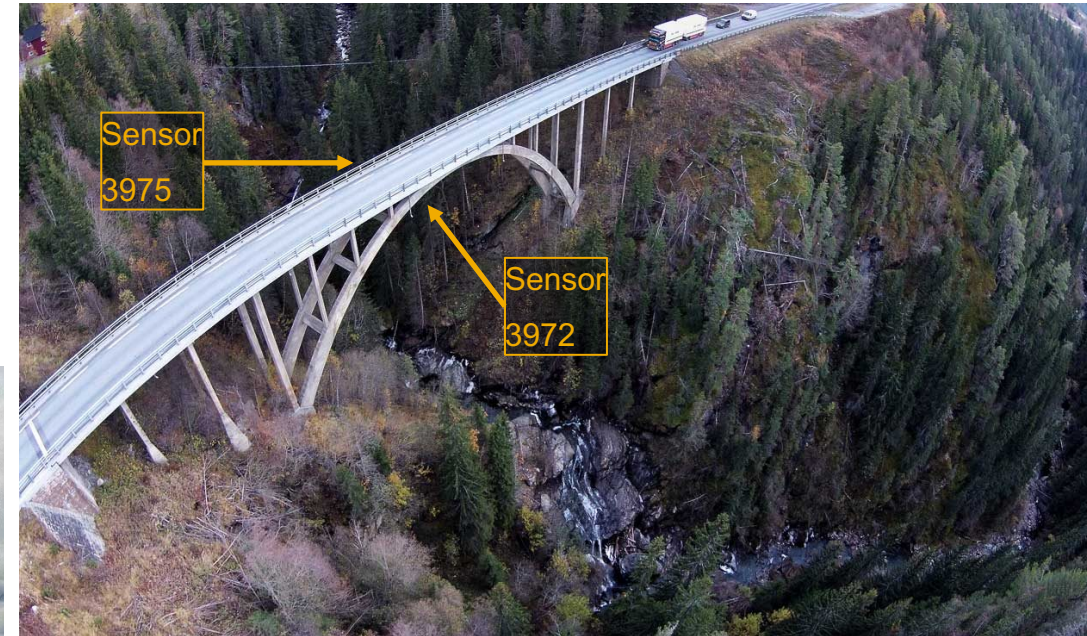


Modelling challenges

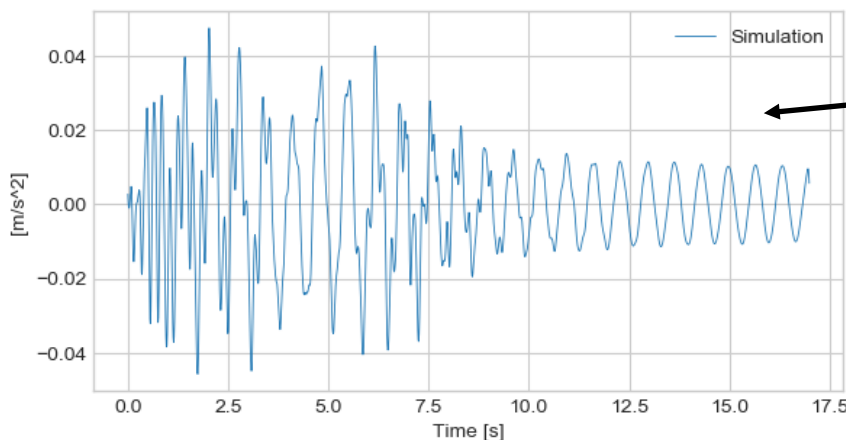
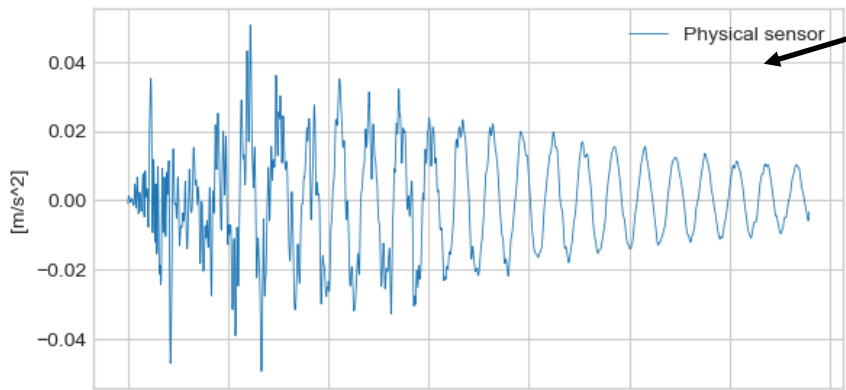


Tuning the model (from ideal to actual)

- Cooperation with ASKO
- Geofencing: Push-message with weight and timestamp for ASKO vessel passing Stavå



Tuning the model (from ideal to actual)



Recapture
physical sensor
behaviour

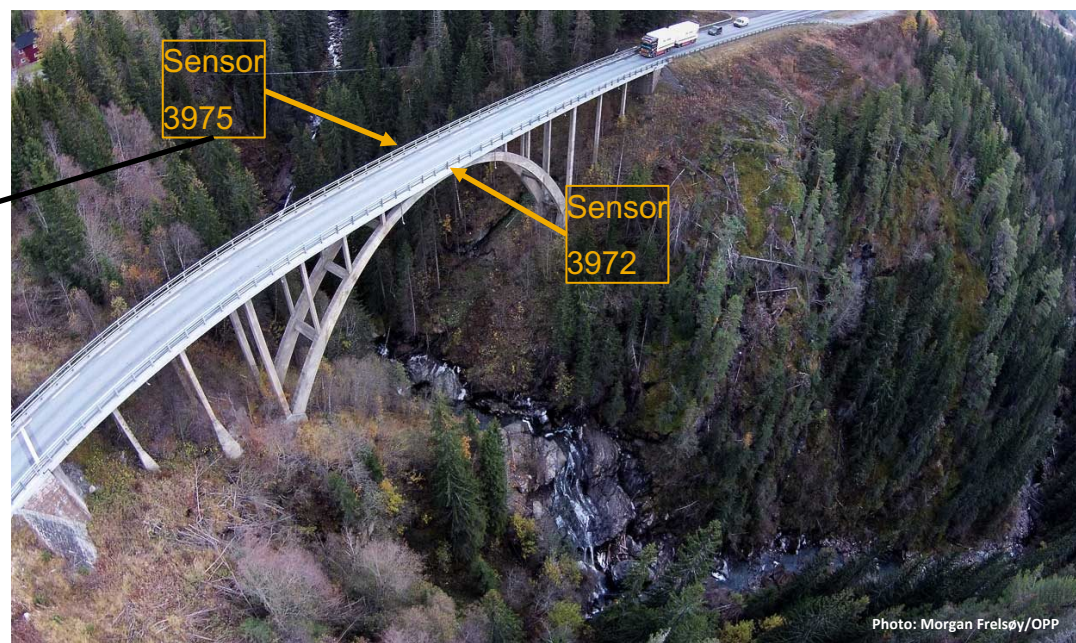
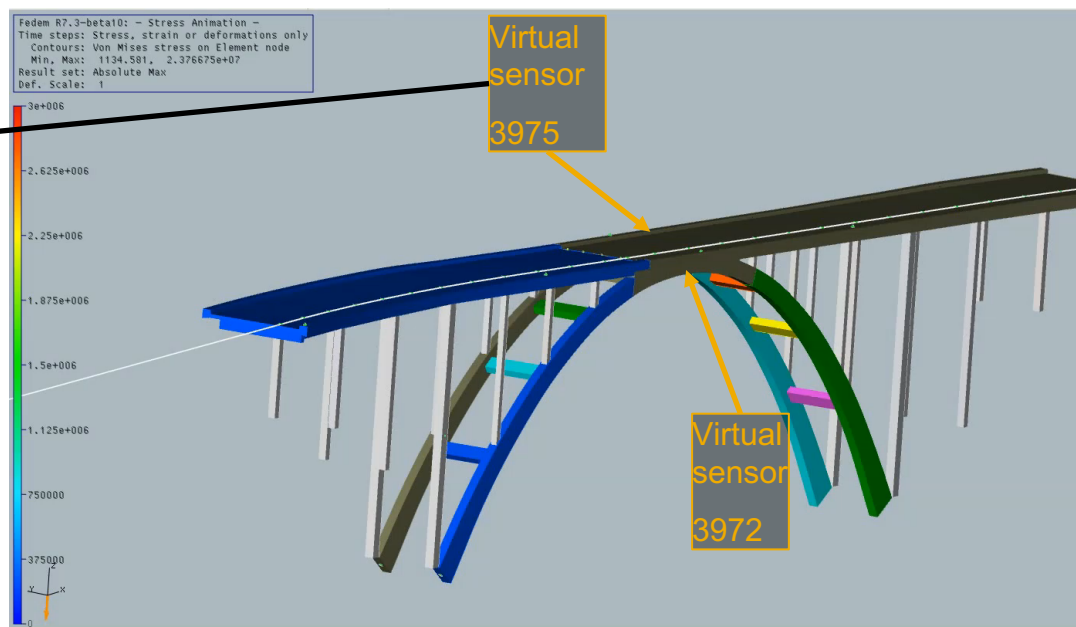


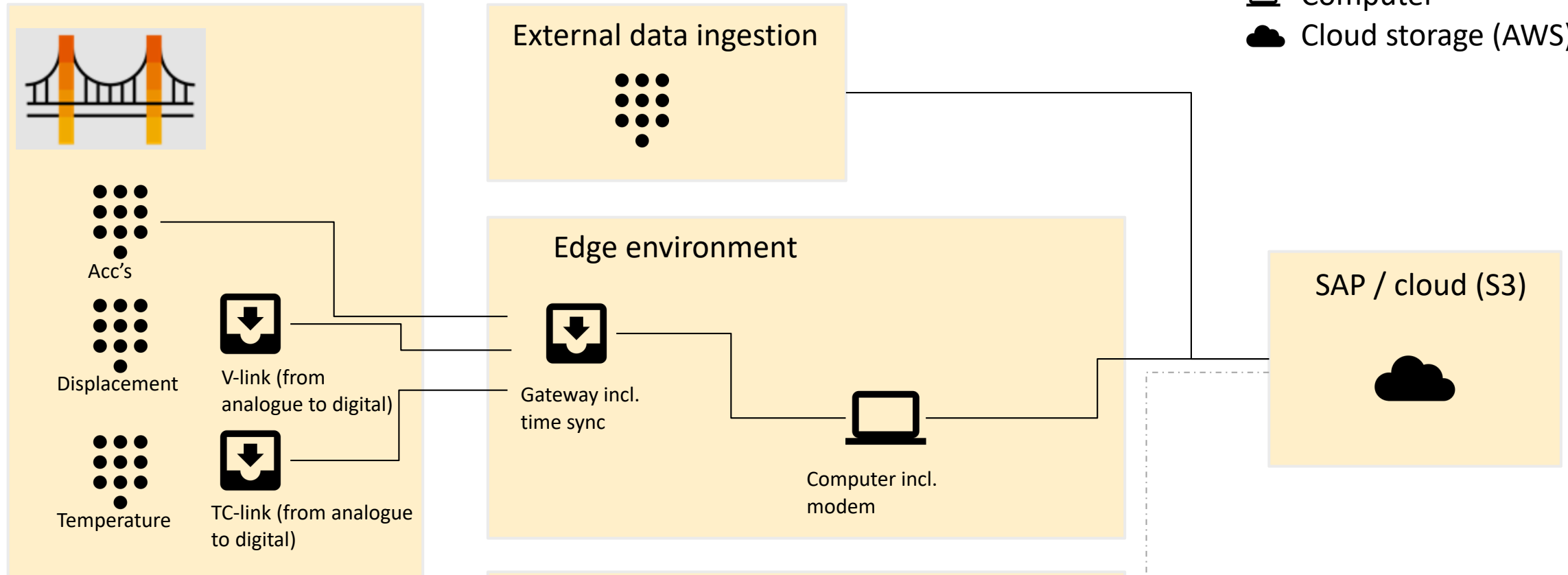
Photo: Morgan Frelssy/OPP



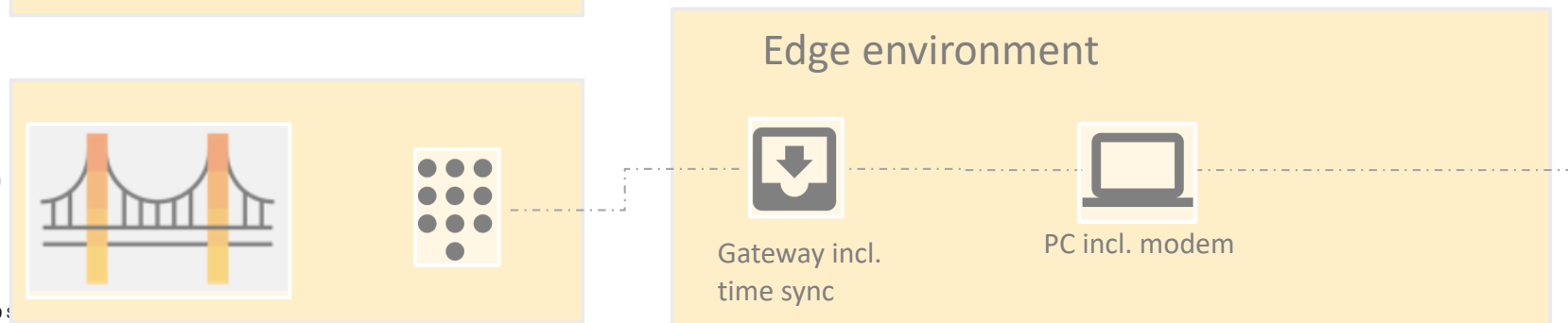
System architecture

-  Sensors
-  Collector hardware
-  Computer
-  Cloud storage (AWS)

Bridge 1



Future bridges



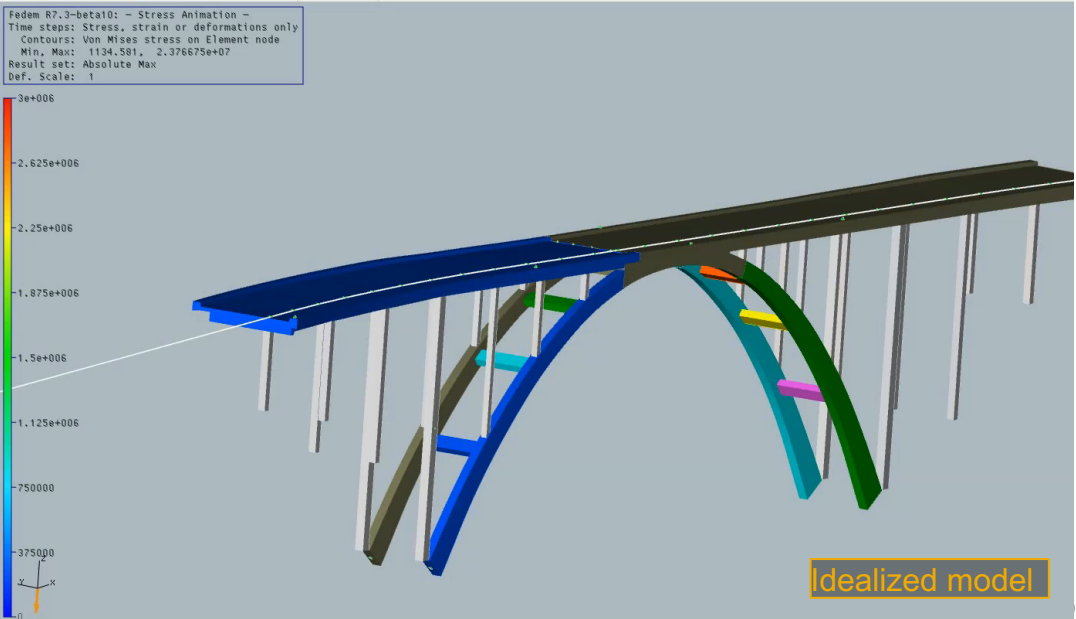
Outcome, value adding features

Actual and WiP

- **Online monitoring vs. campaigns**
 - All events – all the time
 - Onset of change
 - Trending (incl corrections for seasonal variations)
- **Signal processing vs model based approaches**
 - Quantification of responses, identification of root causes
 - Augment the “basic” CM solutions; move to the next level of insight, introduce the “what-if” and the “how”
 - What-if simulations both for the structure and for load cases
 - Simulate failure modes for fingerprinting (ML training)



Global structural deterioration



Tracking vehicles passing, as it happens (here east side, middle of bridge)

Light green lower ASUM threshold

Ignoring ASUM < 0.5, eliminating all low-load events

Green (baseline) ASUM-JI

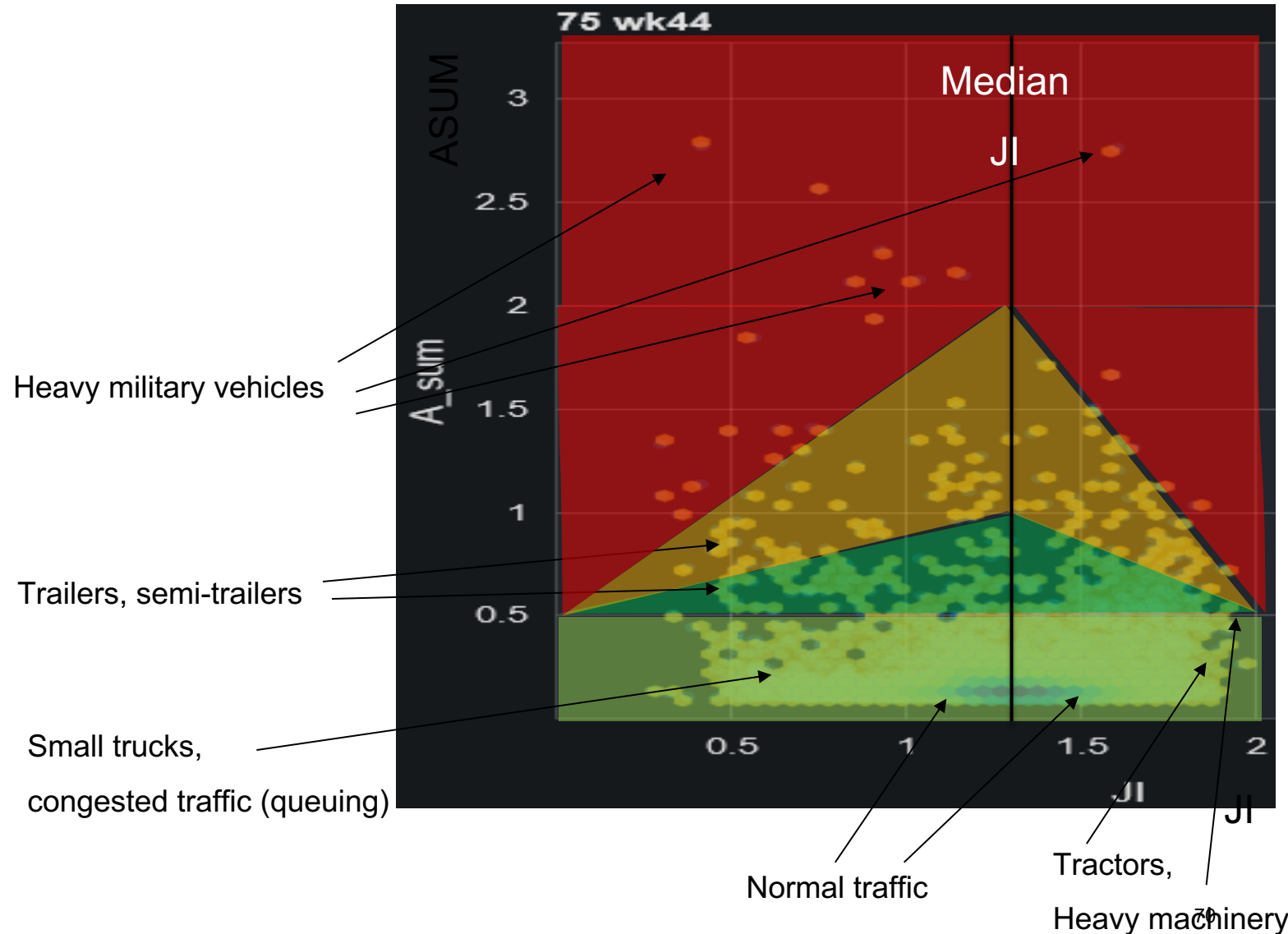
Triangle bounded by (0,0.5), (1.3,1), (2,0.5),
Regular traffic, nothing noteworthy

Orange (warning) (E-04)

Apex in triangle at (1.3, 2), rare events, heavy loads, strange structural behavior

Red (alerts)

All events outside orange and green, all above ASUM 2, heavy loads with unexpected response patterns



Take-home messages

- Digital Twin / SAP PEI implementations are getting mature
- Predictive Maintenance solutions as part of SAP IAM portfolio are being delivered from SAP Norway today
- Data logistics from edge to corporate systems and to cloud are supported by SAP / CoE as part of the implementation project
- You **don't** need equipment models to start implementing digital twins (but it helps)



Agenda

Introduction

Intelligent Enterprise

Intelligent Asset Management

Use Case – Predictive Engineering Insights

Close

Thank you.

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