SAP Enterprise Asset Management
Solution Overview and Strategy in a Nutshell

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SAP Enterprise Asset Management (SAP EAM) solution
Trends in asset management

- ISO 55001, ISO 14001, ISO 45001, and the like
- Optimizing cost, risk, and performance
- Balancing OPEX with CAPEX
- Meeting stakeholder expectations
- Empowering practitioners
- Facilitating collaboration among EPCs, OEMs, service providers, and operators

Business challenges

Technology enablers

- Internet of Things (IoT) to scale connectivity
- Big Data for getting insight from IT and OT
- Analytics for prediction and simulation
- Machine learning to improve business decisions
- Enterprise mobility to empower employees
- Cloud for collaboration
SAP Enterprise Asset Management
Asset management in an ever-more-connected world

Connecting corporate objectives with the asset system

Cost
Risk
Performance

Business needs analysis → Plan and design → Acquisition and commission → Operation and maintenance → Configuration and change management → Decommission and disposal

Connecting all stakeholders alongside the asset lifecycle

Manufacturer → Supplier → EPC

Connecting IT with OT

IT → OT

Service provider
Owner or operator
Dealer

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www.sap.com/eam
# SAP Enterprise Asset Management

Supporting asset management processes from end to end

<table>
<thead>
<tr>
<th>Portfolio and project management</th>
<th>Asset operations and maintenance</th>
<th>Environment, health, and safety</th>
<th>Asset network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea management</td>
<td>Asset strategy and performance</td>
<td>Incident management</td>
<td>Asset information collaboration</td>
</tr>
<tr>
<td>Portfolio management</td>
<td>Maintenance planning and scheduling</td>
<td>Health and safety management</td>
<td>Asset information governance</td>
</tr>
<tr>
<td>Project management</td>
<td>Maintenance execution</td>
<td>Environment management</td>
<td>Predictive maintenance and service</td>
</tr>
<tr>
<td>Resource management</td>
<td>Mobile asset management</td>
<td>Management of change</td>
<td>Maintenance safety and permit to work</td>
</tr>
<tr>
<td>Project connectivity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bimodal IT according to Gartner
Systems of record versus systems of innovation

Mode 2
- SAP Leonardo
- Systems of innovation

Mode 1
- SAP Integrated Business Planning
- Systems of differentiation
- SAP S/4HANA
- Systems of record

Source: Gartner
Envisioned logical architecture for SAP Enterprise Asset Management

Strategic direction

SAP Digital Boardroom

Business intelligence

Mode 1

- SAP Integrated Business Planning
- SAP Ariba solutions
- SAP Fieldglass solutions
- SAP SuccessFactors solutions

SAP S/4HANA

- Master data
- PM
- EH&S
- CO
- PS
- MRS
- FI
- MM
- PLM
- ... Digital core

SAP Leonardo

Mode 2

Internet of Things

- SAP Asset Intelligence Network
- SAP Asset Strategy and Performance Management
- Mobile
- SAP Leonardo IoT Foundation
- STO
- ... Differentiate businesses

- Intelligently connect people, things, and businesses

Run businesses

- Hyperautomate business processes

Embrace data

- Orchestrated data of any volume, velocity, and variety

Steer businesses

- Deliver insights to drive strategic decisions

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SAP Predictive Maintenance and Service
From sensor to insight to outcome

**Sensor**
Connected assets
- Onboarding
- Connectivity
- Device management
- Security

**Data**
IT/OT convergence
- Big Data ingestion
- Big Data infrastructure
- Merging sensor data with business information

**Insight**
Data analysis
- Root cause analysis
- Asset health monitoring
- Machine learning
- Anomaly detection
- Triggering of corrective actions

**Action**
Maintenance activities
- Prioritized maintenance and service activities
- Optimized warranty and spare parts management
- Prescriptive maintenance
- Quality improvements

**Outcome**
Business value
- Customer experience
- Increased quality
- Lower costs
- Operational efficiency
- R&D effectiveness
- Material procurement

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SAP Predictive Maintenance and Service
How can information systems help?

Remote monitoring
Agile planning
Alerts and actions

SAP Leonardo IoT capabilities

Engineering rules
Life indicators
Distance scoring
Anomaly detection
...

Connected assets and sensors
OT systems (such as SCADA)
Other data sources (such as weather)
Digital core (SAP S/4HANA)
SAP Predictive Maintenance and Service
Solution components and value drivers

- Availability through the cloud or on premise
- Flexible extension concept to build industry- or customer-specific models and analytics
- Scalable machine learning engine that drives data science insights into our business processes
- Flexible visualizations across equipment structures
- Comprehensive process integration: alert, discover, remedy
Condition data allows for a ranking of assets according to a health score.

For “healthier” assets, the service interval can be prolonged, while it can be shortened for others.

This results in fewer failures and lower maintenance costs.
SAP Asset Strategy and Performance Management (planned)
End-to-end process enablement

Benefits
- Increase overall asset availability
- Increase MTBF – increase equipment reliability
- Improve utilization of assets
- Control maintenance spend
- Reduce work backlog
- Identify savings opportunities through preventive and predictive maintenance
- Reduce capital tied up in spare parts inventory
- Adopt a proactive and targeted maintenance strategy
- Change the sequence of the process using point apps

Solution integration points
- SAP Asset Intelligence Network
- SAP Predictive Maintenance and Service
- SAP ERP application or SAP S/4HANA (PM, MM, FI/CO, PP functionalities)
- SAP Integrated Business Planning

Process innovation

MTBF – mean time between failures; FMEA – failure mode and effects analysis; RCM – reliability-centered maintenance; RCA – root cause analysis

This is the current state of planning and may be changed by SAP at any time.
What does digital transformation mean for enterprise asset management?

Connect to the asset
- Bring together information from operational and business systems (IT/OT convergence)
- Utilize the IoT for scaling transparency without neglecting existing information sources

Predict asset system behavior
- Avoid unplanned downtime and major operational consequences through simulation and prediction
- Discover patterns of failure and preserve operational integrity
- Blend business IT information with operational (OT) data

Share asset information and collaborate
- Activate the ecosystem of OEMs, EPCs, service providers, and operators
- Make sure there is one version of truth on asset master data
- Use a business network to enable integrated processes in the cloud

Digital transformation in asset management driven by IoT, cloud, and business networks
SAP solutions for the asset management line of business

Where to find more information about our road map and innovation

Road maps:  
http://www.sap.com/roadmaps

Value maps:  
http://www.sap.com/solutionexplorer

Innovation discovery:  
http://sapsupport.info/support-innovations/innovation-discovery/
Thank you.

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www.sap.com/roadmaps
www.sap.com/solutionexplorer
http://scn.sap.com/community/eam
Building the Smart Railroad

SAP Leonardo Live event

Jeroen De Roeck
### Key Figures Asset Management

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>10.176 Main Signals</td>
<td>(31/12/2016)</td>
</tr>
<tr>
<td>6.511 km of Main Track</td>
<td>(31/12/2016)</td>
</tr>
<tr>
<td>7000+ Employees</td>
<td>(31/12/2016)</td>
</tr>
<tr>
<td>SAP objects</td>
<td></td>
</tr>
<tr>
<td>&gt;500.000 Functional locations</td>
<td></td>
</tr>
<tr>
<td>&gt;2.000.000 Pieces of equipment</td>
<td></td>
</tr>
<tr>
<td>1.751 Level Crossings</td>
<td>(31/12/2016)</td>
</tr>
<tr>
<td>5.905 km Overhead lines</td>
<td>(31/12/2016)</td>
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<tr>
<td>11.769 Civil Engineering Constructions</td>
<td>(31/12/2016)</td>
</tr>
<tr>
<td>Spare Parts</td>
<td>270 M€</td>
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</table>
“STUPID Assets”
NOT CONNECTED

“SMART Assets”
CONNECTED

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“STUPID Assets”
NOT CONNECTED

Sensors & Measure Trains

“SMART Assets”
CONNECTED

Sensors & Intranet of Things

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Digital Strategy

Preventive maintenance plans

Preventive/Condition/Predictive-based maintenance

Incidents

SAP

Technicians & TABLETS

ASSET DATA

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Infrabel Movie

Now we have smart assets

Switch sensor

Level crossing sensor

Light signal sensor

Measure train

Shelter sensor
First steps in IOT – the PQUBE case

EBP logbook

Current Curves (1.000.000)
100 Turnouts

SAP Enterprise Asset Management (SAP EAM)

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Turnouts are more or less a blackbox. Information currently available from distance:
- Left or right
- In/out control

Placing the Pqube sensor should increase the:
- Visibility on the functioning of a turnout
- Provide Data to examine behaviour
Data analytics – from measurement to data

Going from individual measurements to current curves

- Plot measurement values in time
- Business value:
  - Current curves
  - A correct image of the physical functioning of a turnout
Data analytics – What we learned

- Each turnout has its own curve that evolves during time
  - Each type of turnout has a typical curve
  - It defines the ‘DNA’ of the turnout
Determine algorithms to define ‘normal’ behaviour

Each unique turnout has its own characteristic evolution of the curve:
- Difference for left or right movements
- Variation in current due to changes in mechanical properties
Determine algorithms to define ‘abnormal’ behaviour

- Abnormal current consumption
- Longer runtimes
- Larger deviations = malfunction
- Specific patterns ie. Bad alignment worm wheel
Normalisation

- Flatten out differences in timestamp between different systems
- Only keep reliable measurements

Data analytics – Define Models
Building a predictive model

- Each movement gets a calculated number

<table>
<thead>
<tr>
<th>Number</th>
<th>Anomaly</th>
<th>Category</th>
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<tbody>
<tr>
<td>0.9762</td>
<td>normal</td>
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</tr>
<tr>
<td>7.84222</td>
<td>failing</td>
<td>F26</td>
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<tr>
<td>0.96101</td>
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<tr>
<td>12.7684</td>
<td>failed</td>
<td>f30</td>
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<td>12.5305</td>
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<tr>
<td>12.4308</td>
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<tr>
<td>0.74115</td>
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</tr>
</tbody>
</table>
Building a predictive model

- Each movement gets a calculated number

- Normal curve = 1
- Early warning > 1,4
  - Includes false positives
- Warning >= 2
  - No false positives
- Failing >= 3,8
- Failed >= 11,9
Data analytics – Introduce AI technology
Data analytics – Introduce AI technology

Unsupervised learning
Dimensionality reduction using neural networks

Normal data
Over Current

Pqube Project – Business value

- **Increase installed base**: install Pqube on critical turnouts.
- **Avoid unnecessary activity** in the field
- **Better planning and preparation** based on indications from predictive model
- **Reduction of unplanned downtime** by early warning
  - Number of false positives to be managed
  - **Prevent extended maintenance downtime** due to unforeseen activities
Starting from traditional Preventive Maintenance Strategy

- Low Risk
- High Cost

- Adapt preventive Maintenance strategy
  - Cost of visits ↓
  - Risk ↑

- Use Predictive model to lower the Risk

- Total cost of Predictive Model + Lower Maintenance strategy < Traditional Preventive Maintenance
  - New balance between cost and risk
Next steps in making assets ‘smart’

Increasing the business value

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Turnout Measurement system</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Turnout Video Inspection system</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TVS Track Video System</strong></td>
<td></td>
<td>DB 500 Gb/year</td>
</tr>
<tr>
<td><strong>SGS Switch Geometry System</strong></td>
<td>Video 100 Tb/year</td>
<td></td>
</tr>
</tbody>
</table>

Linear assets:

- Turning Measurement system
- Turnout Video Inspection system
- TVS Track Video System
- SGS Switch Geometry System

DB 500 Gb/year
Video 100 Tb/year

100 Tb/year
First steps in IoT – What we learned

Pqube case enabled us to:
• Learn and understand possibilities of IoT @ Infrabel
  • In the beginning: a lot of manual work involved
• Unsupervised learning had the same result much faster
• Looking for additional IoT opportunities:
  • Monitoring Control Unit
  • Enhance ‘old’ equipment with nonintrusive new technology
Next steps in IoT – Monitoring Control Unit

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MCU:
• Remote measurement/monitoring of:
  • Batteries
  • Current rectifier
  • Active alerts

• Configuration parameters managed remotely

• Business Value:
  • Fewer physical visits necessary.
    • Visit takes 3,5 hours incl travel * 750 installations = 2625 hours saved
  • Active control of parameters, limit human errors
  • Early warning on battery issues
Next steps in IoT – LED’s tele-monitoring in RTF boxes using Computer Vision
Next steps in IoT – Asset classification with Computer Vision

State-of-the-art research and development at Infrabel
Asset Management information flow

- Measurement Data
- Asset owner (expert) + data scientist
- Reports
- Measurement database
- Model
- Incident
- Intervention
- Malfunction
- Verified measurement results
- Predictive notifications
- SAP EAM
  - Assets checked by Measurement trains
  - Assets to be maintained
- Technician
- Less manual work
- Asset owner (expert) + data scientist
- Measurement database
- Model
- Incident
- Intervention
- Malfunction
- Verified measurement results
- Predictive notifications
- SAP EAM
  - Assets checked by Measurement trains
  - Assets to be maintained
- Technician
- Less manual work

Higher Data Quality
Live data
Asset Master data
SAP EAM

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How to digest all the data

Use of flexible reporting in SAP Lumira software

• Meaningful insight on combined data

• KPI models based on previous data analysis experience

• Tree maps and geographical visualisation to focus on the important stuff
How to digest all the data

SAP EAM with GEOe support

- Visual way of working
- Quickly identifying assets that need maintenance
- Real time follow-up
How to digest all the data

SAP EAM and Expert systems

• Visualising linked assets
• Connecting measurement information
• Display information on previous measurements
• All information available from the back-end system
How to digest all the data

Mobile SAPUI5 apps

• Consult measurement history
• Perform checklists
• Access location-based observations by maintenance crews
Separate engineering and production system

- Production used to plan and predict
- Engineering to develop predictive models and rules

Proven models to be displayed in production system

Only hot data in Production

Warm data in Engineering based on extended Storage.

POC for future architecture

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Increase step by step the maturity in IoT scenarios

How we proceed: Start Small - Think Big

- Start building models
  - Predictive models
  - Anomaly detection
  - Engineering rules
- Data filtering and alerting
- Build a business confidence level
- Automate the models with AI
- Interconnect with SAP EAM for preventive and corrective actions
- Start working on analytics and reporting part
- Set up organisations with data scientists

- Connect and centralize connected assets
- Make ‘stupid’ assets ‘smart’ with sensors
- Collect data – even if you don’t use it yet

- Interconnect different disciplines
- Centralize all data in a Big Data engineering and production environment
- Integrate useful data in mobile apps for field workers
- Work with Geo-enabled videostreams, photos
- Smart visualisation and analytics

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Key Messages

• Bring in Predictive skills (AI knowledge) to get started
• Check the economic model for placing sensors
• Quality of sensor is crucial: avoid sensor failures
• Huge change on way of working: build confidence level first
• Easy and simple solutions can work.
• Maturity can increase step by step.
Thank you