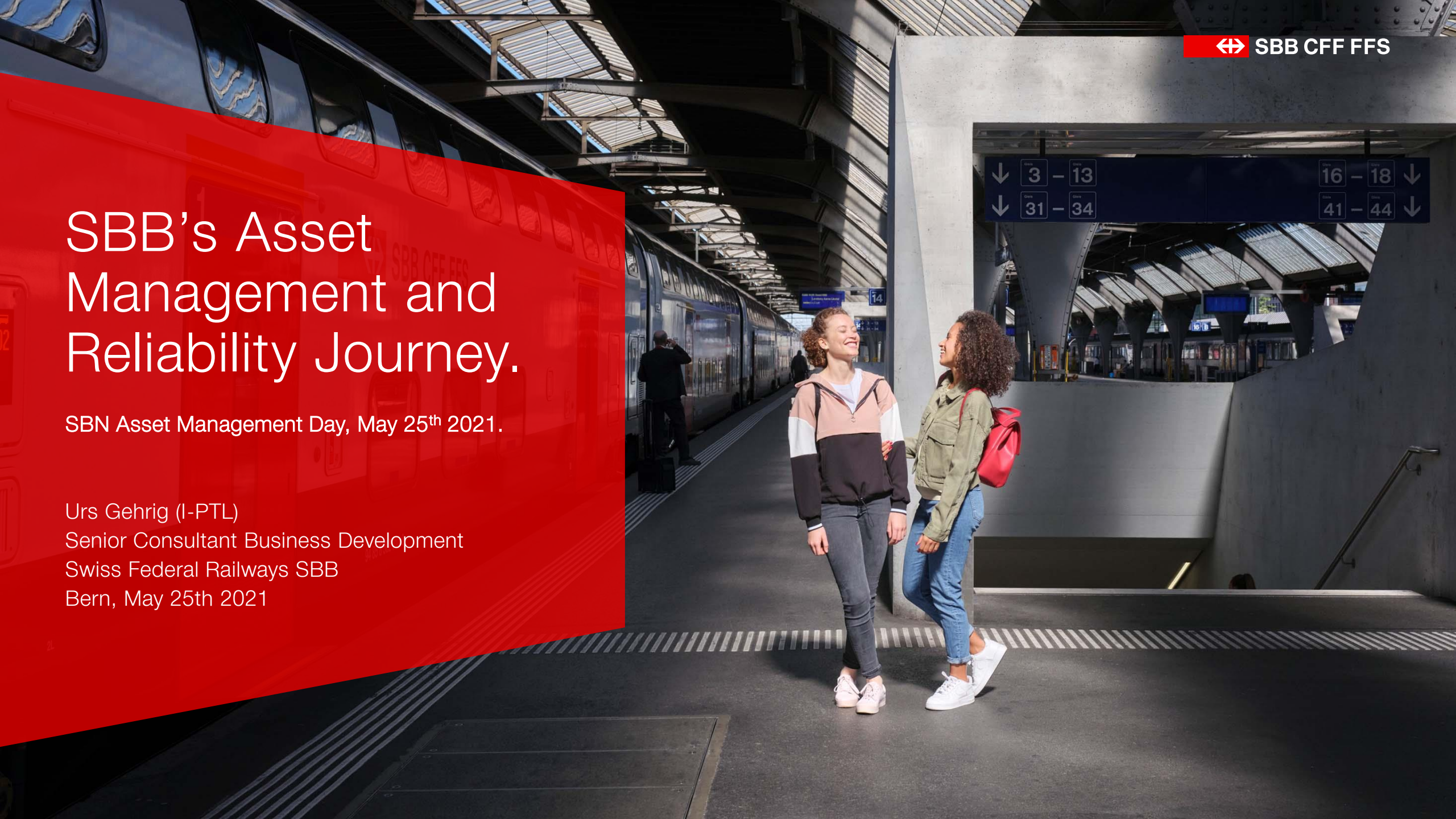


SBB's Asset Management and Reliability Journey.

SBN Asset Management Day, May 25th 2021.

Urs Gehrig (I-PTL)
Senior Consultant Business Development
Swiss Federal Railways SBB
Bern, May 25th 2021

Agenda.

Section 1: «Challenges and Requirements»
- Vision of Swiss Federal Railways (SBB)
- Challenges and strategic goals
- Initiation of an Enterprise Asset Management approach

Section 2: «Solutions and Implementation»
- Paradigm shift in the scalability of Asset Management
- Managing Maintenance on failure-mode level
- Implementation examples and use-cases using failure-data
- Different sources to rapidly build a «Common failure-data environment»

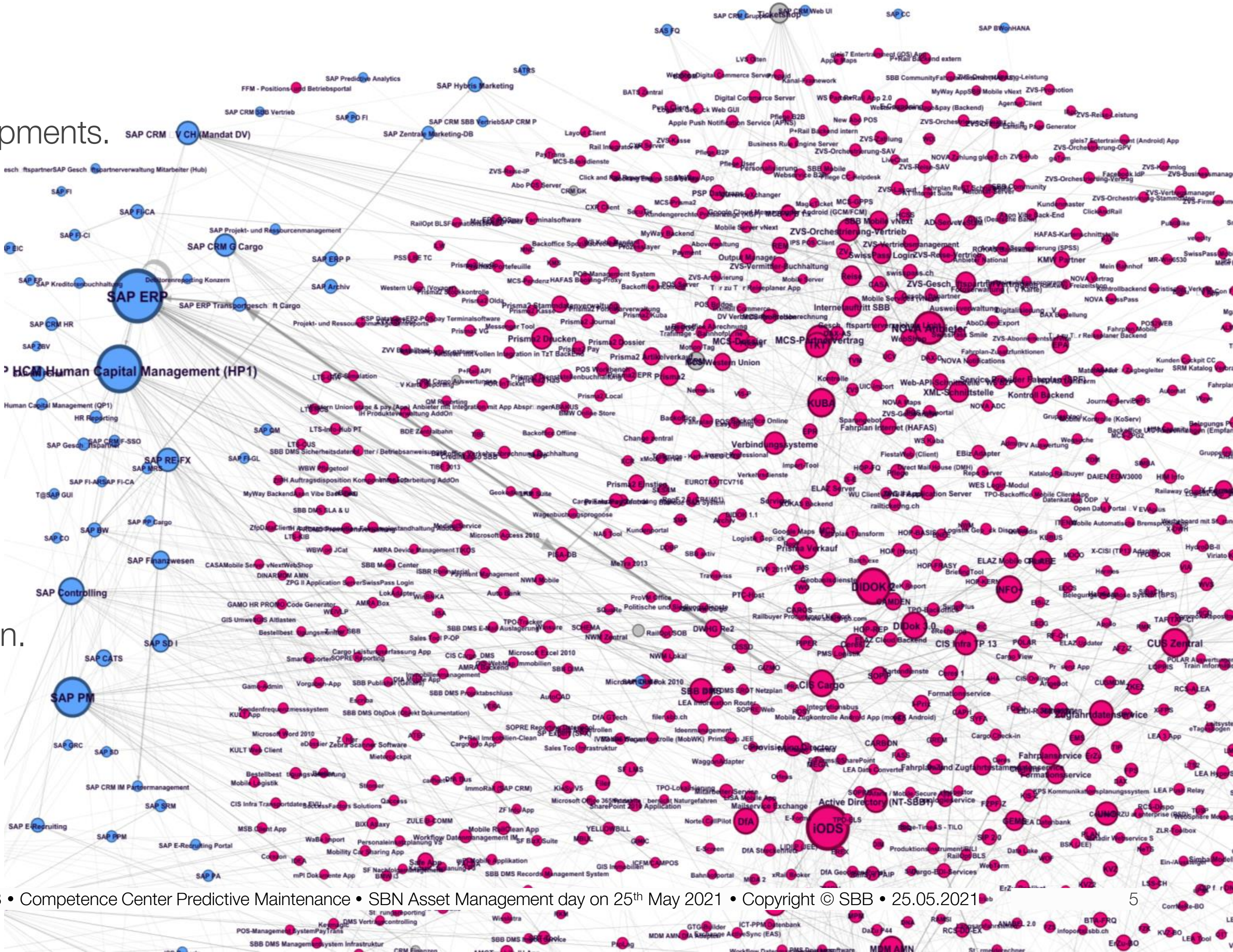
«Challenges and Requirements»

Section 1

Railway under control and shaping
the mobility of the future –
simple, personal, connected.

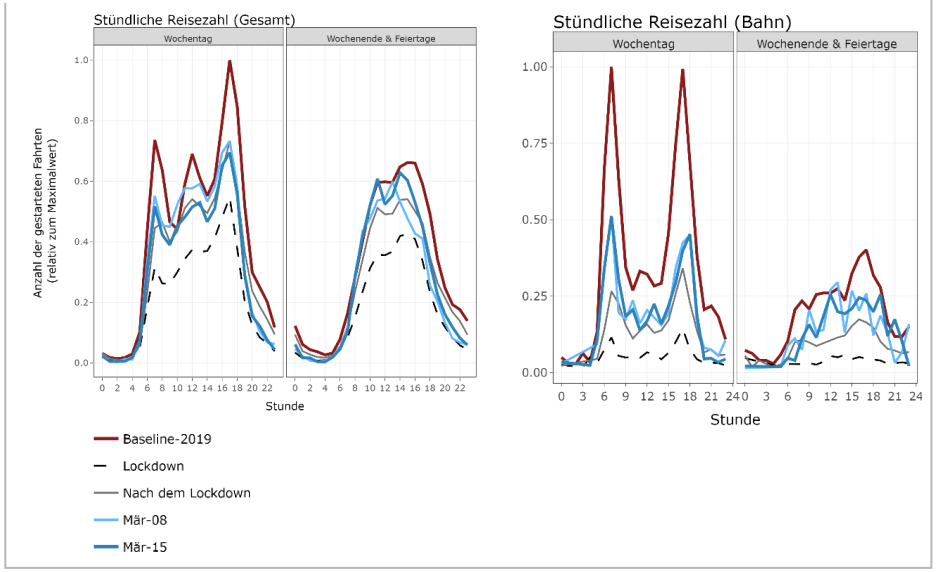
Facts and figures.

41’000 RFID-Tags on Rolling stock equipments.
34‘000 GSM mobile phones.
32’535 staff.
10’991 trains run daily.
6’000 km telecom network.
3‘236 km rail network.
2’833 application interfaces.
1‘200 applications.
564 km water network.
450 IT projects at Infra Division.
299 tunnels.
160 business projects at Infra Division.
90 percent renewable energy.
7 hydroelectric power stations.
4 networks.
3 water sources.
1.32 million passengers a day.

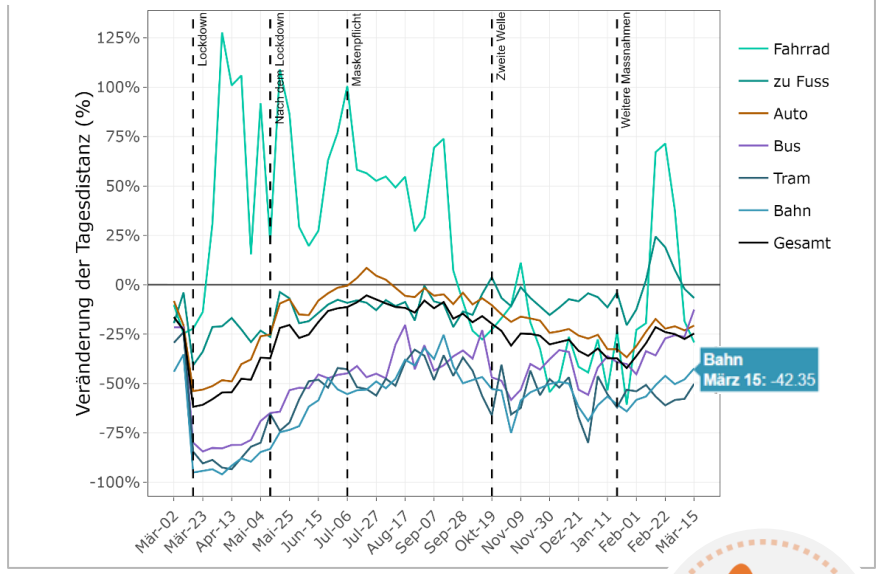


Changes in the operating context of the assets require a more dynamic adaptation of their maintenance.

Hourly trip count



Δkm travelled by mode



Research project **MOBIS / COVID-19:** Mobility behaviour in Switzerland - Coronavirus Study - For a better understanding of the impacts of the coronavirus, documented on https://ivtmobis.ethz.ch/mobis/covid19/

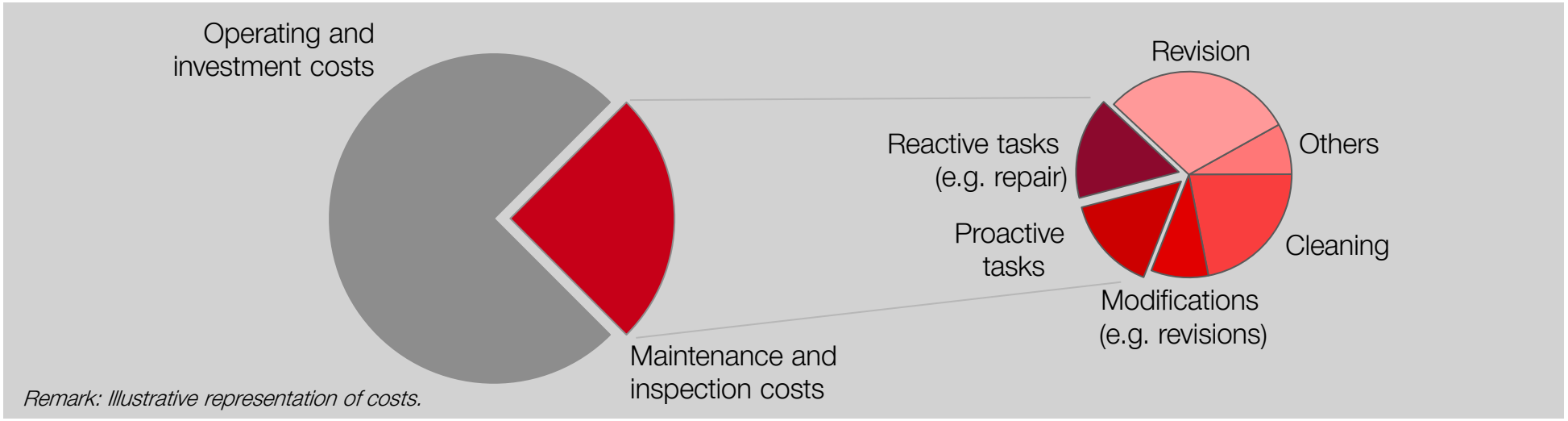
Yet this has for now and will have in the near future an impact on the **operational context** of **fixed and rotable assets** – and – on the strategies on **Asset Management** where we need to be able to manage with **fewer financial ressources**.

A standardized corporate wide asset performance and maintenance management approach supports cost control.

Targeted investments/ Innovation

Overall system costs

Earnings and Capacity utilization



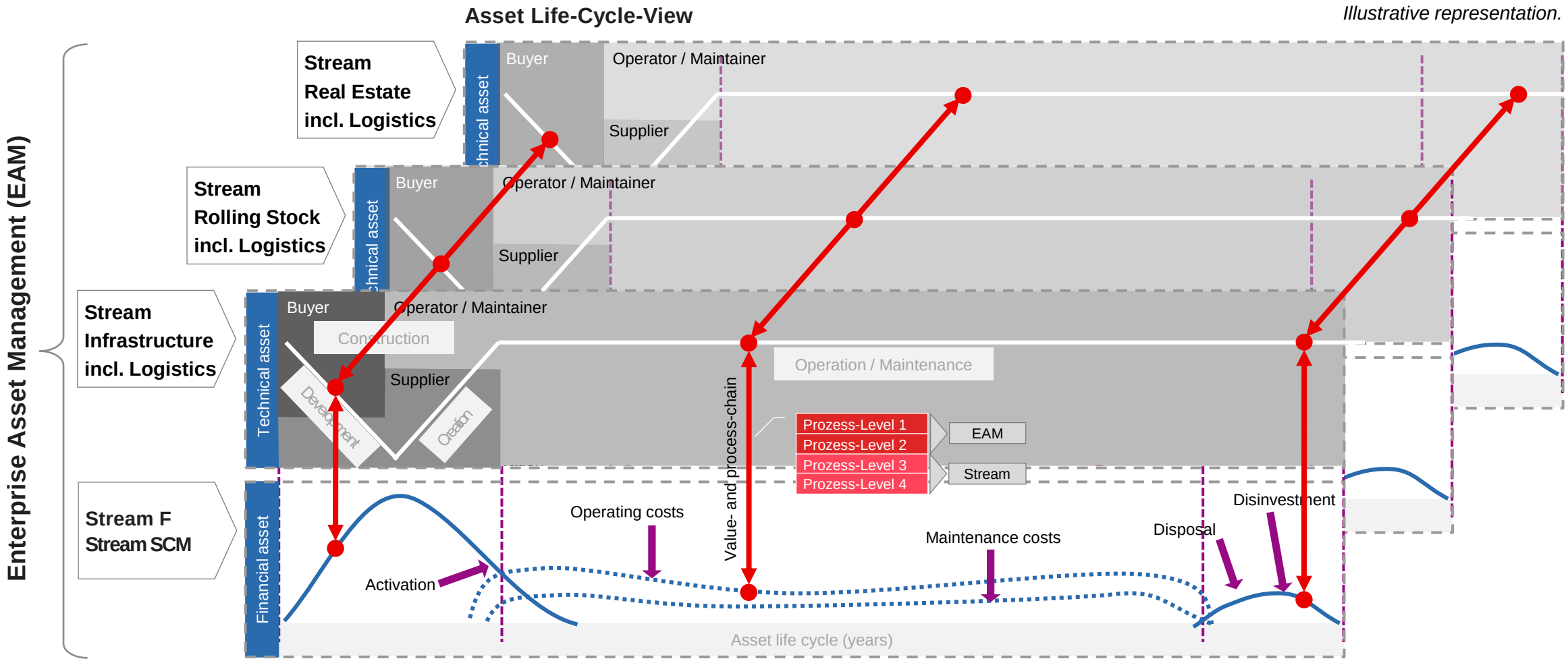
Leadership and performance culture

Initiation of an «Enterprise Asset Management» approach triggered by the SAP S/4HANA transformation.

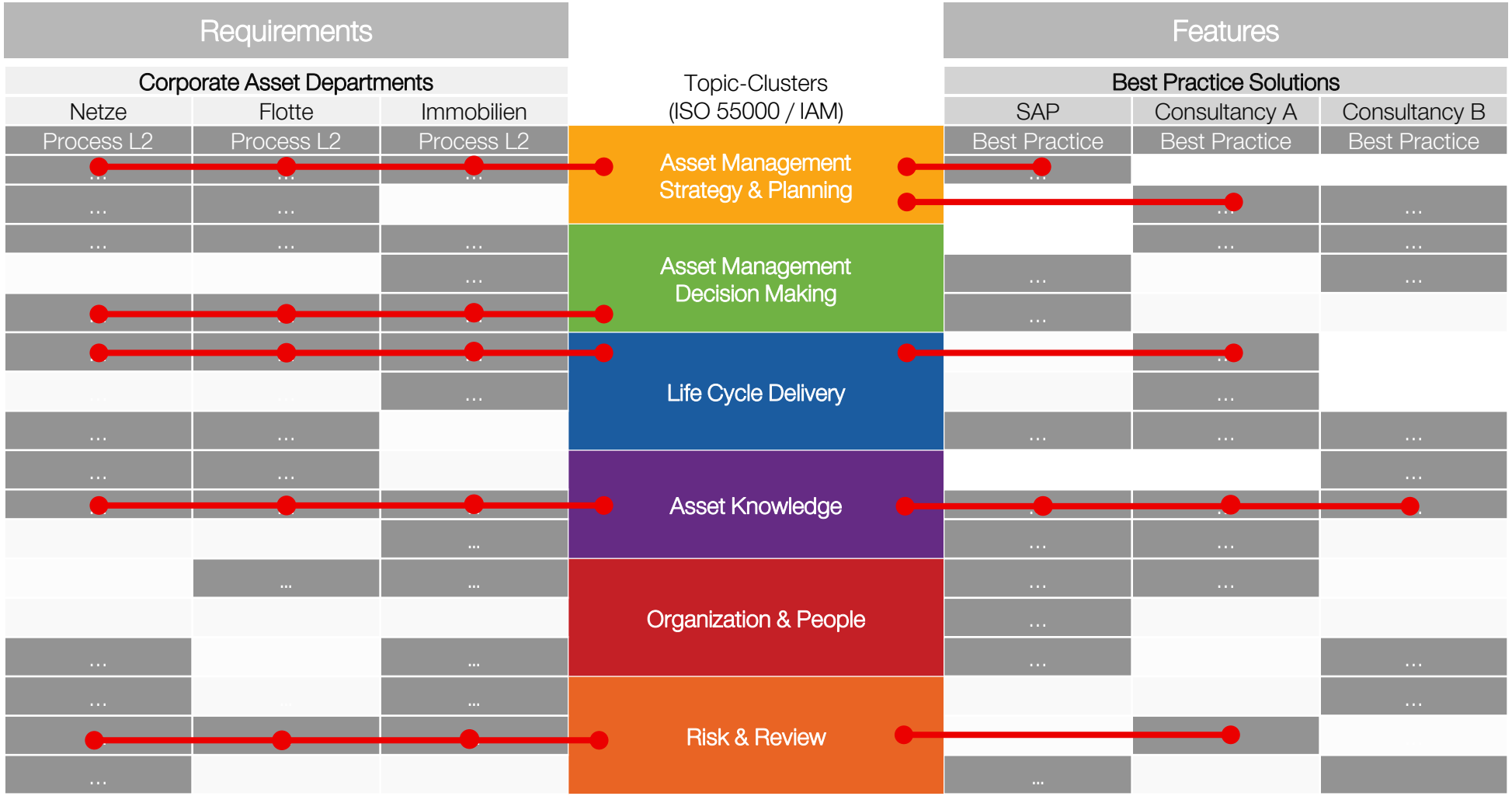
«**We create** the **foundation for a cross-divisional** asset management in order **to act** in a **fact-based** and **proactive** manner.

For this SBB-wide asset management, **we use** common **core processes** and the **standardized**, unique 'digital twin' of **all physical assets**.»

A common understanding of asset life-cycle and relevant value chains are at the heart of the Digital Transformation.

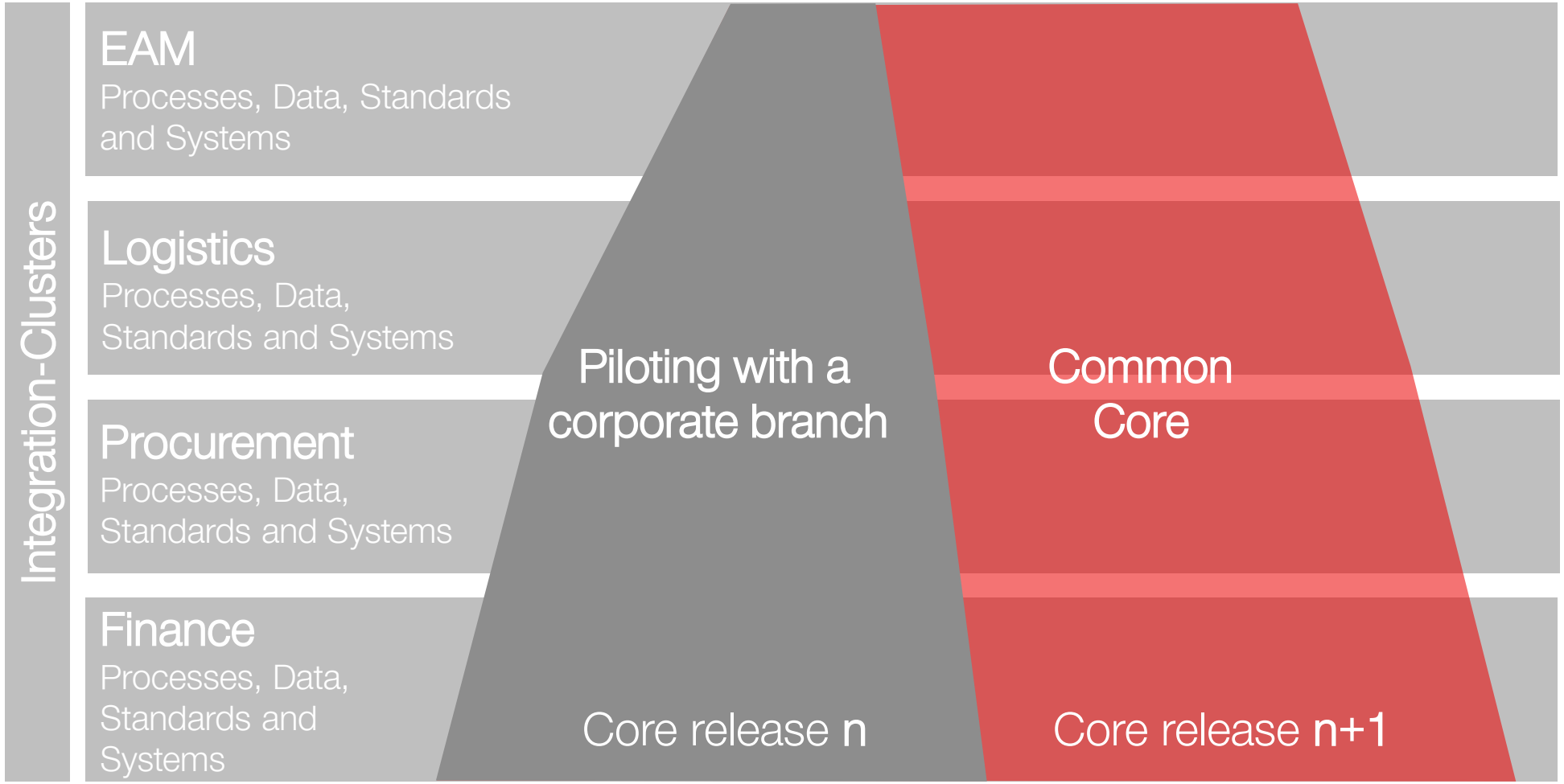


Common standards and methods to identify the harmonization potential for common processes, data and IT-solutions.



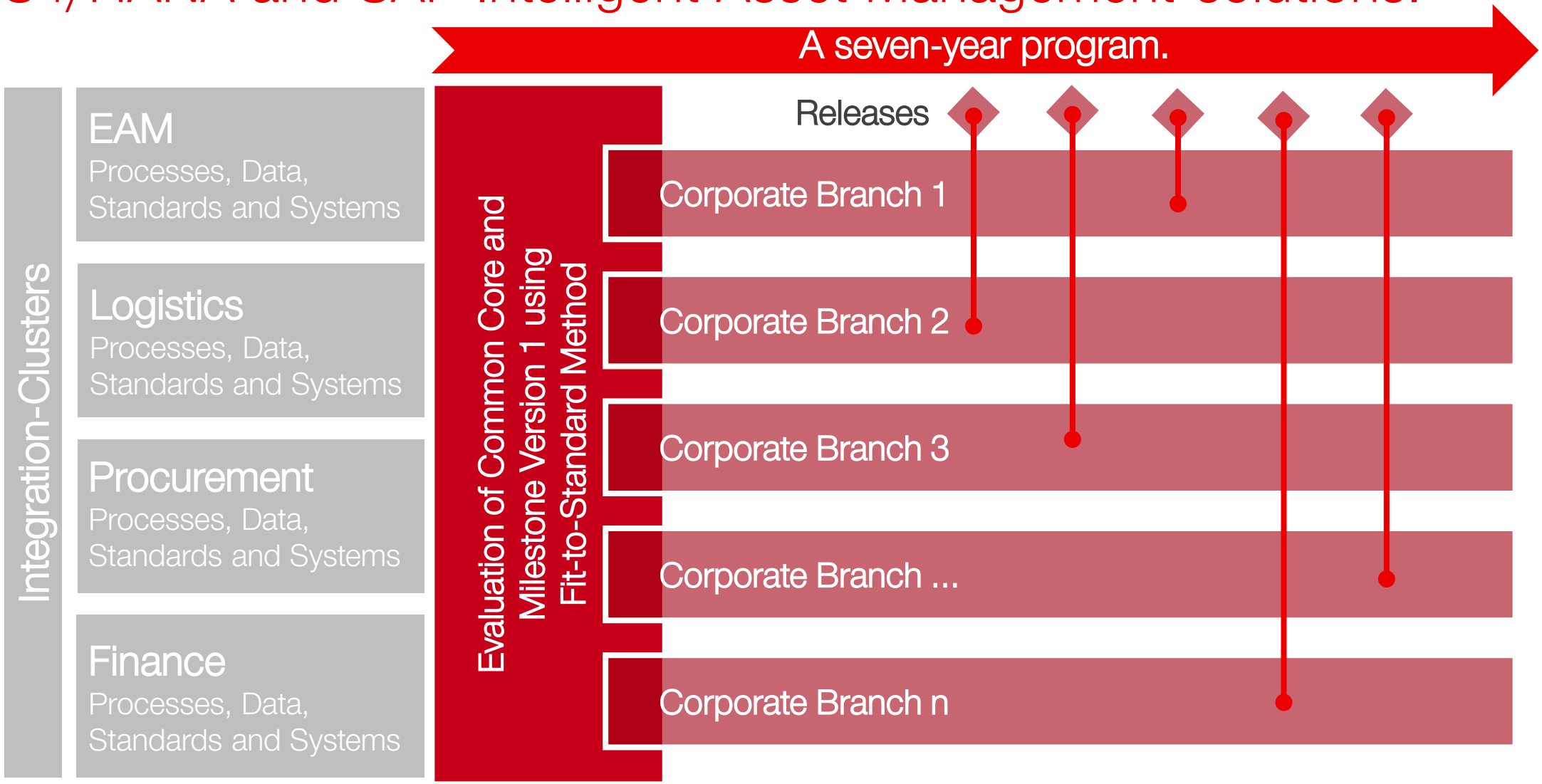
Illustrative representation.

A common understanding of asset life-cycle and relevant value chains are at the heart of the Digital Transformation.



Illustrative representation.

Illustrative Roadmap for the implementation of S4/HANA and SAP Intelligent Asset Management solutions.

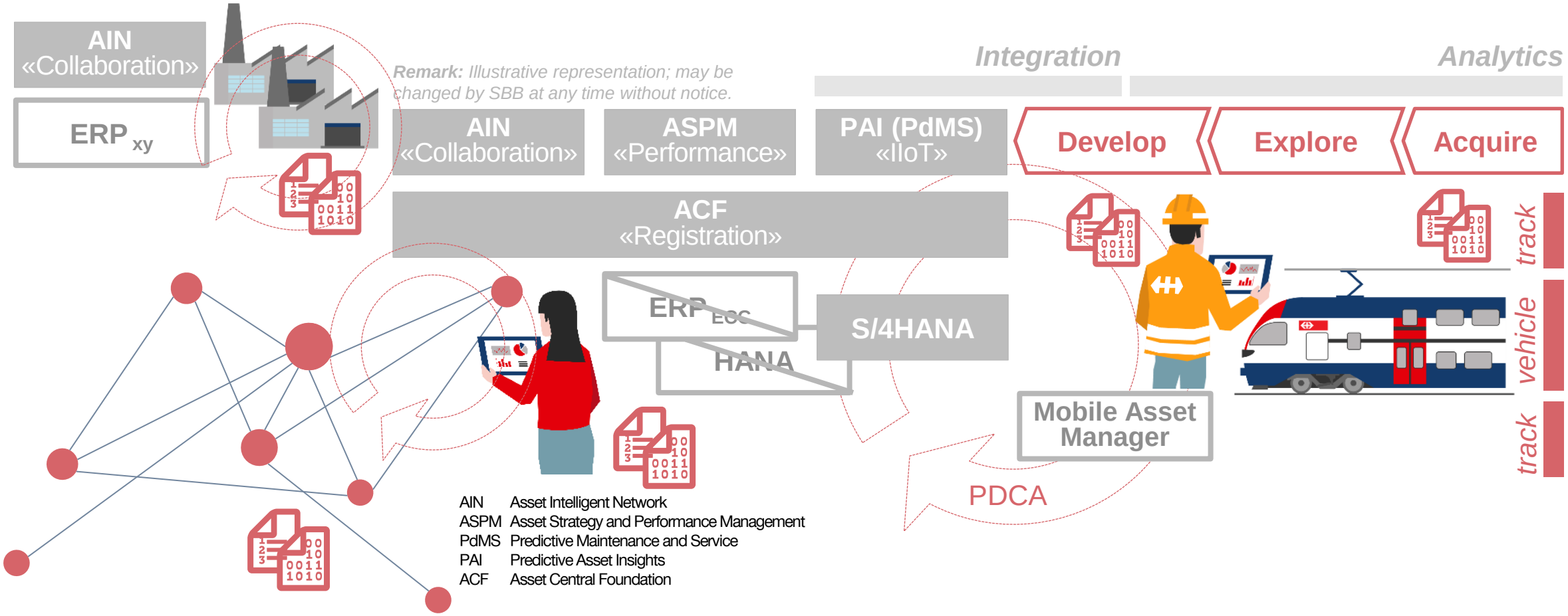


Illustrative representation.

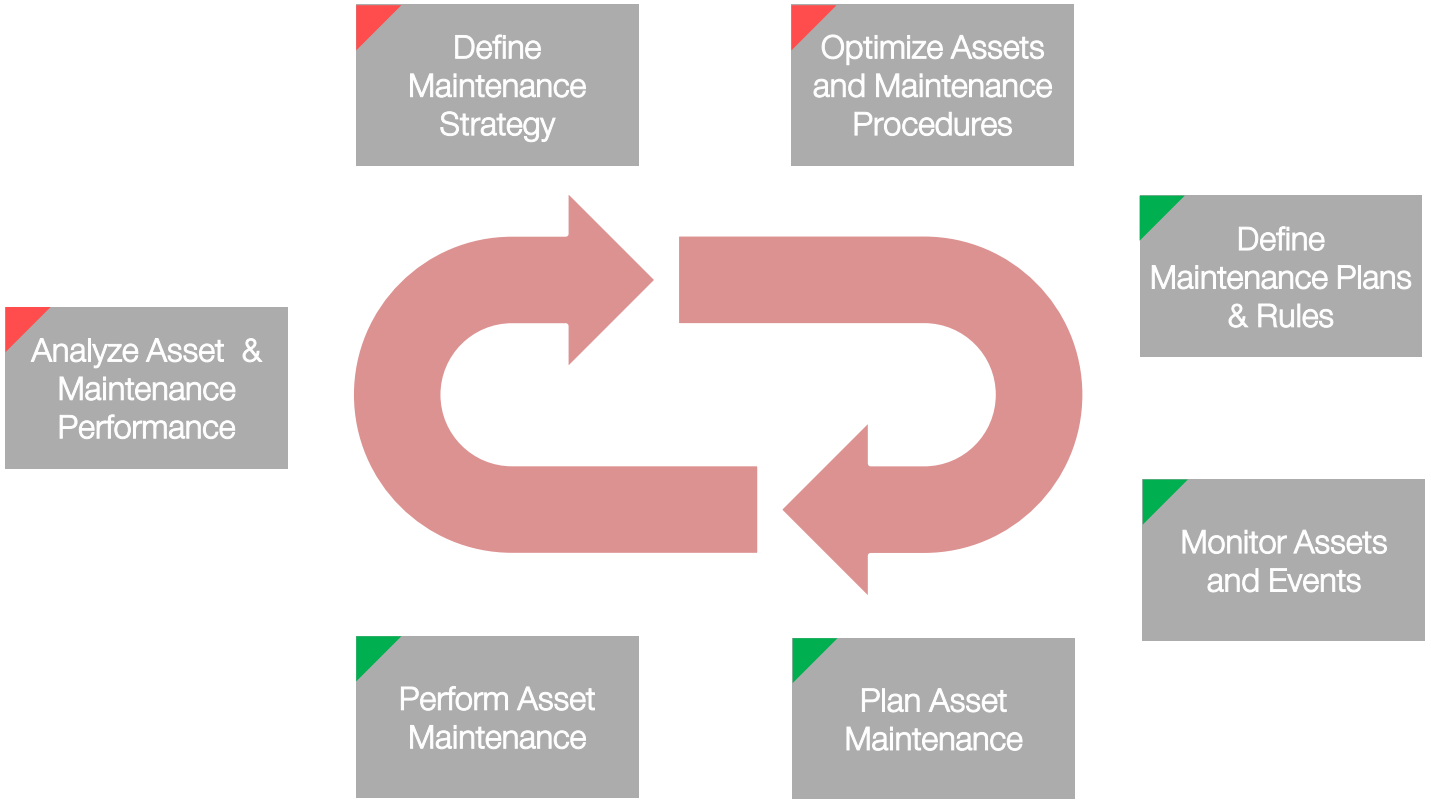
«Solutions and Implementation»

Section 2

Establishing an Enterprise Asset Management at SBB taking benefit of SAP S/4HANA and Intelligent Asset Management architecture.



Paradigm shift in asset performance and maintenance management by closing a gap in the feedback loop.



- → Considering the **Asset life-cycle** as a **closed loop**.
- → **Value-chain** orientation in a **process-oriented organization**.
- → Systematic **management of causes-effect** relationships.
- → **Implementation** of **use cases** along value-chain stages («process-chains»).
- → Enabling and developing **business capabilities** in the sense of ISO 55000.

Reliability-Centered Maintenance (RCM) as key element regarding intelligent asset and maintenance management.

Bundling of specialists with **technical expertise** and knowledge of the **operational context** by performing an RCM assessment.

IT-wise documentation of RCM assessment as a justified, well-founded **maintenance file** in a **standardized and scalable way**.

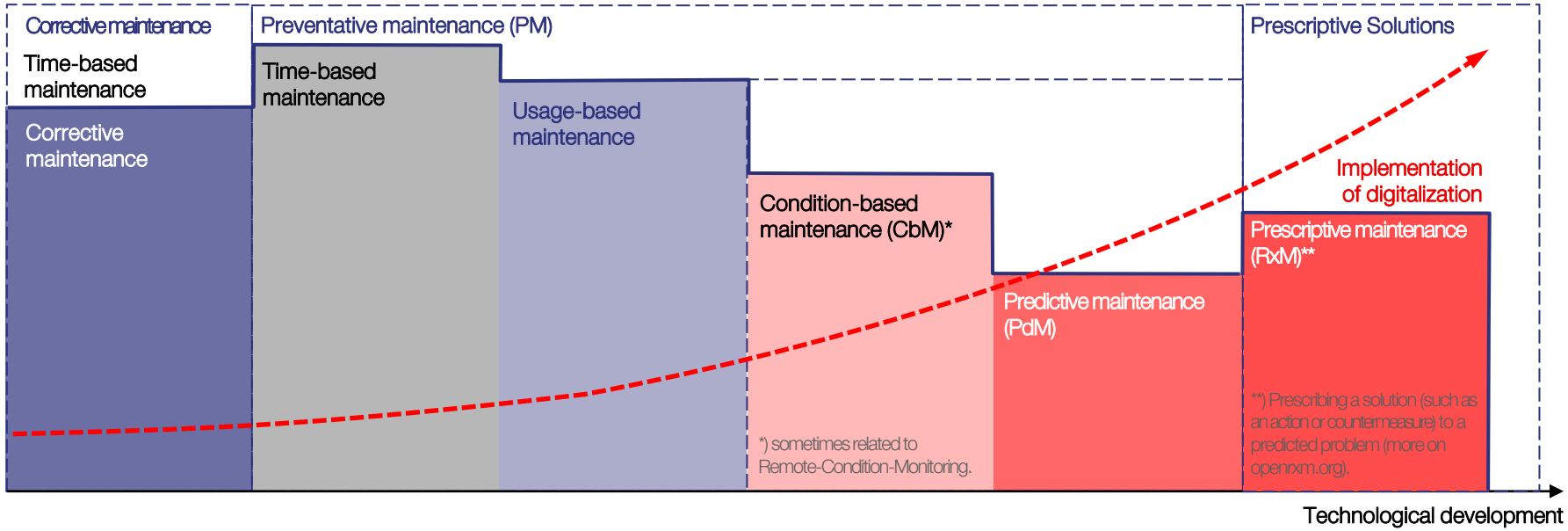
Having **preventive** and **corrective** maintenance tasks available in a **prescriptive way** to standardize activities along workshop sites.

Knowing functions, functional failures, **failure modes** and effects, risks and countermeasures and having a **feedback-loop** for **optimization** installed.

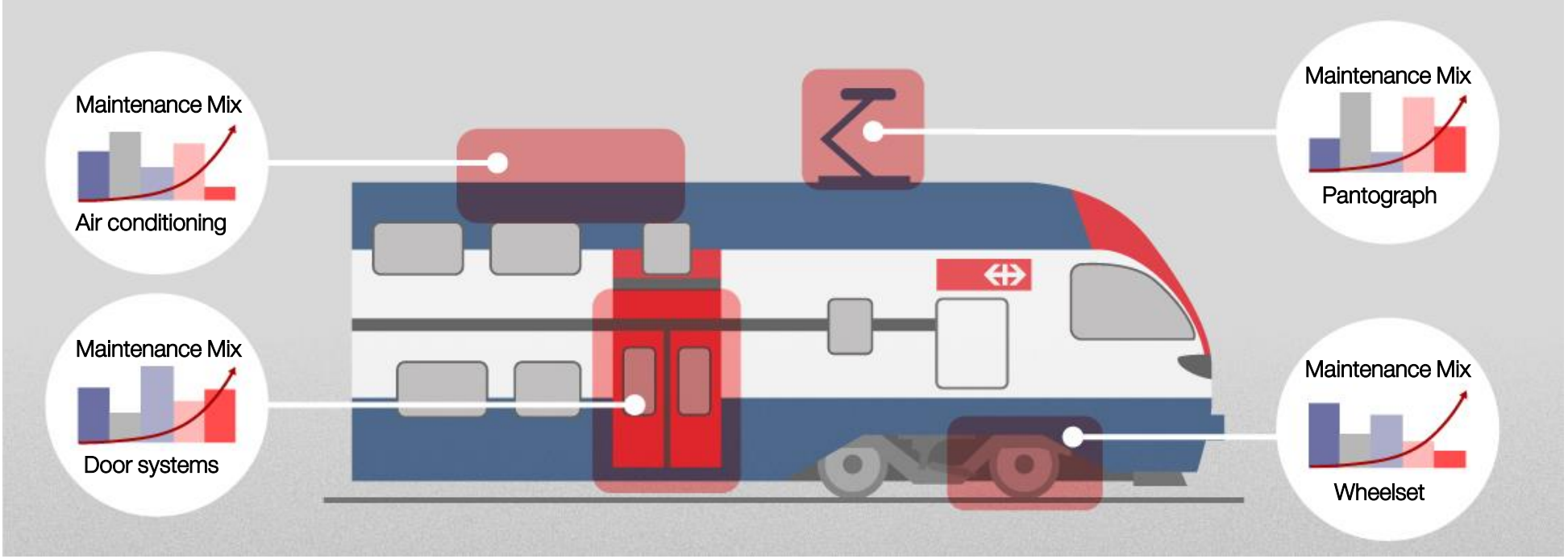
«Maintenance is management on ‘failure-mode’ level.»

Reliability Centered Maintenance gem. EN 60300-3-11:2009.

Source: EN 13306.

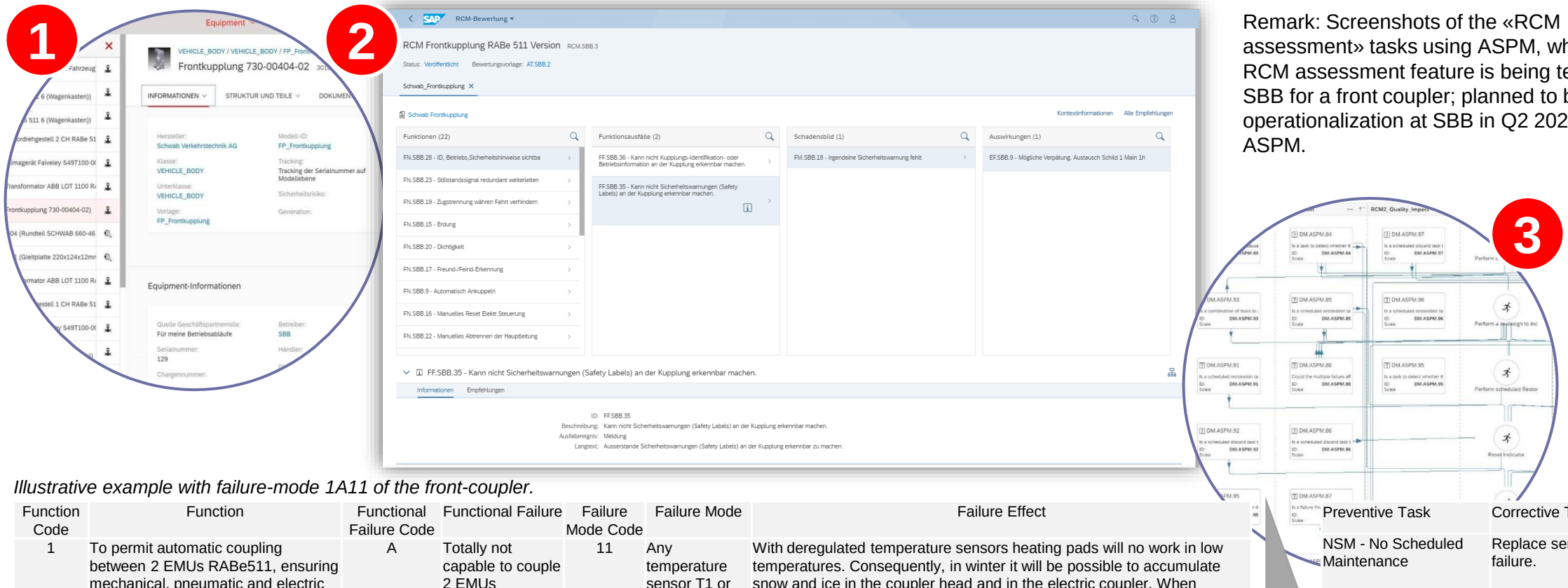


Appropriate rollout-method by implementing Reliability Centered Maintenance (RCM) system by system.



The **blend of maintenance strategies** on system level is built up by **identifying** the **appropriate** maintenance approach per failure-mode. After having run through the Moubray decision diagram it might e.g. be reasonable for a failure-mode «Sensor S2 fails open due to internal defect» to define **«No scheduled maintenance.»** as planned task and **«Replace sensor in failure.»** as corrective task. Once being able to predict the failure-mode likely to happen, **the recipe** is in place.

Performing a complete RCM assessment by using SAP Asset Strategy and Performance Management (ASPM).



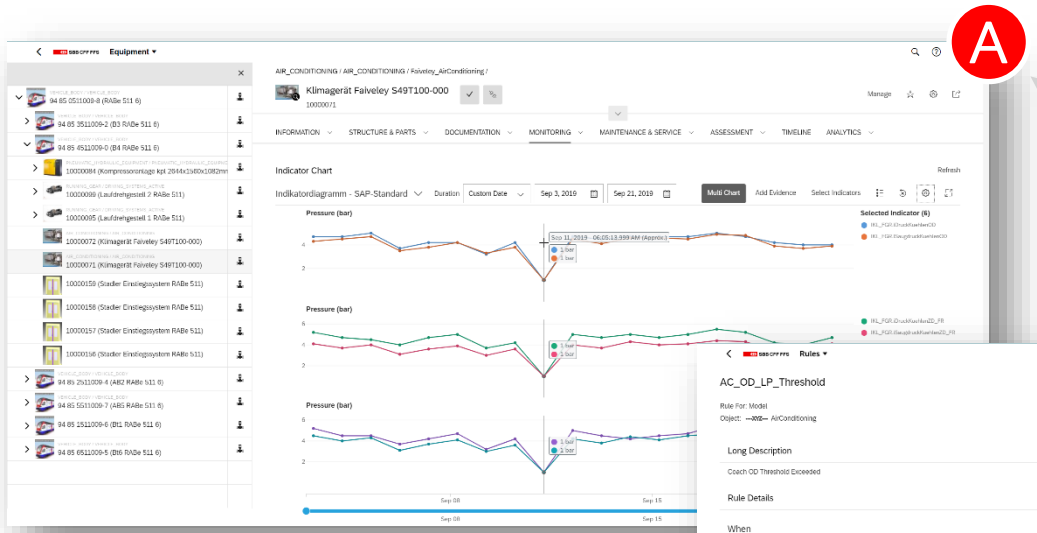
Remark: Screenshots of the «RCM assessment» tasks using ASPM, where the RCM assessment feature is being tested by SBB for a front coupler; planned to be operationalization at SBB in Q2 2021 using ASPM.

Illustrative example with failure-mode 1A11 of the front-coupler.

Function Code	Function	Functional Failure Code	Functional Failure	Failure Mode Code	Failure Mode	Failure Effect	Preventive Task	Corrective Task
1	To permit automatic coupling between 2 EMUs RABe511, ensuring mechanical, pneumatic and electric connections, at a speed up to 5 Km/h and curve radius higher than 250m, providing a mechanical resistance to rupture of 850KN (pulling), a mechanical resistance to deformation of 1500 KN (pushing), coupler lateral movements of +/- 23º, coupler vertical movements of +/- 5º.	A	Totally not capable to couple 2 EMUs RABe511 automatically, ensuring mechanical, pneumatic and electric connections.	11	Any temperature sensor T1 or T2 deregulated for higher values.	With deregulated temperature sensors heating pads will no work in low temperatures. Consequently, in winter it will be possible to accumulate snow and ice in the coupler head and in the electric coupler. When coupling 2 EMUs RABe511 in snowy days the electric coupler will not couple due to accumulated ice. This will be notice by the driver when he´s coupling the trains. If that happens in a railway station, service has to be performed in single operation with reduced capacity. This will likely cause a delay higher than 5 minutes and will have impact on service image care. The cost of the delay will be CHF xyz/min after the first 5 minutes. Recovery of condition is made by replacing the coupler involving 2 technicians up to 3 hours.	NSM - No Scheduled Maintenance	Replace sensor in failure.

SAP IAM

Indicators, rules and actions for HVAC fluid circuits «use-case».

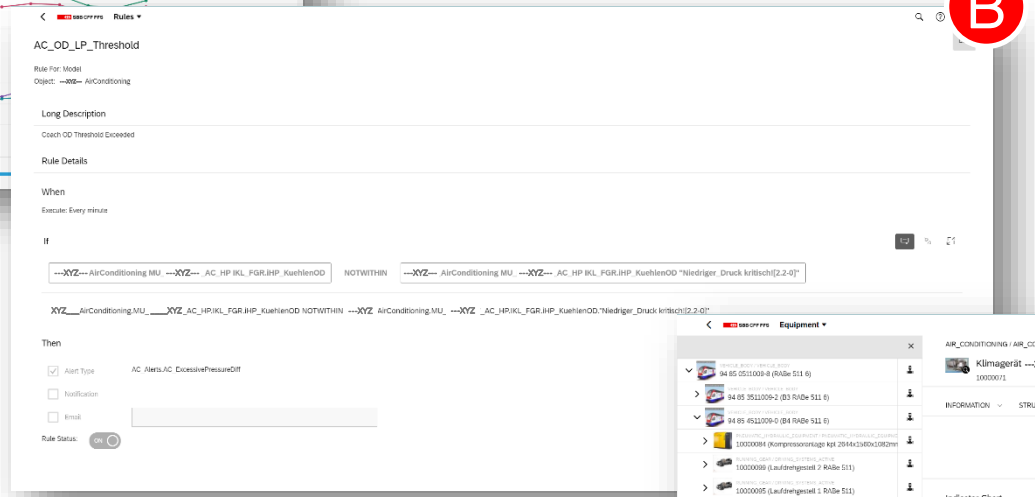


Setting up indicators:

- Sensor signals imported through custom pre-processing.
- Definition of idicators for the fluid circuits signal («pressure»).

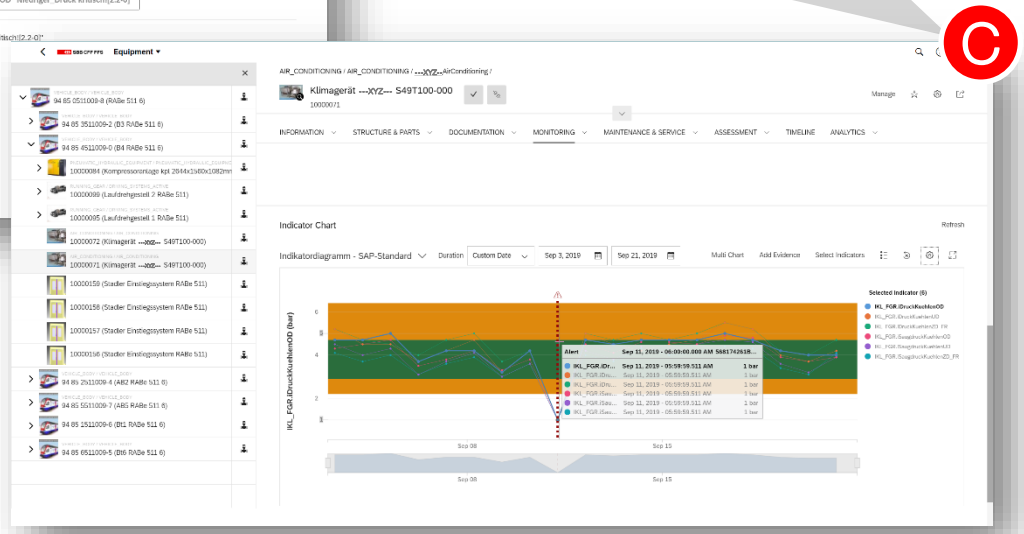
Threshold definition:

- Defining ranges and thresholds to run idicators against.
- When-If-Then logic available.
- Triggering e.g. a notification.



Monitoring selected indicators:

- Running indicators against rules.
- Monitoring indicators and cross-check reliable triggering.
- Supervision of the rule-set.

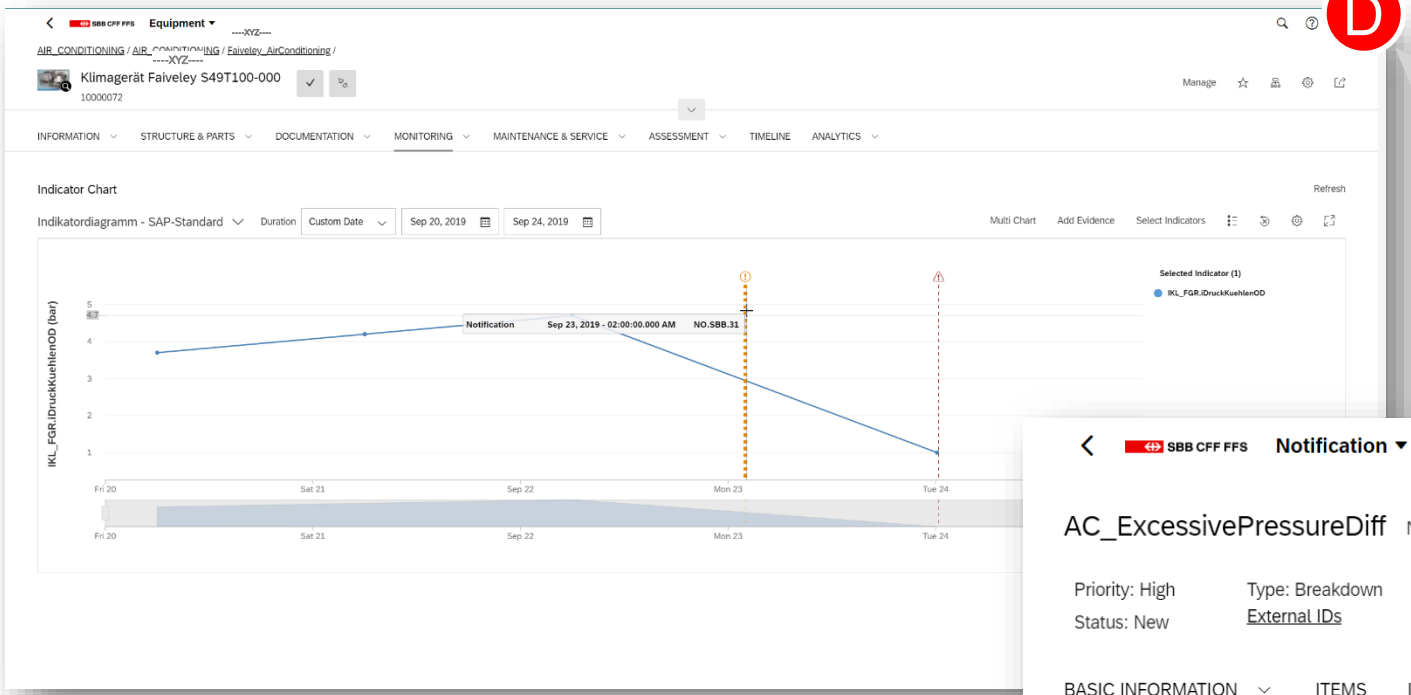


HVAC «use-case» in brief:

- failure-modes for leakage have been identified.
- Sensor signals transferrable through Remote Monitoring.

SAP IAM

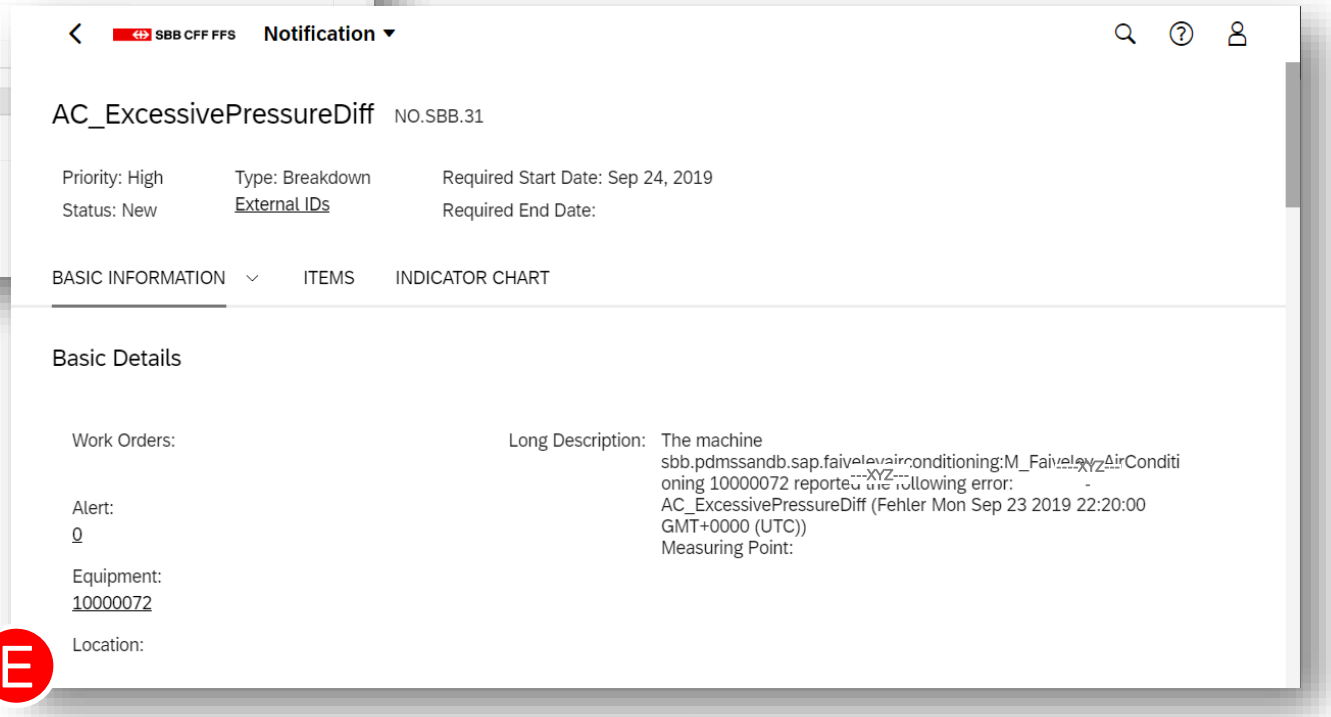
Trigger(s) and notification for an HVAC fluid circuits «use-case».



D

Monitoring a trigger:

- PdMS showing a selected indicator and its diagram.
- A notification has been triggered and is made transparent in the diagram.



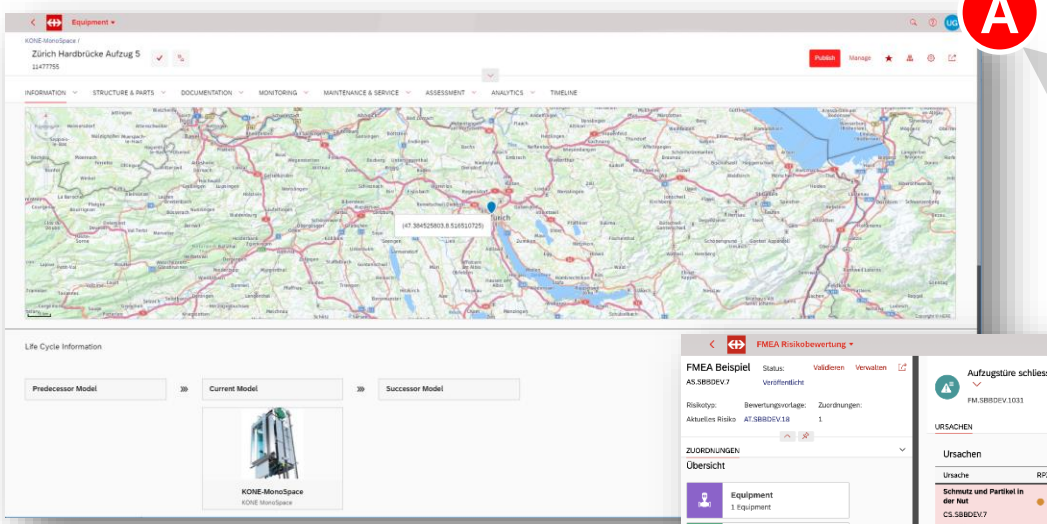
Basic notification information:

- Basic information on the generated notification is depicted in the detailed dialogue to notification «NO.SBB.31».

E

SAP IAM

Implementing an SAP IAM use-case with an elevator.



A

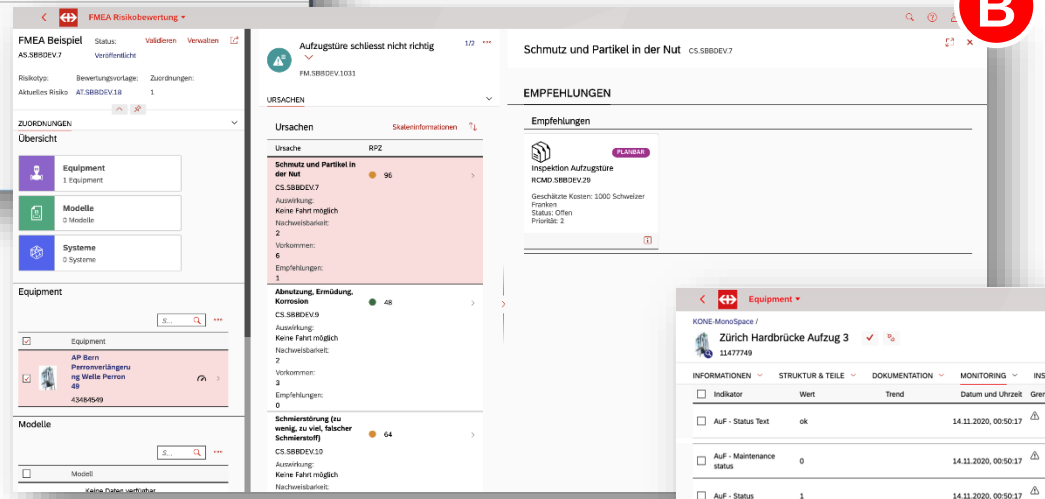
Asset identifaction on a map:

- Affected assets will be visible on a map and access to relevant information is easily avaiable.

Failure data management:

- Failure-modes to the specific elevator are being managed using RCM capability in SAP ASPM.

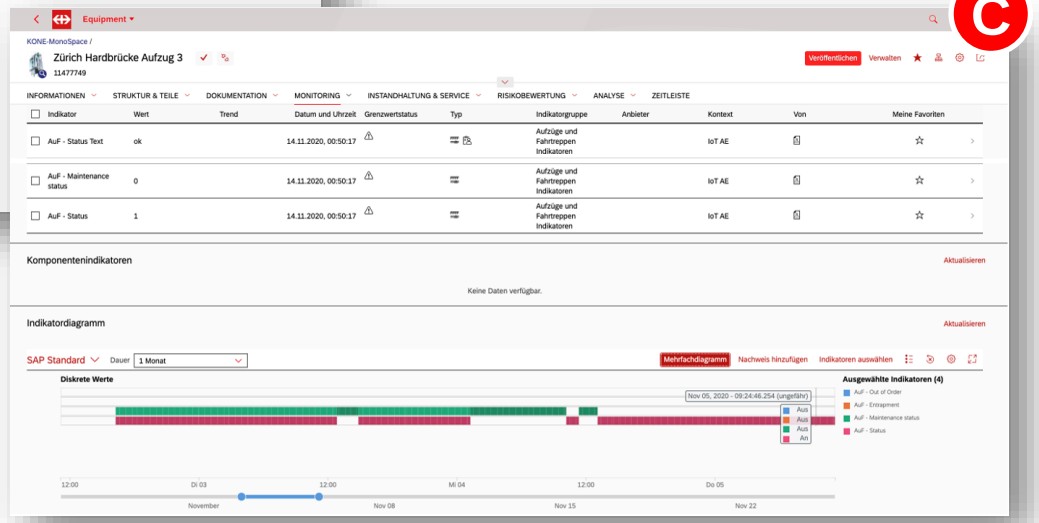
B



Condition monitoring:

- Multiple indicators are being monitored using SAP PAI.
- Thereshold violation will trigger e.g. a maintenance notification.

C

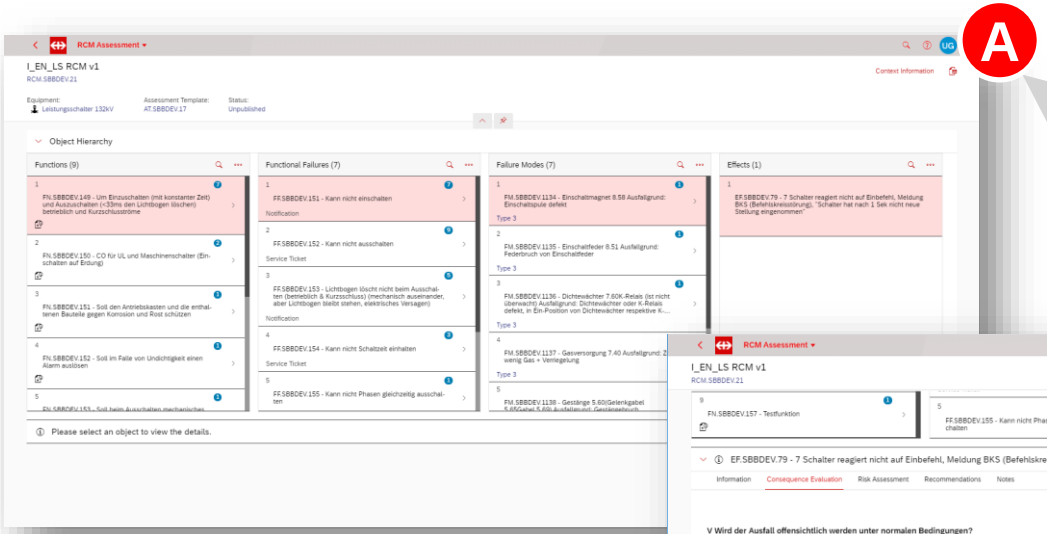


Elevator «use-case»:

- Elevator as a relevant equipment at Zürich Hardbrücke train station, e.g. with failure mode CS.SBBDEV.7 «Dirt and particles in the groove».

SAP IAM

Implementing an SAP IAM use-case with a circuit breaker.



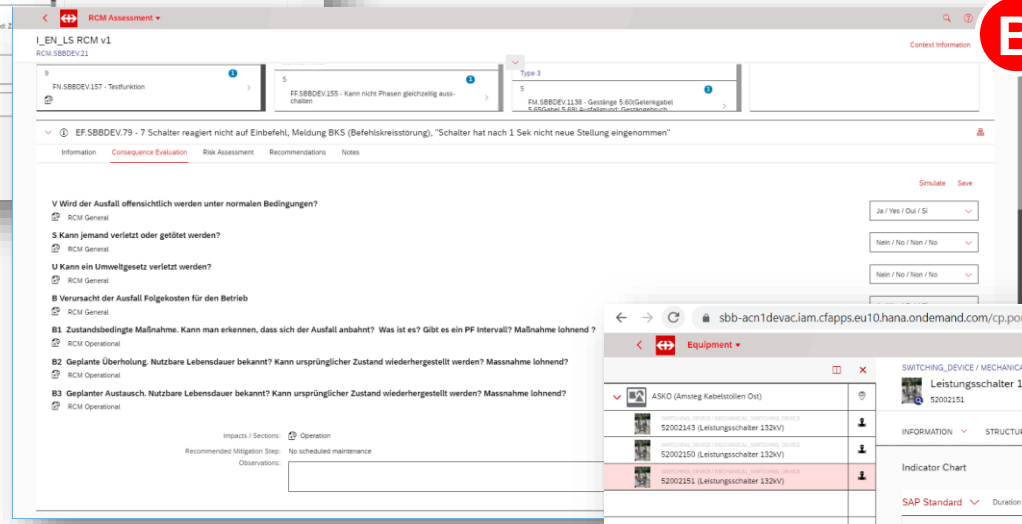
A

Full RCM Assessment:

- Failure-mode and effect analysis of the circuit breaker is being managed using RCM capability in SAP ASPM.

Consequence evalution:

- Consequences of the cause of a failure is captured by the assessment team using a structured questionnaire.



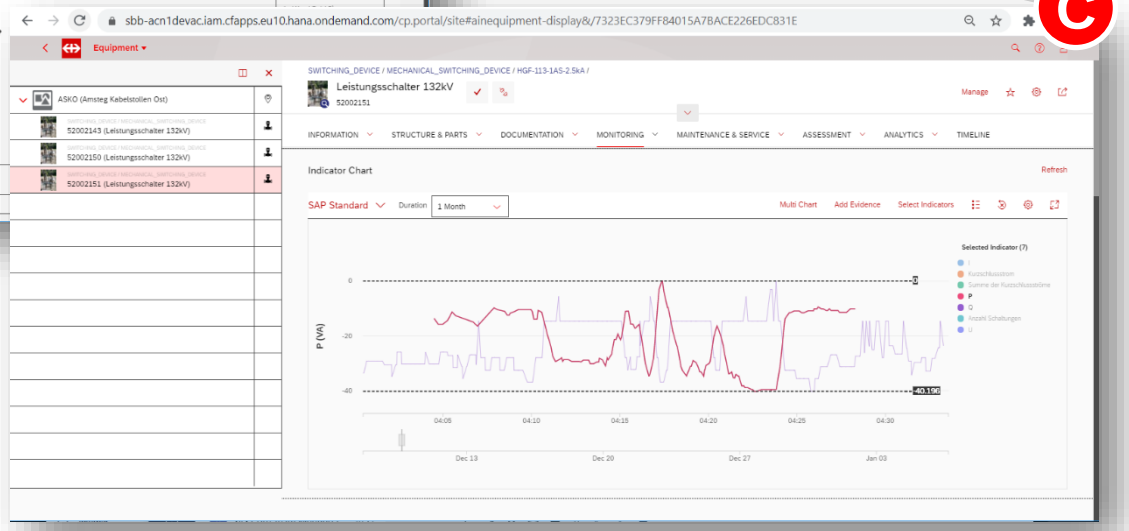
B

Condition monitoring:

- Multiple indicators are being monitored using SAP PAI.
- Thereshold violation will trigger e.g. a maintenance notification.

Circuit breaker «use-case»:

- GE HGF-113 High Voltage circuit breaker in a real-life scenario, e.g. with failure mode EF.SBBDEV.79: Switch does not respond to «switch on» command.



C

SBB - PoC

Reverse engineering of «failure-modes» from notifications.

Entry systems «use-case»:

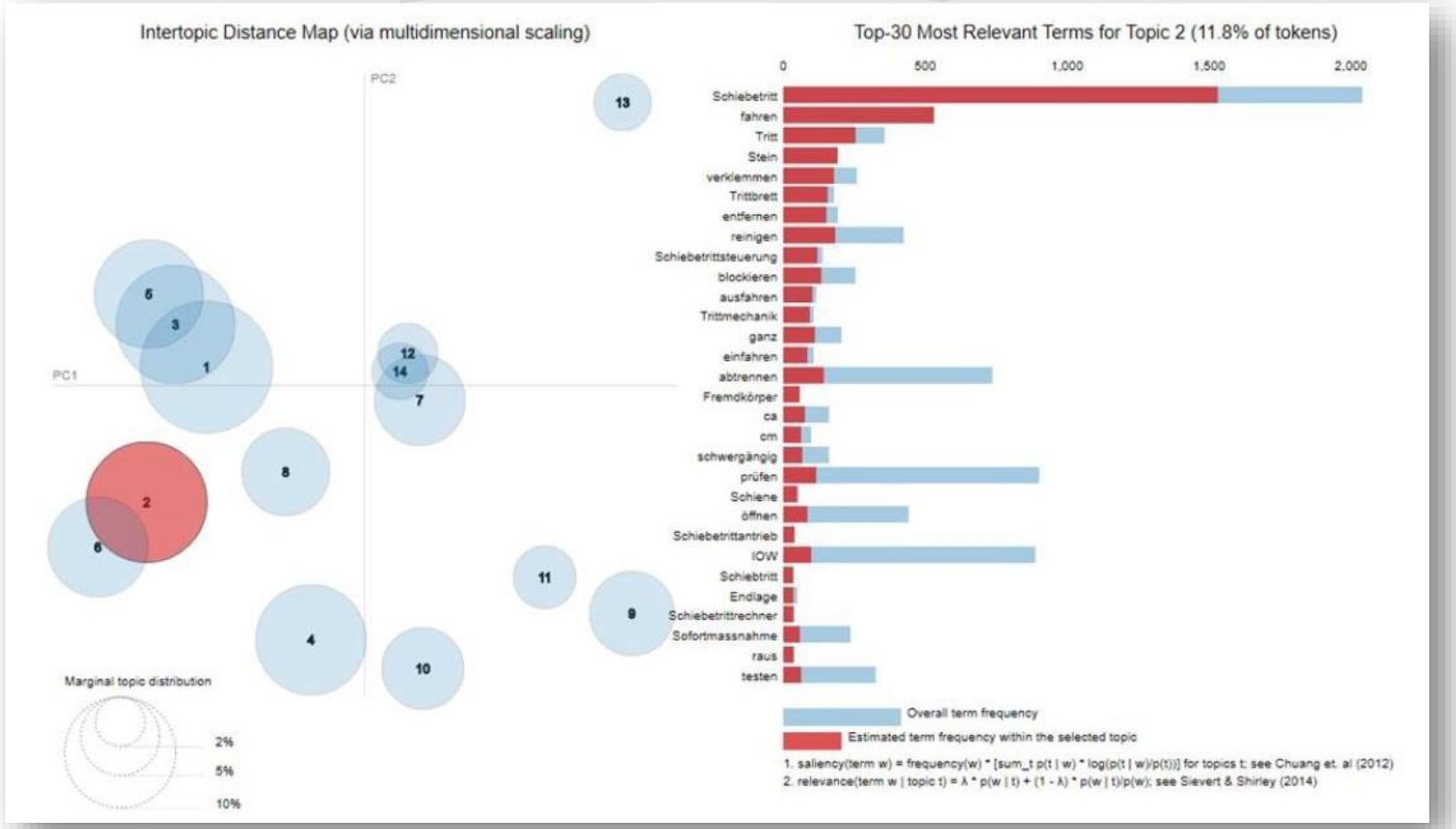
- RCM Assessment has been already excecuted for said two-wing entry system.
- Historical notifications have been identified as source for the reverse engineering approach.
- RCM Assessment as reference for reverse engineered failure-modes.

Group of specific topics:

- The applied algorithms allowed to cluster the failure-modes into multiple topics.

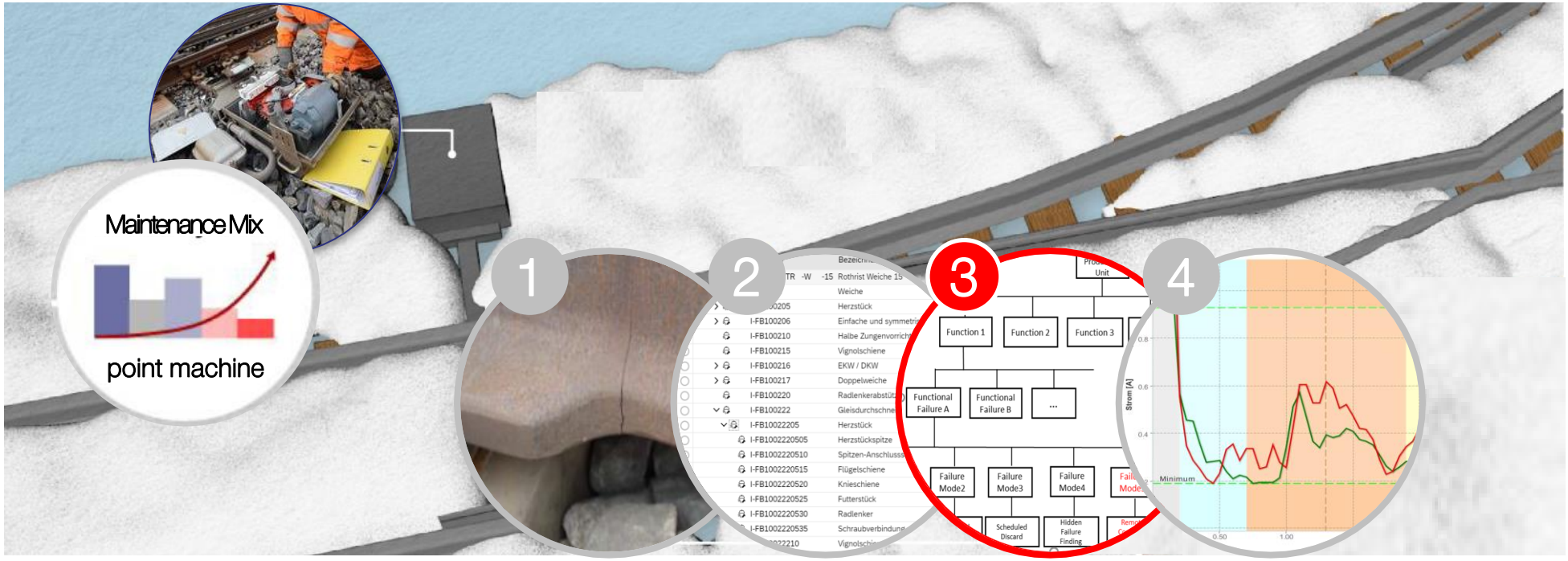
Elements for failure modes:

- Topic 2 shown in detail giving specific information about terms found in said topic.
- *«Sliding step of the door blocked by a stone.»*



pat. pending.

Methods and lessons learned can be applied to assets of Rail Networks or Real Estate.



Understanding the **physical object** (1), it's **technical (2)** and **functional** (3) structure with its **failure-modes** and **effects** to make optimum use of **digitalization** (4). Failure-data as a relevant foundation for Asset Management.

Building a «Common Failure-Data Environment» for Rail industry assets.

- **Managing maintenance on failure mode level** leads to a well founded and transparent management of reliability, safety and costs.
- **Optimization against costs** and reliability becomes possible on a scalable level.
- **Dependencies** between **multiple systems** such as in multiple-unit train units, electrical network, etc.) get visible and can be managed.
- **Analytics, monitoring and prediction** are no longer «buzz-words» but within reachable distance.
- **Reliable sourcing** regarding failure-data as shown can be established by a) **Operators** [FMEA, RCM], b) **OEM**/Manufacturers [FMEA/RCM] and c) **Machine Learning** and d) **Collaboration** among Peers.

Summary: Building a «Common Failure-Data Environment» for critical assets in the Rail domain will help to support the Asset and Reliability Management.

Key Takeaways.

1. Initiation of an **Enterprise Asset Management approach**, which was triggered by the availability of standardized SAP solutions, esp. offering a Live-Cycle delivery loop.
2. Paradigm shift in the scalability of Asset Management solutions by SAP by allowing **Maintenance to be managed** on **failure-mode level**.
3. Implementation examples and use-cases heavily based on failure-data gives the **organization a chance to learn** to deal with the new features.
4. **Accessing different sources** to build a reliable **«Common failure-data environment»** as a next step.


SBB CFF FFS
Thank you.

Speaker.

Urs Gehrig is Senior Consultant Business Development and Head of the Competence Center (CoC) Predictive Maintenance SBB. He has a degree in Electrical Engineering (HTL), a Master in Law (lic. iur.) and a degree in Secondary Education. Urs Gehrig currently leading the Integration Management of the S/4 SBB program at SBB Infrastructure Division. He is giving lectures on «Digitalized Maintenance» at Zurich University of Applied Sciences and is a member of the Advisory Board of the Locomotive bOgie Condition mAinTEnance (LOCATE) project running European Union's Horizon 2020 research and innovation program. He is a Certified SAFe® 5 Agilist. Urs is Chairman of SUGRail SIG for Intelligent Asset Management since 2019. He is a passionate drummer and composer.

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