

AI FACTORY /MINING MOBILE MACHINERY

Project Overview

VINNOVA
Sweden's Innovation Agency



LULEÅ
TEKNISKA
UNIVERSIT

LULEÅ
UNIVERSITY
OF TECHNOLOGY

RAMIN KARIM

- LTU, Div. of Operation & Maintenance Engineering
- Professor of Industrial AI & eMaintenance
 - Computer science & Data Science
 - Operation & maintenance
- Director of the ‘Centre of Intelligent Asset Management (CIAM)’ at LTU
- Founder of Predge AB (former eMaintenance365 AB)
 - 2 times on the Swedish “33-listan”
- Scientific leader of the ‘ePilot’ project, listed on IVA 2020
- Scientific leader of the ‘AI Factory’, listed on IVA 2021
 - RAILWAY, MINING, MANUFACTURING, CONSTRUCTION, AVIATION, ...
- Board member of ‘Sustainability Circle’
- Board member ‘Association of Swedish Maintenance (SvensktUnderhåll)’
- >20 years of industrial experience



Our research is included in **IVA's 100 List 2020**, a list of research projects focusing on **sustainability** with significant potential to benefit areas such as business and method development or to have a positive impact on society.



Our research is included in **IVA's 100 List 2021** listing research projects focusing on **sustainable emergency preparedness** with potential to create value through innovation.

AI FACTORY /MINING

Main Partners



Associate Partners



EXAMPLES OF MACHINES IN OPERATION AT LKAB & BOLIDEN



WHY WE DO - PURPOSE

Enable sustainable **asset management**
of mining **mobile machines**
by utilisation of **AI** and **digital technologies**

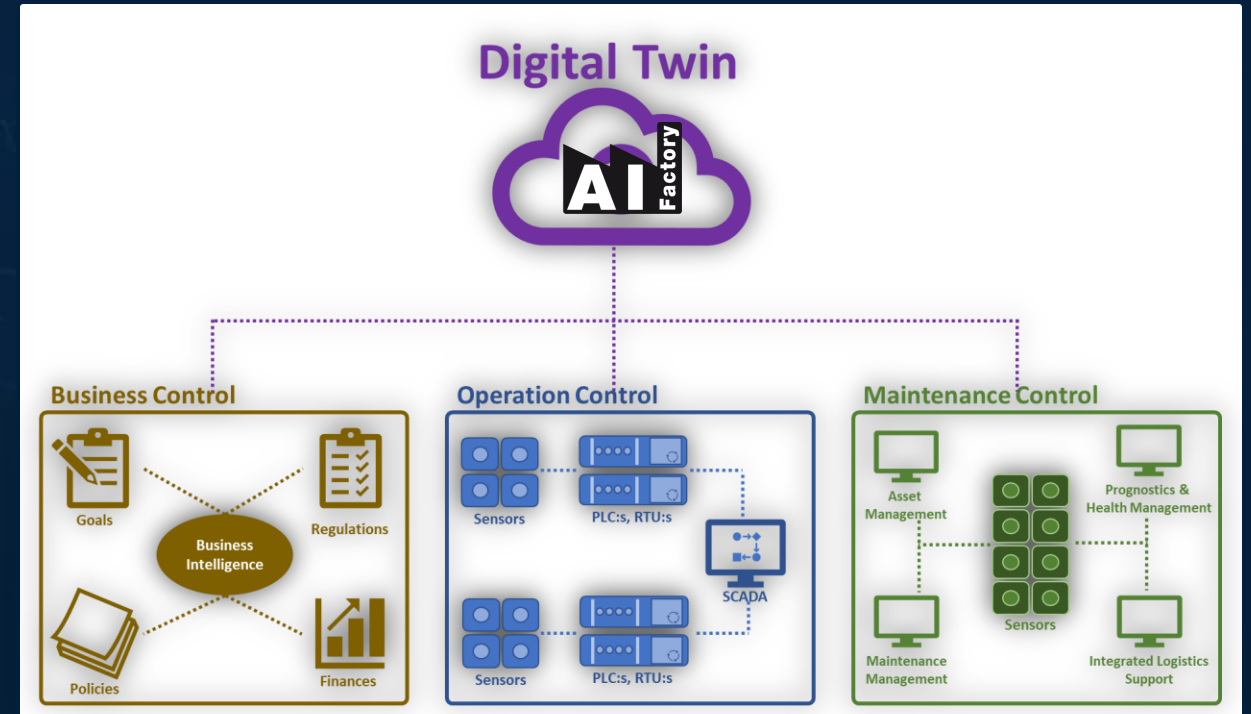
HOW WE DO - OBJECTIVE

Develop and demonstrate
a digital twin aimed for
nowcasting and **forecasting**
of machines' health

1. What happened in the past
2. Why something happened
3. What will happen in the future
4. ~~What needs to be done next~~ (Not within the scope of the project)

WHAT WE DO – THE PLATFORM

A **Multi-Space** environment
(a **Metaverse**)
for
Intelligent Asset Management



AIFM – PROJECT SCOPE

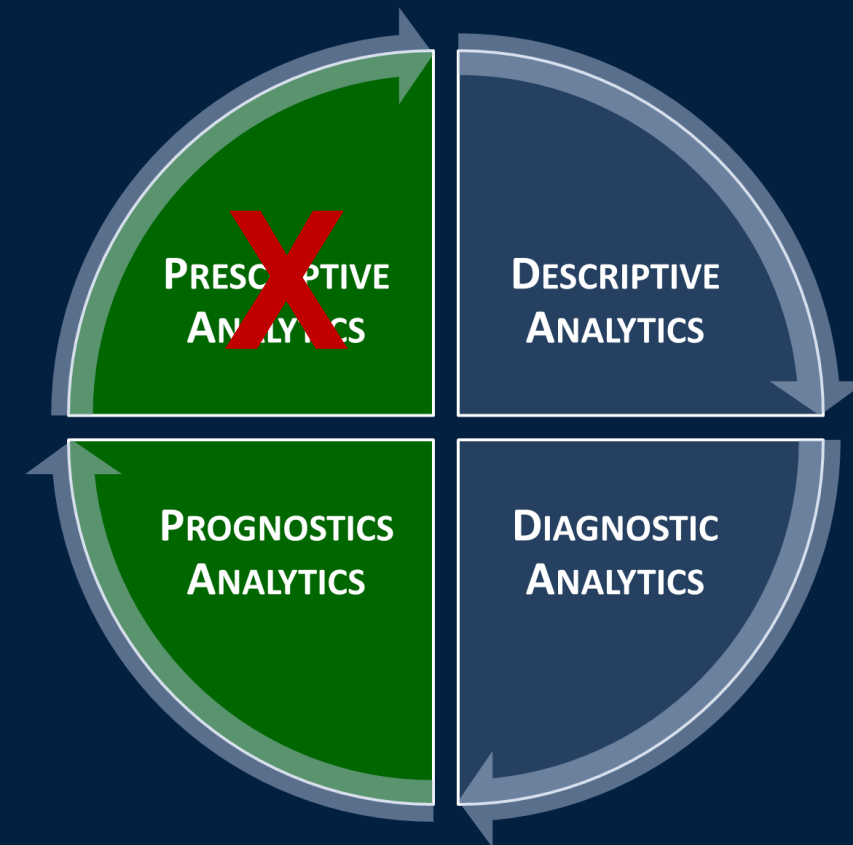
- AIFM will focus on mining machines developed by Epiroc and operated by LKAB and Bolide
 - ❖ LKAB (underground environment)
 - ❖ Boliden (underground & open pit environment)

- The project will have a special focus on the components that are identified as **critical** and **significantly impact the system availability**
 - ❖ Based on the failure analysis phase



AIFM – PHASES

- Phase I: **Descriptive analysis**
 - Investigate the failure rate for addressed components
 - Identify the failure modes per components
- Phase II: **Diagnostics**
 - Identify the root-cause per failure mode (reversed FMECA)
 - Data-driven approach
- Phase III: **Prognostics**
 - Hybrid approach
 - Develop data-driven and physics-based models for RUL estimation



AIF/M - USE CASES

UC01: Digital Twin for Decision-Support in Asset Management of mobile machinery

- Focus: Process Development**
- Asset management decision process
 - Nowcasting & Forecasting
 - Logistics
 - Maintenance & inspection
 - Safety & Security
 - Condition monitoring

UC02: Data Source Integration

Focus: Technology Development

- Data integration
- Ontology adaptation
- Pipeline development
- Sensor fusion
- Data exchange automation

UC03: AR, VR Integration

Focus: Technology Development

- 3D-model generation
- Gaming technology integration
- VR-visualisation of model
- AR-visualisation of model

UC04: Robotic & Sensor Integration

Focus: Technology Development

- Spot integration
- Sensor integration (LIDAR)
- Drones
- LiDAR data processing
- Smart object recognition & tagging

UC04: Robotic & Sensor Integration

Focus: Technology Development

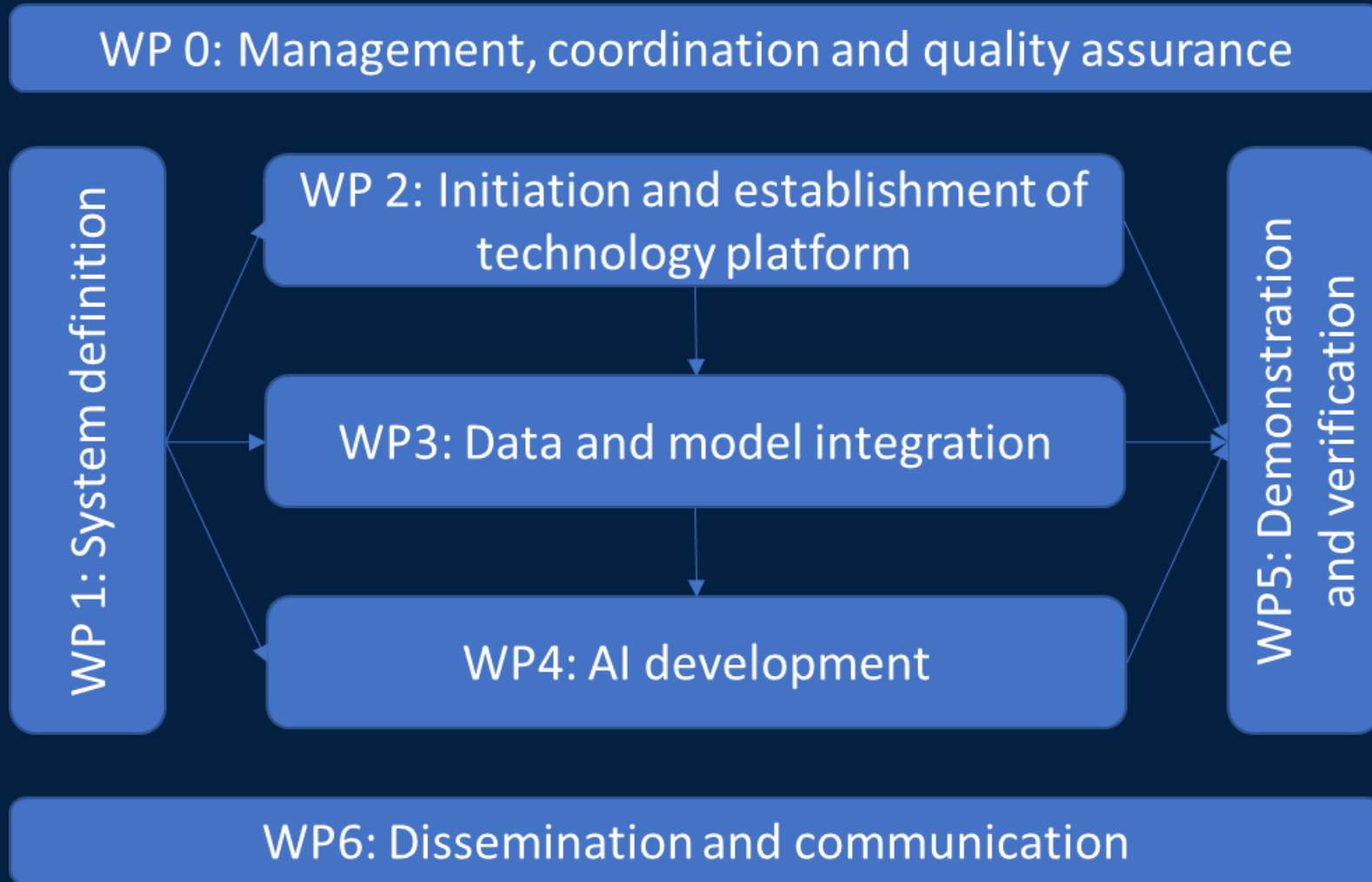
- Spot integration
- Sensor integration (LIDAR)
- Drones
- LiDAR data processing
- Smart object recognition & tagging

UC06: Cybersecurity

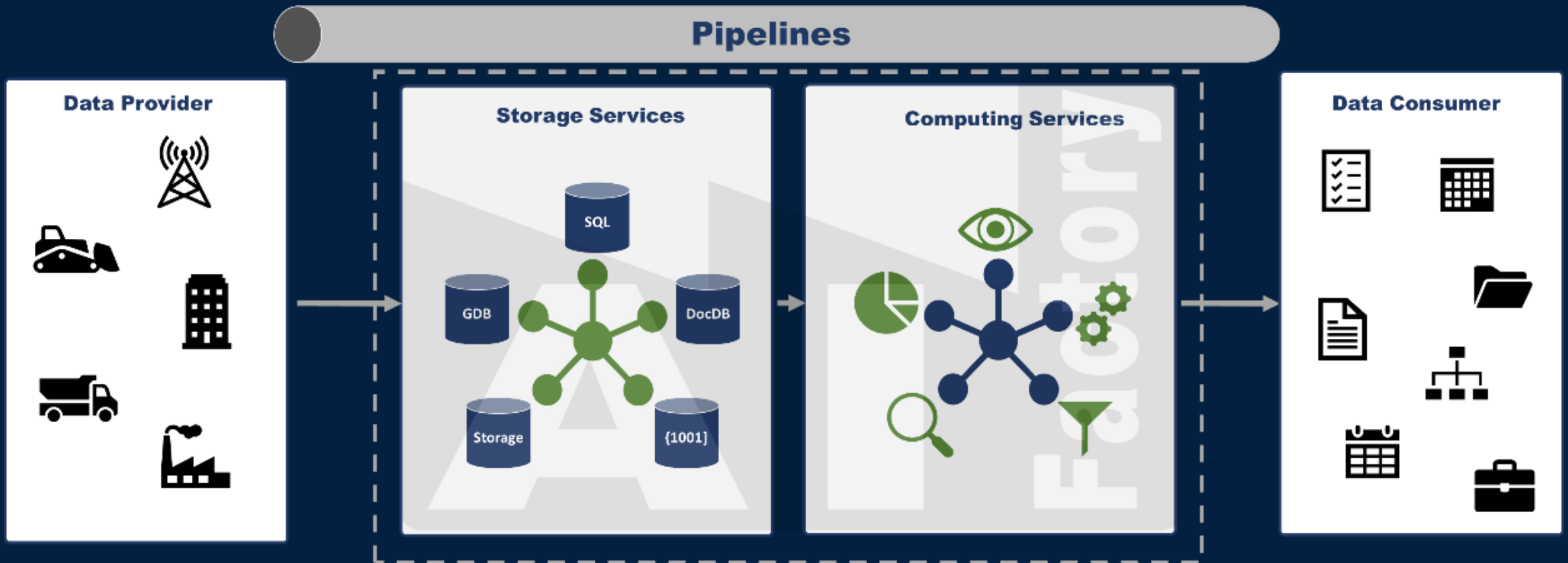
Focus: Technology Development

- Cybersecurity & Blockchain
- Authentication
- Authorization
- Encryption
- Just-in-time access
- Just-enough-access

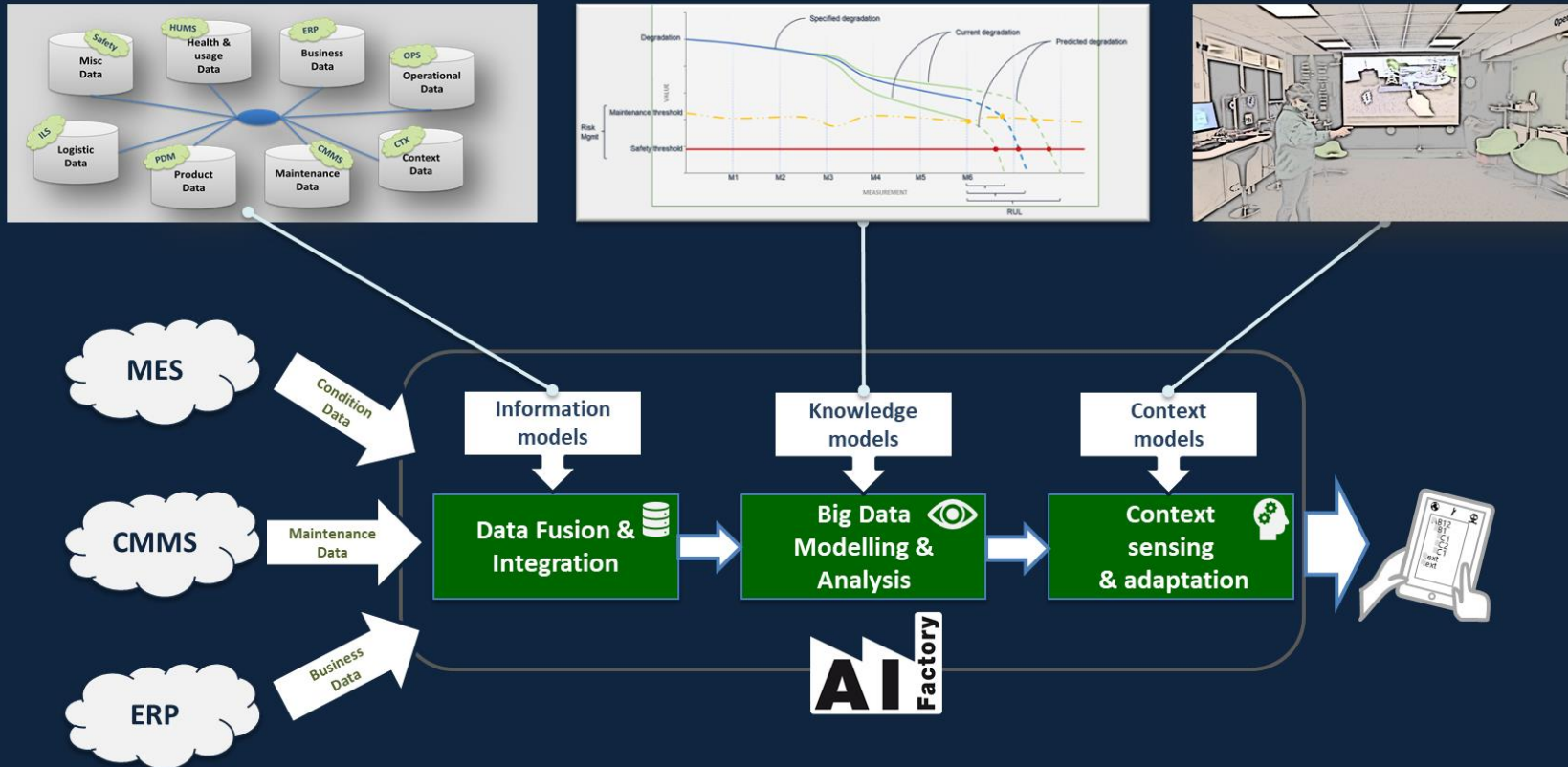
AIF/M – WORK PACKAGES



AIF/M – MICRO-SERVICE-BASED ARCHITECTURE

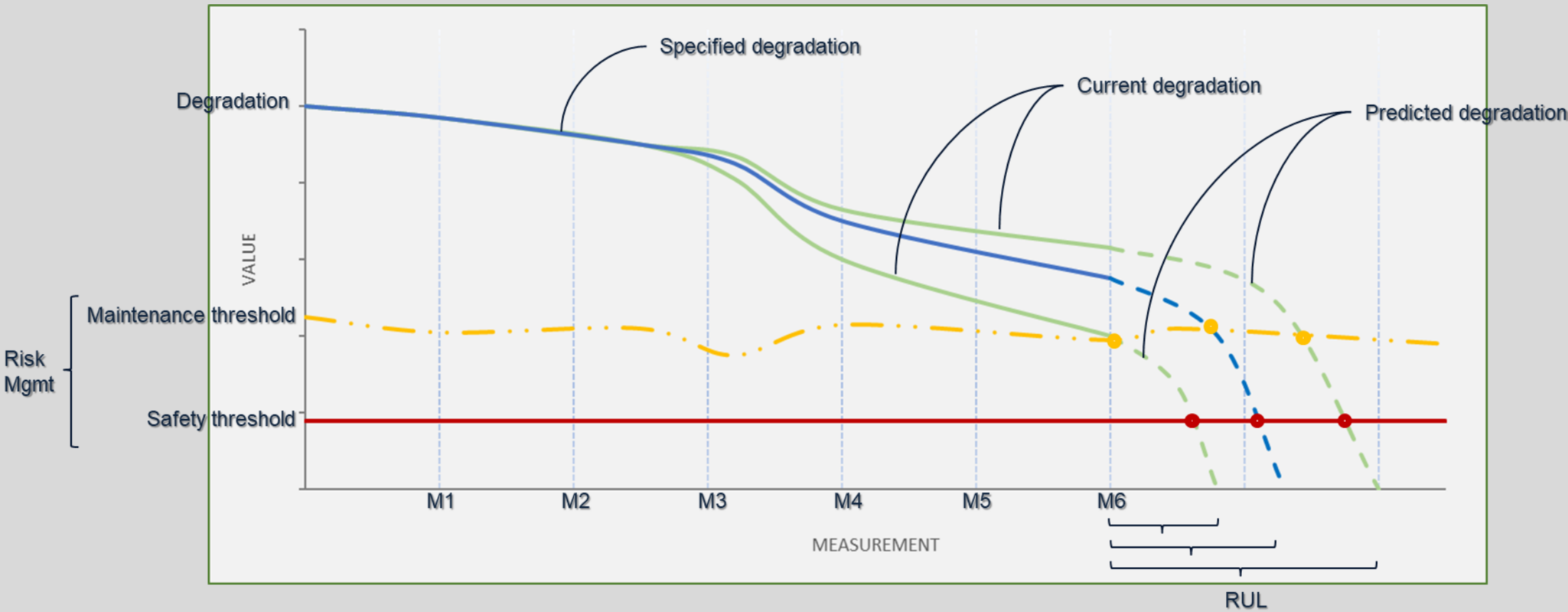


DATA SOURCES FOR ANALYTICS



-  ERP (Movex, Maximo)
-  Vehicle (Onboard sensors)
-  Production planning data
-  Operation environment data (topology etc.)
-  Reliability data (from design, e.g. life expectancy per component)

AIF/M - COGNITIVE CAPABILITIES



(Karim et al., 2014)

AI FACTORY – SCIENTIFIC CHALLENGES



Business
 Pay-as-you-go
 Service or product
 Micro or macro transactions

Governance
 Digital asset
 Ownership, IP
 Freedom-To-Operate

Democratisation
 Data & model
 Availability
 Accessibility

Quality
 Quality-of-Service (QoS)
 Quality-of-Data (QoD)
 Quality-of-Model (QoM)

Information Assurance
 Security
 Safety
 Resilience

Integration
 Services
 Messaging
 Orchestration

Distribution
 Computing
 Storage
 Model

Autonomy
 Reasoning
 Acting
 Automation

AI FACTORY – DEVELOPMENT ENVIRONMENT PLATFORM

▪ Architecture

- Service-oriented architecture
- Micro-services

▪ Development tool

- OpenAI
- Azure
- Python, C#

▪ Storage

- Blob
- Sql
- Graph

▪ Visualisation

- Browser-based
- Power BI
- Unity
- AR (Hololens)
- VR (Quest II & Pro)

▪ Cloud environment

- Azure

▪ Fog environment

- Windows
- Linux

▪ Edge environment

- Epiroc Certiq
- Azure IoT



THANK YOU FOR YOUR ATTENTION!

