AI FACTORY /MINING
MOBILE MACHINERY

Project Overview

VINNOVA
Sweden's Innovation Agency

AI Factory

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 eMaintenanance365 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, CONTRUCTION, AVIATION, …
- Board member of 'Sustainability Circle'
- Board member 'Association of Swedish Maintenance (SvenskUnderhåll)'
- >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.

IVA
Research2Business
IVA's 100 List

IVA
Research2Business
IVAs 100-lista

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

LKAB

Epiroc

NEW BOLIDEN

IBM

LULEÅ UNIVERSITY OF TECHNOLOGY

Associate Partners

ERICSSON

HEAD MINING

Smurfit Kappa

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**

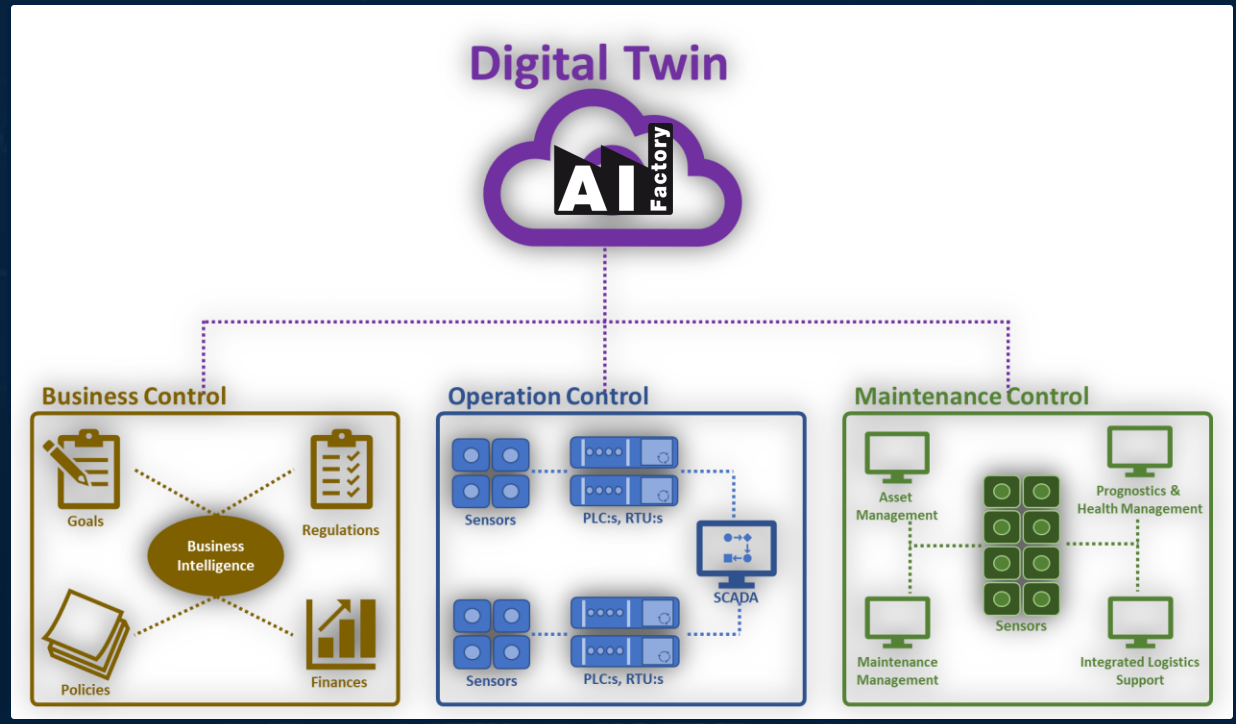
HOW WE DO - OBJECTIVE

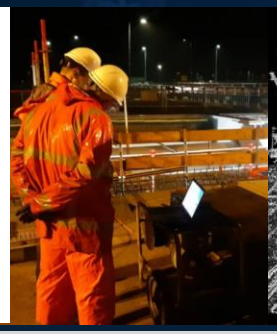
Develop and **demonstrate**
a **digital twin** aimed for
nowcasting and **forecasting**
of machines' health

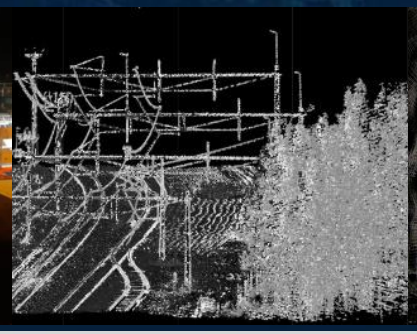
1. What happened in the past
2. Why something happened
3. What will happen in the future
4. ~~What needs to be done next~~ (Not within the scope of the project)

WHAT WE DO – THE PLATFORM

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







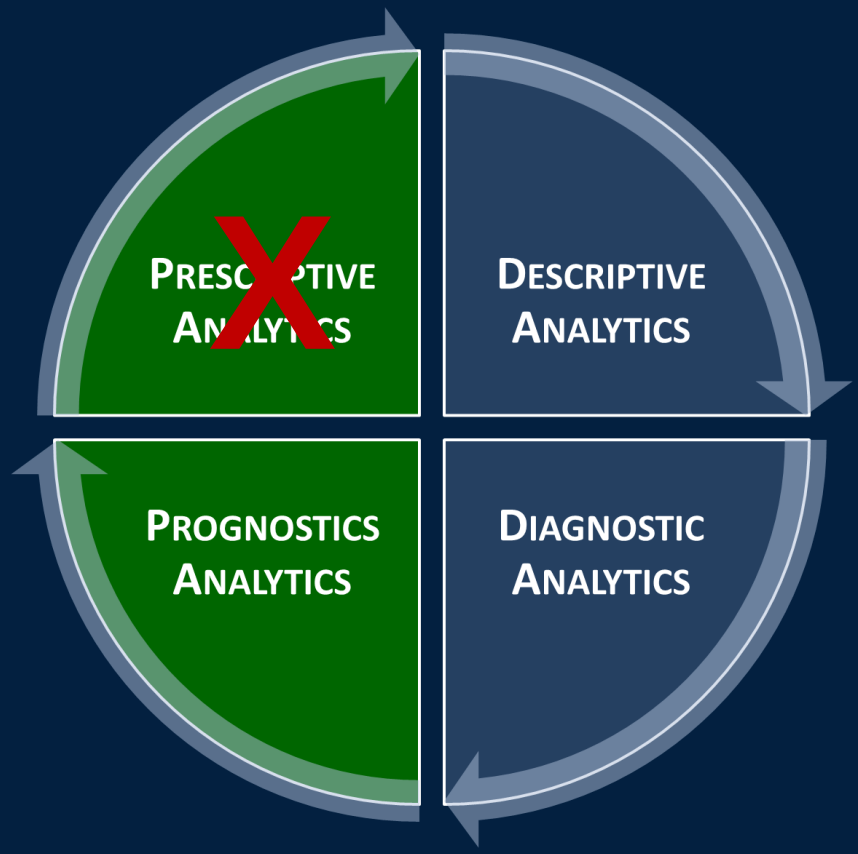
AIFM – PROJECT SCOPE

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

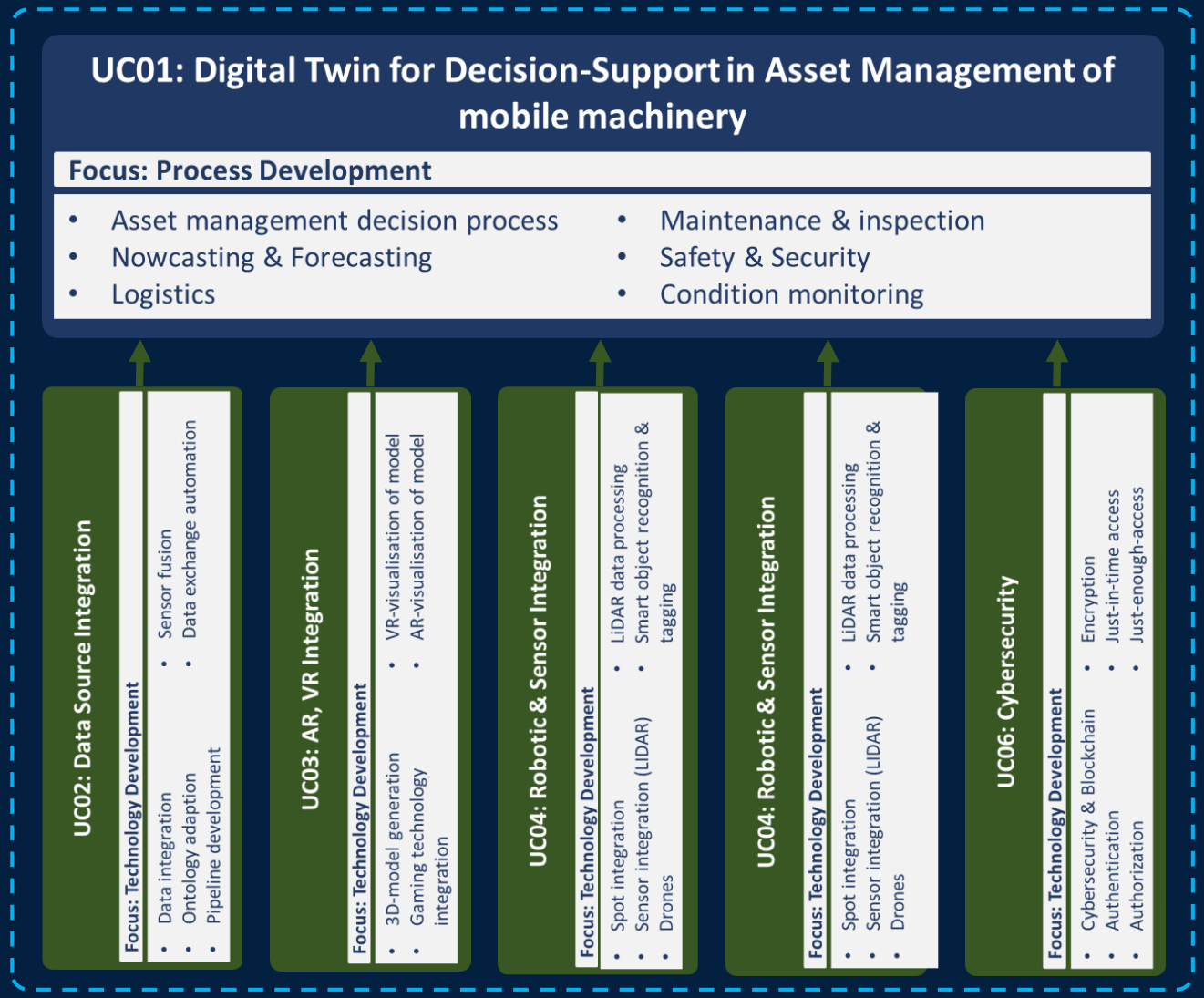
- The project will have a special focus on the components that are identified as **critical** and **significantly impact** the **system availability**
  - Based on the failure analysis phase

AIFM – PHASES

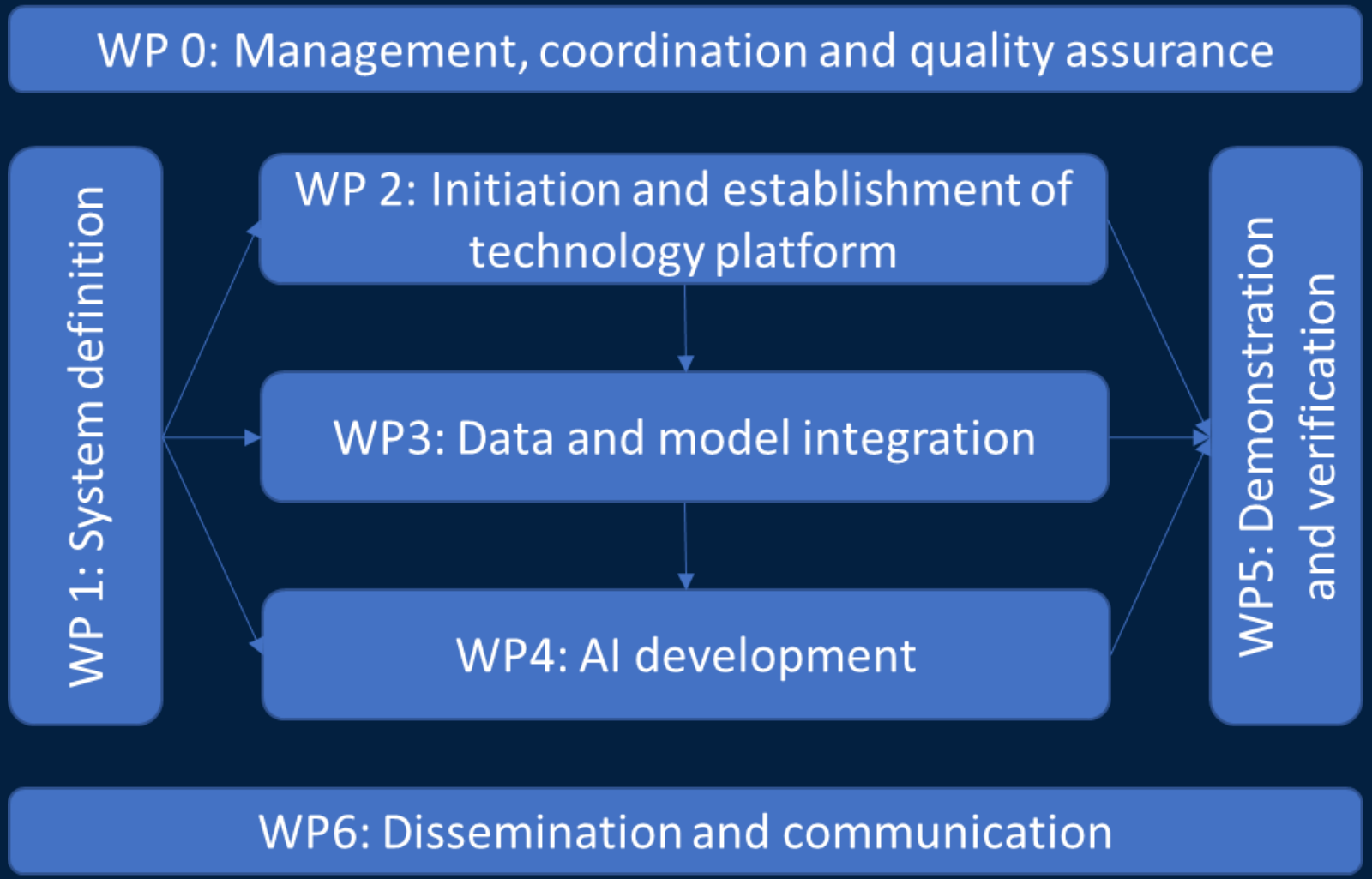
- Phase I: ***Descriptive analysis***
  - Investigate the failure rate for addressed components
  - Identify the failure modes per components
- Phase II: ***Diagnostics***
  - Identify the root-cause per failure mode (reversed FMECA)
  - Data-driven approach
- Phase III: ***Prognostics***
  - Hybrid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



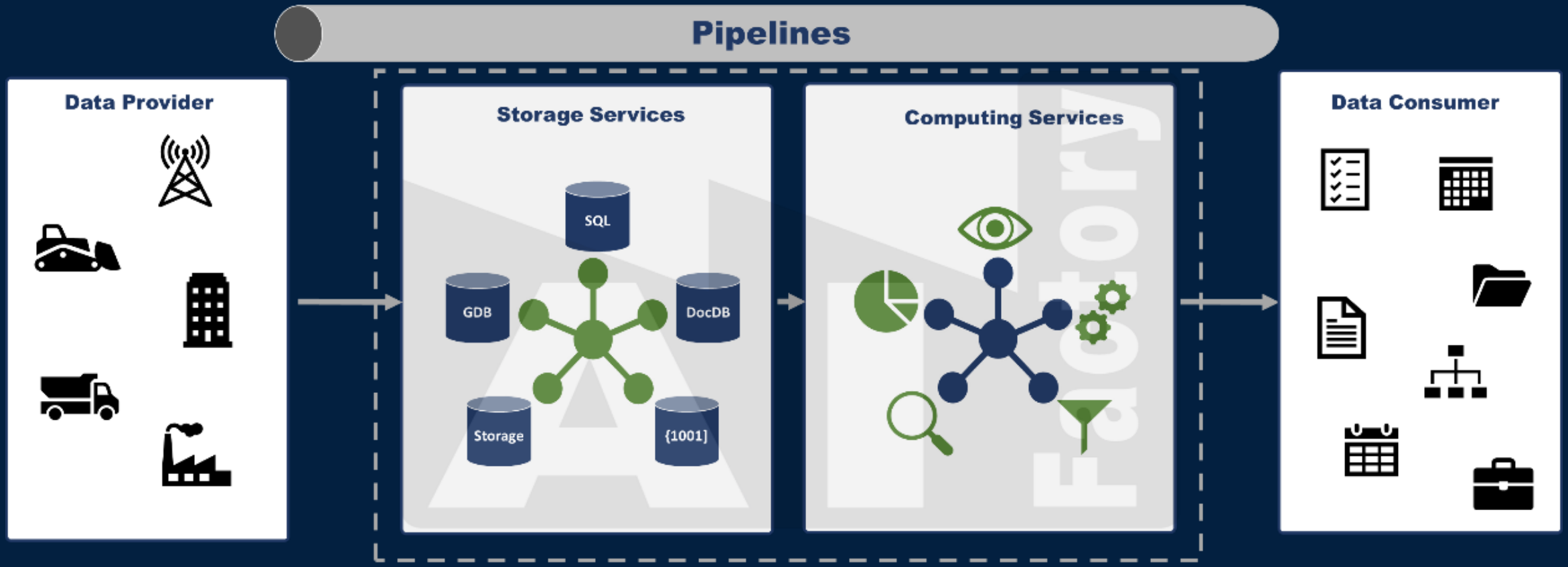
AIF/M - USE CASES



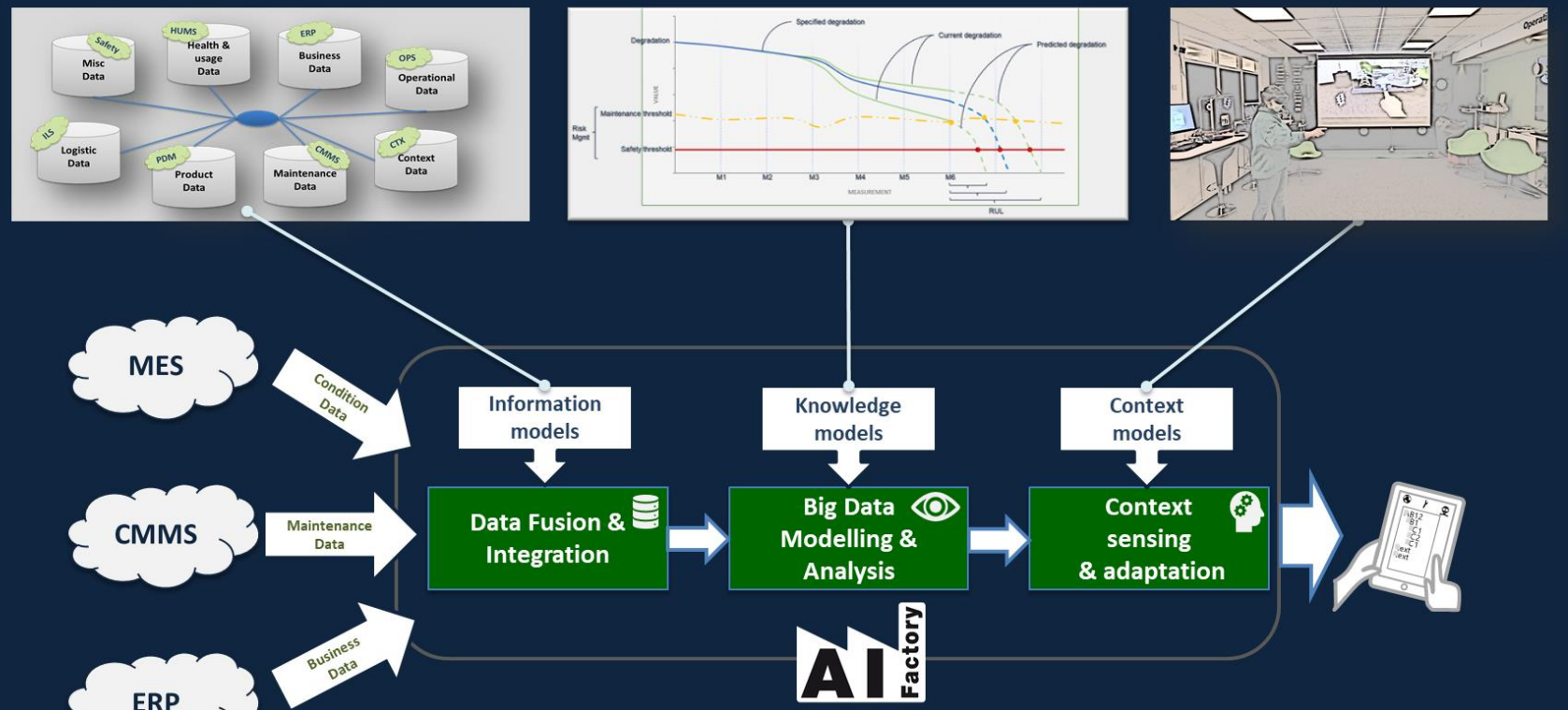
AIF/M – WORK PACKAGES



AIF/M – MICRO-SERVICE-BASED ARCHITECTURE

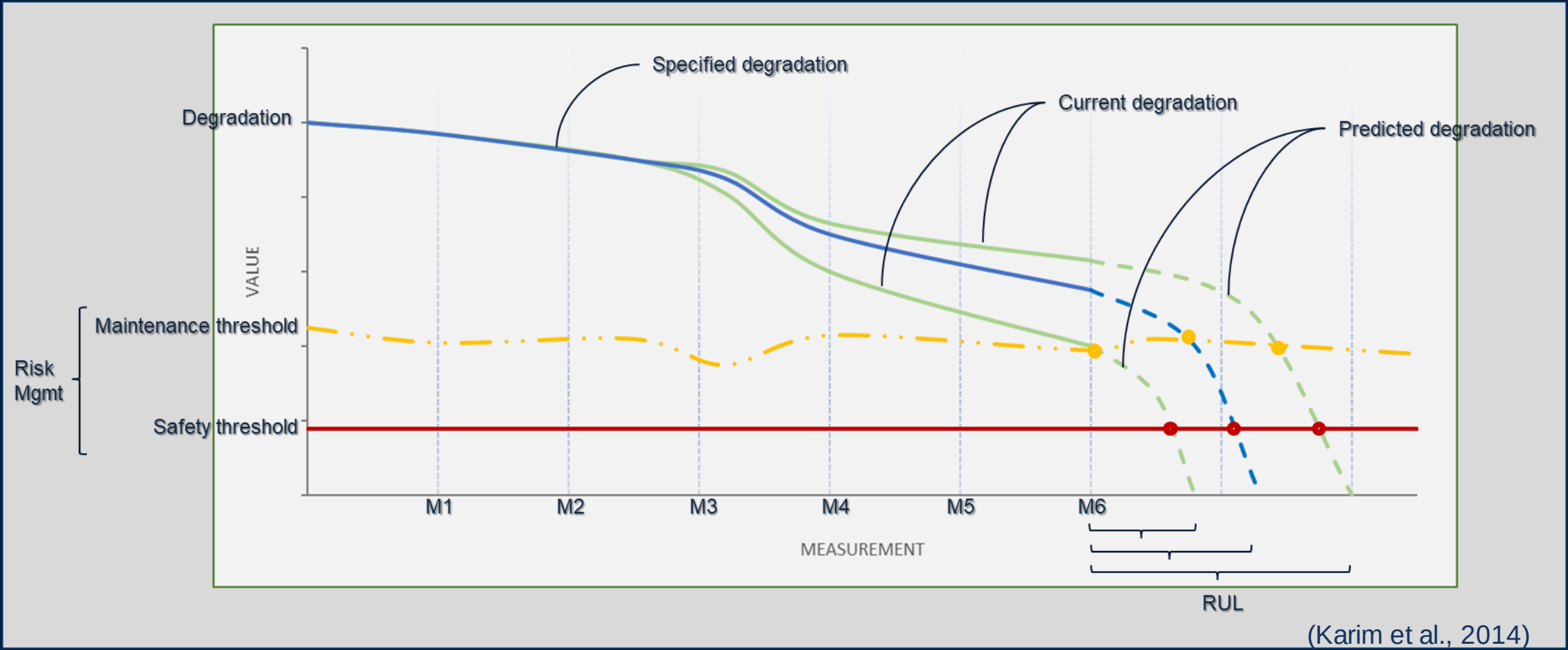


DATA SOURCES FOR ANALYTICS



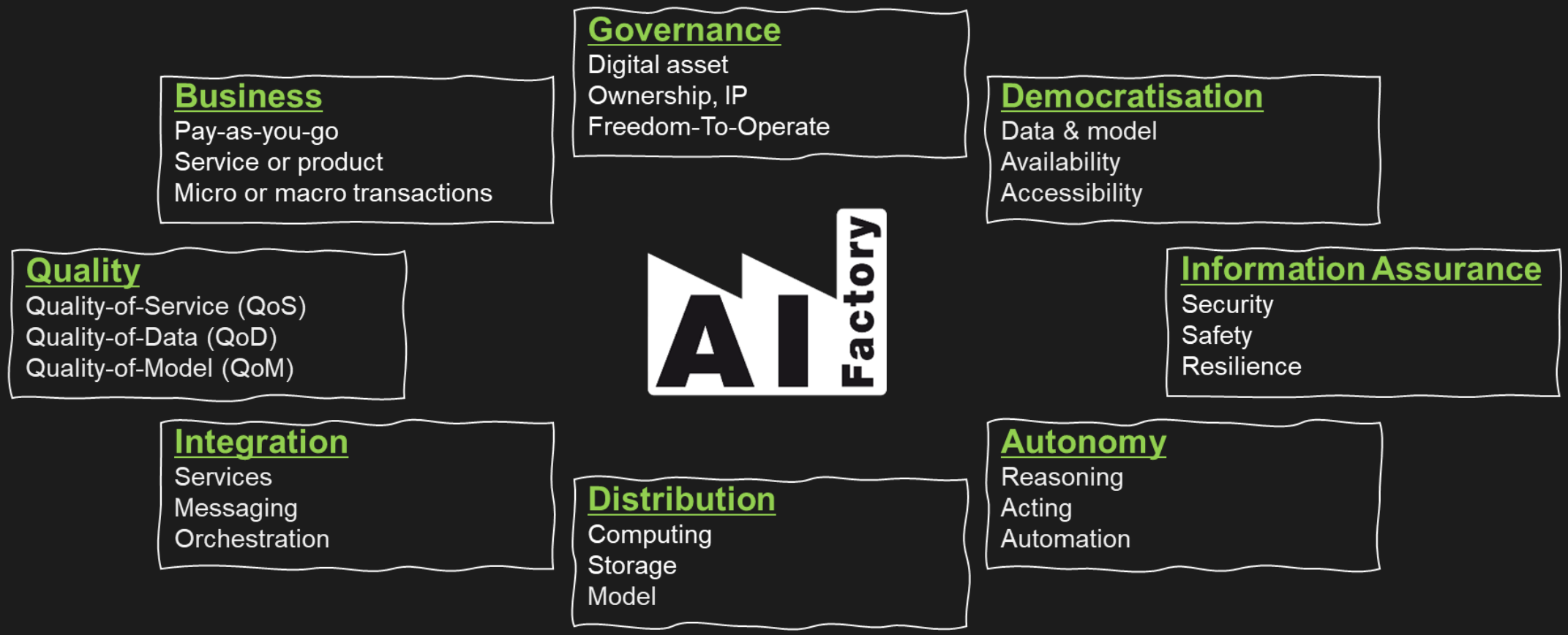
- ERP (Movex, Maximo)
- Vehicle (Onboard sensors)
- Production planning data
- Operation environment data (topology etc.)
- Reliability data (from design, e.g. life expectancy per component)

AIF/M - COGNITIVE CAPABILITIES



(Karim et al., 2014)

AI FACTORY – SCIENTIFIC CHALLENGES



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!