Sensing is life

Digital Twin SURE 5.0 Webinar

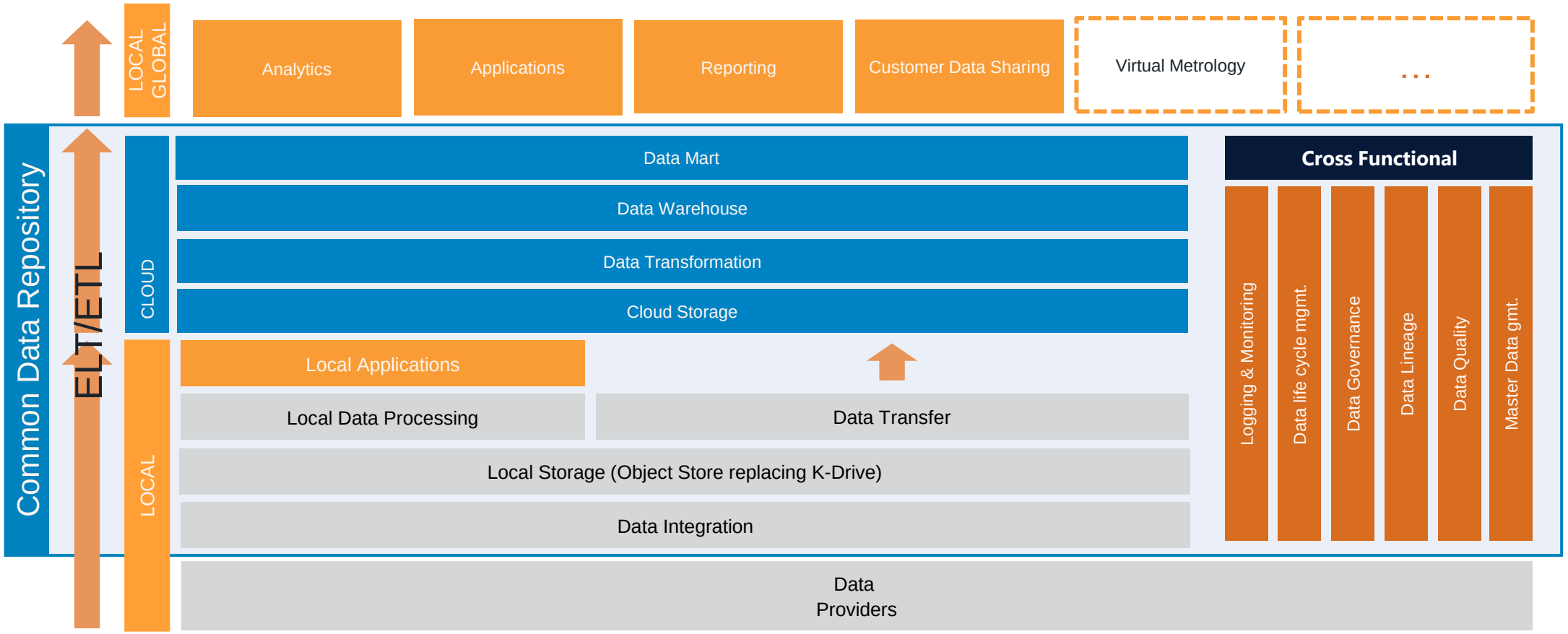
Marcus Gumberger, IT OT, ams-OSRAM International GmbH
17.06.2024, SURE 5.0 Webinar

Agenda

1. Data Architecture – Common Data Repository
2. Digital Twin Modelling and Showcase “Epi Reactor” with AZURE Digital Twin

Common Data Repository….

…. is about establishing a **harmonized data architecture** starting at
local sites to global,
on prem to cloud,
production and enterprise data,
to provide centrally data to internal and external customers and enable new ways of working with data.



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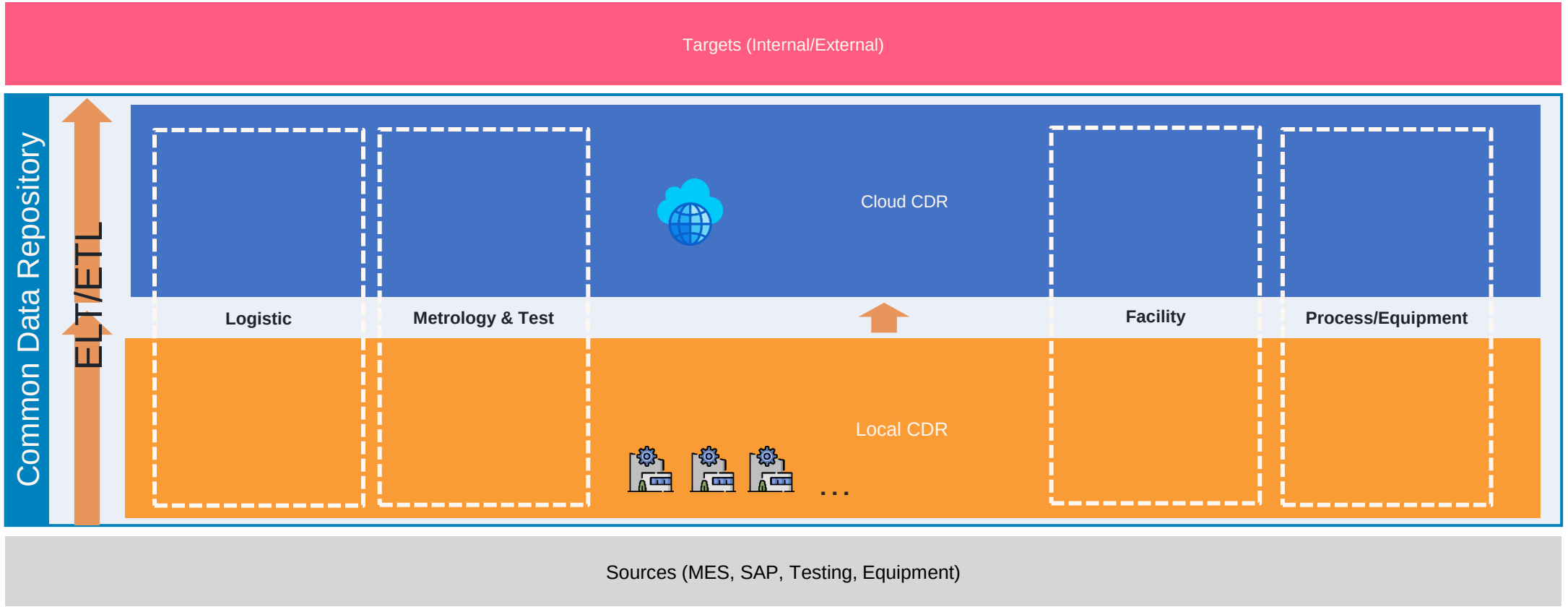
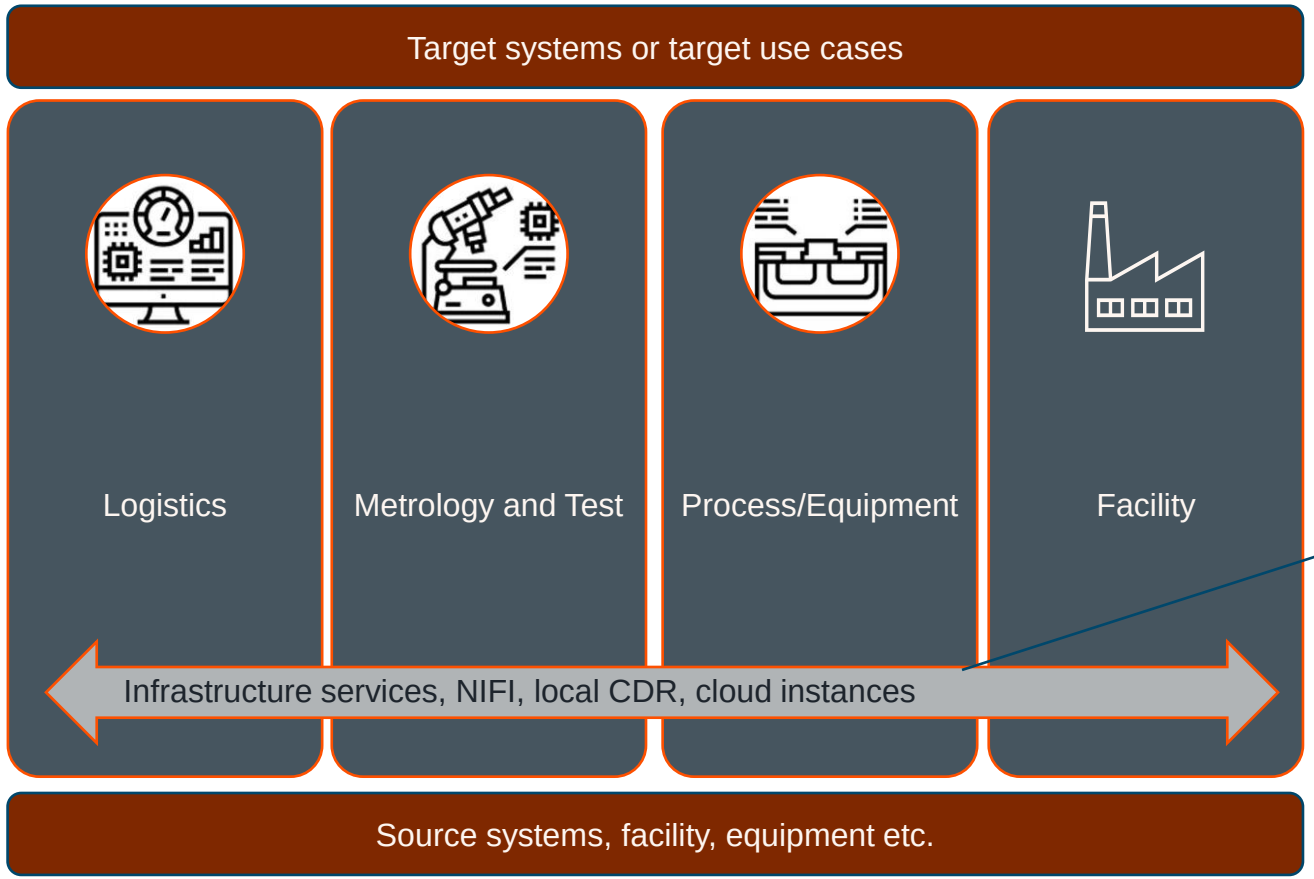


CDR – Team organization – setup with agile SAFe concept

- Will follow e-2-e responsibility design guideline
- Data domains bound together by joint user story decisions and common target architecture
- Technical service will enable standards across domains and procurement of architectural components



Central services (middle-ware team) will provide baseload services and ensure standards are being availabe adn used

Disclaimer
There may be use cases or areas, where the model is difficult to apply.
Those will ask for managerial creativity and we decide jointly on the spot…

Agenda

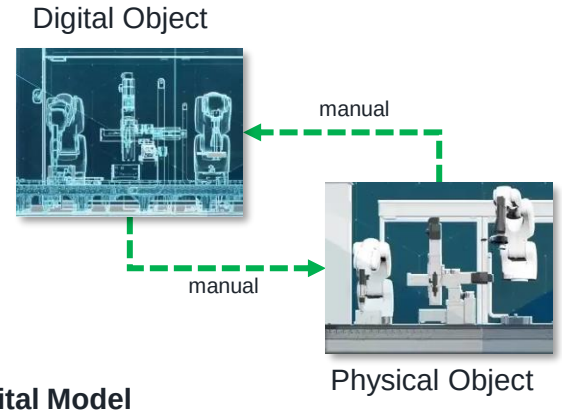
1. Data Architecture – Common Data Repository
2. Digital Twin Modelling and Showcase “Epi Reactor” with AZURE Digital Twin

Azure Digital Twins

Definitions

A **Digital Twin** is a digital representation of an intended or actual real-world physical product, system, process or person that serves as the digital counterpart of it for practical purposes, such as simulation, integration, testing, monitoring, maintenance…

Showcase

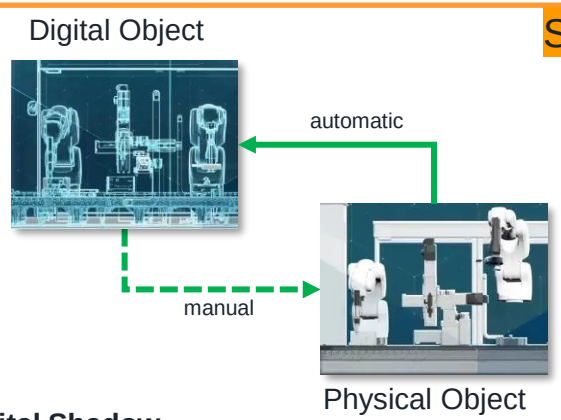


Digital Model

⇒ Digital version of a physical object

⇒ No automatic data exchange between the physical model and digital model, changes are manual

⇒ E.g., CAD model of a building

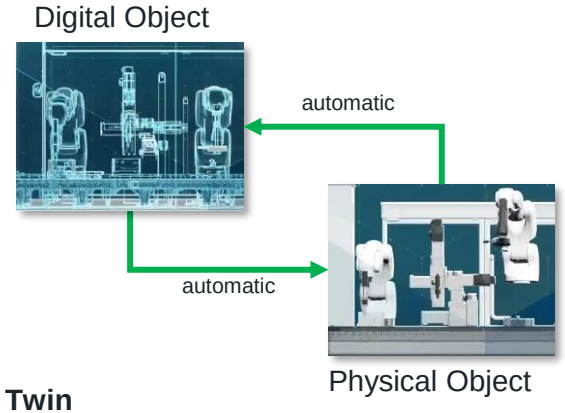


Digital Shadow

⇒ Digital representation of a physical object

⇒ Automatic data flow from physical to digital object – way back from digital to physical is only manual

⇒ E.g., data logs from a real production process



Digital Twin

⇒ Automatic data flows between physical and digital object

⇒ A change made to the physical object leads to a change in the digital object and vice versa

⇒ E.g., Tesla collects data from their cars in digital twins and pushes updates back to the car

Digital Thread (Chain)

⇒ "… is a communication framework that connects traditionally siloed elements in manufacturing processes and provides an integrated view of an asset throughout the manufacturing lifecycle" (2)

(1) Derived from: Fuller, Aidan & Fan, Zhong & Day, Charles. (2020). Digital Twin: Enabling Technologies, Challenges and Open Research, DOI 10.1109/ACCESS.2020.2998358, IEEE Access, pictures taken from plm.automation.siemens.com

(2) Diann Daniel in https://www.techtarget.com/searcherp/definition/digital-thread)

Azure Digital Twins

Digital Twin Modelling

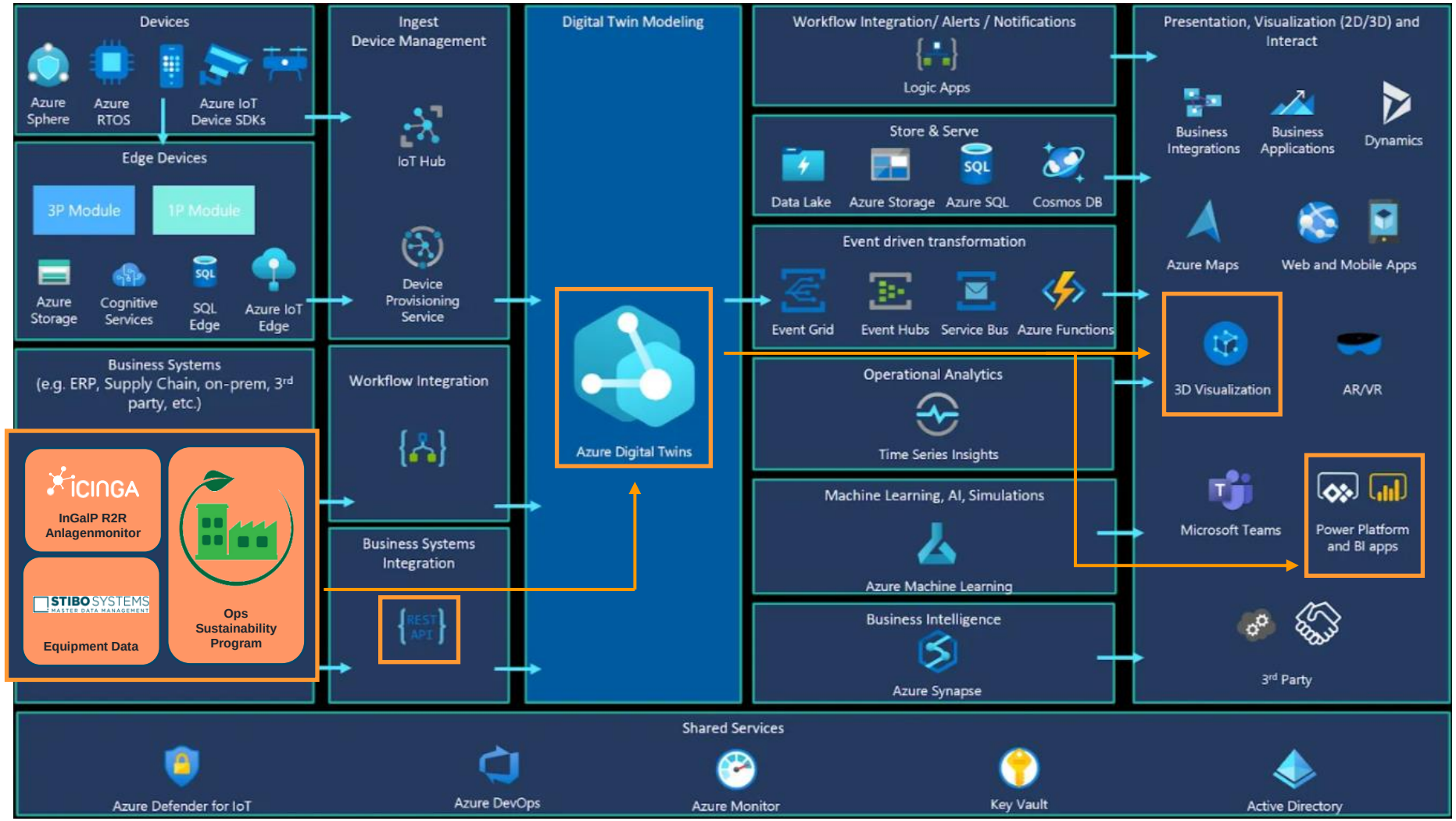
Model Information


```
{
 "@context": "dtmi:dtdl:context;2",
 "@id": "dtmi:amsosram:it:ot:OSBaseModel;1",
 "@type": "Interface",
 "displayName": "OSBaseModel",
 "description": "Abstract base model for all OS models",
 "comment": "",
 "contents": [
  {
   "@type": "Property",
   "name": "id",
   "displayName": "_ID",
   "schema": "string",
   "description": "Objects in the information model which require unique identifications"
  },
  {
   "@type": "Property",
   "name": "type",
   "displayName": "_Object Type",
   "description": "Object Type",
   "schema": {
    "@type": "Enum",
    "valueSchema": "string",
    "enumValues": [
     {
      "name": "Enterprise",
      "displayName": "Enterprise",
      "enumValue": "enterprise"
     },
```


- Digital Twin models are described using the *JSON-LD*-based “**Digital Twins Definition Language**” (DTDL, open source on GitHub)
- Models are like classes in object-oriented programming languages
- Models describe twins in terms of **telemetry**, **properties**, **commands**, **relationships** and **components**
- Models define semantic relationships to connect twins into a **twin graph**
- Inheritance can be used to “specialize” twin models from “parent” models
- A set of models that comprehensively describe a given domain, like manufacturing, building structures, IoT systems and more, is an **ontology**. Open-source DTDL ontologies that has been built on widely accepted industry standards (e.g., Open Digital Twins - Asset Administration Shell) can be adopted/extended.

Azure Digital Twin

Architecture of Showcase “EPI Reactors”



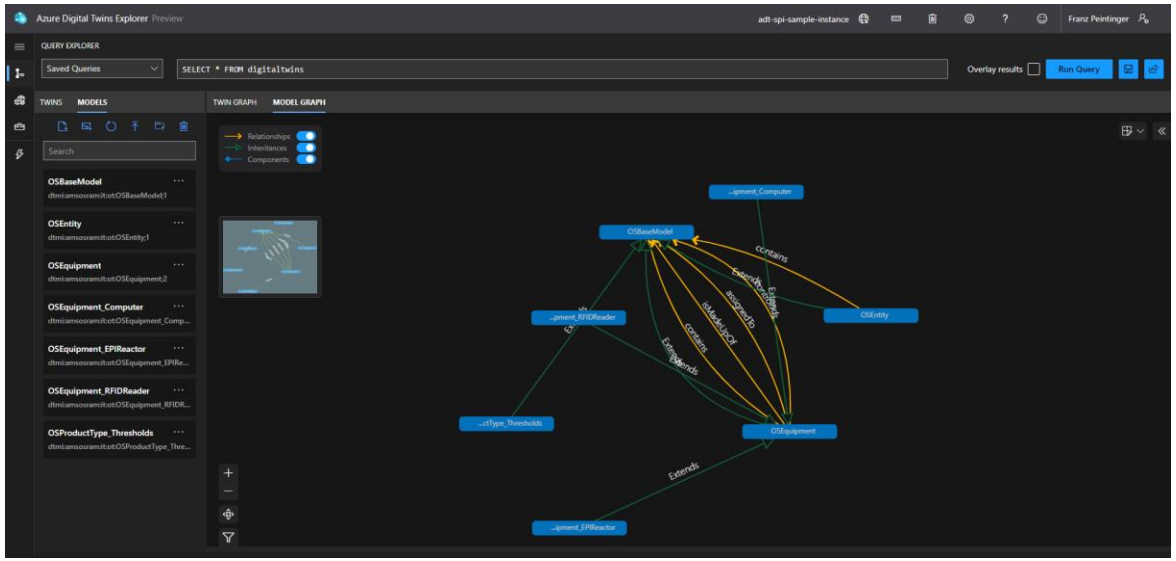
Integrated business systems:

- STIBO Step MDM: Equipment data for twin modelling (properties and relations)
- InGaIP R2R Anlagenmonitor: R2R process states (Icinga dashboard,owned by IT OT PDE) **Downtimes**
- Ops Sustainability Program: Energy and **media consumption** data (data extraction sample from WinCC/FM)

Azure Digital Twins

Digital Twin Modelling

Tool: Azure Digital Twins Explorer (Preview)



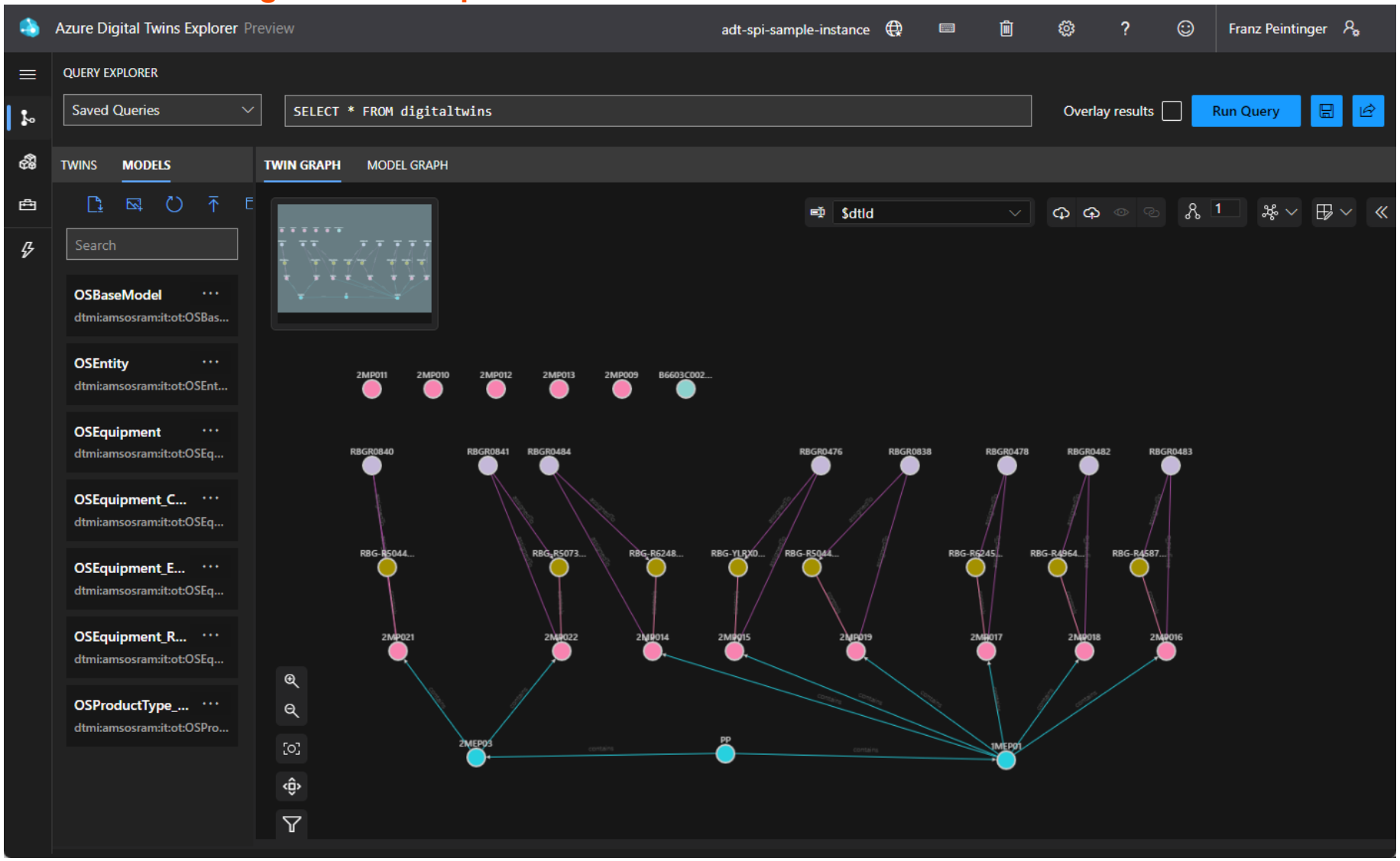
Microsoft's **Azure Digital Twins Explorer** (cloud service, in preview) provides a GUI for creating digital twin models, offering a rich set of features for describing their contents, including properties, components, inheritance, and more.

The tool lets users also view digital twin models and instances, as well as their relationships (twin graph).

https://explorer.digitaltwins.azure.net/

Azure Digital Twins

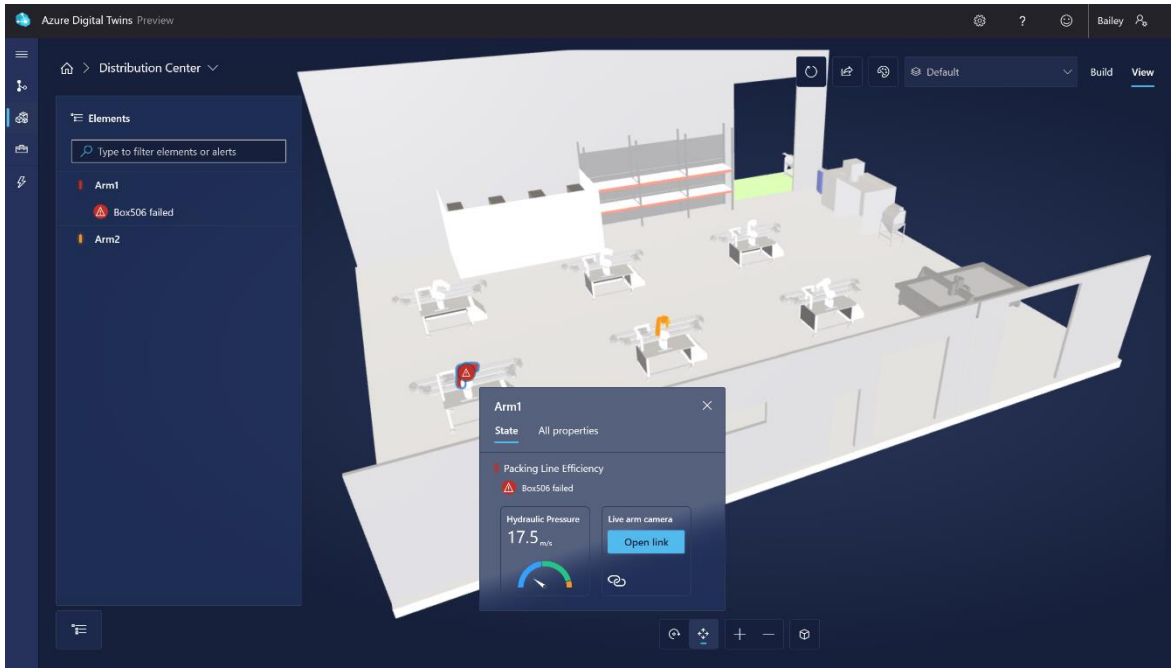
Demo Screenshot “Azure Digital Twins Explorer”



Azure Digital Twins

Showcase Simulations

Tool: Azure Digital Twins 3D Scenes Studio (Preview)



Azure Digital Twins 3D Scenes Studio is an immersive 3D environment, where users can consume and investigate operational data from their Azure Digital Twins solutions with visual/spatial context.

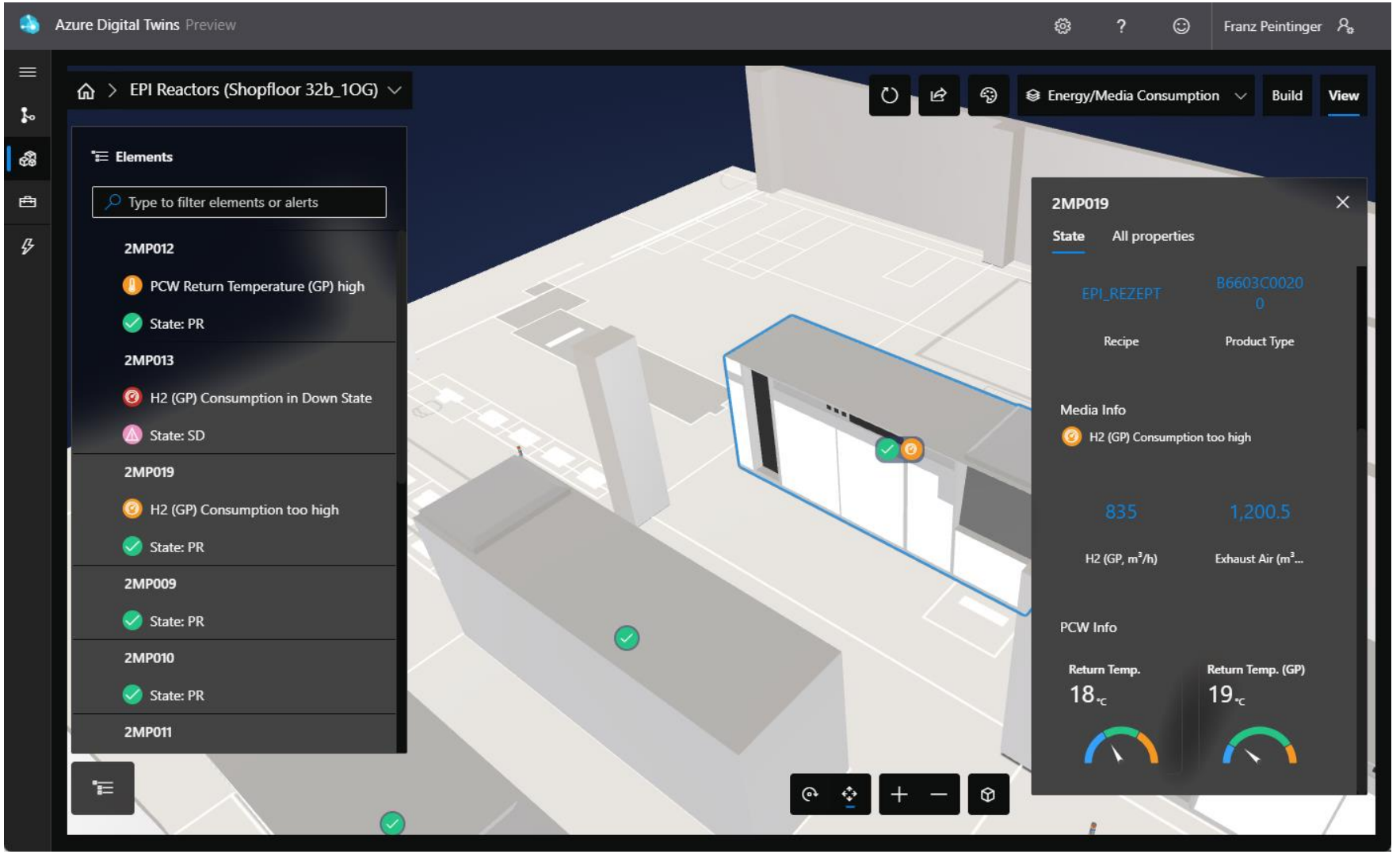
The tool is in public preview and is based on an open source React Component Library intended for creating internet of things (IoT) web experiences.

Azure Digital Twins

Demo Screenshot “Azure Digital Twins 3D Scenes Studio”

Azure Digital Twins

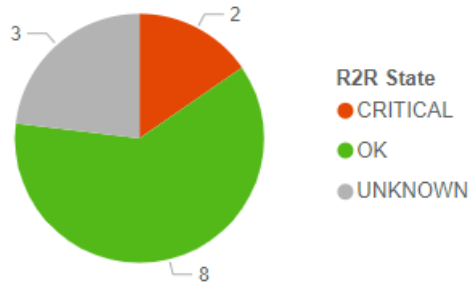
Demo Screenshot “Azure Digital Twins 3D Scenes Studio”



Azure Digital Twins

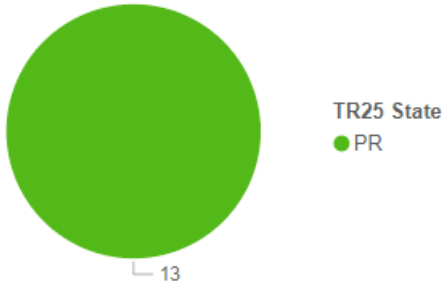
Demo Screenshot “Digital Twins Report”

EPI Reactors by R2R State



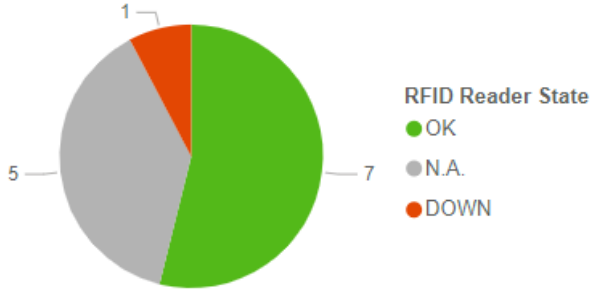
$dtId	r2rState	r2rStateInfo
2MP009	0	OK since 03:07
2MP010	0	OK since 03:07
2MP011	0	OK since 03:07
2MP012	4	Unknown
2MP013	4	Unknown
2MP014	0	OK since 06:48
2MP015	2	CRITICAL since 03:07
2MP016	4	Unknown
2MP017	0	OK since 07:20
2MP018	0	OK since 03:07
2MP019	0	OK since 03:53
2MP021	0	OK since 03:07
2MP022	2	CRITICAL since 05:10

EPI Reactors by TR25 State



$dtId	tr25State	tr25StateInfo
2MP009	PR	Productive
2MP010	PR	Productive
2MP011	PR	Productive
2MP012	PR	Productive
2MP013	PR	Productive
2MP014	PR	Productive
2MP015	PR	Productive
2MP016	PR	Productive
2MP017	PR	Productive
2MP018	PR	Productive
2MP019	PR	Productive
2MP021	PR	Productive
2MP022	PR	Productive

EPI Reactors by RFID Reader State

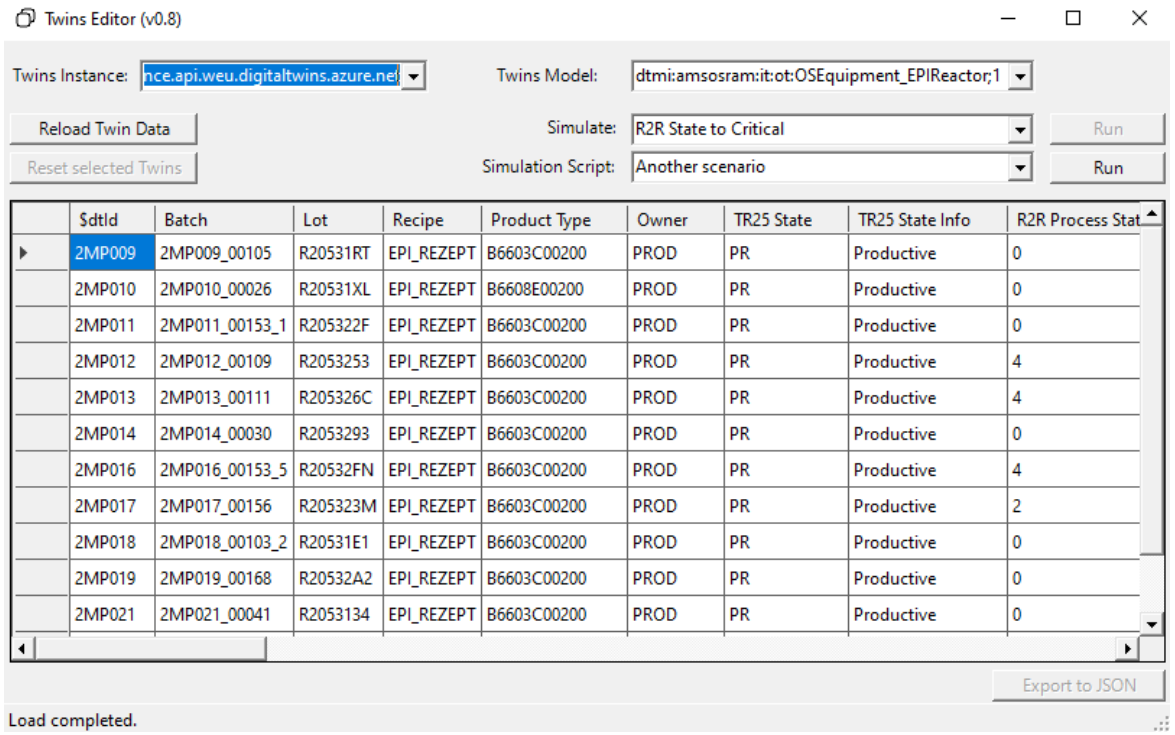


$dtId	rfidReaderState	rfidReaderStateInfo
2MP009	N.A.	No reader assigned.
2MP010	N.A.	No reader assigned.
2MP011	N.A.	No reader assigned.
2MP012	N.A.	No reader assigned.
2MP013	N.A.	No reader assigned.
2MP014	OK	No problems.
2MP015	OK	No problems.
2MP016	DOWN	No ping!
2MP017	OK	No problems.
2MP018	OK	No problems.
2MP019	OK	No problems.
2MP021	OK	No problems.
2MP022	OK	No problems.

Azure Digital Twins

Showcase Simulations

Tool: Twins Editor



	$dtId	Batch	Lot	Recipe	Product Type	Owner	TR25 State	TR25 State Info	R2R Process Stat
▶	2MP009	2MP009_00105	R20531RT	EPI_REZEPT	B6603C00200	PROD	PR	Productive	0
	2MP010	2MP010_00026	R20531XL	EPI_REZEPT	B6608E00200	PROD	PR	Productive	0
	2MP011	2MP011_00153_1	R205322F	EPI_REZEPT	B6603C00200	PROD	PR	Productive	0
	2MP012	2MP012_00109	R2053253	EPI_REZEPT	B6603C00200	PROD	PR	Productive	4
	2MP013	2MP013_00111	R205326C	EPI_REZEPT	B6603C00200	PROD	PR	Productive	4
	2MP014	2MP014_00030	R2053293	EPI_REZEPT	B6603C00200	PROD	PR	Productive	0
	2MP016	2MP016_00153_5	R20532FN	EPI_REZEPT	B6603C00200	PROD	PR	Productive	4
	2MP017	2MP017_00156	R205323M	EPI_REZEPT	B6603C00200	PROD	PR	Productive	2
	2MP018	2MP018_00103_2	R20531E1	EPI_REZEPT	B6603C00200	PROD	PR	Productive	0
	2MP019	2MP019_00168	R20532A2	EPI_REZEPT	B6603C00200	PROD	PR	Productive	0
	2MP021	2MP021_00041	R2053134	EPI_REZEPT	B6603C00200	PROD	PR	Productive	0

The **Twins Editor** is a self-developed tool that allows you to change twin property values and perform certain scenarios within the simulation environment.

Uses Azure CLI (PowerShell) with extensions for ADT.

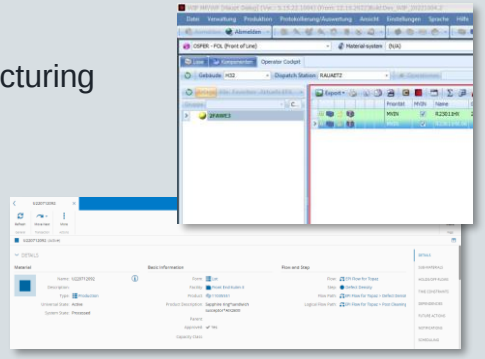
Azure Digital Twins

Potential Use Cases

There are quite a few building blocks there today – most of them are Digital Models or Shadows which can contribute to a Digital Thread, only a few have initial Digital Twin characteristics…

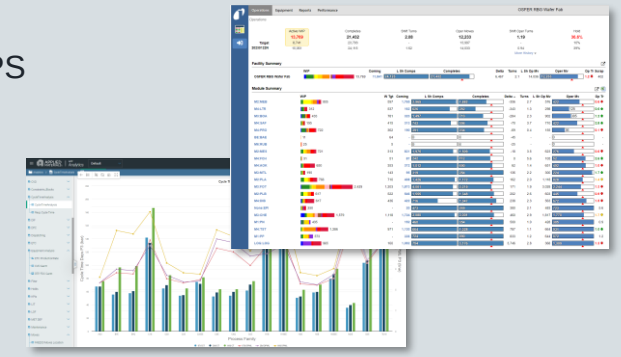
MES systems / Equipment Integration

- ProTOS
- Critical Manufacturing
- Gefasoft
- Promis
- FactoryLook



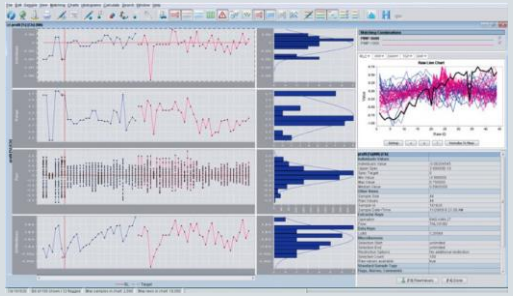
Planning and Scheduling systems

- FPS
- GDPS
- RTD
- LDS



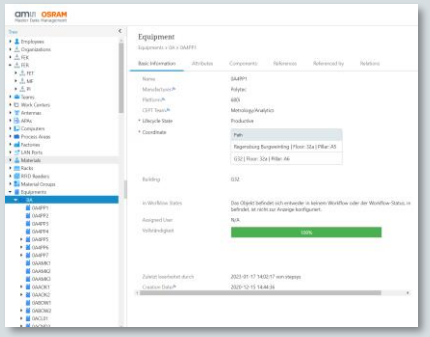
Other Production systems

- YMS
- FDC
- R2R
- SPACE
- TADOS
- EADOS
- MTS



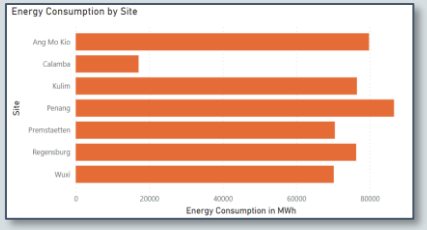
Master Data / systems

- Stibo/STEP
- SAP
- CAD (Layouts)



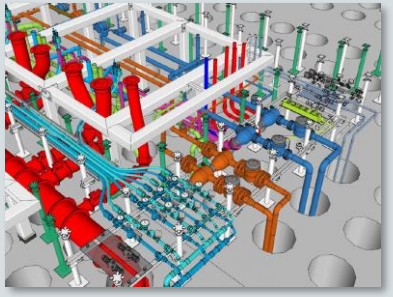
Energy Management Systems

- Global Project active to evaluate Global Energy Management platform
- Systems existing
  - KMI Tool
  - WinCC/ACRON
  - Schneider



Modelling / Simulation systems

- anySIM
- SHK/SemiSoft
- BIM systems planned for TOPAZ / KamBa
- FabSim
- FabLIVE (CM)



Azure Digital Twins

Potential Use Cases

- Production Line Monitoring
- Supply Chain Monitoring
- Monitoring Shipping between Front-End/Back-End
- End2End Views

An application example of a digital twin solution in semiconductor production:

The American semiconductor manufacturer Globalfoundries (GF) is already successfully using predictive maintenance with the help of digital twins. It recently began using intelligent sensor technology to monitor its ultrapure water valves at its Dresden site. The valves are critical to production and were previously monitored analogously by employees at great expense. Globalfoundries is now recording audio data on the valves in order to create a data model using machine learning methods. In combination with continuously recorded sensor data, this enables an assessment of the current status and a forecast of the expected changes to the valves.

Azure Digital Twins

Global Industrial IoT Platforms

According to Gartner study: (studies always have to be taken with care and you should make your own opinion)

Strengths

- Microsoft has a **large partner ecosystem**, and end-user organizations will have several integrators and technology partners to choose from for most industries and regions.
- Microsoft demonstrates **deep knowledge and support for complex security profiles** along with supporting software (Azure Defender, Azure Sphere and Azure RTOS).
- Microsoft demonstrates **expertise in adjacent supporting capabilities**, including database management, data integration, advanced analytics, visualization, enterprise app integration, security, and support for citizen developers.

Cautions

- The breadth and complexity of the product portfolio can cause **confusion for customers**, as well as delivery partners, and delay project completion and increase project cost.
- The **complex pricing structure** and contract negotiations require enterprises to assess project business objectives and clarify how the IIoT platform aligns to them.
- **Inconsistency of customer experience** across regions, industries and technology partners will require enterprises to set clear project objectives and measurable outcomes.

Sensing is life

Sensing is life

Revolutionizing Design of Experiments using Bayesian Optimization

Lavinia Israel, Daniel Grünbaum
17/06/2024 | SURE 5.0 webinar

ams OSRAM at a glance

3.59bn
EUR revenues FY 2023

5,500+
Engineers

20,000+
Customers

~20,000
Employees worldwide

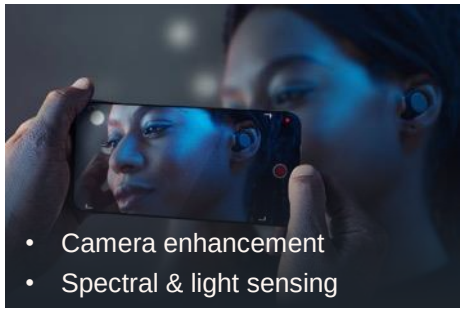
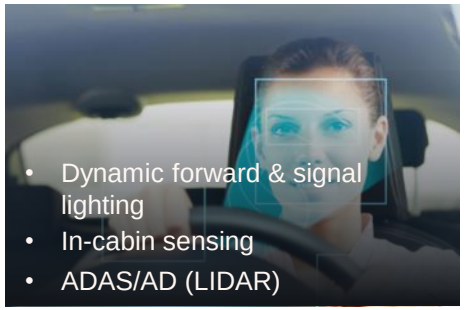
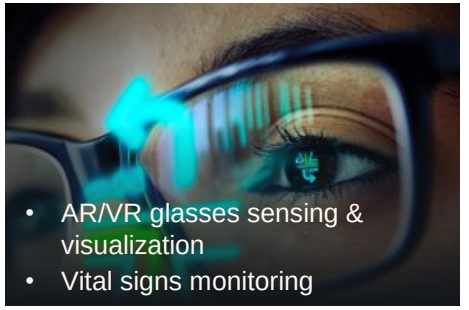
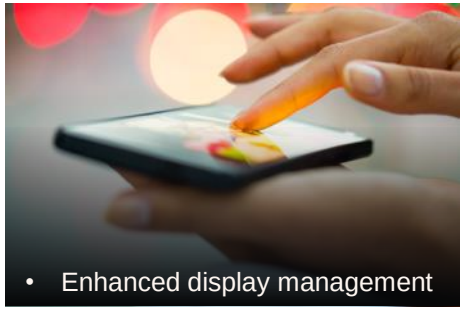
~52/28/19%
AUT/I&M/Consumer revenue split FY 2023
AUT – Automotive, I&M – Industrial & Medical

40+
Major R&D locations

15,000+
Patents granted and applied for

110+
Years design + manufacturing

Our core portfolio addresses secular megatrends

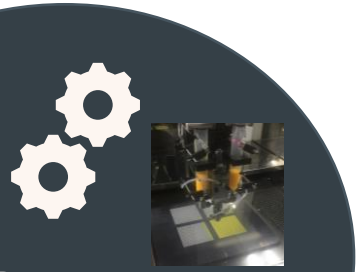
	Automotive	Industrial	Medical	Consumer
Digitalization				
Smart Living (IoT)				
Energy efficiency & sustainability				

Why do we need Design of Experiments?

→ **Reduce number of measurements to gain efficiency**

Find **best** x1*, x2*, x3* to reach target(s)

Inputs:
Input x1
Input x2
Input x3
…

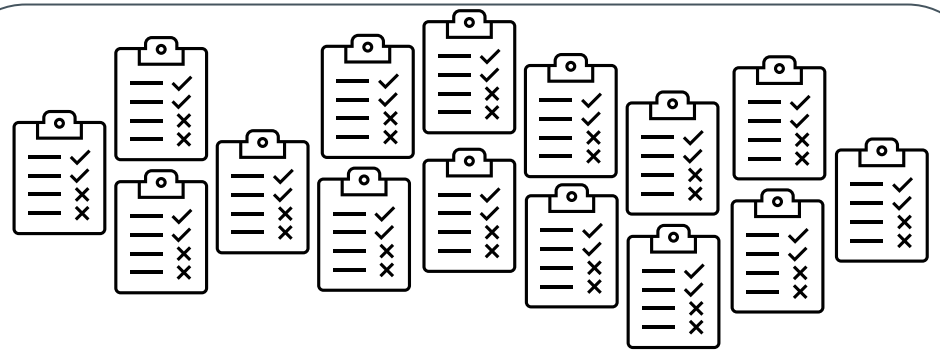


Process (Development, Production, …)

Outputs:
Output y1
Output y2
…

Target:
Target y1*
Target y2*
…

Trial & Error

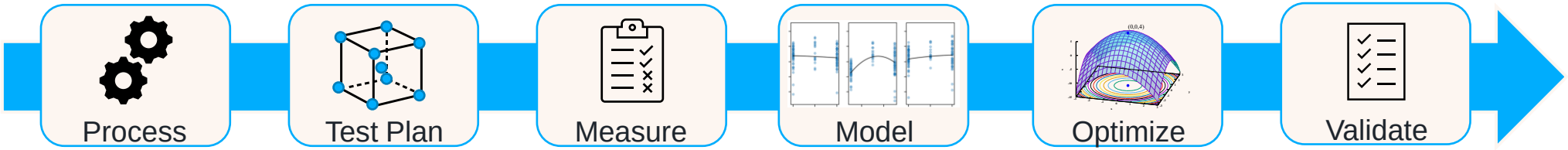


Measurements are expensive and time consuming

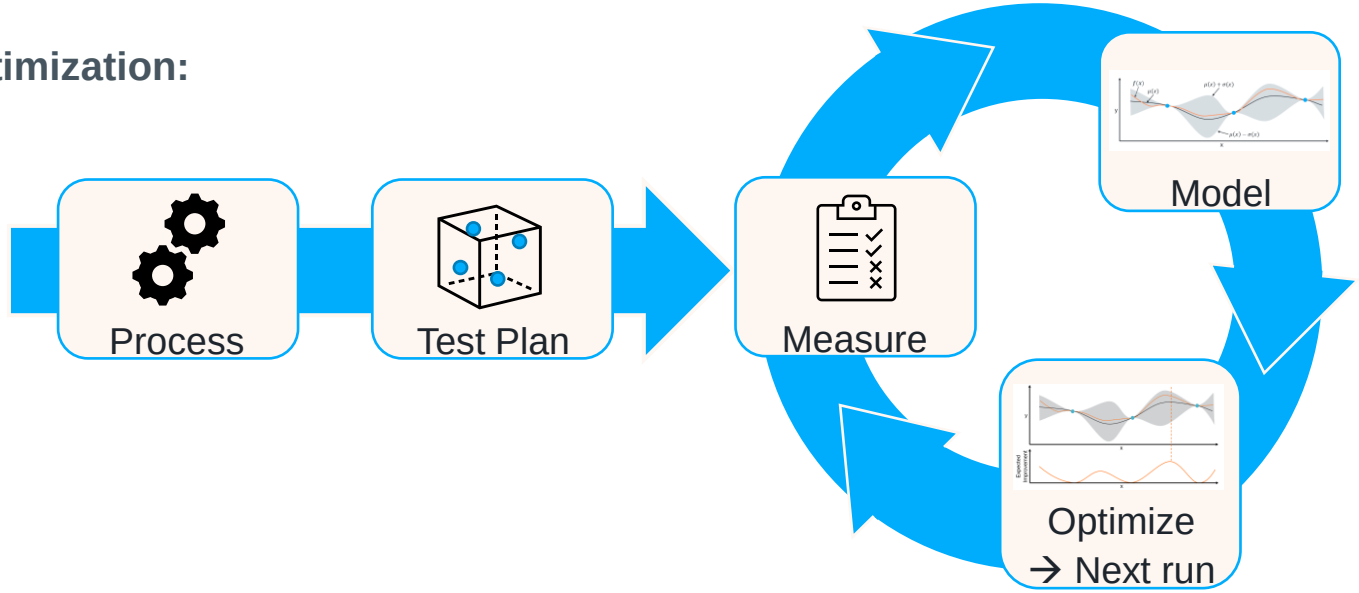
Method:
- Design of Experiments
- **Bayesian Optimization**

Design of Experiments vs Bayesian Optimization

Classical Design of Experiment (DoE):

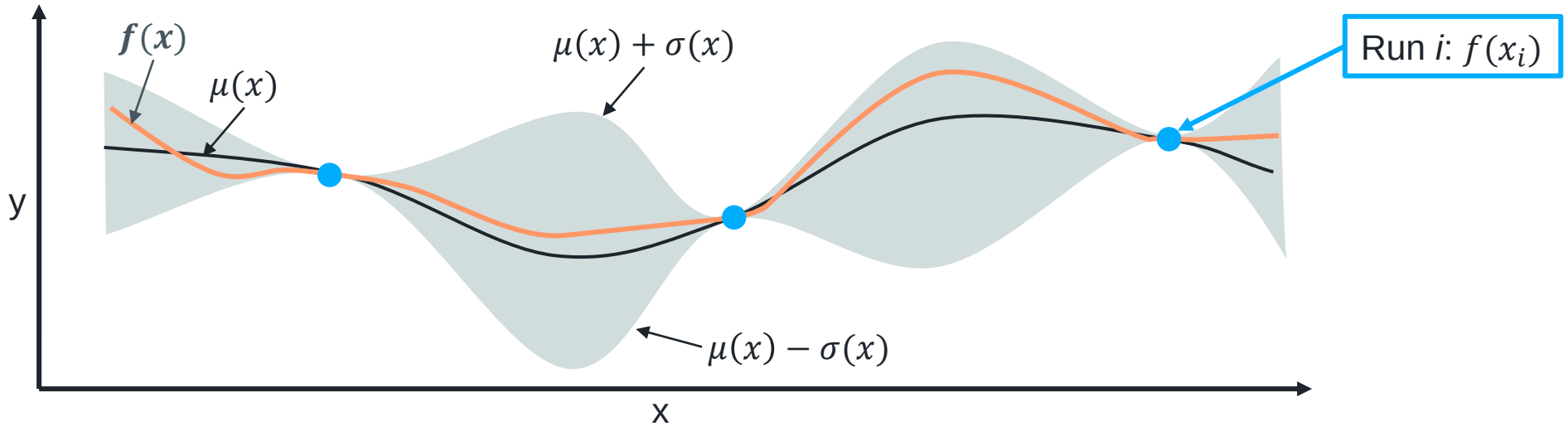


Bayesian Optimization:



Bayesian Optimization

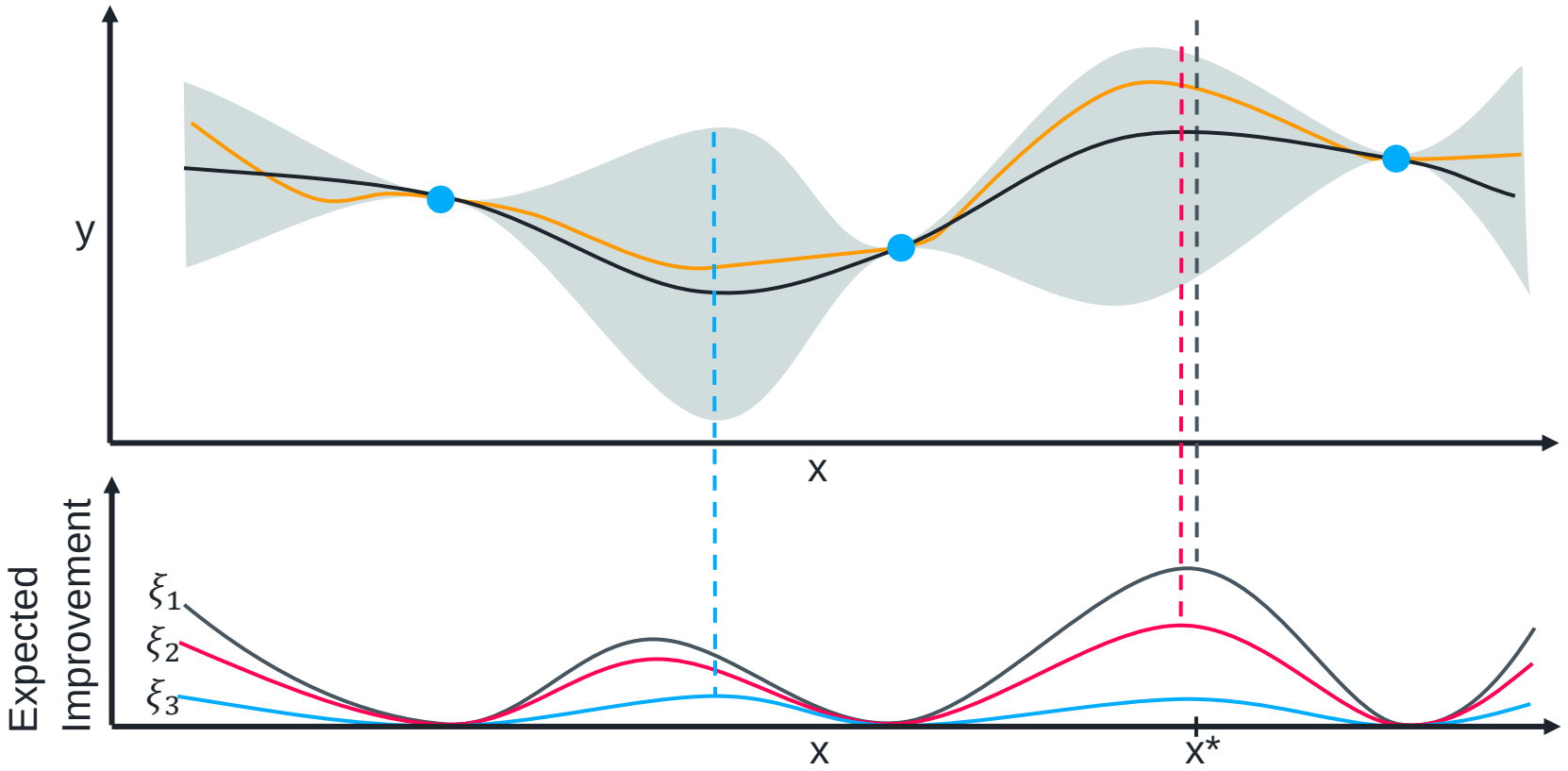
Fitting Gaussian Processes



- Unknown function $f(x)$ where we want to find the maximum
- We know the function only at a few points
- Fitting a Gaussian process gives a point-wise estimation $\mu(x)$ of the unknown function
- Gaussian process also gives a value for the uncertainty of our function fit $\mu(x) \pm \sigma(x)$

Bayesian Optimization

How to choose the next point?



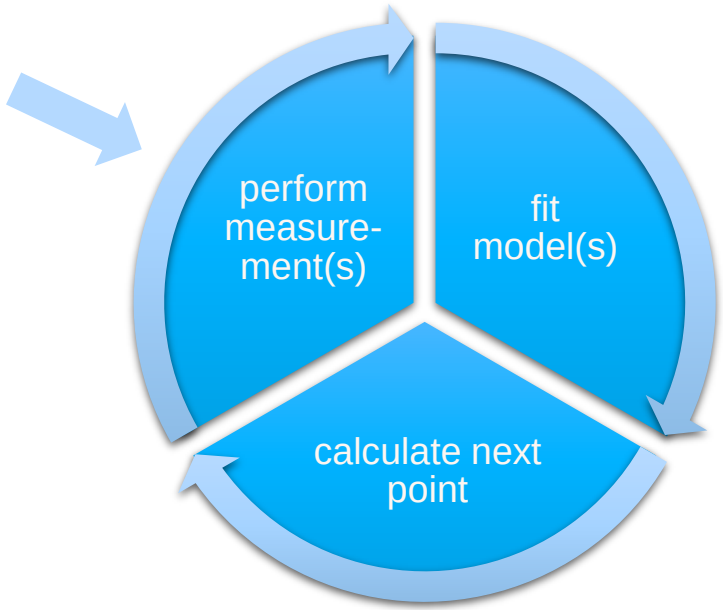
- Use an acquisition function to calculate the next point, e. g. expected improvement EI(x)
- Find x* = argmax EI(x) → next point to evaluate
- Hyperparameter ξ: exploration vs exploitation

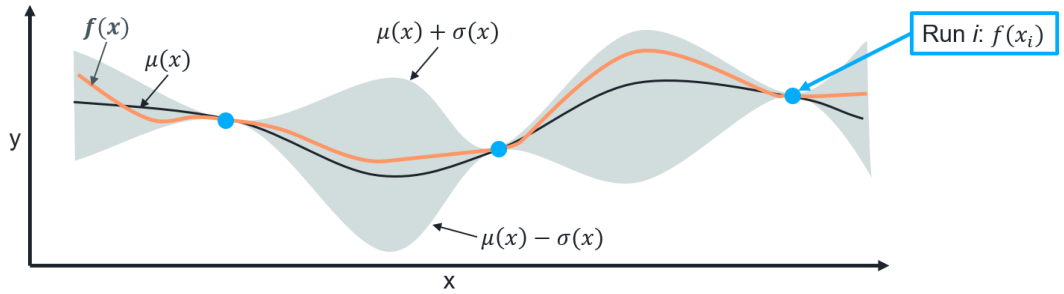
Bayesian Optimization

Sequential design strategy for global optimization of expensive-to-evaluate black-box functions

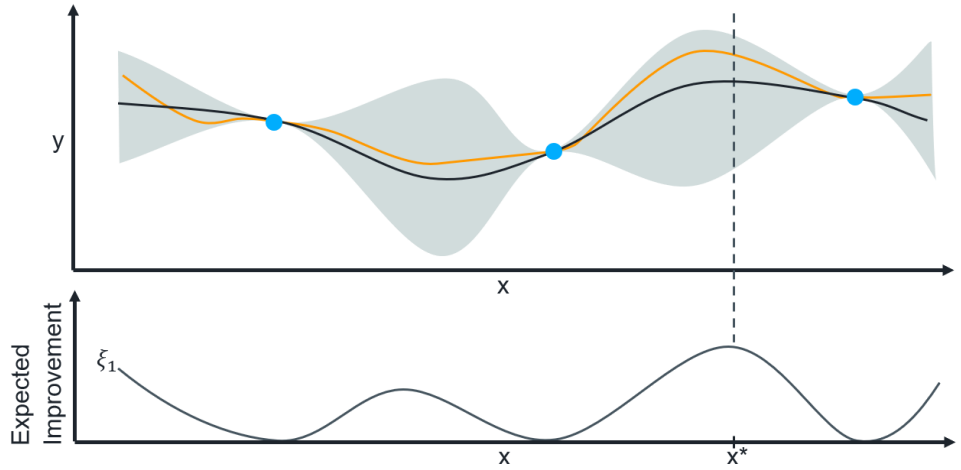
Start with small initial test plan (space-filling)

Run	phosphor_content	p_atom	z_height	dot_pitch
1	1.56	2.4	89	5
2	1.44	2.1	81	7,5
3	1.33	3	67	7,2
4	1.67	3.1	80	5,1
5	1.6	3.9	70	6,7
6	1.35	3.6	62	6
7	1.78	3.8	73	7,9
8	1.26	2.6	63	5,6
9	1.66	2.7	86	6,4
10	1.71	2.2	68	6,4
11	1.4	3.3	77	5,6
12	1.49	3.3	83	7,2





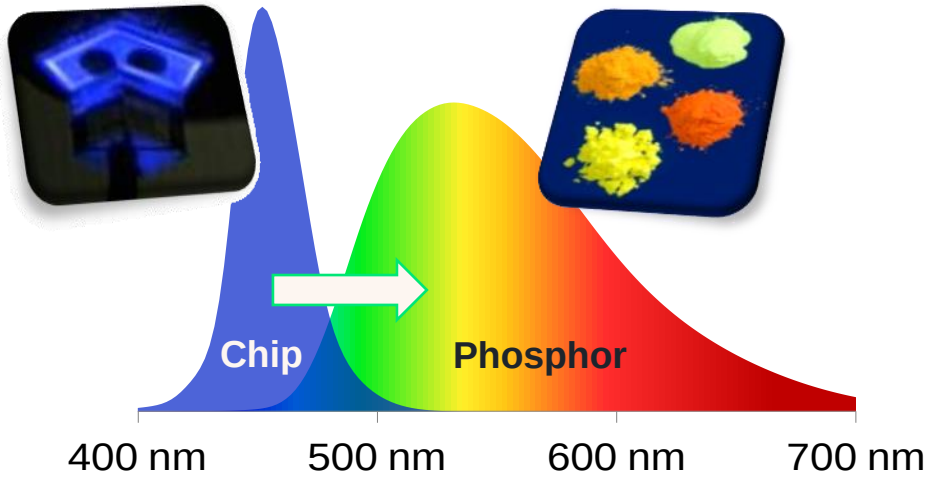
Fit Gaussian Process to measured data



Calculate and maximize expected improvement to obtain next point

Use case: Light Conversion for LEDs

Why do we need conversion?



- **Blue** LED plus phosphor conversion: Create cold white light, warm white light or any other color up to infrared
- **LED market:** ~75% of all LEDs are based on light conversion (*)
- **Human perception:** 97% of the luminous flux of these LEDs is derived from phosphors or conversion elements
- **Strategic relevance:** Conversion significantly impacts LED color, quality of light, cost, efficiency, and stability

Light conversion is essential and specifically optimized for each application



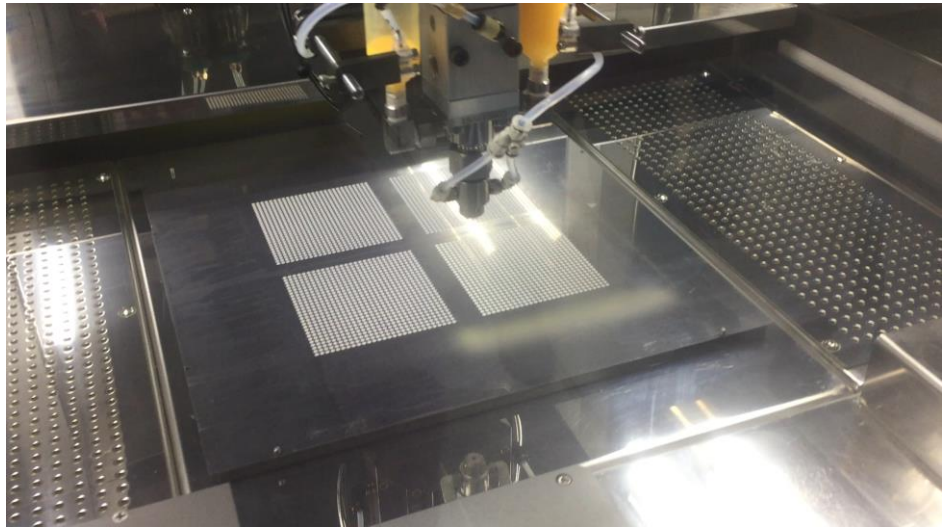



(*) Source: Based on McKinsey LED Market Report

ams OSRAM

Use case: Conversion for LEDs using spray coating

Applying Bayesian Optimization to Reduce Color Spread during Spray Coating



Spray-coating is used to deposit phosphor layer on blue LED chips.
Problem: it can lead to unfavorable color distributions and consequently yield loss.

Optimization of spraying parameters is necessary

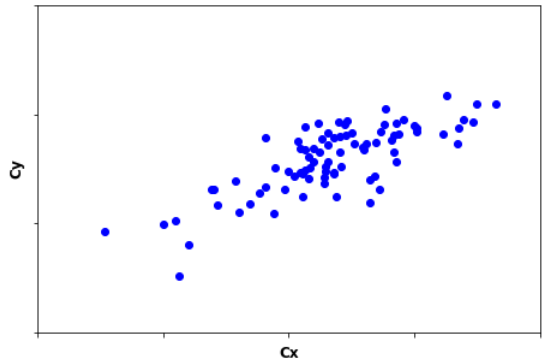
Inputs: 4 – 6 process parameters

Target: Minimize color spread

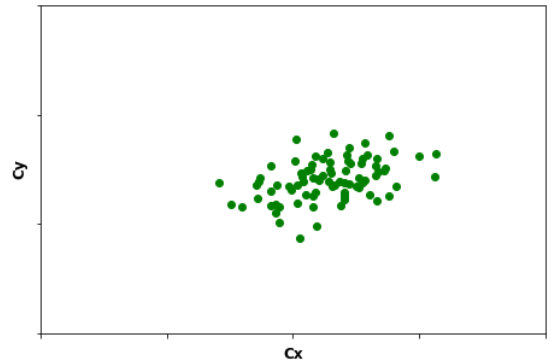
Indicator for color spread: Standard deviation along first principal component → **Minimize**

Verify that brightness does not deteriorate
Sometimes also constraints on other targets such as processing speed, overall layer weight, …

Color spread before optimization

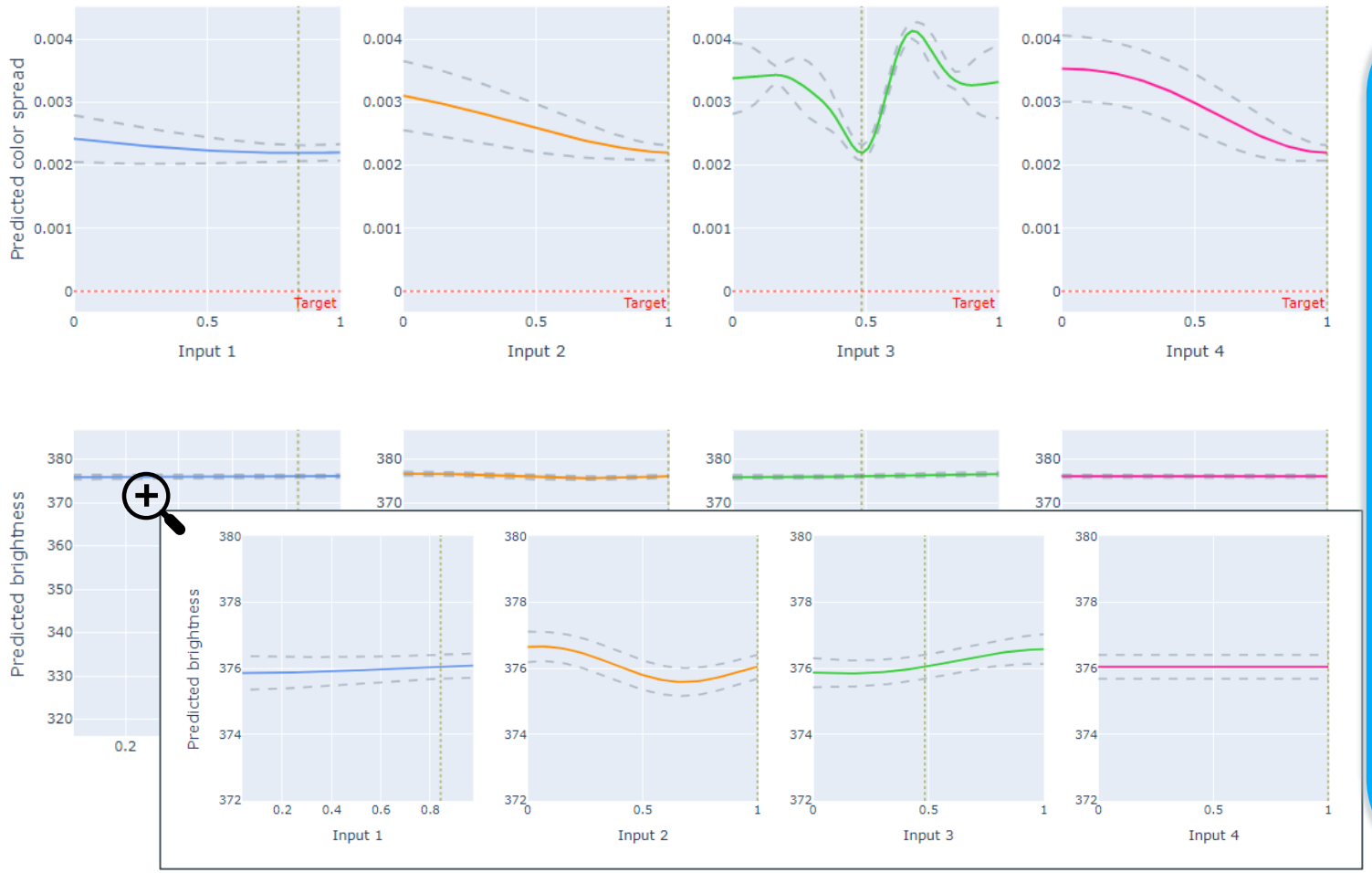


Color spread after optimization



GP models and results

Applying Bayesian Optimization to Reduce Color Spread during Spray Coating



Achievements:

- Optimum after 14 runs (12 initial runs + 2 optimization runs) vs 21 runs with classic DoE
  → **saved several working days + material**
- **47% reduction of color spread**
- **46% reduction in spraying duration**
- no significant impact on brightness

Outlook:

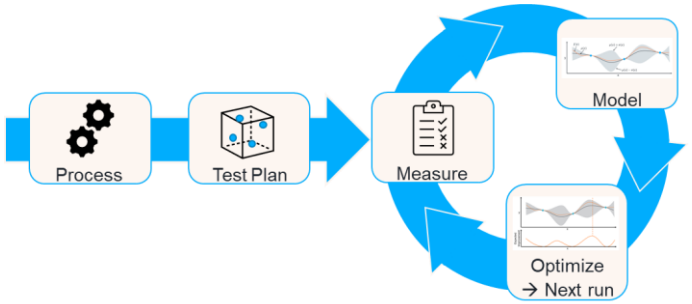
- Bayesian Experimental Design successfully introduced for all spray-coating process parameter optimizations
- Depending on material, very different behavior of the models

When to apply Bayesian Optimization – and when not?

Conclusion

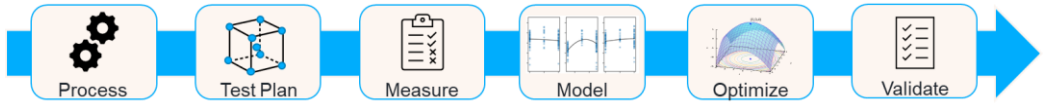
Use Bayesian Experimental Design if

- # input parameters ≥ 4
- Process behavior unknown or complex
- Domain boundaries unknown
- Sequential measurements with short feedback loops



Bayesian Experimental Design less suitable if

- Simultaneous DoE measurements
- Very long feedback loops



Alternative to full Bayesian Experimental Design:

- Use medium sized initial test plan
- Fit Gaussian processes & calculate optimum
- Perform validation run

Sensing is life

Thank you!

Digital Twin and AI: the new frontiers for the manufacturing industry

Artificial Intelligence: In 7 steps to AI

17.06.2024 | Alexander Kreppein, *M.Sc.*

SURE5.0

Fraunhofer IPT

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Basics of AI and ML

What words/ideas come to mind when you think of these topics?

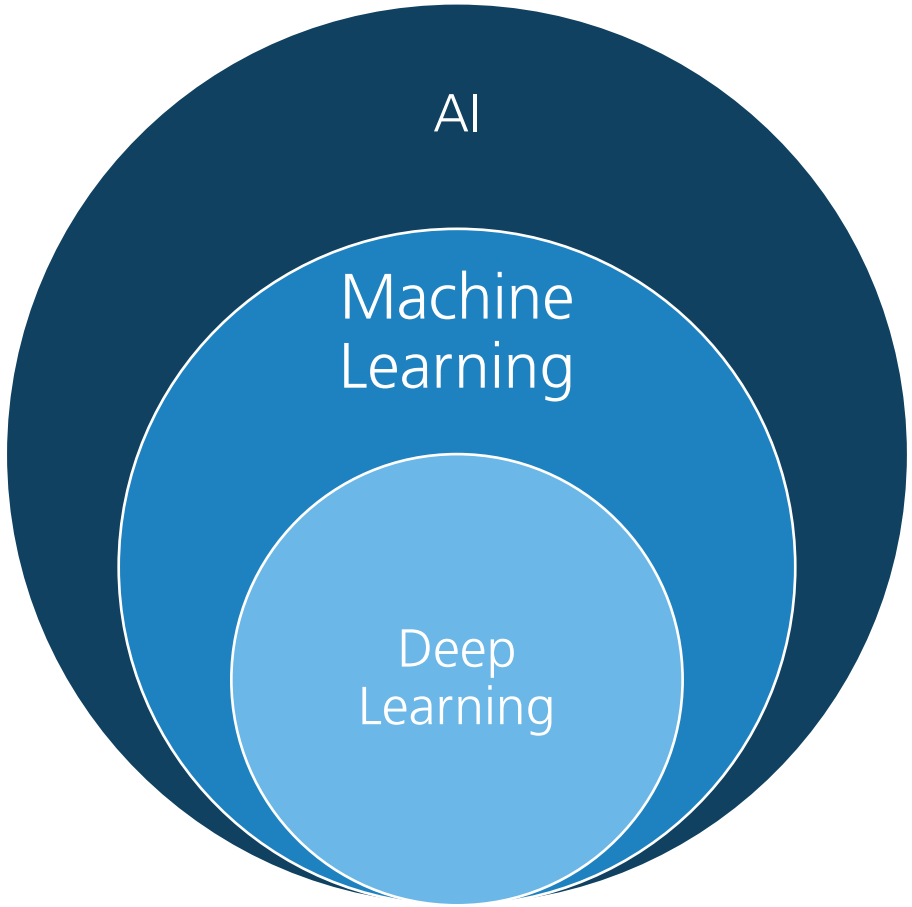
Do you know the difference between Artificial Intelligence (AI) and Machine Learning (ML)?

What is AI?

What is ML?

Source: Pexels by Florian Weihmann

Differentiation AI, Machine Learning and Deep Learning



AI

A technique that allows machines to mimic human behavior

Machine Learning

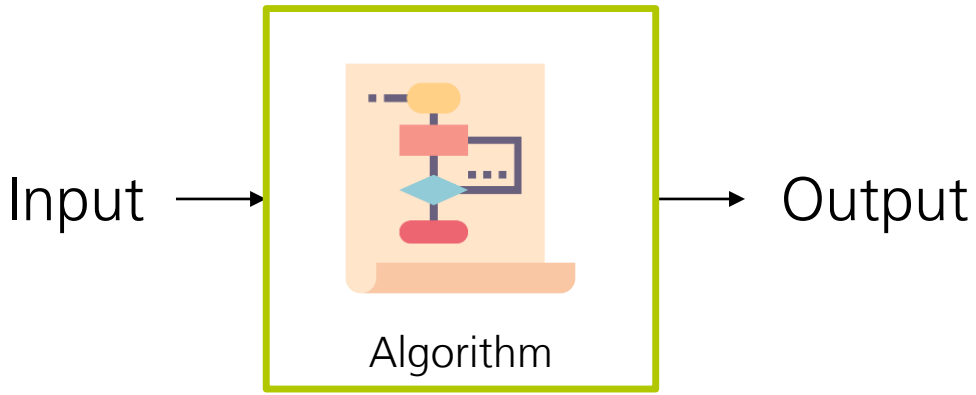
Subfield of AI technology in which statistical methods are used to enable machines to improve themselves through experience

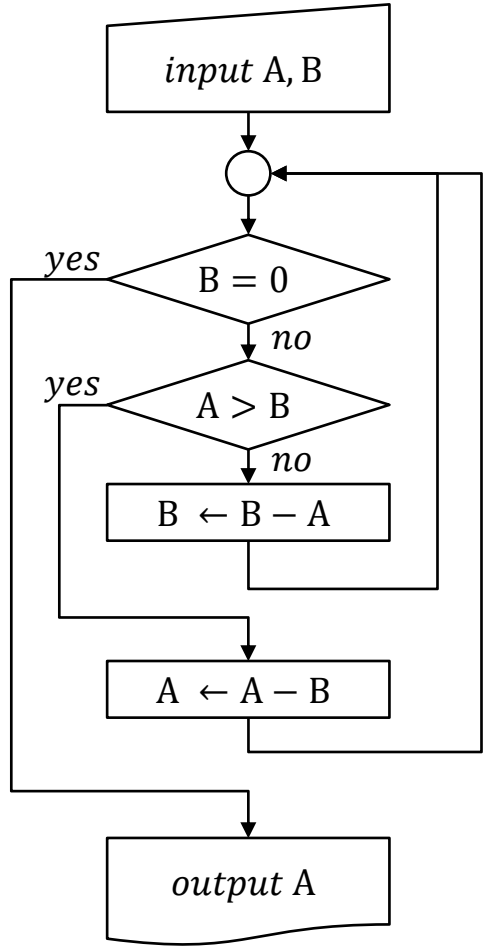
Deep Learning

Subset of ML that enables the computation of multilayer neural networks.

Traditional algorithms

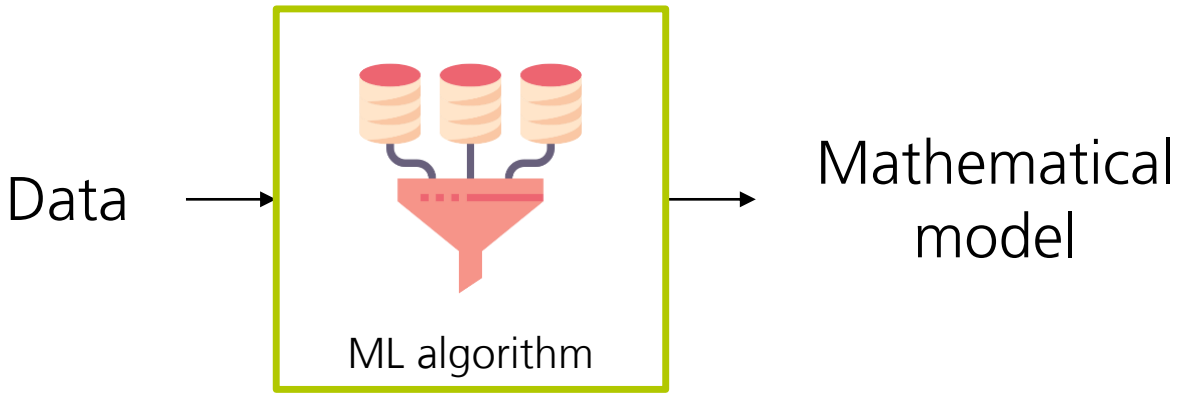
An **algorithm** is a set of (deterministic) instructions that receive an input and produce an output

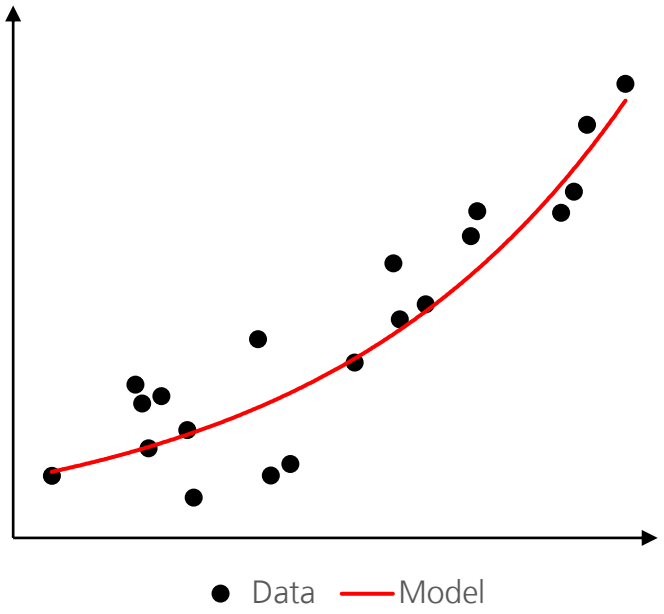




Machine learning algorithms

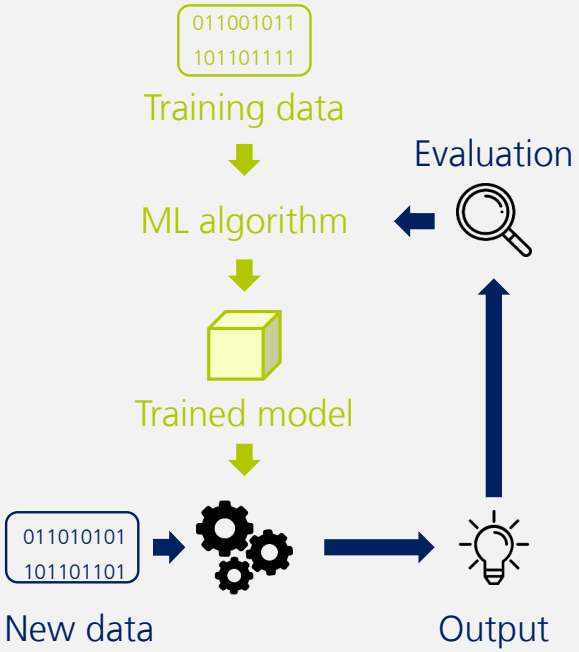
Many **machine learning algorithms** are instructions for building mathematical models on data



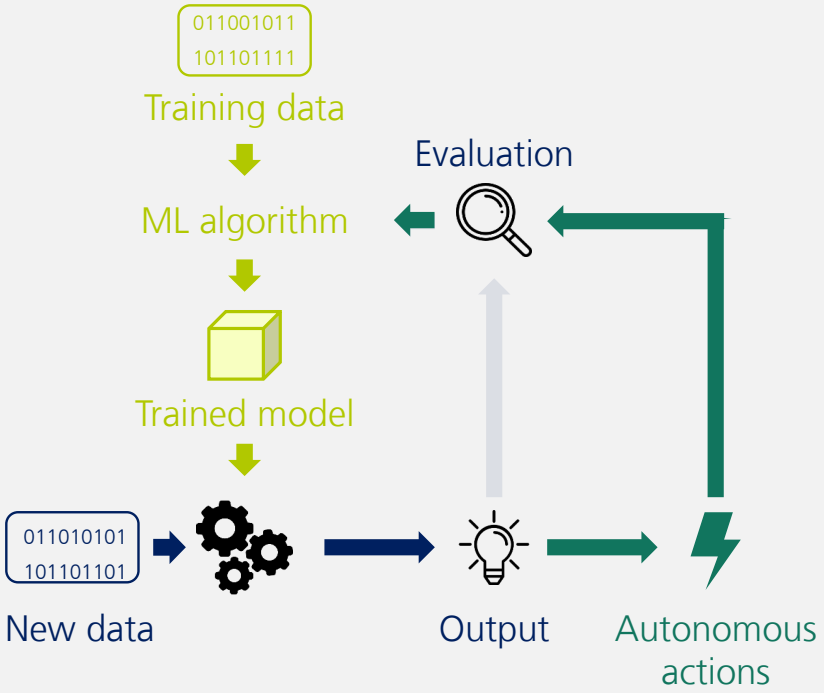


Introduction to AI and ML - Summary

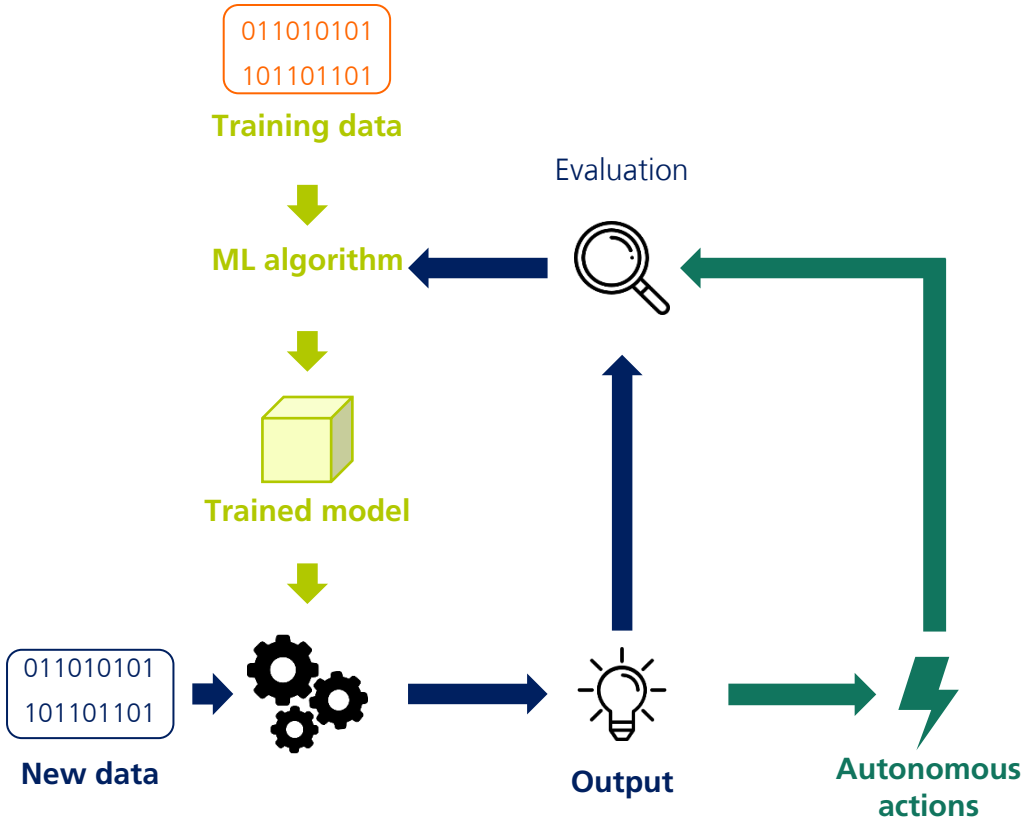
Machine learning involves processes that are in part similar to those of the human brain.



The goal of machine learning is to derive actions based on the output.



Introduction to AI and ML - Summary

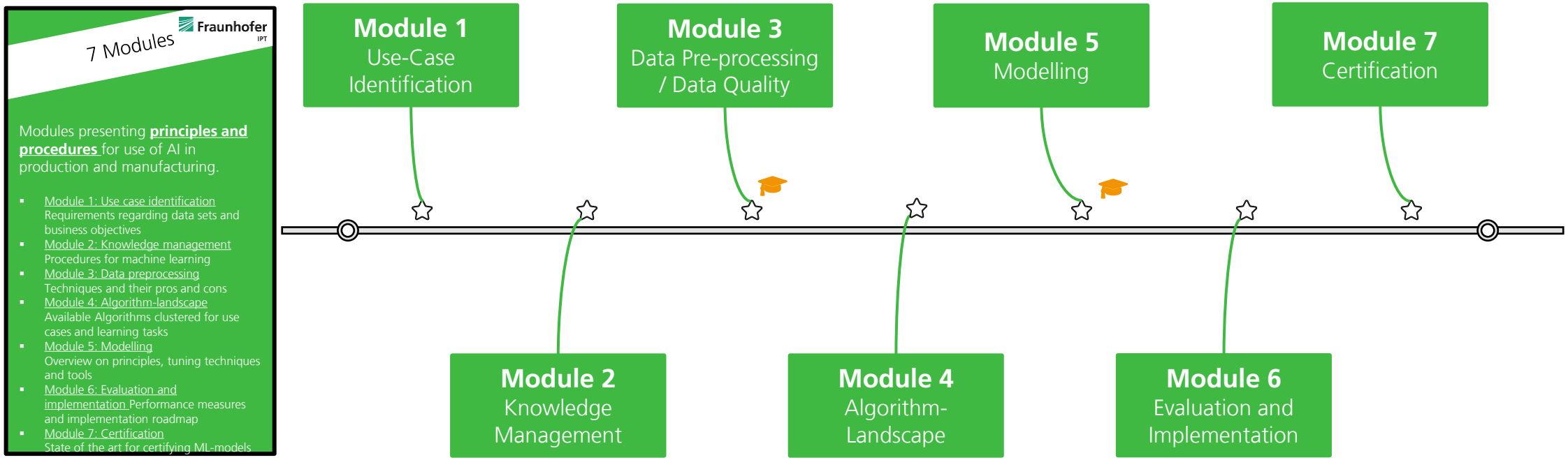


- **ML algorithms** generate models from **input data**
- The **performance of** a model is determined by its output on new, unseen data
- **Artificial intelligence applications** build on models to perform **autonomous actions** in an environment

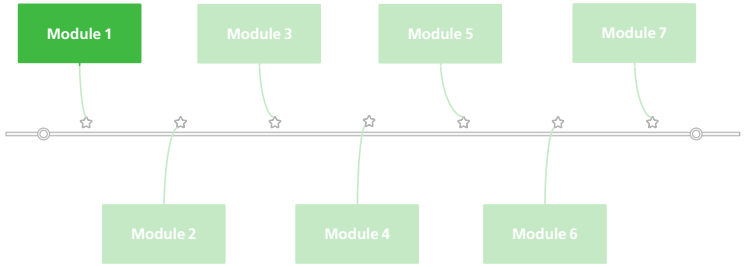
Machine learning can serve as the foundation for an AI system. It can also be used to gain data insights.

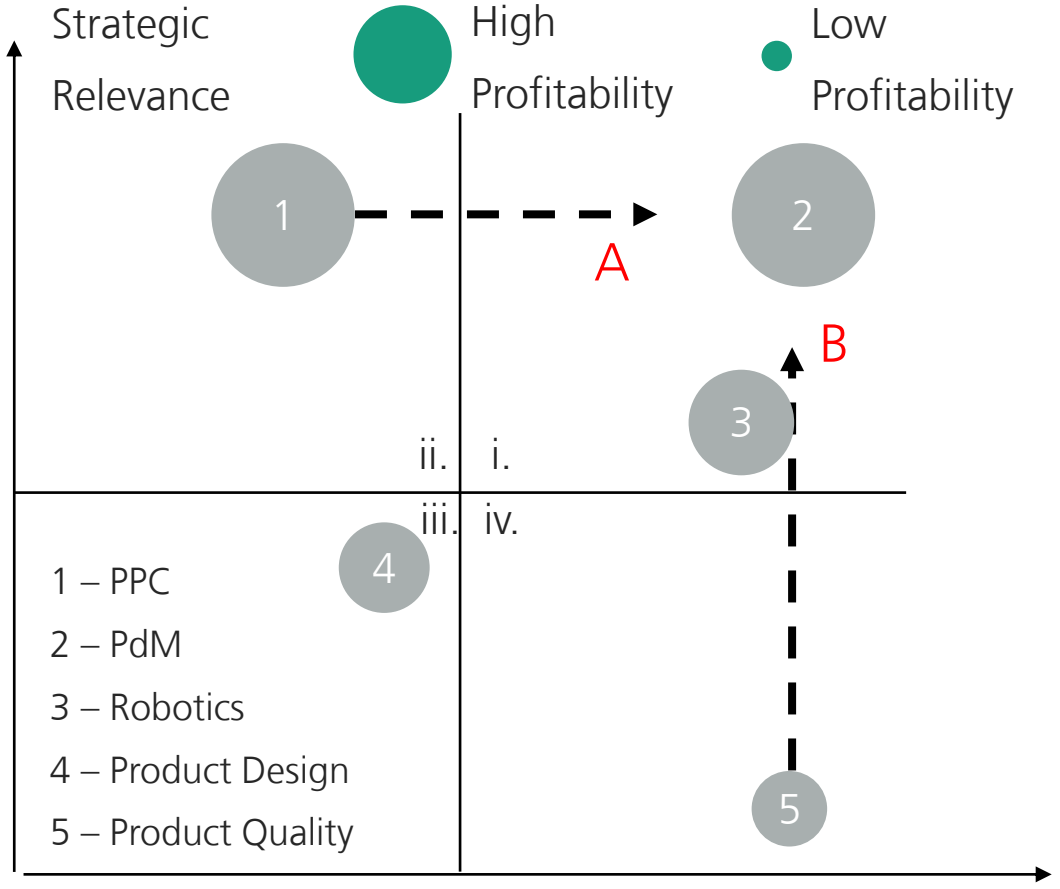
In 7 steps to AI

In 7 steps to AI | Overview



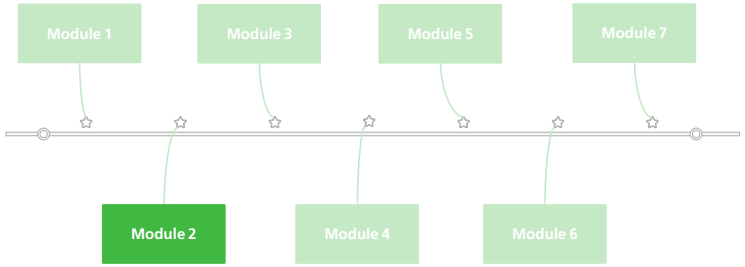
In 7 steps to AI | Use-Case Identification

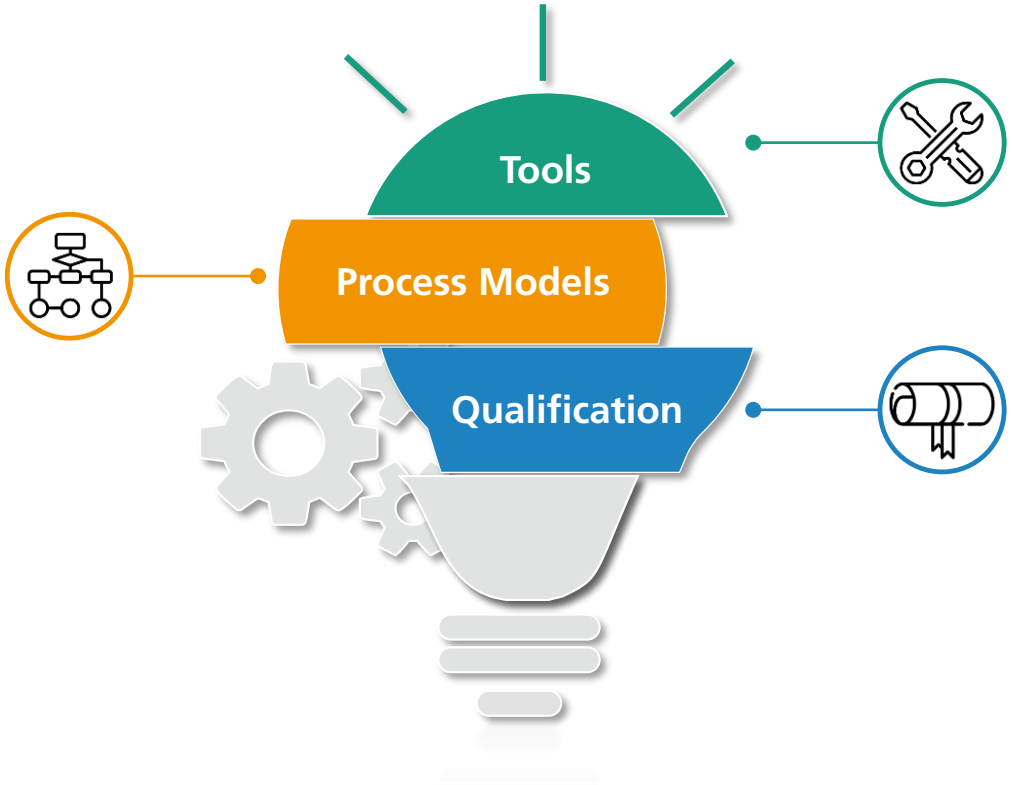




Select suitable AI use-cases!

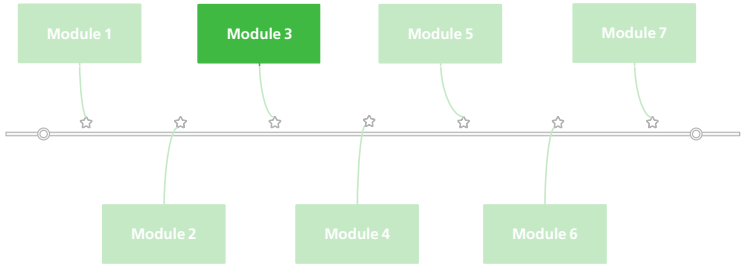
In 7 steps to AI | Kowledge Management

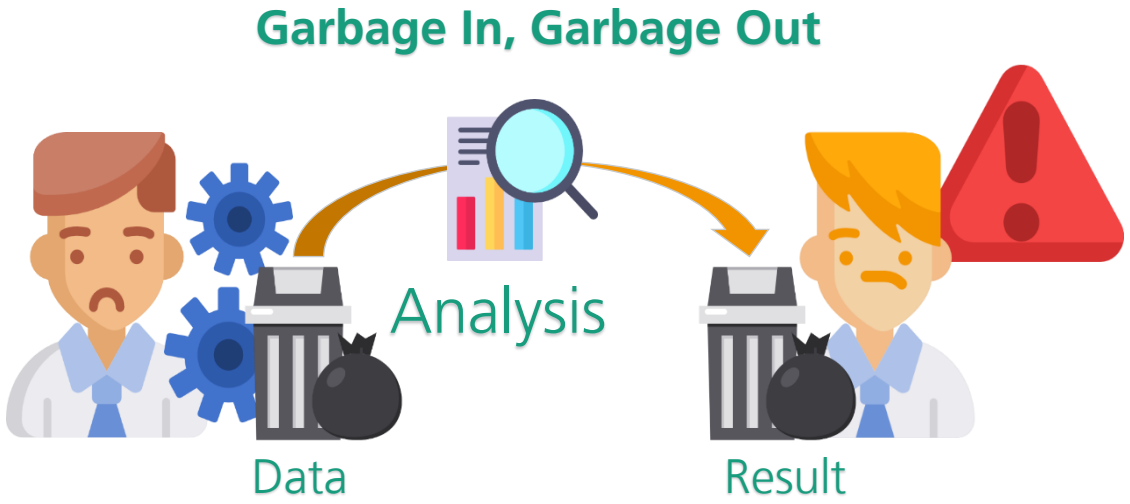




Gather knowledge to conduct AI projects!

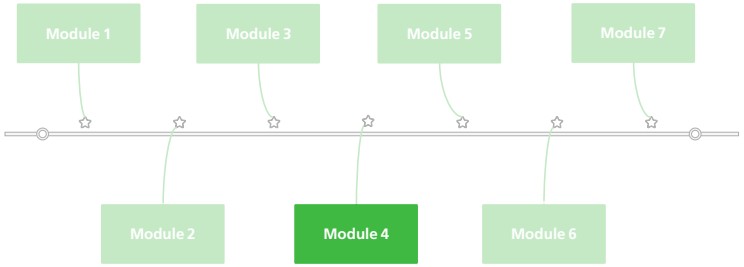
In 7 steps to AI | Data Preprocessing

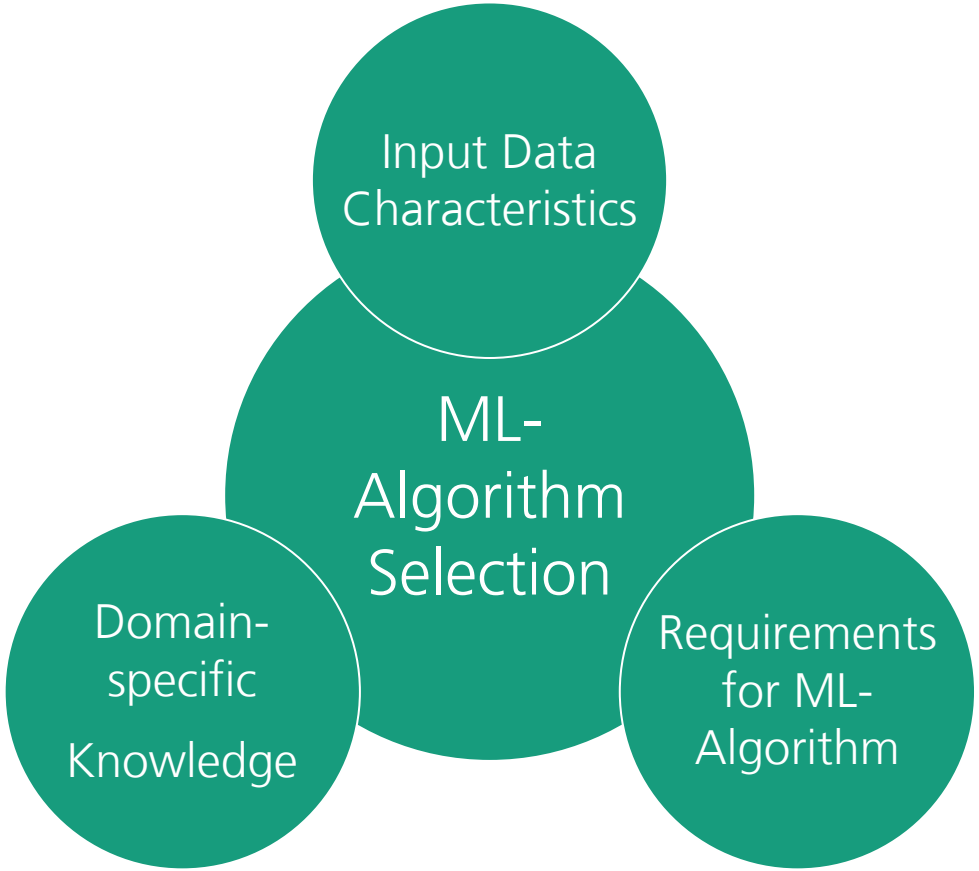




Get your data ready!

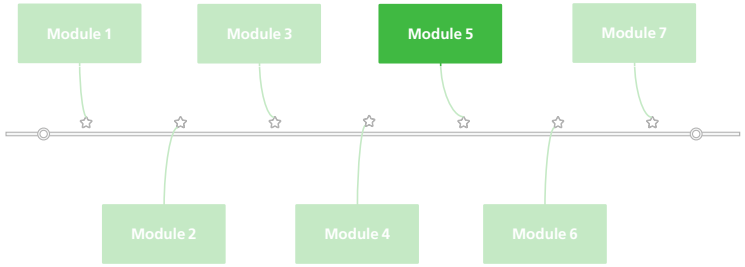
In 7 steps to AI | Algortihm landscape

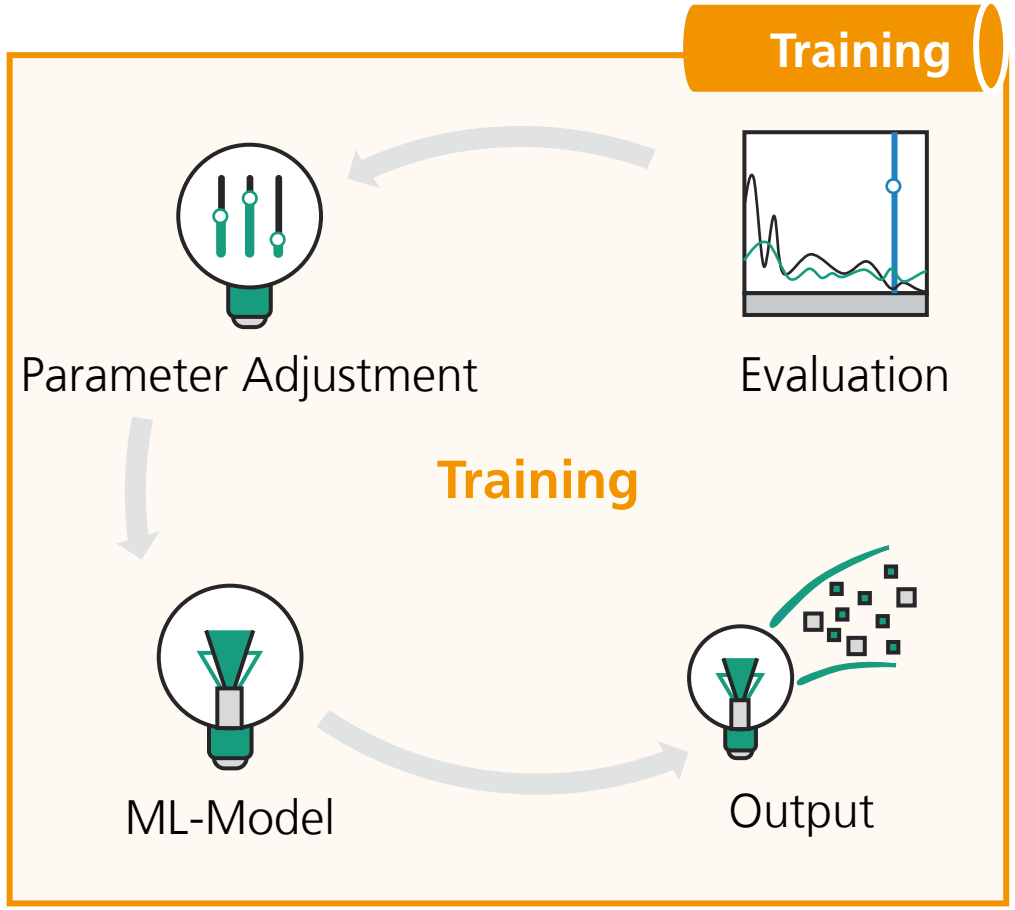




Select the right algorithms/ modelling approaches!

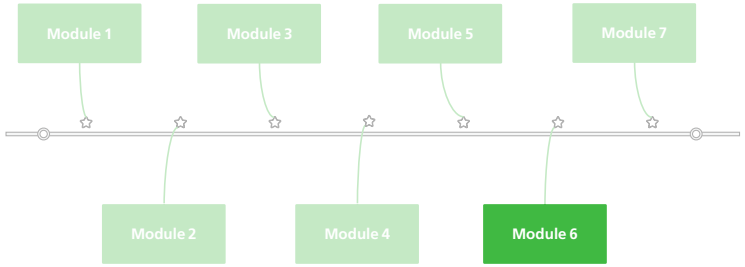
In 7 steps to AI | Modelling

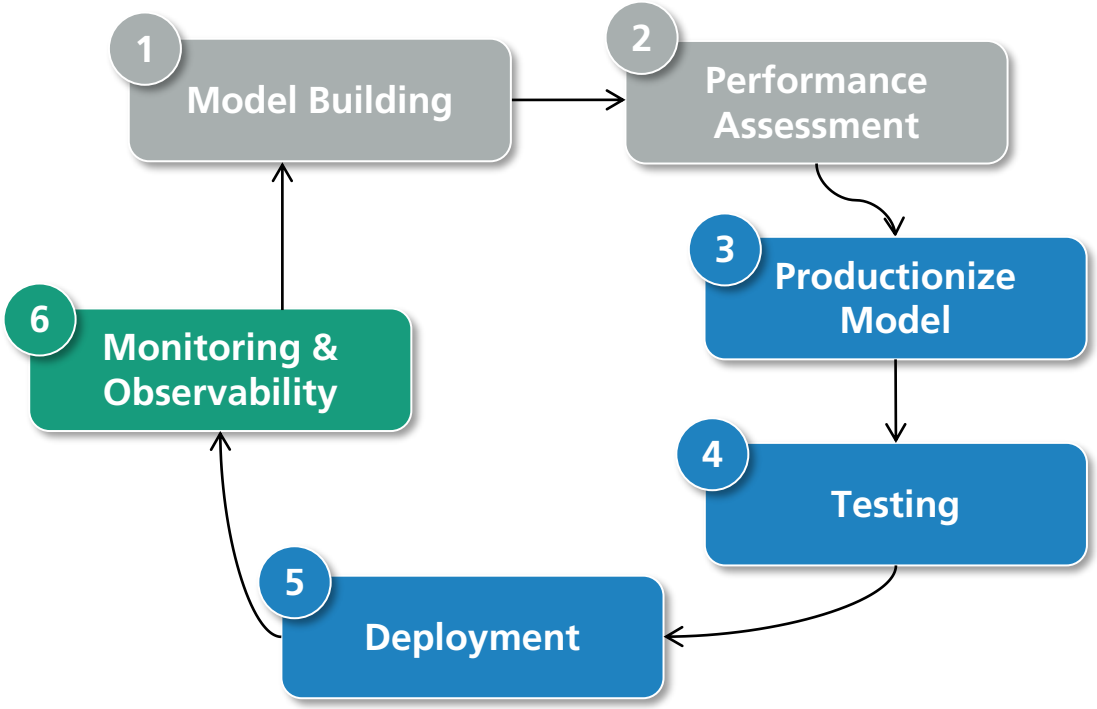




Train the model!

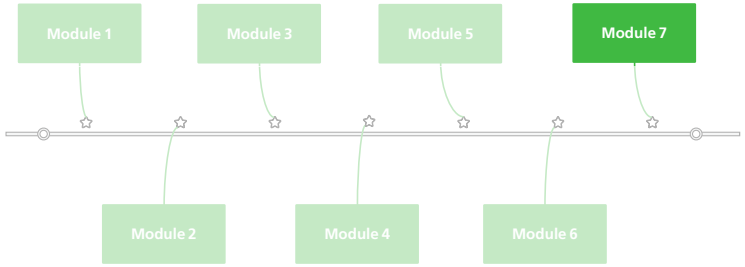
In 7 steps to AI | Evaluation and Implementation





Evaluate and integrate the model!

In 7 steps to AI | Certification



Certify the model!

Where to learn more?

In 7 steps to AI | Free course on ParcOOroo

SCAN ME

ParcOOroo

Visit the seminar

“AI-enabled sustainability for industrial value chains”

on ParcOOroo!

Link: https://www.parcooroo.com/tg42aud2

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Contact

Alexander Kreppein, M. Sc.

Research Fellow
Production Quality Department

Email: alexander.kreppein@ipt.fraunhofer.de
Tel.: +49 241 8904-289

Fraunhofer Institute for Production Technology IPT

Steinbachstrasse 17
52074 Aachen

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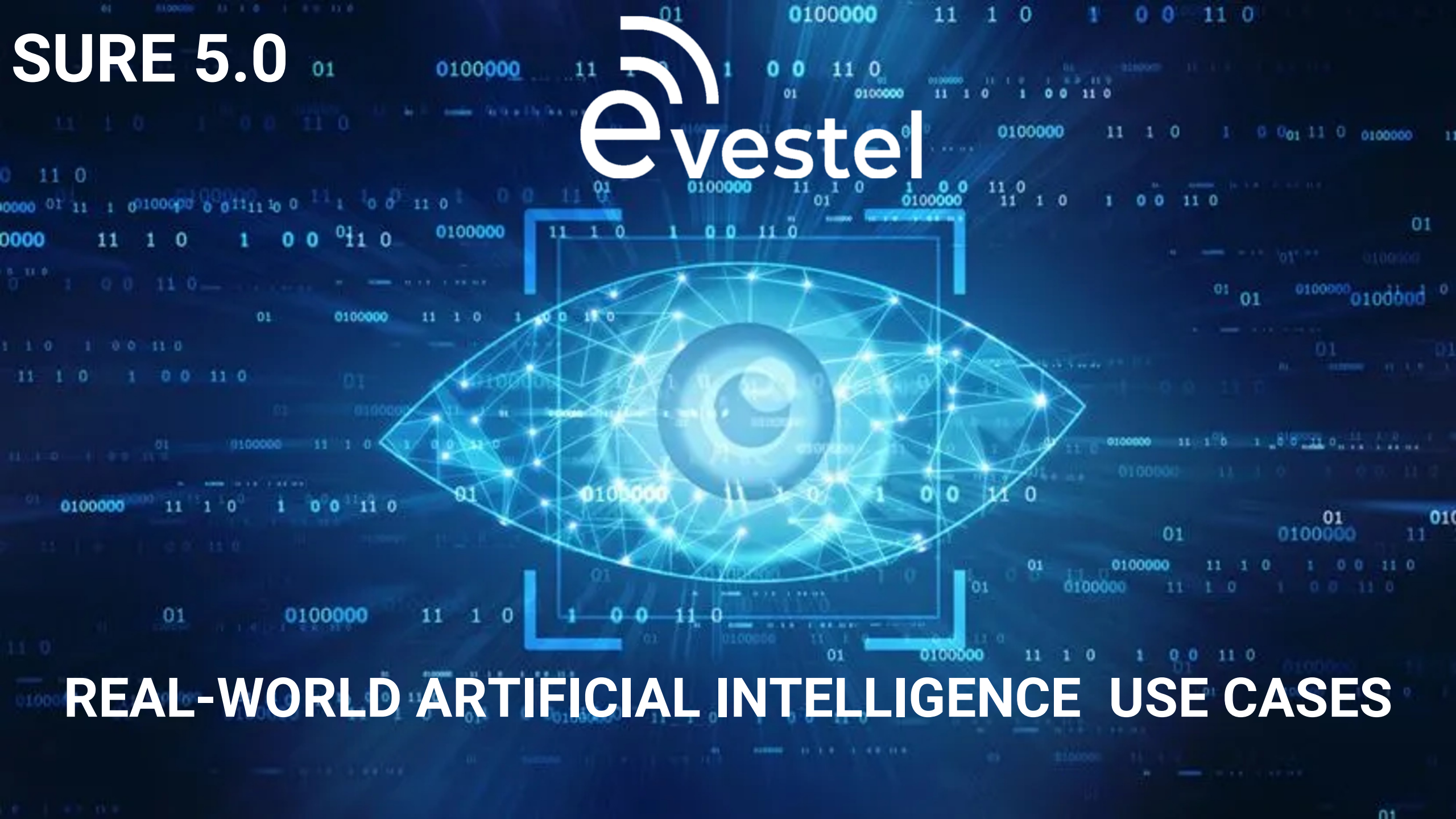


REAL-WORLD ARTIFICIAL INTELLIGENCE USE CASES

Evestel – Who We Are?

A group of professionals with **20 years of experience in IT** services and solutions.

Specialized in solutions for improving security and efficiency through **Computer Vision technologies.**

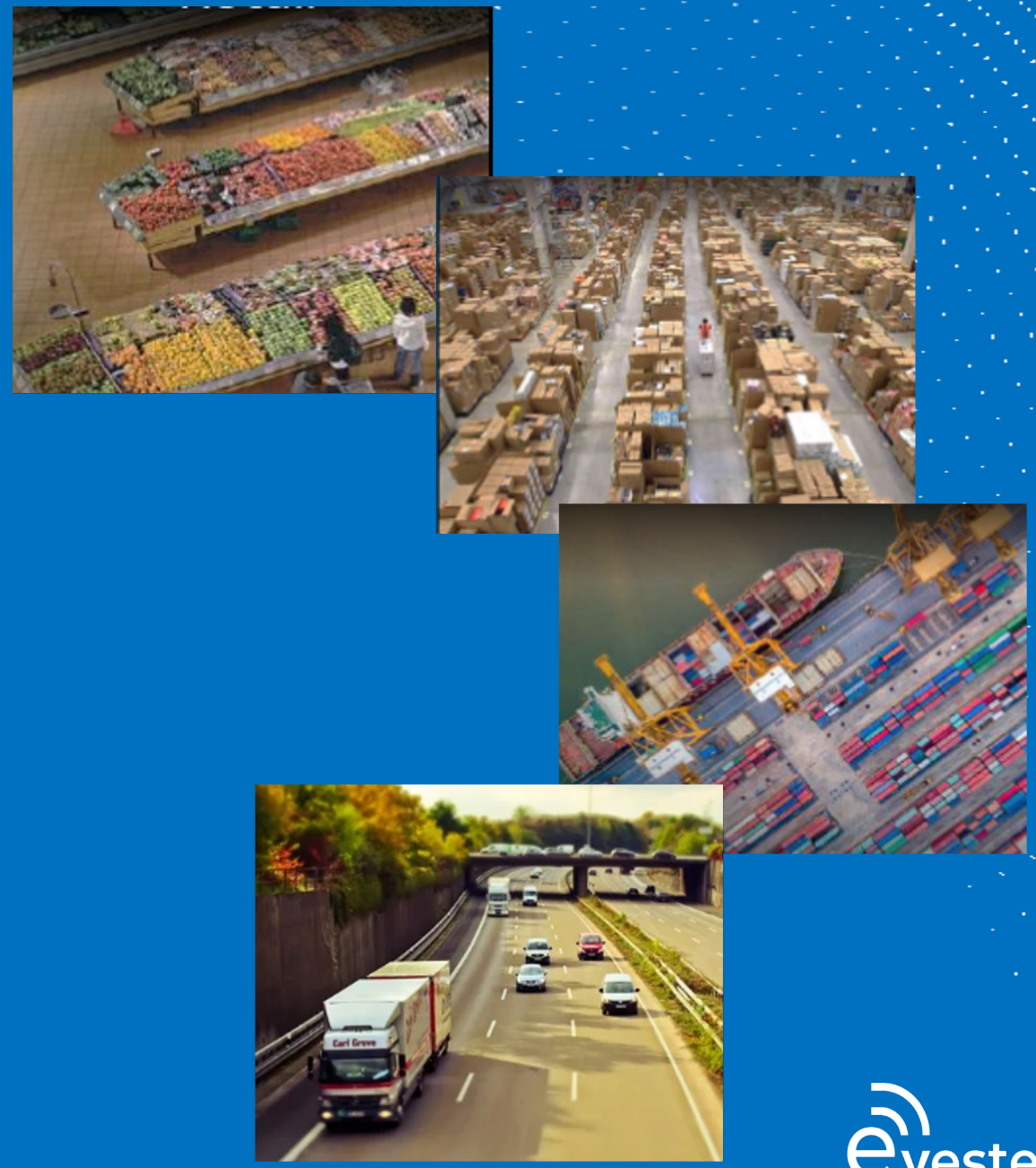
Our objective is to **Ensure the Leadership of our clients** through the incorporation of **the most advanced technological solutions.**

Evestel – Sectors of Activity

→Mobility

→ Retail

→ Ports



Mobility Use Case

EmotAI

Road Safety and Efficiency for Fleets

vestel

Mobility – EmotAI – What is EmotAI?

Emot-AI is a solution to measure and enhance the contribution of professional drivers to the safety of fleets.

How does it work?

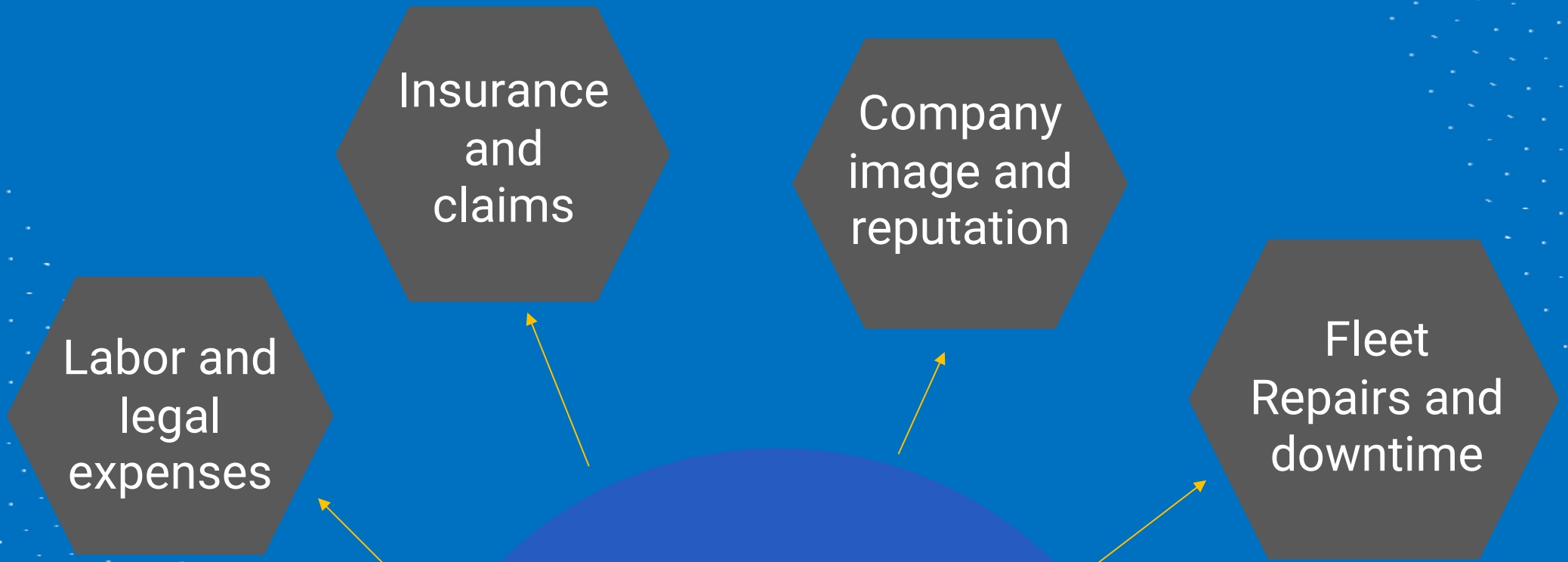
By analyzing **external and internal factors** affecting driving and assisting the driver in correcting unsafe behaviors while driving.

The goal is to **reduce risks and accidents on the road**

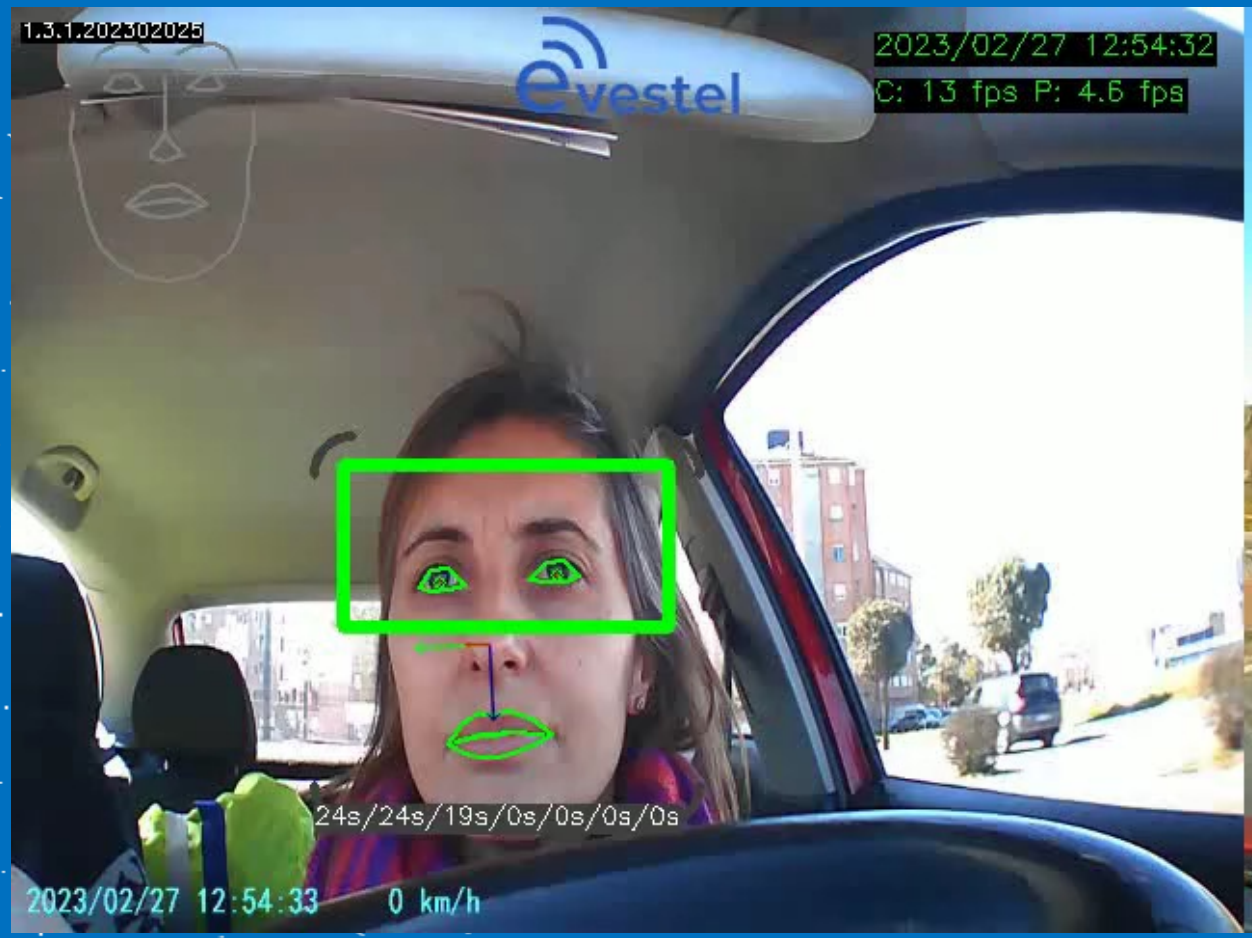
vestel

Mobility – EmotAI – The Costs of Accidents

The most important cost of any accident is **human lives**. However, **it isn't the only one** to consider; other factors include:



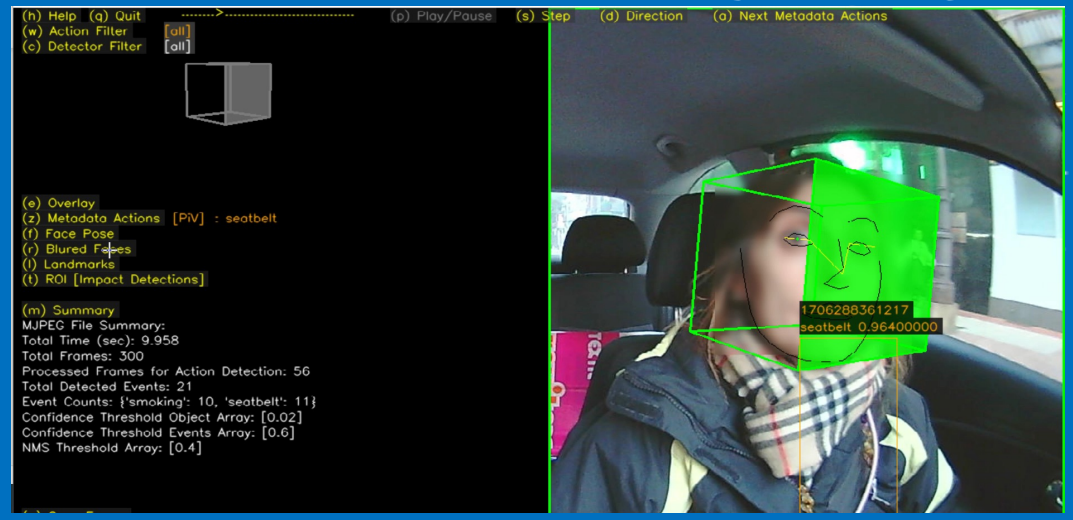
Mobility - EmotAI – How do we solve it?



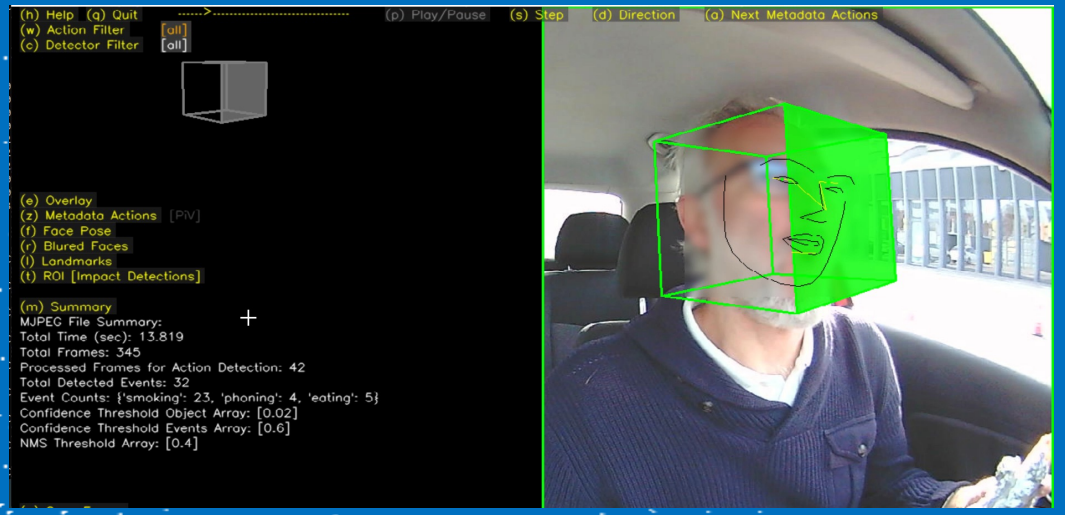
Mobility - EmotAI – How do we solve it? (II)

Seatbelt

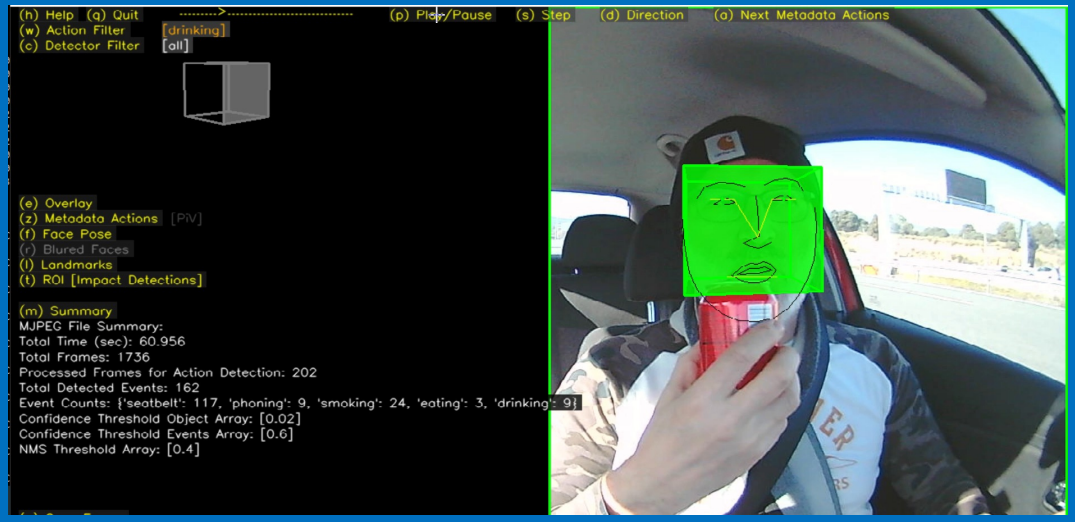
Distraction



Eating



Drinking



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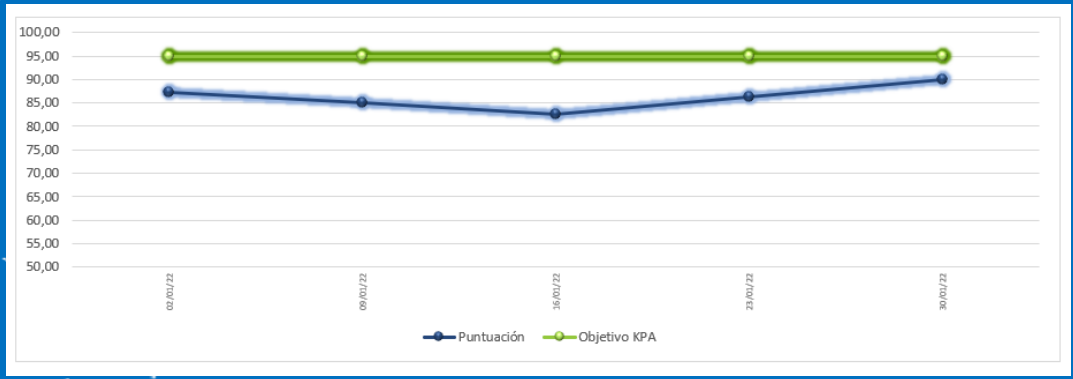
Mobility - EmotAI – Cloud Dashboards

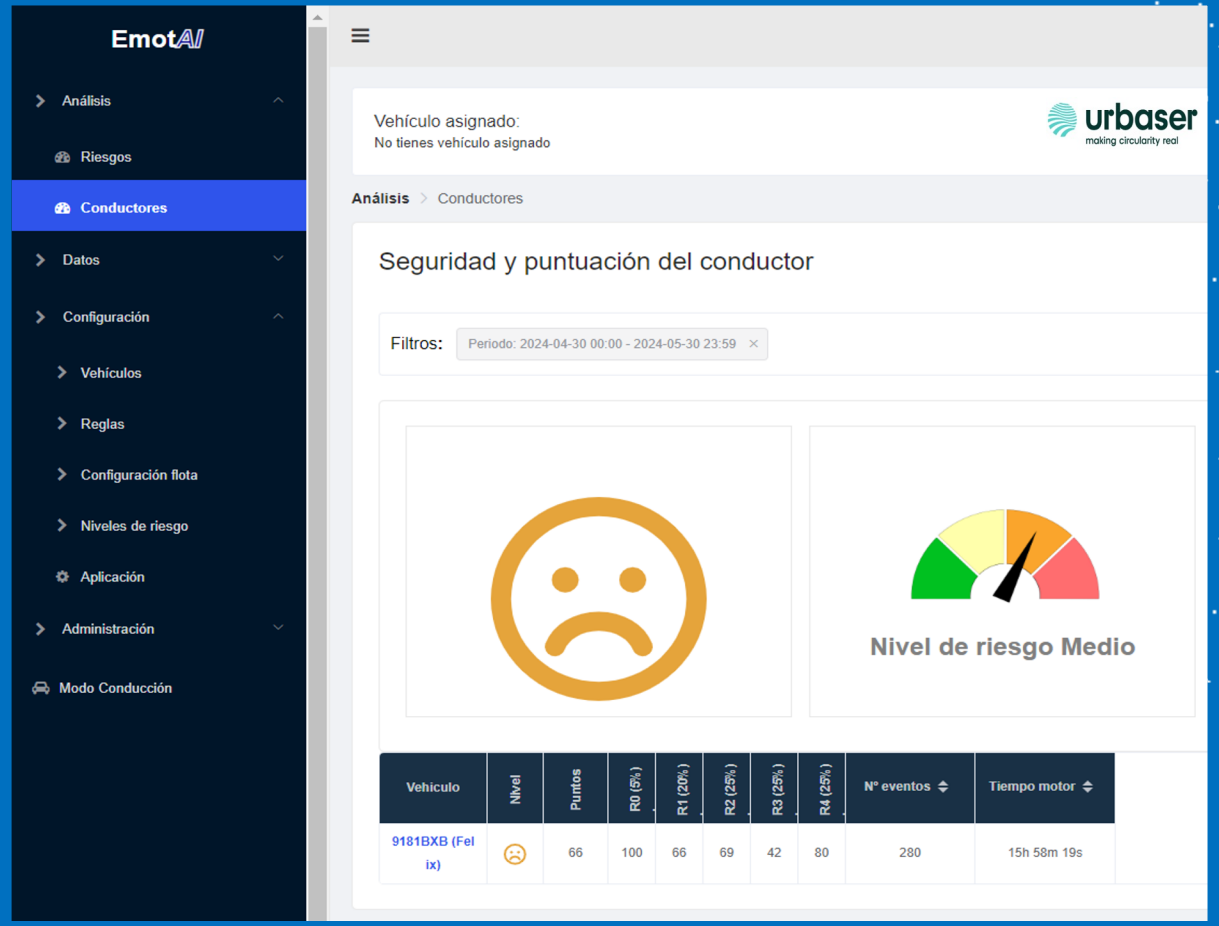
Safety History



Safety Scoring Levels

RISK	Emoji	SCORE
LOW		>= 95 points
MIDL		Between 75 and 94 points
MEDIUM		Between 60 and 74 points
HIGH		Up to 59 points

EmotAI – Cloud APP



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Retail Use Case

SVA - AI

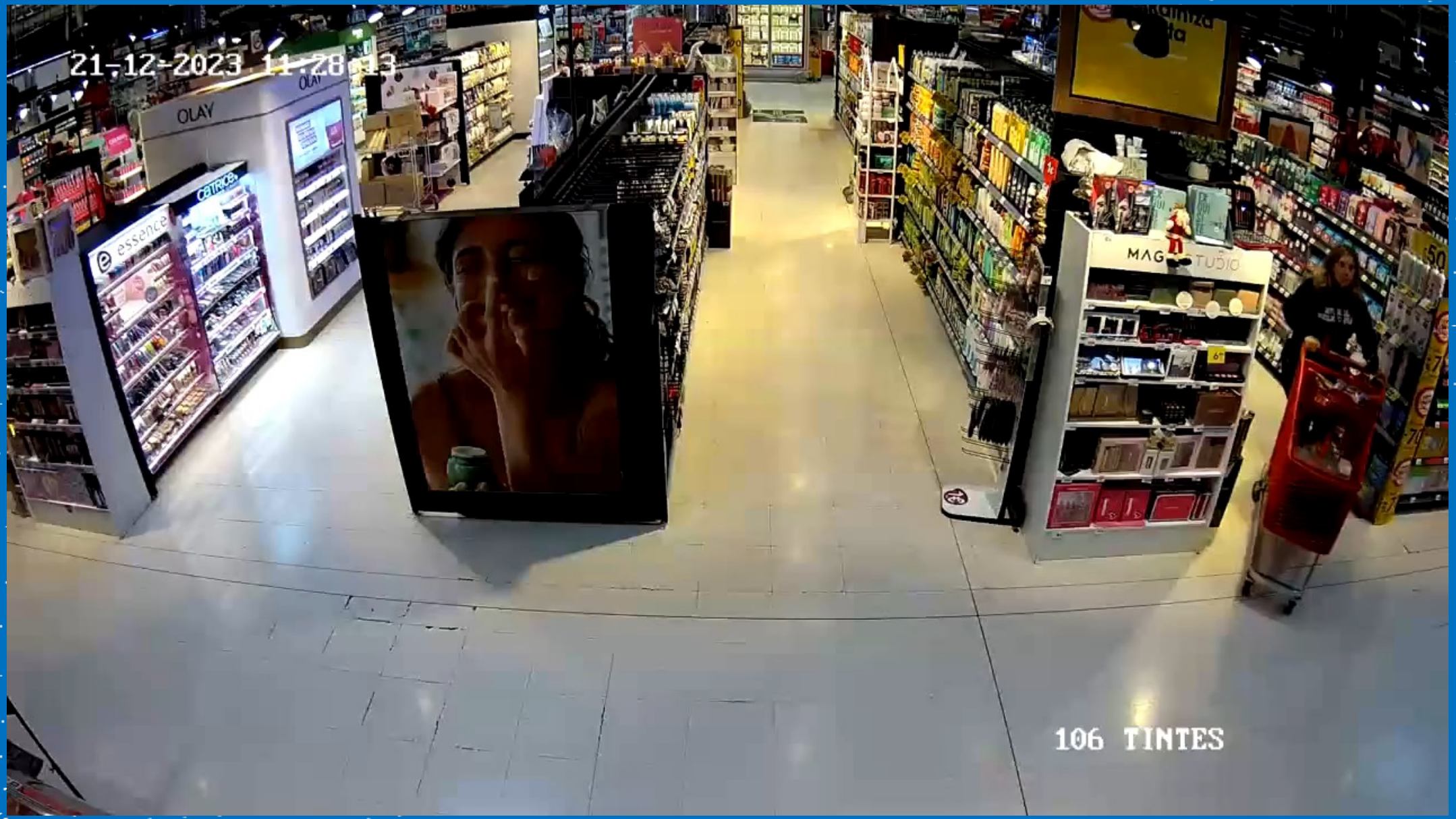
MULTI-CAMERA VISUAL TRACKING

evestel

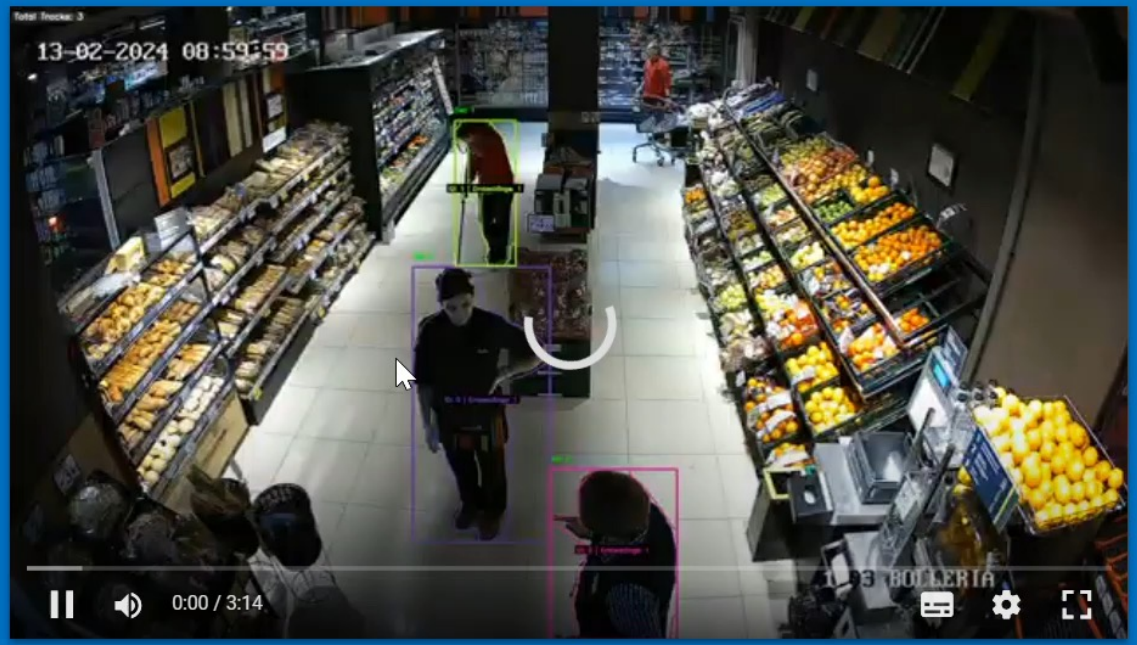
Retail – SVA – MULTI-CAMERA VISUAL TRACKING

- ➔ People Tracking and Identification in multi-camera environment in shopping centers.
- ➔ Tracking videos across multiple cameras.
- ➔ Compatible with the majority of existing video surveillance systems.

Retail – SVA – VIDEO Example



Retail – SVA – VIDEO Example



CAM-01

CAM-02

CAM-03

evestel

Retail – SVA – Benefits

- ➔ Tracking videos creation reducing the manual workload of security employers, allowing for a tenfold increase in daily interventions with the same personnel.
- ➔ SVA-AI improves operational efficiency by avoiding data network saturation during the download of videos from multiple centers.
- ➔ Identification of suspects generating solid evidences without the need for manual intervention, high-resolution cameras or cameras with integrated AI.

Ports Use Case

Risk-AI

AI RISKS FOR CRANE OPERATORS IN MARITIME PORTS

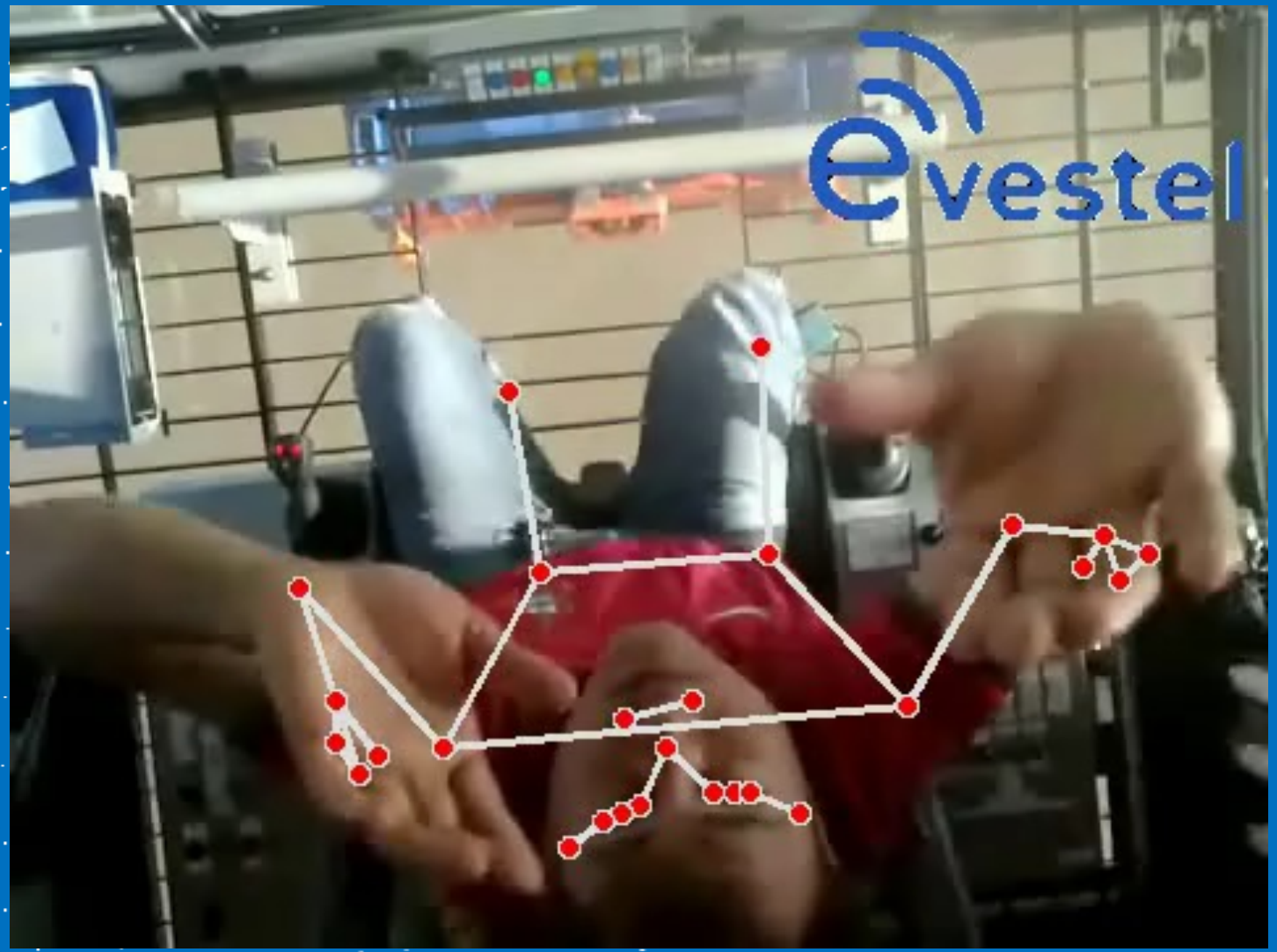
evestel

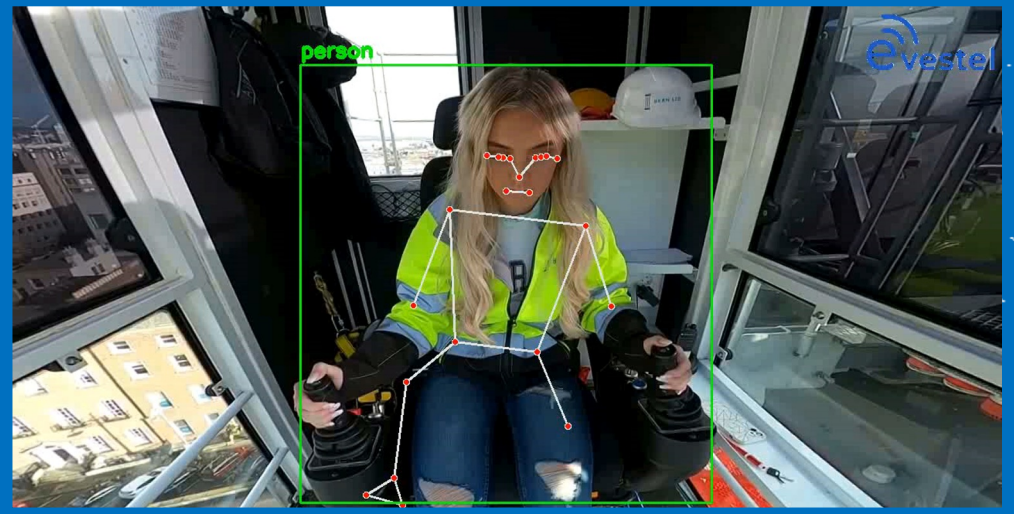
Ports - RiskAI – Solution

Identifying phases of crane operator operations with safety risks and decreased comfort:

- Reducing accident risks
- Reducing personnel injuries
- Minimizing equipment damage costs

Evestel – Video Examples





Ports Use Case

Ferro-AI

INCIDENT DETECTION IN RAIL TRAFFIC IN MARITIME PORTS

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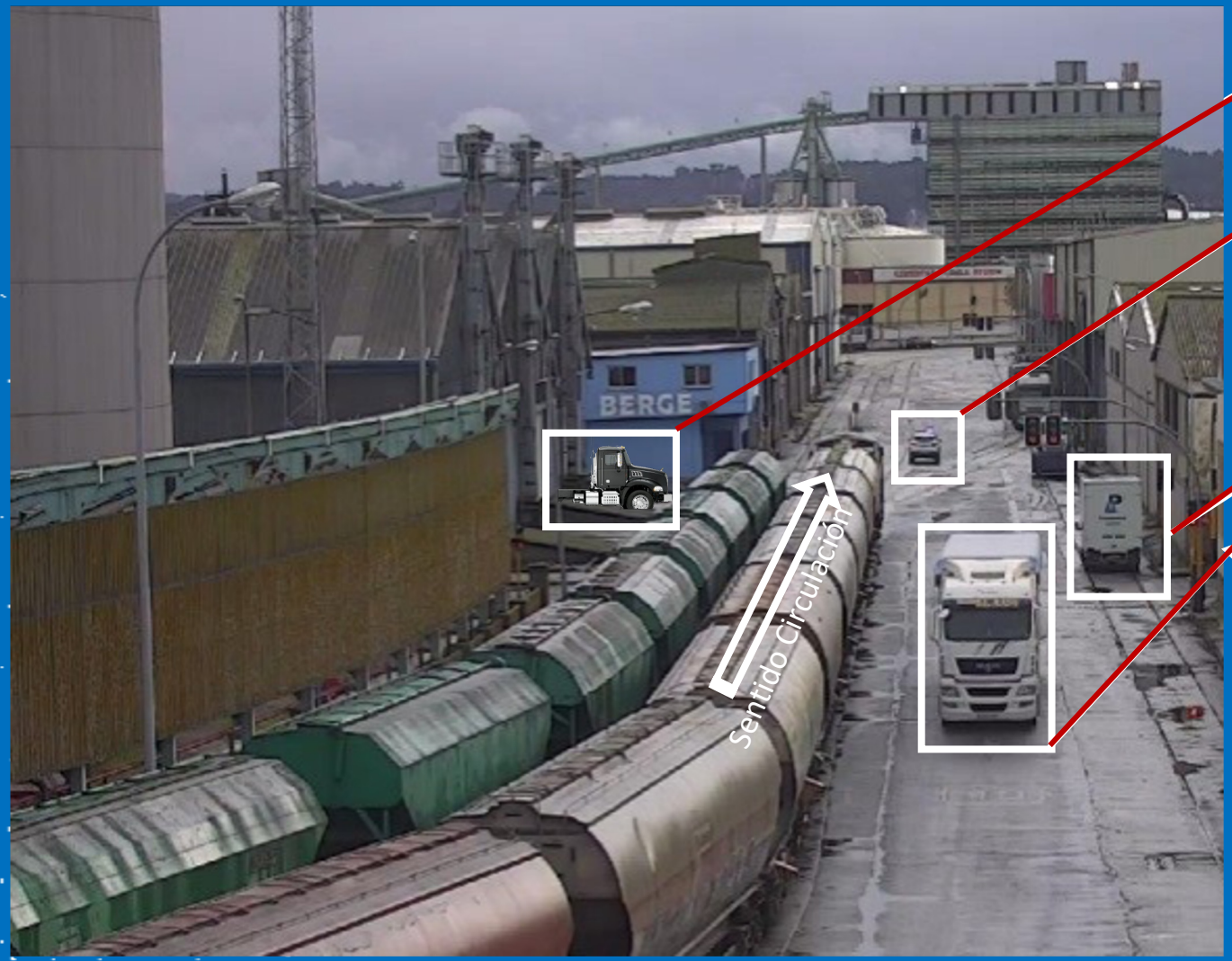
Evestel – Solutión



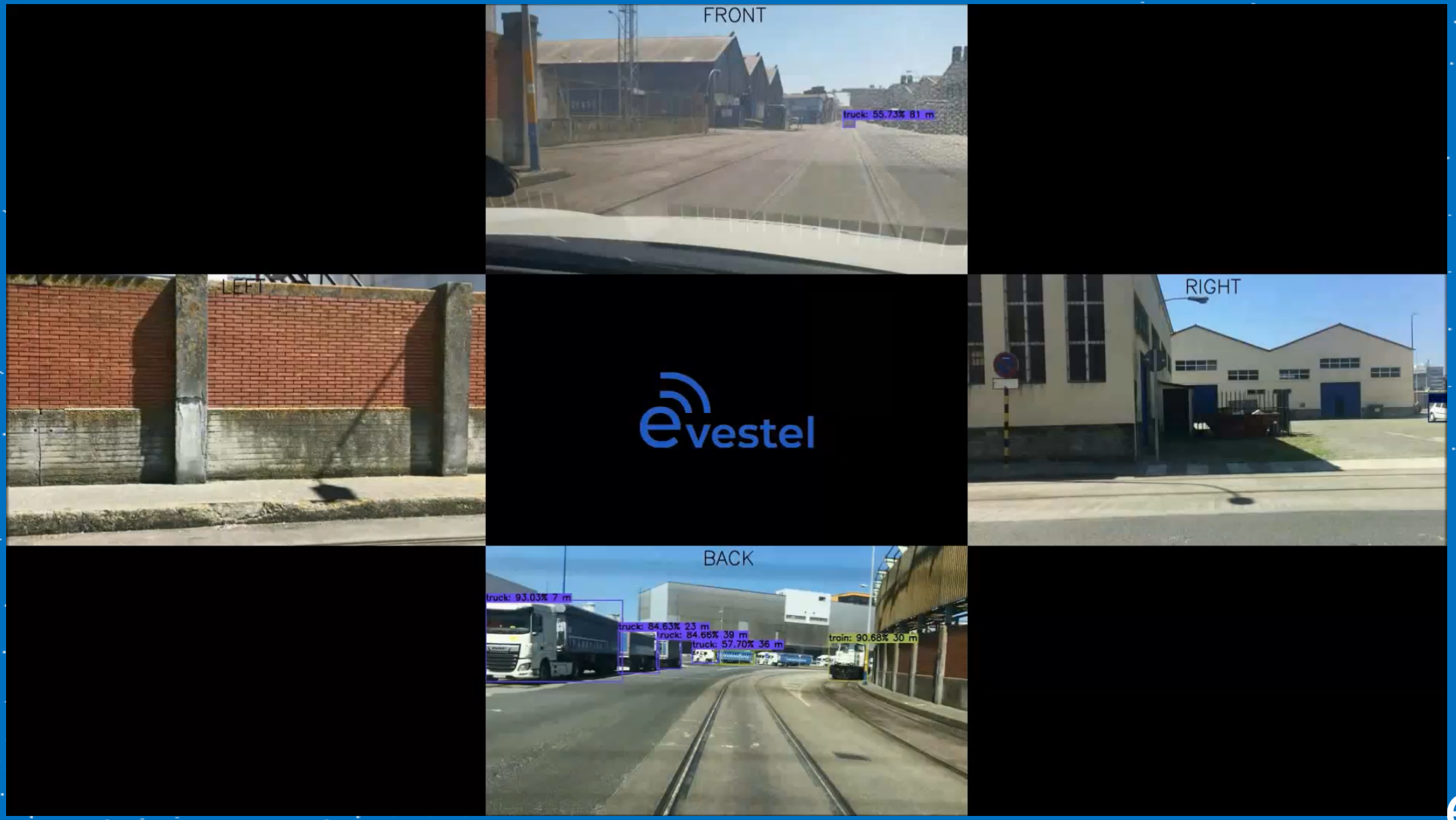
Detection of vehicles on **crossroad lanes** adjacent to the train

Detection of **safety distance** between Port Police vehicle and train

Detection of vehicles in a **lane parallel** to the train track

Ports - FerroAI – COLLISION RISK - TRAIN TOO CLOSE

Ports - FerroAI – PEDESTRIANS AND VEHICLES RISK



evestel

THANK YOU !!

EVESTEL IBERIA S.L.
CALLE AREA PORTUARIA BOUZAS SN
36208 VIGO – PONTEVEDRA

hello@evestel.com

Mobility - EmotAI – Benefits

01. SAFETY

Trust in the driving of your drivers by improving their safety and that of your vehicle fleet, as well as the image, prestige, and reputation of your organization.

02. SUSTAINABILITY

Drive in a more efficient and safe manner by reducing fuel consumption, emissions, and carbon footprint.

03. PROFITABILITY

Achieve maximum reduction in road accidents, work absences, repair costs, and insurance premiums. Additionally, prolong the lifespan of your vehicle fleet.

04. DRIVER WELL-BEING

Prioritize the well-being and retain the talent of your professional drivers by achieving lower turnover rates. If they are well, your organization will be too (and therefore, your clients and suppliers). EmotAI is not about control, but trust and security for all.

Benefits for you, but above all, for your drivers!

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