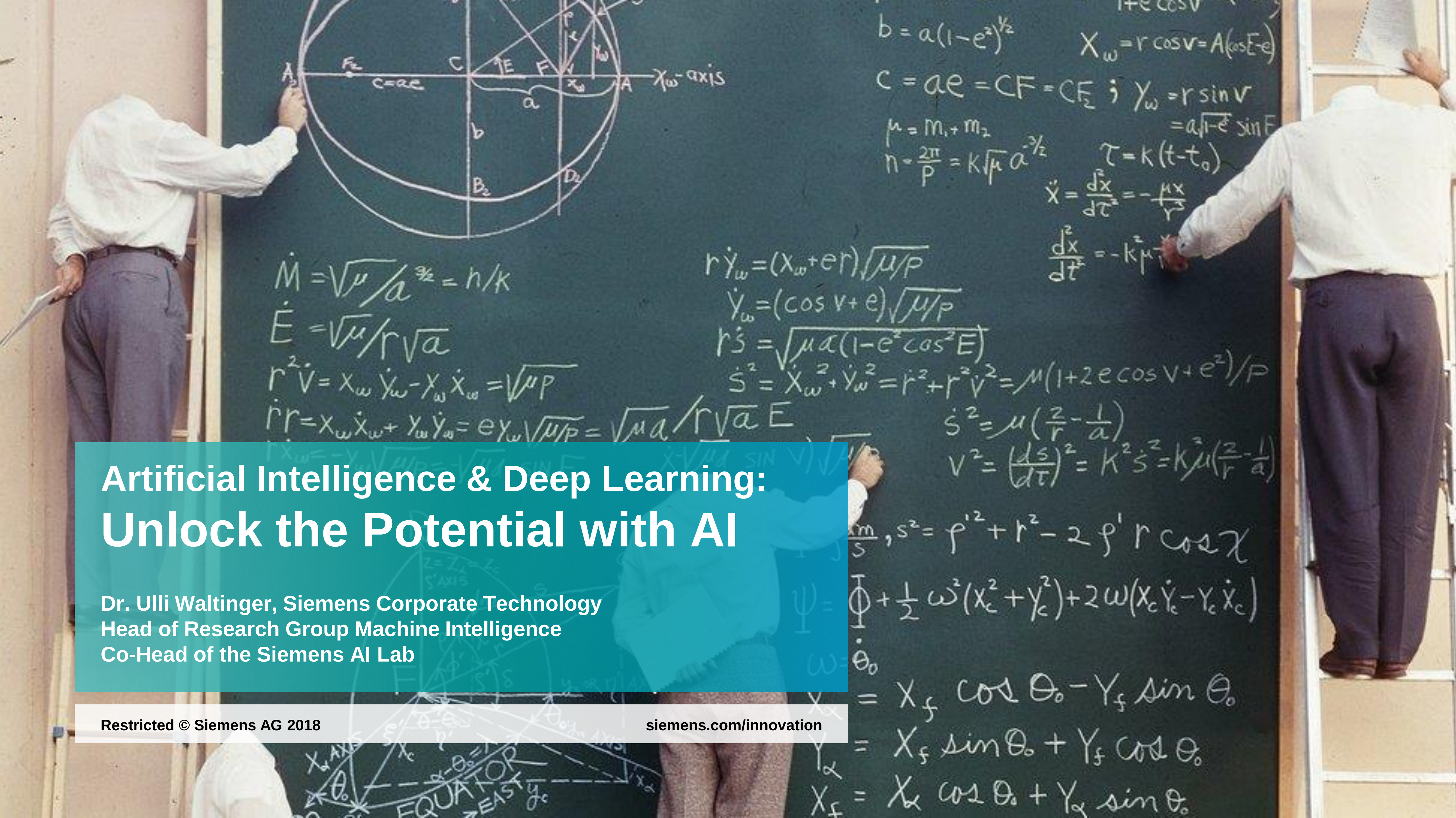
Lab Session: Data Analytics/ AI

siemens.pt/digitalizacao



Artificial Intelligence & Deep Learning:
Unlock the Potential with AI

Dr. Ulli Waltinger, Siemens Corporate Technology
Head of Research Group Machine Intelligence
Co-Head of the Siemens AI Lab

Digitalization is disrupting entire customer value chains

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- **Data analytics**
- **Artificial Intelligence**
- **Simulation tools**
- **Cloud & platform technology**
- **Secure connectivity**
- **Cyber-Security**

Enabling the next level of ...

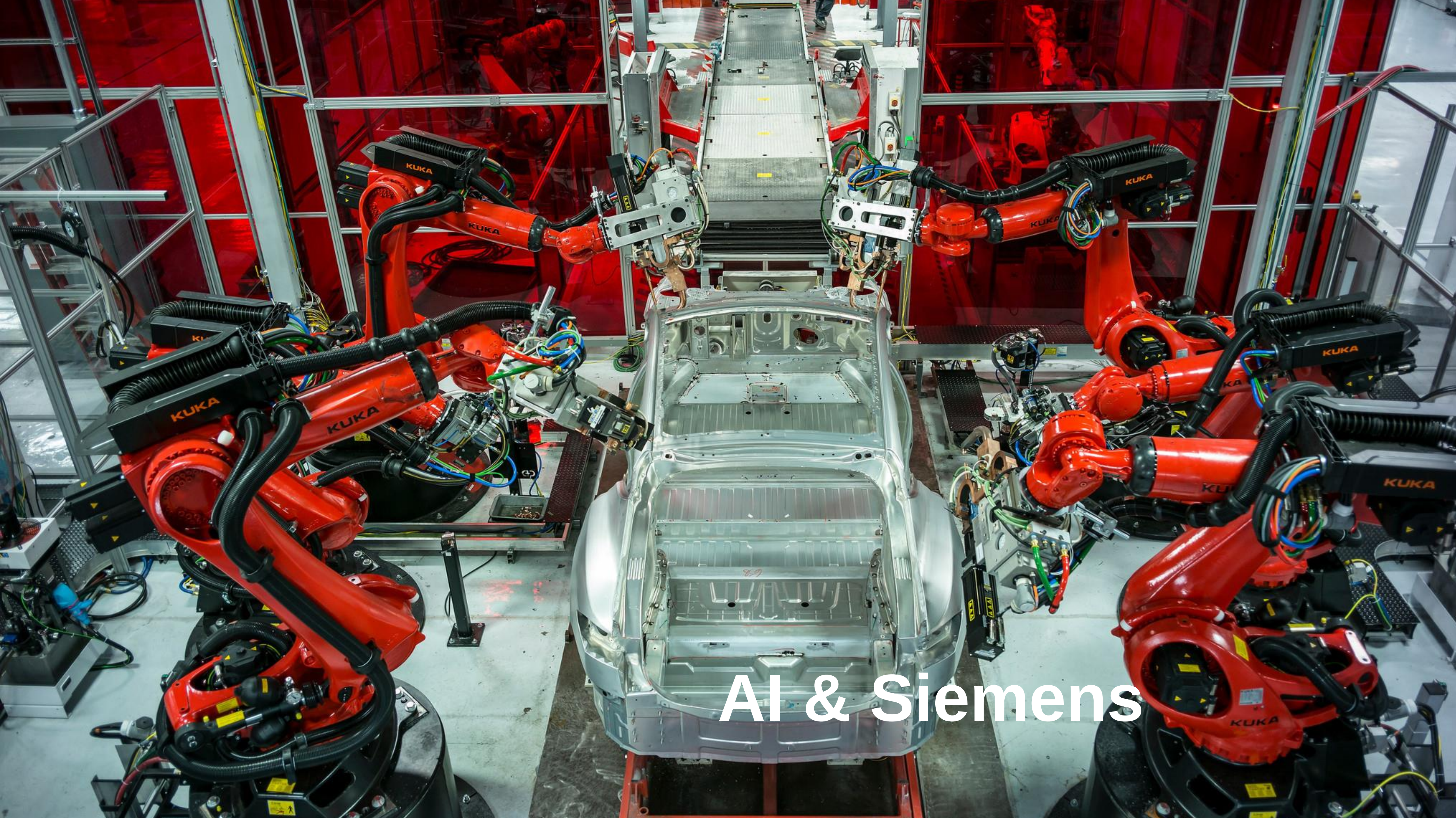
... productivity and time-to-market ...	... flexibility and resilience ...	... availability and efficiency ...
Design and engineering	Automation and operation	Maintenance and services

The passion…

Artificial Intelligence as the enabling technology of **Digitalization** is driven by **entrepreneurial passion** for technology…

AI & World


PERSON
99.3%
OUTDOORS
83.1%
CREST
83.0%
ROCK
82.8%
Female
100%
Eyes are open
100%
Happy
82.8%
Smiling
75.8%

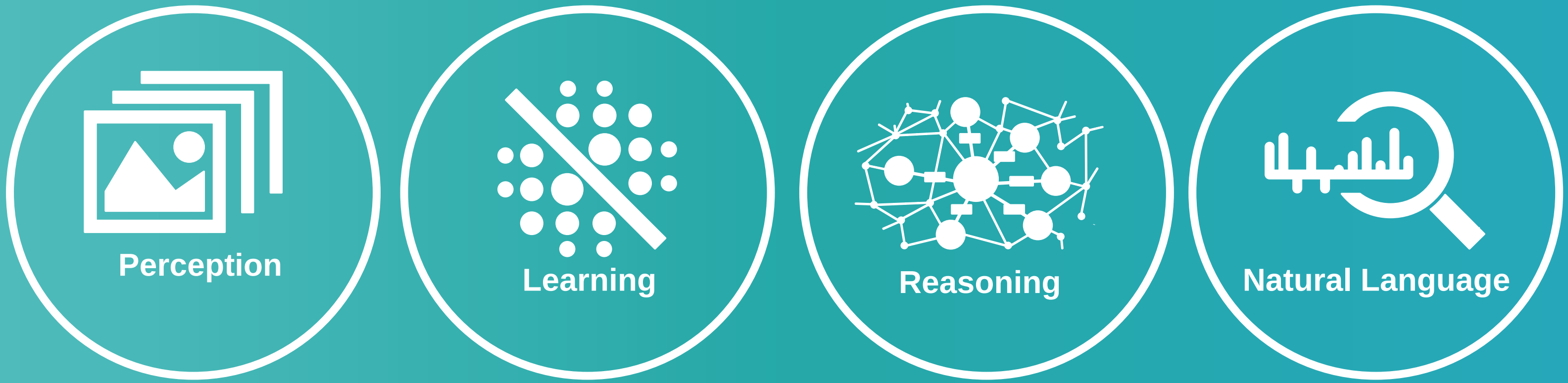


AI & Siemens

Artificial Intelligence & Deep Learning Research Communities & Disciplines

Computer Vision

Speech and Dialog



Reinforcement Learning

Robotics

Decision an Plans

Knowledge Representation

Probabilistic Graphical Models

Algorithmic Game Theory

Deep Learning

Much of the progress of Artificial Intelligence over the past years is based on significant advances in Machine & Deep Learning

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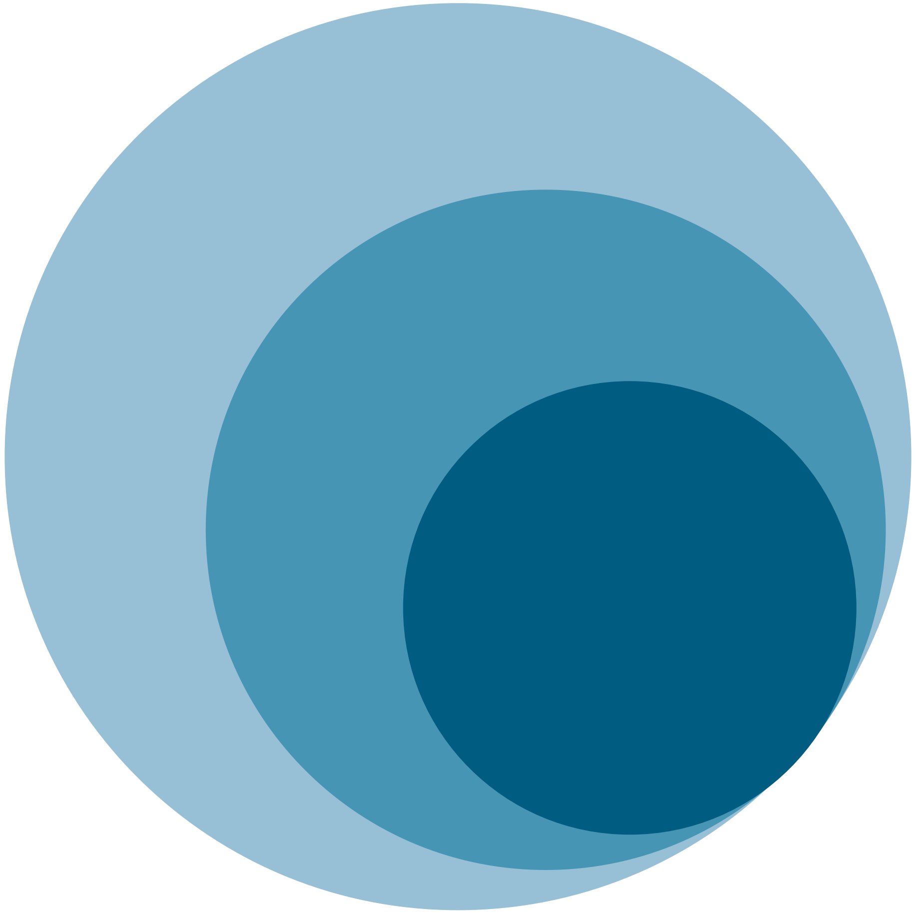

Artificial Intelligence

Making machines capable of performing intelligent tasks like human beings

Machine Learning

A set of algorithms used by intelligent systems to learn from experience.

Deep Learning

Building systems that use Deep Neural Network on a large set of data making non-linear transformations

The challenge…

Capturing all complexity and the unknown unknows in Industrial Artificial Intelligence applications

Research Trends and Challenges in AI & Deep Learning
Capturing all complexity and the unknown unknows in AI research

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AI & Data Scarcity

Deal with insufficient / unlabeled data?

Directions:
- Transfer learning
- Learn from rich simulations
- Learn generative models

AI & Companion

How to augment and who supports whom?

Directions:
- Models of people & tasks
- Model of complementarily
- Coordination of initiative

AI & Society

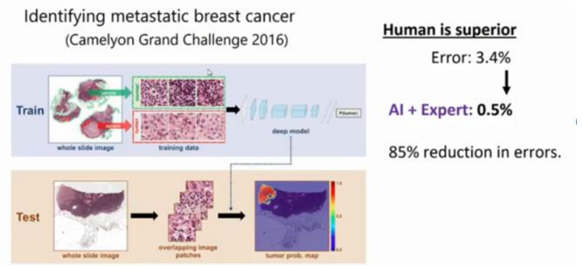
Provide explain- and responsibility?

Directions:
- Trust and safety
- Fairness and transparency
- Ethical / legal autonomy
- Jobs and economy

AI & Open World

Reliable predictions of unknown unknowns?

Directions:
- Expanded real-world testing
- Algorithmic portfolios
- Failsafe designs
- People + machines



Eric Horvitz: AI, People, and the Open World, ACM 2017
Lakkaraju et al: Identifying Unknown Unknowns in the Open World: Representations and Policies for Guided Exploration, AAAI 2017

Siemens has 20+ years of experience in Industrial Data Analytics and Artificial Intelligence research & applications

Energy analytics

Siemens factory in Amberg

Root Cause Analysis & Failure Prediction

CERN Large Hadron Collider

Predictive Maintenance

> 20 high-speed trains at Renfe Spain

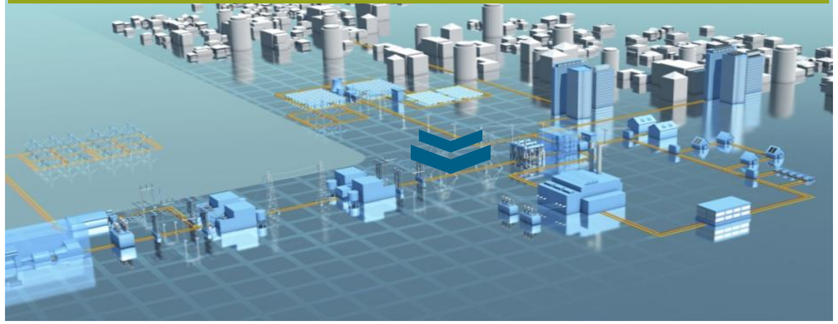
> 20 years online learning neural networks

Deployed in > 30 steel plants

Condition Monitoring & Wear Prediction

Power plants

Asset performance management



Smart Grid, Seestadt Aspern, Vienna

Fusion of simulation with (deep) machine learning: New and more precise insights at reduced costs

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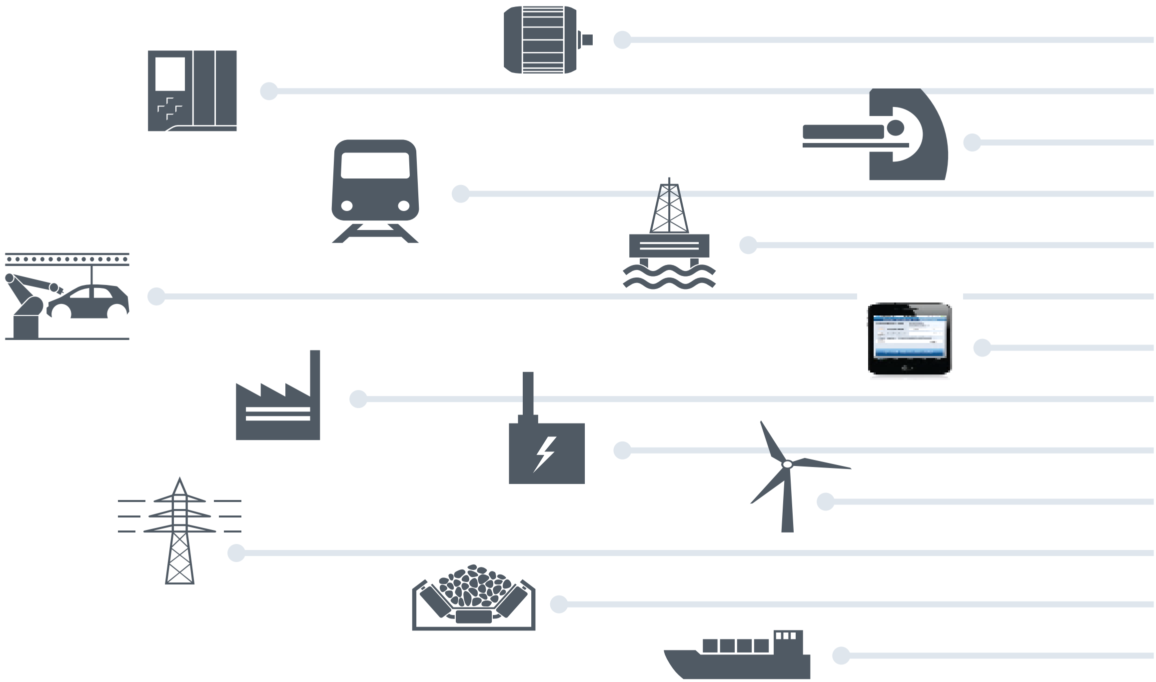
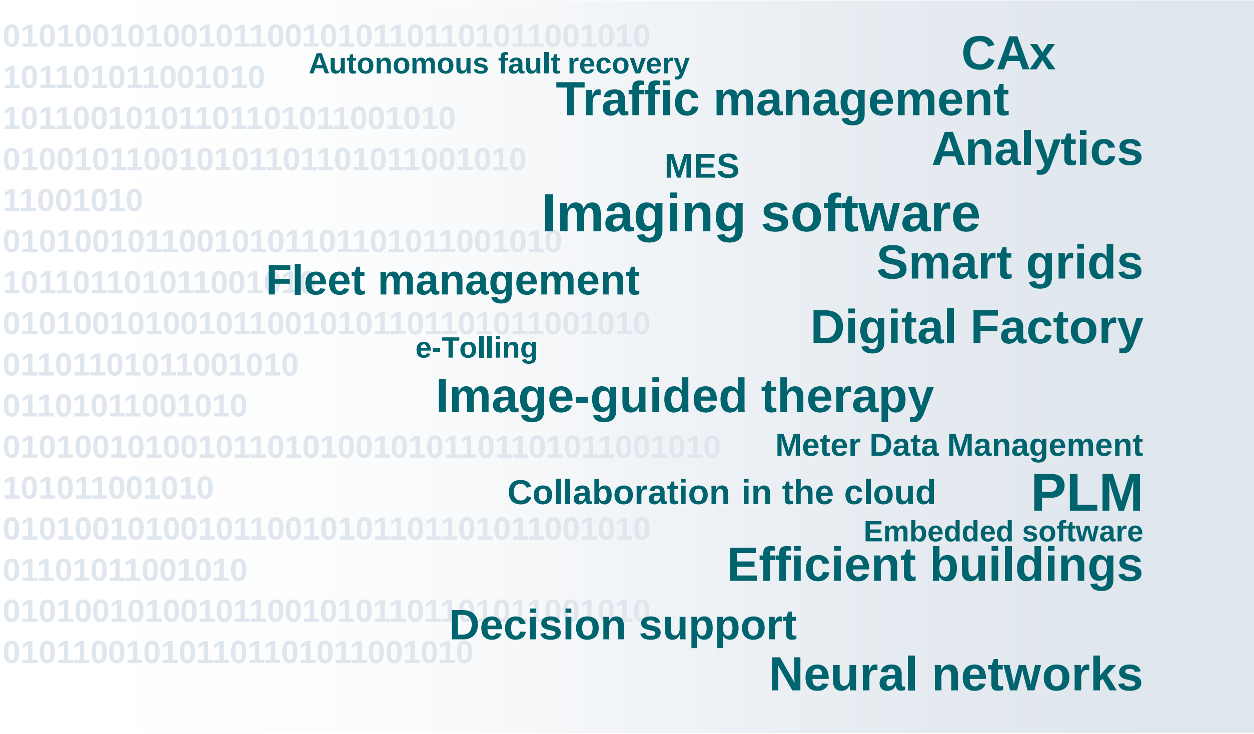
Physical world

Industrial installed base – connected assets



Virtual world

Digital offerings (digital services and industrial applications)



The fundament…

Artificial Intelligence & Deep Learning
Applied Research at Siemens

Fault Localization and Classification of Contingencies from Power Network for Online Decision Support in Power Grids

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D. Krompass, V. Tresp: Method and apparatus for automatic recognizing similarities between perturbations in a network, IP 2017
D. Krompaß, M. Nickel, X. Jiang, V. Tresp. Non-Negative Tensor Factorization with RESCAL. ECML/PKDD 2013

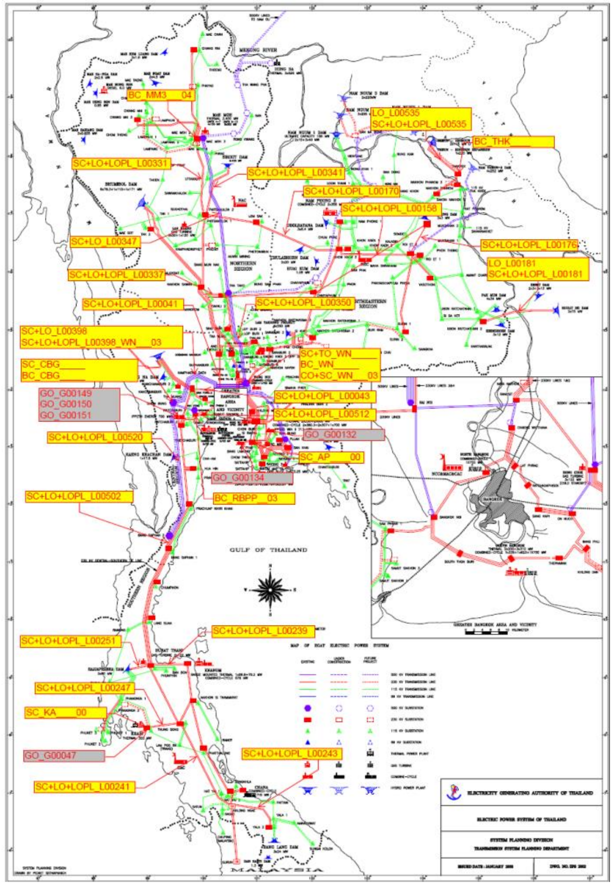
Challenges:

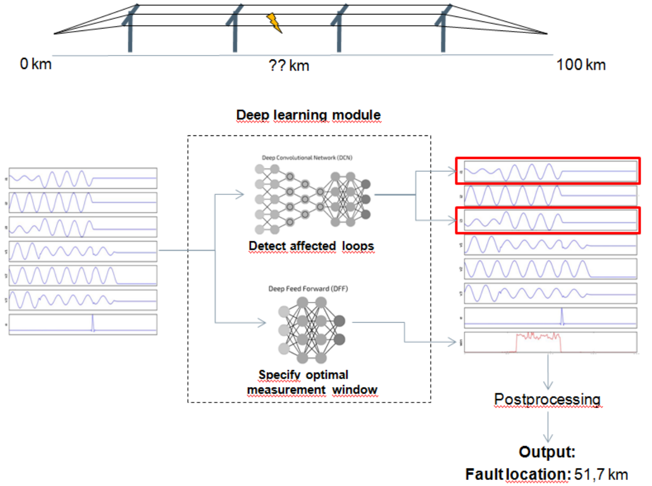
- Recognize simulated contingencies (SIGUARD DSA) in data streams recorded by Phase Measurement Units (PMUs) placed on the lines in a power network.

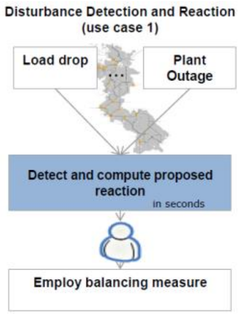
Benefit:

- Recognizing disturbed simulated contingencies from a real power network (Thailand).
- Robust against noise, load change, single PMU failure, fuzzy anomaly detection. (Only neural approach)
- Robust against small topology changes.

Thailand Power Network

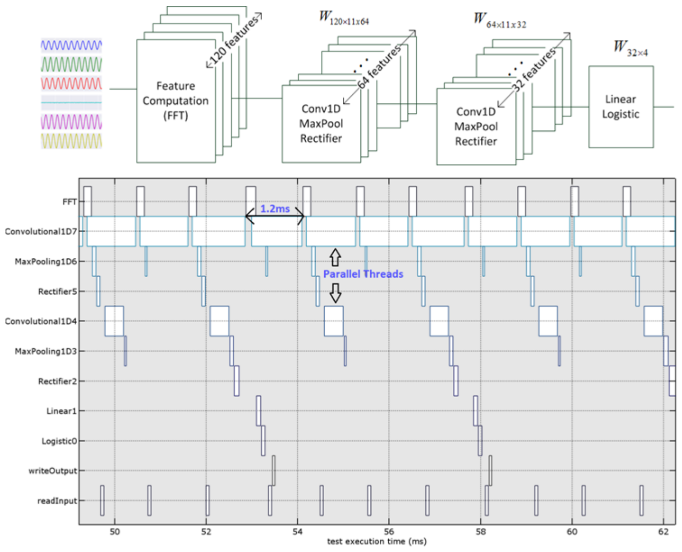


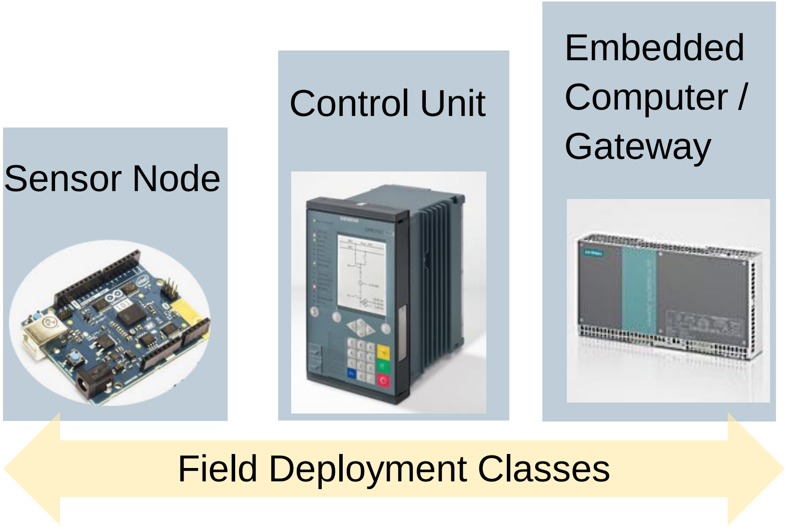




In-Field and Embedded Analytics – Deep Learning Models can be deployed and executed directly on Field Devices

J. Garrido, Light-weight Embedded Analytics Framework (LEAF), (IP, 2017)



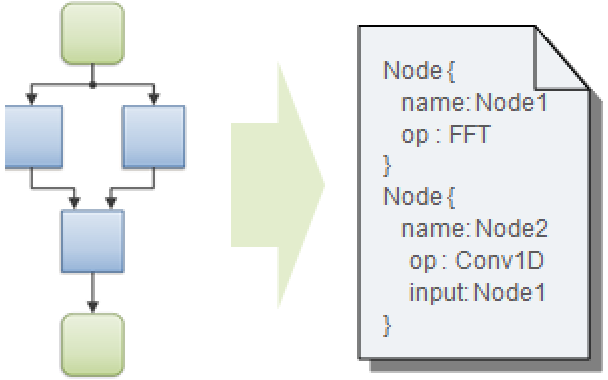


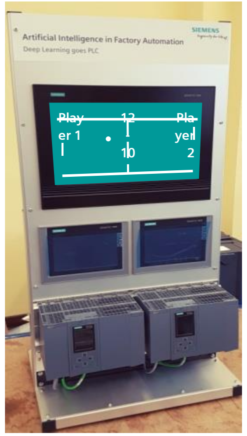
Challenge:

- Faster Response. Work directly on local streams of sensor data. Low latency required for prescriptive analytics, e.g. actuator control.
- Limited Resources. Impossible or inefficient to send and store all device data on data centers.

Benefit:

- Fully parameterized building blocks.
- Execution of arbitrary topologies.
- Easy development of new operations.
- Efficient C++ implementation based on Eigen linear algebra library





 Ulli Waltinger

Deep Learning for Powder Bed Defect Classification for Additive Manufacturing

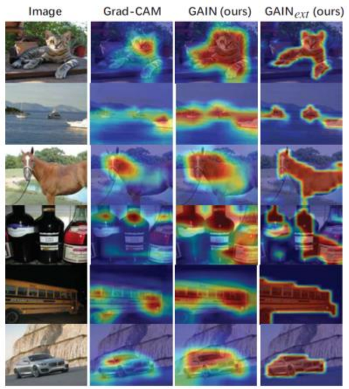
F. Buggenthin, C. Otte, M. Joblin, A. Reitinger et al, Machine intelligence #2 – Additive manufacturing, 2018

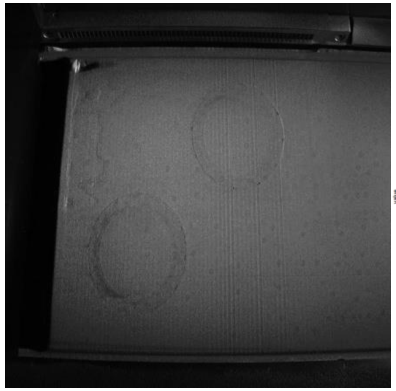
Challenges:

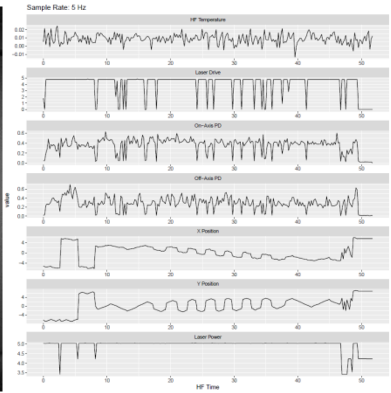
- Can we design a machine learning system that learns what is important in a powderbed image?
- Can this system differentiate between the defined error classes

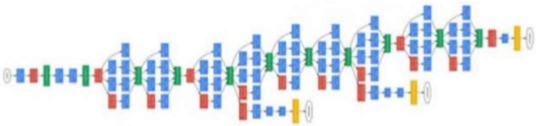
Approach:

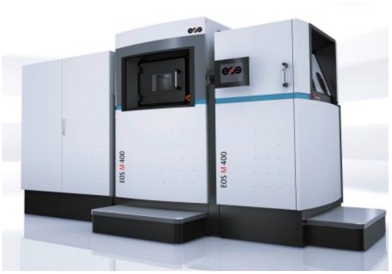
- Normalize image: Subtract median image of perfect powderbed samples
- Correct optical distortions: Mask regions that should not be taken into account by classifier
- Compute features: Augmentation
- Train ML Model (with Attention)

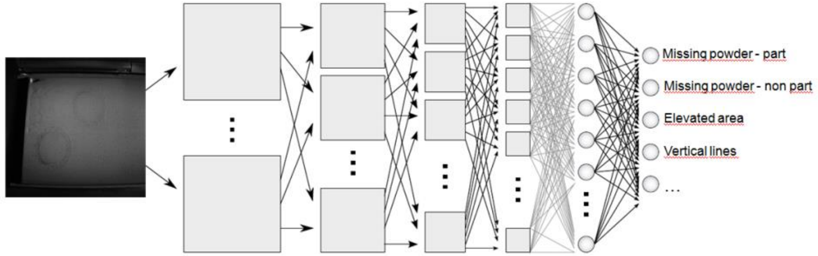












The value proposition…

Artificial Intelligence & Deep Learning From Applied Research to Customer Value from Siemens

Siemens Digital Services – Combining technology with domain and context know-how for customer value

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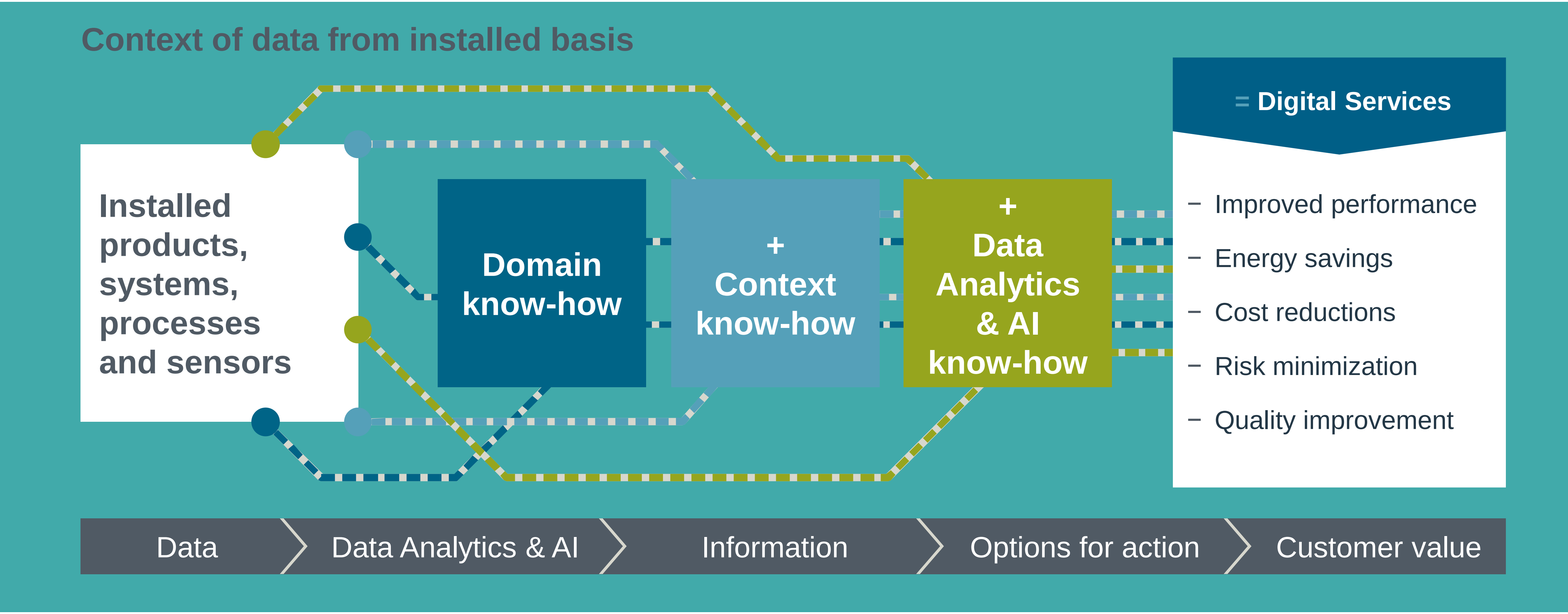

Smart data to business example:
Optimization of gas turbine operation

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Results
- Reduced NOx Emissions
- Extension of service intervals

Energy system
- Market drivers
- Customer needs
- Product cycles

Gas turbines
- Mechanical Engineering
- Thermodynamics
- Combustion chemistry
- Sensor properties

Analytics
- Neural Networks
- Smart Data Architecture processes data from 2000 sensors per sec.

Domain know-how + Device know-how + Data Analytics & AI know-how = Smart Data

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Productive

Gas turbine optimization

Reducing NOx emissions of gas turbines with **artificial intelligence**

Machine learning algorithm automatically optimizes the control parameters **better than human experts**

Benefit: **15 – 20% more** NOx reduction

EasyDetect – Identifying parts in 10 seconds, ordering in three minutes, delivering in 24 hours

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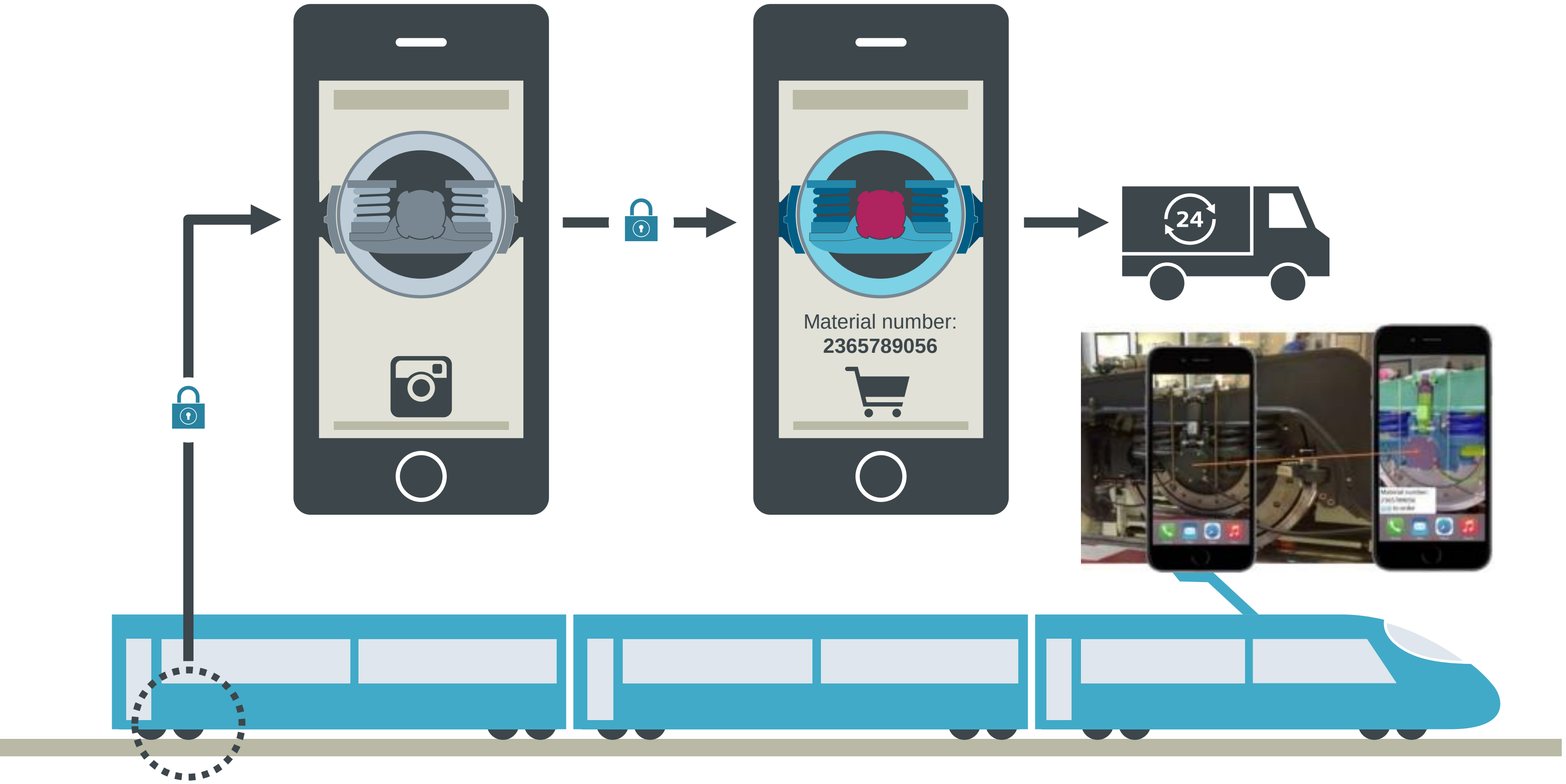

- Parts are identified in 10 seconds, ordered in three minutes, delivered in 24 hours
- Automated identification of parts via smartphone or tablet by state-of-the-art and new innovative technologies (e.g. 3D image analysis with CAD data) as part of the holistic service parts delivery

Machine learning and distributed analytics – Intelligent grid controllers

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Challenge

- Reliably classifying and locating faults in power grids
- Conventional methods at ~80% reliability

Solution

- Machine learning applied to ~70,000 fault events
- Resulting optimized algorithms embedded in SIPROTEC™ protection relays
- Real time streaming and interpretation of grid data

Outcome/benefit

- Considerably improved reliability of locating faults
- Faster recovery times, reduced maintenance cost
- Enabling large-scale integration of solar and wind
- Up to 10% operation costs

From autonomous optimization of gas turbines, improved monitoring of smart grids or predictive maintenance of industrial facilities - artificial intelligence harbors great potential

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Customer value chain

Design & engineering	Operations	Maintenance
Productivity & time-to-market	**Flexibility & resilience**	**Availability & efficiency**

Digital Factory

Streamlined product to automation design

Vertical software

Energy Management

Optimized grid automation integrating renewables

Enhanced E&A

Wind Power

Data-driven upgrades, moving to self-learning

Enhanced E&A

Power & Gas, Power Generation Services

Analytics-based availability and performance guarantees

Digital services

Process Industries & Drives

Integrated process & plant engineering and operation

Vertical software

Healthcare

Image guided therapy for novel surgery procedures

Vertical software

Building Technologies

Data driven advice for building efficiency

Digital services

Mobility

Guaranteed availability via predictive maintenance

Digital services

Digitalization & AI has had huge impact on products, value creation processes and business models

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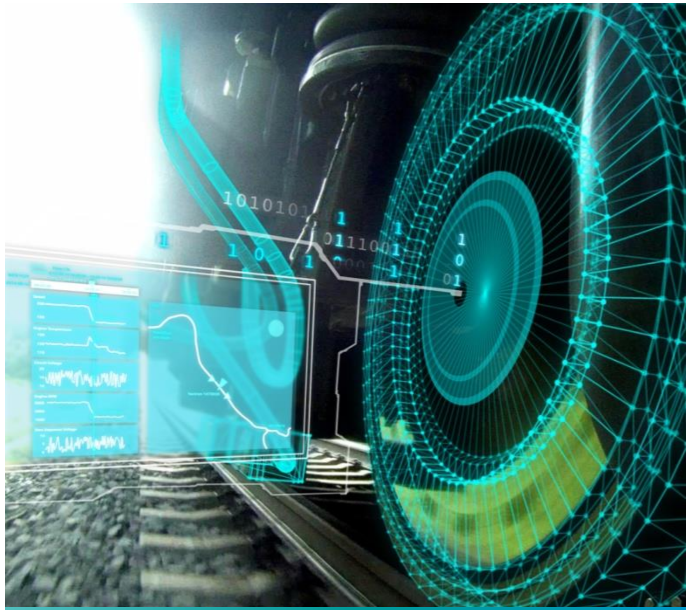
Digitally enhanced products

NOx emission reduction of gas turbines based on machine learning

Value chain

Machine learning & analytics for intelligent grid controllers

New business models



Availability guarantee for train service

Balancing out technology, data and use cases speed up AI innovations and lead us to the real business value

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Challenge to find real user

BUSINESS USE CASE

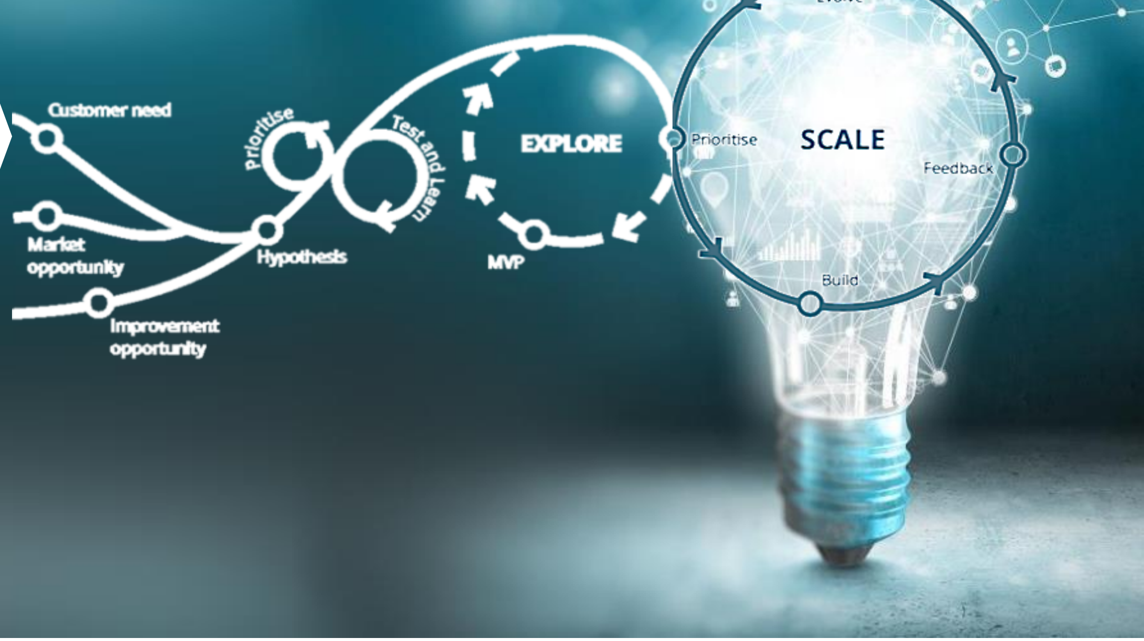
DATA & PRODUCT ASSETS

AI TALENT & TECHNOLOGY

Ensure data availability in needed quality

Provide tailored competences and skills

Win-win solutions with rapid business impact using AI technology



Bold. Committed. Open-minded.

Thank you!

SIEMENS AI Lab MUNICH

Siemens Corporate Technology –
Contact and further information

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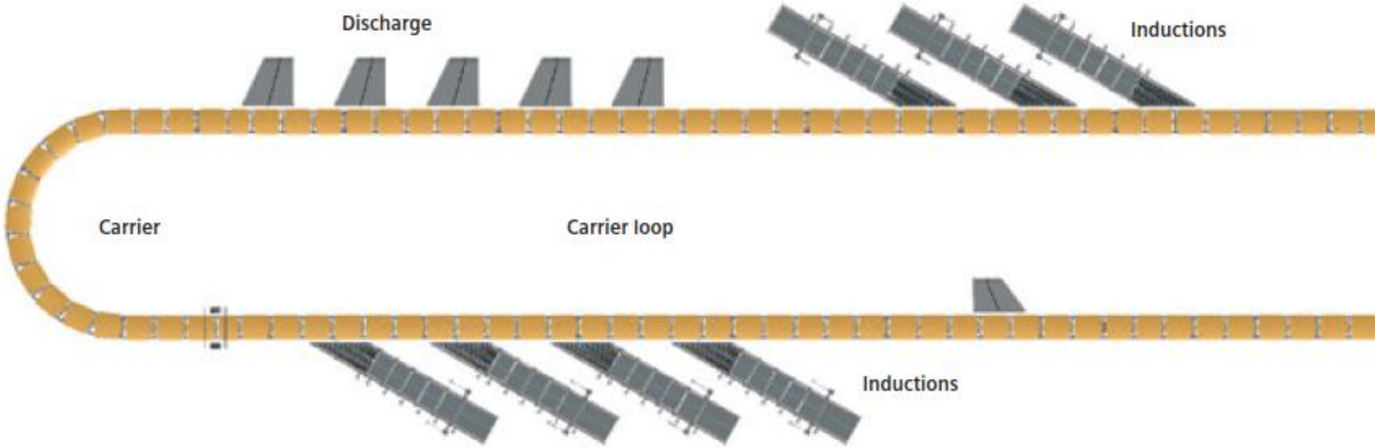
Mobil: +49 162 283 5720

LIS Airport

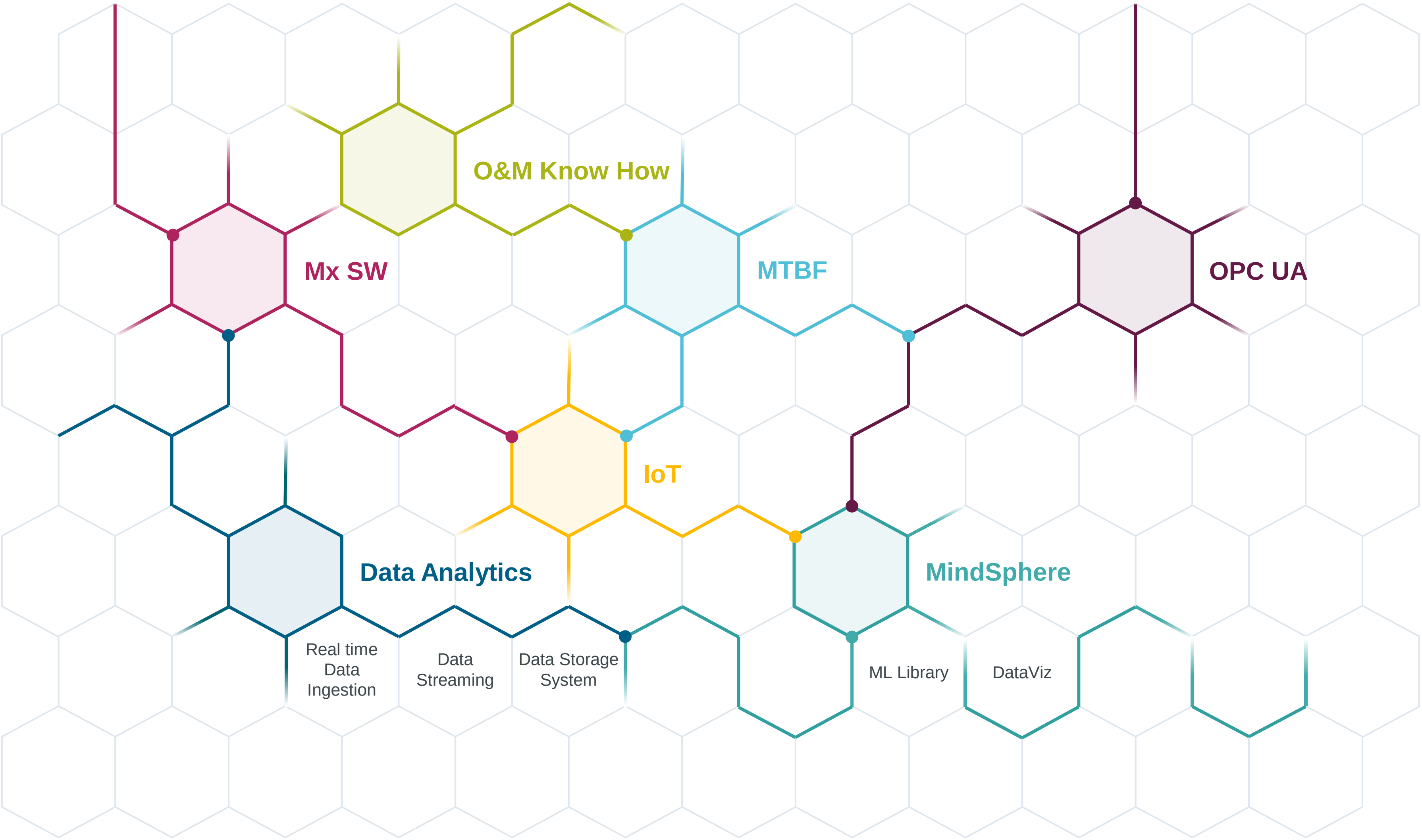
Service 4.0

The machine


VarioSort TTS 1100
Siemens solution for fast and efficient baggage sortation


Discharge
Inductions
Carrier
Carrier loop
Inductions

The Journey



O&M Know How
Mx SW
MTBF
OPC UA
IoT
Data Analytics
MindSphere
Real time Data Ingestion
Data Streaming
Data Storage System
ML Library
DataViz

Behind the Scenes

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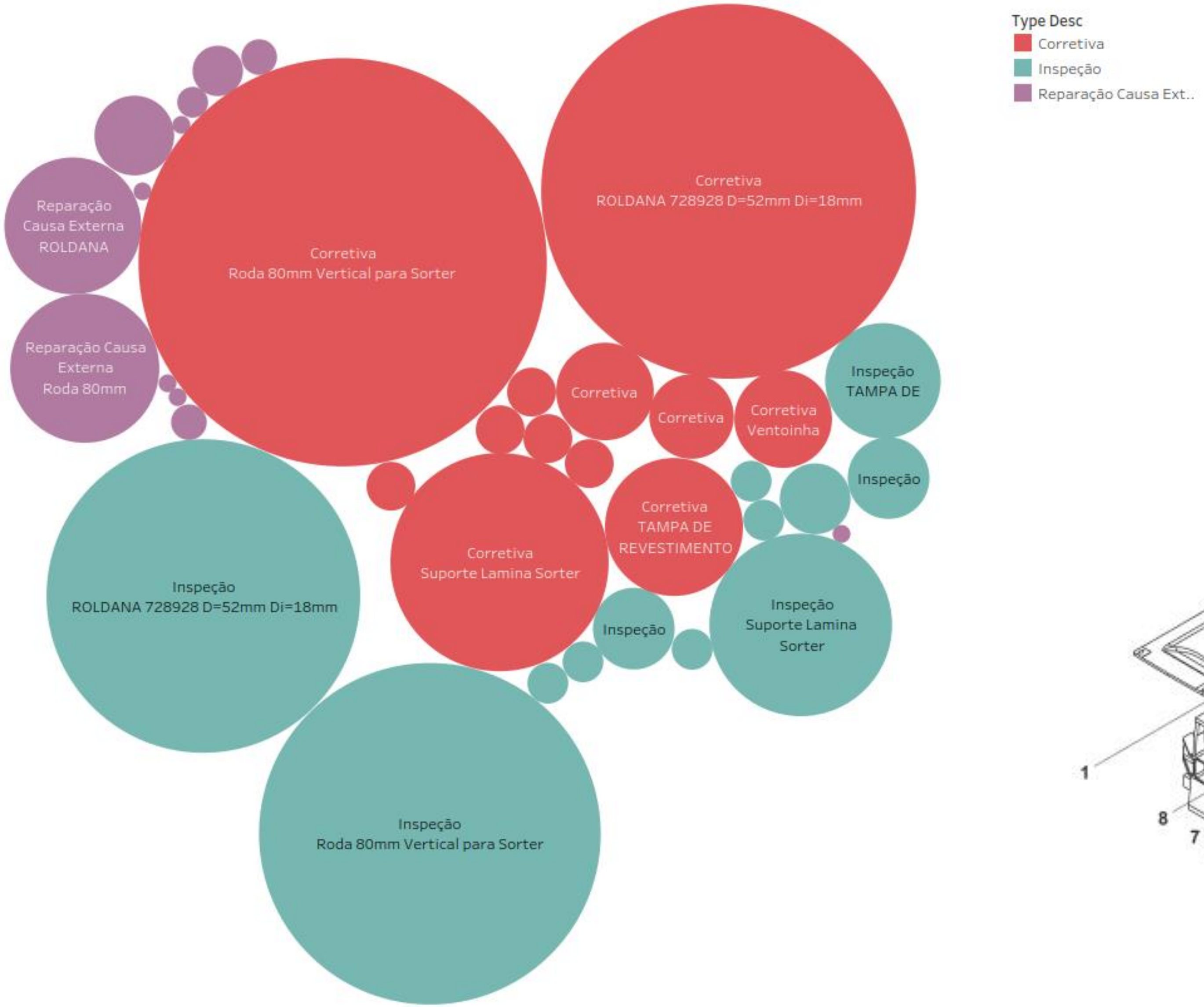
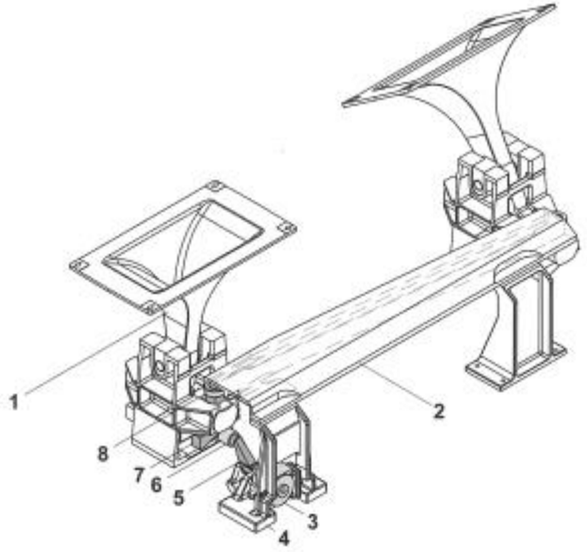
1	Solving critical O&M problem
2	State of the art technology
3	Leverage unparalleled O&M knowledge to generate value added services

LIS Airport Service 4.0

Solving critical O&M problems

LIS Maintenance Analytics





LIS Airport Service 4.0

State of the art technology

This is MindSphere

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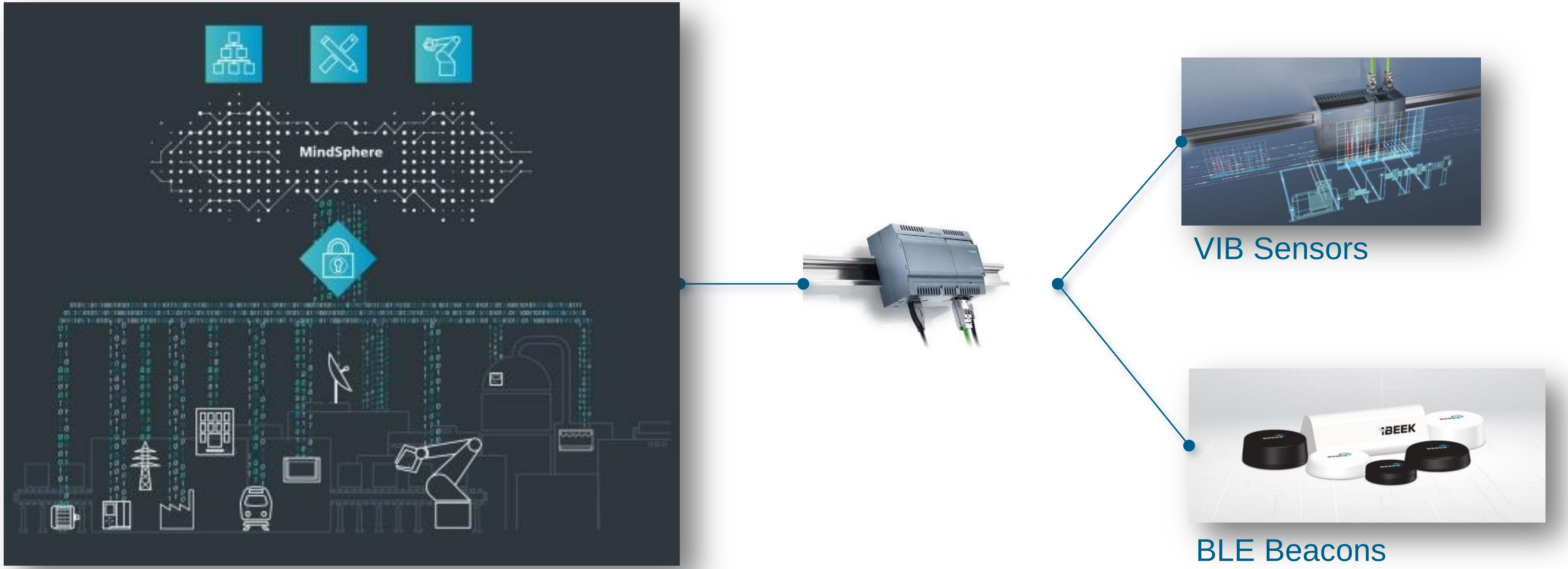

Real Time IoT Data Analysis

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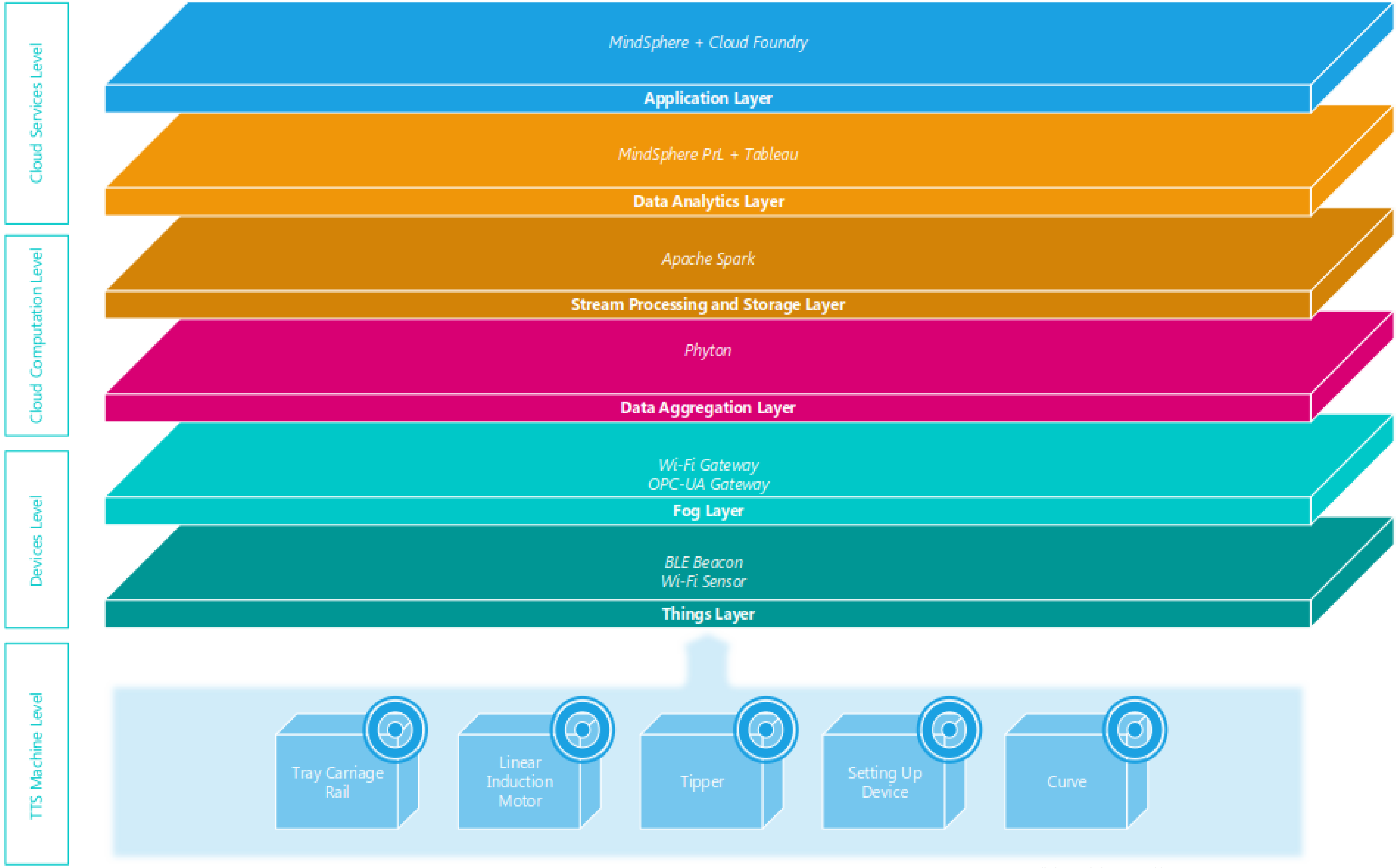

Source: Predictive Analytics App Architecture, SPPAL, 2018

MindSphere IoT Platform

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Karina Ospina

LIS Airport Service 4.0

Value added services

Reliability Based Maintenance

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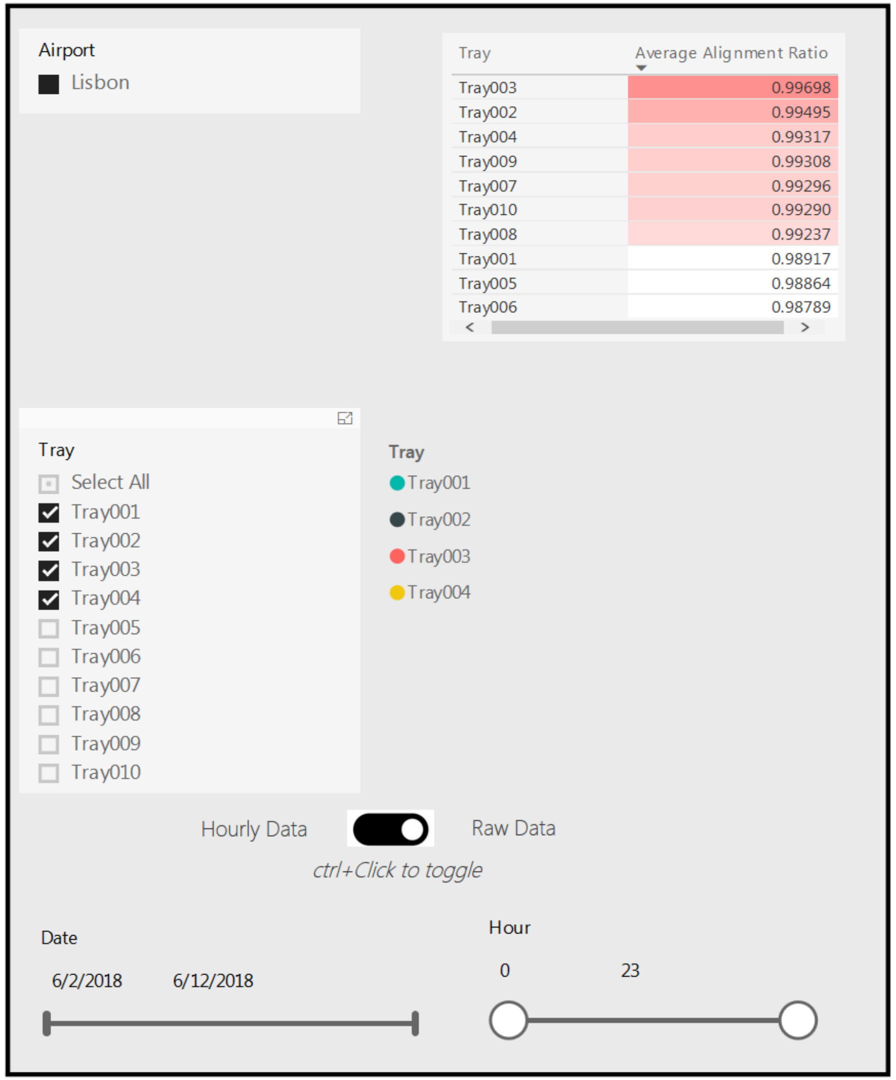
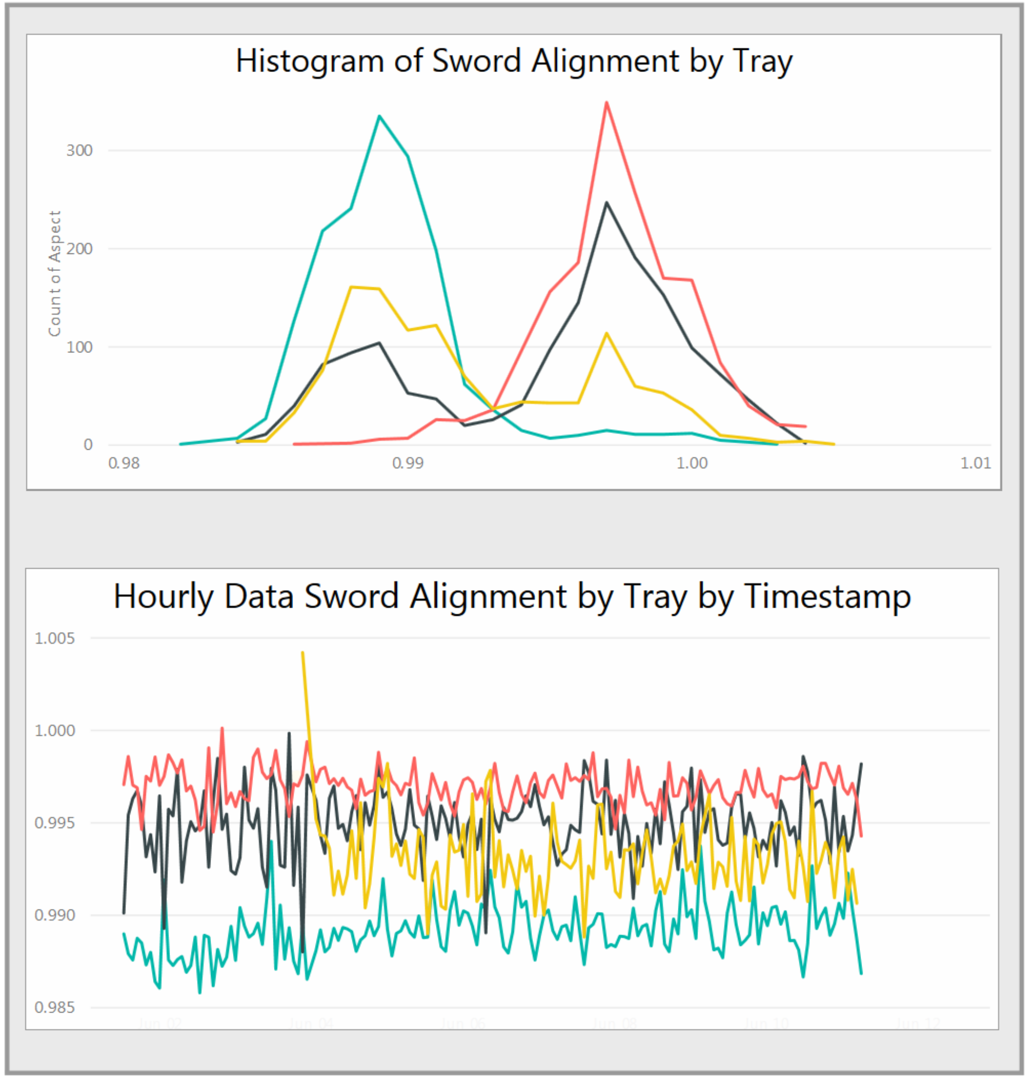
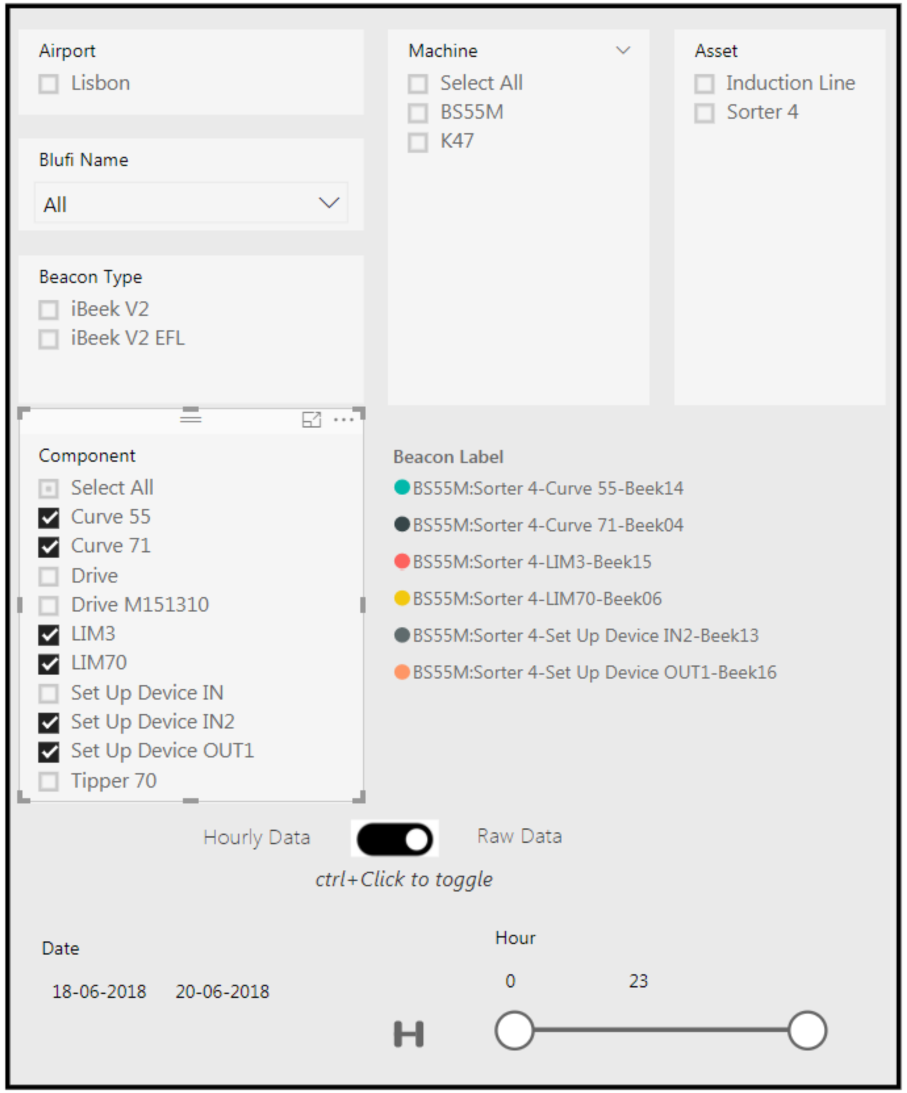
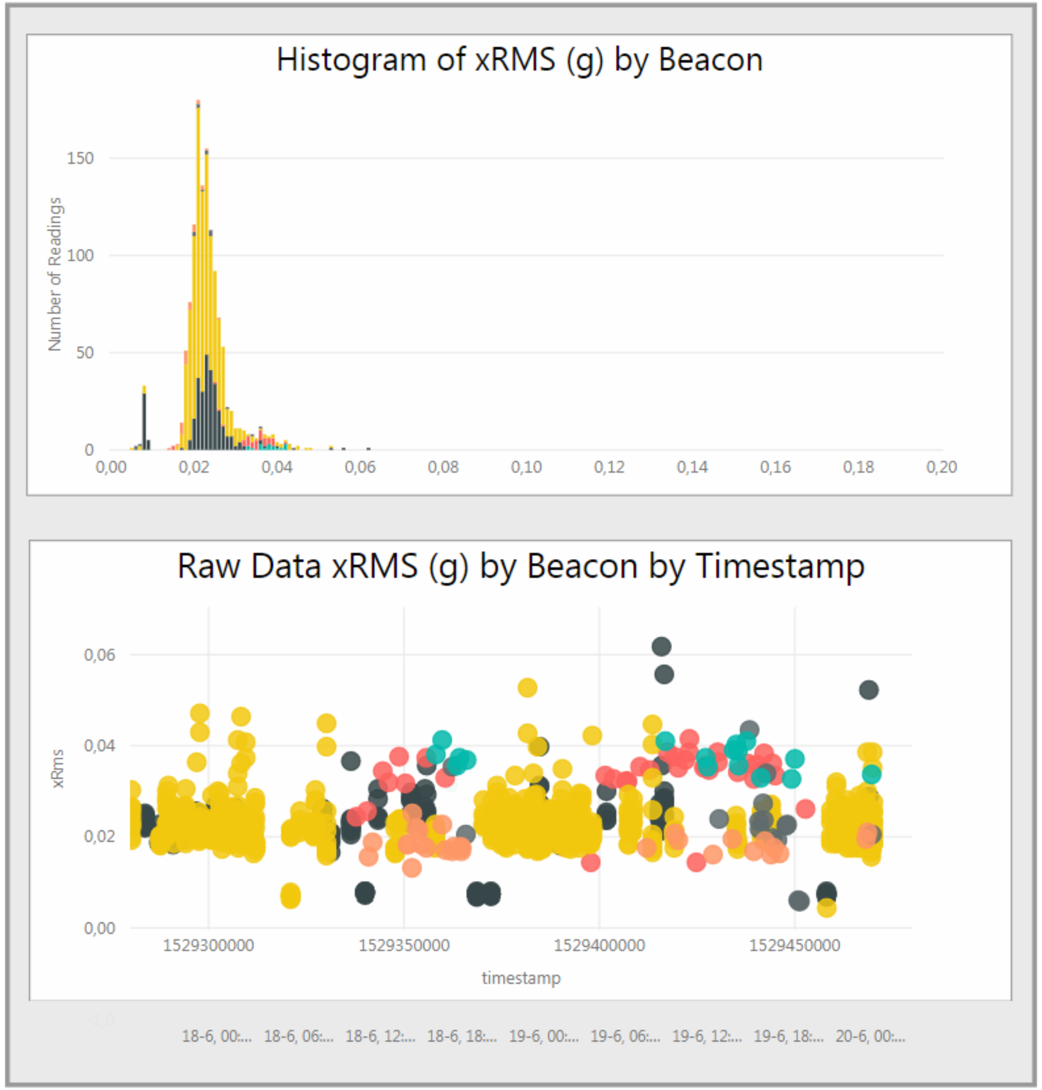


Tray	Average Alignment Ratio
Tray003	0.99698
Tray002	0.99495
Tray004	0.99317
Tray009	0.99308
Tray007	0.99296
Tray010	0.99290
Tray008	0.99237
Tray001	0.98917
Tray005	0.98864
Tray006	0.98789



Machine Condition Based Monitoring





Karina Ospina

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“I have no special talents. I am only passionately curious”

A. Einstein

Contact

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Ingenuity for life

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E-mail: karina.ospina@siemens.com

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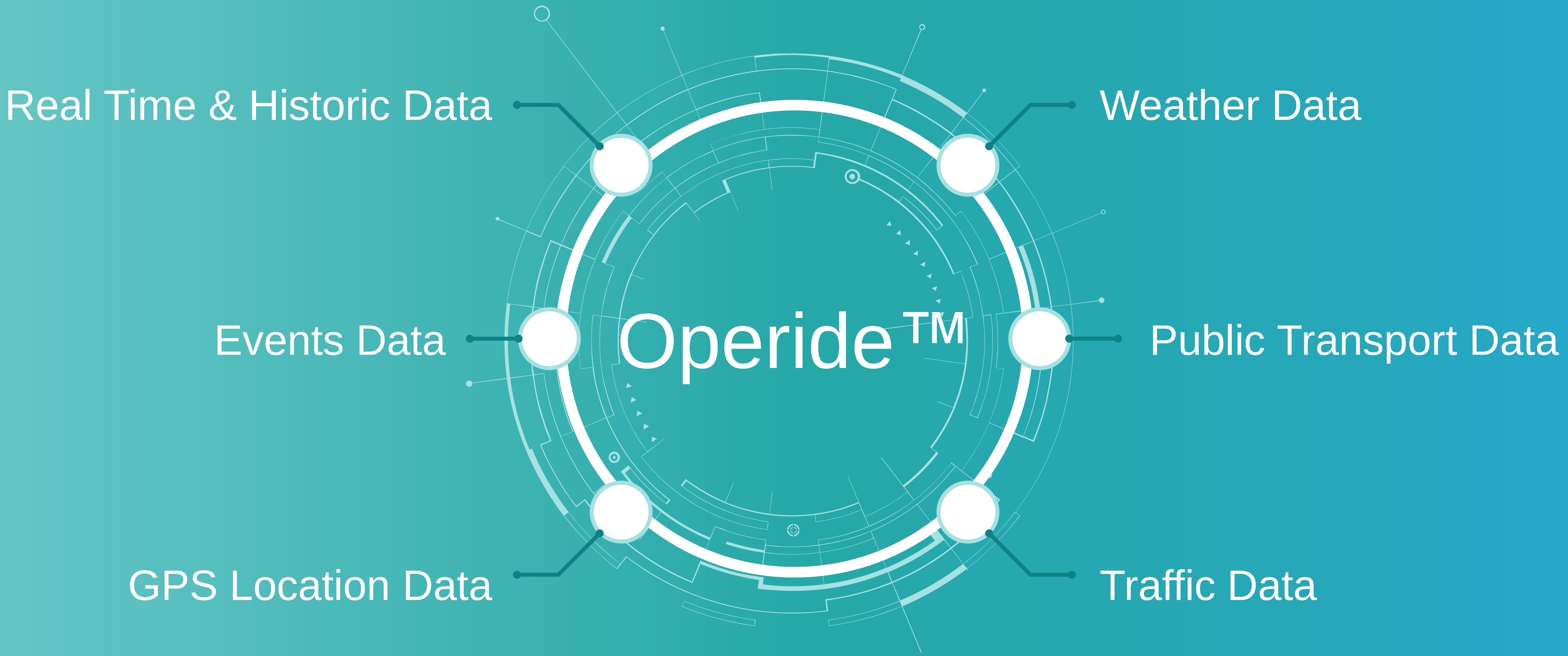
Data Analytics rides e-Bike Sharing

Siemens.pt/digitalizacao


Something new in Lisbon

Gira Bike Sharing | Key Stats

Data Overview



Operide™ – Improving eBike fleet performance with AI-driven Operator Support System

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Customer challenge

- Establish new viable transportation mode
- System becomes imbalanced across the network
- Operator needs to manage complex network

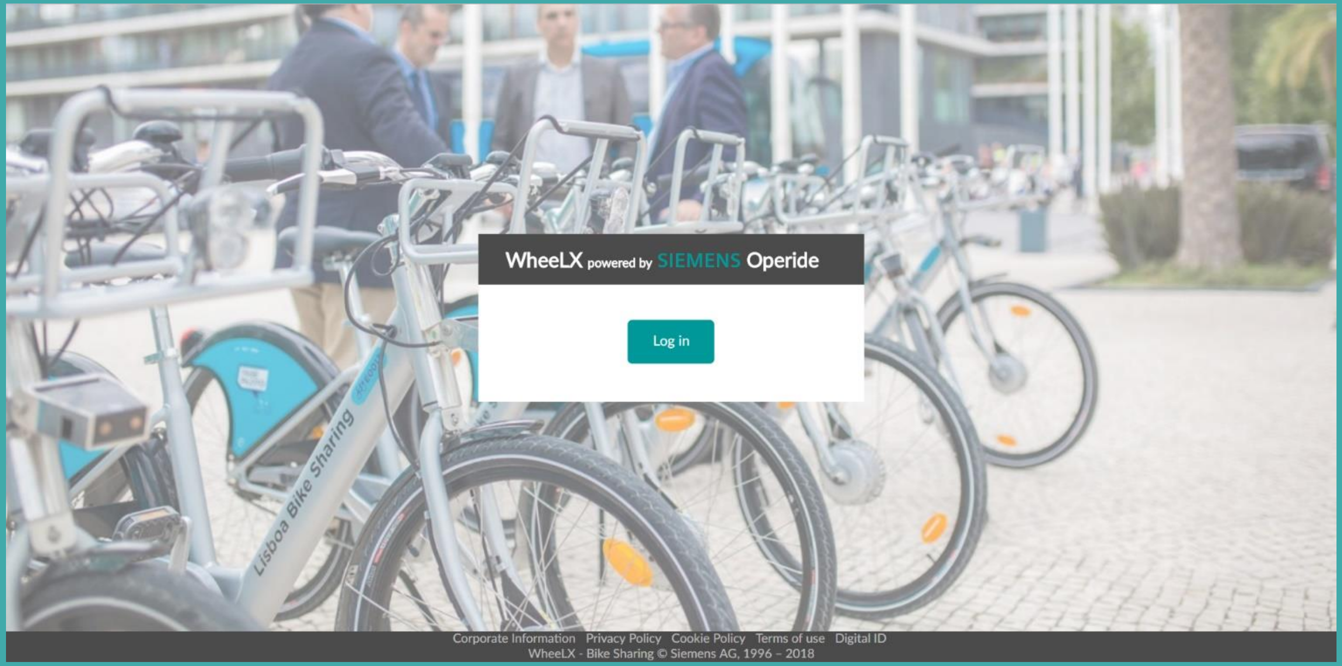
Our solution in Lisbon

- **Predict** status of bikes & stations
- **Provide guidance** to operator on actions to balance the network
- **Optimize** operation

See
Transparency for operator

Understand
Prediction of utilization of stations and bikes & integration of additional data sources

Act
Recommendation to optimize performance of system



Operide™ guides the operator to the most critical stations & provides recommendations for balancing the network

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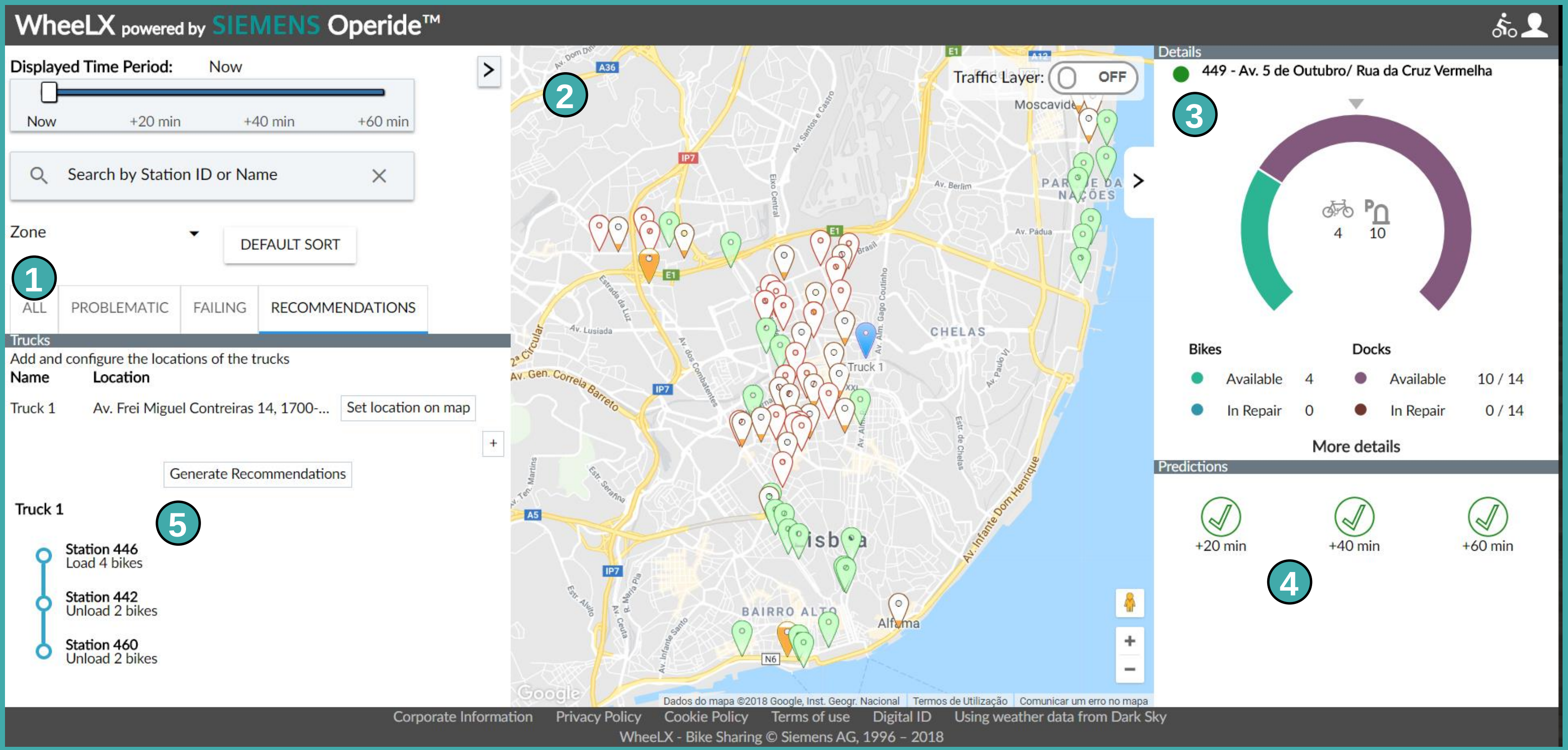
1 **Overview**
- Sorted list of stations

2 **Map**
- Color-code draws attention to high-priority / problematic stations

3 **Station details**
- Selecting a station shows detailed information (e.g. docks available & in repair)

4 **Predictions**
- Predictions of the station status for next 20, 40 and 60 provided to guide which stations are the most critical

5 **Recommendations**
- Guidance on what actions to take to improve station status
- Rebalancing itineraries provided on the map



Operide™ – From Predictions to Optimal Rebalancing

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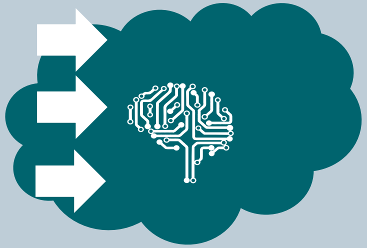
Predictive model driving optimal rebalancing in space & in time

1. System & External Data

Station
Trip data
GPS
Weather



2. System status predictions

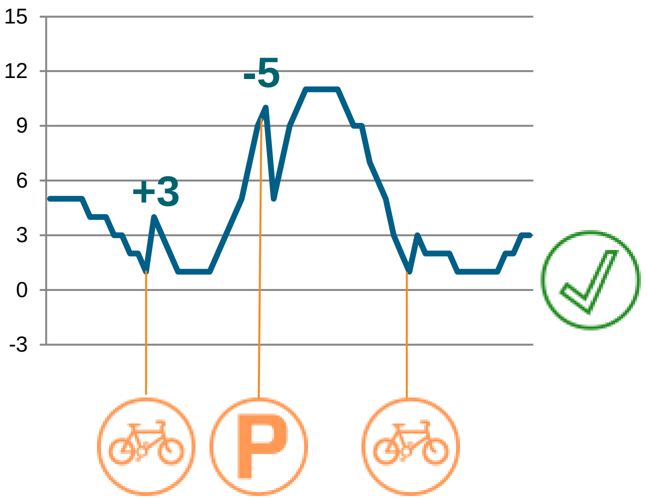
3. Recommendations

A Predict deficiency between demand and availability

Predicted demand
Actual utilization (availability limited)

Stations are failing as predicted, firstly no bikes and then no docks

B With predictions and recommendations



Actual status: improved availability thanks to rebalancing action based on forecasts

Our recommendations ensure that bikes and docks are always available. Sometimes, we predict a recovery and in this case no action is required

Afonso Pais de Sousa

How to go faster?

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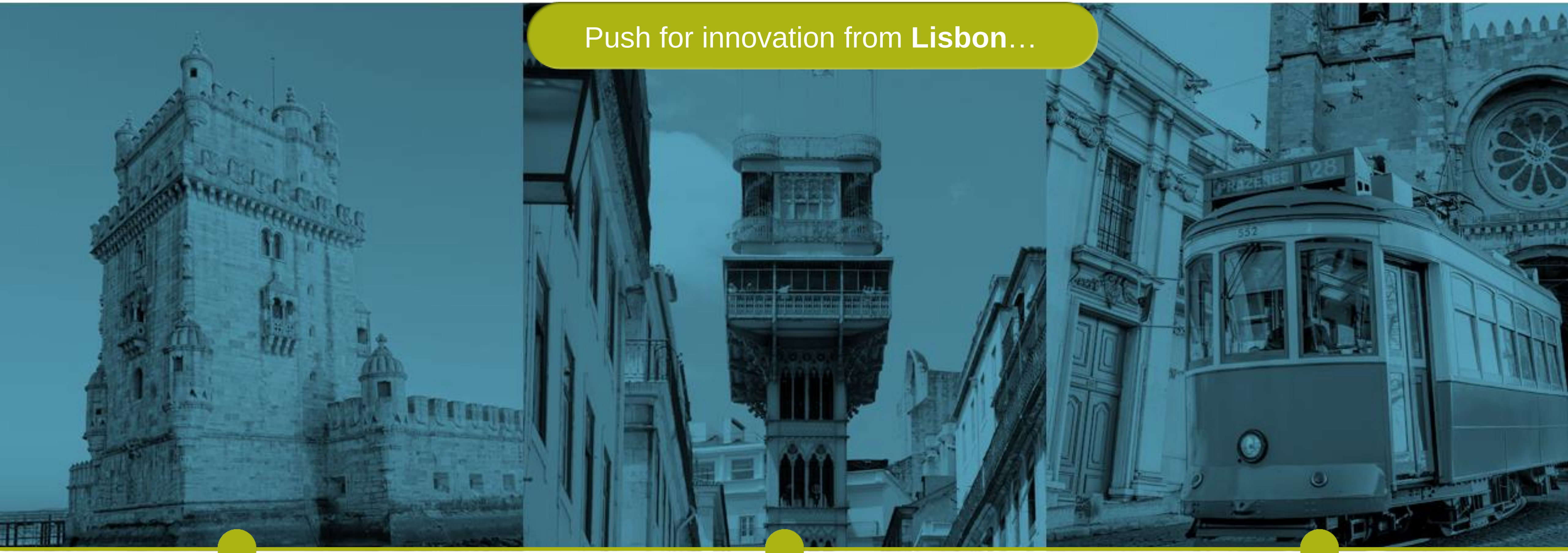
Push for innovation from **Lisbon**…



Make strong synergies with both the city and with core activities of ITS

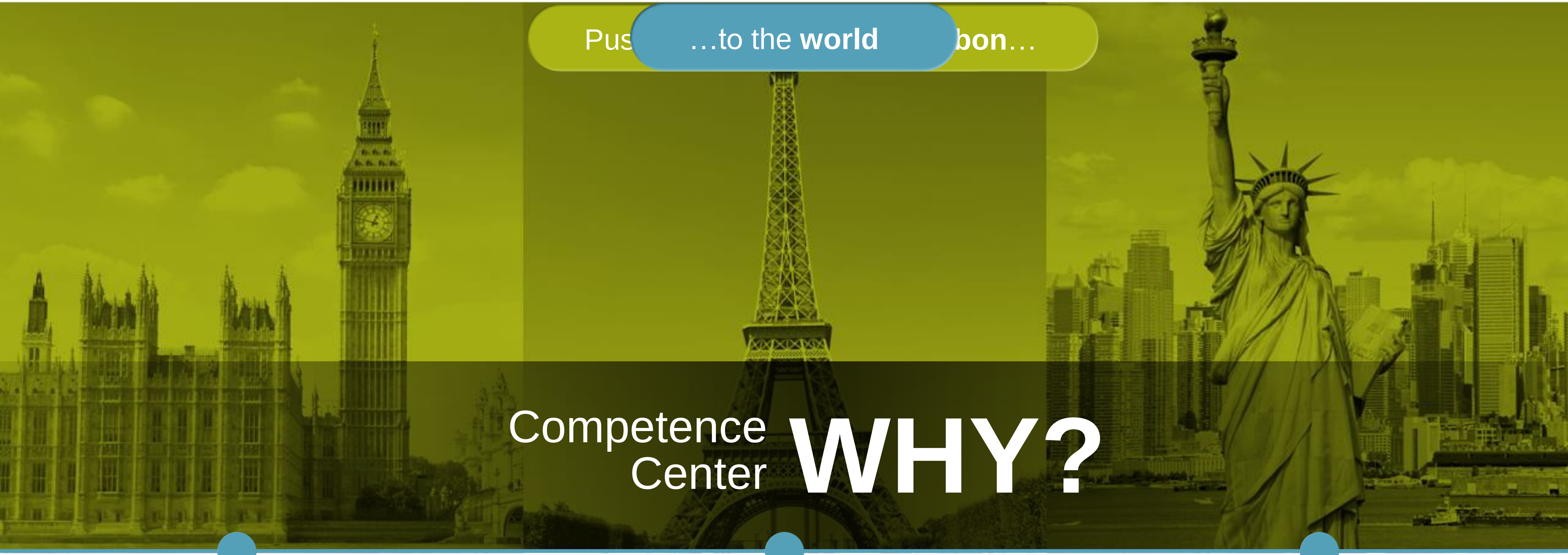
Set the infrastructures standards to higher levels

Get in depth information to develop innovative Big Data solutions and rely on Data Analytics to develop new products

Afonso Pais de Sousa

How to go faster?

SIEMENS
Ingenuity for life



Know-how

Experienced partner

An innovative service

Contact

Afonso Pais de Sousa
Head of Engineering
Intelligent Traffic Systems

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Thank You