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VIMS
VIRTUAL IOT MANUFACTURING SYSTEM

Intelligent Maintenance Conference 2021, Zurich

7th September 2021

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AICAM HO Technologies

VIMS PLATFORM

The core of the VIMS system combines an **IIoT platform** with a data-driven **Digital Twin** of the factory or production line.

The Digital Twin yields a fully immersive and bi-directional experience at the factory or production line thanks to **Virtual Reality** and **Augmented Reality** technologies.

A collaborative project to develop and industrialize a new, complete, and integrated digital ecosystem for industrial & manufacturing environments funded by the EC under H2020 program.

Maintenance app

Digital Twin will be visualized using user-friendly maintenance solutions:

Monitoring & Control in real time

Production Line monitoring

Predictive Calibration Predictive Performance

Virtual Training

Assisted Operator

Path Finding Assistance Guidance

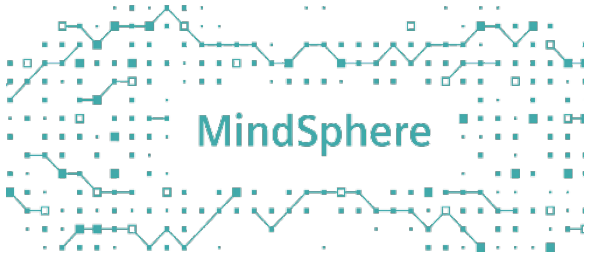
The performance of the system will be assessed in real cases of aerospace and pharmaceutical industry .

Selecting real use cases for such different industries assures that the VIMS system architecture, will be applicable to and compatible with a wide range of factories and production processes of many different industries.

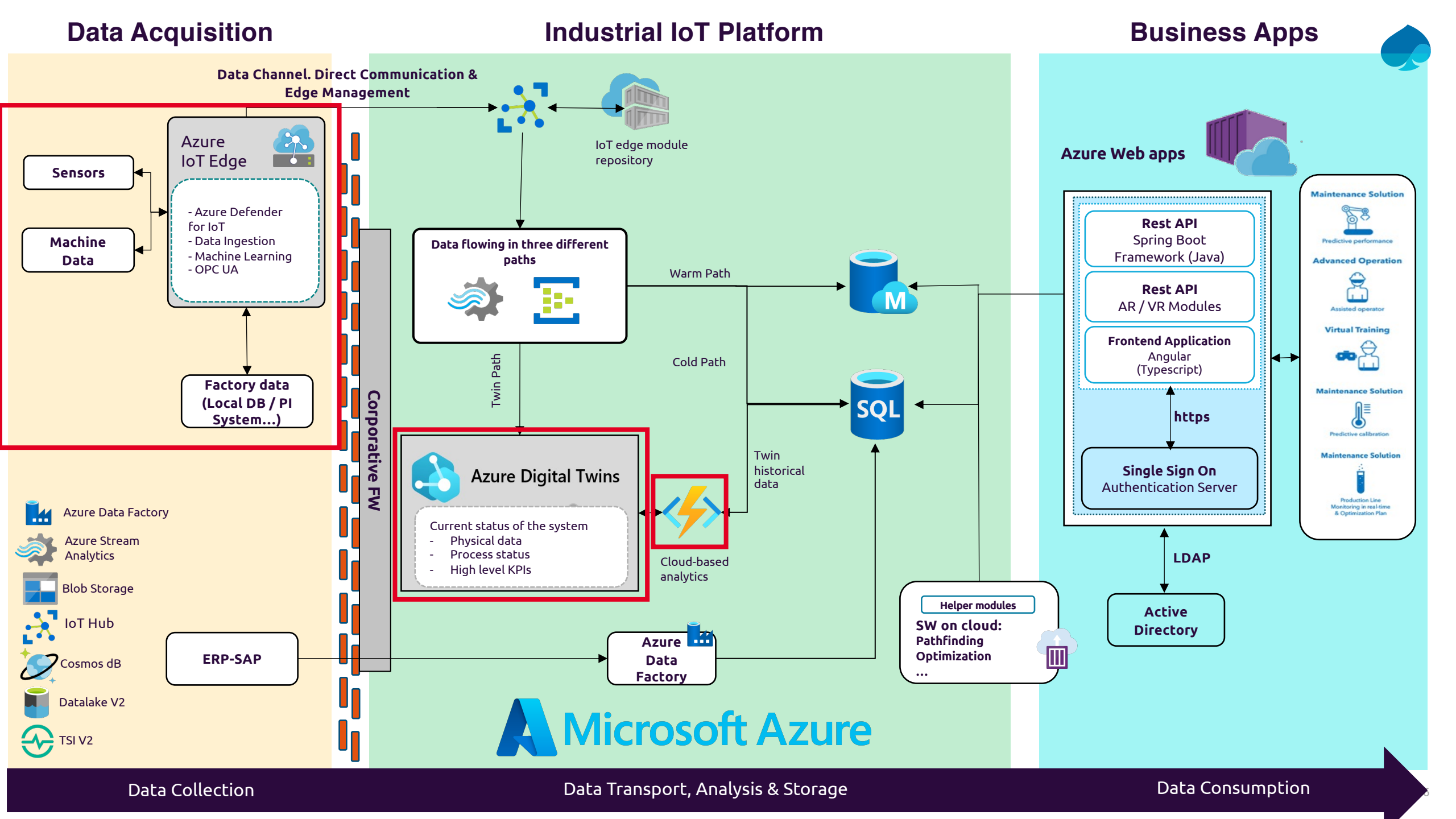
ARCHITECTURE

Cloud platform selection

Initial selection based on key criteria



1. Asset connectivity
2. Analytics
3. Visualization
4. Third party connections
5. Security
6. High availability
7. Support and training
8. Scalability


Data Acquisition
Industrial IoT Platform
Business Apps
Data Channel. Direct Communication & Edge Management
IoT edge module repository
Azure IoT Edge
- Azure Defender for IoT
- Data Ingestion
- Machine Learning
- OPC UA
Sensors
Machine Data
Factory data (Local DB / PI System...)
Corporative FW
Data flowing in three different paths
Warm Path
Cold Path
Twin Path
Azure Digital Twins
Current status of the system
- Physical data
- Process status
- High level KPIs
Cloud-based analytics
Twin historical data
Azure Web apps
Rest API
Spring Boot
Framework (Java)
Rest API
AR / VR Modules
Frontend Application
Angular
(Typescript)
https
Single Sign On
Authentication Server
LDAP
Active Directory
Maintenance Solution
Predictive performance
Advanced Operation
Assisted operator
Virtual Training
Maintenance Solution
Predictive calibration
Maintenance Solution
Production Line Monitoring in real-time & Optimization Plan
Helper modules
SW on cloud:
Pathfinding
Optimization
...
Azure Data Factory
ERP-SAP
Azure Data Factory
Azure Data Factory
Azure Stream Analytics
Blob Storage
IoT Hub
Cosmos dB
Datalake V2
TSI V2
Microsoft Azure
Data Collection
Data Transport, Analysis & Storage
Data Consumption

DIGITAL TWIN

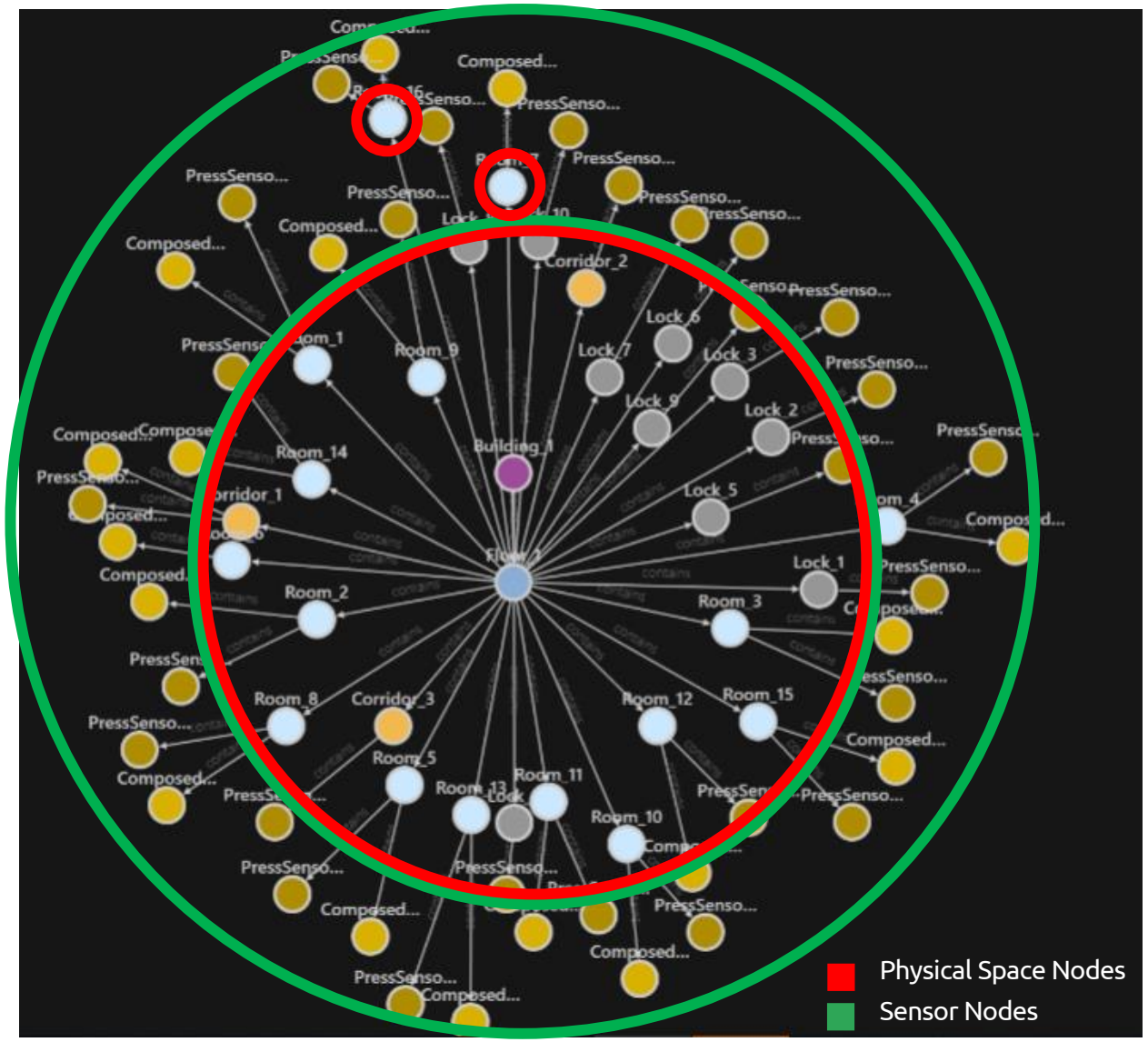
Digital Twin Ontology

Live execution environment to bring your digital twins in a live graph representation.

Open modeling language to create custom domain of any connected environment using Digital Twins Definition Language.

Input from IoT and business systems to connect assets, including IoT devices, using Azure IoT Hub, Logic Apps and REST APIs.

Output to Time Series Insights storage and analytics using event routes to downstream services including Azure Synapse Analytics.



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EDGE-BASED PERFORMANCE MONITORING

ADVANCED MONITORING

Performance of complex shopfloor machinery is assessed real time via advanced analytics.

- Increased visibility into the status of the manufacturing processes.
- Improved maintenance activities, root cause analysis.
- Leveraging the edge to reduce operational costs & reduce/remove latency in time-sensitive operation.
- Medium-term goal of replacing verification tasks with real-time status monitoring.

95%

Bandwidth reduction

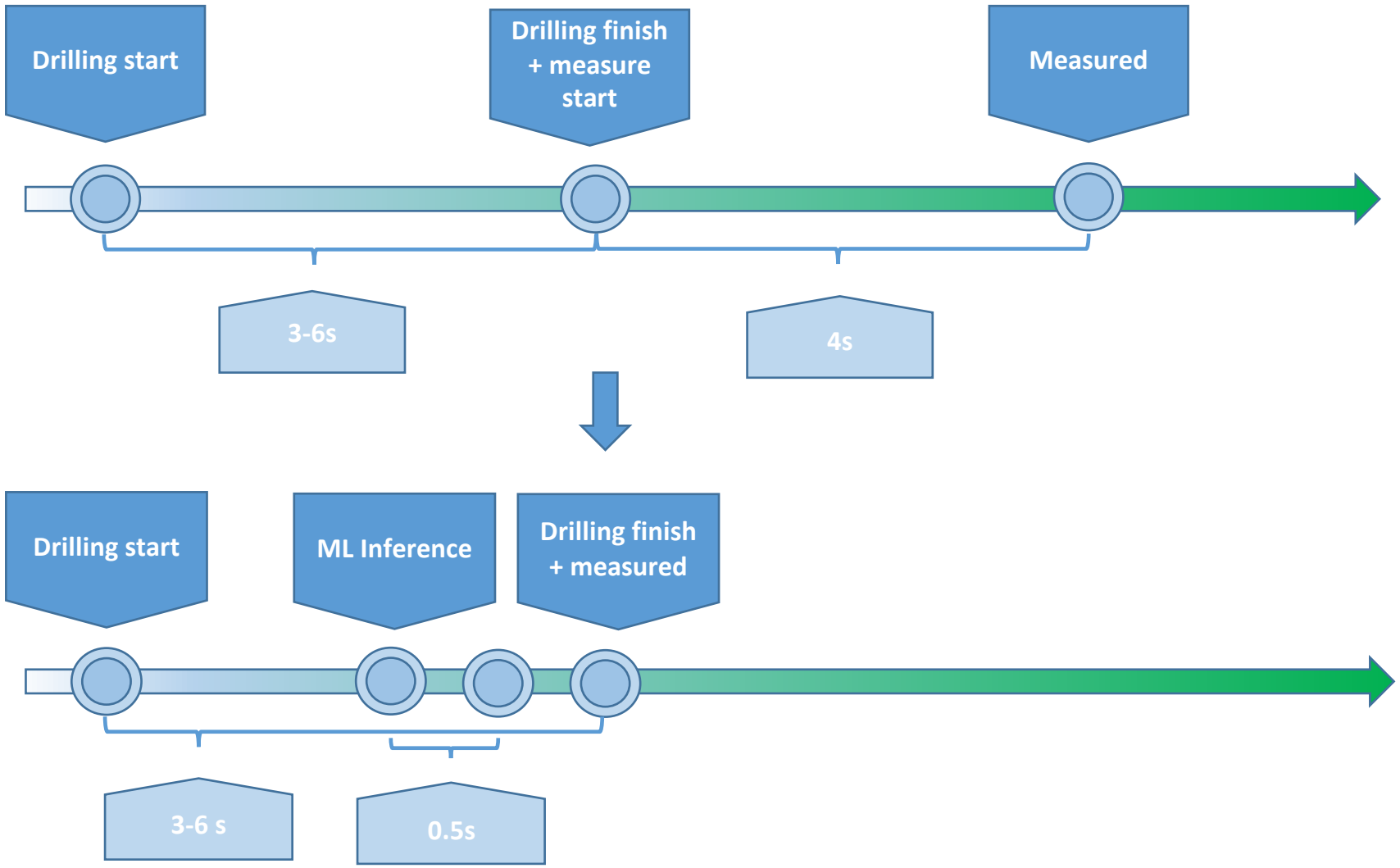
>90%

Latency reduction

2%

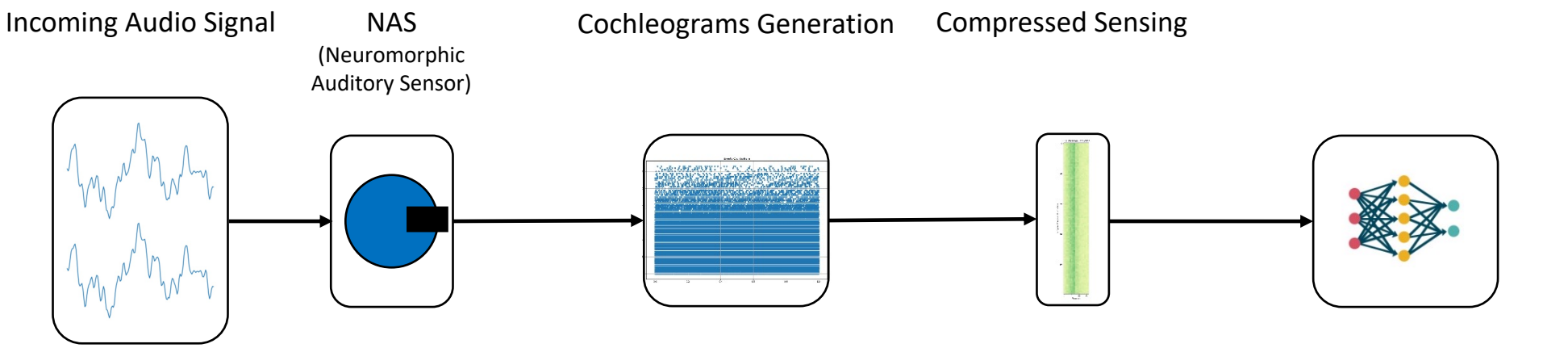
Manufacturing throughput increase

EDGE PERFORMANCE MONITORING
PROCESS TIME REDUCTION



EDGE PERFORMANCE MONITORING
NOVEL, BIO-INSPIRED APPROACH

Performance monitored via analysis of the cochleogram generated by a Neuromorphic Auditory Sensor.



Jiménez-Fernández, A., Cerezuela-Escudero, E., Miró-Amarante, L., Domínguez-Morales, M. J., Gómez-Rodríguez, F. D., Linares-Barranco, A., & Jiménez-Moreno, G. (2016). A Binaural Neuromorphic Auditory Sensor for FPGA: A Spike Processing Approach. *IEEE Transactions on neural networks and learning systems*, 1-15.

Candes, E., Romberg, J., & Tao, T. (2006). Stable Signal Recovery from Incomplete and Inaccurate Measurementes. Communications on Pure and Applied Mathematics, 1207-1223.

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AUTOMATIC DETECTION OF SENSOR DECALIBRATIONS

ADVANCED MONITORING

Calibration status of ambient (Temperature, Pressure, Humidity) sensors is assessed in real time by simply analysing their measurements.

- Improves the calibration strategy from Periodic Maintenance to Condition Based Maintenance, reducing the risk of non-conformance.
- Detect decalibrations in sensors hours/days after they occur (as opposed to weeks/months after they do).
- Provides an estimate of the time left until the sensor readings go out of tolerance, enabling scheduled operations.

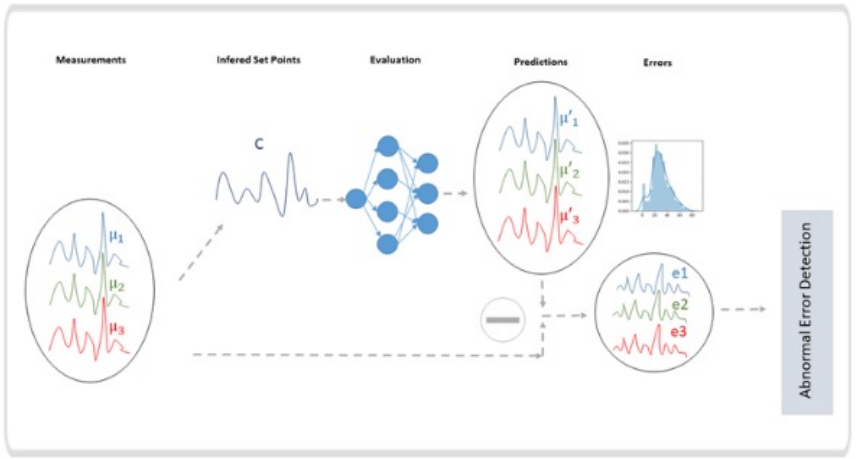
Condition-based maintenance

Increased visibility

Scheduled maintenance

HOW IS IT POSSIBLE TO DETECT DECALIBRATIONS?

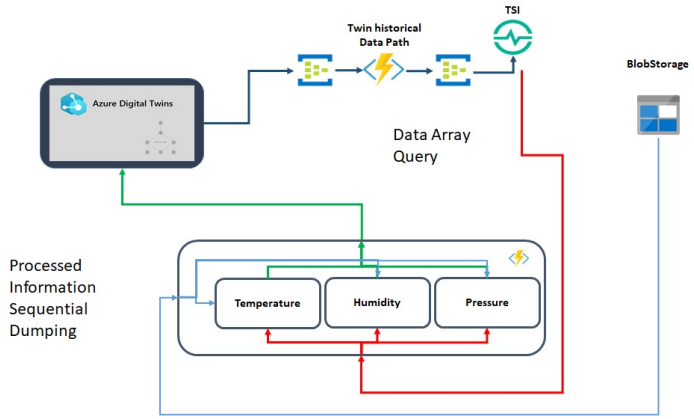
Predictive calibration



- An **Artificial Intelligence (AI) Solution** has been developed in order to detect decalibrations of a sensoric system. Such a solution has not only returned good results (in terms of detection capability) but is also re-trainable and adaptable to new sensor arrays or locations with no to much extra information.
- The architecture is replicated for each kind of sensor.

Please, find the paper in the following link: https://arxiv.org/abs/2102.01565

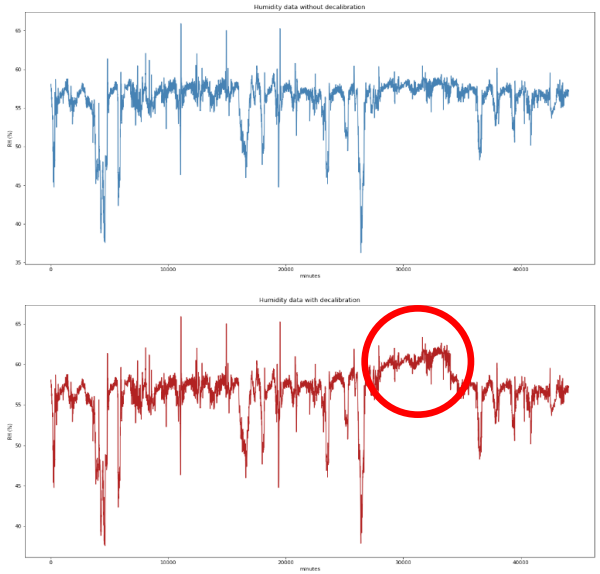
Implementation

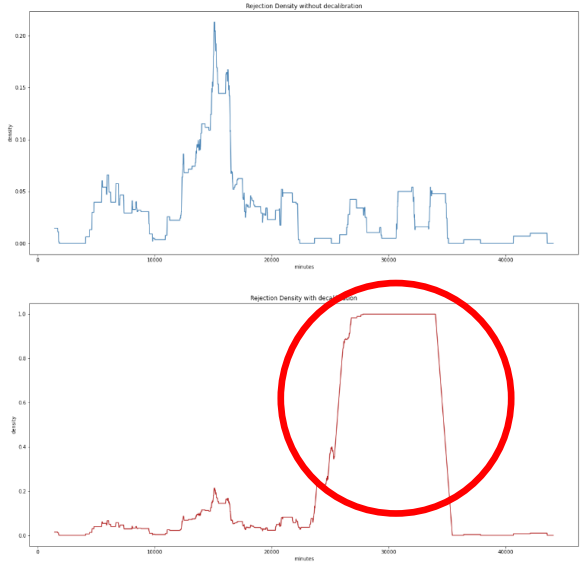


- Sensor measurements are processed in the cloud by specialized modules (with one model available per sensor type).
- Live data from the sensors and from the supervisor system are combined in the digital twin.
- Historic data is available in time series databases.

PREDICTIVE CAPABILITIES

- Supervisory system based on decoders.
- The detector can be continuously re-trained to adapt to machine changes in the environments where the sensors are located.
- The system is able to detect decalibrations for 100% of the studied sensors even before the sensors provide readings outside of their calibration threshold (~4% for humidity, <1K for Temperature & <1Pa).
- The system can typically detect decalibrations within days.





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