Smart Factory IT-Architektur

Mit modernen IIoT-Plattformen den Weg von der Konnektivität bis Prädiktion meistern

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Cognitive Factory 2.0 – Architecture Overview

Collected manufacturing and enterprise data…

…made into a transparent, comprehensive, interactive, minable corpus of information…

…that makes visible new patterns in the data…

…to continuously monitor, predict, respond and interact with humans and machines

Shared data corpus

IIoT Platform

Are you master of your own data? Then…

- ✓ Digital Twin
- ✓ Predictive Quality
- ✓ Predictive Maintenance
- ✓ Simulation
- ✓ AI
- ✓ AR
- ✓ …(whatever you want)

But many IoT and IT environments face challenges

Bandwidth & Latency

Connectivity to cloud is too slow or intermittent

Cost

Sending data to cloud is expensive

Regulations

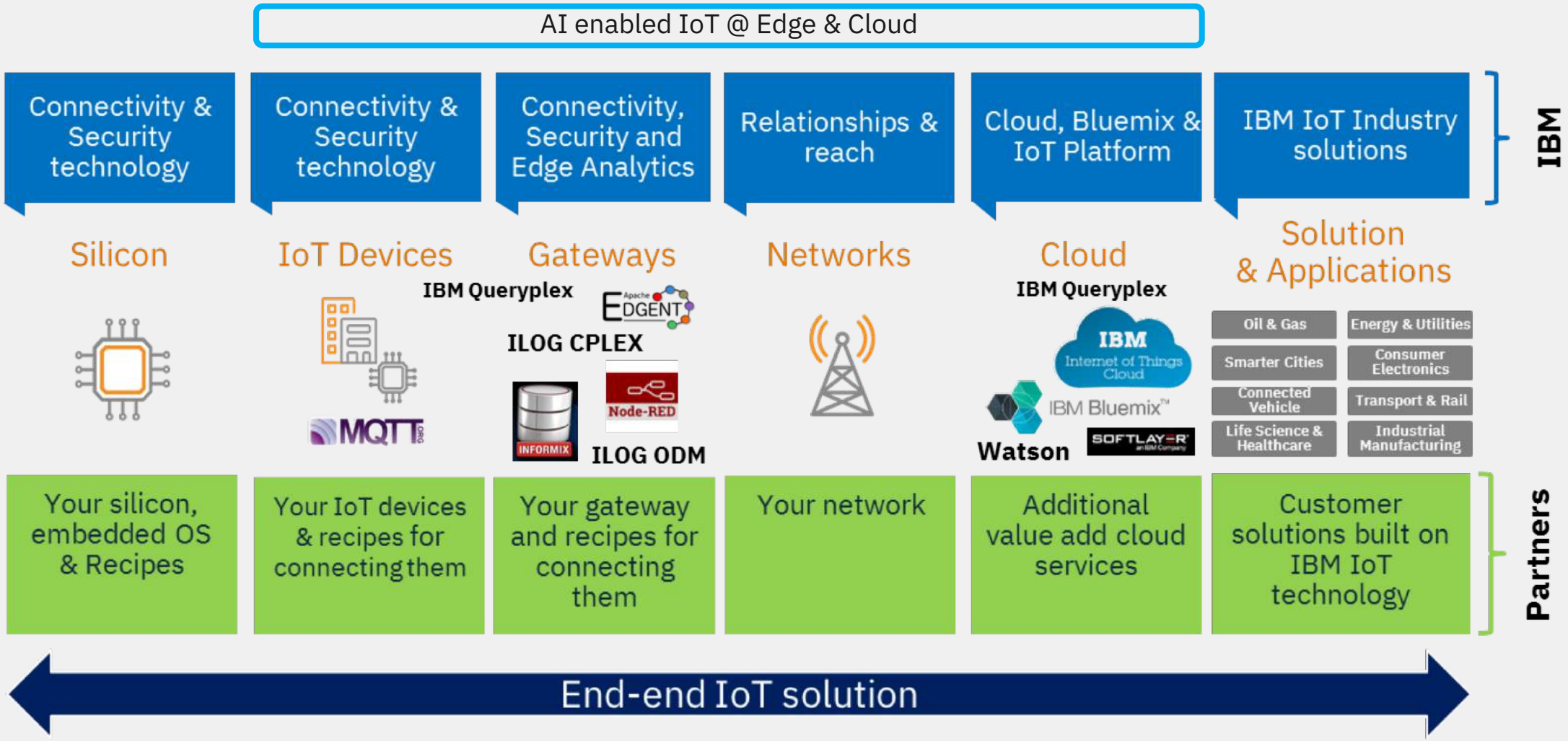
Some data is restricted

Privacy

Some data is too sensitive

IBM's big picture – IoT from Sensor to Edge to Cloud to App

The IBM Watson IoT ecosystem helps companies build and deploy IoT end to end



Today: a typical Industrial IoT / Industrie 4.0 Scenario

Industrial Shop Floor Sensors

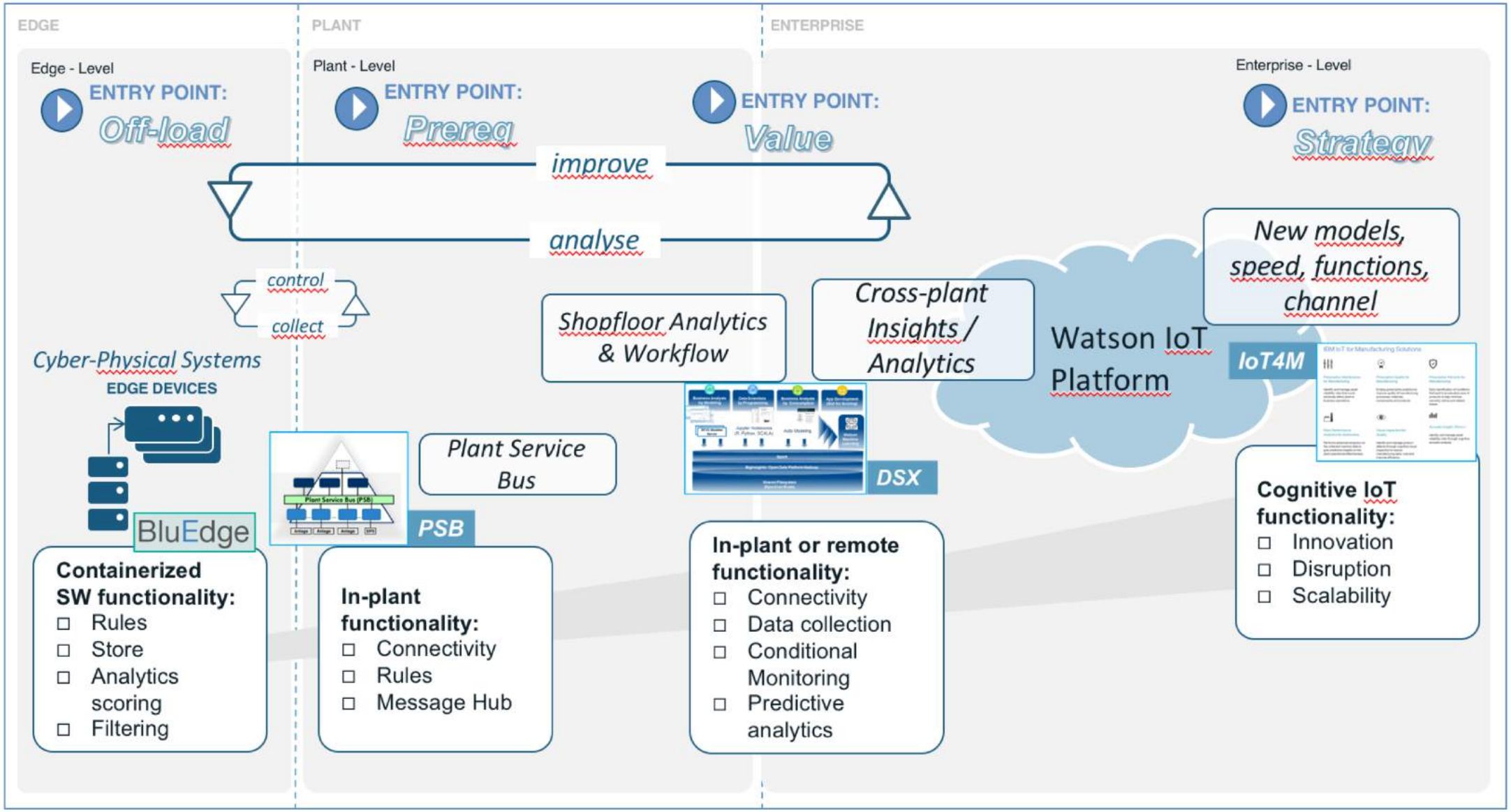
Direct sensor data transfers

Raw Sensor Data
via industry specific automation protocols (e.g. PROFINET, BACnet, OPC UA, Modbus, TSN etc.)

Industrial IoT-/Edge-/Fog-Gateway(s)
with specific industry communication stacks
and local Analytic capabilties (in motion / at rest analytics)

Aggregated / Filtered Sensor Data
via standard communication protocols and formats (e.g. MQTT/JSON) into the Cloud...

IBM's three-layered *Industrie 4.0 Reference Architecture* balancing load with lifecycle capabilities at Edge, Plant and Enterprise



Definitions

Edge Computing...

"...is a method of optimising cloud computing systems by performing data processing at the edge of the network, near the source of the data. This reduces the communications bandwidth needed between sensors and the central data center by performing analytics and knowledge generation at or near the source of the data."

Fog Computing...

"...or fog networking, also known as fogging, is an architecture that uses one or more collaborative multitude of end-user clients or near-user edge devices to carry out a substantial amount of storage (rather than stored primarily in cloud data centers), communication (rather than routed over the internet backbone), control, configuration, measurement and management."

Both sources: Wikipedia, July 2017

How does IoT Gateway Sensor Data processing helps IoT solutions?

IoT Gateways can reduce the cost of the backend cloud

- Reduces cloud storage by filtering/aggregating/analyzing data locally
- Reduces cloud CPU requirements by precomputing values

Increased reliability and security

- Sensor data caching during unexpected Cloud outages
- Local data ownership

Support of Real-Time requirements

- Intelligent gateways can detect and respond to local events as they happen rather than waiting for transfer to the cloud

Sensor Data Analytics move close to the data

- Gateways allow customers to capture and get value from their sensors without necessarily sending all data into the cloud

Protocol Consolidation

- Cloud does not need to implement the multitude of IoT protocols

Data Quality Optimization

- Duplicate elimination, Data Cleansing, Missing Values Handling, Sorting etc.

Optimal database requirements for an IoT (Edge-) Gateway…

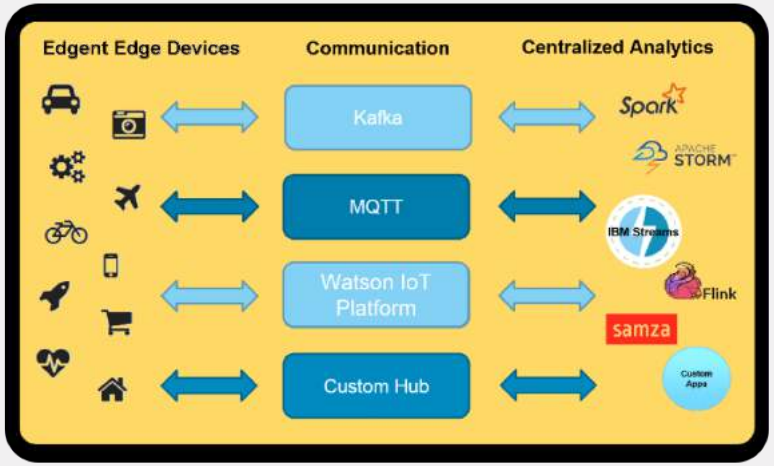
- Have a small install footprint, typically **less than 100 MB**
- Run with low memory requirements – **less than 256 MB**
- Availability on typical embedded platforms like ARM or Intel Quark
- Ideally use **compression or other techniques** to minimize storage space
- Supports a round robin storage concept to e.g. avoid storage overflows
- Have built-in support for common types of IoT data like **time series and spatial/GIS** data
- Simple application development with support for both **NoSQL and SQL**
- It must require **absolutely no administration**
- Ideally it should be able to **network multiple gateways** together to create a single distributed database

The database should be powerful enough to *ingest, process and analyze data in (near) real-time*

In-Motion Edge-/IoT-Gateway Analytics with Apache EDGENT

Apache Edgent: Programming model and runtime for analytics at the edge

- Edgent programming SDK
- Edgent lightweight and embeddable runtime
- Edgent initially built by IBM based on 12 years experience with IBM Streams
- Edgent is Open Source, available on github (http://edgent.apache.org/)



Edgent Features:

- Java APIs for developing streaming applications
- Windowing support aggregation
- Micro-kernel style runtime for execution
- Connectors for MQTT, HTTP, JDBC, File, Apache Kafka and IBM Watson IoT Platform
- Simple analytics and pattern detection device sensors
- Web-console to view the graph of running applications
- Integration with assertion based testing systems like JUnit
- Android support, e.g., streaming a phone's sensor events
- Multi-Platform support including Java 8, Java 7 and Android

Language Support

- Initial support

  Java

  - Easy to get running, demonstrate the concept on many platforms
  - Java 8 running on Raspberry Pi B & Pi2 B today (ARM chip)

  Android

  - Smart phones and increasing adoption for devices

- Will support multiple languages

  - Integrated vision, not a specific edge language

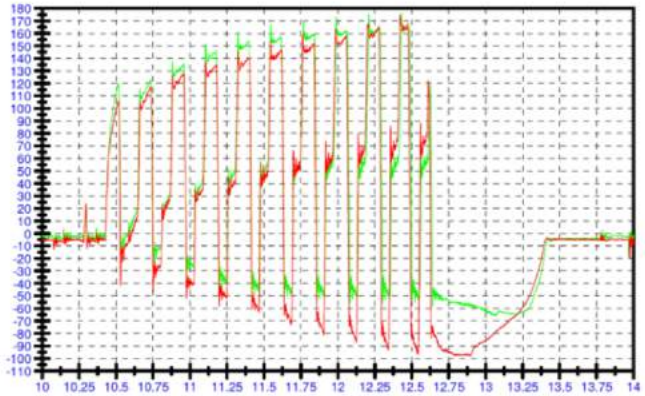
- Other options for the future

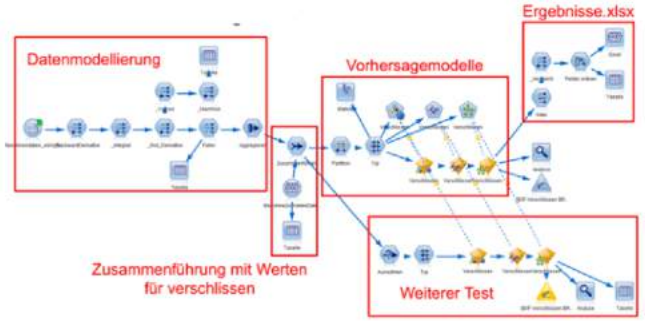
  C, **C++** – Generate code for customer to compile to support custom kernels
  Open Swift - iOS
  Python – Python runs on Raspberry Pi, popular language on Pi
  Streams Processing Language – Simpler way to declare a flow and produce C/C++ code

Language priorities driven by Open Source Community

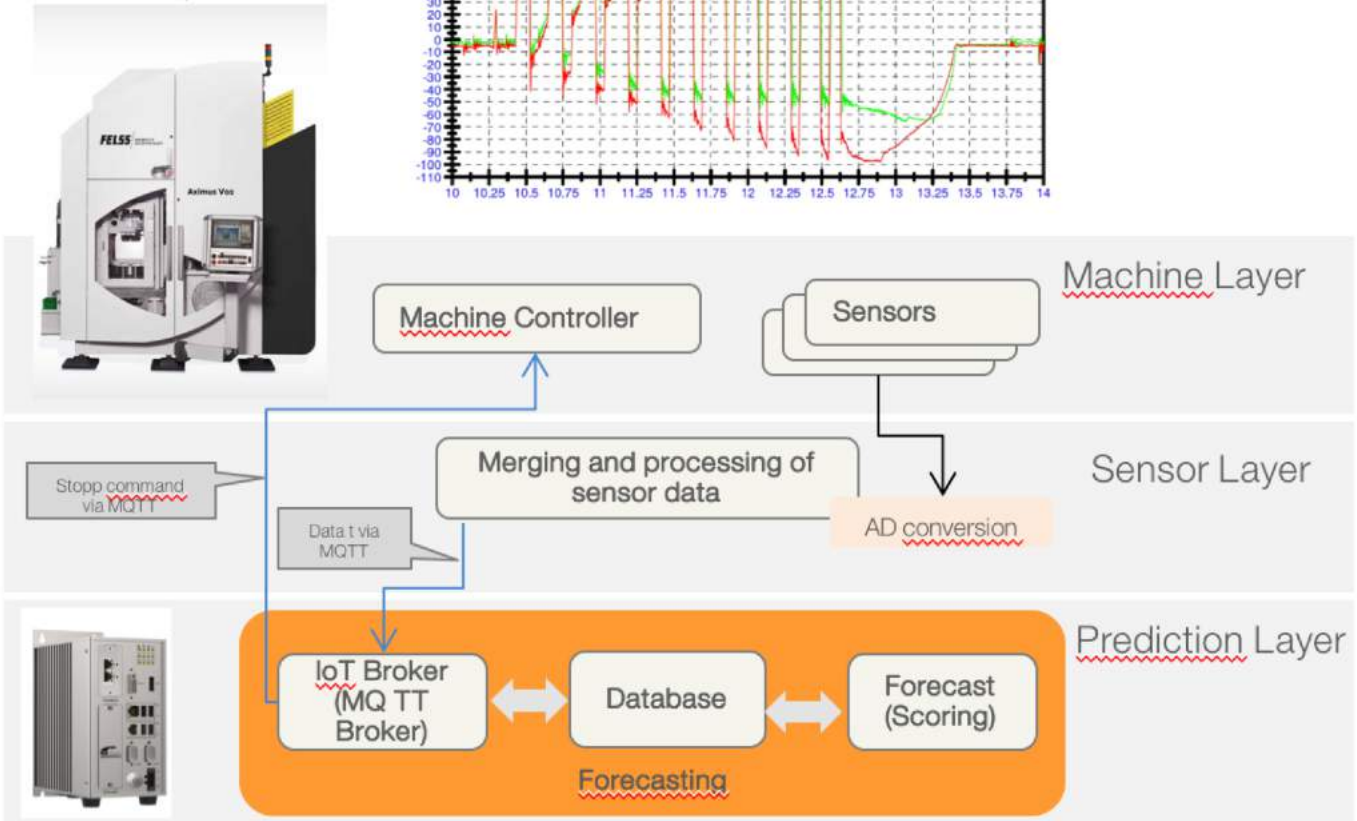
X-INTEGRATE IoT Scoring Gateway for the Edge (and Plant)

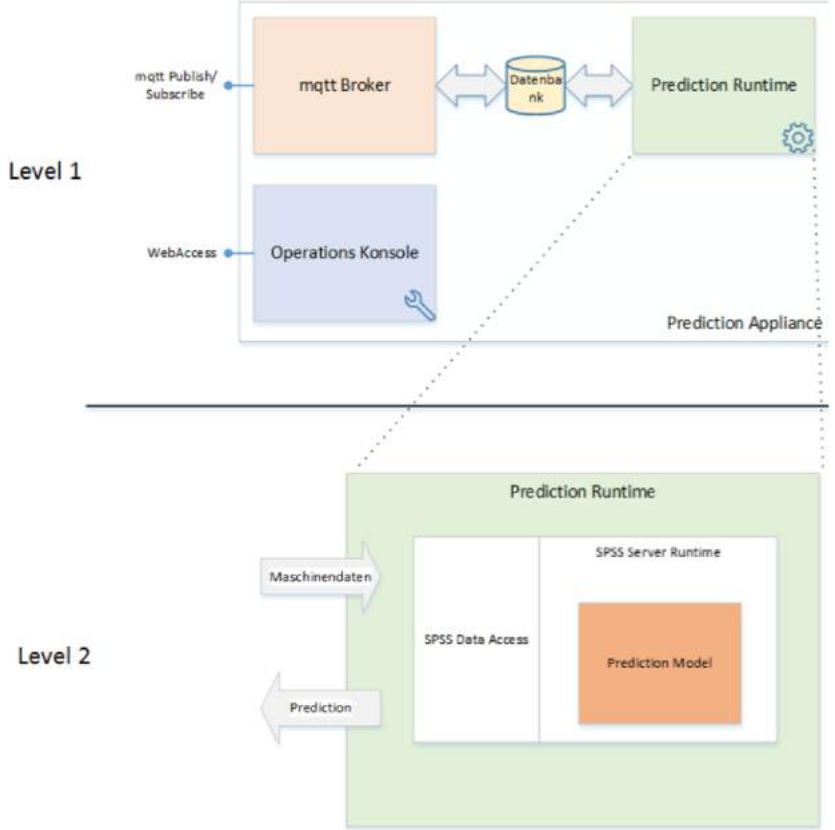
- Scoring of product quality
- Pattern recognition on force/action curves





Edge Analytics pattern





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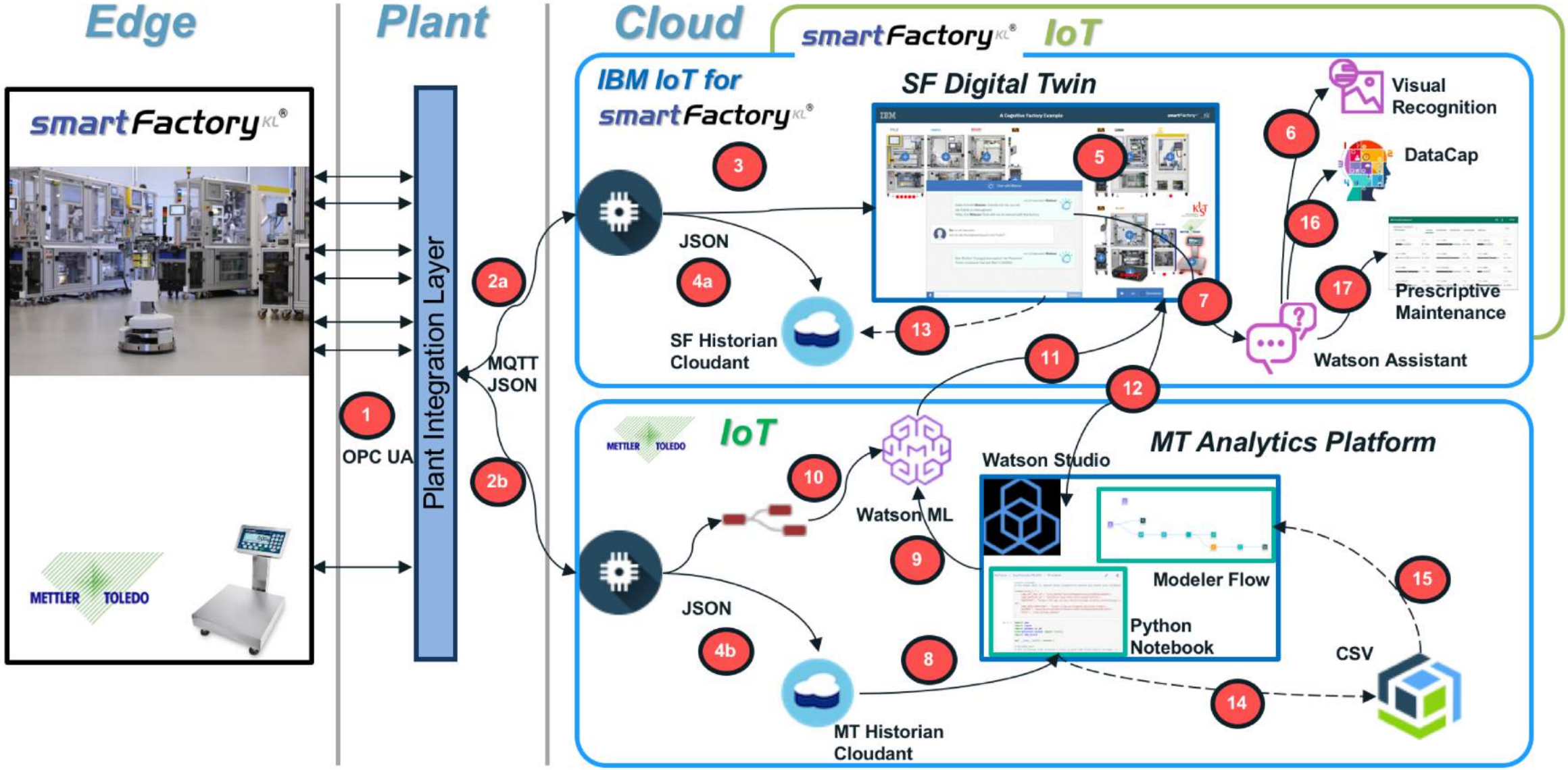
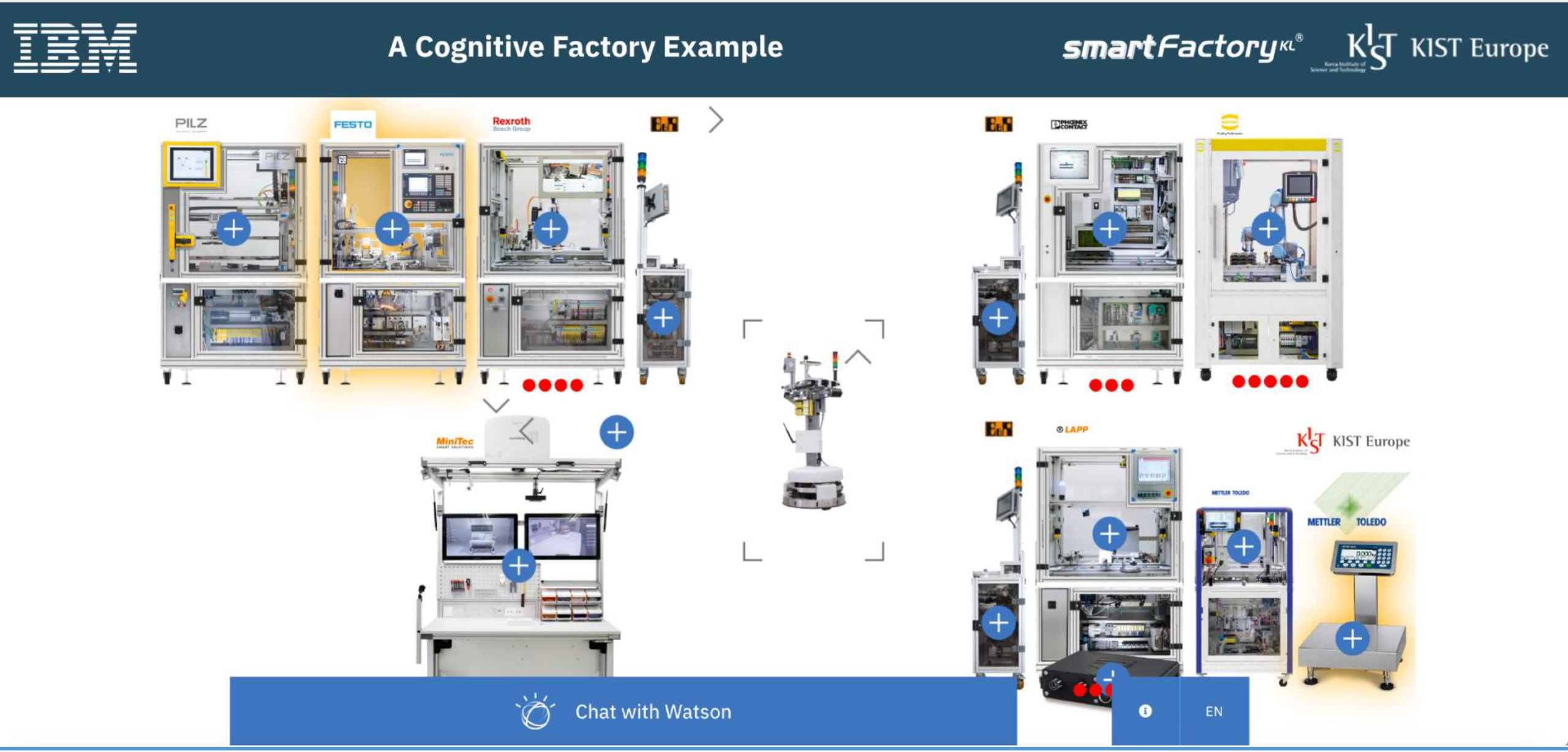


https://cognitive-factory.mybluemix.net/



Adding Acoustics to Cognitive Manufacturing

What was that sound ? What do I do ?

Detecting abnormal against a trained baseline

Based on RTI, determine if a work order is issued, or sound is ignored. If yes investigate, recording of sound is sent in “work order,”,possibly with corrective actions.

Work order, along with sound recording, is sent to best qualified personnel to do investigation/repair

The completed work order supplies the feedback to further refine the model through machine learning. If the baseline needs to be retrained, RTI rules changed -this feedback would promote that. Enable predictive analytics.

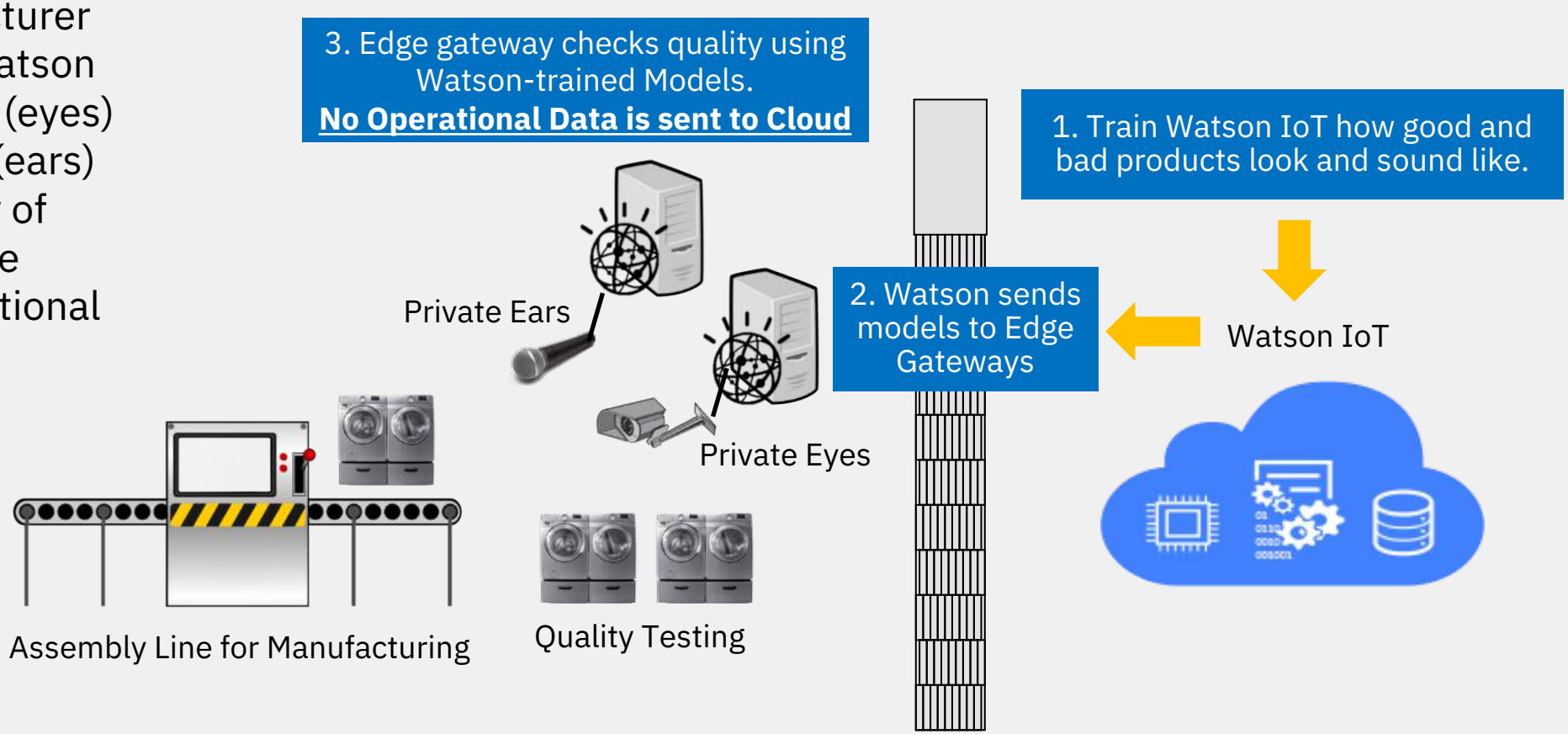
IBM WATSON

Watson advises best corrective action including pointers to manuals, videos, etc

IBM Watson IoT Edge AI Use Case

Private Eyes and Ears for Predictive Maintenance and Quality Control

How can a manufacturer use the power of Watson IoT visual analytics (eyes) and audio analysis (ears) to check the quality of their products, while keeping their operational metrics private?



The motivation for edge based acoustic analytics

- Sound is a human cognitive capability that we use instinctively – “What was that?... Ahh the pump.”
- Abnormal sounds can detect something is not working correctly, <u>even though all other indicators seem normal.</u>
- High volume of low power, low cost silicon MEMs, ultrasonic microphones hitting the market... “Thanks Alexa.”
- Same technology used for conversation interfaces, can be repurposed to collect / analyze sound data.
- IBM-developed self-learning libraries for analyzing sound clips can create cognitive enablement for improving quality, operational processes, asset utilization and reliability, and safety.
- Train and create models in the cloud and do the model execution (analytics) on Edge-Devices/-Gateways

Create a cognitive "stethoscope" to listen and then to identify normal / abnormal sounds in machines

- Non invasive instrumentation
- Works with legacy systems
- Ubiquitous low cost microphones

Low Cost

- High noise areas can impair hearing
- Abnormal sound gives advance warning

Safety

- Always on audio sensors
- Adaptively learn base-line noise levels

Continual Monitoring

Thank you!

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