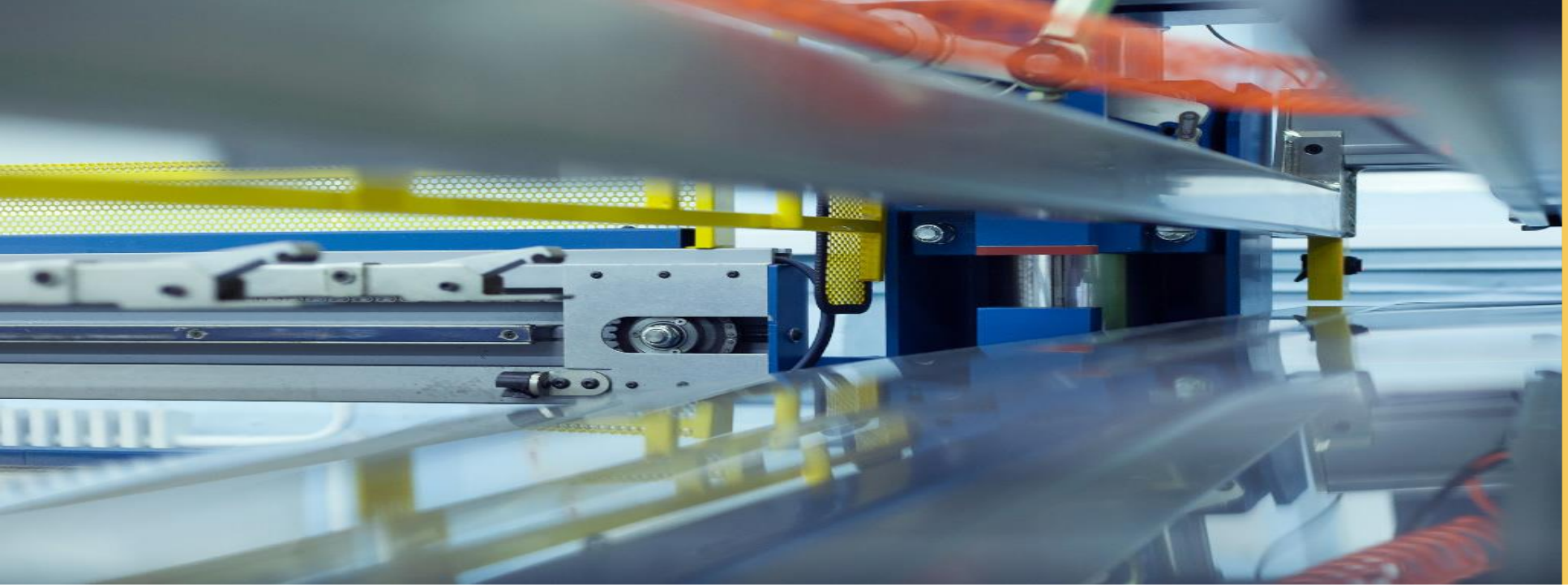

Customer

SAP Leonardo IoT Edge

Connect with intelligence at the edge to transform operations and reimagine your business

Merlin Yamssi, SAP
April, 26th 2018

SAP Run Simple

Legal

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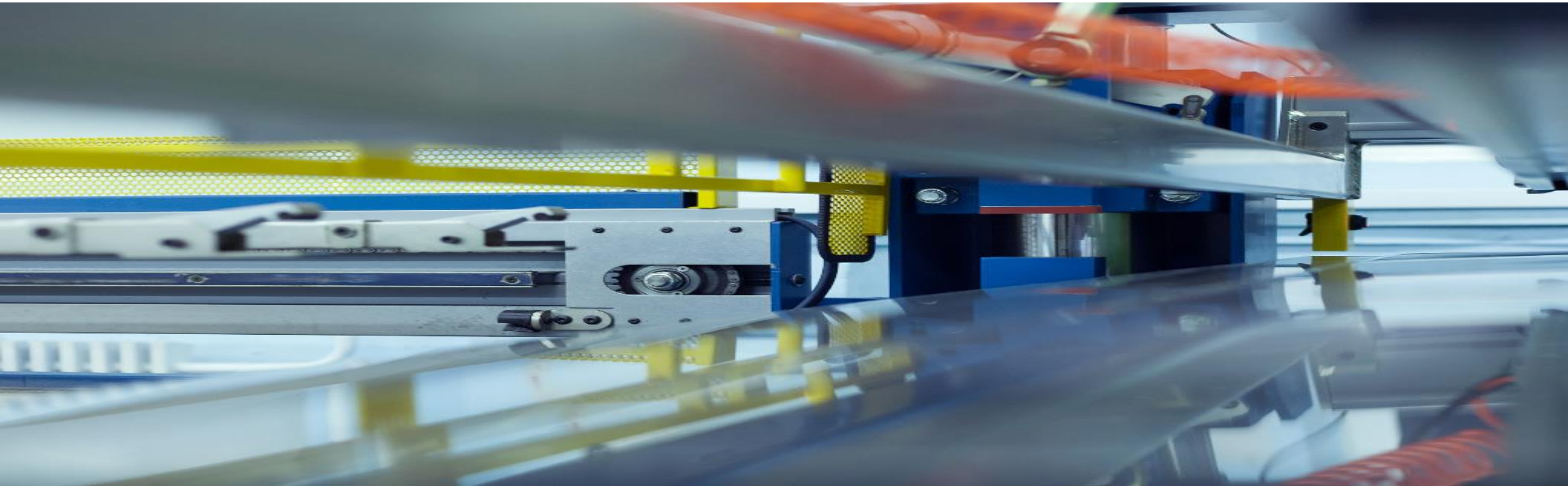
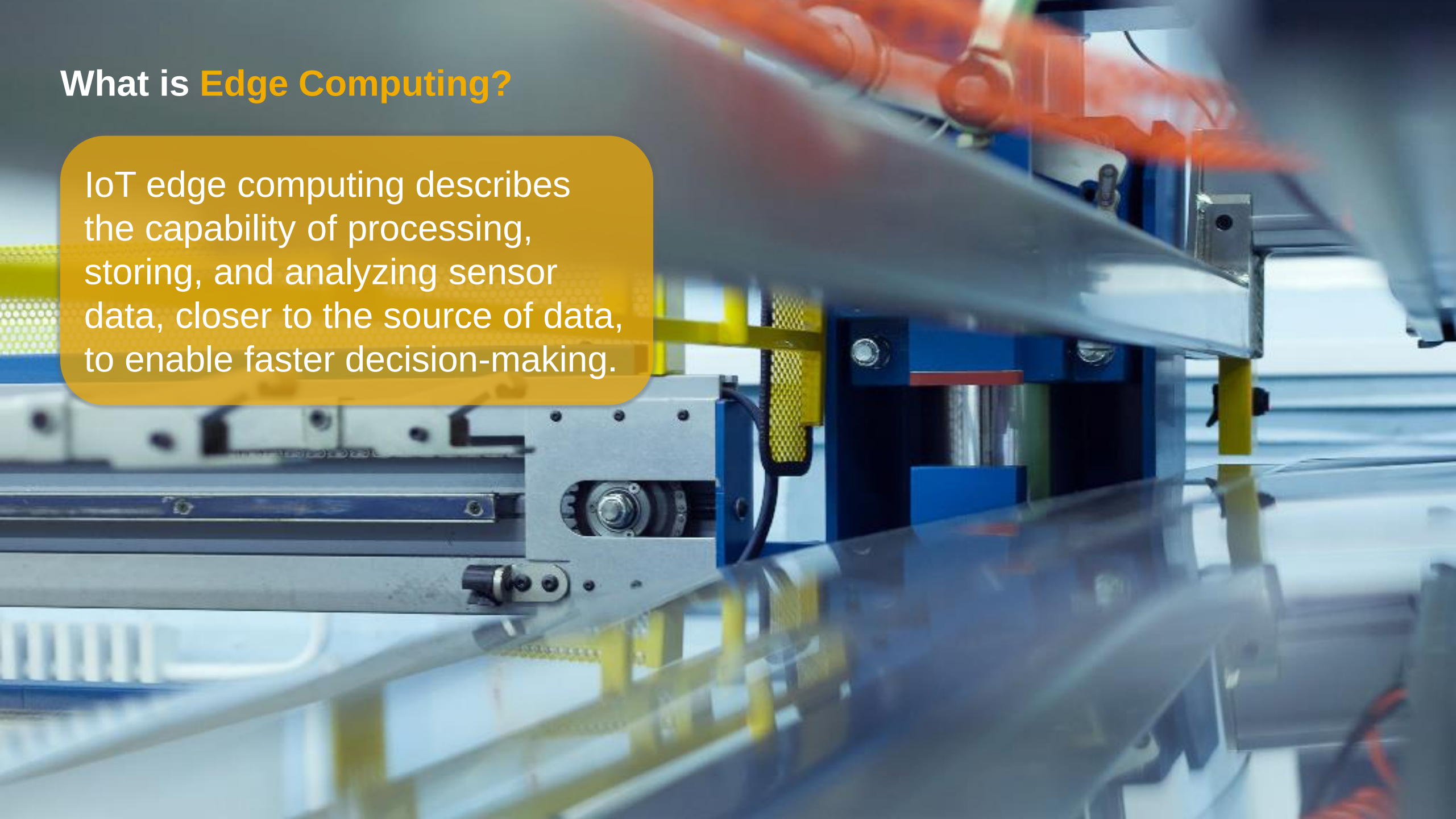
Agenda

- What is Edge computing and why is it important for IoT?
- Leonardo IoT Edge Overview
- SAP Edge Services Business Scenarios
- SAP Edge Services Solution Offering
- Customer Example
- Editions & Pricing
- Key Links & Resources





What is Edge Computing?

IoT edge computing describes the capability of processing, storing, and analyzing sensor data, closer to the source of data, to enable faster decision-making.

What does Edge look like?

+

IoT Gateways
(e.g. Intel, Dell, Cisco)

Remote servers

Industrial PCs

Raspberry Pi, etc

IoT Gateways

What is an IoT Edge gateway?

A network node or networking hardware component where the software sits and edge computing occurs. The gateway is equipped to interface with different IoT protocols and to the cloud.

IoT Hardware for the Gateway

Recommended IoT Gateways for deploying SAP Edge Services:

- IoT Gateways following Intel's reference architecture, e.g. Dell 3000/5000, Adlink
- Industry PCs
- Data center in a box, HPE Edgeline

For testing and prototyping purposes a laptop can be used

Pervasiveness of Edge

45%

of IoT-created data will be stored, processed, analyzed, and acted upon close to, or at the edge, of the network[1]

5.6 Billion

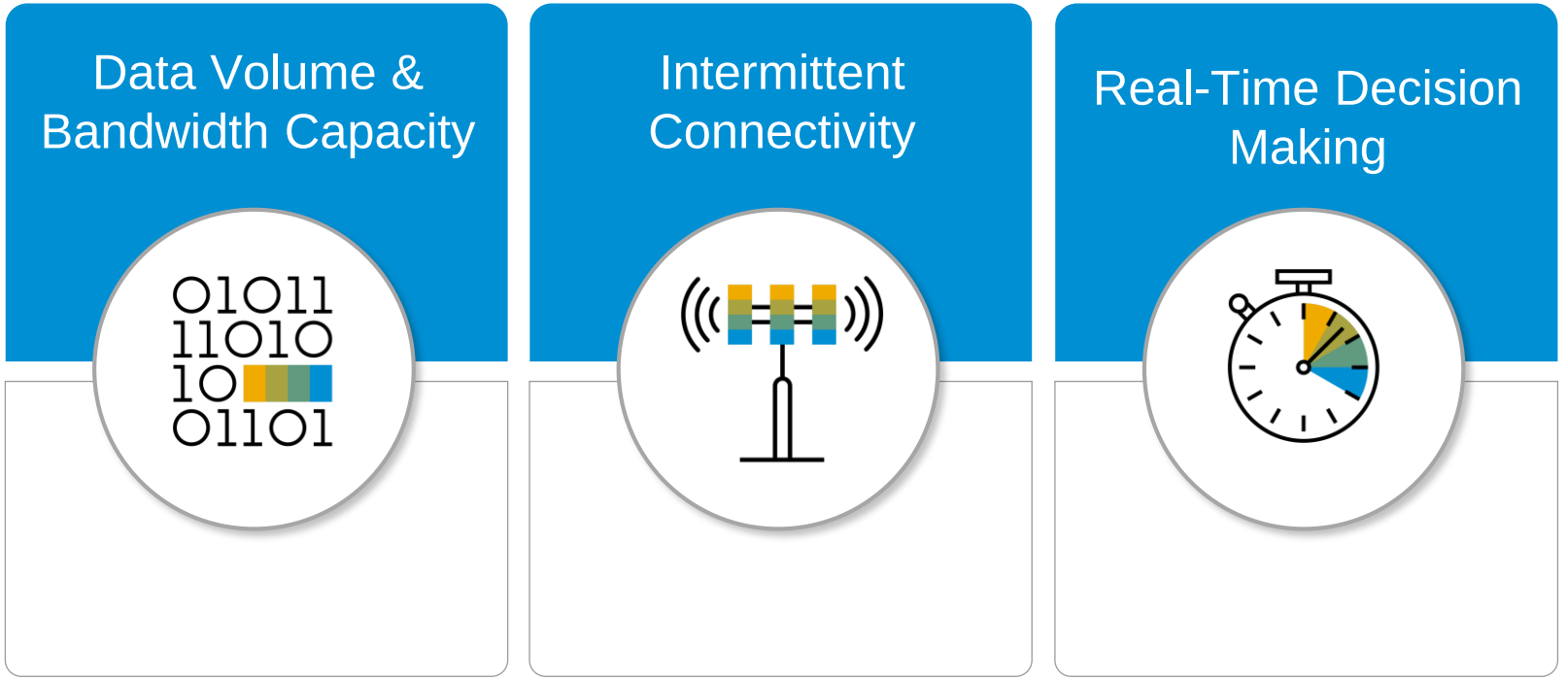
IoT devices owned by enterprises and governments will use edge computing for data collection and processing in 2020[2]

Trillions

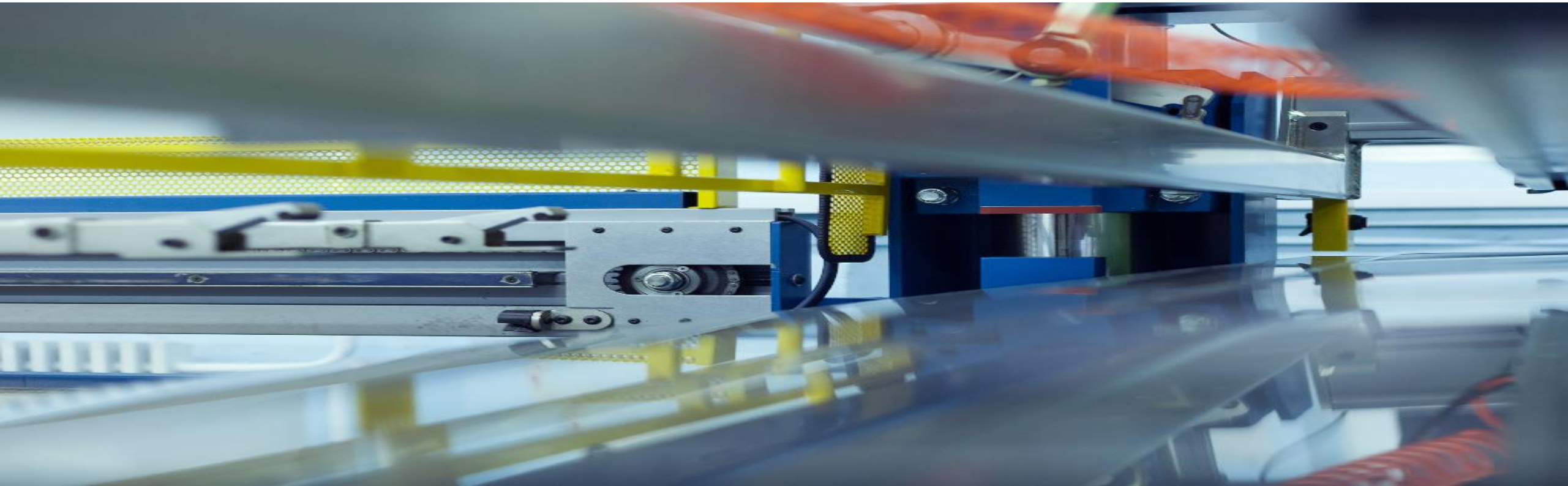
of sophisticated end-point devices are collecting the world's information in massive data sets **today** requiring real-time processing[3]

Sources:
1. IDC FutureScape: Worldwide Internet of Things 2016 Predictions, IDC, 2015
2. EDGE COPMUTING IN THE IoT, Business Insider, 2016
3. Peter Levine, Andreesen Horowitz VC, 2016

Drivers for Edge Computing



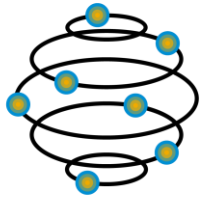
SAP Leonardo IoT Edge Overview



SAP Leonardo Portfolio Overview

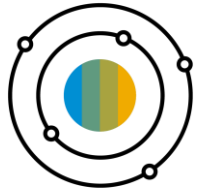
IoT

Connecting things with people and business



Big Data

Manage vast amounts of big data

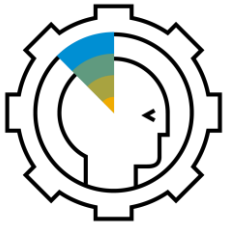


Data Network

Data put into business context

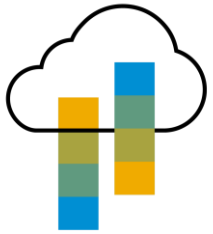
Analytics

Insights that enable transformative actions



Machine Learning

Intelligence enabled by learnings from data

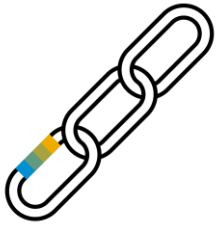


Cloud Platform

Foundation for SAP Leonardo

Design Thinking

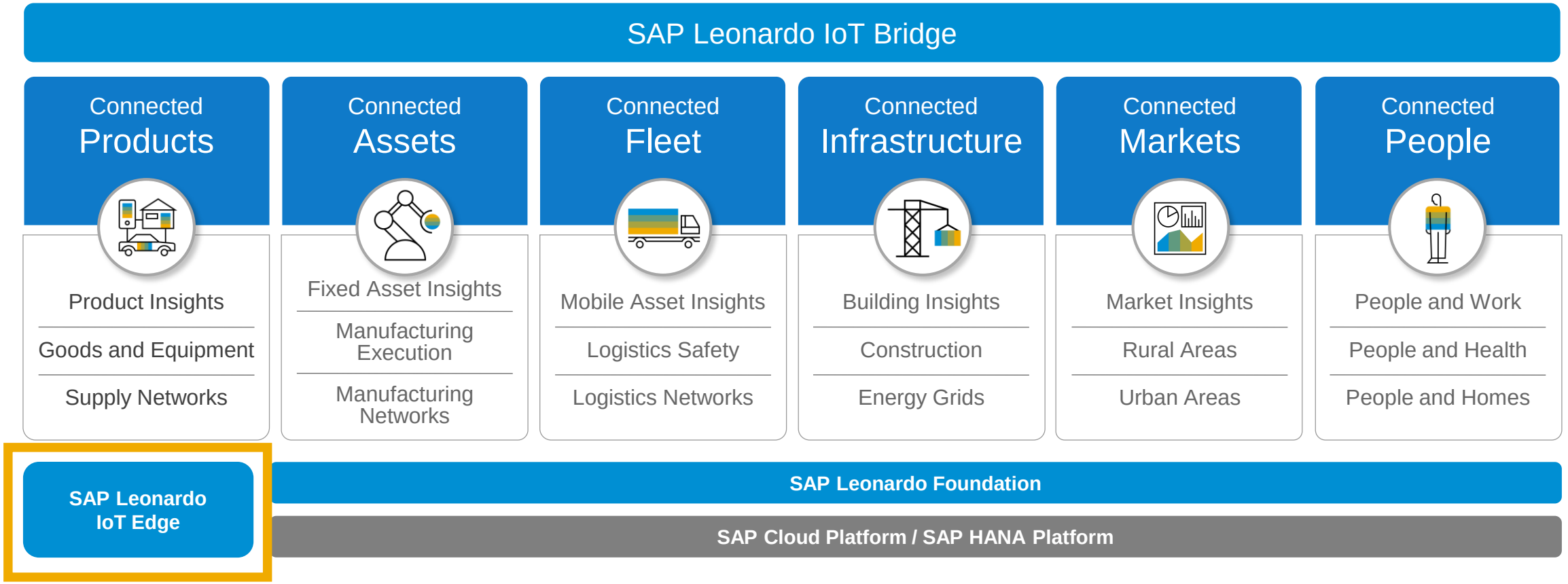
Innovative, engaging methodology used to uncover the opportunities for your digital transformation



Blockchain

Blockchain services embedded into business applications

SAP Leonardo Internet of Things



SAP Leonardo IoT Edge

Brings together local compute, persistency, and business transactions at the Edge

SAP Edge Services enables powerful ***microservices*** to be deployed at the edge of computing devices to ***extend the processing power*** of the cloud to the edge

Policy Service

Deployment and lifecycle management of edge services

Business Essential Functions Service

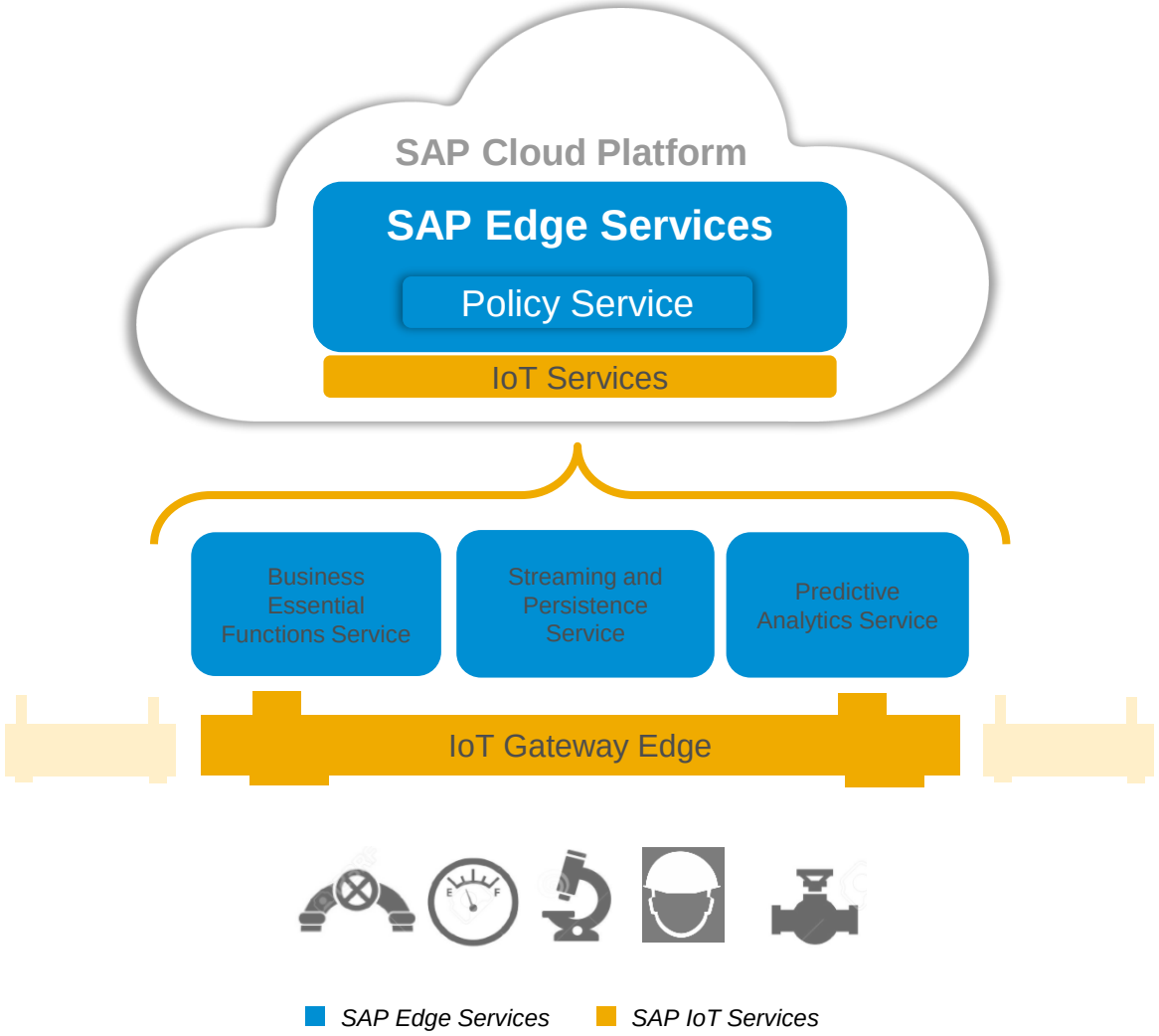
Provides business context (data and processes) at the edge

Streaming and Persistence Service

Locally store IoT data on IoT gateways and analyze IoT data streams in real-time based on business logic

Predictive Analytics Service

Deploy, execute, and update predictive analytical models at the edge



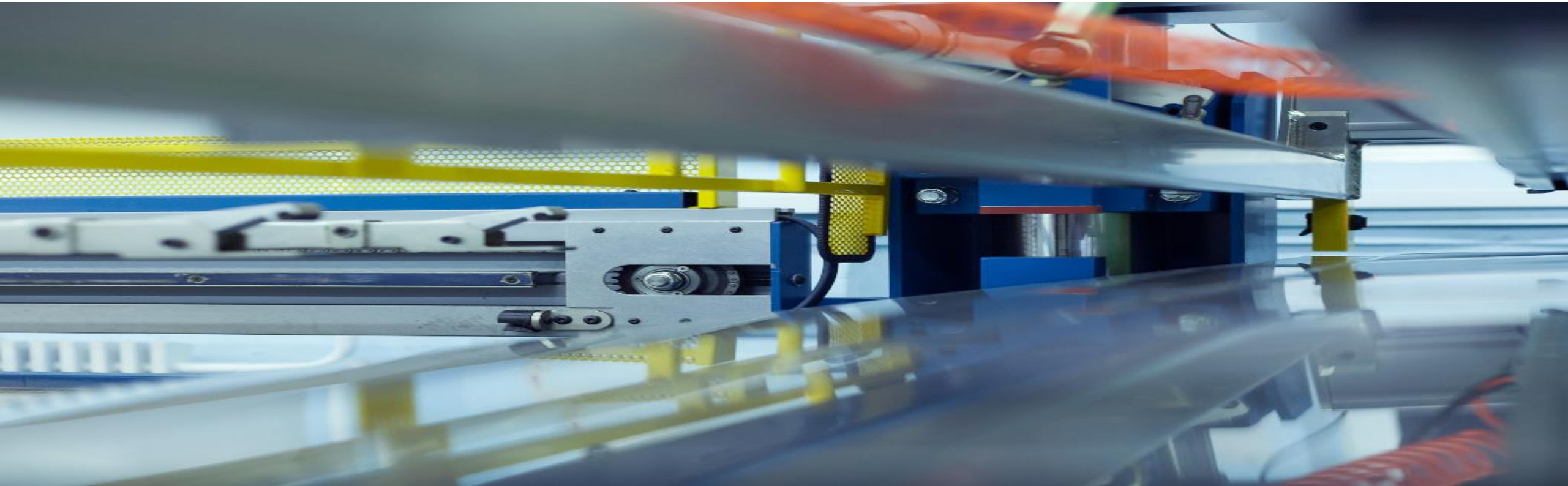
SAP Leonardo IoT Edge

SAP Edge Services Offers a Choice of Flexible Deployment Options

	SAP Edge Services, cloud edition	SAP Edge Services, on-premise edition
Deployment Option	Cloud edge	On-premise stand alone
Platform	SAP Cloud Platform – Cloud Foundry Windows, Linux (Gateway Edge)	Windows, Linux
Line of Business	Cross-Industry	Cross-Industry
Pricing	Subscription based model, based on number of devices	Perpetual license model, based on number of devices (includes PCo*)
Connectivity	Integrates to Plant Connectivity (PCo) via SAP Cloud Platform IoT	Edge Services, on-premise edition (7018944) embeds PCo*
Distinction	**Policy Service** for central, cloud-driven deployment and lifecycle management	
Considerations	• Low TCO • Fast time to value • Standardization • Extends and scales cloud to the edge	• Adoption speed • Regulatory or regional preferences • Upgrade efforts / frequency

* Usage of PCo is permitted to integrate with ECC, however not S4/HANA

SAP Edge Services Business Scenarios



SAP Edge Services

Wide Range of Applicable Industries

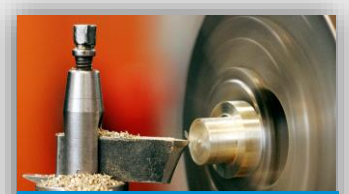

Oil and Gas


Chemicals


Utilities

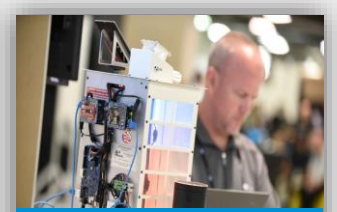

Mining


Defense & Security

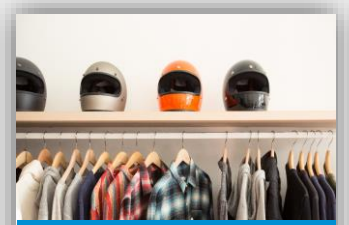

Industrial Machinery & Components


Aerospace & Defense

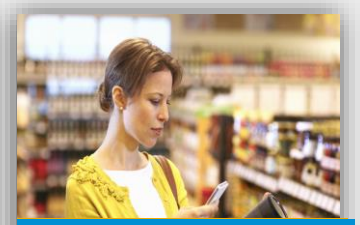

Automotive

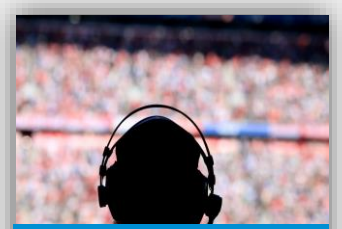

High Tech


Public Sector


Retail


Life Sciences


Consumer Product


Sports & Entertainment

Areas extended to Edge : Plant Maintenance,Inventory Management, Material Management, Inline Analytics for Manufacturing, AIN

SAP Edge Services Use Cases

Uninterrupted and real-time business processes despite poor latency or connectivity

Plant Maintenance

Maximize technician wrench time irrespective of latency or connectivity

Derive work order workflows even when offline

Synchronize with digital core when online and cost effective

Future Proof Stores

Accurate inventory count in real time

Trigger purchase requisitions based on quantity threshold

Enhance customer experience while increasing associates productivity

Connected Worker Safety

Analyze and detect emergency situation and alert rescue team in real time

Automatically create incident report with context-sensitive sensor data

Gain insight to increase safety and operational integrity

Extend AIN to the edge (New Edge)

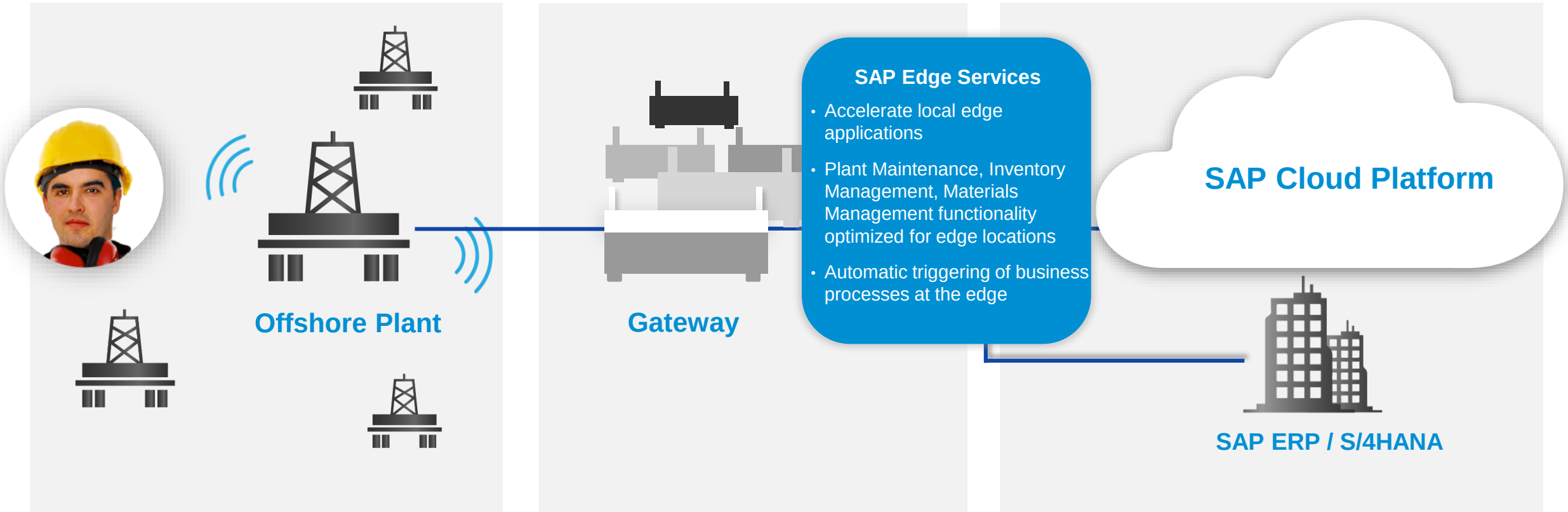
Complete mission critical tasks with fast local performance even with poor network connectivity

Perform refreshes to keep documents current

Synchronize asset-core data with the edge (Future) to trigger local events based on sensor data

Plant Maintenance with SAP Edge Services

Use Case 1: Access Standard Workflows Despite Intermittent Connectivity



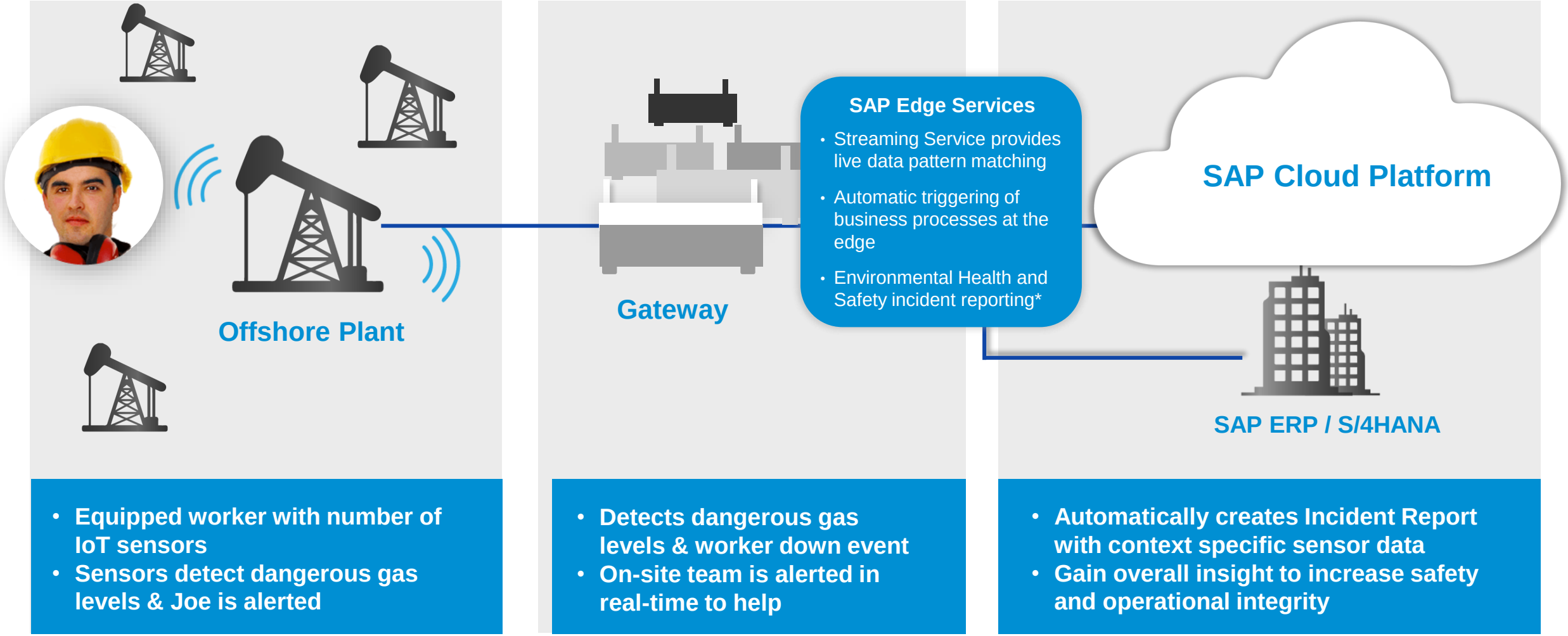
- **Environment with intermittent connectivity**
- **Needs to access work orders despite latency or connectivity**

- **Up-to-date inventory can be retrieved**
- **Repairs can be completed without interruptions**

- **Data opportunistically sent to digital core**
- **More efficient operations and improved wrench time**

Worker Safety with SAP Edge Services

Use Case 2: Connected Worker Man Down Scenario



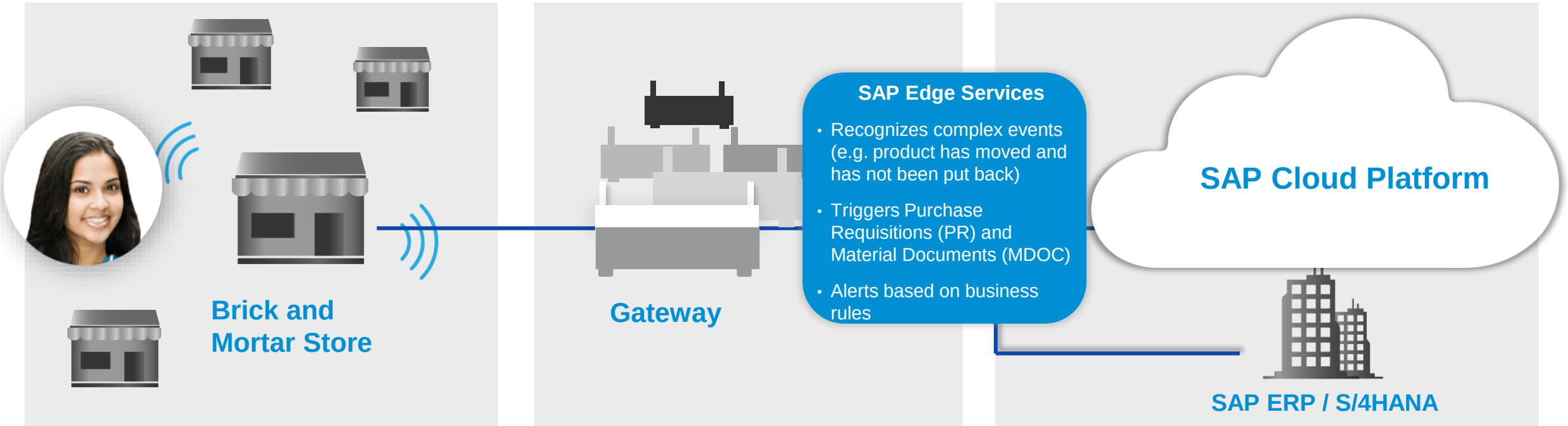
- **Equipped worker with number of IoT sensors**
- **Sensors detect dangerous gas levels & Joe is alerted**

- **Detects dangerous gas levels & worker down event**
- **On-site team is alerted in real-time to help**

- **Automatically creates Incident Report with context specific sensor data**
- **Gain overall insight to increase safety and operational integrity**

Inventory with SAP Edge Services

Use Case 3: Connected Inventory for Smarter Retailing



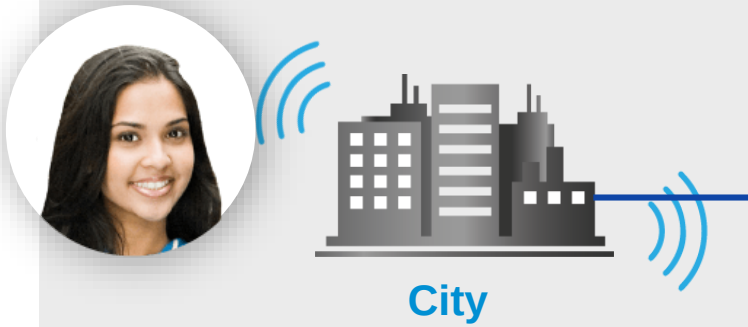
- **Equipped product inventory with sensors**
- **Receives restock and new product shipment alerts**

- **Streaming Service monitors inventory sensor data for patterns**
- **Business Essential Functions Service automates critical in-store workflows**
- **Persistence Service provides data for in-store analytics**

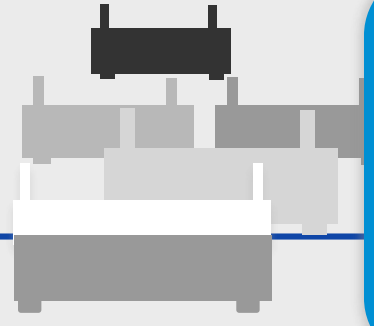
- **Accurate inventory updates to headquarters with aggregated in-store insights**
- **Produce superior customer experience while increasing associate productivity**

City Safety with SAP Edge Services

Use Case 4: Efficiently Process Video Analytics While Adding Context and Protecting Privacy



City



Gateway

SAP Edge Services

- Matches video feed for known patterns
- Send video stills for further classification matching
- Generate anonymous alerts to officials for anomalies (e.g. prone body in tunnel)

SAP Cloud Platform

SAP ERP / S/4HANA

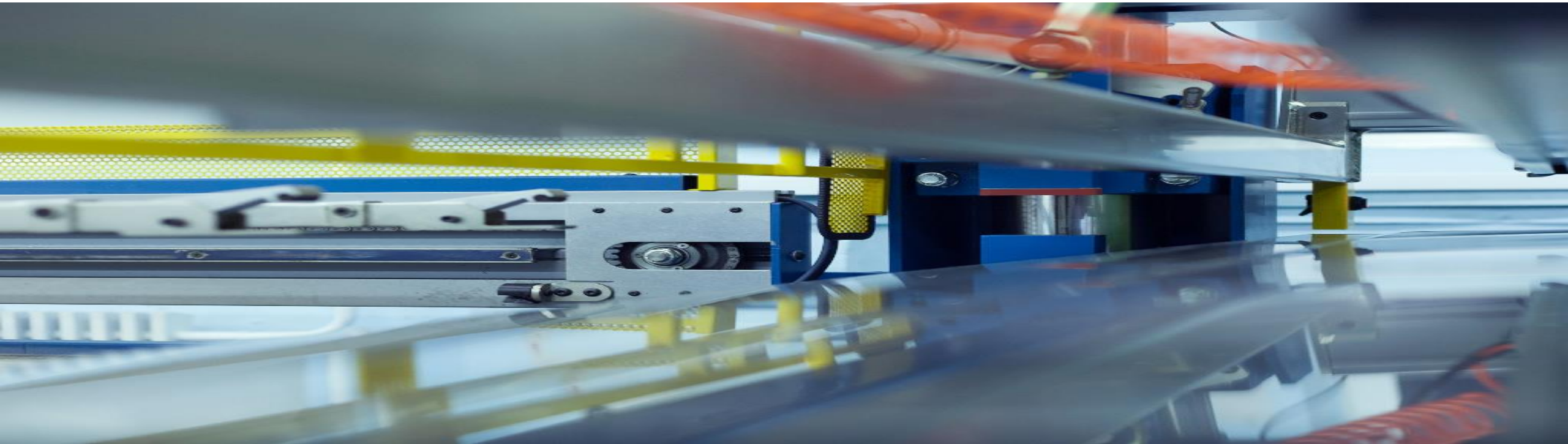
- **Duty of care for city occupants**
- **Ensures CCTV network**
- **Alerts authorities when *moments of interest* occur**

- **Streaming Service for analyzing video feeds**
- **Persistence Service for encrypt and store**
- **Business Essential Functions Service provides planning context**

- **Rapid response when events are detected**
- **Decoupling encrypted data from access keys**
- **Anonymous data adds to open city data**

SAP Edge Services

Industrial Manufacturing

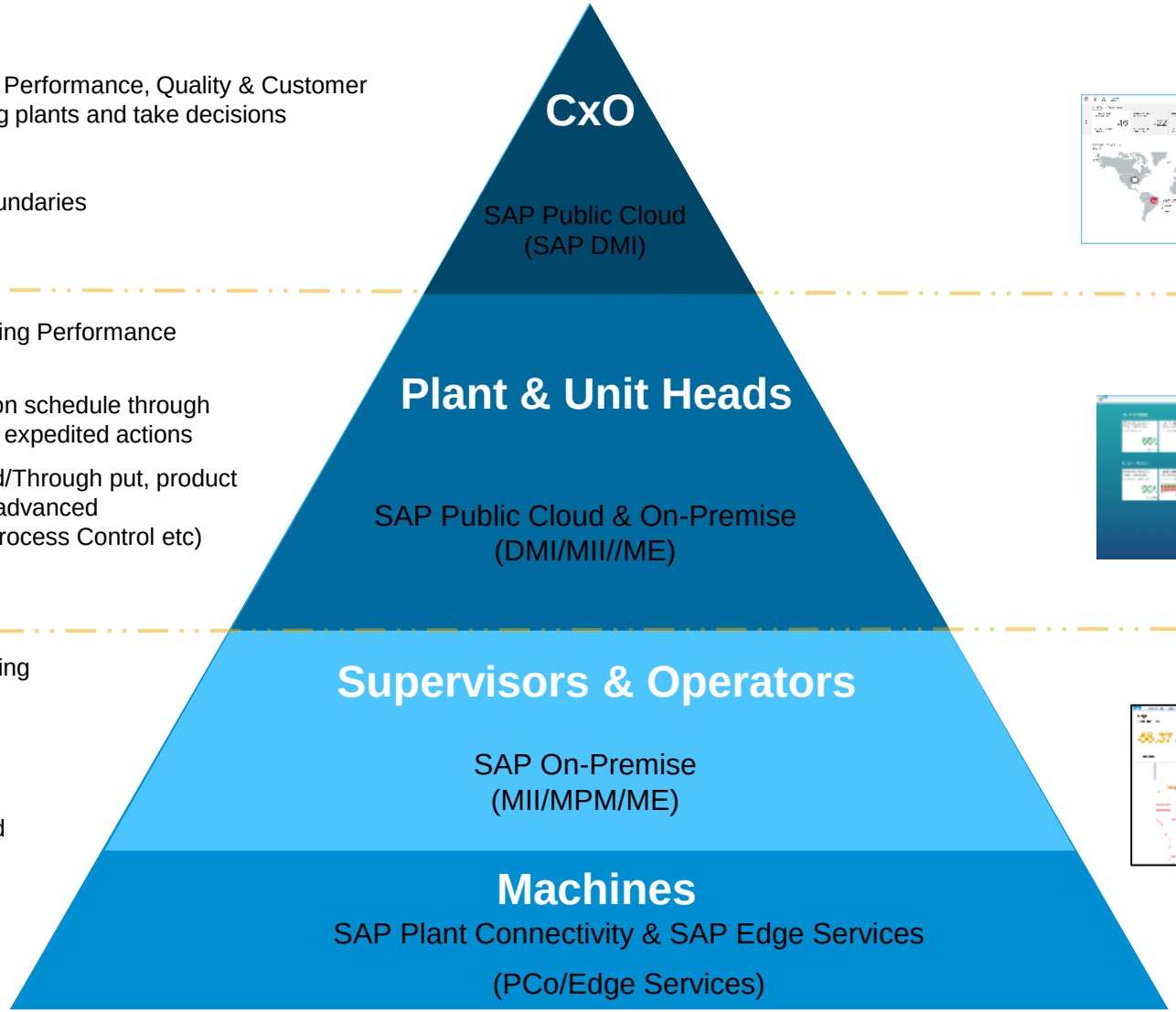


SAP Digital Manufacturing Stack

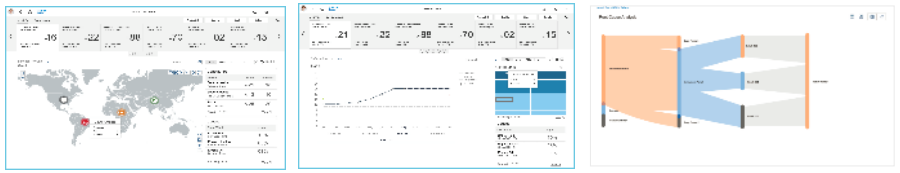
Insights to Action @ All Levels

Quality | Cost | Delivery | Productivity | Energy

- ✓ Review Revenue, Cost, Delivery Performance, Quality & Customer satisfaction across manufacturing plants and take decisions
- ✓ KPI Scorecard
- ✓ Collaborate across corporate boundaries



Key Performance Indicators

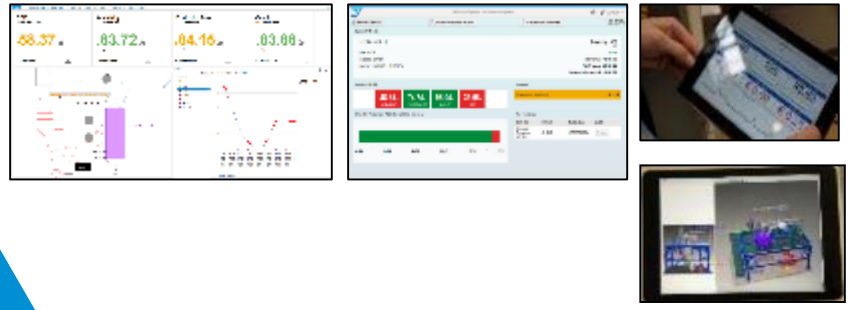


- ✓ Monitor and Analyze Manufacturing Performance Indicators
- ✓ Improved adherence to production schedule through real time production insights and expedited actions
- ✓ Continuous improvement of Yield/Through put, product Quality, Vendor Quality through advanced analytics(Predictive, Statistical Process Control etc)

Metrics, Alerts, & Performance Indicators

- ✓ Real time visibility to manufacturing line/area/cell performance (Build Conformance, Process conformance)
- ✓ Real time visibility to top issues related to production, Quality and equipment availability
- ✓ Take actions to improve KPI

Operational Intelligence



Protocols Supported by SAP Plant Connectivity

SAP Plant Connectivity (Pco) Protocols

Supported protocols: OPC UA, OPC DA, OPC HDA, OPC A&E, Citect, IP21,Osisoft PI (2), Proficy Historian, File-Monitor (2), ODBC, OLE DB, TCP Socket, Modbus, MQTT, SDK for proprietary specific agents (e.g. ifm Linerecorder-Agent)

SAP Leonardo IoT Edge Use Cases for Industrial Manufacturing

Improve production reliability and quality with uninterrupted real-time business processing

In-Line Analytics

Retrieve up to date inventory in real-time

Access work orders despite latency or intermittent connectivity

Improve wrench time and worker productivity

Increase production reliability by running complex algorithms and machine learning at the edge

Manufacturing Quality

Monitor Golden Batch in real time

Analyze the quality deviation of the current batch from Golden Batch

Facilitate inline corrective action at the batch or lot level

Better Production Reliability (SPC)

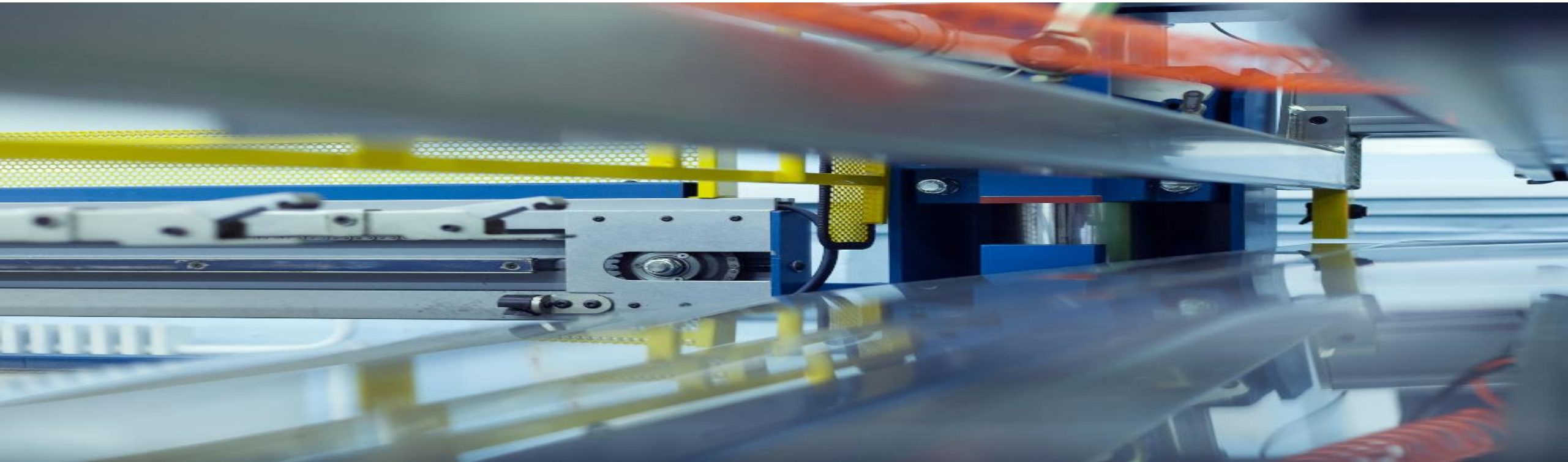
Early detection and prevention of problems

Resolve critical repairs without interruption due to latency or connectivity

Improve quality, production reliability, SPC and unit health monitoring

Perform real-time analytics verses batch

SAP Edge Services Solution Offering

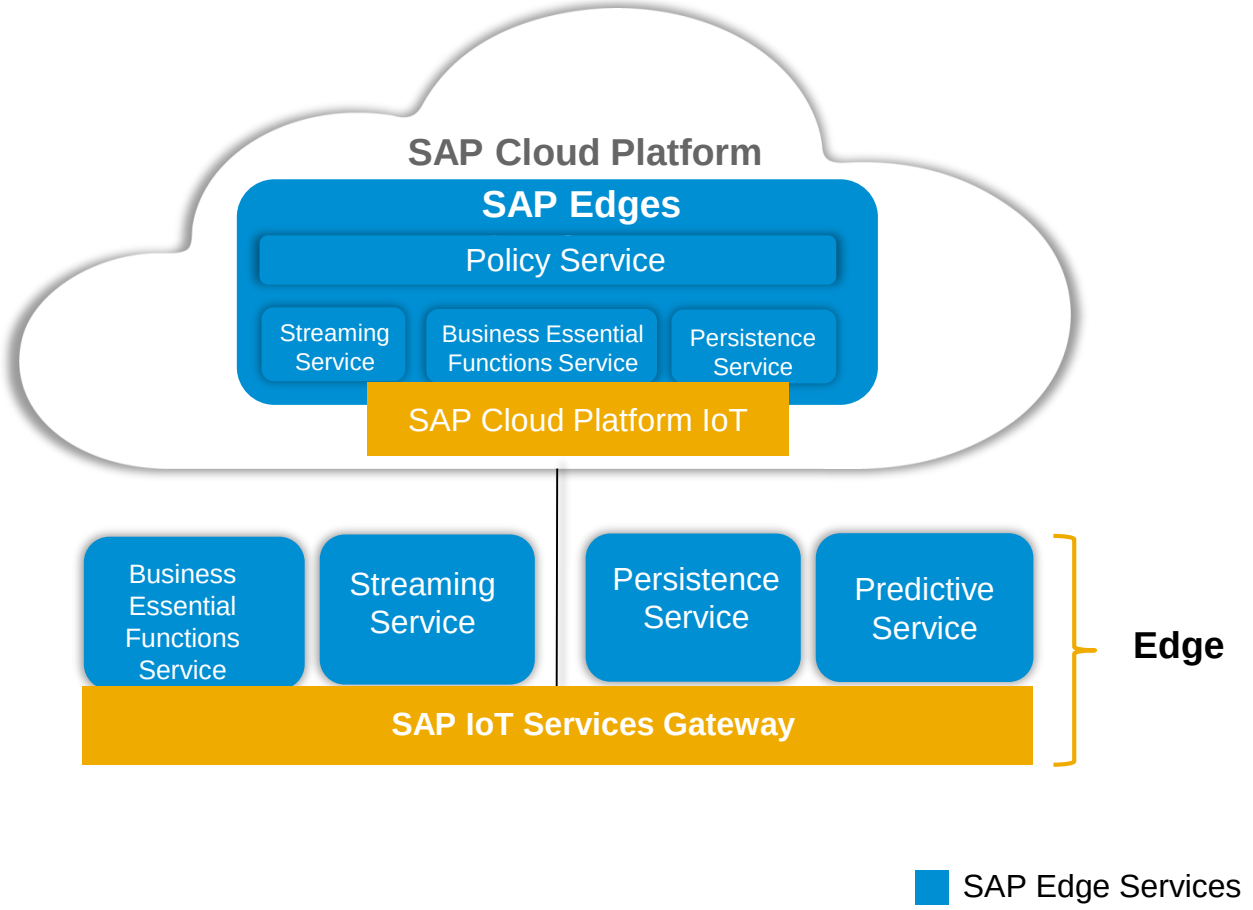


SAP Edge Services

Edge Services are micro services which can be deployed on edge computing devices and extended to work with ERP and S4/HANA.

These services are provided within a secure run-time environment ensuring:

- ✓ Lifecycle management
- ✓ Communication to Things via protocol adaptors
- ✓ Integration to SAP Cloud Platform (cloud edition)



** Note: SAP Cloud Platform IoT service may be abbreviated as SAP Cloud Platform IoT. SAP Cloud Platform IoT Gateway Edge may be abbreviated as IoT Gateway Edge.*

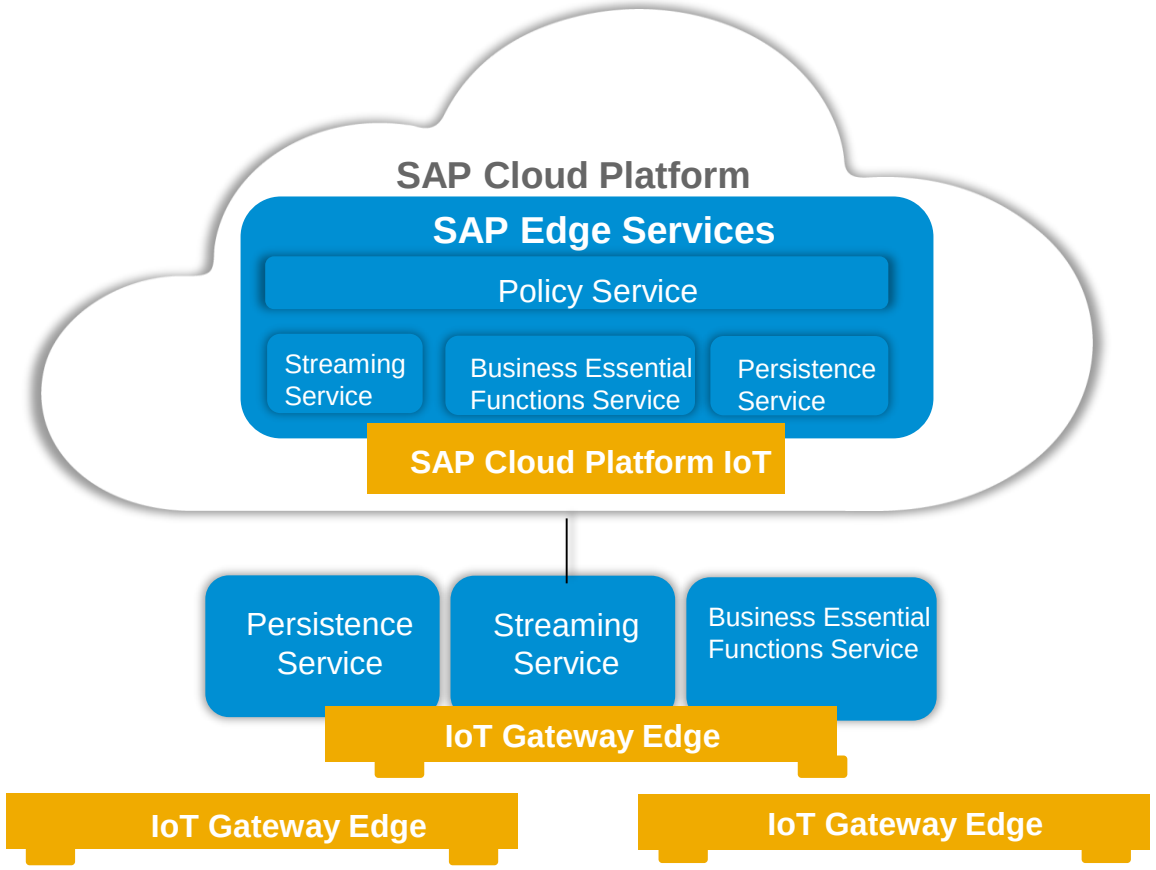
SAP Edge Services

Edge Cloud

- **SAP Edge Services** has been optimized to run inside of **SAP Cloud Platform IoT**
- **SAP Cloud Platform IoT** is the transport link to the **SAP Cloud Platform**

Leveraging **SAP Cloud Platform IoT** offers the following benefits:

- ✓ Runtime for updating services dynamically
- ✓ Secure transport of data and runtime sandbox
- ✓ Ingestion and protocol conversion of data from things
- ✓ Extended authentication feature with SAP Cloud Platform IoT 4.12



** Note: SAP Cloud Platform IoT service may be abbreviated as SAP Cloud Platform IoT. SAP Cloud Platform IoT Gateway Edge may be abbreviated as IoT Gateway Edge.*

SAP Cloud Platform Internet of Things

Protocols via IoT Gateway Adapters*

Protocols

HTTP[1]
Zigbee
XBee
ZWave
6lowPAN
BT & BTLE
WiFi & LPWiFi
IEEE 802.15.4
MQTT[1]
CoAP
TR069
SNMP
HART & W-HART
SIGFOX
Semtech LoRa
NWAVE UnB
DDS
BACNET
LON
KNX
Modbus
Profibus
Infibus
DLMS/COSEM
KSAT (Viasat)
PLC(*)
OPC UA
OMA LWM2M(*)
Active Message
SWAP(*)
XMPP
LoRa
File

Vendors

Agora Energy
Agulla
AnyDATA
Arduino
Asoka
ATIM
Axible
AXIS
B&B Electronics
CalAmp
Cisco
CloudGate
CPL
Cradlepoint
Dell
DiGi
Digicom
Distech Controls
E-Senza
Ekahau
Elster
EPISENSOR
Eurotech
Honeywell
Intenses
ITRON
Kamstrup
LIBELIUM
Marvell
MeterSit
MICRON
Mobile Devices
Morey Corp.
NaelBox
Netcomm Wireless
NETVOX
NWAVE
Orbiwise
Packet Power
PARADOX
PIKKERTON
Pulsar
Radiocrafts
RaspberryPI
Schneider Electric
Semtech LoRa
Sensinode
SIERRA WIRELESS
SIGFOX
SimpleHomeNet
SITEC
SmarteoWater
SMARTEX
ST Micro
Sterela
Telecom Design
TELIT
TekPea
TRIDIUM
VIASAT
WAGO
Wi-NEXT
Worldsensing

* Check for updates

Eclipse Plugin for New Protocols

Templates for USB, Serial, API, or Network Based

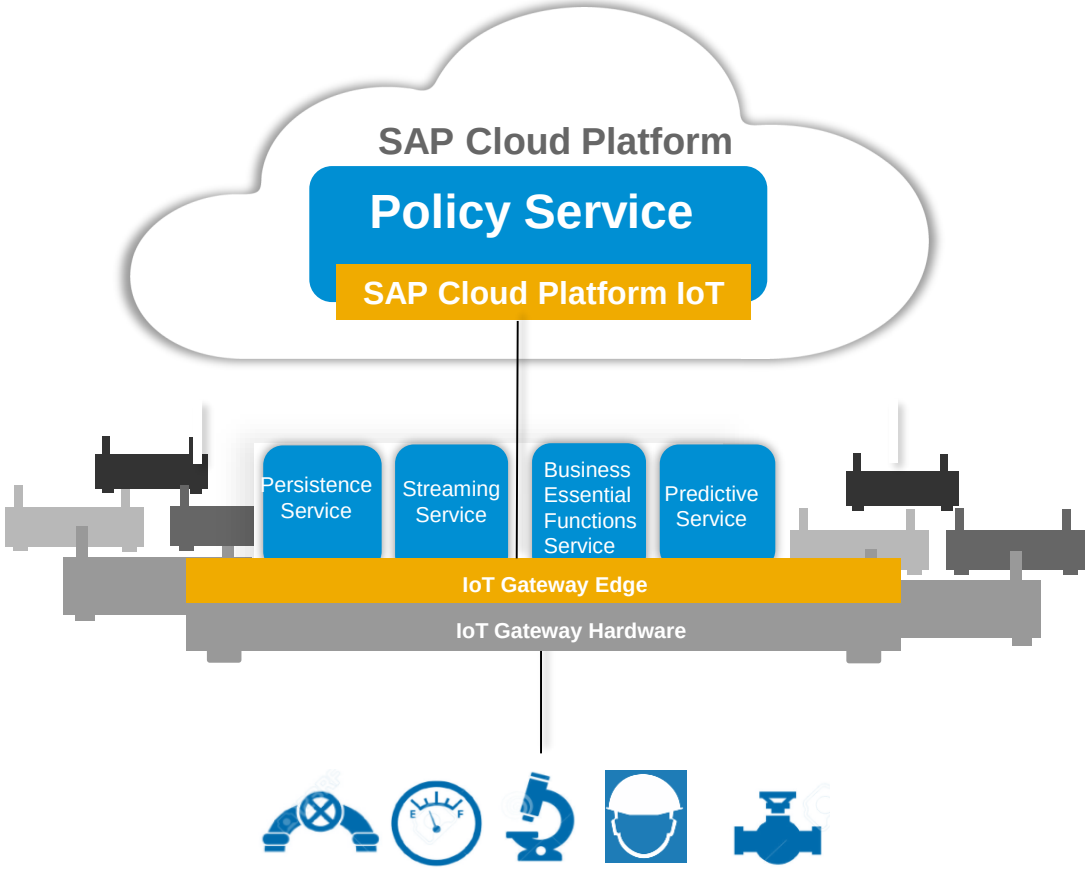
*1 – also device ⇔ cloud, *: Limited implementation (**bold = GA**)*

SAP Edge Services

Policy Service

The **Policy Service** deploys SAP Edge Services to the IoT Gateway Edge

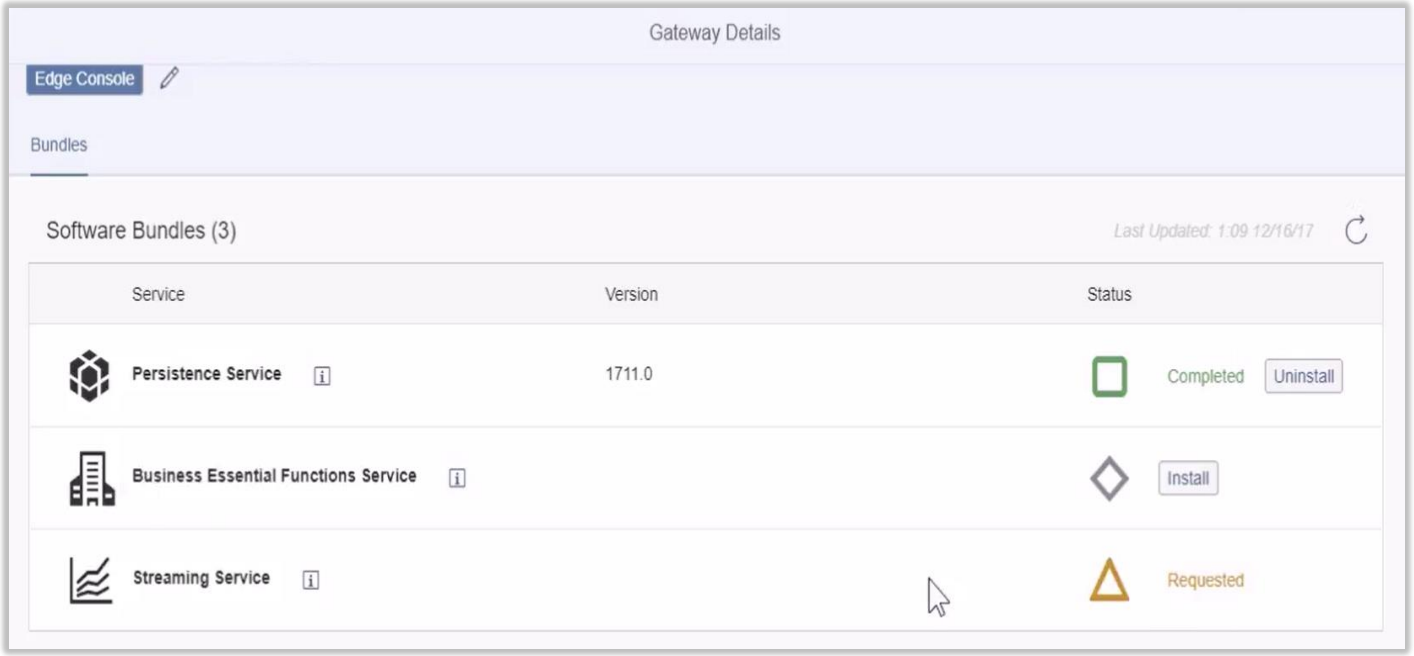
- Deployment and lifecycle management of edge services
- Serves as a central repository of policies (configurations)
- Configured by the *Edge Services Console*
- All edge services are loaded into the Policy Service, deployed and published to gateways:
  - Persistence Service
  - Streaming Service
  - Business Essential Functions Service
  - Predictive Service
- Each customer has a unique URL for their Policy Service



SAP Edge Services

Policy Service

Edge Console: Gateway Details View



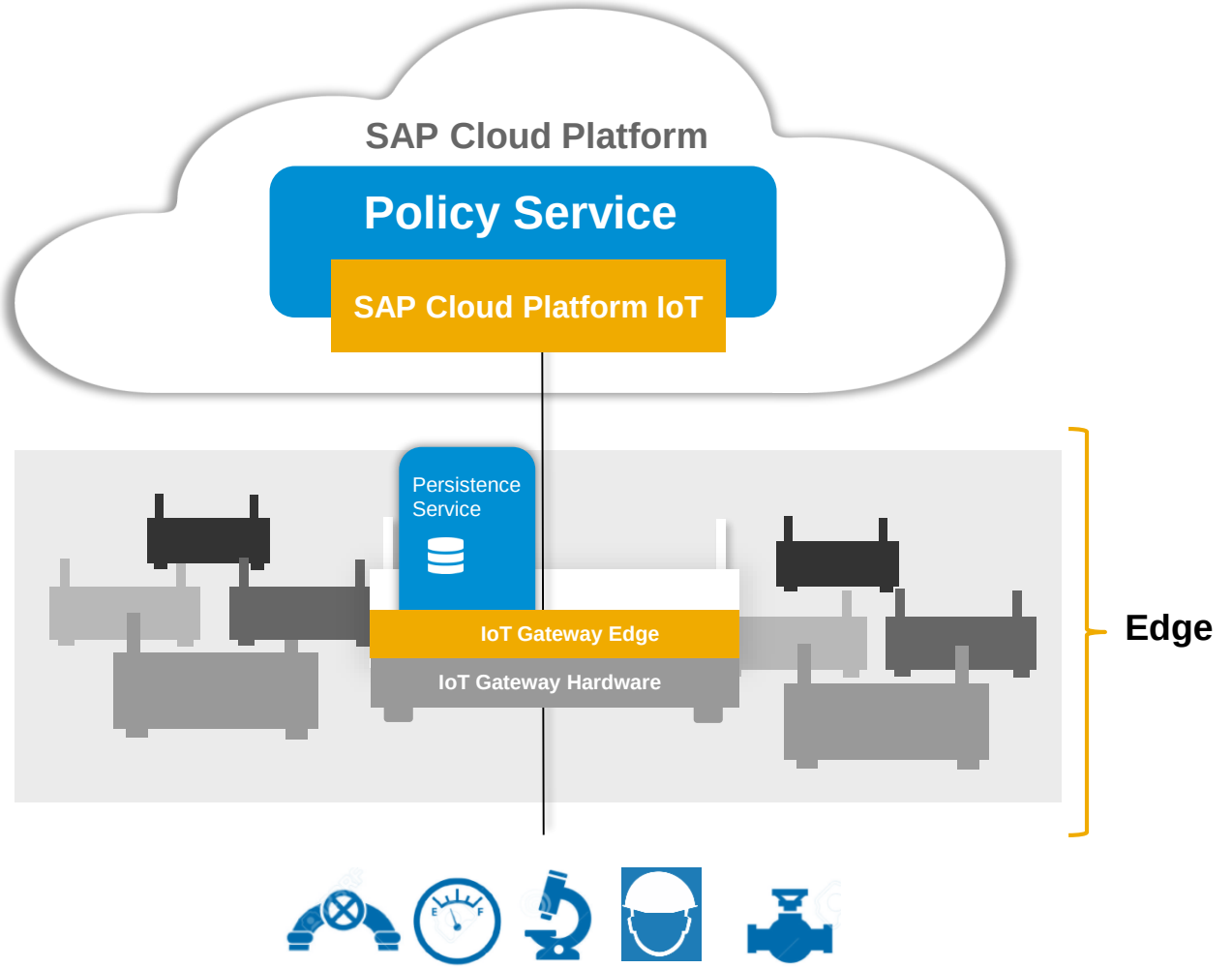
- Each individual service is an OSGI software bundle
- The Policy Service allows you to install the bundles on a designated edge node
- Three edge services have been bundled and published to this gateway via the Policy Service:
  1. Persistence Service
  2. Business Essential Functions Service
  3. Streaming Service
- Each bundle needs to be installed to activate or uninstalled to deactivate

SAP Edge Services

Persistence Service

Persistence Services provides ability to store data on the edge:

- ✓ Reads incoming data via OSGI Event Services and the interceptor from the protocol adaptor
- ✓ Acts as a secure generic database for other OSGI based applications, customers and partner have the ability to create a secure sandbox to for custom tables and functionality



Scope of SAP Edge Services

SAP Edge Services

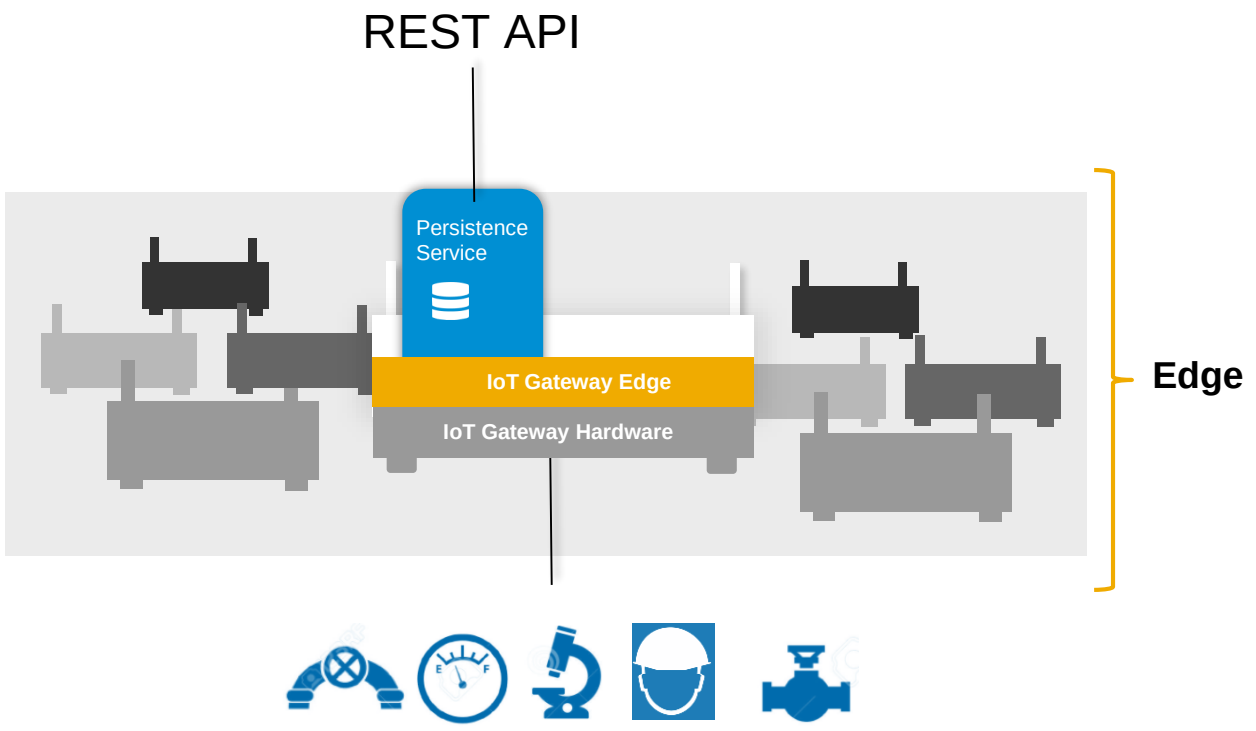
Persistence Service – REST API

Option - Diagram

The data stored in **Persistence Service** can be accessed via a REST API, as visualized in the sample UI shown:

- ✓ Select by measurement, profile and device
- ✓ Filter by time
- ✓ Limit the size of the result set

This REST API allows customers and partners to extend functionality on the edge while using data stored in the persistence service.



SAP Edge Services

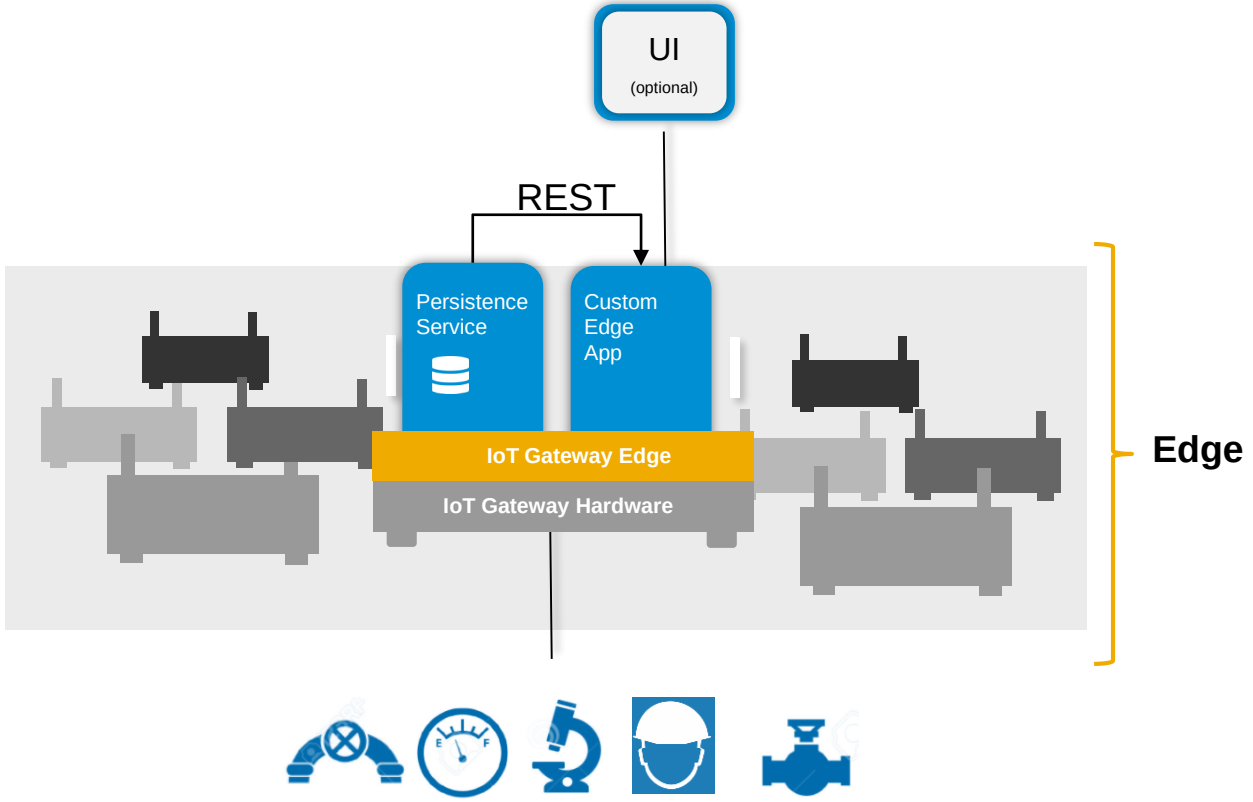
Persistence Service – Enabling custom edge apps

The **Persistence Service** is a key service for building custom applications for edge.

It provides access to measurement data and provides persistence services to custom applications.

Examples include:

- ✓ Dashboards
- ✓ Local user interaction
- ✓ Custom logic



SAP Edge Services

Persistence Service – Enabling machine learning

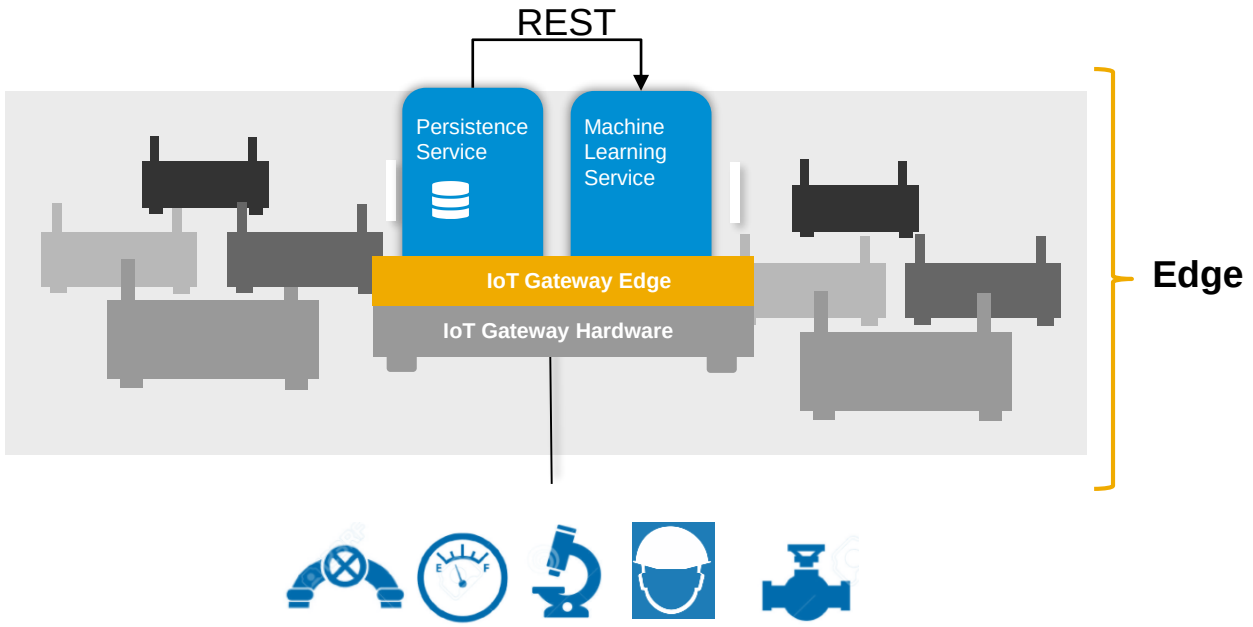
The **Persistence Service** is a key service for enabling machine learning on the edge.

Train model on edge:

- ✓ Collect and store training and test data
- ✓ Provide data to Machine Learning Service

Scoring model on edge:

- ✓ Collect and store data
- ✓ Enabling feature calculation

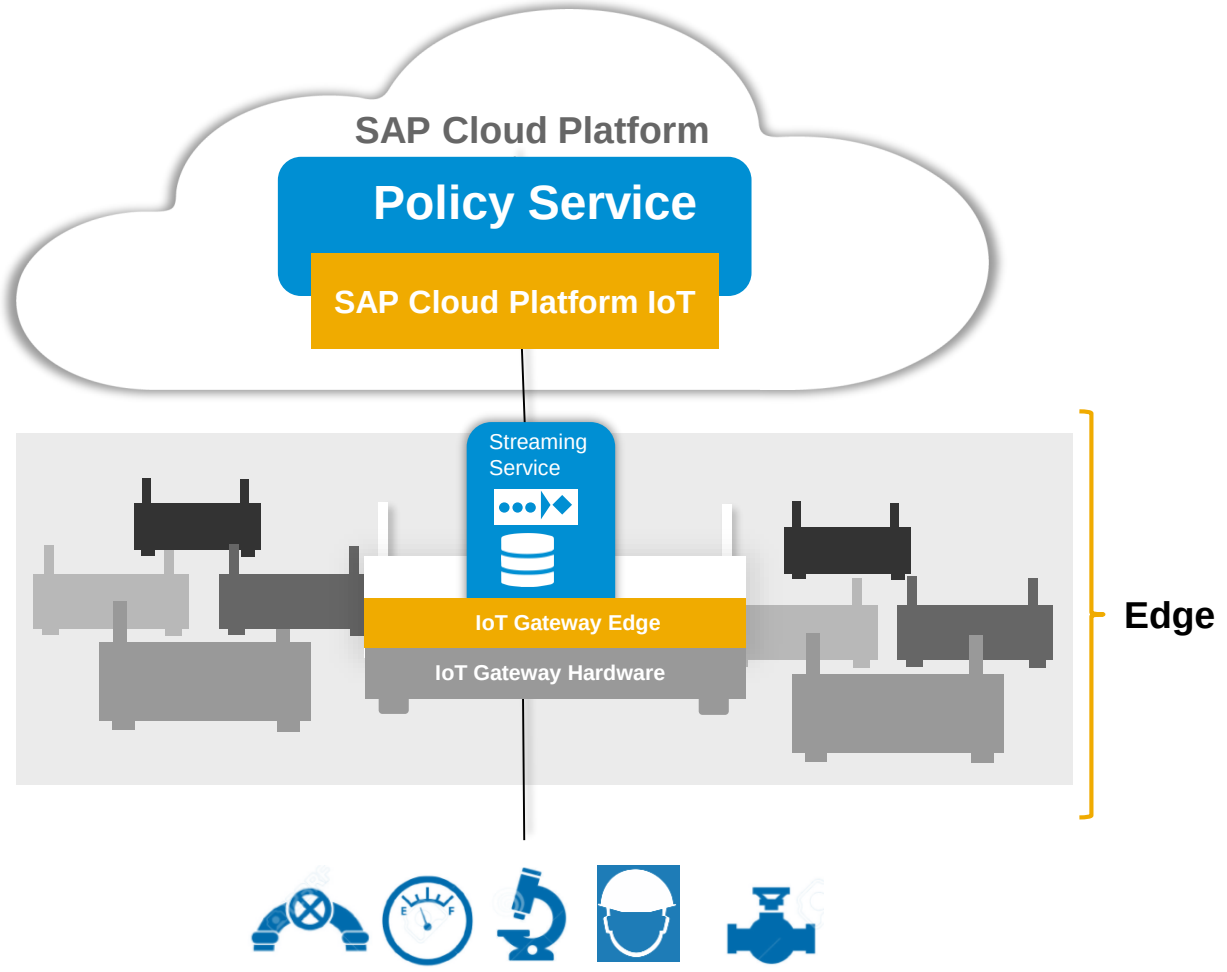


SAP Edge Services

Streaming Service

Streaming Service provides ability to analyze incoming data in real-time based on rules over time windows

- ✓ Set up sophisticated rules
- ✓ Deliver import and export of streaming service configuration to configure edge nodes for improved scalability



Scope of SAP Edge Services

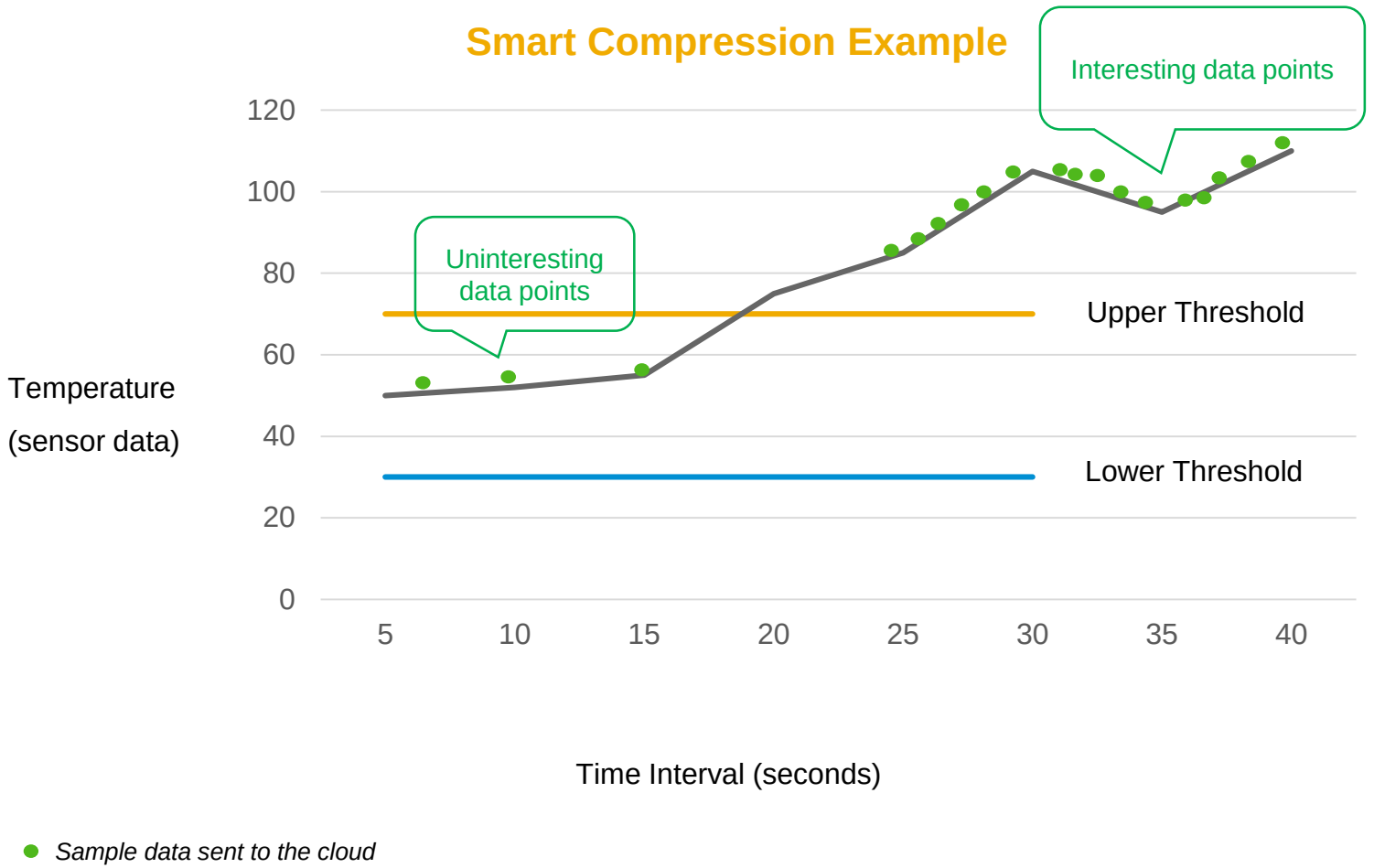
SAP Edge Services

Support Levels for Rules

Level 1: Built-In Rules	Level 2: Extension Rules	Level 3: 3rd Party Logic
Common Math/Calculations	Upload Custom Built CCL	Complex Math/Calculations
Zero-Code Console Admin	Built-in Optimized Streaming Math Functions	Bridges 3rd Party Code Module
Sampling Rate & Fidelity Changes	Access to Events/Actions and Persistence Service	Access to Events/Actions and Persistence Service

Streaming Services: Smart Compression with Intelligent Sampling of Data sent to Cloud

Dynamically modulate from low fidelity to high fidelity as signal curve gets more interesting with Sensor Fidelity Rule Type



Smart Compression with Edge:

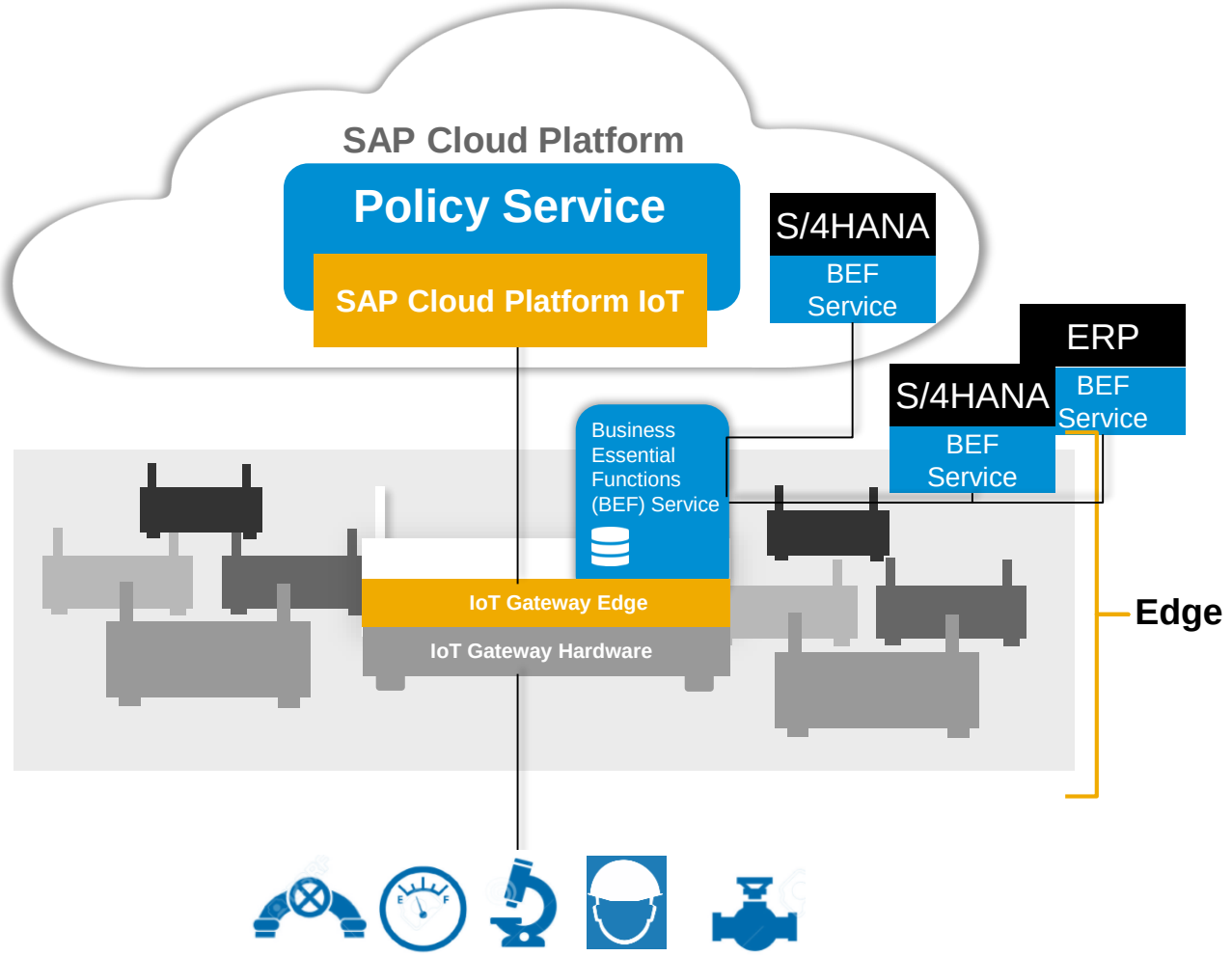
- Smart data compression enables lower bandwidth, transmission and cloud storage costs, without losing data, while achieving high compression.
- When data is within threshold or “uninteresting” (e.g. operating as expected), only minimal data points are sent to cloud
- When data gets more “interesting” (e.g. outside of threshold), immediate detection and strategic clustering of additional data points to be sent to cloud, preserving complex events/curves.

SAP Edge Services

Business Essential Functions Service for ERP and S/4HANA

Business Essential Functions Service provides business context data and transactions from ERP systems and S/4HANA in the cloud or on premise at the edge

- ✓ Extends SAP Plant Maintenance (PM), Materials Management (MM), Inventory Management (IM) functionality to the edge
- ✓ Provides repeatable architectural foundation and methodology to extend other SAP functional areas to the edge
- ✓ Edge Services can be extended to work with SAP ERP and S4/HANA



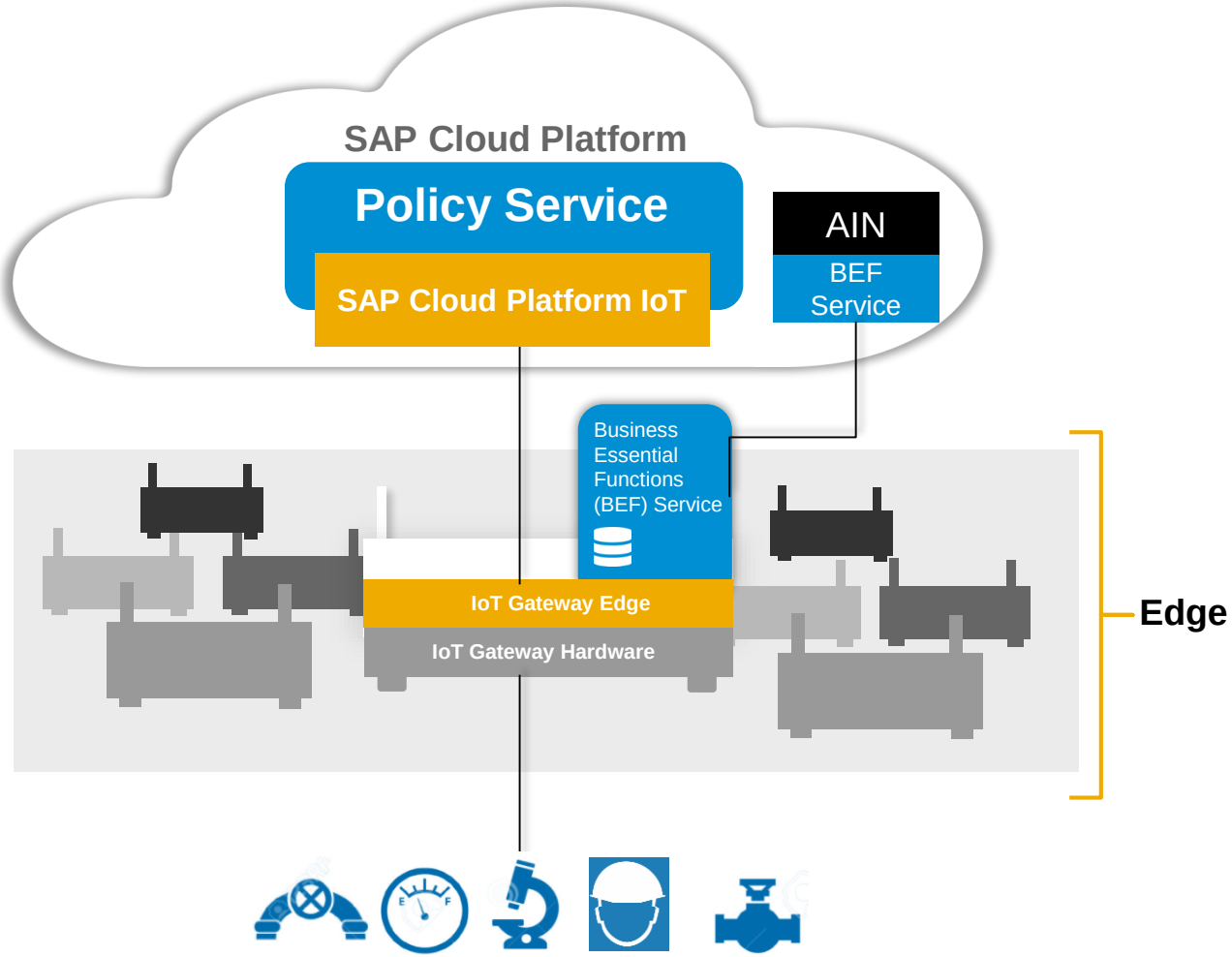
Scope of SAP Edge Services

SAP Edge Services

Business Essential Functions Service for AIN

Business Essential Functions Service provides business context (data and processes) at the edge

- ✓ AIN unstructured data such as manuals
- ✓ AIN structured data such as threshold values for equipment operation



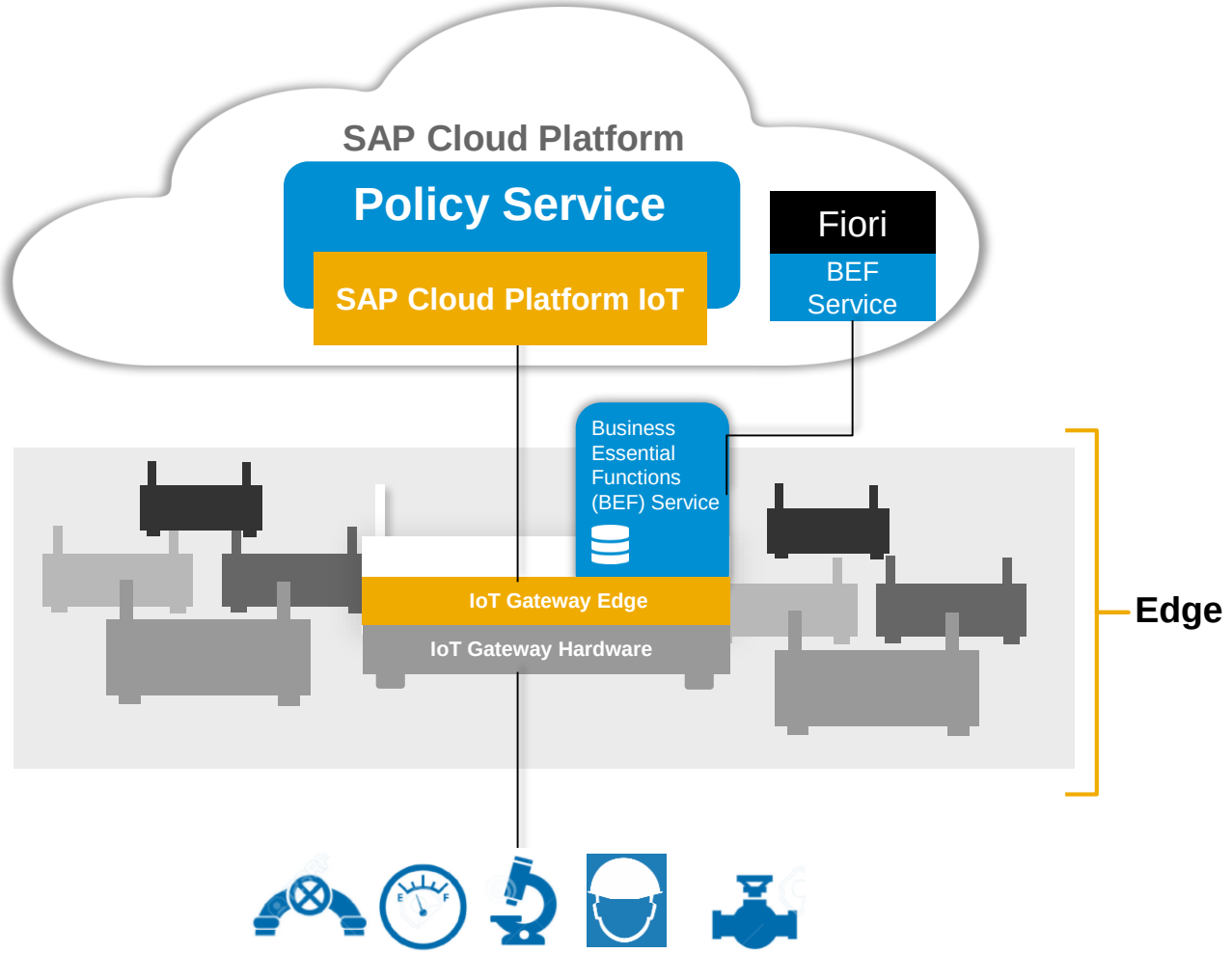
Scope of SAP Edge Services

SAP Edge Services

Business Essential Functions Service for Fiori

Business Essential Functions Service provides business context (data and processes) at the edge

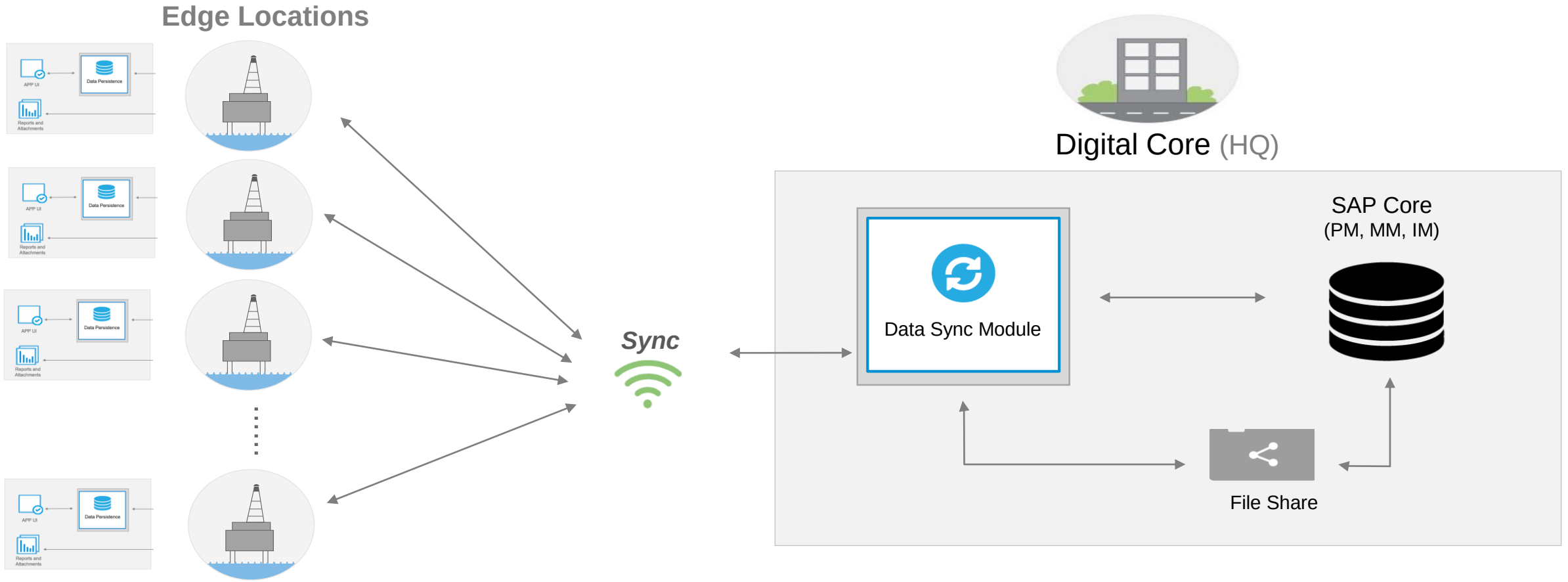
- ✓ Enable customers to extend/leverage Fiori applications at the edge
- ✓ No modification to existing Fiori applications just a change the end point



Scope of SAP Edge Services

Synchronization Between Edge and Core

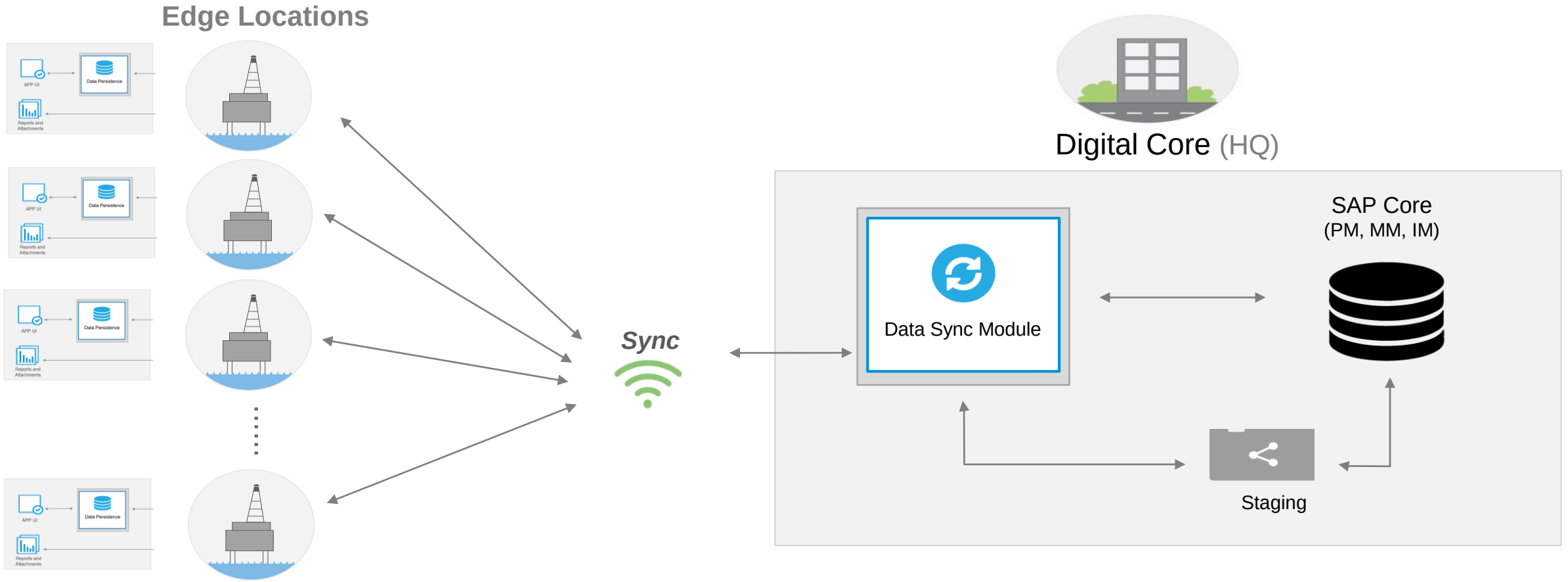
Bi-directional, off-line asynchronous processing at scale



- Edge performance by providing partitioned data that is closest to the edge user
- Scalability by processing business transactions from tens of thousands of edge locations and users *asynchronously*
- Unifying data from a wide range of heterogeneous systems from SAP to third party to home grown, at the edge
- Allows recognition of edge system fluctuations via sensors, and trigger business functions in real time to accommodate irregularities

Synchronization Between Edge and Core

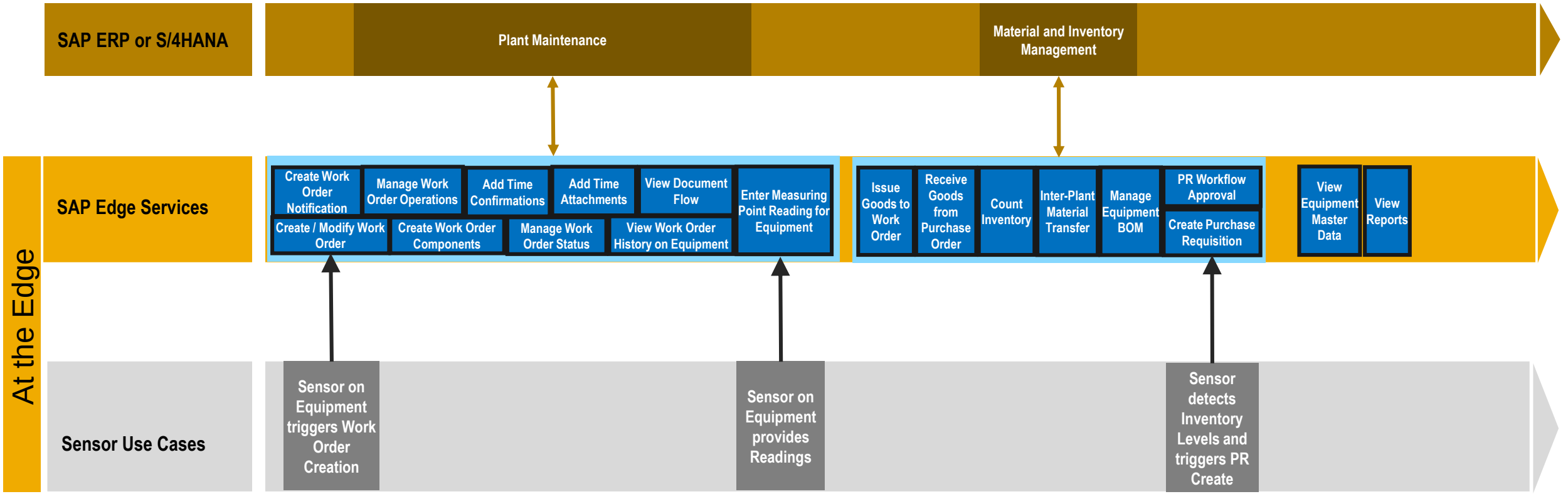
Bi-directional, off-line asynchronous processing at scale



- Relevant data is extracted from ERP Modules PM, MM and IM to a staging table
- Data partitions are synchronized to the edge nodes and stored in local databases
- Edge applications access data local and execute transactions locally
- Transaction are synchronized with central staging table and the executed in ERP system
- Delta changes in ERP systems and sent to edge via staging table and synchronization protocol

SAP Edge Services

Backend Integration of Business Essential Functions



Legend:

Integration

Implemented

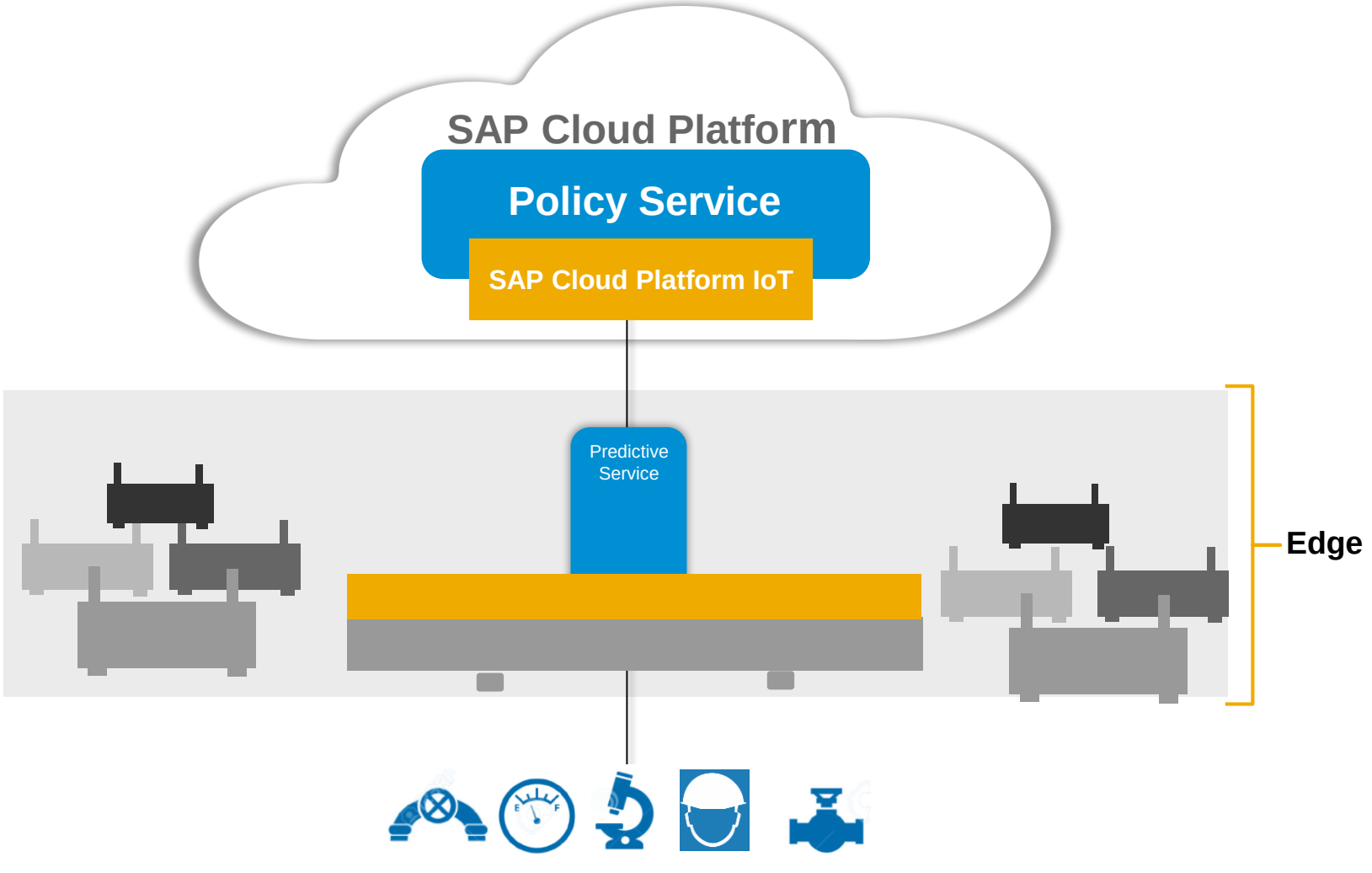
SAP Edge Services

Predictive Analytics Service

The Predictive Analytics Services allows to deploy models trained in the cloud or on premise on the edge.

The model can be created with SAP Predictive Analytics, open-source or 3rd party tools.

The deployment is done as for all edge services from the loud via the Policy Service.



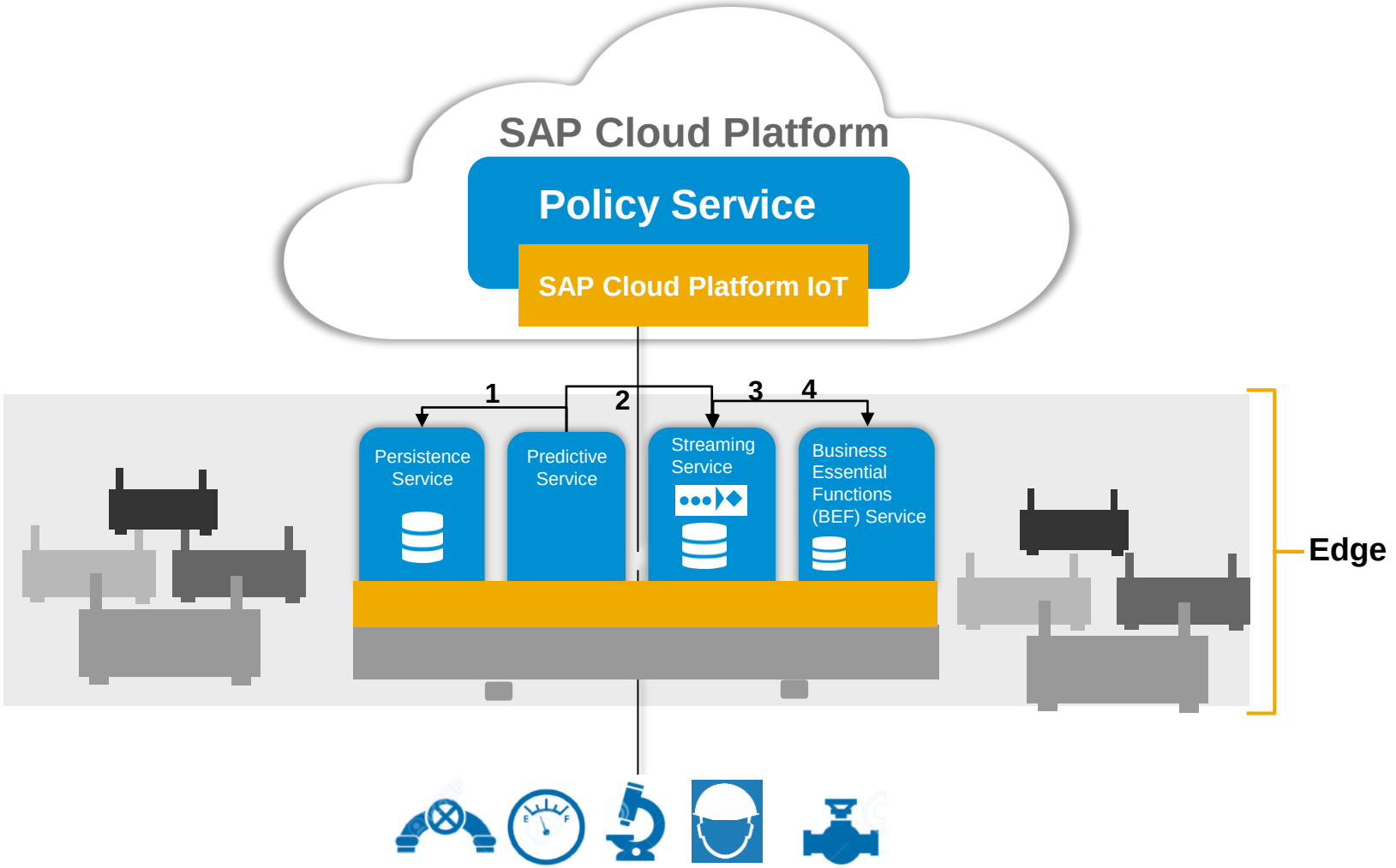
SAP Edge Services

Predictive Analytics Service w/ Persistence Service

Typical scenario:

1. Periodically, e.g. every minute, the predictive service queries the persistence service, calculates the input vector and scores the model[1]
2. It sends the score as an event to the Streaming Service. The score can also be stored back in persistency service for historical analysis
3. The Streaming Service applies business rules which may include enterprise data from the Business Essential Functions Service.
4. The Streaming Service drives an action, e.g. executing a transaction at the Business Essential Function Service or sends a notification.

Applications scenarios include predictive maintenance and predictive quality.



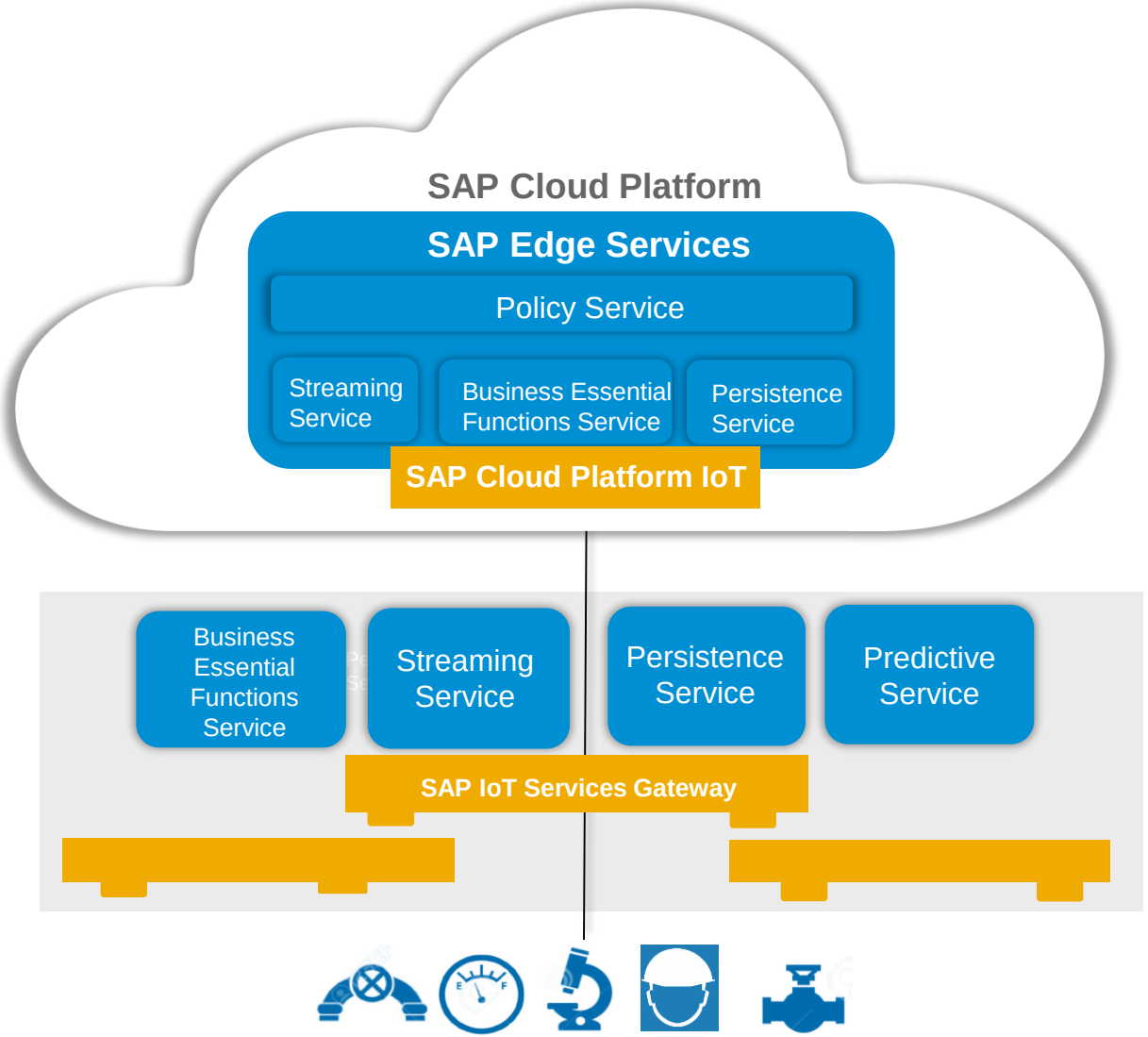
SAP Edge Services

Edge Cloud

SAP IoT Gateway Edge (included in the **SAP Cloud Platform IoT** offering) provides device management, connectivity, and lifecycle management at the edge.

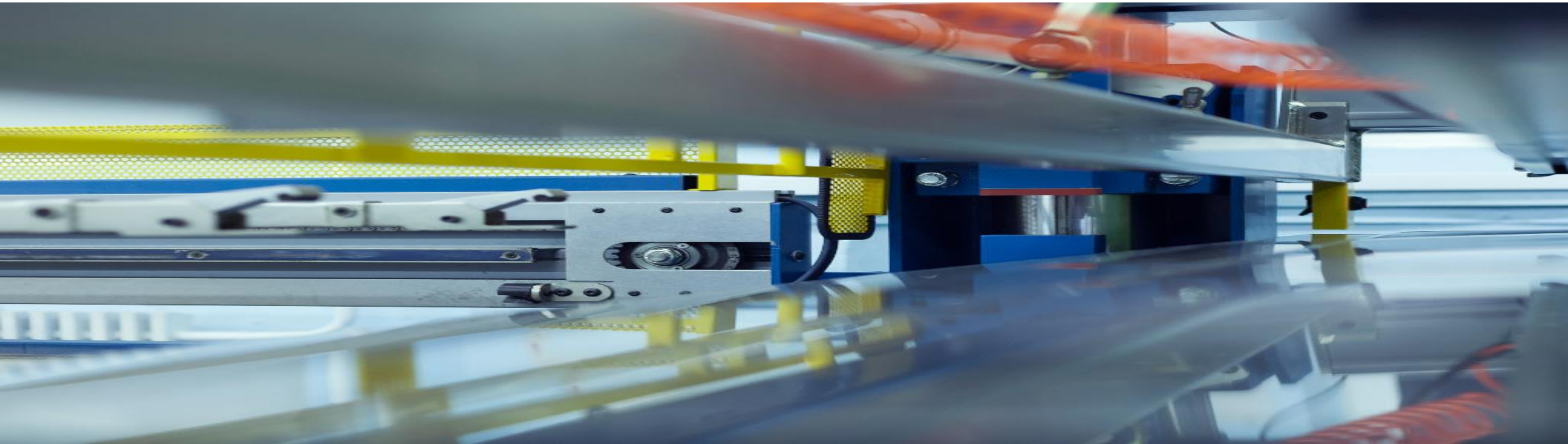
SAP Edge Services runs on top of **SAP Cloud Platform IoT** and brings compute (streaming micro-services), storage (persistency micro-services), and business semantics to the edge for latency sensitive use-cases and deterministic performance of business processes.

SAP Edge Services includes predictive analytics/machine learning capabilities at the edge.



SAP Edge Services

Customer Example



Customer Win - Pregis Quote

"In just a matter of weeks, we were able to pilot and demonstrate tangible value with SAP Leonardo IoT Accelerator packages. **SAP Connected Goods** and **SAP Edge Services** allows us to enhance customer solutions and achieve greater productivity for improved customer satisfaction.. "

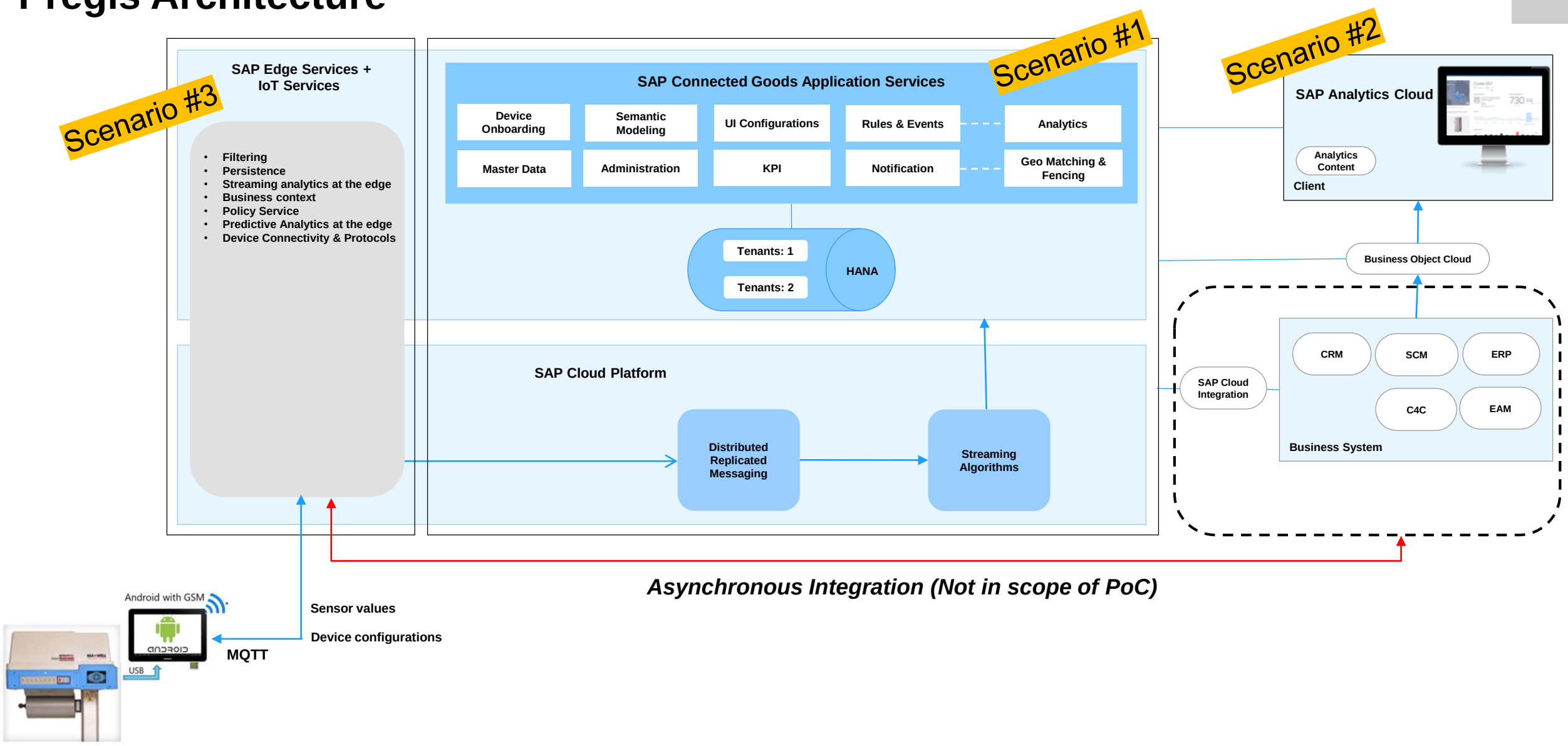
Jeff Mueller, Chief Information Officer, Pregis LLC

Edge Services Use Case

- Improve technician productivity and lower costs by allowing technicians to remotely monitor chemicals (input), product (output), and control the configuration of machines.
- * Synch with S/4 HANA to create work orders, despite intermittent network connectivity in their customers distribution centers; deployment of predictive/ML models to the edge

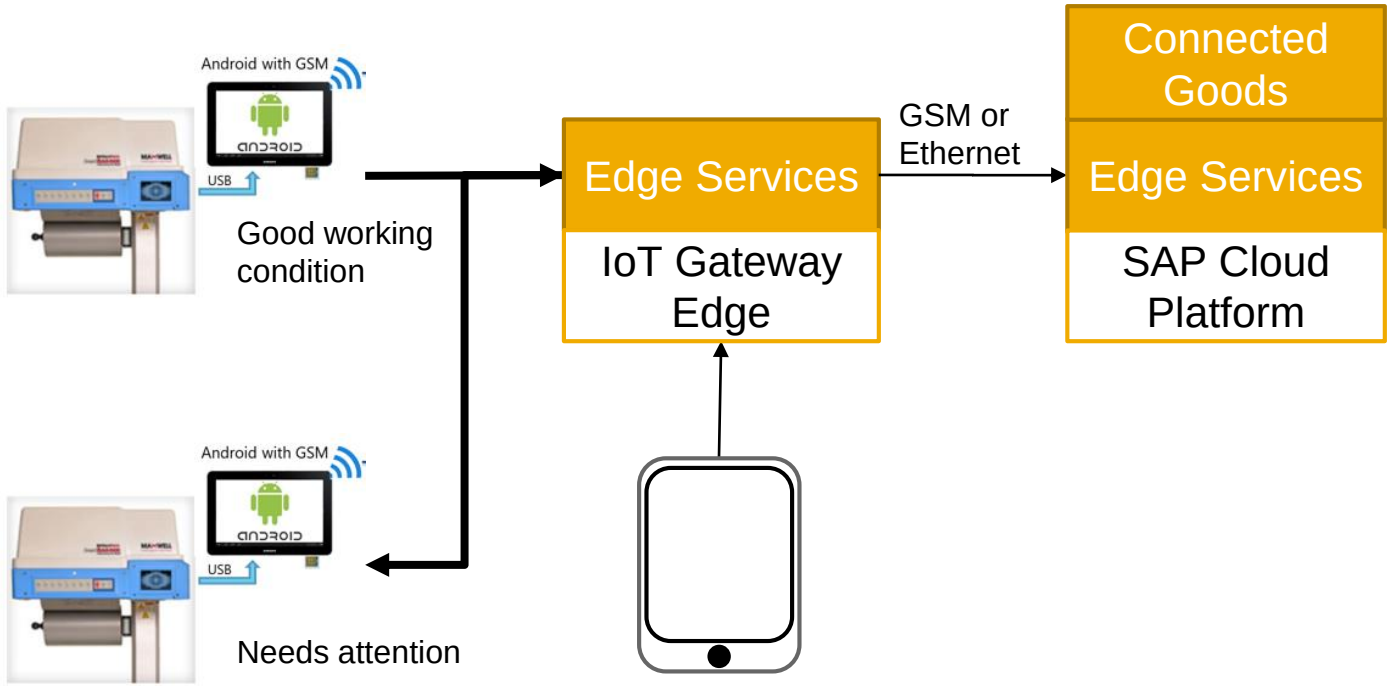
Pregis is a leading provider of packaging materials (bubble wrap, air pillows, and foam sheeting) found in everyday packages

Pregis Architecture



PoC Scenario #3 | SAP Edge Services

- Save Smart Bagger configurations
- Re-configure new/malfunctioning Smart Baggers
- Best use of existing network infrastructure

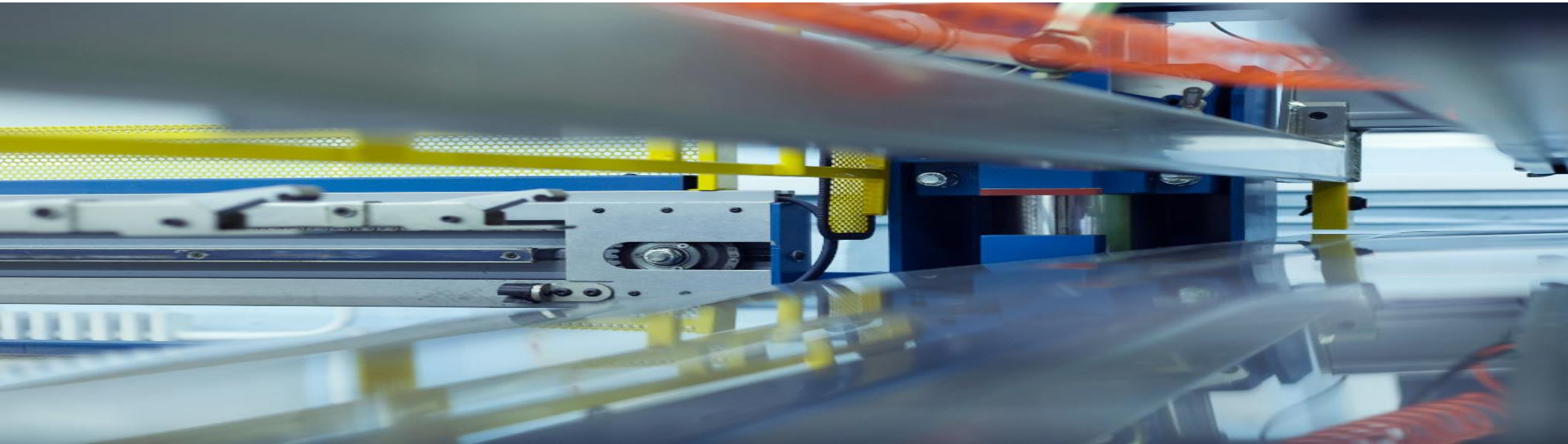


Scenario #3: Objective

Demonstrate the value of SAP Edge Services for Pregis

1. Monitor machine location and condition in real-time
2. Save bandwidth and communication cost
3. Deploy machine configurations from the Cloud to the Edge
4. *In future, integrate IoT enabled machines at the Edge with backend business processes*

Editions & Pricing



SAP Edge Services Cloud Edition Pricing/Functionality – Standard vs Enterprise

SAP Edge Services, Cloud Edition, Enterprise Version– Currently Available

- Pricing starts at €20.00/device/month

Streaming

Persistency – Data & Rules

Business Essential Functions

Predictive Services

Custom Edge Apps

Micro Services (Future)

SAP Edge Services, Cloud Edition, Standard Version – Proposed Solution

- Pricing starts at €6.50/device/month

Streaming

Persistency – Rules

Business Essential Functions

What is the definition of a device?

"Device means a uniquely identifiable object and its virtual representation in the Cloud Service which has a device ID allocated to it."

SAP Edge Services, on-premise Edition – Pricing Summary

Pricing Structure

Pricing: 1,000(EUR) / $1,500US per device

No pre-requisite (includes PCo and SQL Anywhere)
No minimum Purchase.

What is the definition of a device?

A device is any piece of equipment or hardware, included but not limited to: a workstation, terminal, point of sale terminal, notebook, handheld, tablet, PDA, smartphone, internet connected television, scale device, device installed in a vehicle (on-board units) or other networked devices

SAP Edge Services – Partner Cloud and Demo License

Pricing Structure

- **Price metric**
  670 EUR/month
- **Use Metric**
  - 1 x Cloud Test & Demo for SAP Edge Services Tenant
  - 100 devices

Prerequisite: SAP Cloud Platform Internet of Things (material code 8005404).

License Details*

- Must be an SAP Partner with a valid partnership**
- Allows non-productive test, demonstration and evaluation purposes with sample data only
- Subject to use metrics and fees outlined in the SAP Partner Price List
- Includes Enterprise Support, Cloud Edition

**See Partner Cloud Test & Demonstration License, available here

*Open Ecosystem partners must have a specialized engagement – Build, Sell, Service, Run – i.e. operational partner type status in Manage My Partnership

- SAP.com / SAP help.com
- SAP Partner Price List
- Order

Additional Resources for SAP Leonardo IoT Edge

SAP Edge Services on SAP.com

SAP Edge Services Solution Brief

SAP Edge Services Demo (Video)

Thank You