AWS re:Invent

IOT339

Transforming automotive manufacturing with Volkswagen

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Agenda

- Business challenges in Automotive Manufacturing
- Building a platform from use cases
- Use case: Digital shop floor management
- Target architecture of the platform

Introduction

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Transforming automotive manufacturing with VW Industrial Cloud

Objective

Improve manufacturing and logistics performance by 30% over the next five years

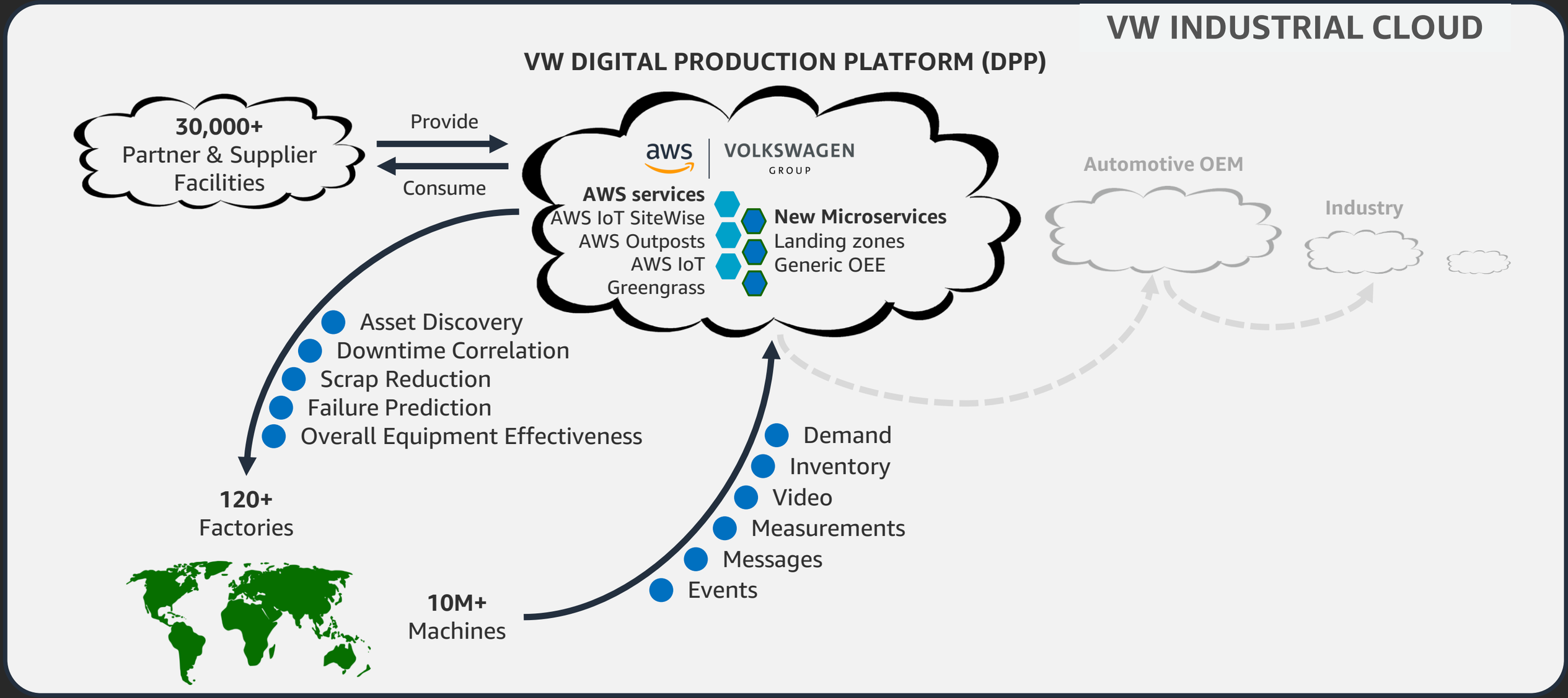
Challenges

- Unplanned downtime
- Limited transparency
- Regional process differences
- Single-purpose applications
- Availability of highly specialized equipment
- Time and data synchronization and standardization

Outcomes

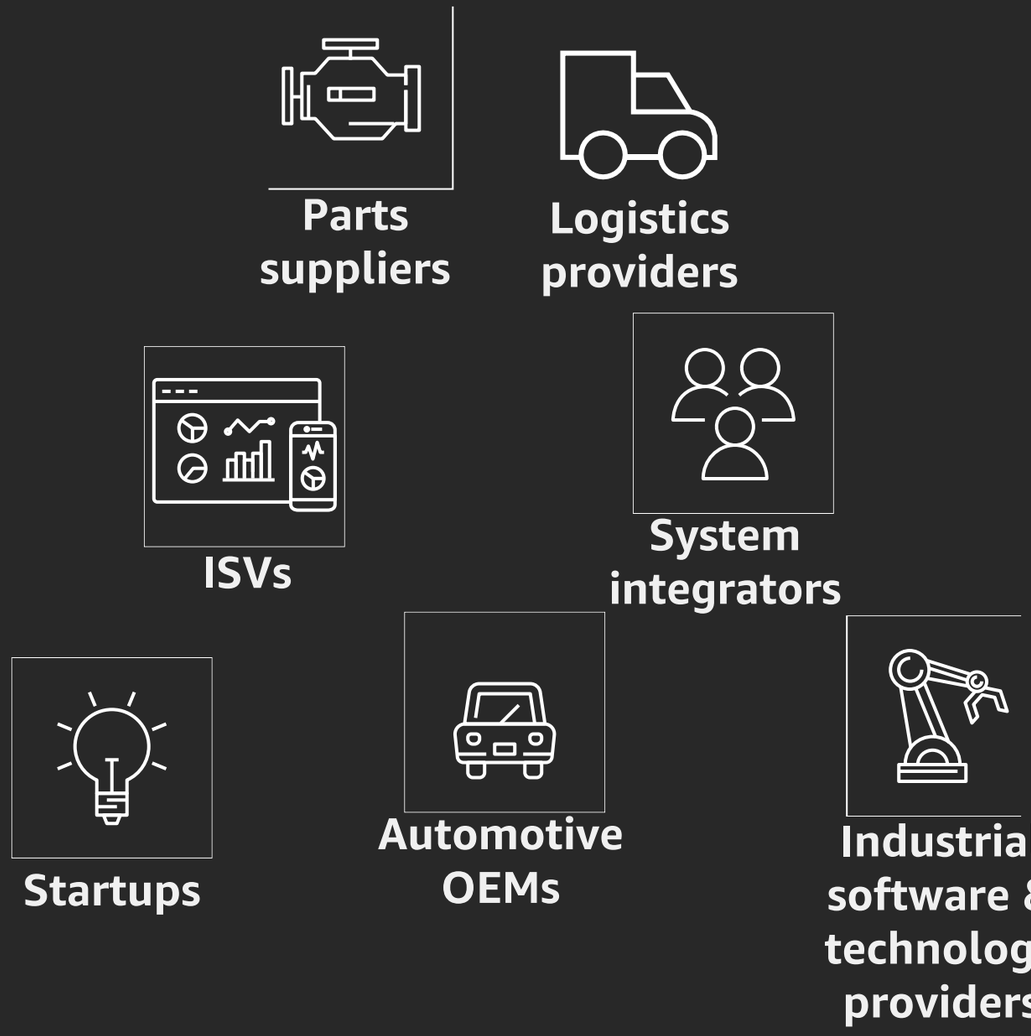
- Reduce cost
- Predict failures
- Reduce scrap
- Reduce variation
- Increase equipment changeover speed
- Increase internal and external automation

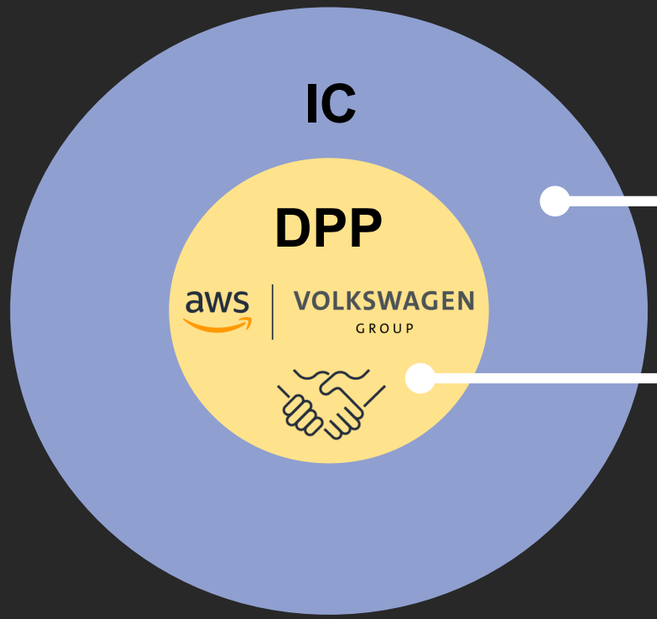
A digital services platform and application marketplace connecting vehicle production, suppliers, and logistics providers



Creating the future of industrial production together

Through an ecosystem of collaborative industry partners





Industrial Cloud (IC):

- Based on the DPP, the Industrial Cloud will be an **open industry platform** and **ecosystem**
- Global supply chain with over 1,500 suppliers and partner companies to be integrated

Digital Production Platform (DPP):

- **Combines data** of all machines, plants, and systems within VW Group
- **Cloud-based platform** essential to **scale up new applications** rapidly across the world

Co-development: Partnership interaction model for DPP

Interaction	Amazon leadership principles	How we're doing it differently
aws | VOLKSWAGEN GROUP		**We're closer to the customer** • Co-equal partners with 1:1 staffing for the next five years • Executive governing board with senior AWS and VW executives
aws		**We're joining forces internally** • AWS Proserve, services, Account, and AWS Partner Network staff working as one team • Joint team with total of 50+ total AWS resources
VOLKSWAGEN GROUP		**We're redefining the culture** • Top-down commitment to use Amazon innovation methods • Shift from decision-by-committee to small pizza teams • Replacing engineering mindset with rapid iterations

Use case–driven platform

AWS services for Industrial Manufacturing use cases

Machinery

- CNC
- Ovens
- Lathes
- Presses
- Welders
- Conveyors
- Paint guns

DPP capabilities & services

AWS IoT SiteWise

AWS IoT Analytics

AWS IoT Core

Amazon Kinesis Data Firehose

Amazon S3

Amazon DynamoDB

Amazon Elastic Kubernetes Service

Amazon SageMaker

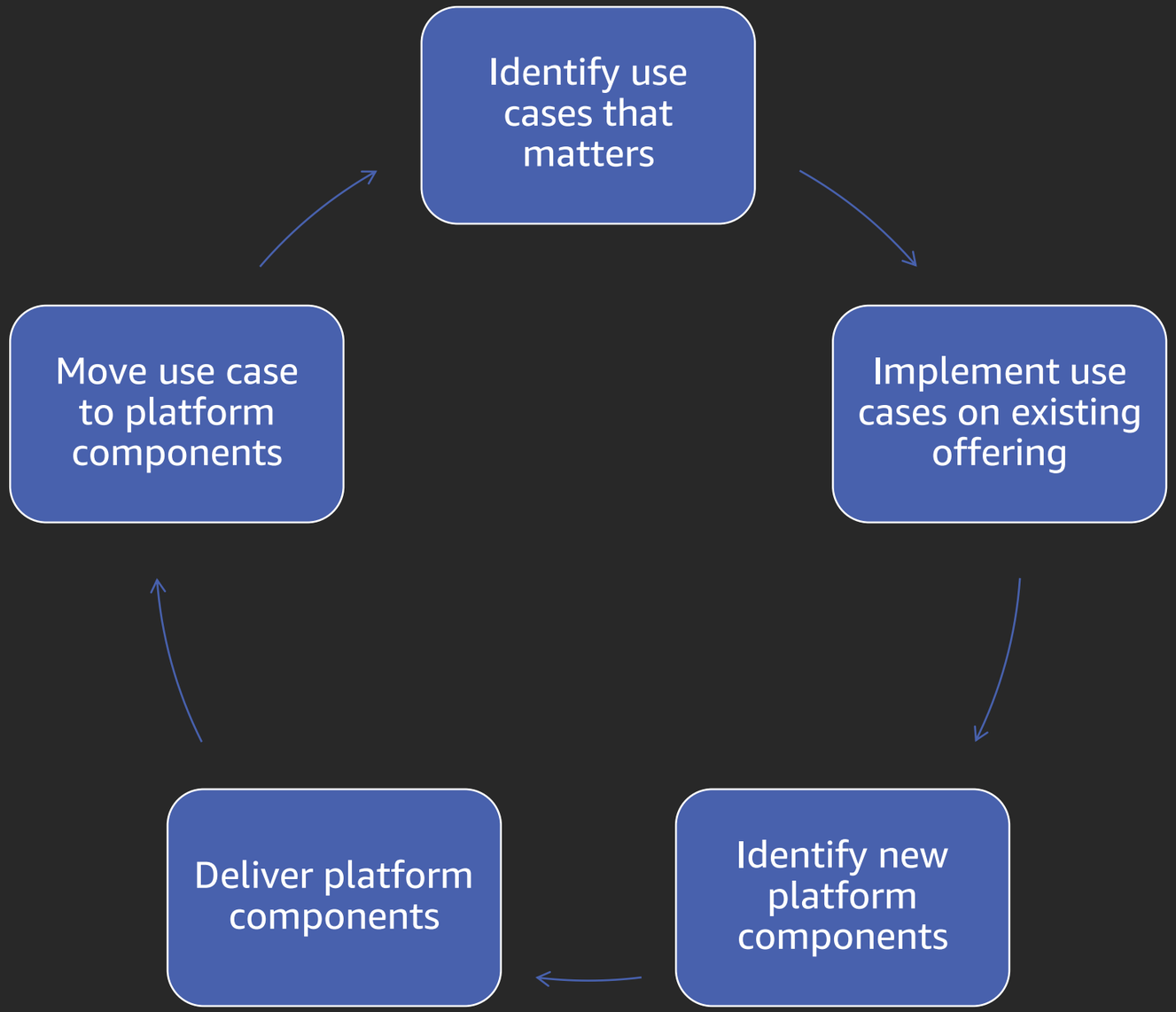
Amazon Athena

Amazon QuickSight

End users

- Plant managers
- Supervisors
- Technicians
- Industrial engineers
- Equipment mechanics
- Operations managers
- Logistics specialists

Platform development methodology



Use case: Digital shop floor management

Business summary

Vision

The digital shop floor management + is a group-wide established solution of components technology. About 50,000 employees from management to operators in over 61 factories using DSFM+ to continuously improve the processes on the shop floor.

DSFM+ …

… increases velocity and quality of processes on shop floor

… standardizes processes through the usage of “Group Production System”

… provides a process-integrated transparency across value-adding process steps

… enables a cost-efficient rollout of new components/processes of shop floor management

… enables cross-plant knowledge sharing

Targets

Reduce administrative efforts by automated data retrieval, automated reporting, etc. => more time for problem solving

Transparent activity tracking and knowledge sharing across plants => sustainable improvement of machine availability

Bottleneck-oriented process improvement (value-stream, delivery reliability, etc. => optimized throughput times

Maximum of transparency over all losses and their factors of influence => increased productivity

The solution—Digital shop floor management across the plants

- Transparency at place of action
- Structured problem-solving with up-to-date information
- High motivation and continuous improvement of employees

Plant/Production manager

Area manager

Subdepartment manager

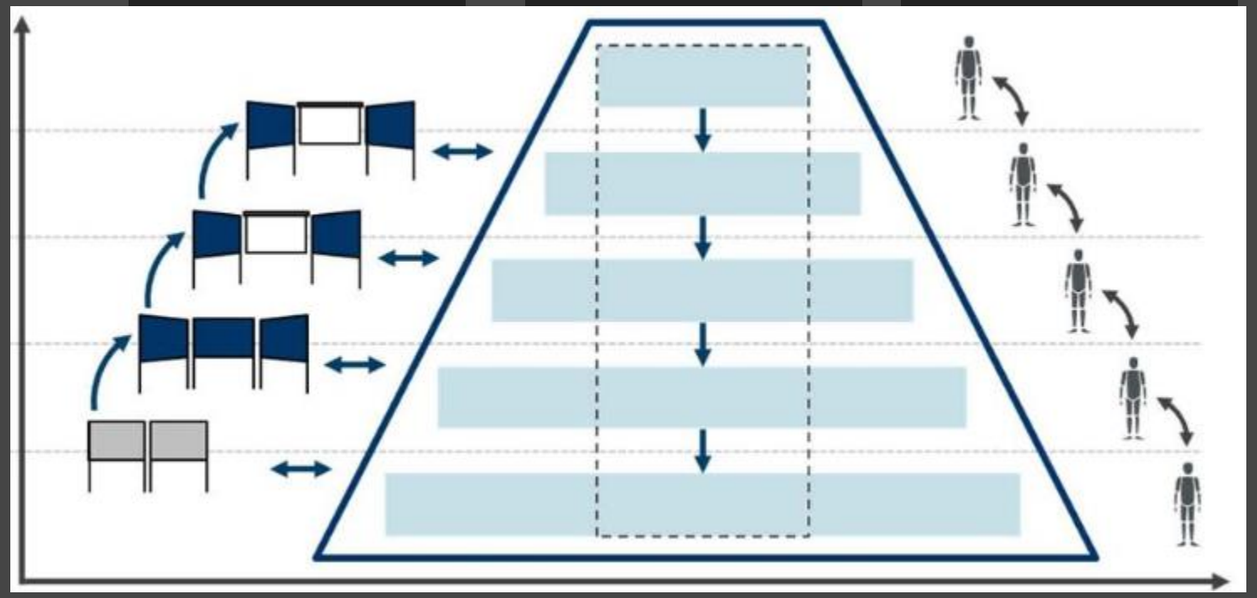
Group leader

Team speaker

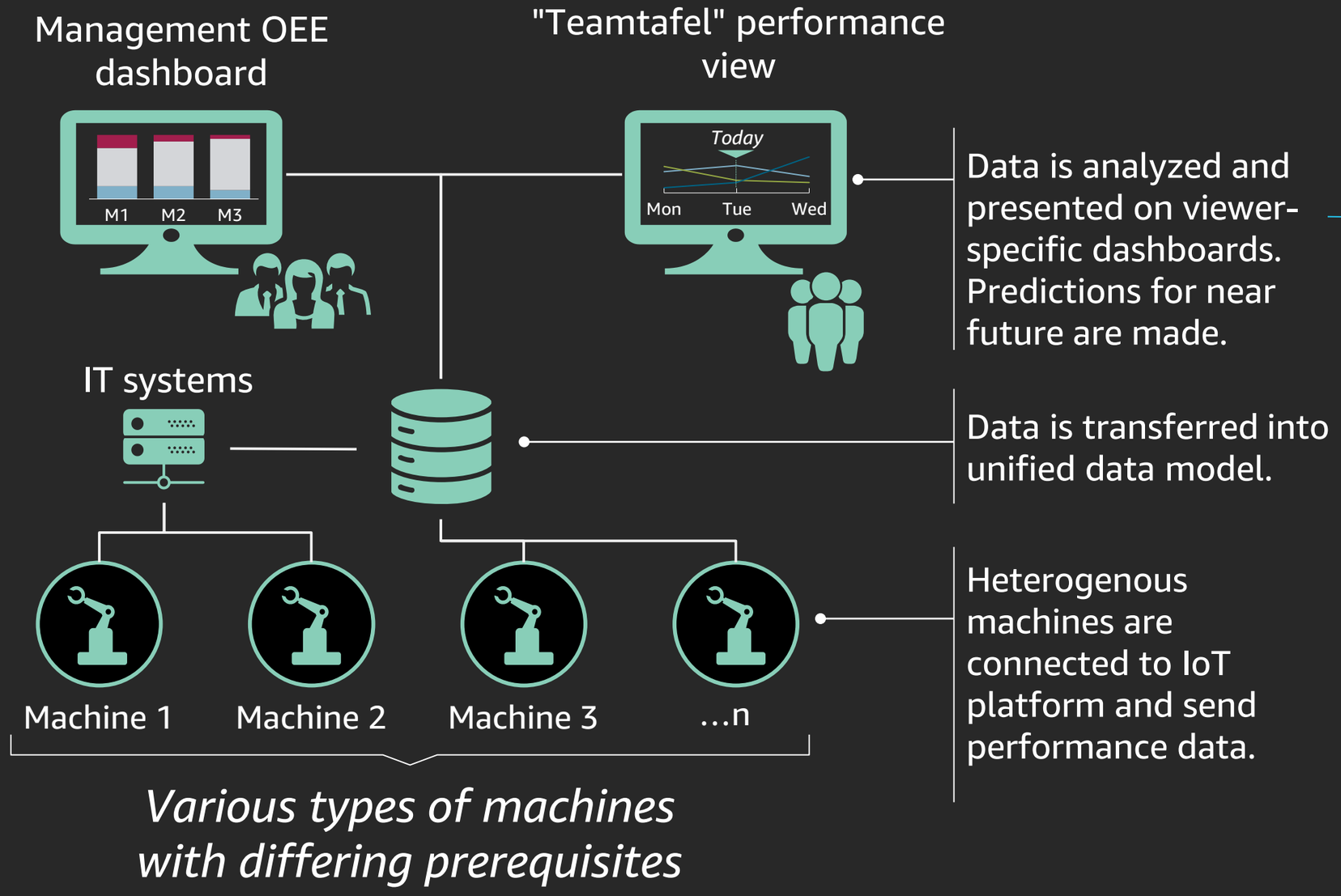
Information cascade

Time window

Mentor-mentee



Use case: DSFM+, digital shop floor management



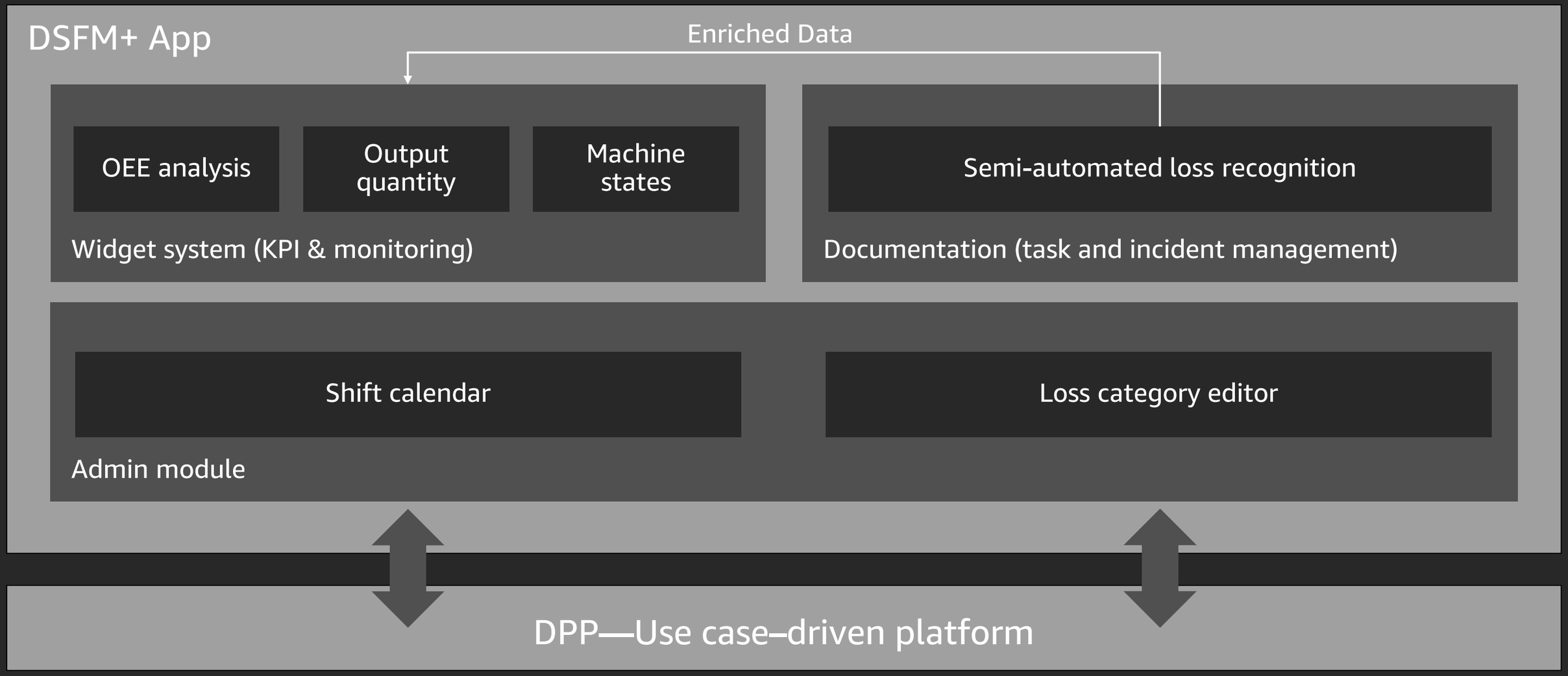
Data is analyzed and presented on viewer-specific dashboards. Predictions for near future are made.

Data is transferred into unified data model.

Heterogenous machines are connected to IoT platform and send performance data.

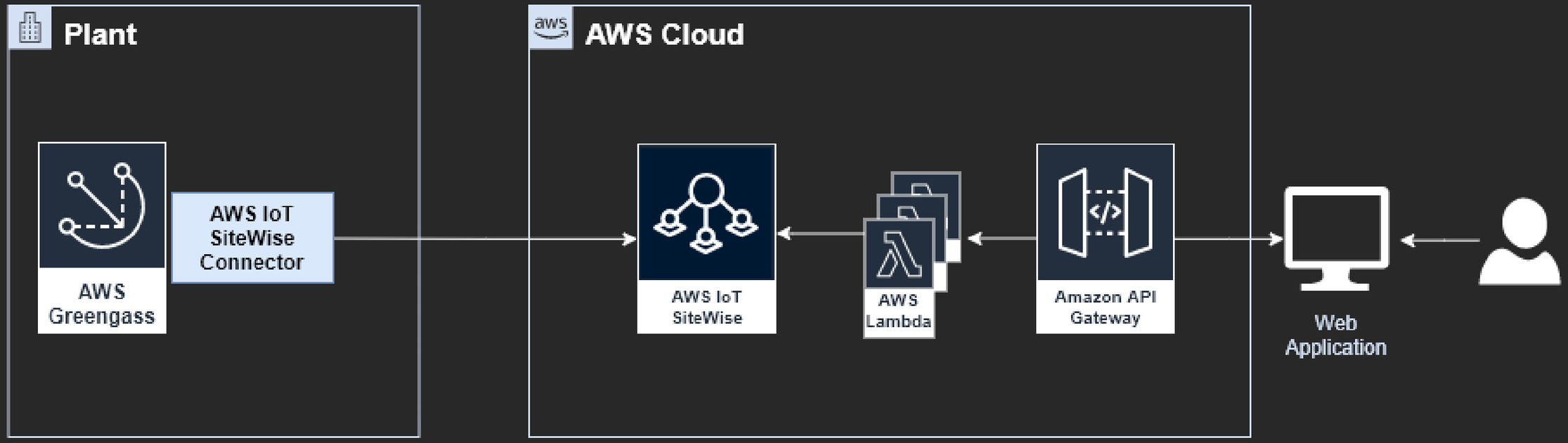
The plant is a VW component plant in which engine cylinder heads are being manufactured for various VW brands. The work on the shop floor is organized in process steps. The machines in each process step are controlled by one single production logic controller (PLC). The aim of this use case MVP is to provide a dashboard showing the overall equipment efficiency (OEE) of each single-process step.

Modules of DSFM+ MVP 2019

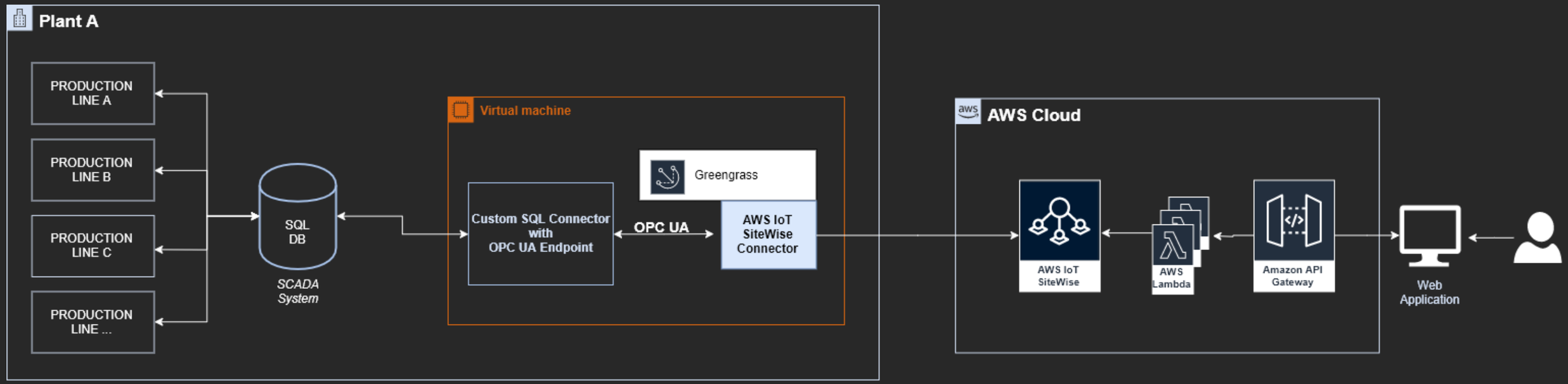


DSFM+ solution and technology

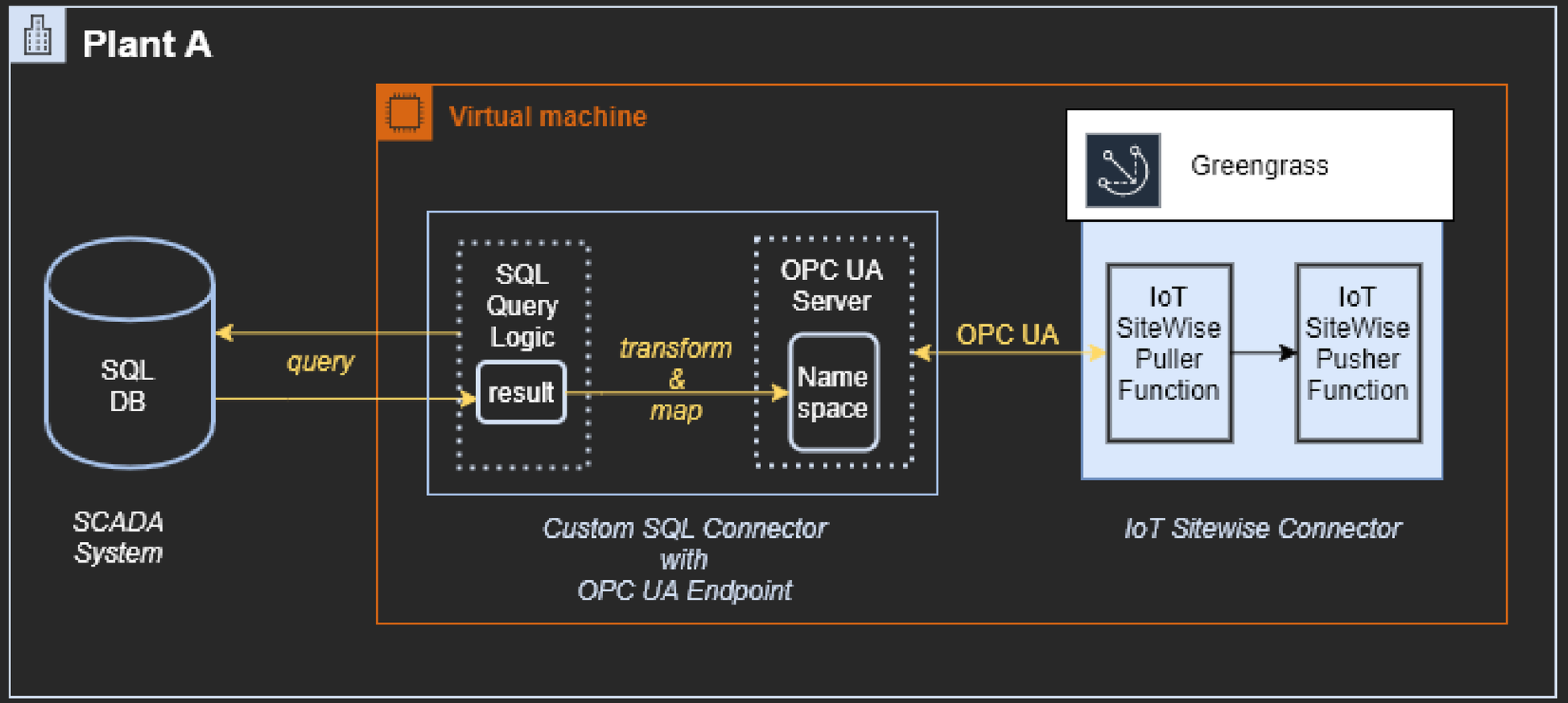
Rough architecture



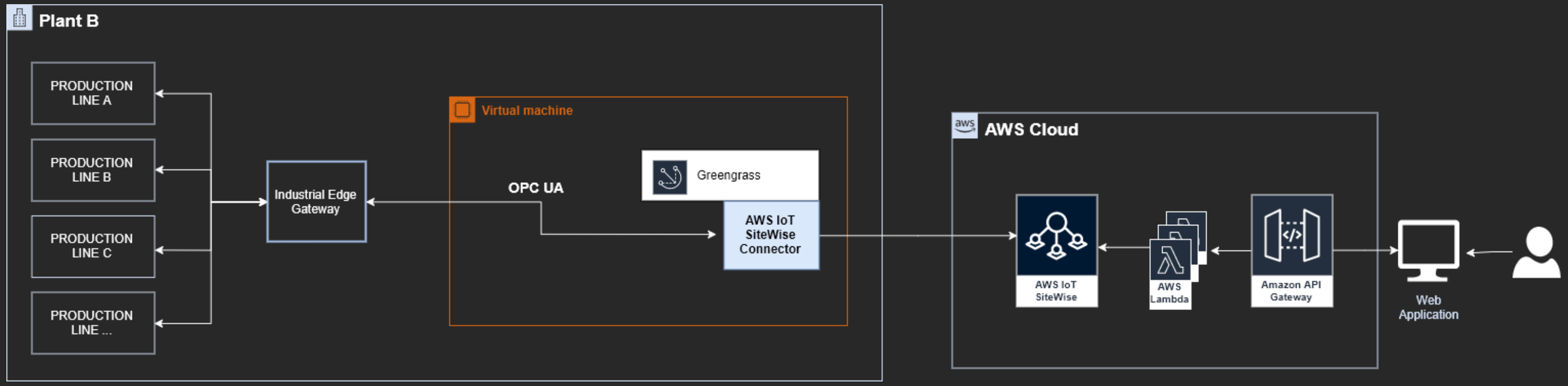
Connectivity Plant A



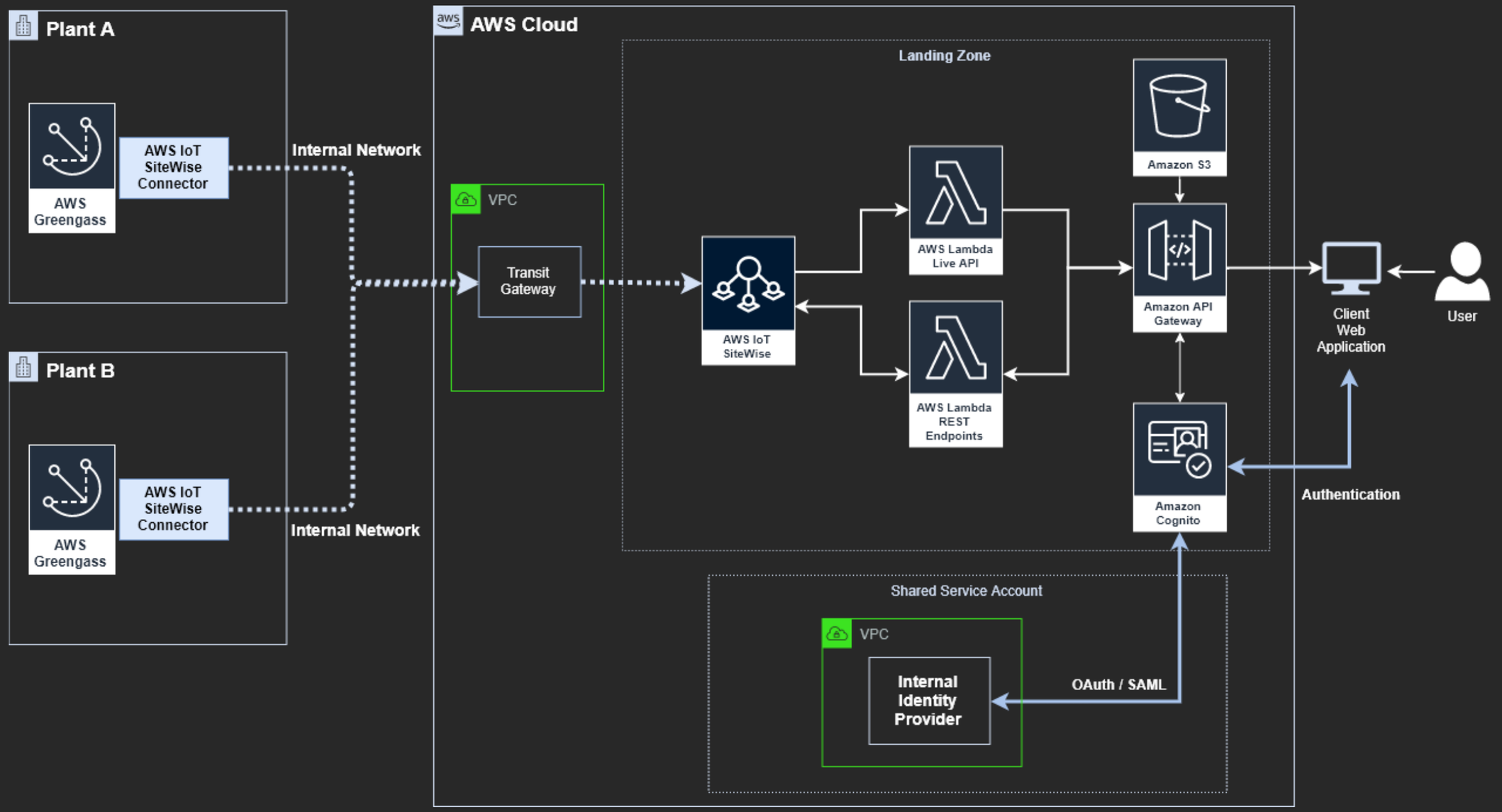
Details: Connectivity Plant A



Connectivity Plant B

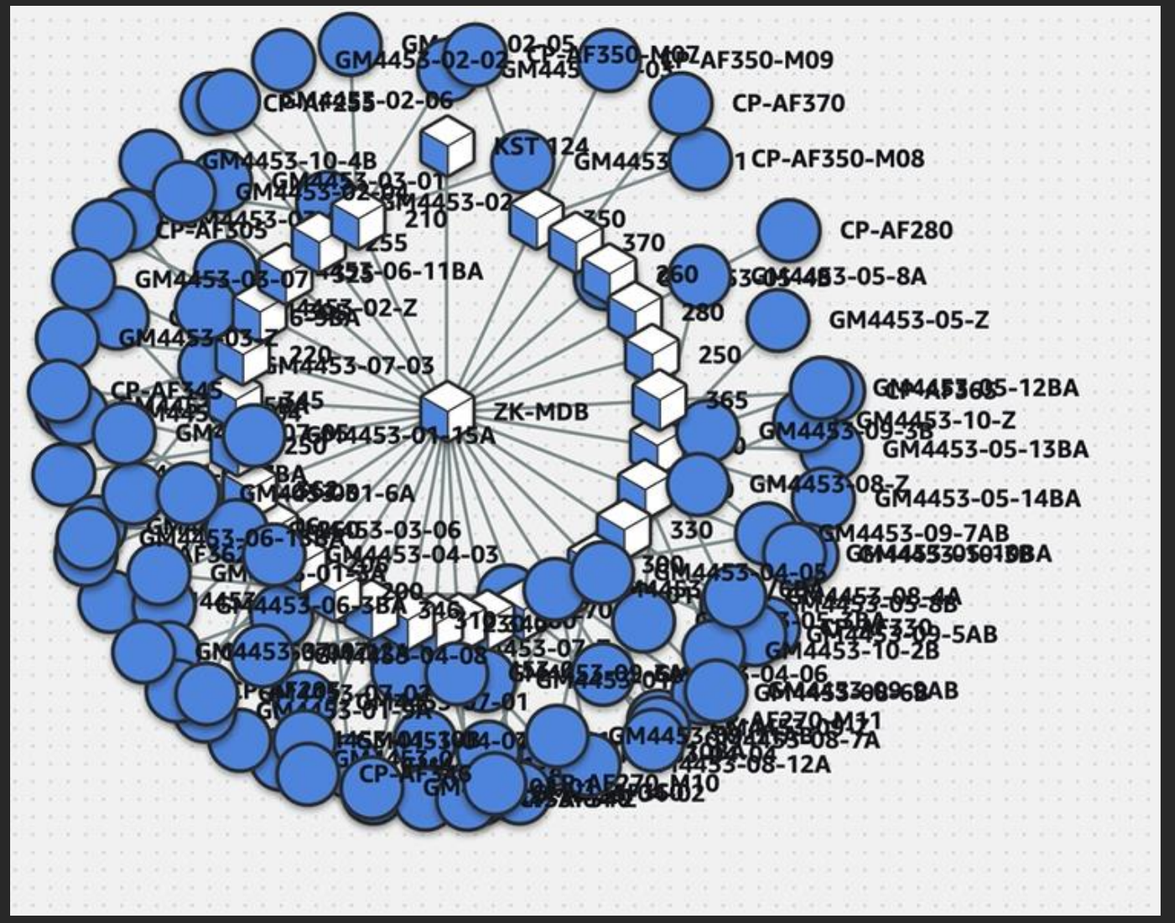


Cloud Architecture overview



We need assets—Automated asset provisioning

- Implementation of a custom resource for AWS IoT SiteWise
- Asset importer (SAP, CSV input)
- 94 assets from plant automatically imported



Deep dive—Custom resource for AWS IoT SiteWise

View Provisioner is the lambda that is used by the custom resource (CR). Therefore, it must cover the three request types: Update, Create, and Delete, where Update does not update, but re-creates the resource completely.

1. Fetch config from Amazon S3 bucket
2. Validate config
3. Execute request
4. Response to S3 bucket
    1. No error: Send success response to bucket
    2. An error: Send failed response to bucket

```
try {
  // ...

  await sendResponseToS3(ResponseURL, {
      Status: 'SUCCESS',
      PhysicalResourceId: viewId,
      // ...
  });

} catch ({ viewId, message }) {

  await sendResponseToS3(ResponseURL, {
    Status: 'FAILED',
    PhysicalResourceId: viewId || PhysicalResourceId,
    Message: message,
    // ...
  });

}
```

Deep dive—Create and update of custom resource

```
try {
  let viewId = '';

  /* --- CREATE & UPDATE --- */
  if (RequestType === 'Create' || RequestType === 'Update') {
    console.info('START PROVISIONING OF SITEWISE');

    // Fetch config from S3 bucket
    const { Bucket, Key, assetTemplateId } = ResourceProperties;

    if (!Bucket || !Key || !assetTemplateId) {
      console.error('Either Bucket, Key or assetTemplateId is not set.');
      throw new Error('Error: Either Bucket, Key or assetTemplateId is not set.');
    }

    const config = await getConfigFromS3AsJson(Bucket, Key);
    console.info('Config:\n%o', config);
    console.info('assetTemplateId: %s', assetTemplateId);

    // Validate config
    configValidator(config);

    // Execute request
    viewId = await executeRequest(RequestType, { config, assetTemplateId });
    console.info('PROVISIONING SUCCESSFUL:\n%o', viewId);
  }
```

Event triggered by AWS CloudFormation to custom resource, RequestType is set by Amazon CloudFront

Fetch config JSON from S3 bucket with the hierarchy asset model information

Calls the particular function according to the request type

We need KPIs—Calculations based on PLC data

```
"measurementTemplates": [ { {
   "metricName": "OEE_last15min_shift_1",
   "metricTypeId": "025d7ffe-86db-4421-b5d6-f2267fe72f82",
      "formula": {
            "expression": "(target_cycle) * (part_io) / (running_time)",
            "variables": [{
                  "name": "target_cycle ",
                  "value": "latest_target_cycle_time",
                  "type": "METRIC“
            },{
                  "name": "part_io",
                  "value": "parts_io_last15min_shift_1",
                  "type": "METRIC“
            },{
                  "name": "var_running_time",
                  "value": "running_time_last15min_shift_1",
                  "type": "METRIC“
            }
]}
```

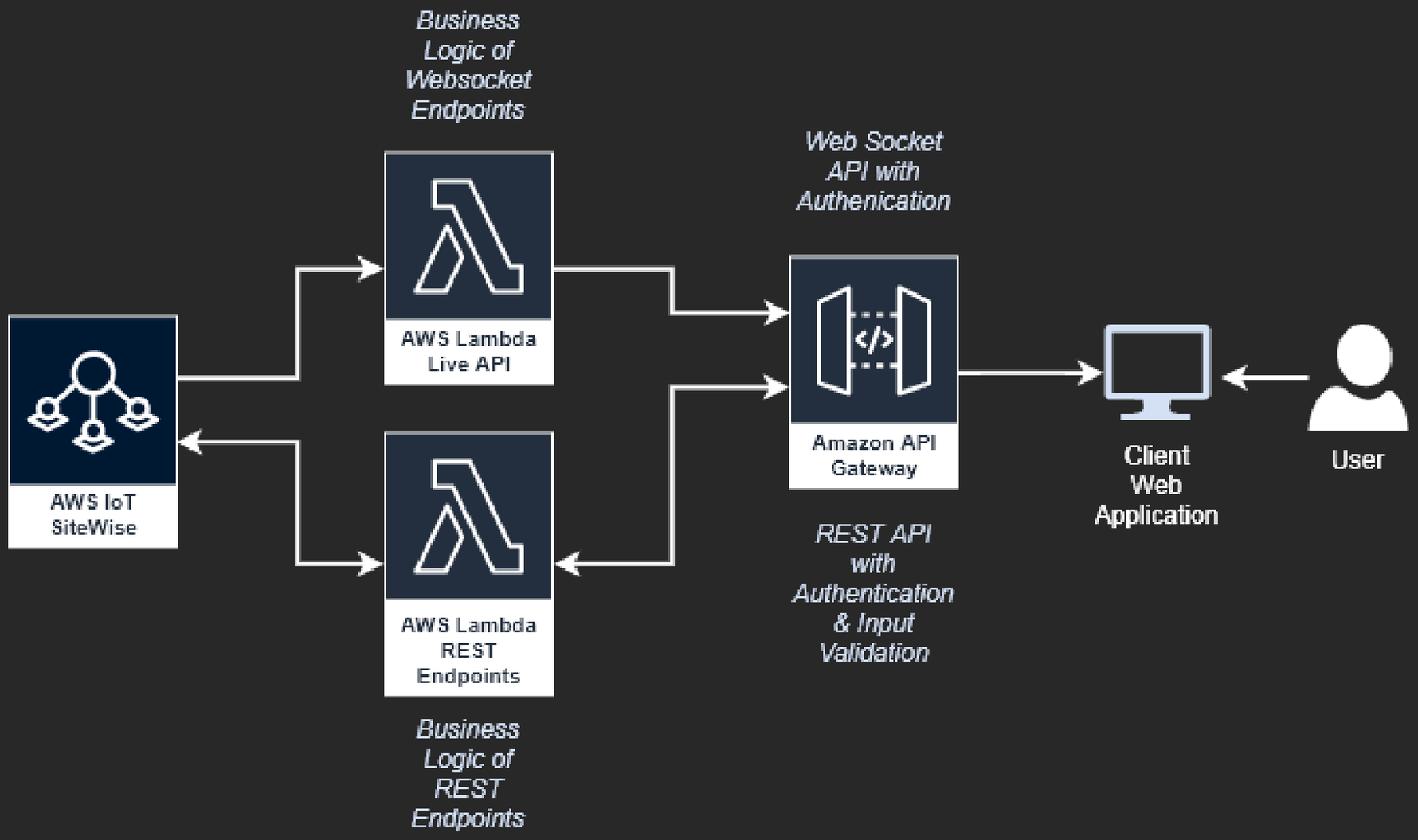
Overall equipment efficiency of last 15 minutes for trend calculation

Measurement latest(var_time)

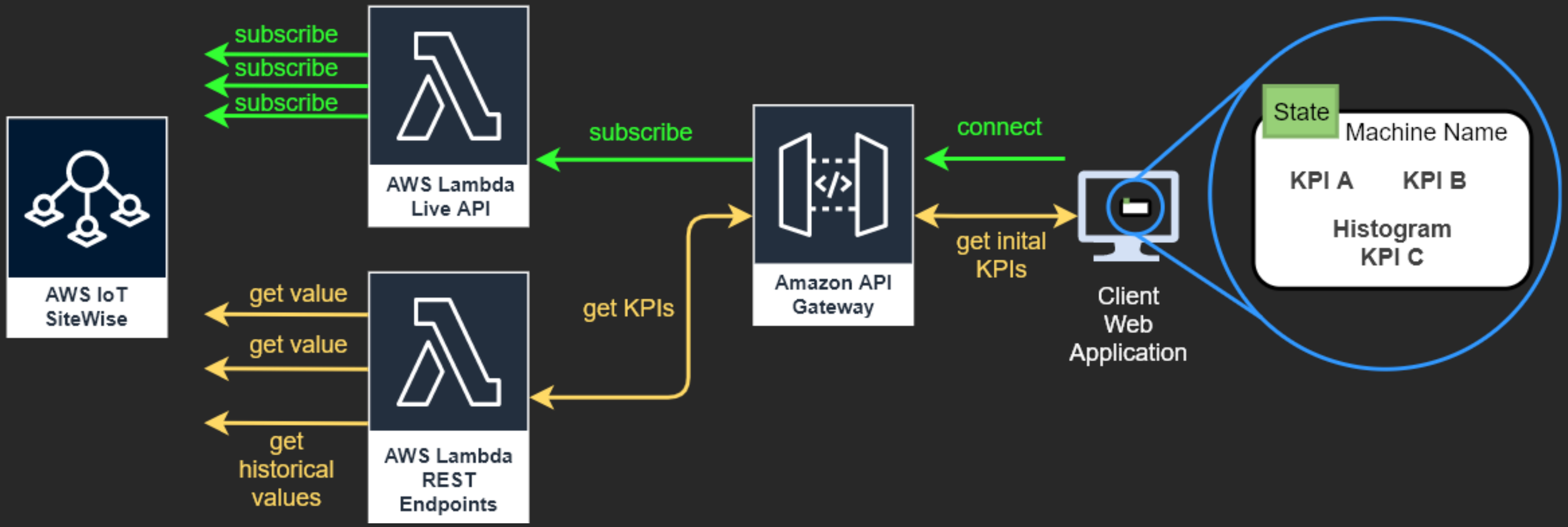
Measurement (latest(var_part_val)) - (earliest(var_part_val))

Measurement (var_autotime) + (var_manual_time) - (var_failure_time)

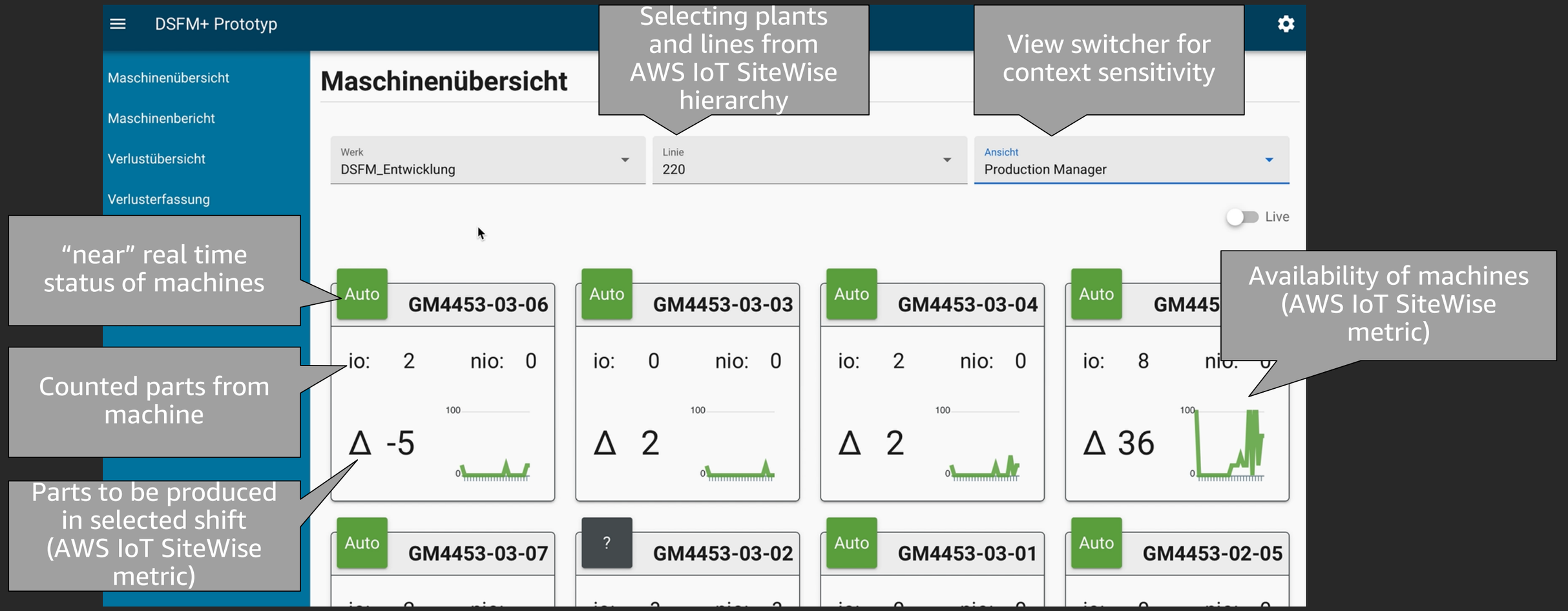
From AWS IoT SiteWise to frontend—API integration



Details: AWS IoT SiteWise API integration



Transparency across the line—Machine dashboard



Platform architecture

The foundation digital platform spans key production and supply chain capabilities

DPP Production Equipment Tier

OT-IT Gateway

OPCUA Server

OPC UA

MQTT Broker

MQTT

Data Transformation

Fieldbus Connectors

DPP Industrial Edge Tier

Edge Gateway

AWS IoT SiteWise

AWS IoT Greengrass Connectors

OT-IT Infrastructure Services

Plant Cloud

AWS Outposts

DPP Plant/Edge Services

On-prem Applications

AWS Direct Connect

DPP Enterprise Cloud

DPP Application Landing Zone

DPP Use Case Application Framework

DPP Data & Service Catalogs

API Gateway

DPP Services

AWS Lambda

Amazon QuickSight

Amazon EKS

Authentication

AWS IoT SiteWise
IIOT Data/Metrics

AWS IoT Analytics
Data Prep & Analysis Pipeline

AWS IoT Events
Event Detection & Response

AWS IoT Core
Secure Broker

Amazon S3 + Lake Formation
Data Lake & Storage

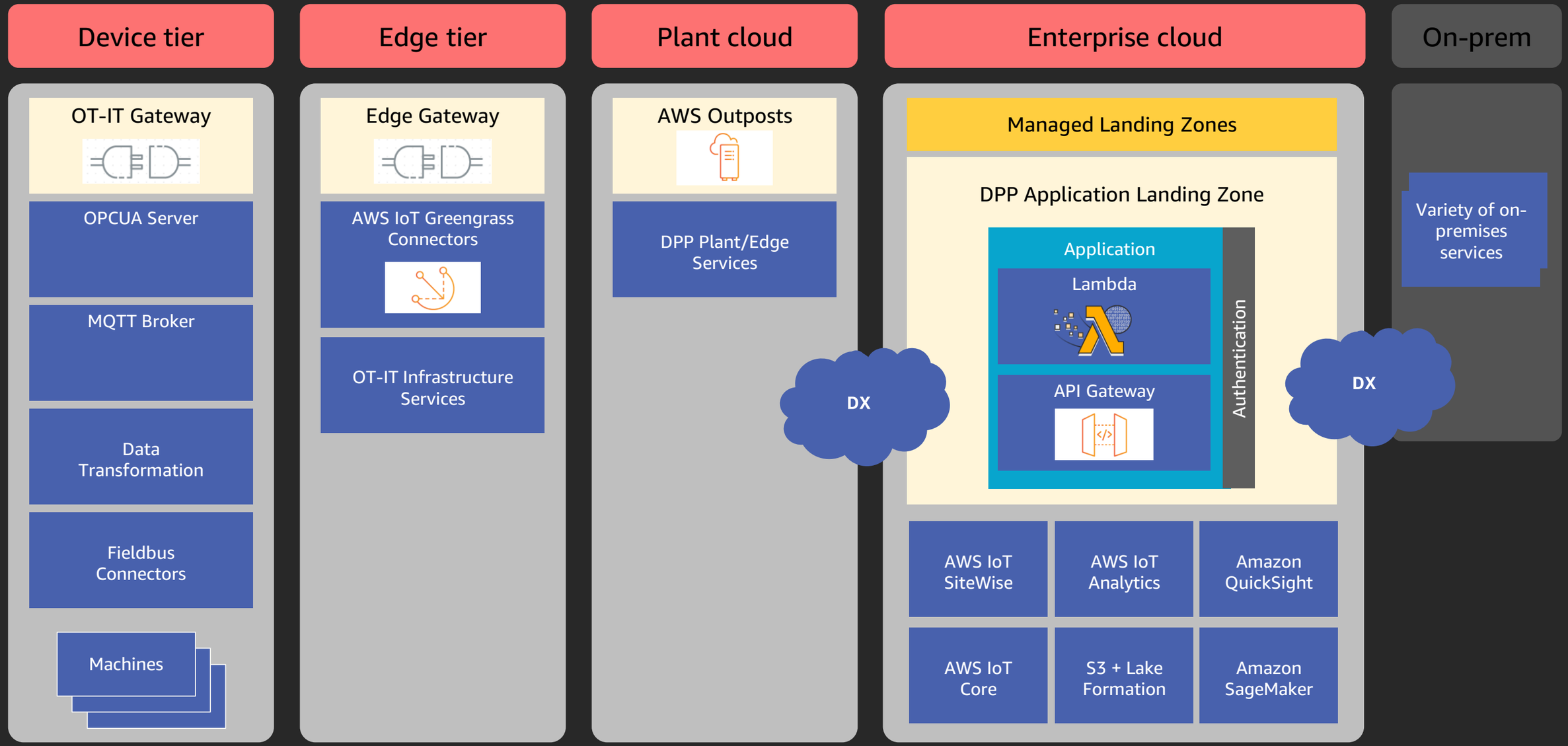
Amazon SageMaker
ML Training

Managed Landing Zones

On-premises

Variety of on-premises services

While the platform delivers key capabilities …



Q&A

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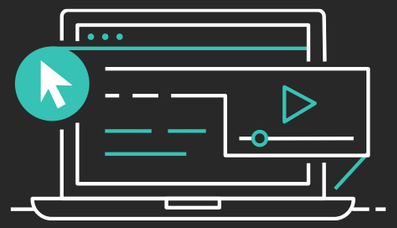

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