AWS re:Invent

TLC305

Industry 4.0 with mobile edge network services powered by AWS Outposts

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Our journey over the last 3 years

2017

Dedicated
edge networks services with
AWS IoT Core and AWS IoT
Greengrass

2018

Machine learning
with dedicated edge
and private LTE networks

2019

Dedicated edge networks
at scale, powered by
AWS Outposts

Agenda

- Industry 4.0 and the role of edge computing
- Understanding the problem statement
- Defining the solution approach w/ AWS Outposts
- Dive deeper into the architecture
- Lessons learned

Industry 4.0 and the role of Edge Computing

AWS re:Invent

aws

Industry 4.0 is transforming industrial processes

IoT brings sensors, machines, cloud computing, analytics, and people together to improve productivity and efficiency

Manufacturing

Mining

Oil & gas

Agriculture

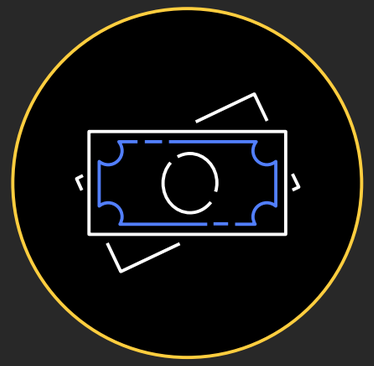
What are customers telling us?

Convergence of business, process, and government standards like Industry 4.0 and Society 5.0

Mass production

↓

Mass customization



Buy

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Lease

Pay upfront

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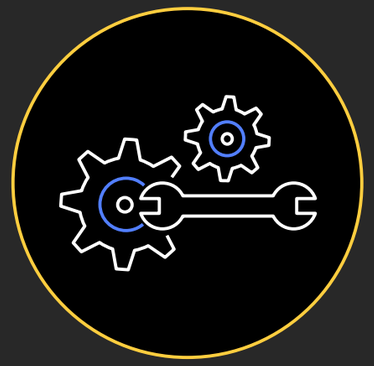
Pay as you go



Manual

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Automatic

Important industrial application use cases

Predictive maintenance

Predictive quality

Asset condition monitoring

Oil and gas customer explores anomaly detection

Problem

Inability to access IoT data, teams operated independently using on-premises software

Solution

AWS IoT Core processes data from field assets, enriches it, and stores it in a time-series optimized data store

Impact

Build and train predictive models
In the future, will deploy them on devices

Predictive maintenance

Predictive quality

Asset condition monitoring

Predict crop quality

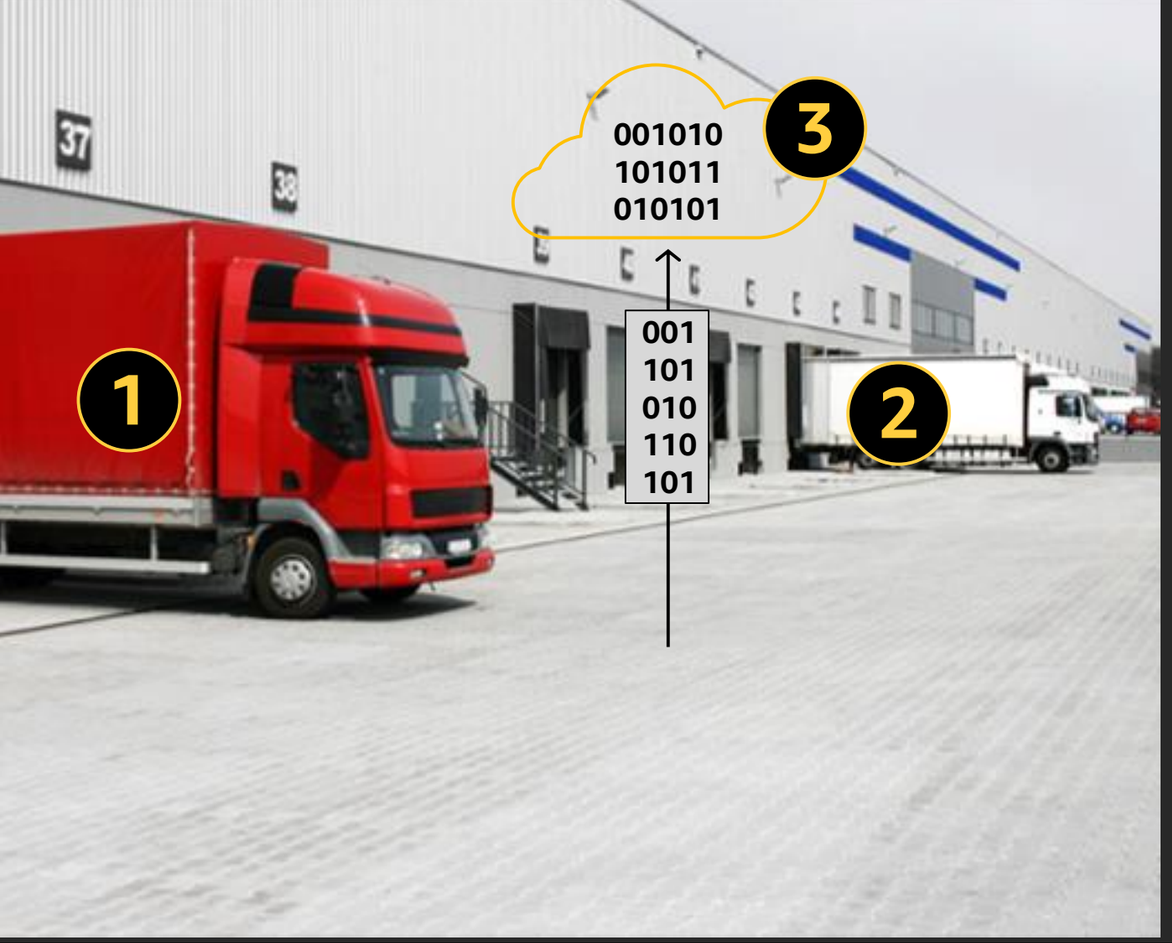
1. Soil sensors measure PH, moisture, nutrients, and gases

2. AWS IoT Analytics enriches soil sensor data with geolocation, rainfall, and weather information and predicts crop health and quality. Makes suggestions on watering and fertilization schedule to increase crop yield

Predictive maintenance

Predictive quality

Asset condition monitoring



Optimize truck loads

1. Sensors measure truck weight and idle time
2. Model powered by AWS-enabled device and alerts loading crews of changes to packing mix
3. AWS IoT Analytics collects truck data and builds a model to predict the most efficient load for location of truck over time. Sends updates to the model back to the AWS IoT Greengrass enabled device

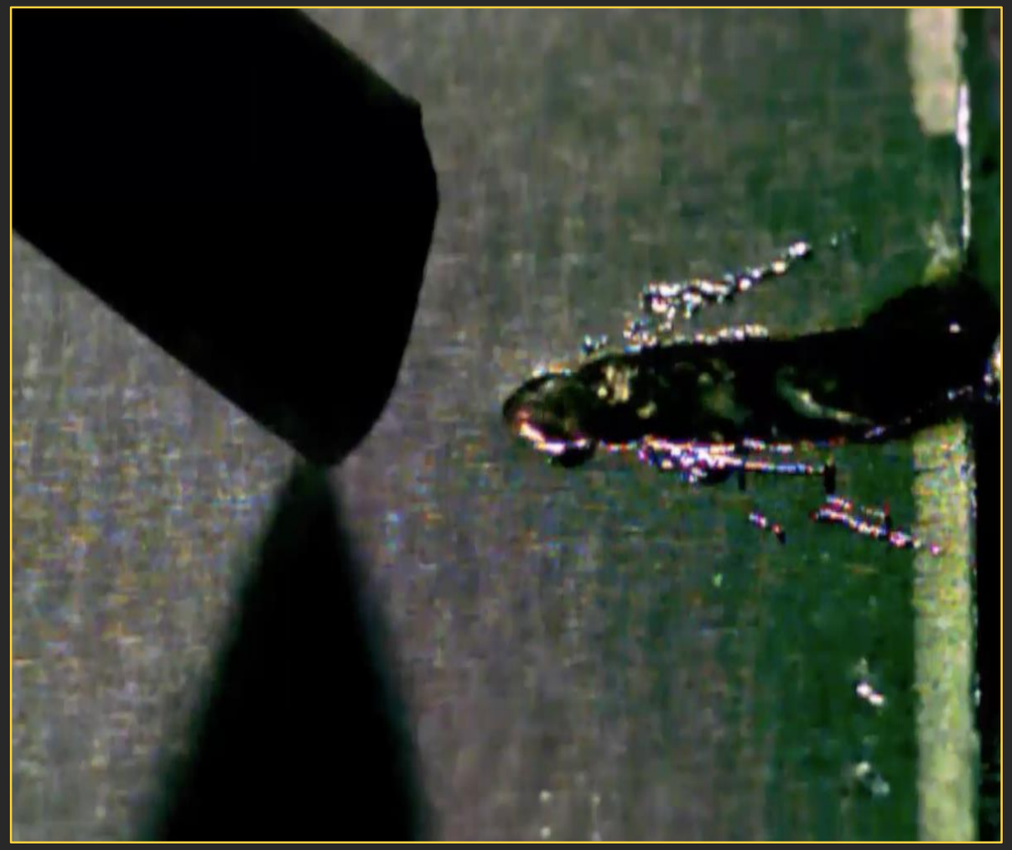
Predictive maintenance

Predictive quality

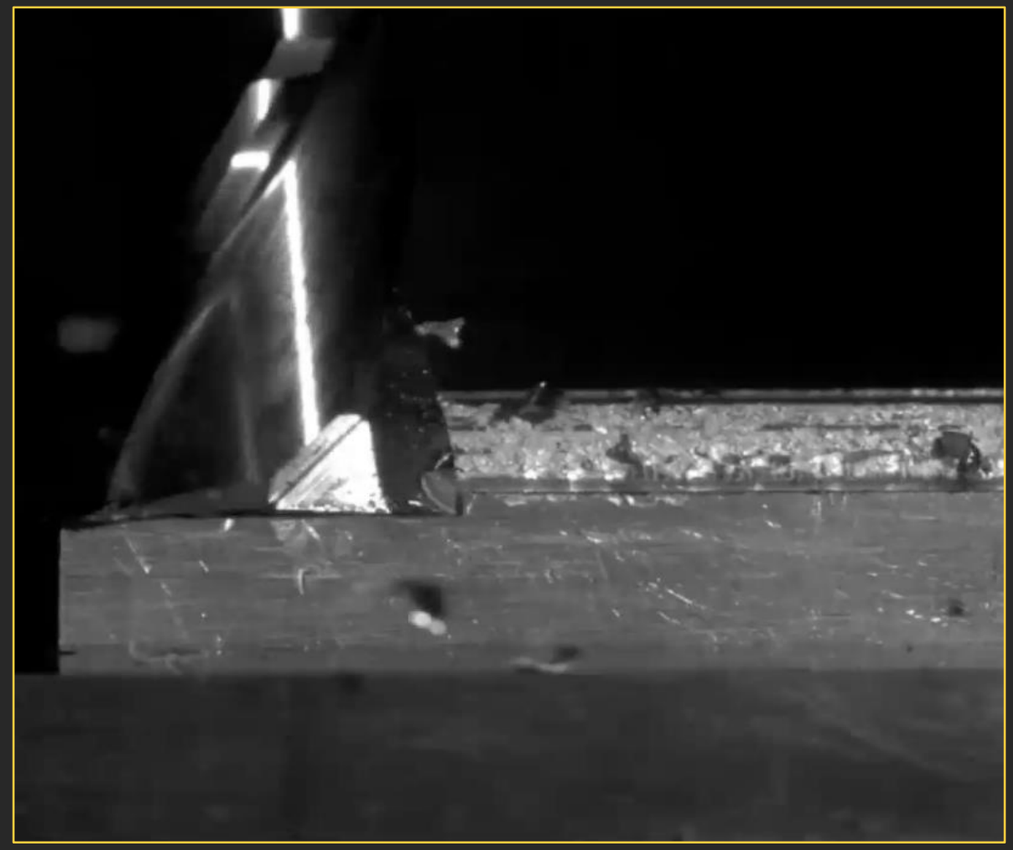
Asset condition monitoring

Closed loop machine control—use cases

Laser based cutting



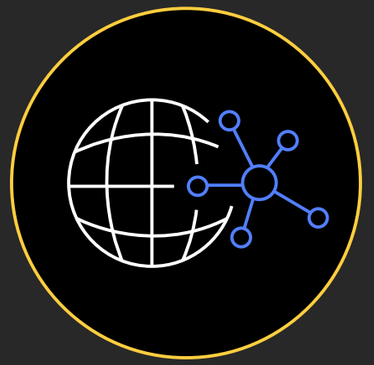
Milling operation



Challenges faced by customers

Security

Keep devices and data secure



Connectivity

Operate at top performance with local mobility, even in remote locations

Legacy equipment

Onboard Greenfield and Brownfield devices

Reliable, low latency and high-performance services

Why dedicate edge networks for Industry 4.0?

Industrial use cases is an emerging solution to millions of locations globally

WiFi does not scale	Time to set up networks	Optimize operational cost

Industry private LTE networks' total connected devices will grow from more than 150 million devices in 2017 to 750 million by end of 2023

Enterprise clients use conventional wireless network connectivity, which is not scalable, high performing, and secure, to deliver IoT use cases

Key industry verticals	Number of sites globally
Transport venues and ports	50,000
Military bases	10,000
Warehouses	3,300,000
Industrial and manufacturing	10,710,000
Oil and gas	8,000
Power generation	47,600
Water utility plants	140,000
Mining	54,000
Hospitals and labs	263,000

Source: Harbor Research, The Private LTE/5G Opportunity for Industrial and Commercial IoT

What do I need to create dedicate edge mobile network at industrial locations?

What if I need dedicated edge networks for 100s of locations?

Solving for dedicated edge networks at scale

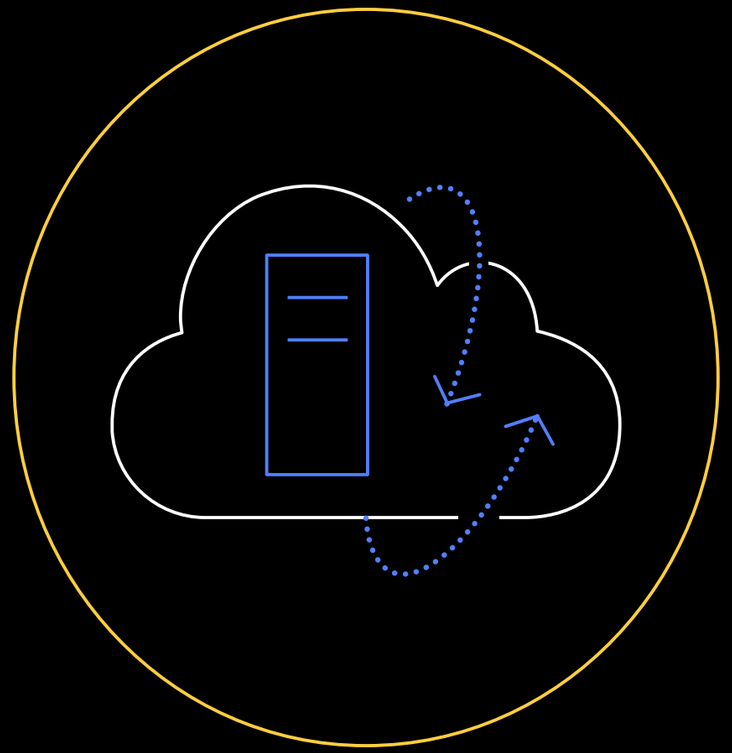
1. Extend 4G and 5G virtual network functions to the edge
2. Planning, orchestration, and management for dedicated edge networks
3. Extend industrial ISV solutions to the edge
4. Make it easy for customers to identify devices for dedicated edge networks

AWS Outposts for Dedicated Mobile Edge

AWS Outposts

- Consistent AWS experience with AWS designed infrastructure for security and performance
- Seamlessly extend AWS services to your premises and access regional AWS services
- Fully managed and updated as part of AWS Regions with a single point of service and support

Build once,
deploy anywhere



Bring the cloud experience to your premises

Same infrastructure

Same AWS-designed hardware and virtualization for high performance and security

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Same programming interface and deployment tools

Standard AWS CLI and SDK. Same deployment tools as in the cloud: AWS CloudFormation templates, AWS Elastic Beanstalk, AWS Cloud9

Same APIs

Build using familiar APIs, as Outposts maintains a unified control plane in the Region for both Outposts and AWS Cloud

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Same monitoring and automation

Amazon CloudWatch Metrics, AWS CloudTrail, and other reporting capabilities enabled

AWS services available on Outposts

Compute & Storage
Amazon EC2 instances and EBS volumes

Secure Networking
Amazon Virtual Private Cloud (Amazon VPC)

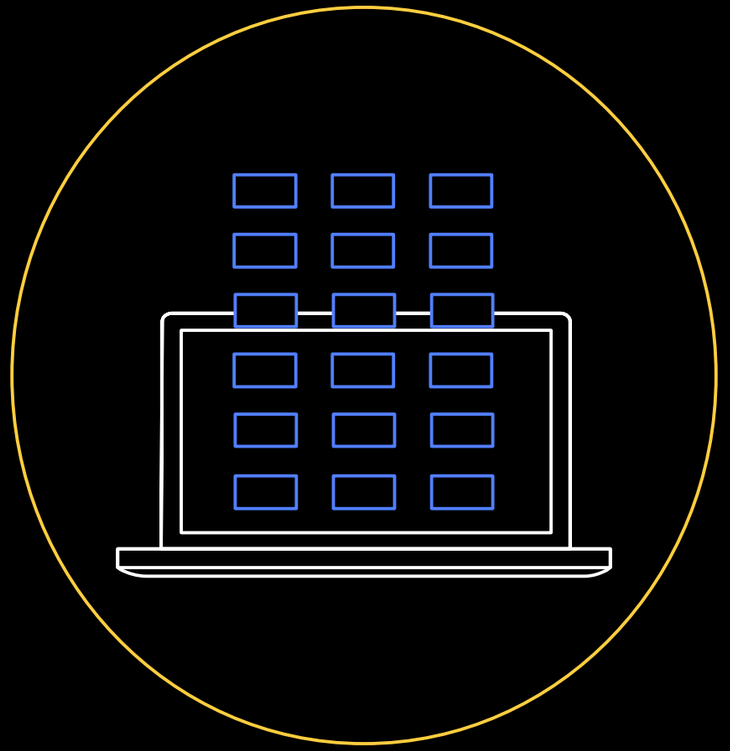
Database
Amazon Relational Database Service (Amazon RDS)

Containers
Amazon Elastic Container Service (Amazon ECS) and Amazon Elastic Kubernetes Service (Amazon EKS)

Data Processing
Amazon Elastic Map Reduce (EMR), Amazon Managed Streaming for Kafka (Amazon MSK)

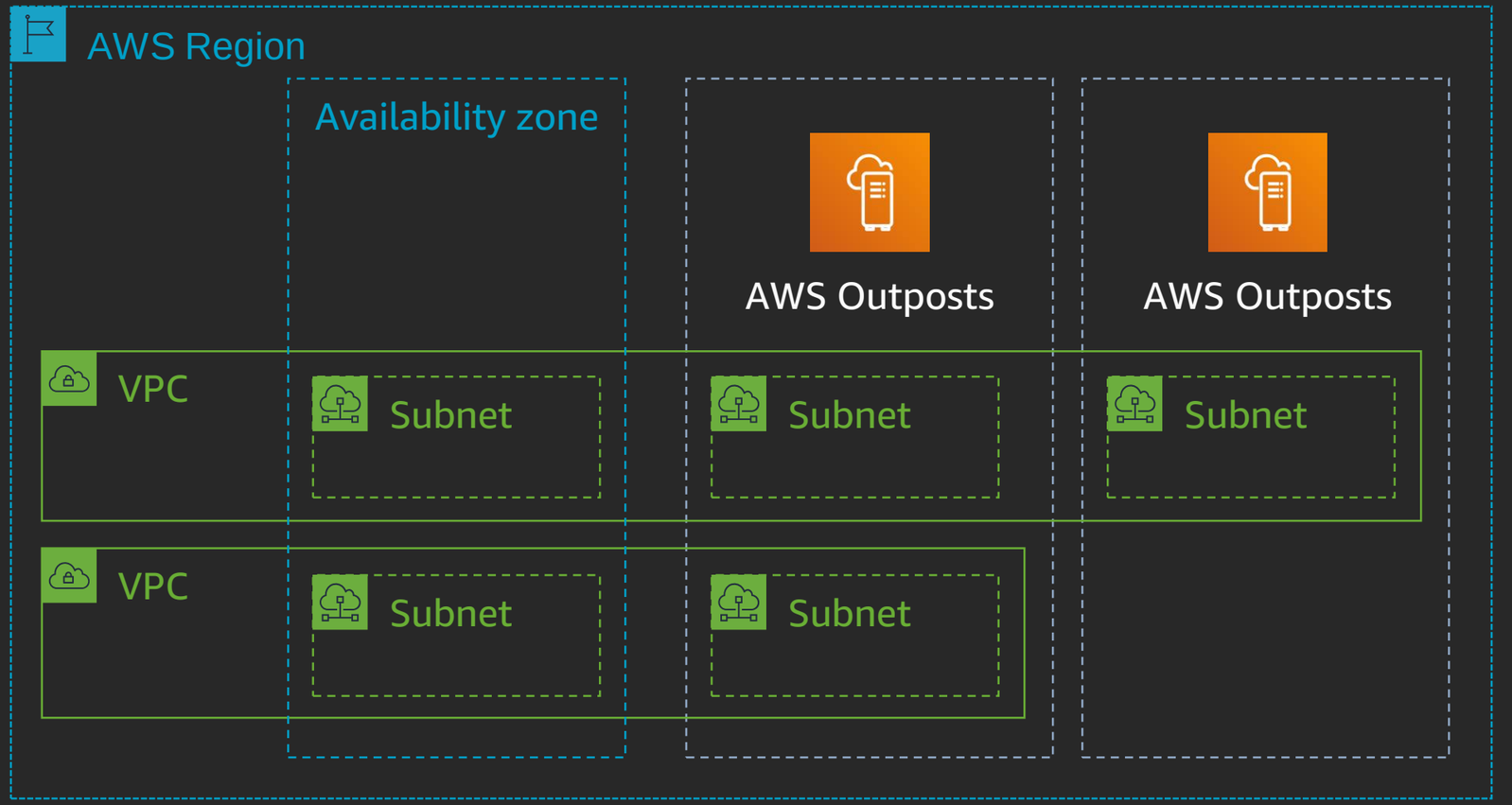
File System Processing
Amazon FSx

Machine Learning
Amazon SageMaker

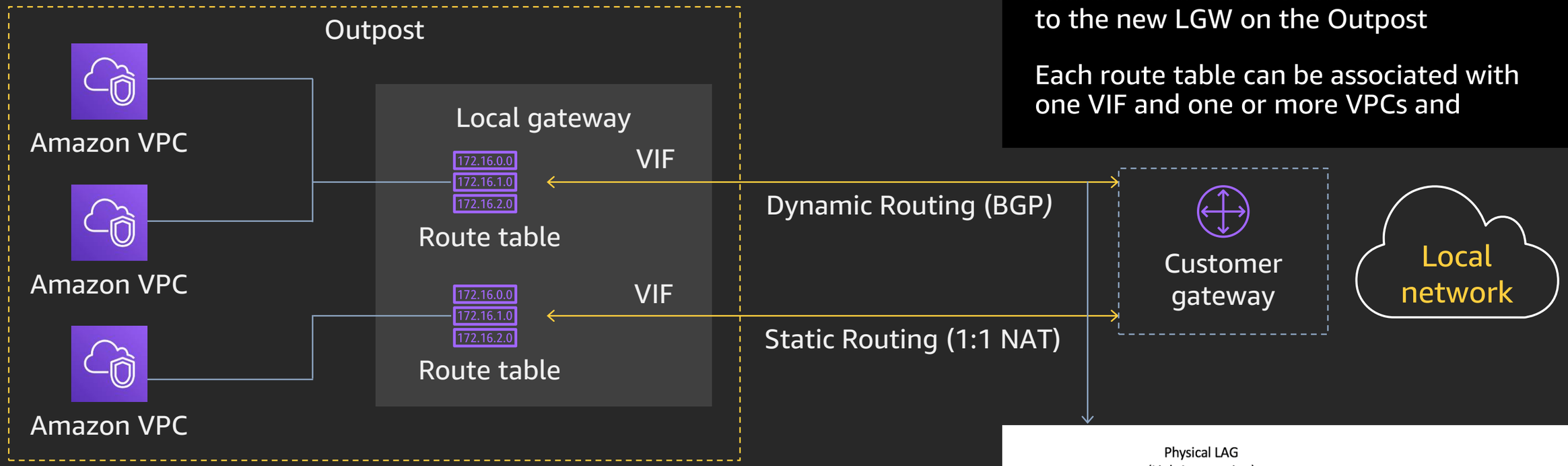


Seamlessly connect your Regional and Outpost environments

Extend your existing VPC experience to the edge



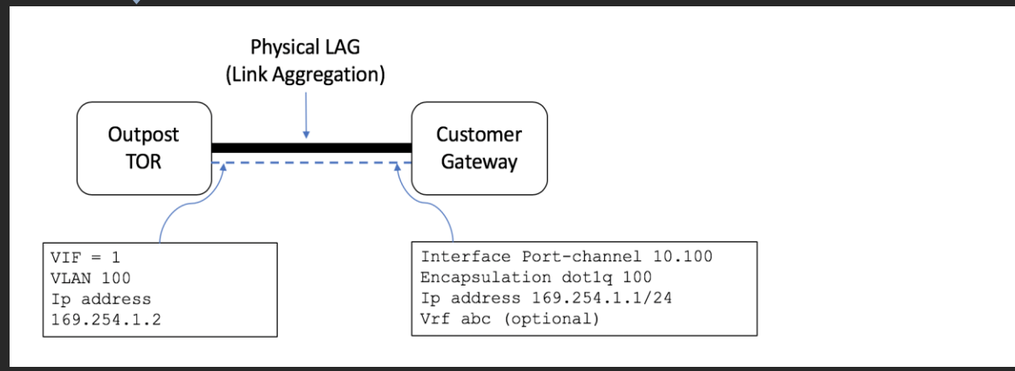
Connecting Outposts to local edge network



Attach one or more route tables to the new LGW on the Outpost

Each route table can be associated with one VIF and one or more VPCs and

Destination	Target
10.0.0.0/16	Local
0.0.0.0/0	IGW–11aa22bb
192.168.10.0/24	LGW–1a2b3c



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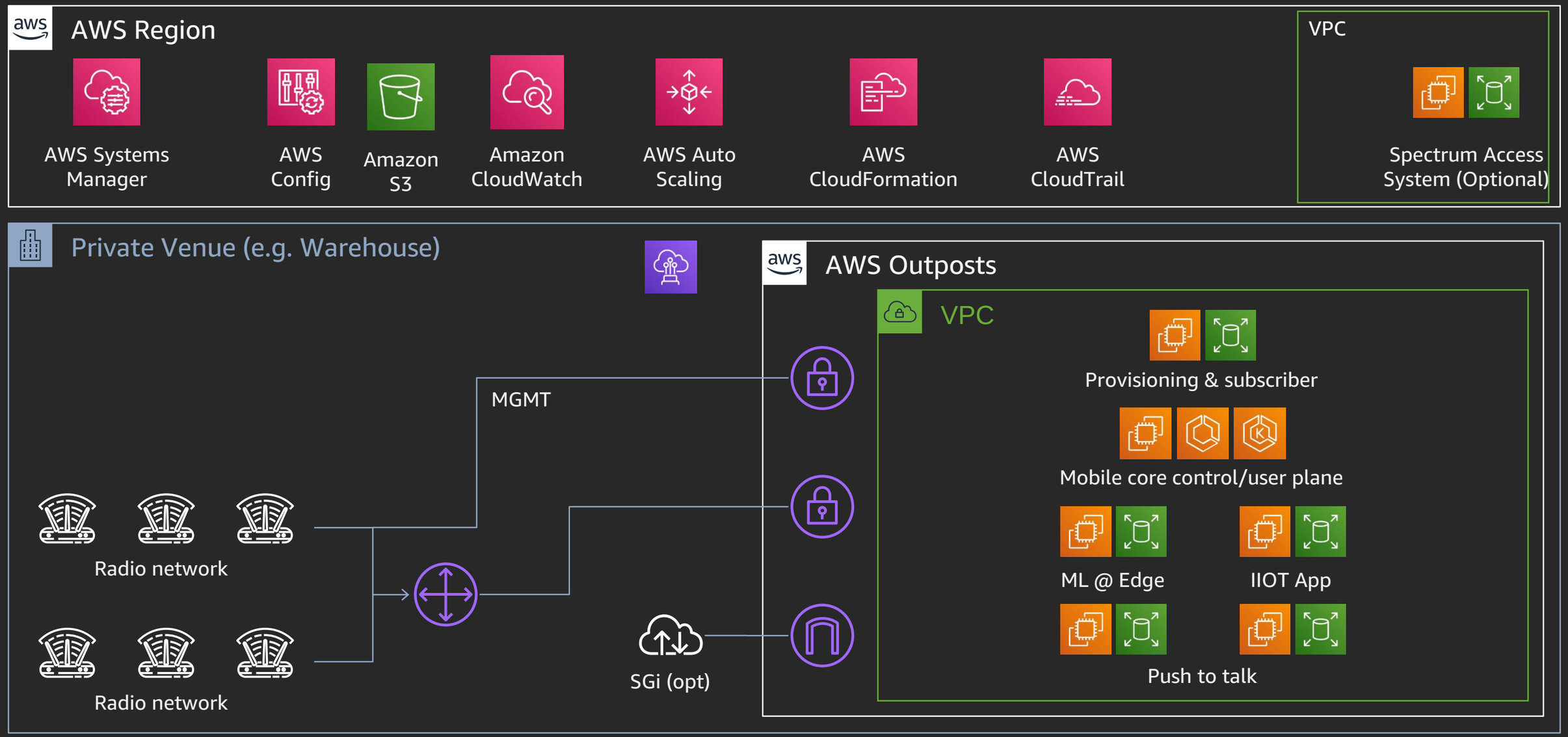
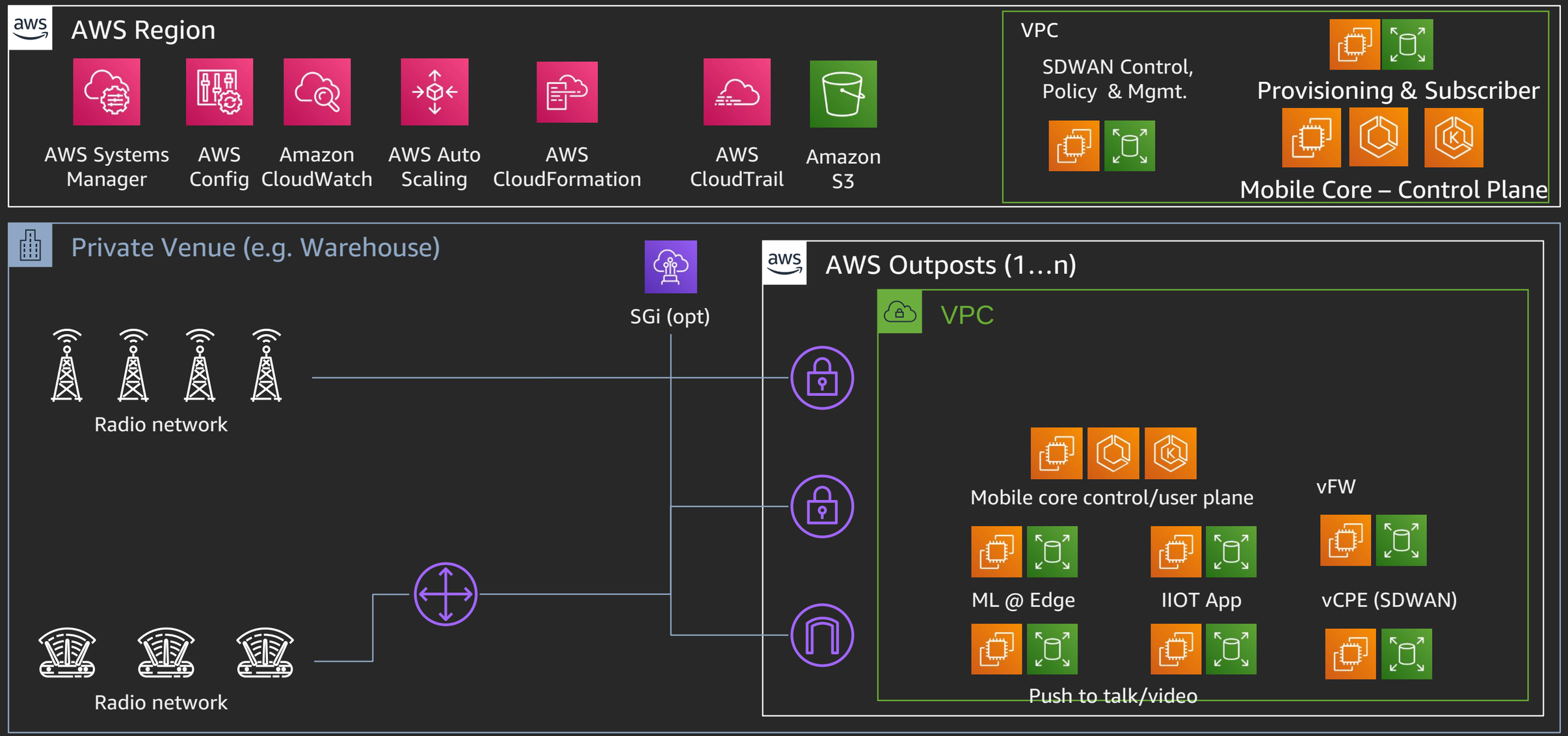
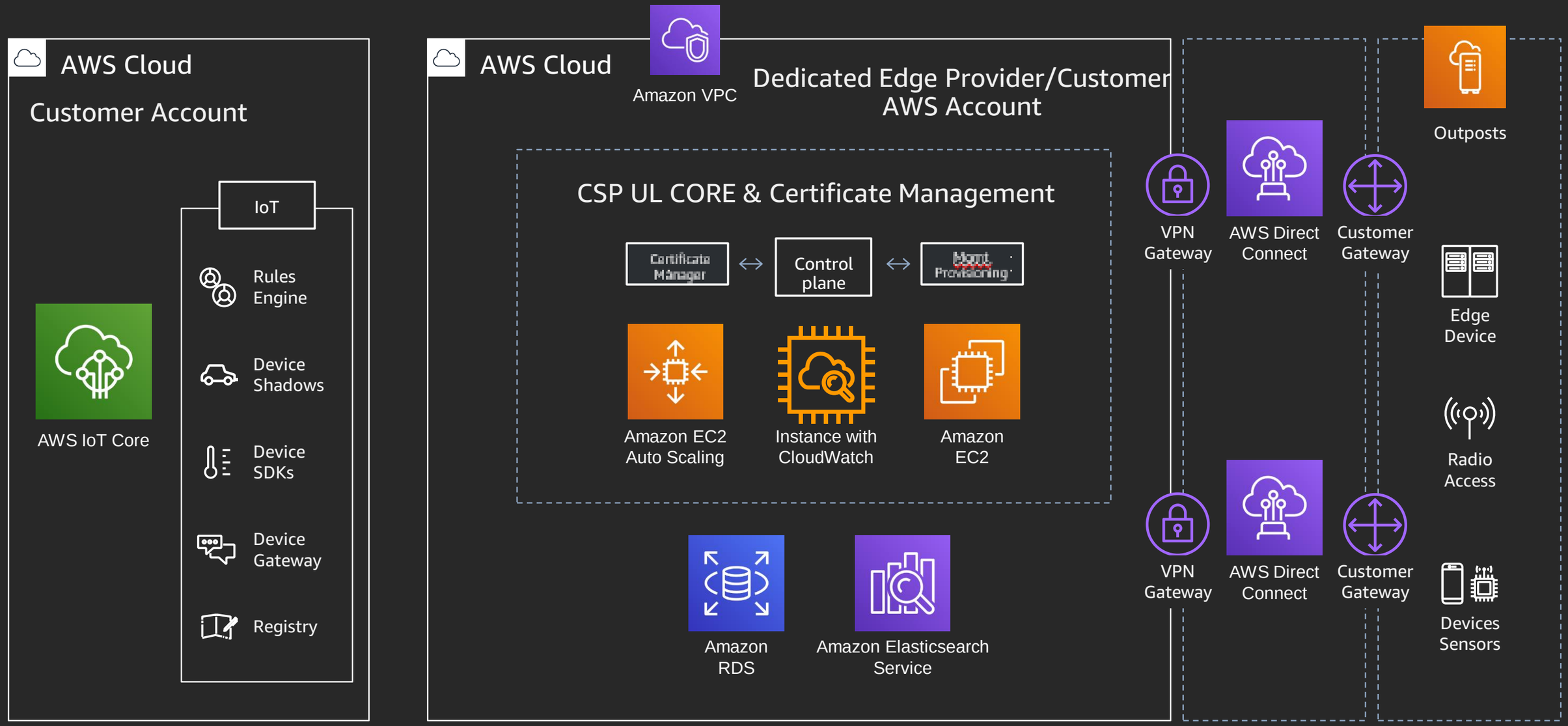
Dedicate Mobile Edge architecture: Single site



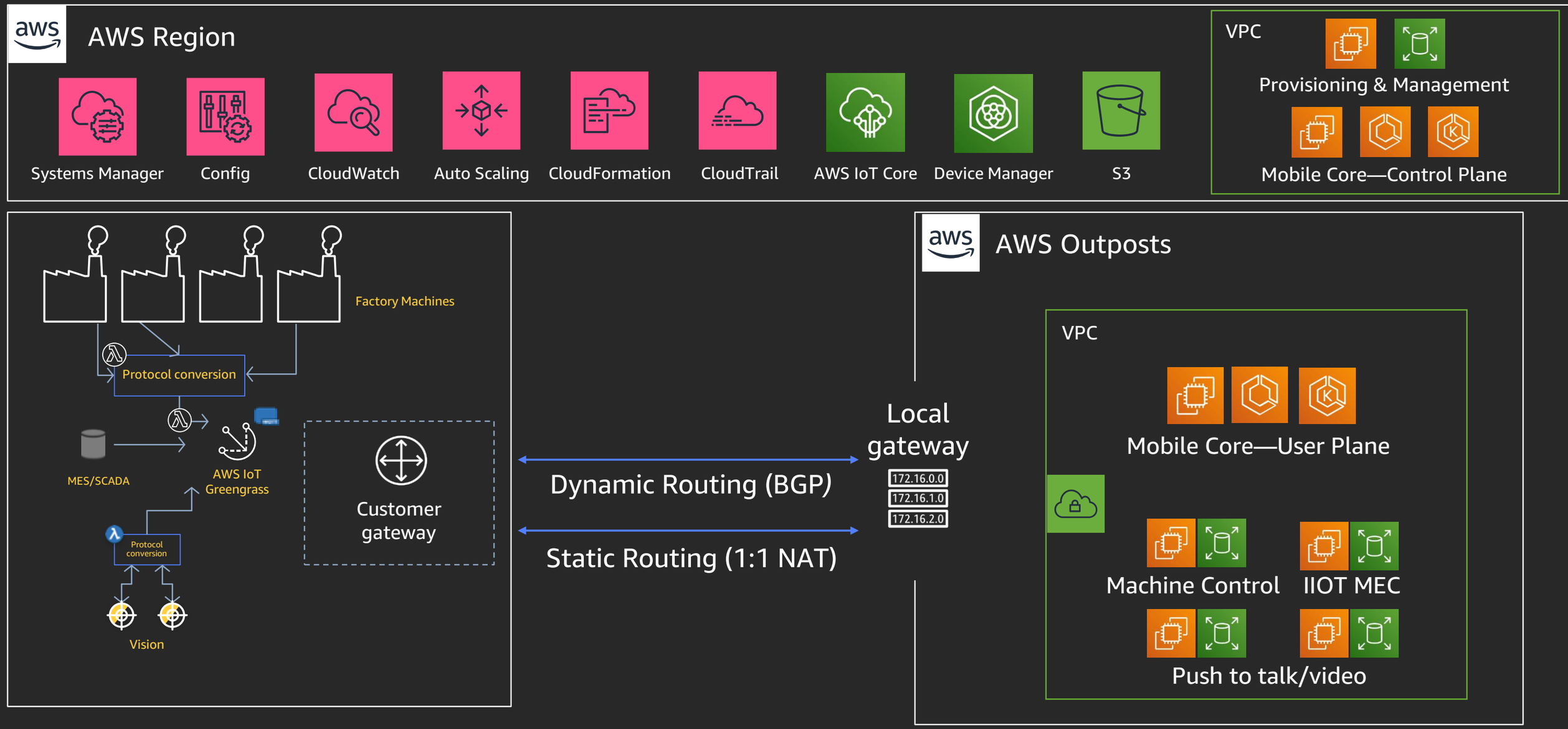
Dedicated Mobile Edge architecture: Multi-site



Dedicated Mobile Edge architecture: IoT Integration



Dedicated Mobile Edge architecture: IoT integration



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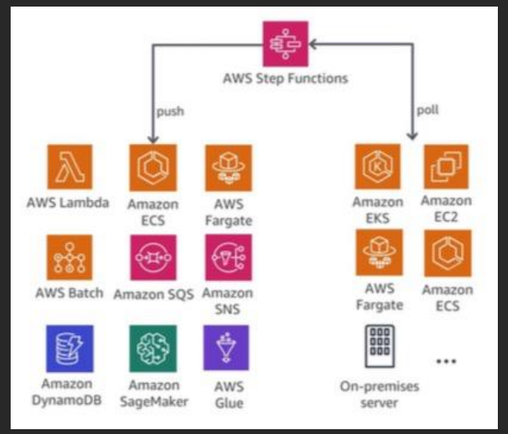
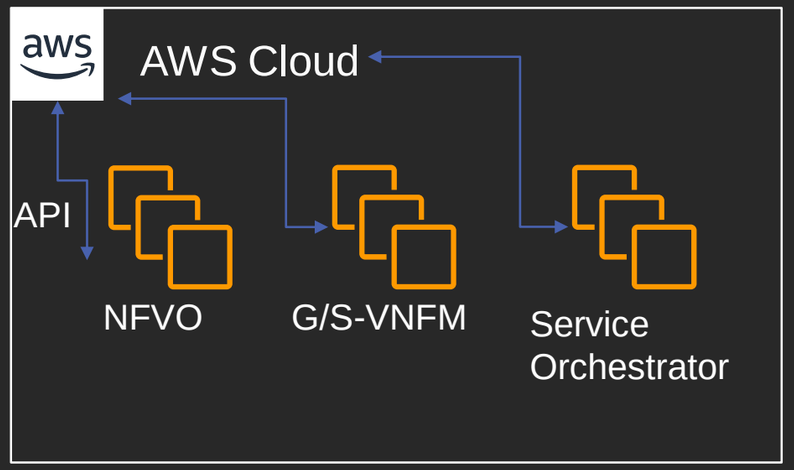
Orchestration Approaches for Edge

AWS Native Tools



Cloud Native Orchestration

Hosting NFVO/VNFM on AWS with API Interworking



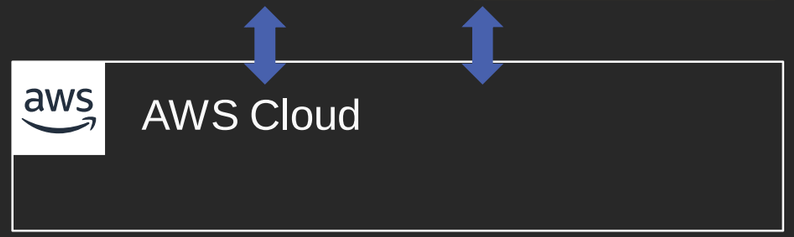
MANO model with AWS service integration
AWS provides NFVI & VIM layer and other automation tools

Using 3rd Party Orchestration Platforms

NOKIA

ONAP
OPEN NETWORK AUTOMATION PLATFORM

Open Source MANO



Using ONAP or OSM, w/ positioning AWS as NFVI and VIM layer

Network Service Orchestrator: AWS Service Mapping

Key Functions by ETSI MANO	AWS Services
On-board Network Service	AWS Service Catalog
Instantiate Network Service	AWS Service Catalog, CloudFormation
Scale Network Service	Amazon EC2 Auto Scaling, Lambda
Update Network Service	Config, Config-rules, Systems Manager (Run Command)
Terminate Network Services	Amazon EC2 APIs & Console

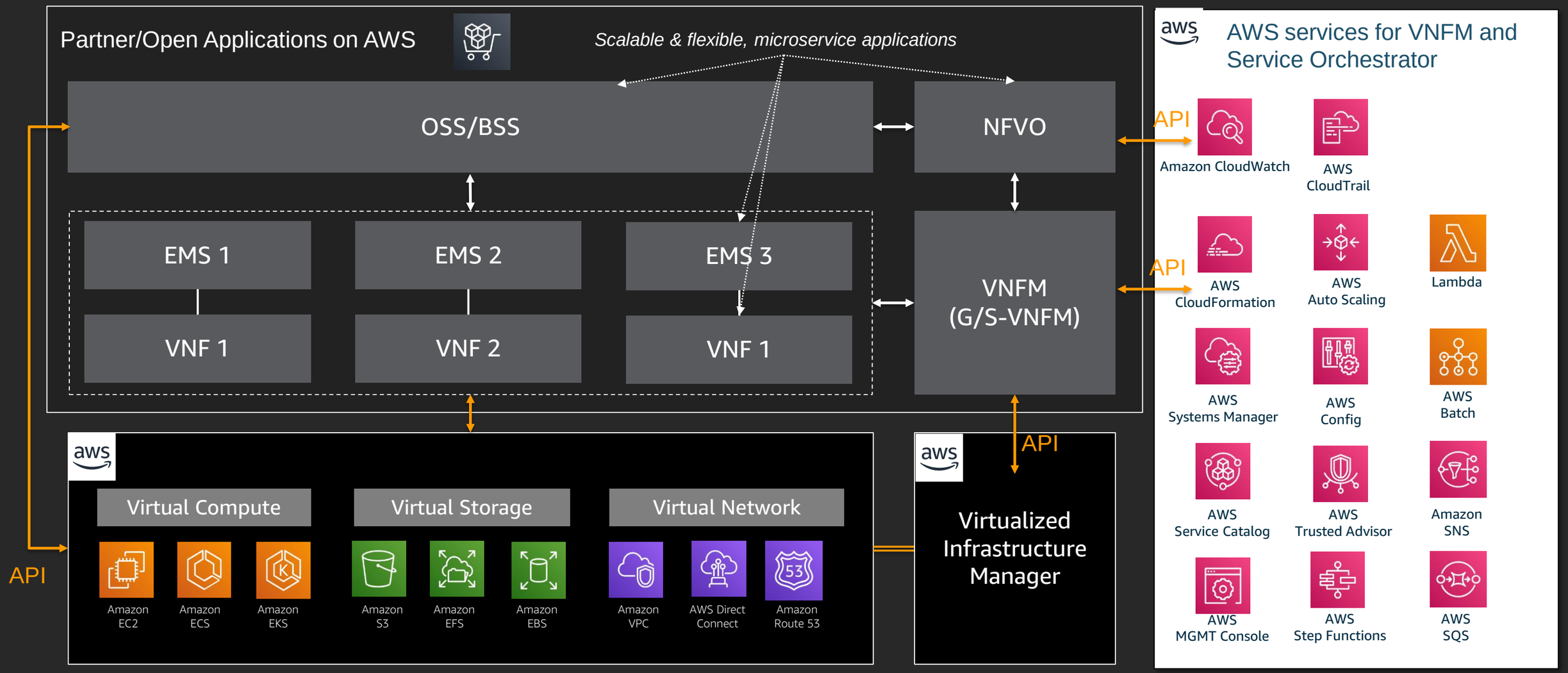
VNFM Requirements: AWS Service Mapping

Key Functions by ETSI MANO	AWS Service
Instantiate VNF (create a VNF using the VNF on-boarding artefacts)	CloudFormation EC2 API's & Console
Scale VNF (increase or reduce the capacity of the VNF)	AWS Auto Scaling, Lambda
Update and/or Upgrade VNF (support VNF software and/or configuration changes of various complexity)	Systems Manager (Patch and Run)
Terminate VNF (release VNF-associated NFVI resources and return it to NFVI resource pool)	Amazon EC2 APIs & Console

VIM Requirements – AWS Service Mapping

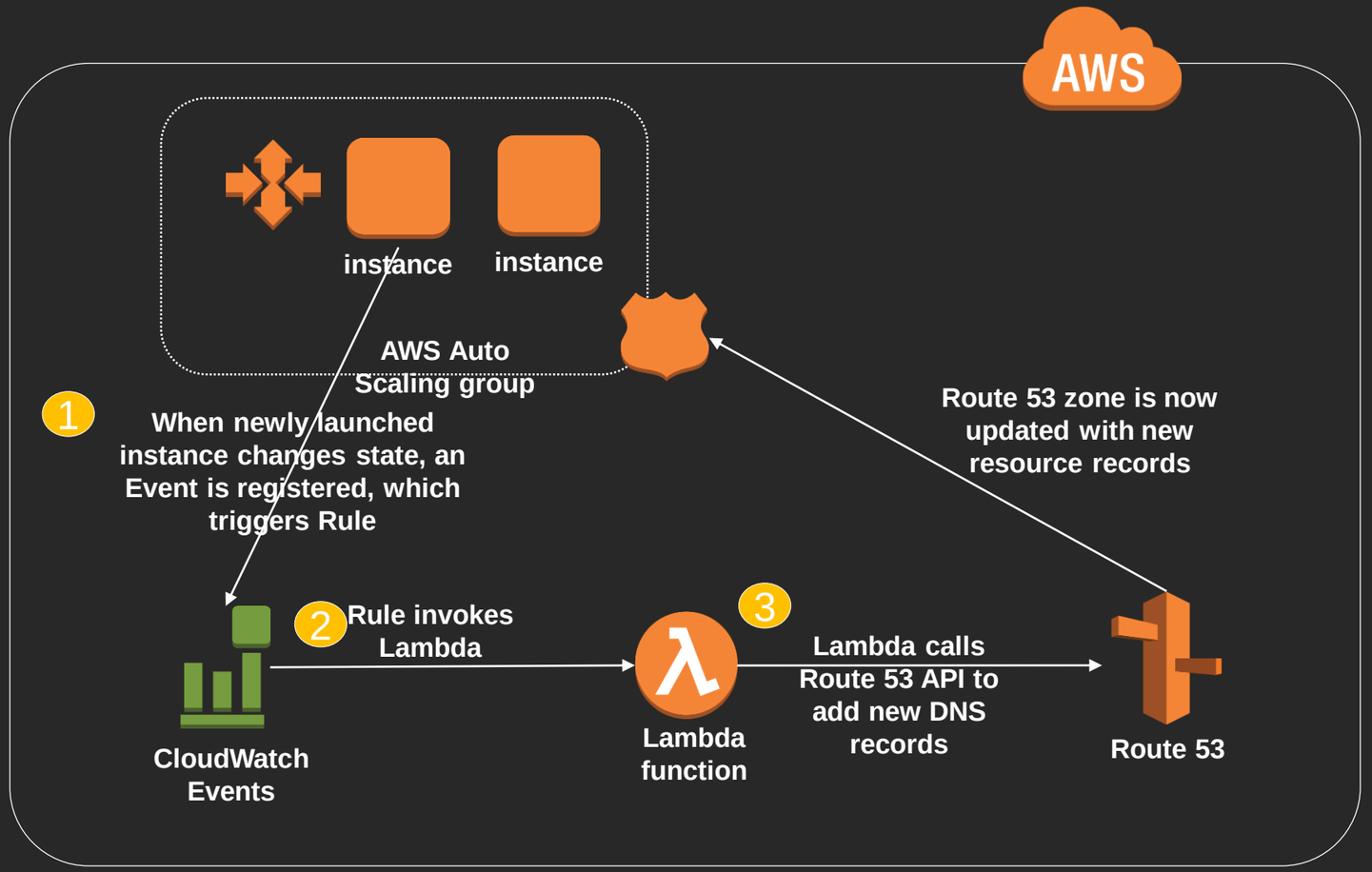
Key Functions by ETSI MANO	AWS Service
Discovery of available services	Amazon EC2
Management of virtualized resources availability/allocation/release	Amazon EC2
Physical and virtualized resource fault/performance management	Amazon EC2
Terminate VNF (release VNF-associated NFVI resources and return them to NFVI resource pool)	Amazon EC2

Carrier-grade Telco Orchestrator on AWS



Event-driven scaling of network service: Example

Event-Driven Orchestration using CloudWatch Events & Lambda



Use Case: Event-driven Scale-Out

Auto-scaling Scale-Out Policy triggers CloudWatch Events when instances change state after launch

Event is configured with a rule to invoke a Lambda function

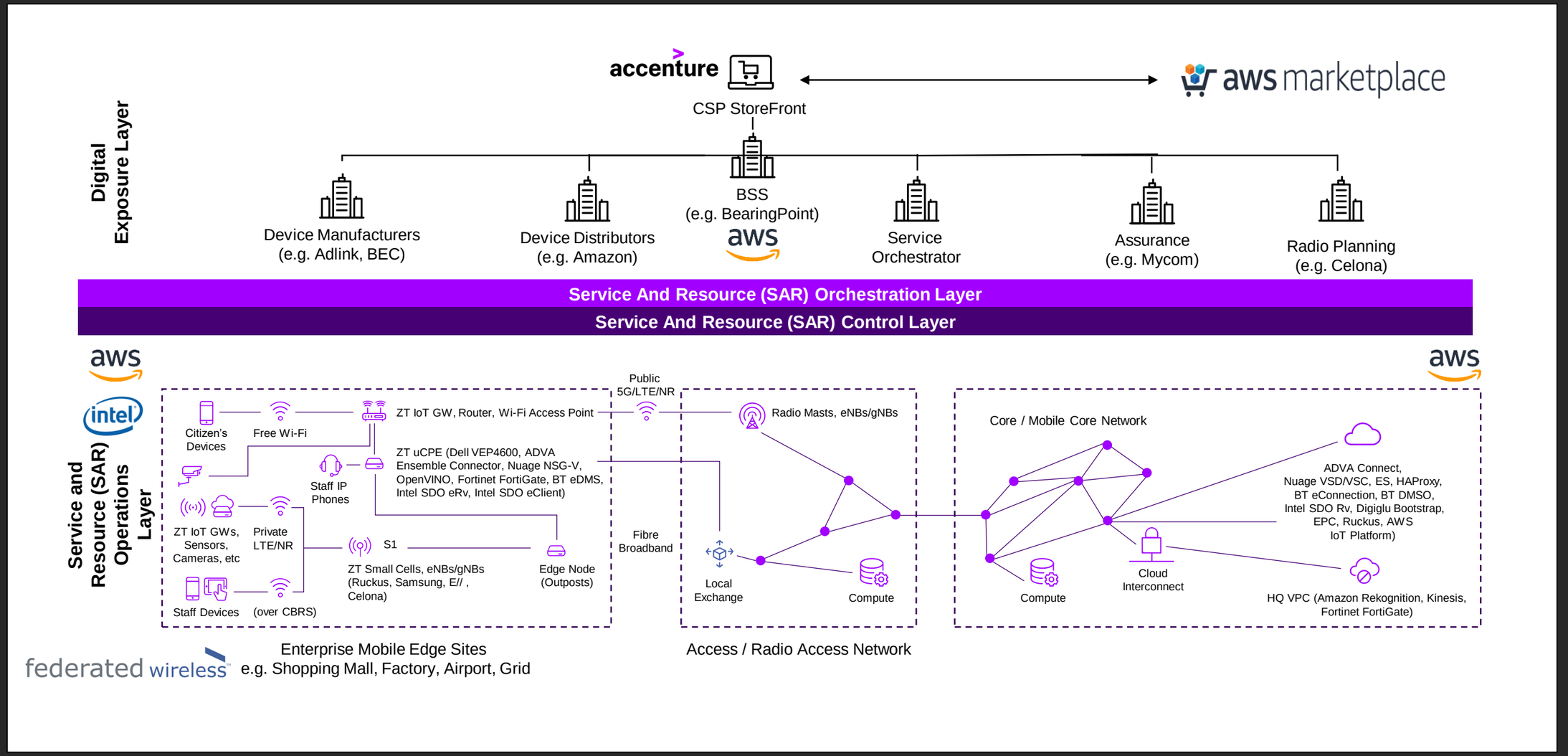
Lambda function handler checks if state change is from pending to “Running,” then updates Route 53 to add DNS A Records to reflect new instances in auto-scaling cluster

Alternatively use startup and shutdown scripts

Digital Exposure & Monetization

Digital Exposure Layer for CSPs to Monetize Edge

Plan to provision; Order to Cash; Trouble to Resolution



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Autonomous Industrial Robotics

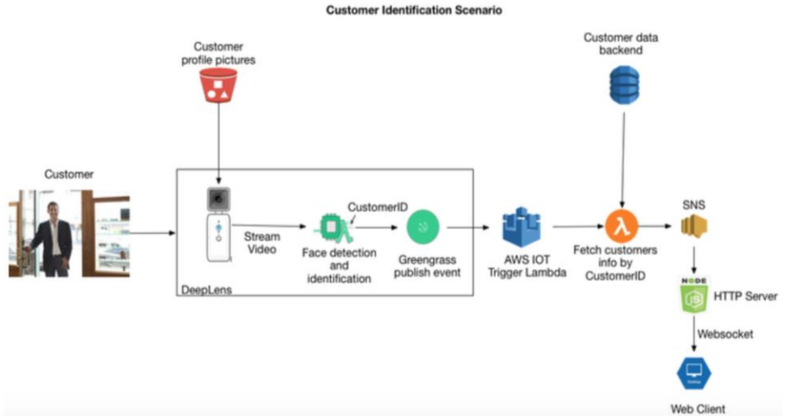
Canvas @ re:Invent 2019

Industrial applications at Telecom Lounge

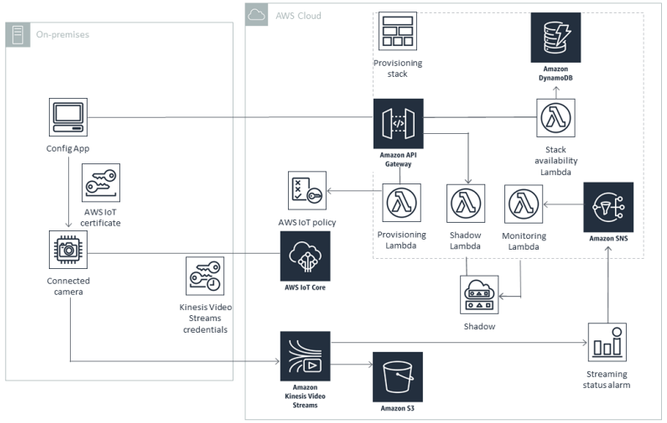
Smart conveyer belts

- Amazon FreeRTOS (Machine Control)
- AWS IoT Greengrass (Machine learning @Edge)
- Amazon Sumerian (Machine management)

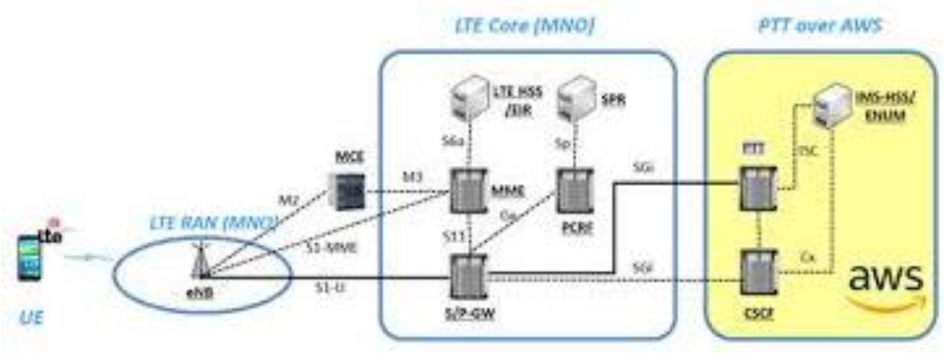
Biometric authentication



Video Surveillance



Push To talk



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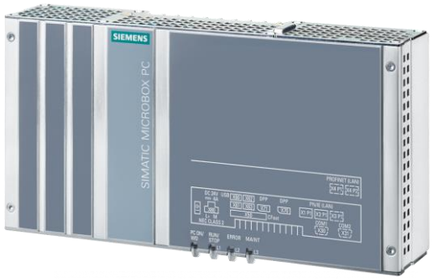
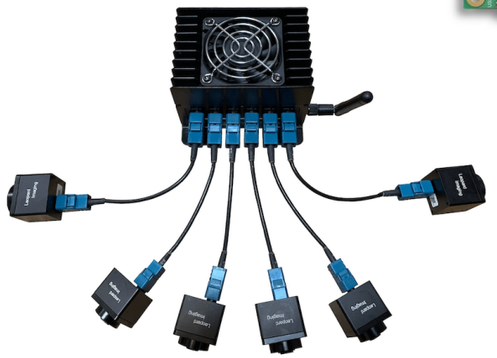
Multiple IoT devices
for dedicated edge networks
including LTE, LTE-M &
Wi-Fi devices:
https://devices.amazonaws.com/





Lessons Learned

- It is no longer about single venue, factory, or warehouse: think 100s of industrial locations for dedicate private edge solutions
- AWS Outposts enable you to
  - Extend Industrial ecosystem for dedicated/private edge for machine control
  - Implement virtual network functions (4G & 5G) across AWS Regions and edge locations
  - Extend cloud native orchestration & management of network and applications seamlessly to edge
- Remember all the other building blocks including AWS IoT Greengrass, FreeRTOS to integrate end to end solutions
- Digital Exposure layer enables Telecom Operators to monetize CBRS, MulteFire, LAA, sXGP
- AWS IoT Partner Device catalog is an important mechanism to locate the right device for your use case

Visit Telecom Lounge at MGM for Telecom happy hour at 3:30 PM today!

Thank you!

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