Possibilities

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5G Mobile Edge Computing

Opportunities and Challenges

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DGTL-BRKSPM-2020

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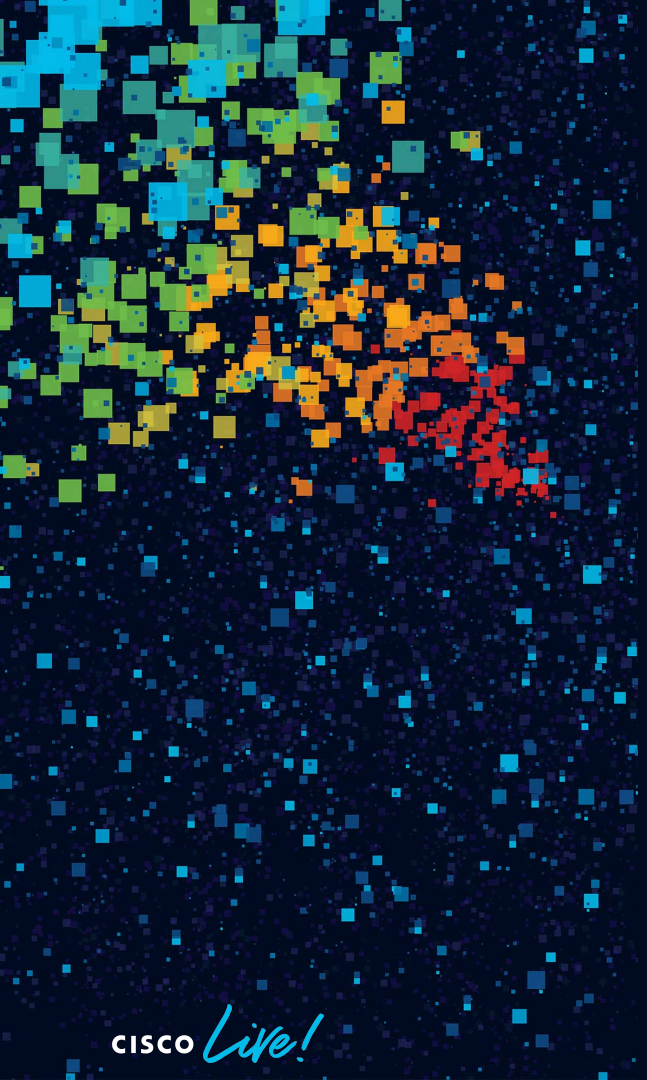


Agenda

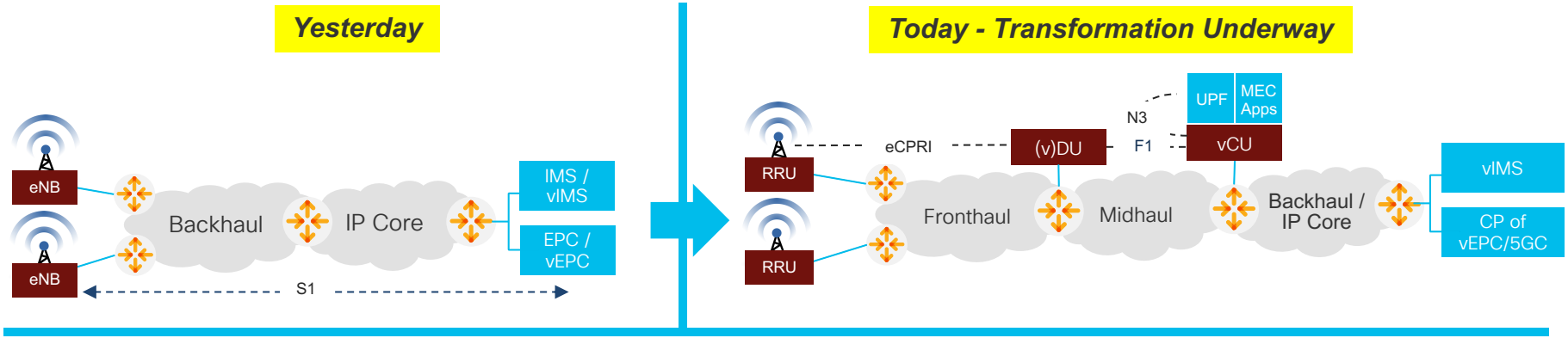
- SP Edge: what, why, where and when
- Inside Edge DC: NF deployment options
- MEC platform: standards and reality
- MEC 4G to 5G transition
- Mobility and transport challenges

Service Provider Edge

- What is SP Edge
- Why do the SPs need it
- Where is an optimal placement for it
- When should it be introduced

Introducing Service Provider Edge

Mobile Architecture Transformation



Mobile Core and RAN Decomposition
Flexible and Optimal Placement in the Network
RAN and Core Converging at the Edge

EPC: Evolved Packet Core
5GC: 5G Core
IMS: IP Multimedia Subsystem
MEC: Multi-access Edge Computing
UPF: User Plane Function
CP: Control Plane
DU: Distributed Unit
CU: Centralized Unit

SP Benefits: 5G Brings New Use Cases

FWA: Fixed Wireless Access
VR: Virtual Reality
V2X: Vehicle to everything

Throughput

Latency

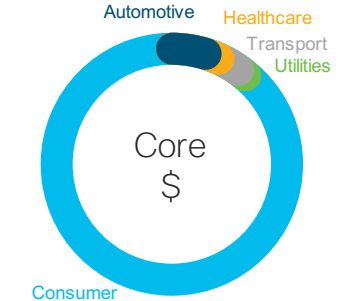
High Density

FWA
- 5G-Only
- No Mobility
- >4Gbps

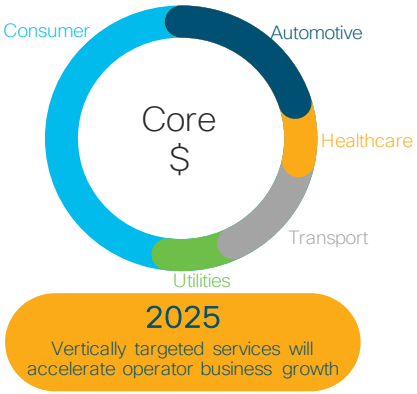
V2X
- 4G/5G
- Ultra Reliable
- Low Latency

Mobile Internet
- 3G/4G/5G
- Mobility & voice
- 1-2 Gbps

Robotics/VR
- 5G & Limited Mobility
- High Data Rate
- Very Low Latency



Source: EU Commission



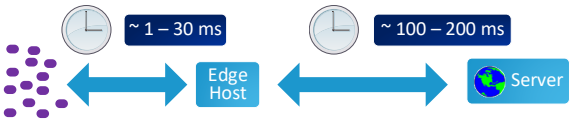
...and some of them are enabled by MEC

Multi-Access Edge Computing is an architecture principle of moving services closer to the user, at the edge of a network to enhance experience and enable delivery of low latency apps

Latency Reduction

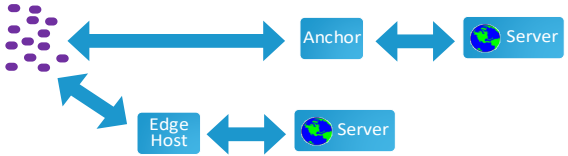
Data Reduction

Offload at Edge



Reducing latency between services and consumers will create a better QoE & allow for new B2B2X services

Edge nodes can perform data analytics (ML inference) to perform bandwidth reduction and/or compute offload compensating for less capable devices



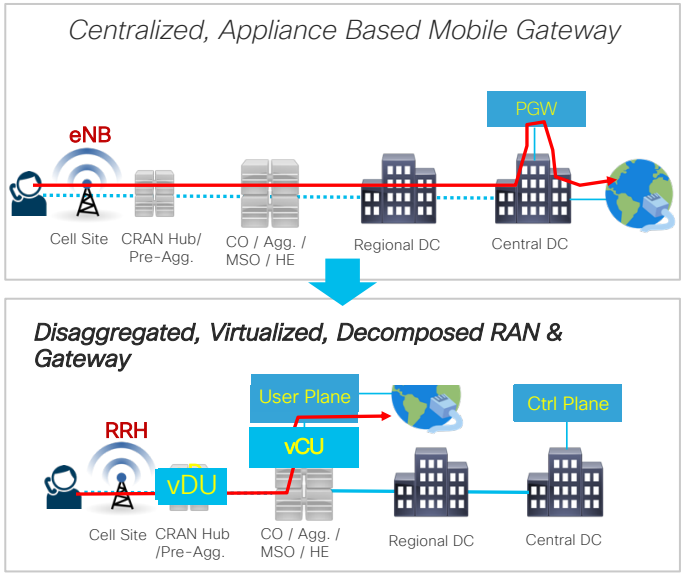
Edge offload will enable less expensive and lower latency path from the edge hosts towards the services

QoE: Quality of Experience
ML: Machine Learning

Architecture Transformation Enabling SP Edge

SP Edge Evolution

Virtualization | Decomposition | Placement



Central Office Transformation

NFV and SDN | DC Architecture & Economics | Cloud Agility

Transformation of the CO Architecture by applying NFV, programmability, SDN and DC-like design; to help bring economics of DC and Agility of Cloud at the CO

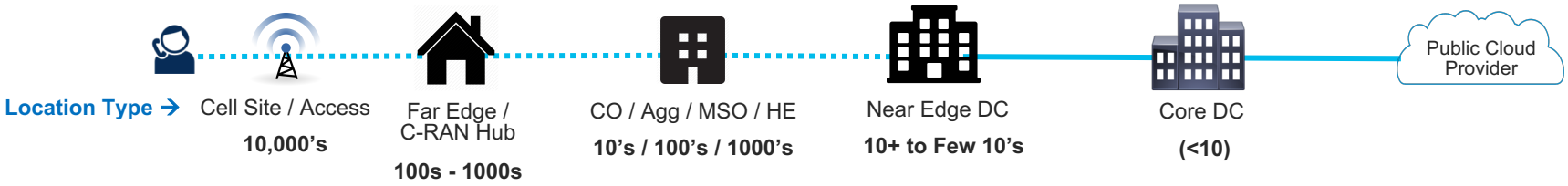
Edge Computing

Latency Reduction | Edge Offload | Data Reduction

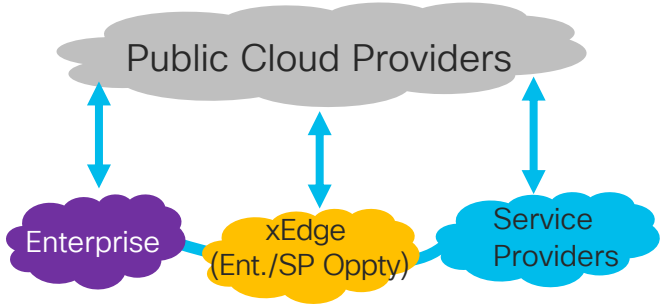
MEC is an architecture principle of moving services closer to the user, at the edge of a network to enhance experience and enable delivery of low latency apps

C-RAN: Cloud RAN
MSO: Mobile Switch Office
HE: Head-end
DC: Data Center
NF: Network Function

Edge DC Placement Options



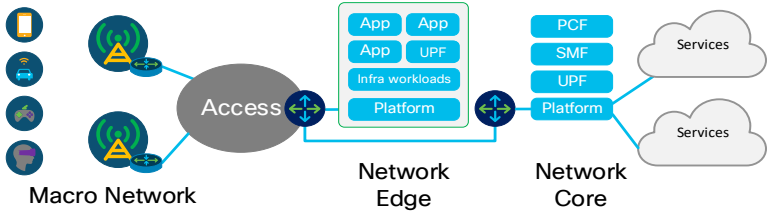
- Performance / Experience improvement
  - Shortest path to the subscriber for optimal experience
  - NF placement as a factor in the path
- Cost control
  - Farther from the Core DC means higher number of Edge DCs
- Public Cloud or Customer Prem placement options



- SPs moving to Cloud
  - Verizon, AT&T, T-Mobile…
- Cloud Providers entering Edge business
  - Amazon Outpost, Google Edge TPU, Azure

Two Types of Edge Computing Deployments for SPs

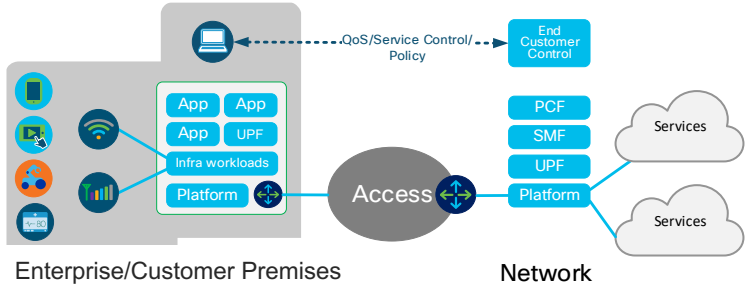
Network-Based Edge Computing



- The edge workloads are at a low latency location with respect to devices (a CO)
- Use cases can be consumer or enterprise but initially are infrastructure based
- Opportunities leverage the reach of the macro network

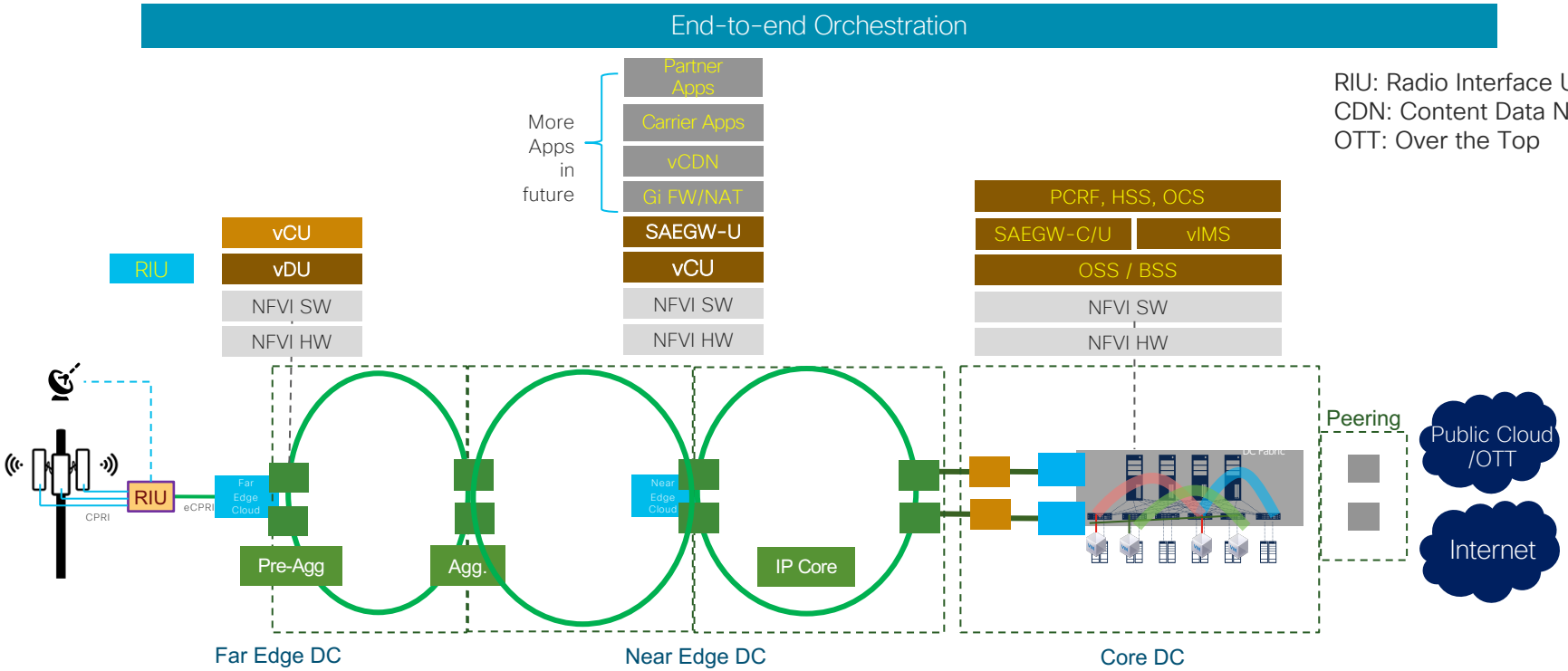
Our Focus Today

Premises-Based Edge Computing



- Places the edge workloads on the customer premises location
- Use cases are enterprise: factory automation, medical, corporate campuses & require domain expertise
- Private radio (licensed or unlicensed) is a significant part of the operator opportunity

Application Placement – Edge and Core DCs

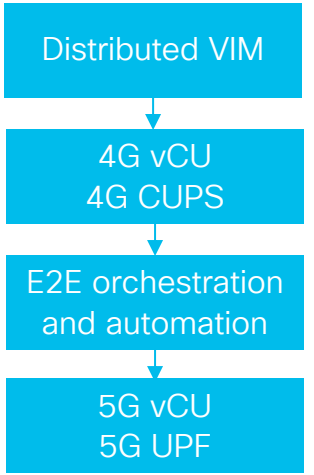


RIU: Radio Interface Unit
CDN: Content Data Network
OTT: Over the Top

Deployment Timeline Considerations

- Greenfield Network: at inception
- Brownfield networks considerations:
  - Applications requirements
  - Use case monetization
  - CUPS is a pre-requisite for MEC and for 5G
  - Relatively easy MEC transition from 4G to 5G
- 4G CUPS introduction may by a good time

One possible Edge DC deployment path:

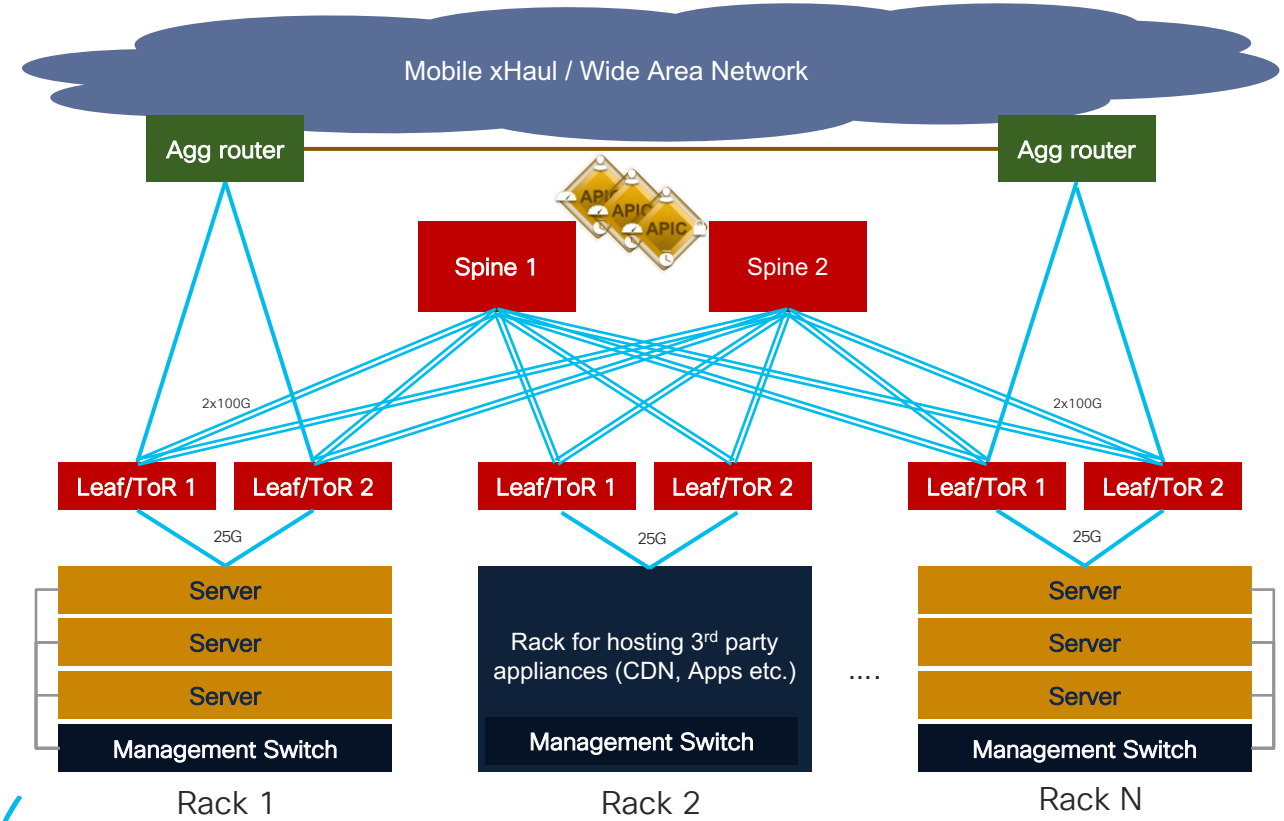


CUPS: Control and User Plane Separation

Service Provider Edge

- Inside Look
- Platform Options
- VNF and CNF coexistence
- Migration Paths

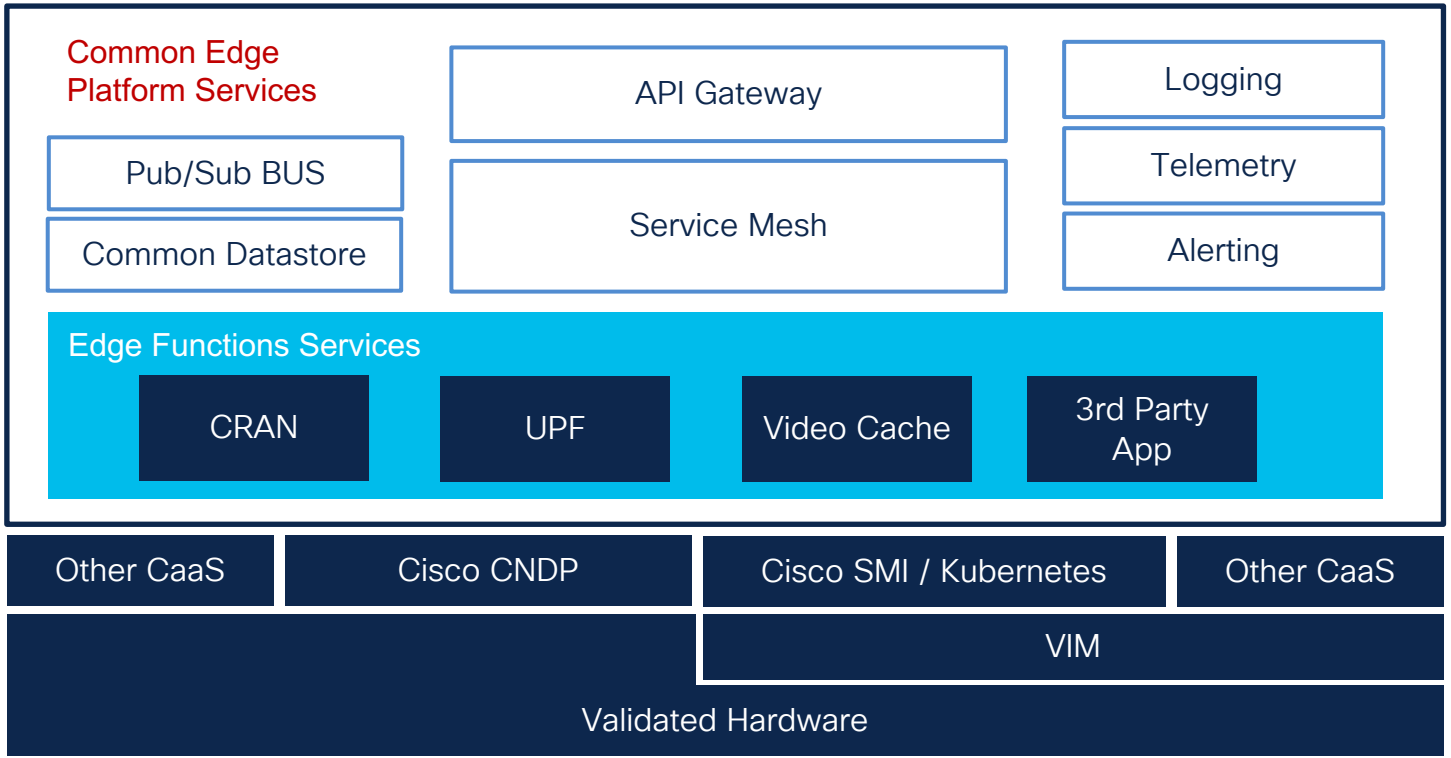
Edge DC High Level Connectivity Diagram



ToR: Top of Rack

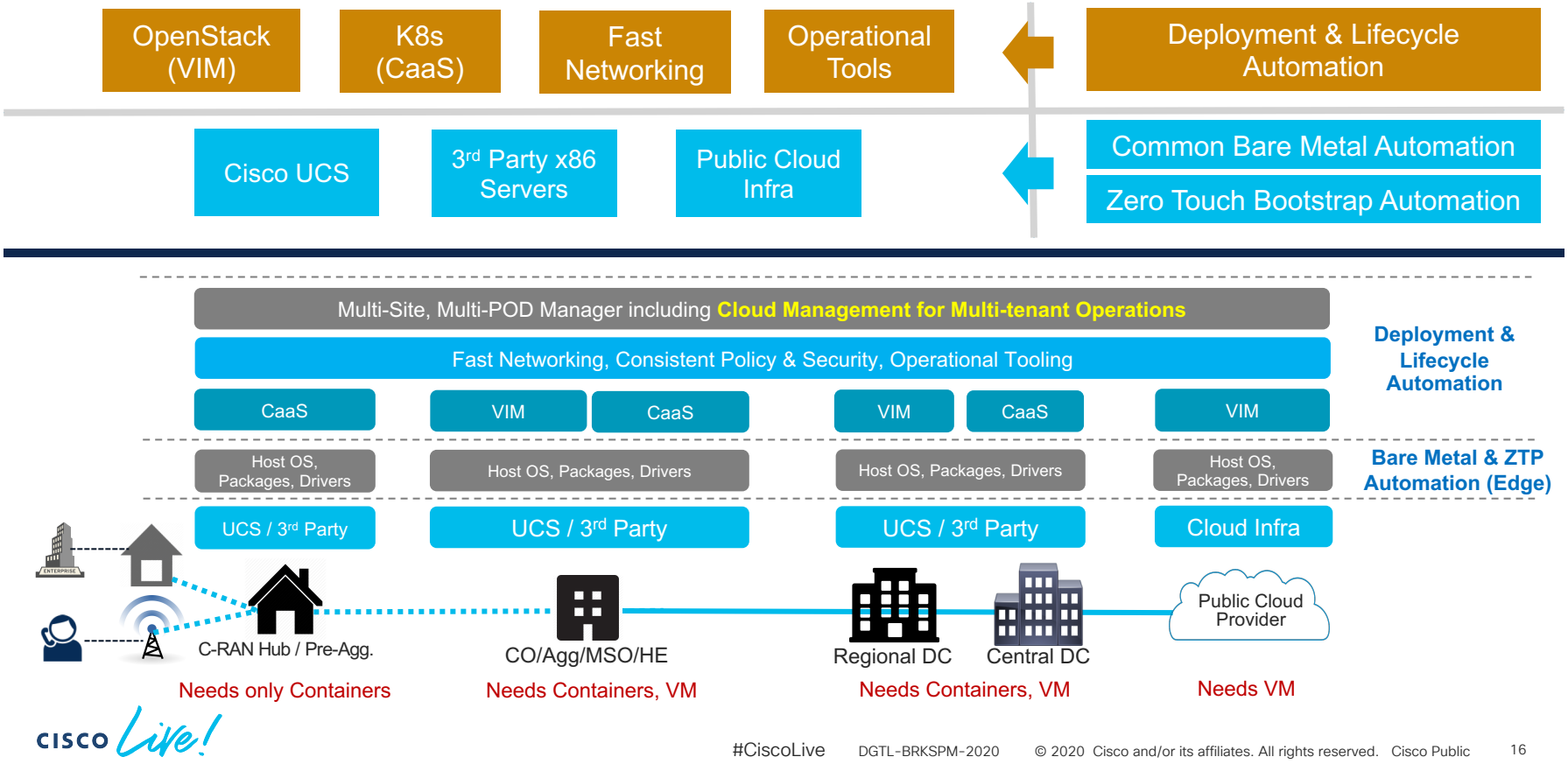
SMI: Subscriber Microservices Infrastructure
CNDP: Cloud-Native Development Platform
CaaS: Cloud-as-a-Service

Cloud Native Evolution of the Mobile Core

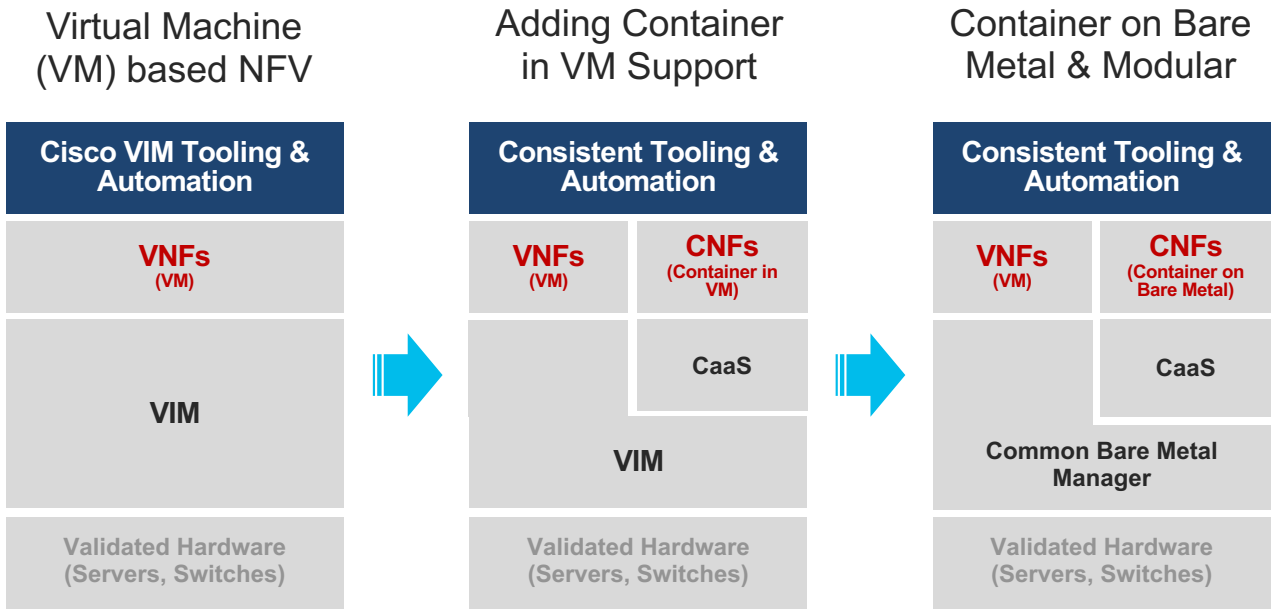


UCS: Unified Computing System
POD: Point of Delivery
ZTP: Zero-touch Provisioning

Towards a Modular Virtualization Platform



Cisco NFVI – Evolution to Cloud Native



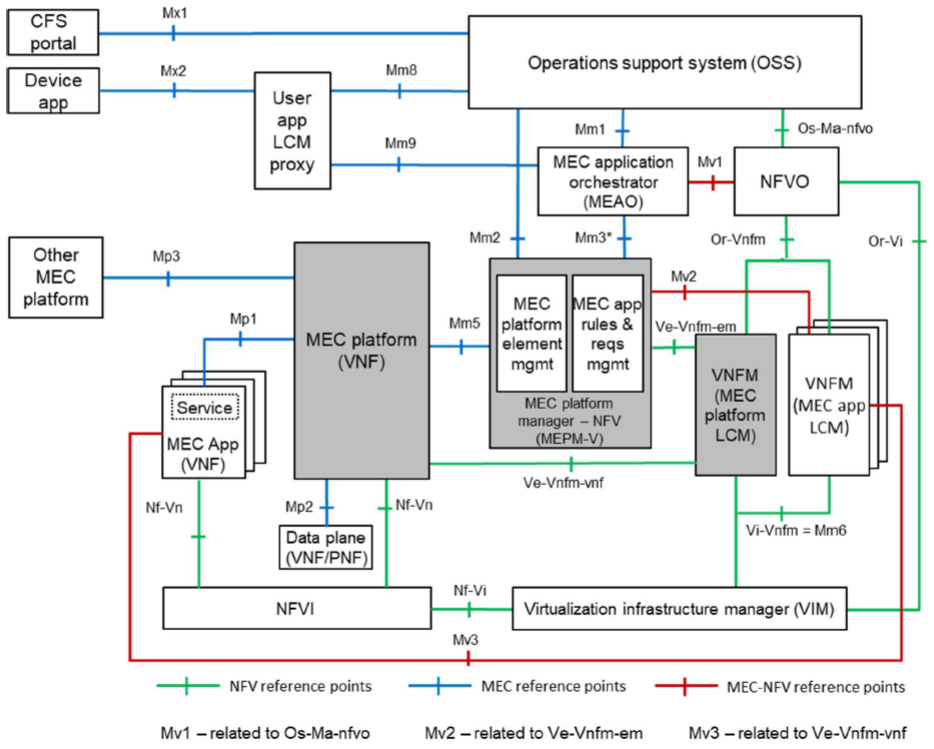
VIM: Virtualized Infrastructure Manager
VNF: Virtualized Network Function
CNF: Cloud-Native Function
V2X: Vehicle to everything

Mobile Edge Platform

- ETSI Standards View
- MEC Platform Challenges
- Where We Are Today

MEC Orchestration Challenge

- Follows general ETSI MANO stack
- Several expansions requiring development
- Same MANO system required for very diverse applications
- Same onboarding process required for very diverse applications



ETSI MEC status: 2nd of a 3-year Phase of Work

ETSI MEC Phase 1 - Completed

- Key overall specification
  - Technical Requirements (MEC 002)
  - Framework and Reference Architecture (MEC 003)
  - MEC Proof of Concept (PoC) Process (MEC-IEG 005)
  - API Framework (MEC 009)
- IaaS Management APIs
  - Platform mgmt. (MEC 010-1)
  - Application mgmt. (MEC 010-2)
  - Device-triggered LCM operations (MEC 016)
- PaaS Service Exposure
  - Required Platform Svcs/ App. Enablement (MEC 011)
  - Service APIs (MEC 012, 013, 014, 015)
- Key Studies for Future Work
  - Study on MEC in NFV (MEC 017)
  - Study on Mobility Support (MEC 018

ETSI MEC Phase 2 – In Progress

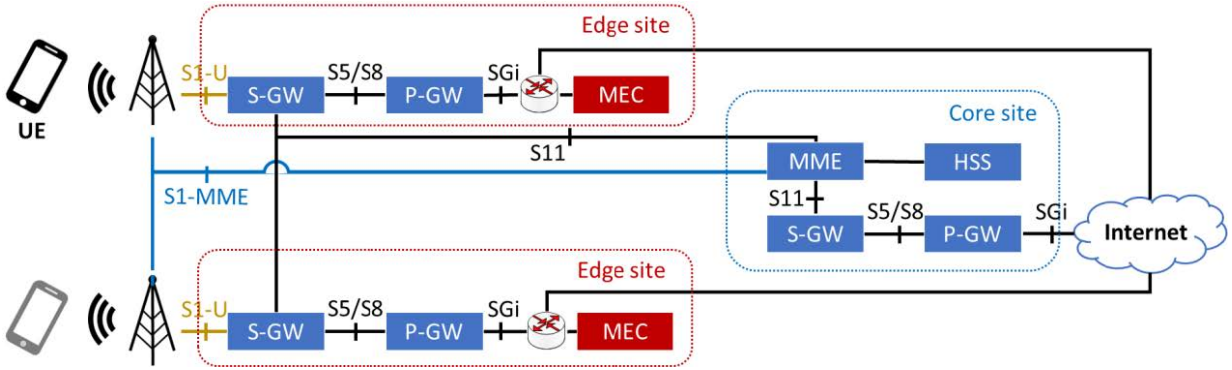
- Evolution of Phase 1 and closing open items
  - Application Mobility (MEC 021)
  - Lawful Intercept (MEC 026 -published)
- Addressing key Industry Segments
  - V2X (MEC 022 -published, MEC 030)
  - IoT (MEC 033), Industrial Automation, VR/AR
- Key use-cases and new requirement
  - Network Slicing (MEC 024)
  - Container Support (MEC 027)
- Normative work for integration with NFV
  - Incorporate in v2 of existing specs as needed
- From “Mobile” to “Multi-Access”
  - Wi-Fi (MEC 028)
  - Fixed Access (MEC 029)
- MEC integration in 5G networks (MEC 031)
- Developer community engagement
  - API publication through ETSI Forge (more overleaf)
  - Hackathons
- Testing and Compliance (MEC 025 -published, MEC 032)

MEC Evolution

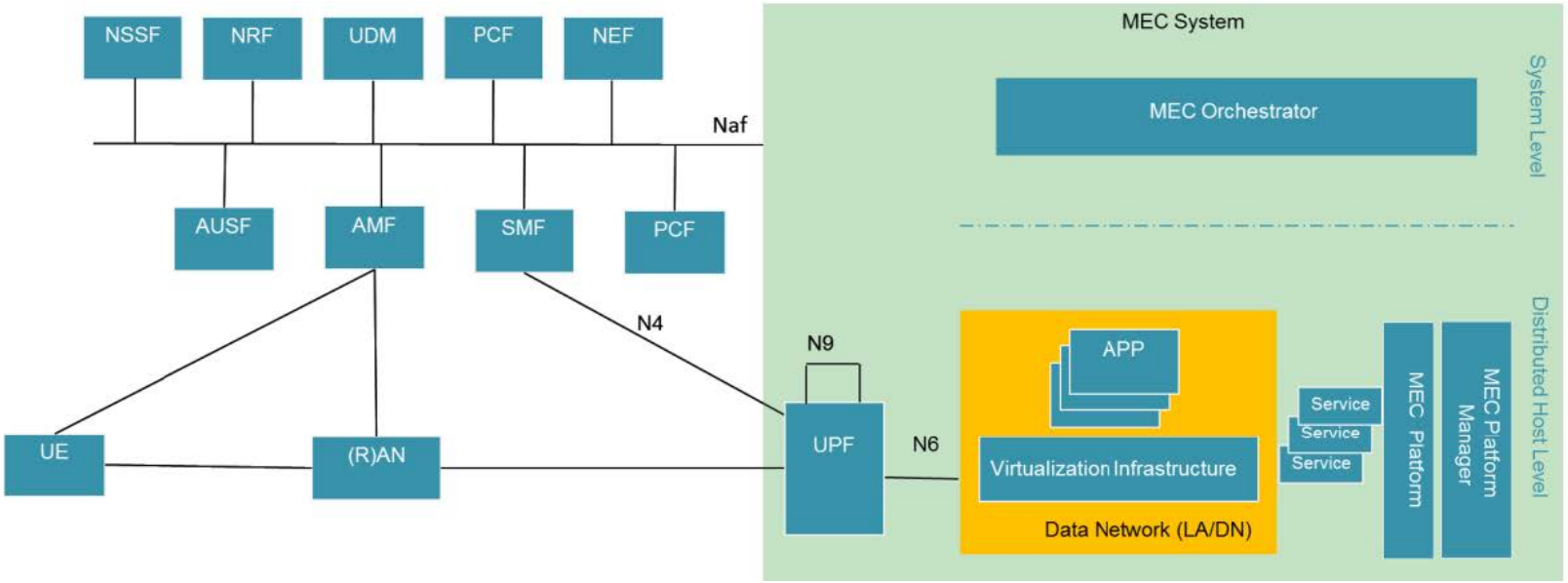
- MEC in 4G
- MEC in 5G
- SP Edge Evolution

MEC in 4G: Deployment Options

- Bump in the Wire
- Distributed EPC
- Distributed S/P-GW (pictured)
- Distributed S-GW with Local Breakout
- CUPS



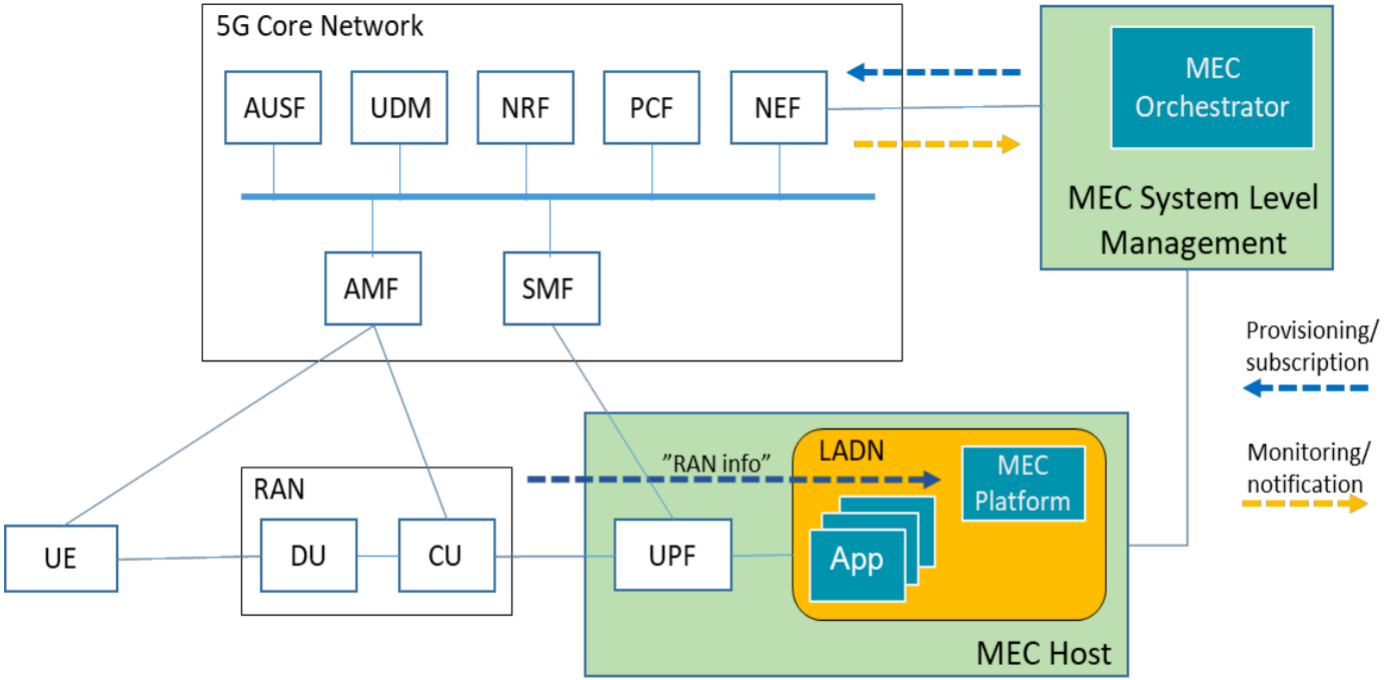
MEC in 5G



5G nodes are CNFs!

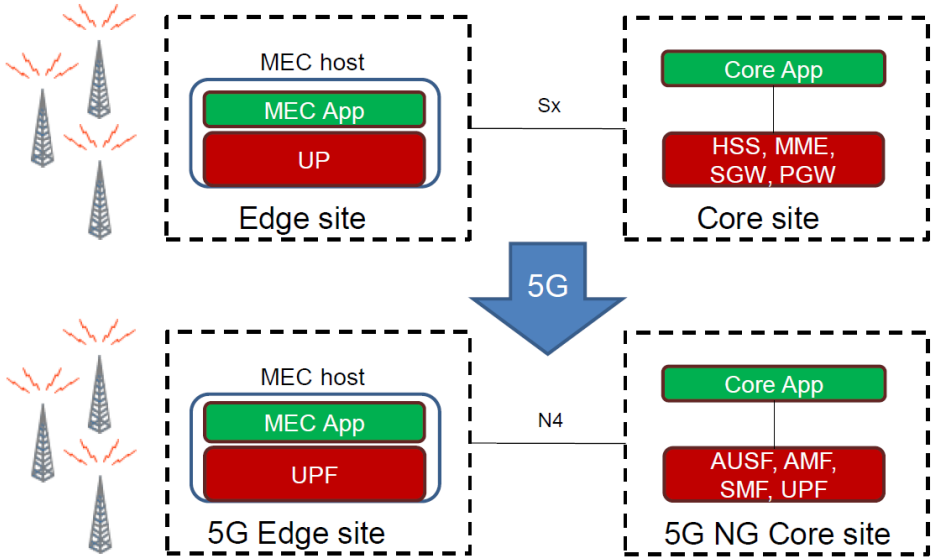
- Some MEC nodes will be cloud-native as well
- Edge DC platform will have to accommodate both VNFs and CNFs

5G MEC Capabilities Exposure



MEC 4G – 5G Migration

- Integrating MEC Data plane with 5G UPF
  - Local routing, app steering
- Integrating AF with 5G Control plane
  - Traffic routing and steering, 5G capability info acquisition, support mobility
- Reusing Edge Compute resources
  - Managing apps and 5G functions



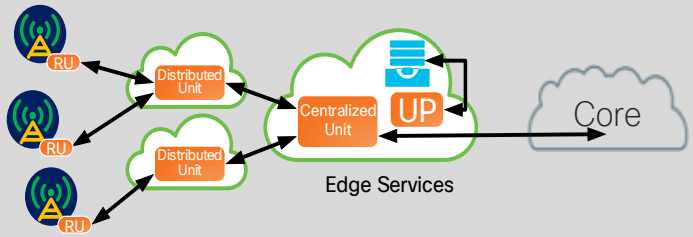
AF: Application Function

SP Edge Challenges

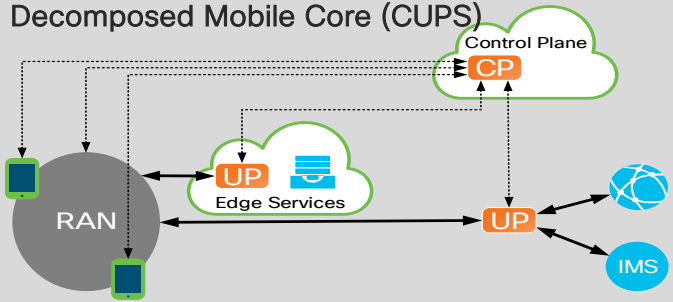
- Use Case Varieties
- Financial Concerns
- Transport
- Mobility
- Migration

SP Infrastructure
Use Cases for Edge

(Open) Virtualized RAN

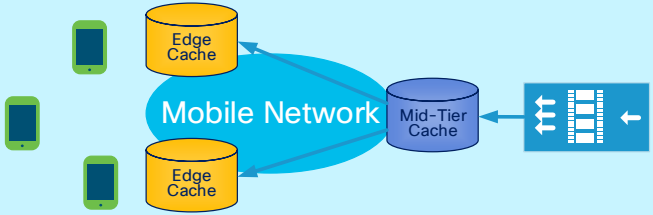


Decomposed Mobile Core (CUPS)

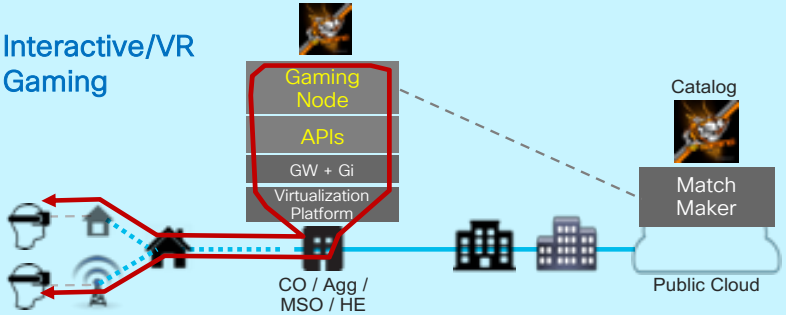


Operator Branded or Business to
Business (B2B) Use Cases for Edge

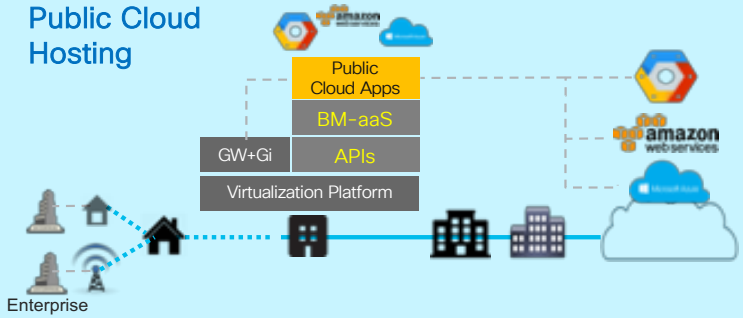
Edge CDN for (Mobile) Video



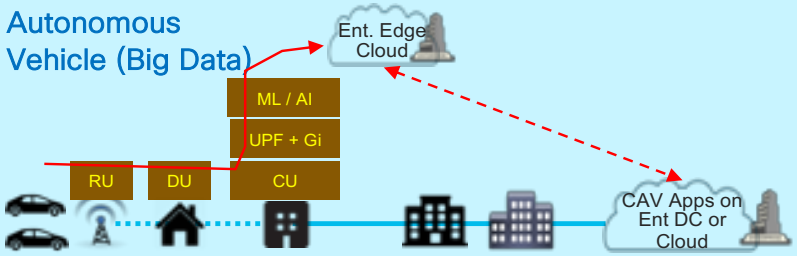
Interactive/VR Gaming



Public Cloud Hosting



Connected Autonomous Vehicle (Big Data)



Big Plans vs. Immediate Deployment

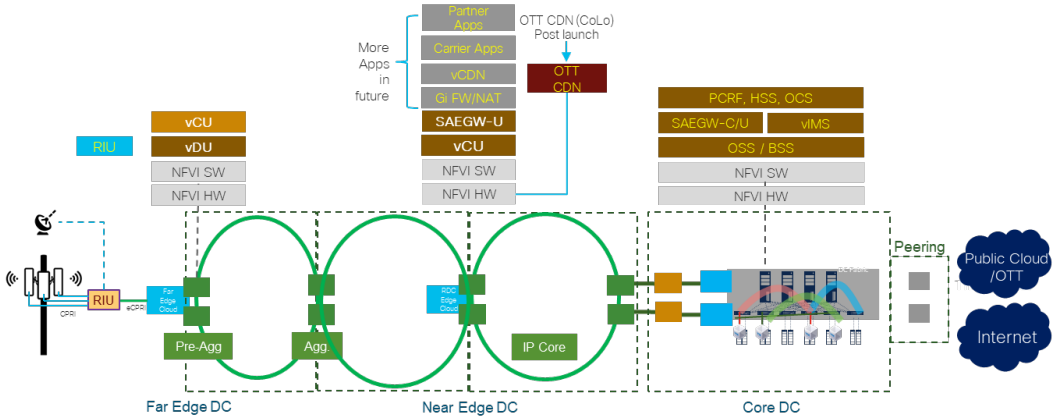
- Planning for a variety of use cases takes time (and some are not known yet)
- CDN as an immediate need
  - Quick monetization
  - Easy implementation
  - Location? (Possibility to deploy at Cust. Premises)
- Dilemma:
  - Implement CDN as quickly and easily as possible, or
  - Consider 5G transition, future use cases and slow down implementation

Economics of MEC

- MEC density
  - Number of “points of presence”
  - Level of coverage (City? Neighborhood? Cell tower? Enterprise?)
  - More density means better experience, but risks higher cost and stranded capacity
- Ownership
  - Service
  - Upgrades
  - Lifecycle management

Internet Access and Transport Challenges

- Internet access availability at Edge DC
- Routing to Edge DC
  - Underlying routing to Edge DC
  - IPv4 routing through IPv6-only backhaul
  - Internet hair-pinning
  - Inbound Internet access
  - Control plane hair-pinning
- Midhaul latency



Mobility Challenges

- SAEGW-U Geo-selection and IP assignment with local DNS
  - DNS-based, 29.303: Based on the TAI/eNodeB-ID on S11 and perform NAPTR from the SAEGW-C
  - Virtual APN-based: Swap the APN and the associated UP based on TAI/eNodeB-ID
- Mobility within home network: session continuity
  - Disconnect with re-attach required when UE moves from Edge-served eNB; session continuity questionable
  - Session continuity will be an issue at the application level too
    - Applications requiring mobility should consider session continuity even with IP address change
- Mobility with domestic roaming: session continuity
  - Same as above with additional geo challenges due to handover

Migration to Edge Challenges

- Highly use case dependent
- CUPS as a starting point
  - Consider off-prem deployment of SAEGW-U / UPF
- Platform Migration
- Transport migration
  - Changing underlay routing without affecting existing traffic
- vCU migration
  - Minimizing downtime for affected cell sites
  - Effect on centrally-based applications

Thank you

Possibilities

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