The bridge to possible

Monolithic or Polylithic Packet Cores?

The case for specialized use-case-based mobile packet cores

Derick Linegar, Technical Solutions Architect

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BRKSPM-2917

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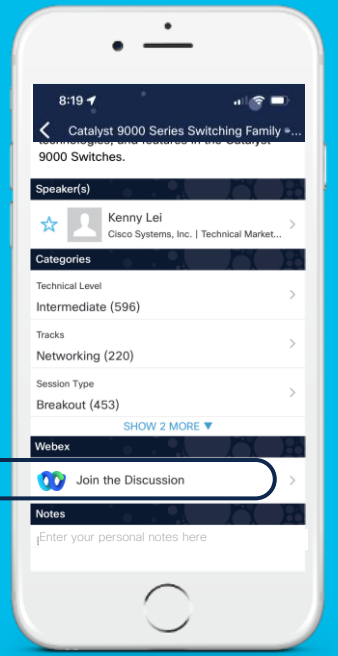

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Agenda

- 5G Status & Deployment challenges
- 5G Monolithic Core using Slicing for Services
- Polylithic Cores as an alternative
- Example PWN Service Creation

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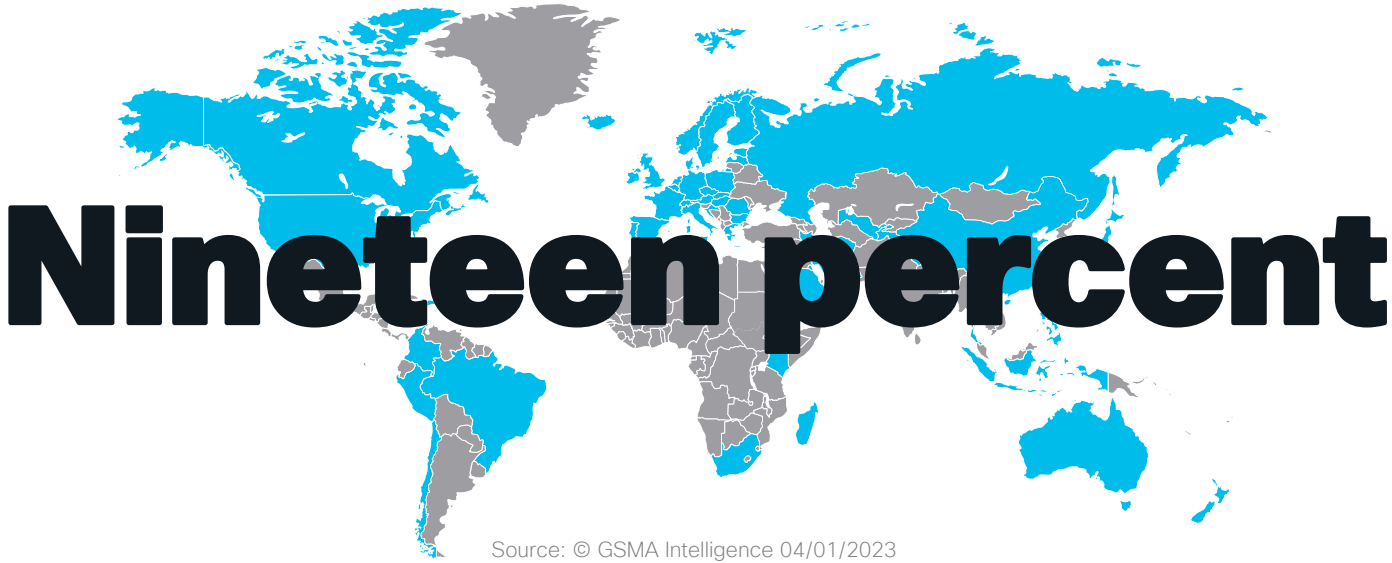
5G Commercialization



Source: © GSMA Intelligence 04/01/2023

189 operators in 68 markets launched mobile 5G

63 operators in 46 markets have plans to launch mobile 5G

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5G SA Commercialization

Source: © GSMA Intelligence 04/01/2023

23 operators in 17 markets operate commercial 5G SA

11 operators in 9 markets have plans to launch 5G SA service

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What's Going on? Analysts' data points

- "Major 5G Standalone deployments are experiencing delays…", STL Partners, September 2022, article
- "Why is 5G SA taking so long?", LightReading, September 2022, article
- "Worsening global uncertainties and lack of 5G business cases beyond mobile broadband continue to cripple the migration to 5G SA", LightCounting, July 2022, article
- "Industry Headwinds to Decrease Mobile Core Network Market Growth", Dell'Oro Group, July 2022, report URL
- "5G SA adoption not living up to hype", LightReading, January 2022, article
- "How's 5G standalone doing in the U.S.?", Fierce Wireless, October 2021, article
- "Mobile operators failing to come up with a strong marketing story for standalone 5G", GlobalData, August 2022, article
- "Carriers With 5G Cores Remain Lonely", SDX Central, January 2022, article
- "5G: A Standalone Future?", EE Times, December 2021, article
- "5G SA Launches Remain Elusive, LightCounting Laments", LightCounting, August 2022, article

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5G Cloud-Native Mobile Core based Subscriber Services

The Future for Service Creation and Business Evolution

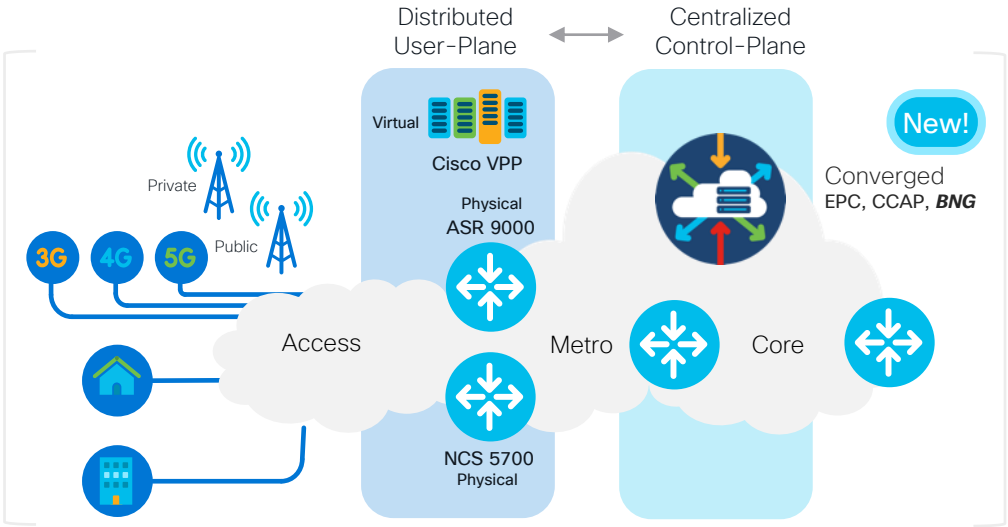
Architectural Improvements

Centralized Control Plane for Mobile, Cable, ***Wireline*** on Common Infrastructure

Distributed User Plane for Optimization and Resiliency

- Physical for Scale
- Virtual for Agility

Integrated visibility, control: ACI, AppDynamics for Operational Insights



New Outcomes

Cross-Domain Services

Expand to MNO or MVNO

Enterprise Use-cases

Private LTE & 5G

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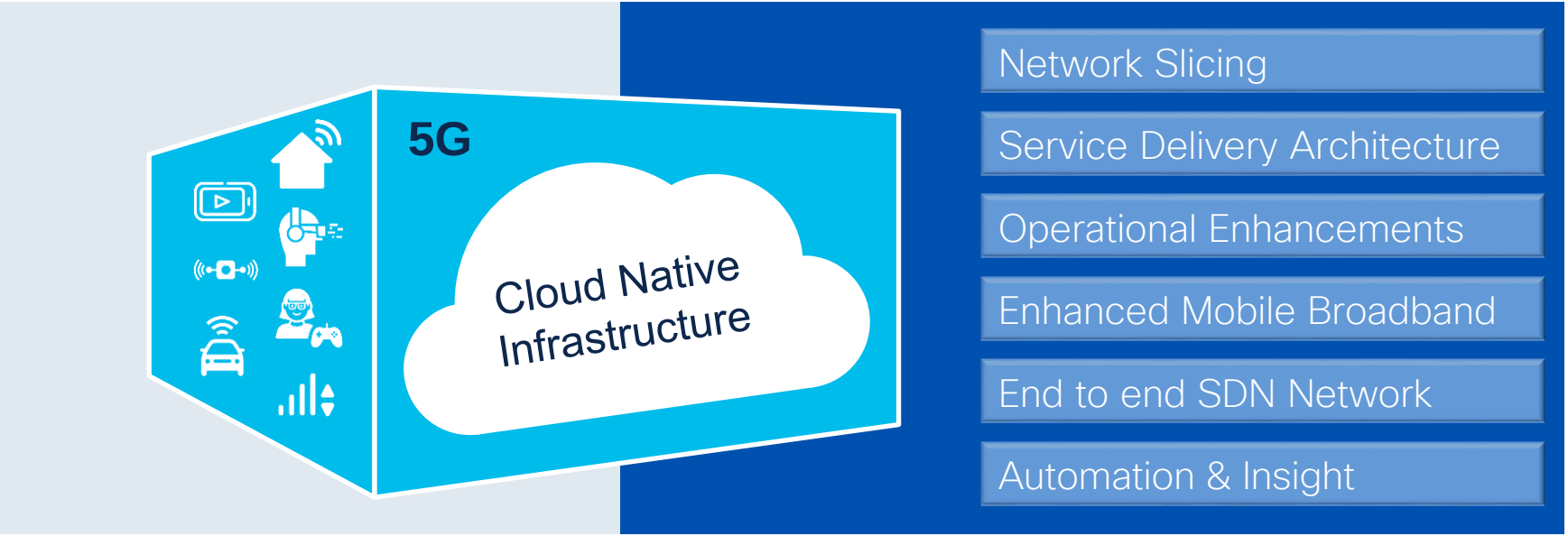
Use cases enabled by 5G

Cloud-Native Distributed Architecture



Scalable Distributed Programmable

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5G Adopted New Architecture Deployment Principles

Radical Change for 3GPP Mobile Cores

New Access

5G Radio's, WiFi-6
"traditional" access
Higher Flexibility
High BW, low latency
Massive MIMO

Decomposition

Open Interfaces
Mobile Core
Converged Core
Disaggregation

SW-Centric

Virtualization
Cloud Native
Edge Computing
Programmable

Convergence

Any Access
Common Sub Mgmt.
Converged Transport
Common Policy

Automation

Closed Loop
Multi Domain
Network Slicing
Service Assurance

5G & WiFi-6 — 3GPP Mobile Core

Recipe for today's Next Generation SP Networks

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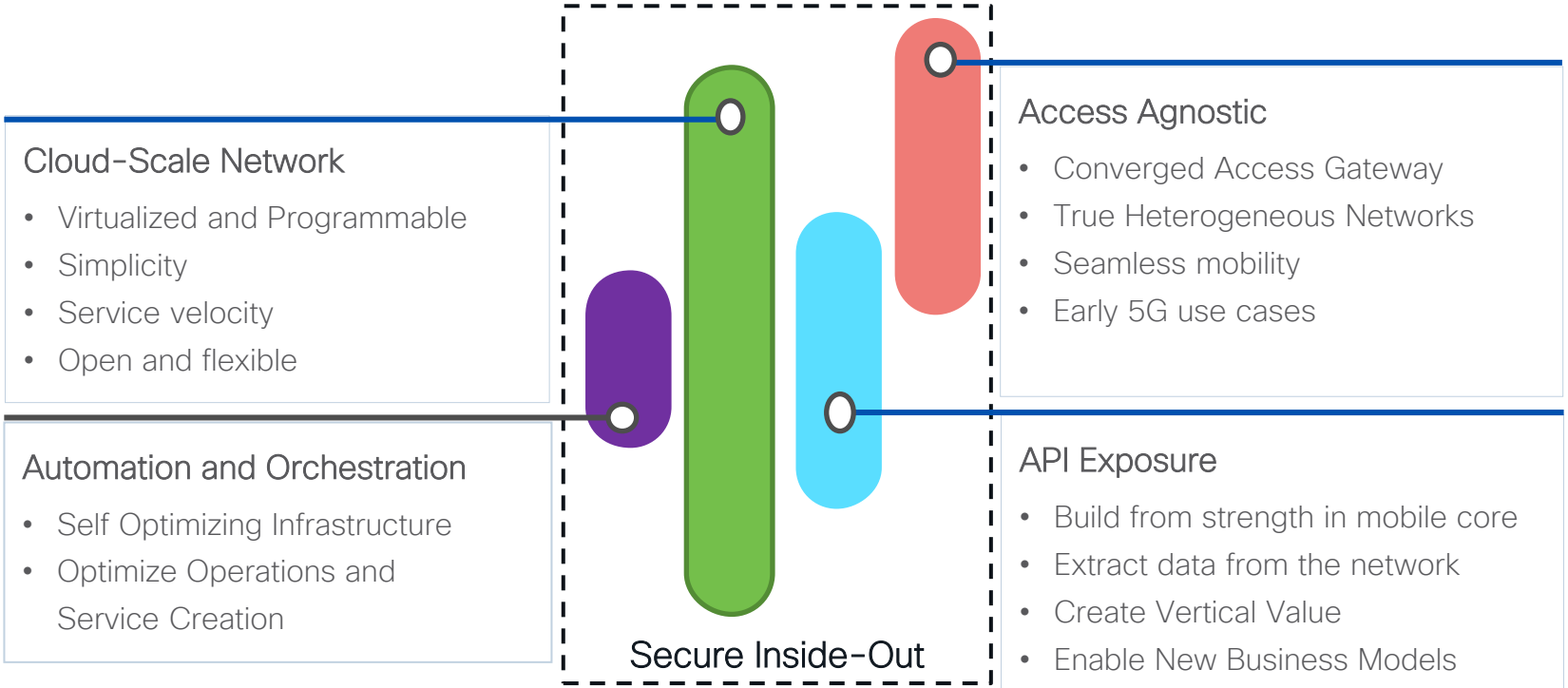
3GPP 5G Architectural Deployment Tenets

Focus is on taking advantage of Cloud Native Principles



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Typical Cloud Native Components for Mobile Cores

Sampling of Elements used

Cloud Native Constructs

- Release Engineering
- Release Automation
- Release Scheduling
- Architecture (3-tier)
- Life Cycle mgmt.
- Telemetry
- Configuration and CLI
- Data Storage

Cloud Native Components

- Docker, Kubernetes
- EFK, Prometheus, Grafana,
- ISTIO Service mesh
- Calico, Weave
- Kafka, NATS
- AppD, ConfD, etcD
- Redis,
- Helm, Tiller
- Internal (Jenkins, jFrog, GIT

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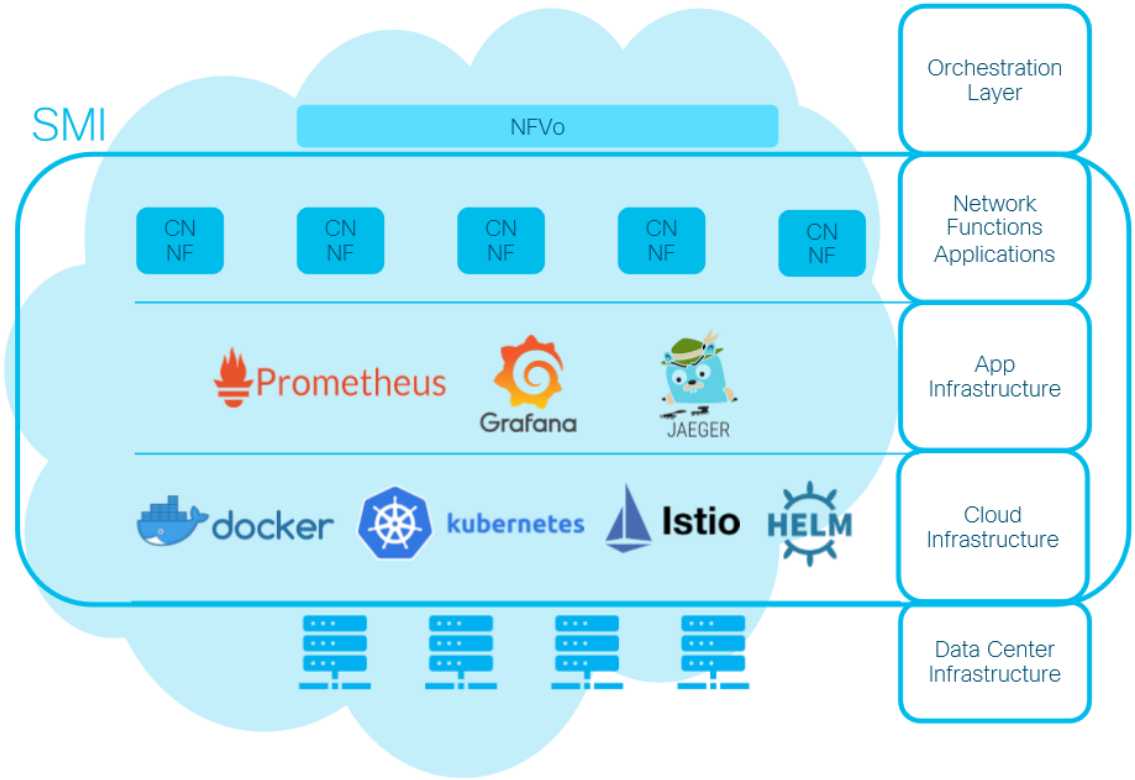
Example: Cisco 5G SA Mobile Core

Cloud Native based Common Execution Environment

Vertical stack designed specifically for high performance, low latency, GeoHA applications

Validated Kubernetes ecosystem and integrated utilities – deployed as private, on-prem cloud.



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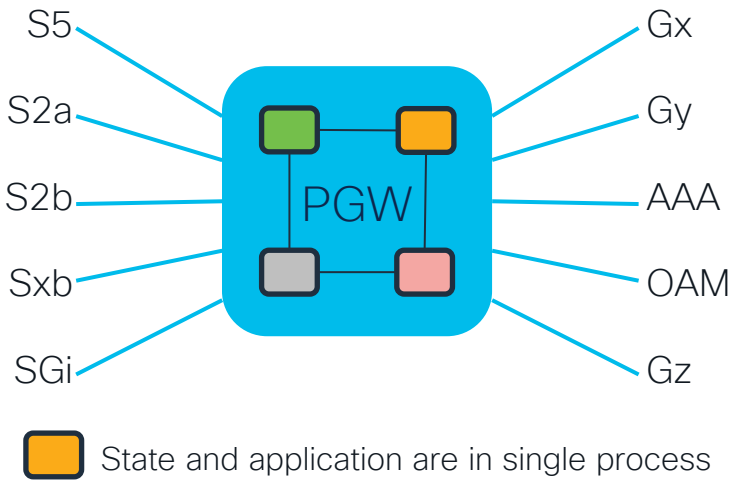
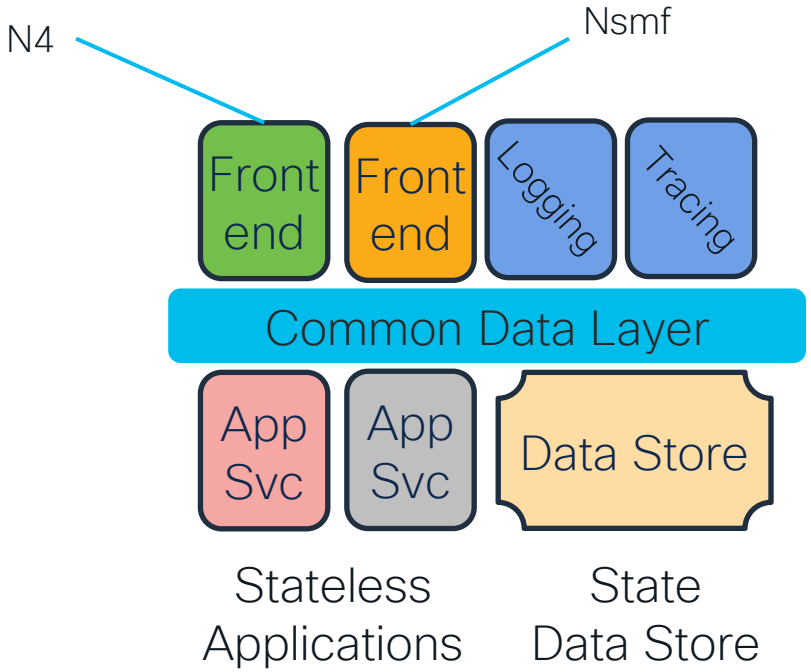
Result: 5G Cloud Native Core Deployment Principle

Software Process Separation

Monolithic Software



Microservice Container Software



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Result: Loads of Micro Services

Cloud Native Pod List

- Example: The Cisco ”Common Execution Environment” combines all the applications and services that are used by all network functions (such as logging, alerting, collecting of statistics etc.)
- This is not 5G per-se, just an environment that 5G NF’s can use
- Pods marked with “*” in the node column run on all nodes (shortened here for visibility)

“kubectl get pods -n cee-global –o wide”

NAME	READY	NODE
alert-logger-74446c8fd6-9krdt	1/1	oam-2
alertmanager-0	1/1	oam-2
alertmanager-1	1/1	oam-3
alertmanager-2	1/1	oam-1
api-cee-oam-ops-center-846d87578-2p599	1/1	oam-1
bulk-stats-0	3/3	oam-3
bulk-stats-1	3/3	oam-1
cee-oam-product-documentation-b6b45c98-2qrnk	2/2	oam-2
core-retriever-2j2dr	2/2	*
documentation-86bcc95bd9-cb9b2	1/1	oam-3
fluentbit-2qctp	1/1	*
fluentd-6dd5ccd89b-t74wn	1/1	sess-data-3
grafana-6b4f4947db-stz49	5/5	oam-2
grafana-dashboard-metrics-b6cccb454-88ddj	1/1	serv-data-4
kube-state-metrics-6c9b445b9b-lbjbz	1/1	oam-1
logs-retriever-5qn7v	1/1	*
loki-0	1/1	sess-data-4
node-exporter-5gbrr	1/1	*
ops-center-cee-oam-ops-center-6b68b6494f-qmlwf	5/5	oam-3
path-provisioner-6sfbt	1/1	*
pgpool-647454fdb8-bxrtb	1/1	oam-2
pgpool-647454fdb8-r46hh	1/1	oam-3
postgres-0	1/1	oam-2
postgres-1	1/1	oam-1
postgres-2	1/1	oam-3
prometheus-hi-res-0	4/4	oam-1
prometheus-hi-res-1	4/4	oam-3
prometheus-hi-res-2	4/4	oam-2
prometheus-rules-685ff55bfd-pfpns	1/1	oam-1
prometheus-scrapeconfigs-synch-6fd89f7768-kkpl7	1/1	serv-data-4
pv-manager-5d7548f785-w8b45	1/1	oam-1
pv-provisioner-6f654d885b-dprng	1/1	oam-1
show-tac-manager-5f4cc946db-j9ghj	2/2	oam-3
smart-agent-cee-oam-ops-center-6f8589765-5wbl4	1/1	oam-2
swift-cee-oam-ops-center-69b68bd7dc-lvqdr	1/1	oam-1
thanos-query-hi-res-5f5577f865-m8rvf	1/1	oam-1
thanos-query-hi-res-5f5577f865-n6zbm	1/1	oam-2
thanos-query-hi-res-5f5577f865-t62n2	1/1	oam-3

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Result: 5G NF Micro Services

SMF NF Pod List

- Each NF (SMF shown) will have its own “zoo” of micro services.
- The number of nodes and replicas for most NF Services is configurable
- Services of the same type use anti-affinity to be deployed on different worker nodes

“kubectl get pods -n smf-data -o wide”

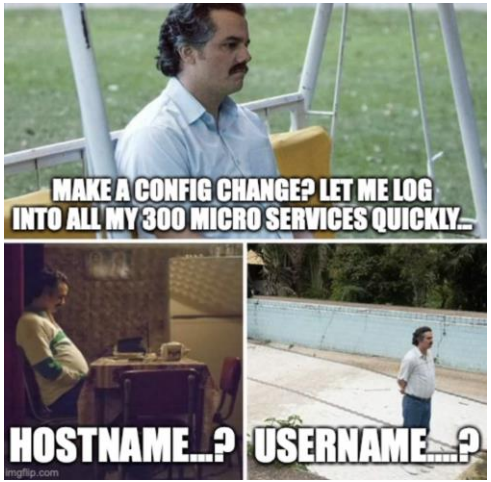
NAME	READY	NODE
api-smf-data-ops-center-5958fd5974-n2zls	1/1	oam-1
cache-pod-0	1/1	proto-data-2
cache-pod-1	1/1	proto-data-4
cdl-ep-session-c1-544bb68dfd-9czwx	1/1	sess-data-1
cdl-ep-session-c1-544bb68dfd-kg7c9	1/1	sess-data-2
cdl-index-session-c1-m1-0	1/1	sess-data-1
cdl-index-session-c1-m1-1	1/1	sess-data-2
cdl-slot-session-c1-m1-0	1/1	sess-data-1
cdl-slot-session-c1-m1-1	1/1	sess-data-2
documentation-7f98b9d685-prf48	1/1	oam-1
etcd-smf-data-etcd-cluster-0	1/1	oam-1
etcd-smf-data-etcd-cluster-1	1/1	oam-2
grafana-dashboard-app-infra-f8968f559-ktwwv	1/1	oam-1
grafana-dashboard-cdl-78dd8f455-bhsz5	1/1	proto-data-4
grafana-dashboard-smf-64b9b76b5-glczp	1/1	oam-2
gtpc-ep-n0-0	1/1	proto-data-1
gtpc-ep-n0-1	1/1	proto-data-2
kafka-0	1/1	sess-data-1
kafka-1	1/1	sess-data-2
oam-pod-0	1/1	oam-1
ops-center-smf-data-ops-center-548446b4bd-2t4r5	5/5	oam-2
smart-agent-smf-data-ops-center-d59b8b99c-b7vd6	1/1	oam-1
smf-nodemgr-n0-0	1/1	serv-data-2
smf-nodemgr-n0-1	1/1	serv-data-1
smf-protocol-n0-0	1/1	proto-data-2
smf-protocol-n0-1	1/1	proto-data-1
smf-radius-dns-n0-0	1/1	proto-data-2
smf-rest-ep-n0-0	1/1	proto-data-2
smf-rest-ep-n0-1	1/1	proto-data-1
smf-service-n0-0	1/1	serv-data-1
smf-service-n1-0	1/1	serv-data-2
smf-udp-proxy-0-7f57c7984b-b7b6c	1/1	proto-data-2
smf-udp-proxy-1-6f94dfc6d5-hqx55	1/1	proto-data-1
swift-smf-data-ops-center-6f46b78f8-z6xcm	1/1	oam-3
zookeeper-0	1/1	oam-3
zookeeper-1	1/1	oam-1 1/1

State Management Services

Protocol Load Balancer Services

Application Services

Result: Seismic Shift in how MSP Operate Networks



- API != OAM
- Horizontal Scaling == Cost (Uncontrolled?)
- Having a Zoo of (micro) Services == No Pets!
- Scale of (micro) services == Complexity and Risk

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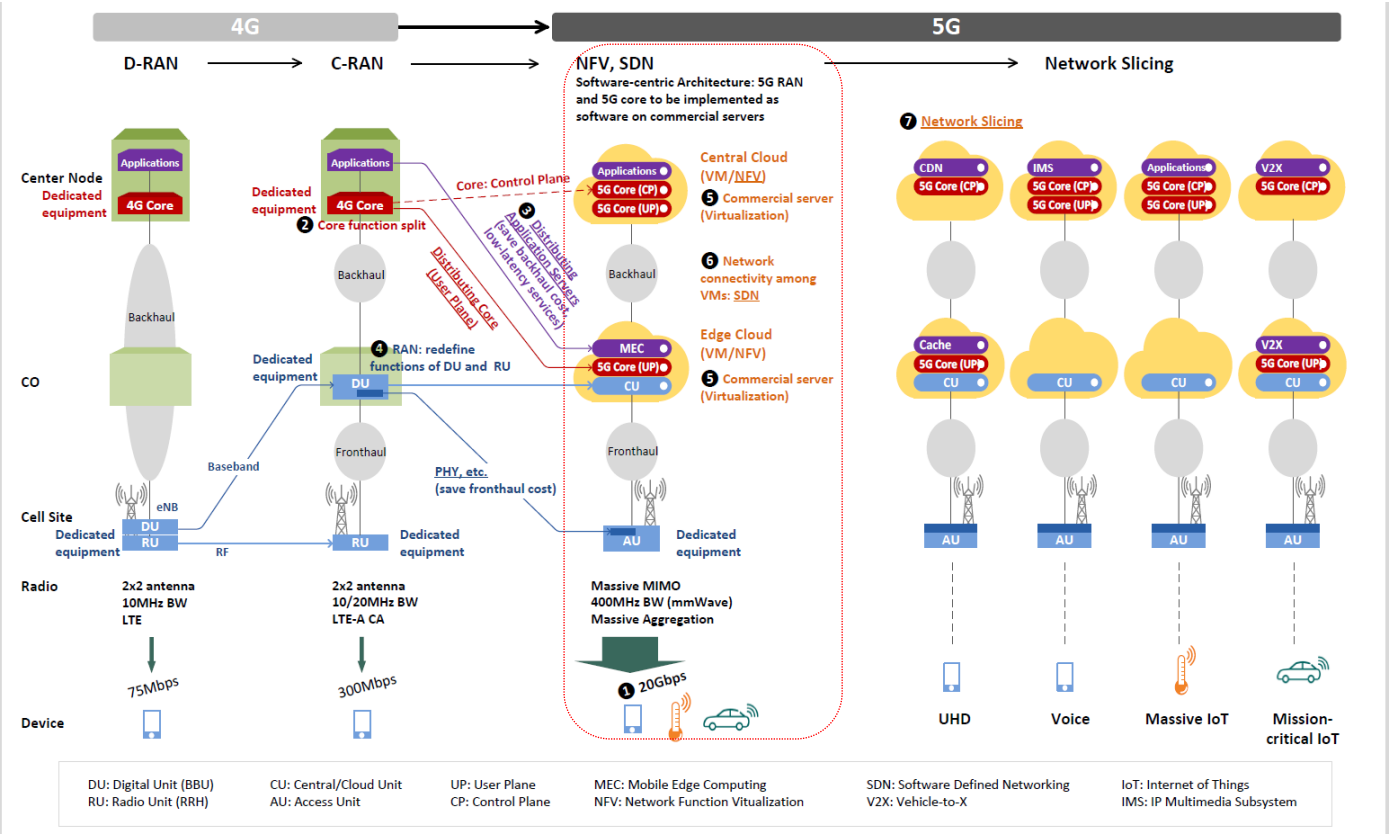
And… How to deal with Multiple Use-Cases?

5G-SA Core + Network needs to "slice"…



MSP has to consider:

- Use-Cases drive conflicting Network, Core and Operational requirements
- To "Slice" a core, and associated Network (IP Transport, RAN etc) requires coordination
- To "Slice" a core, and associated Network (IP Transport, RAN etc) requires a service "contract"
- If Dynamic slicing is required, excess underlying network H/W resources required
- How many slices? 2 … 2000?
- Slice architecture complexity increase with dis-aggregation.

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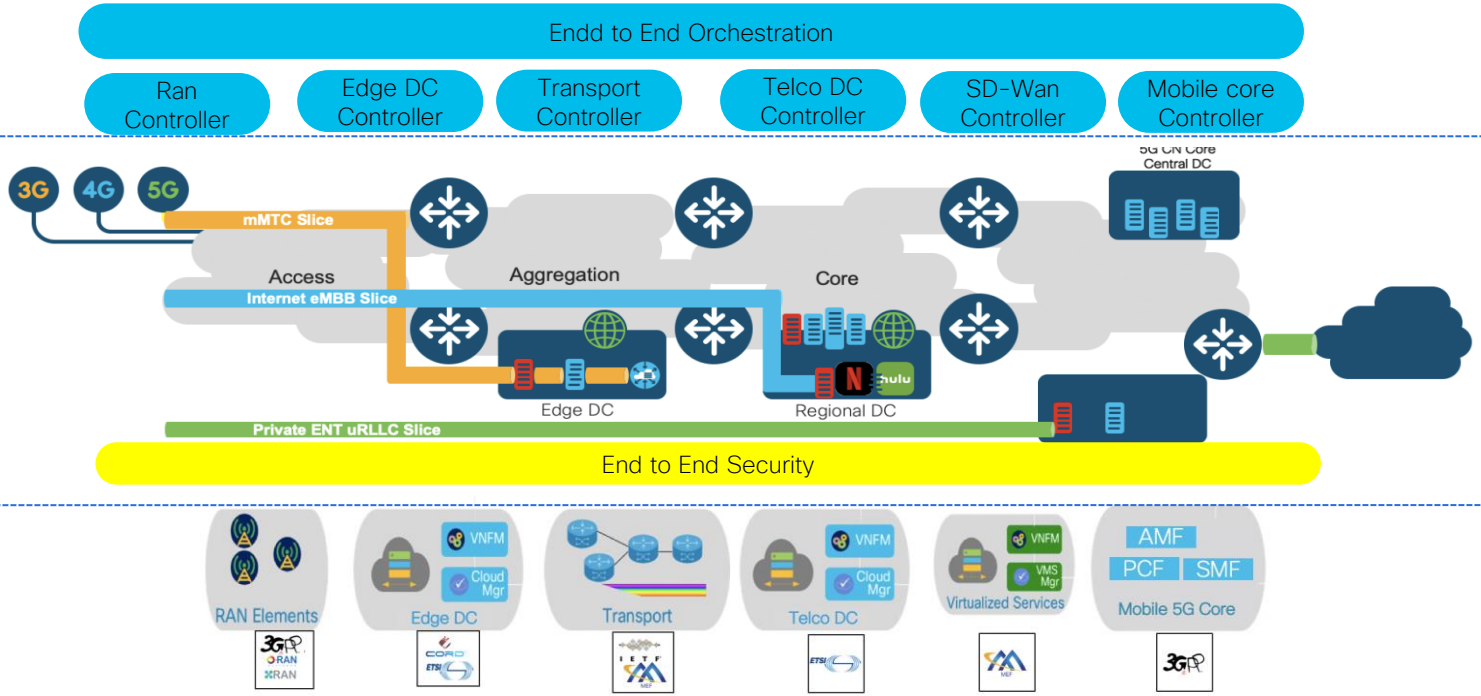
5G Services to be based on End-to-End Slicing …..

Network Slicing is fundamentally an end-to-end partitioning of the network resources and network functions so that selected applications/services/connections may run in isolation from each other for a specific business purpose driven by the Orchestration capabilities



Orchestration offering Network as a Service

Control / User Plane Separation, Distributed physical & Virtual Function Based on Slice attributes, Service isolation and security

Cross Domain Service based on Multiple standard

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Status of Slicing for a “Multi-Core” approach

- Eco-System is still developing
- Handsets/UE not implementing optional parameters
- Slicing has to be implemented EVERYWHERE to be ready…
- Automation/Orchestration complexities
- Multi-Standard Cooperation and Coordination
- Cost…

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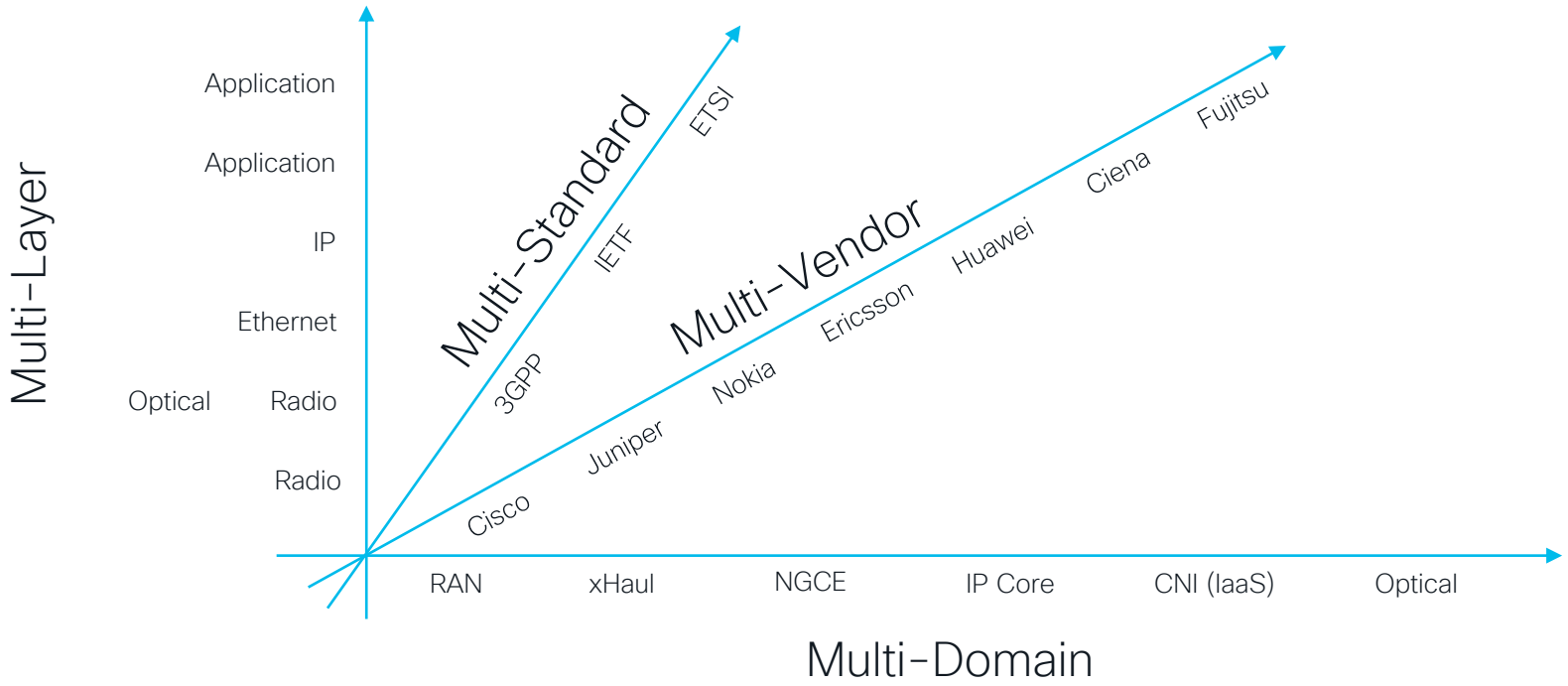
The 4D of Slicing: Lots of Moving Parts



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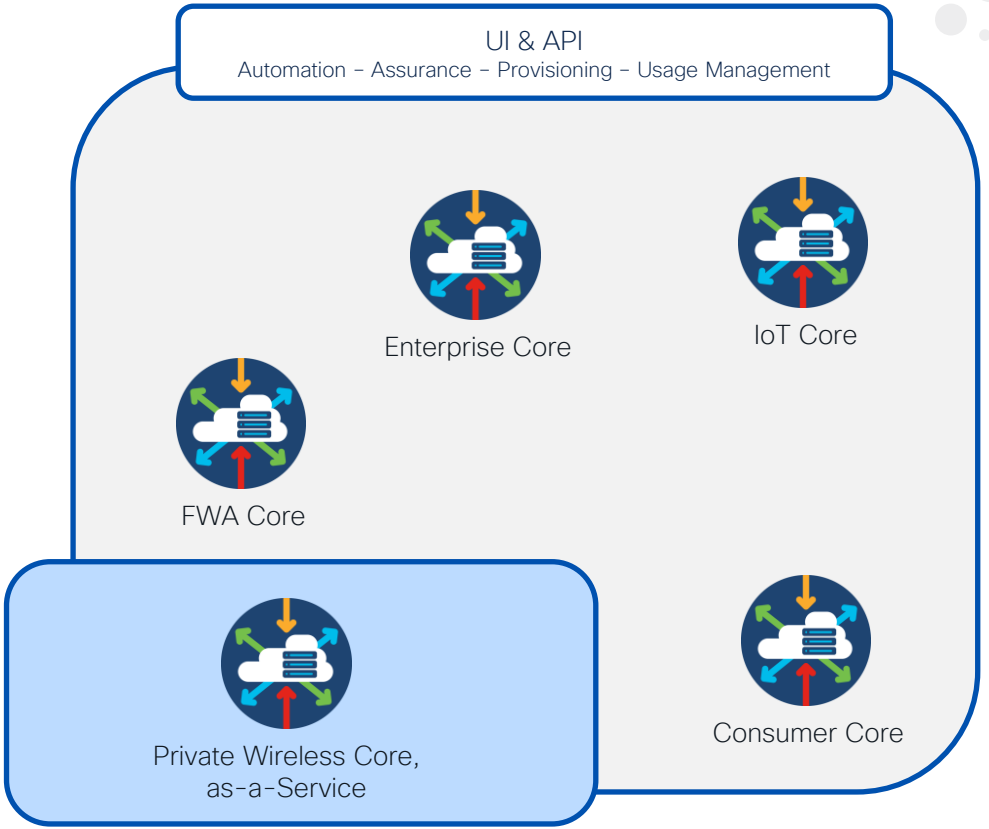
Alternative Approach: Polylithic Mobile Cores

Utilize a "best-of-breed" approach

- Use multiple "standalone", or Polylithic (Cloud Native-based) Mobile Cores focused on specific use cases (FWA, PWN, URLLC, IoT)
- Complexities of having a fully-backed slicing infrastructure are not needed
- Automation "solves" the many core operational costs → No slicing is required! MSP can now pick those solutions that fit their operations the best.
- Outsourcing the physical cost/ownership of these Polylithic Mobile Cores via SaaS models de-risks the MSP's TTM, Space, Skill-set and Revenue/Market Penetration to those providers with proven Service Creation Platforms.



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Polylithic Cores facilitates adoption SaaS Cores

Massive Time to value improvement

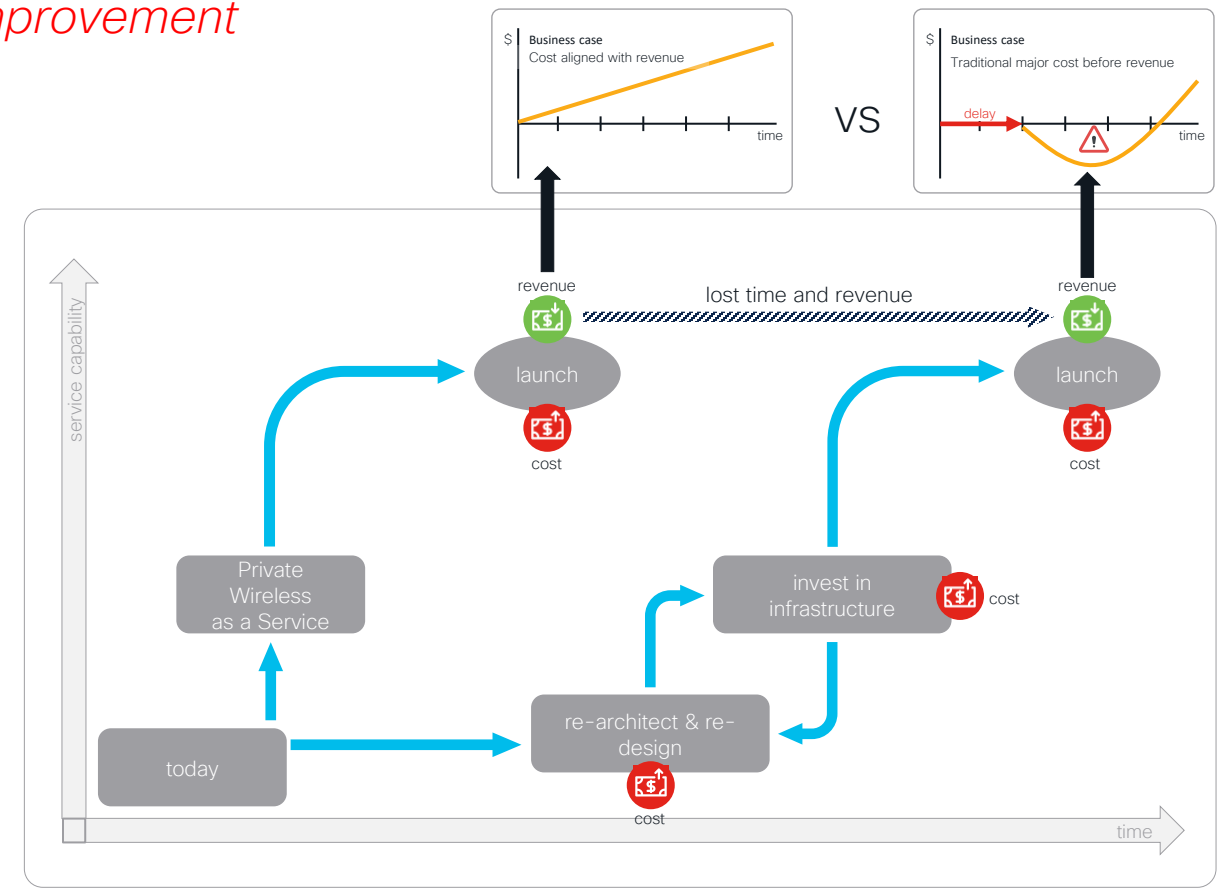
Benefits:

Flexible service creation for MSP & rapid prototyping → TTM & Business Case Validation

High level of service control and visibility via APIs → Lowered Cost of System Integration

Service and customer insights and tooling to enable new segments and increase customer satisfaction → Market Relevance, differentiation

It is not about Technology Religion (Mobile Core, Containerization, 3GPP standards, etc) but about Service Creation & Adoption (How/what to launch, ARPU etc)



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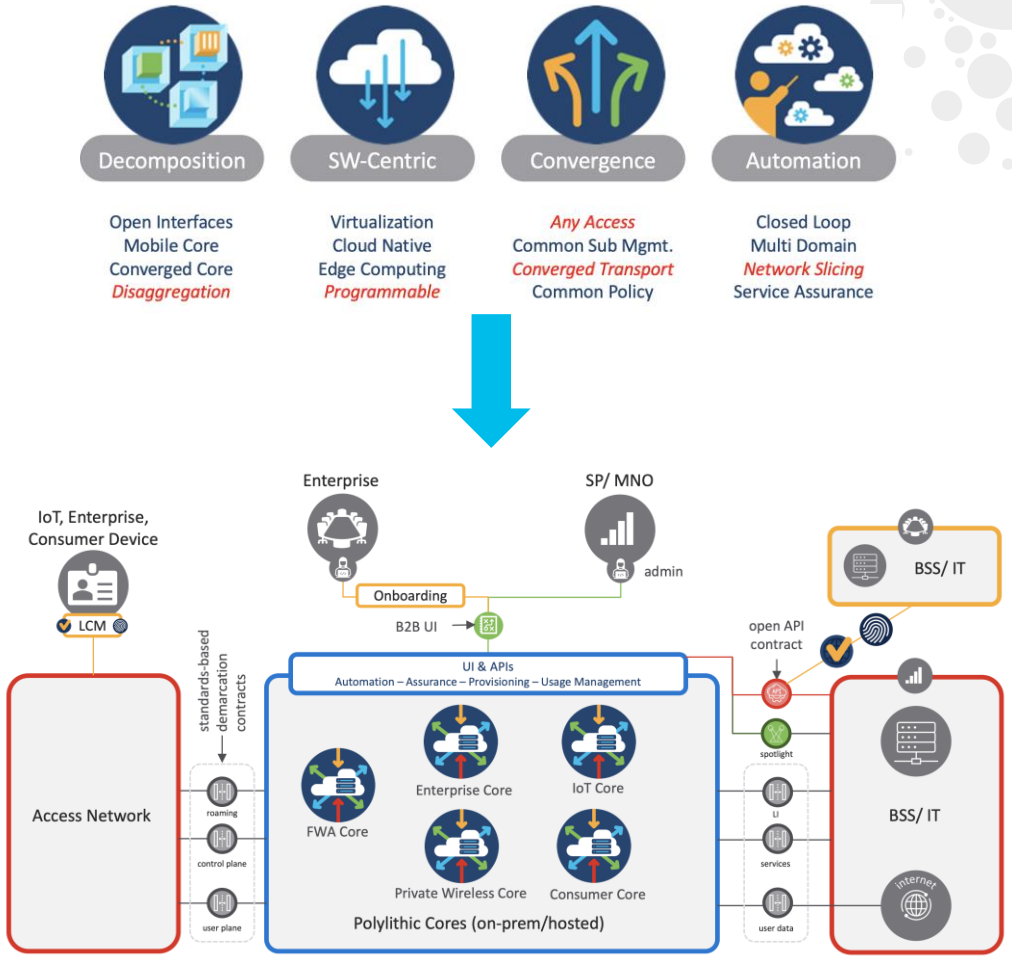
Polylithic Cores Deployments

Benefits

- The approach is not new (done in 4G/EPC) successfully.
- Focus is more on efficiency, cost and revenue.
- Slicing Eco-system is still in development → Risk & Cost for MSP
- TTM (outsourcing) of Cores tied to market penetration and revenue.
- Allows MSPs to be agile and proceed with lower Risk and Cost Structure.



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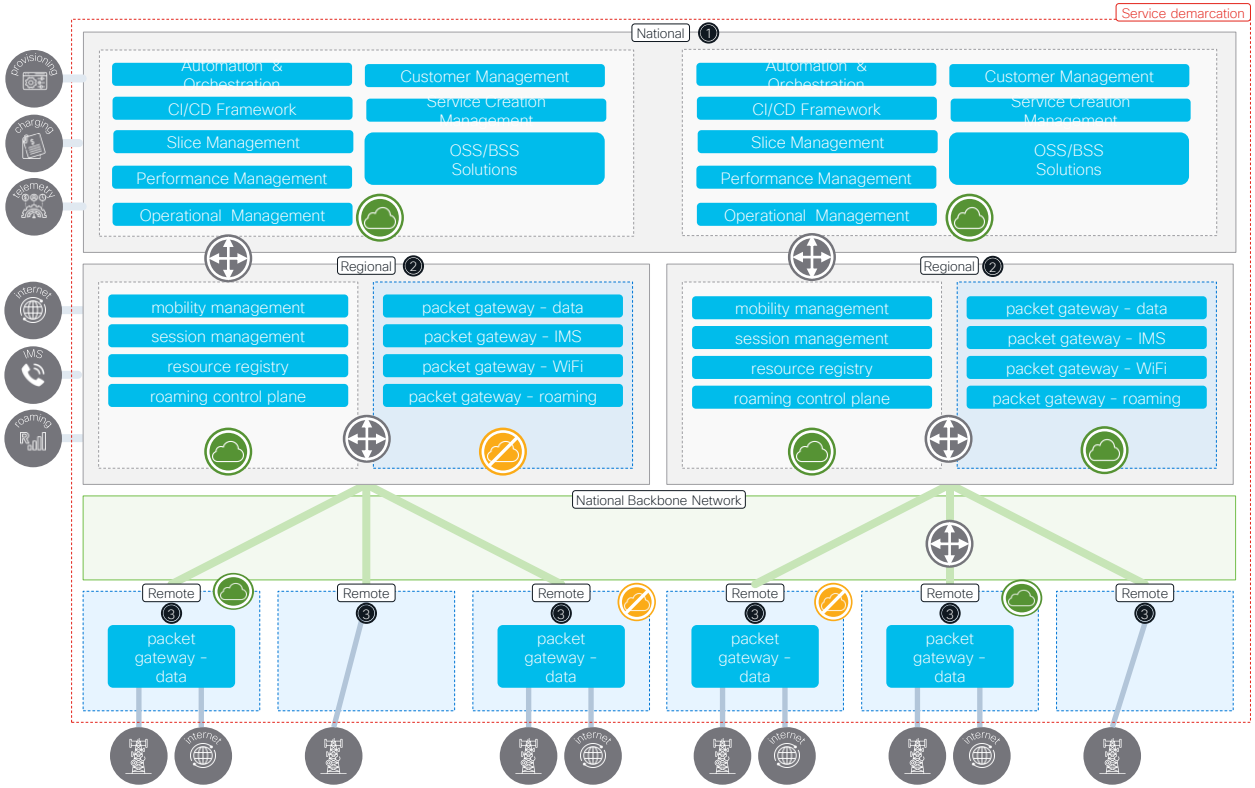
Typical Converged Core MSP as of Today

Representative Architecture



1. MSP has deployed the foundation of a x-domain/x-vendor Automation & Orchestration layer → Defined workflow for Service Creation

2. Regional DC in the midst of transitioning to pure Converged Core (4G/5G) based on Cloud Native Principles where possible

3. Started to adopt the "dis-aggregation" of NFs in remote locations to address scaling and other transport requirements → Limited in scope due to resourcing available.

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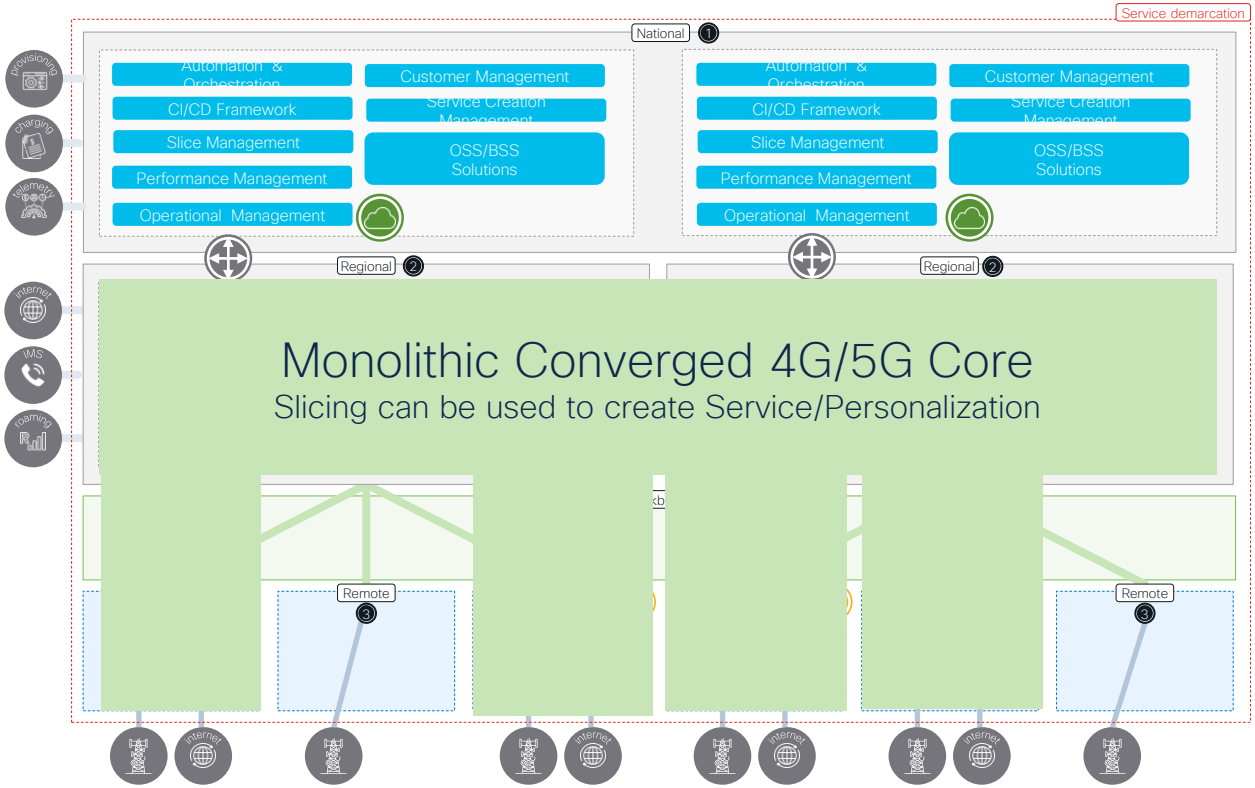
Typical Converged Core MSP as of Today

Services & Personalization based on a Slicing Architecture



- Idea is to use Slicing to create service and personalization, across the deployment
- Still very much in development and concerns persists with respect to the maturity of the slicing ecosystem.

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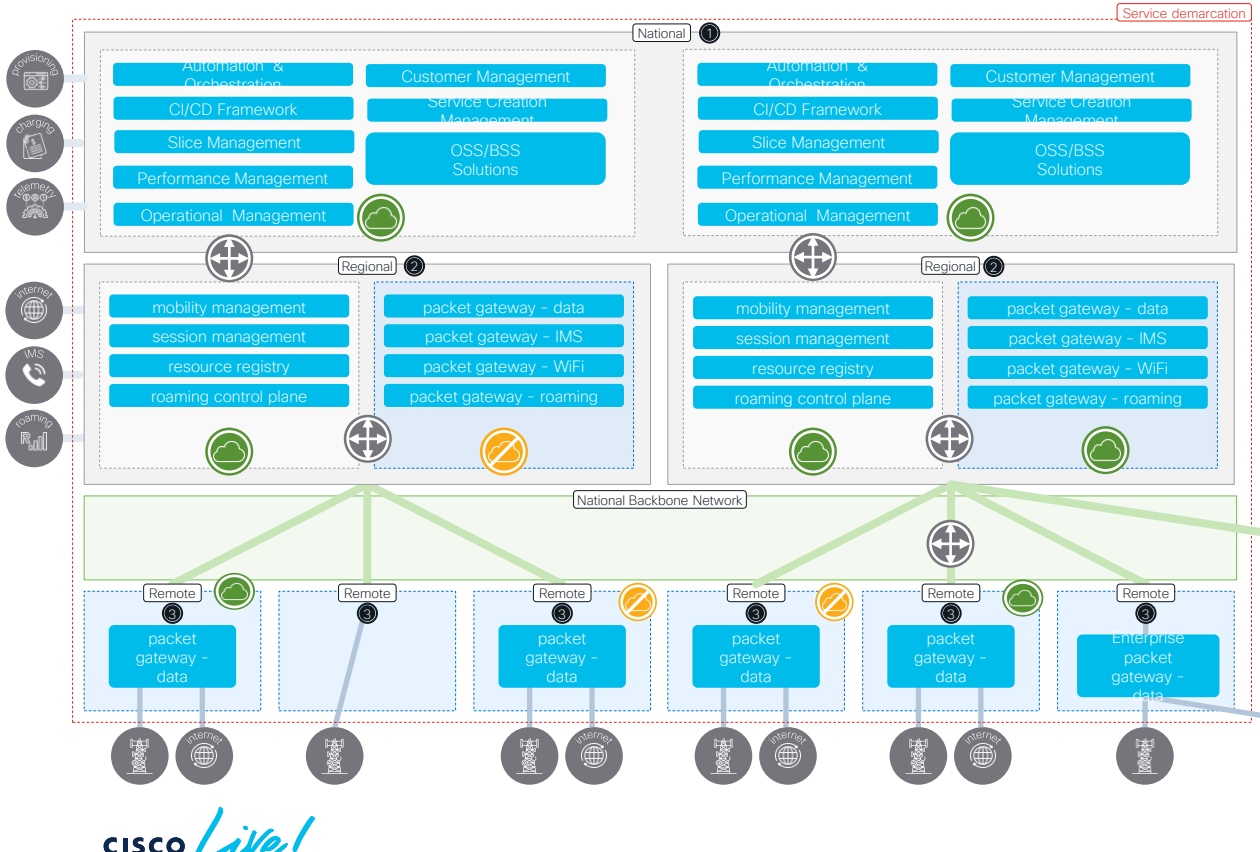
Introduction of Private wireless Service

Services & Personalization based on an Enterprise Slice approach



- Simple connectivity Model, Centralized (Sliced) Converged Core + MEC for Enterprise
- Complex routing (hair-pinning), ussues with Enterprise Data Sovereignty and Privacy Requirements
- Enterprise domain as an extension of MSP domain
- Enterprise has to adopt and accept MSP Deployment and management framework

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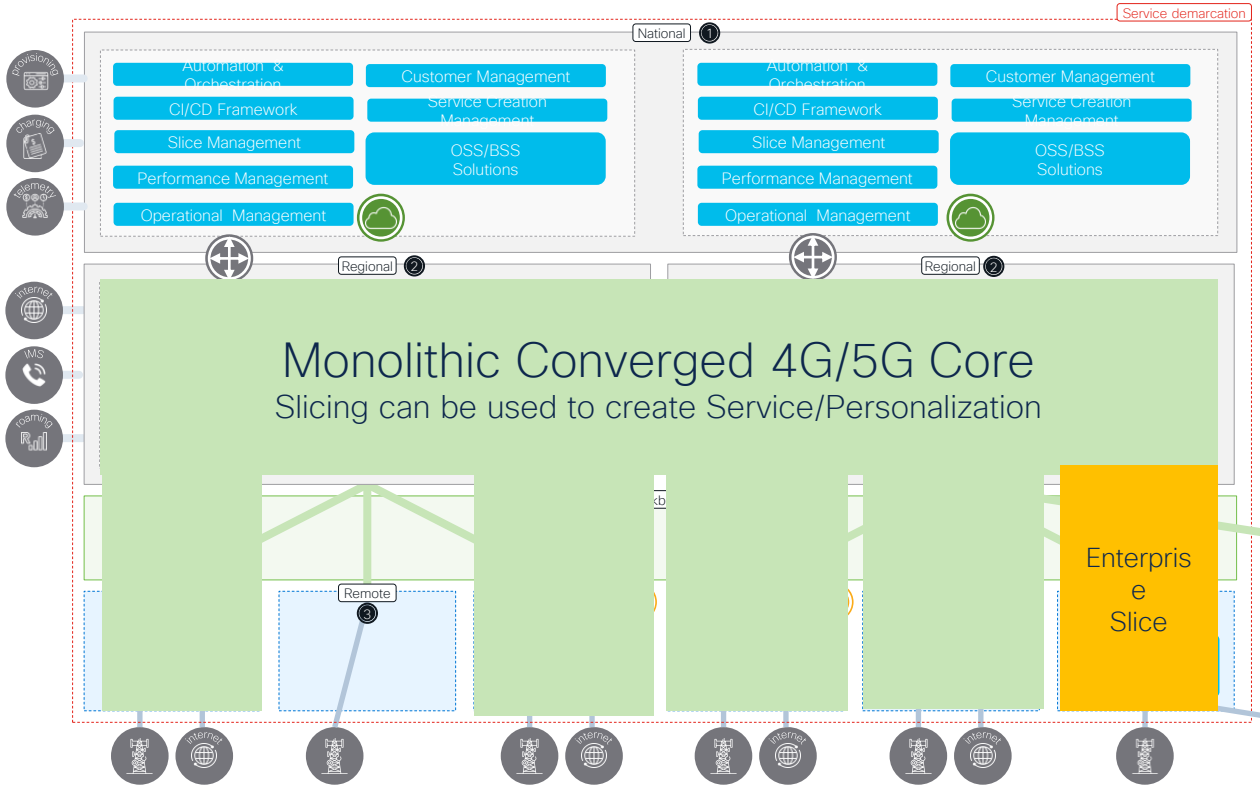
Introduction of Private wireless Service

Services & Personalization based on an Enterprise Slice approach



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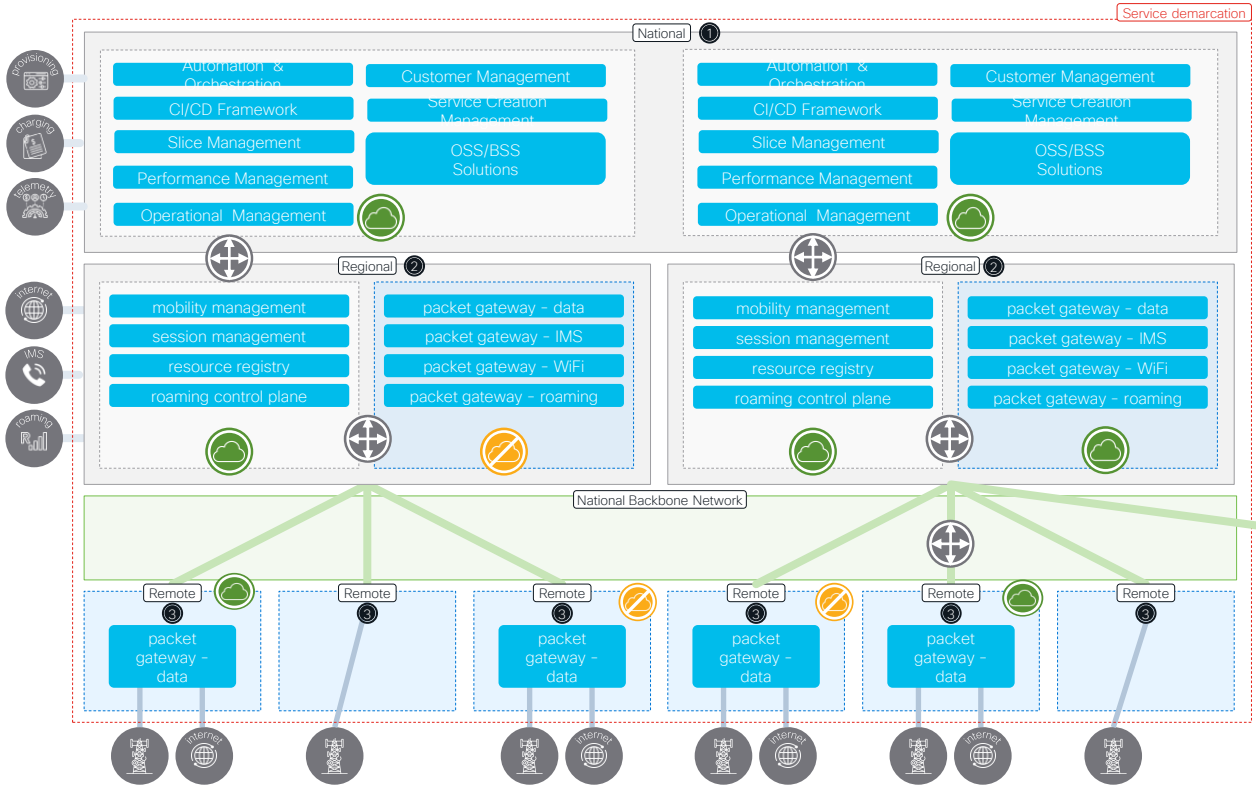
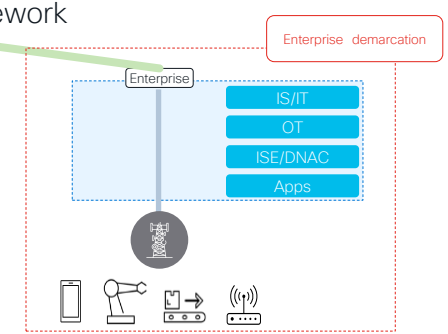
Introduction of Private wireless Service

Services & Personalization based on a Slicing + Private Radio Architecture





- Simple connectivity Model, Centralized (Sliced) Converged Core
- Complex routing (hair-pinning), issues with Enterprise Data Sovereignty and Privacy Requirements
- Enterprise domain as an extension of MSP domain
- Enterprise has to adopt and accept MSP Deployment and management framework

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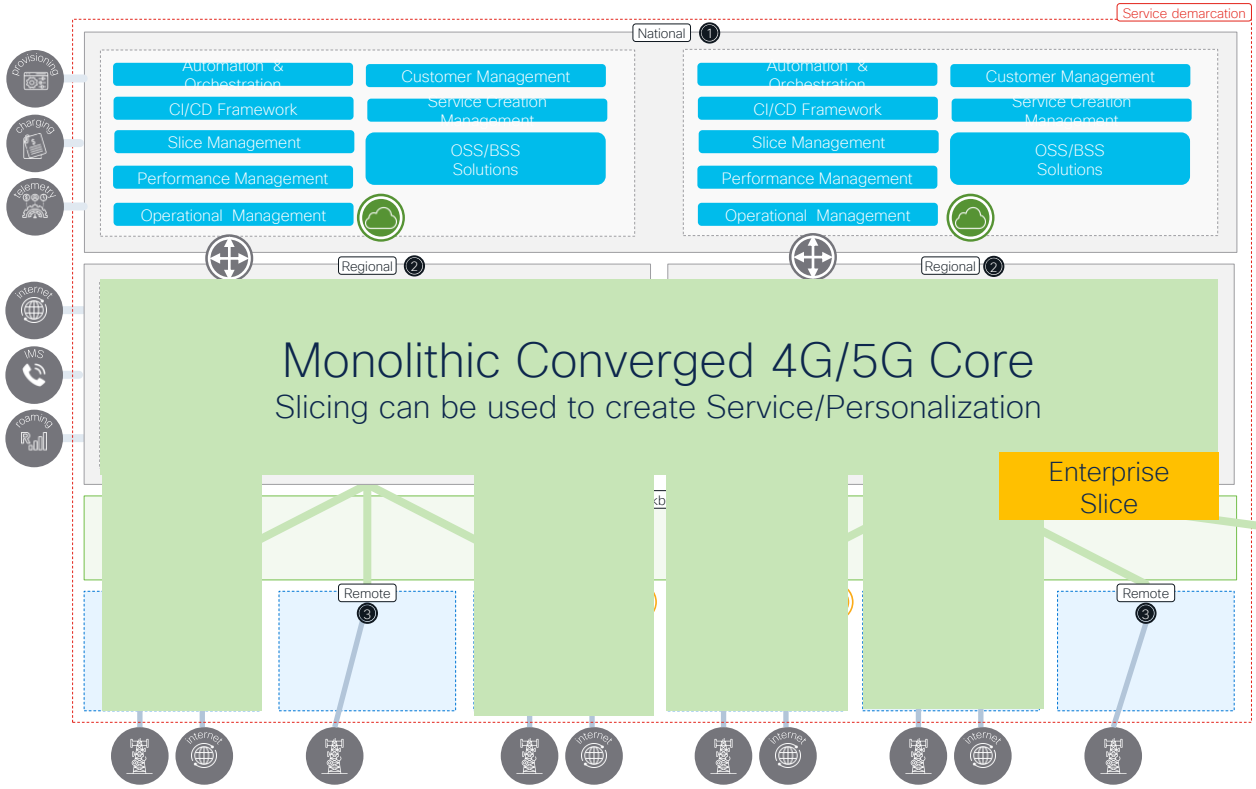
Introduction of Private wireless Service

Services & Personalization based on a Slicing + Private Radio Architecture



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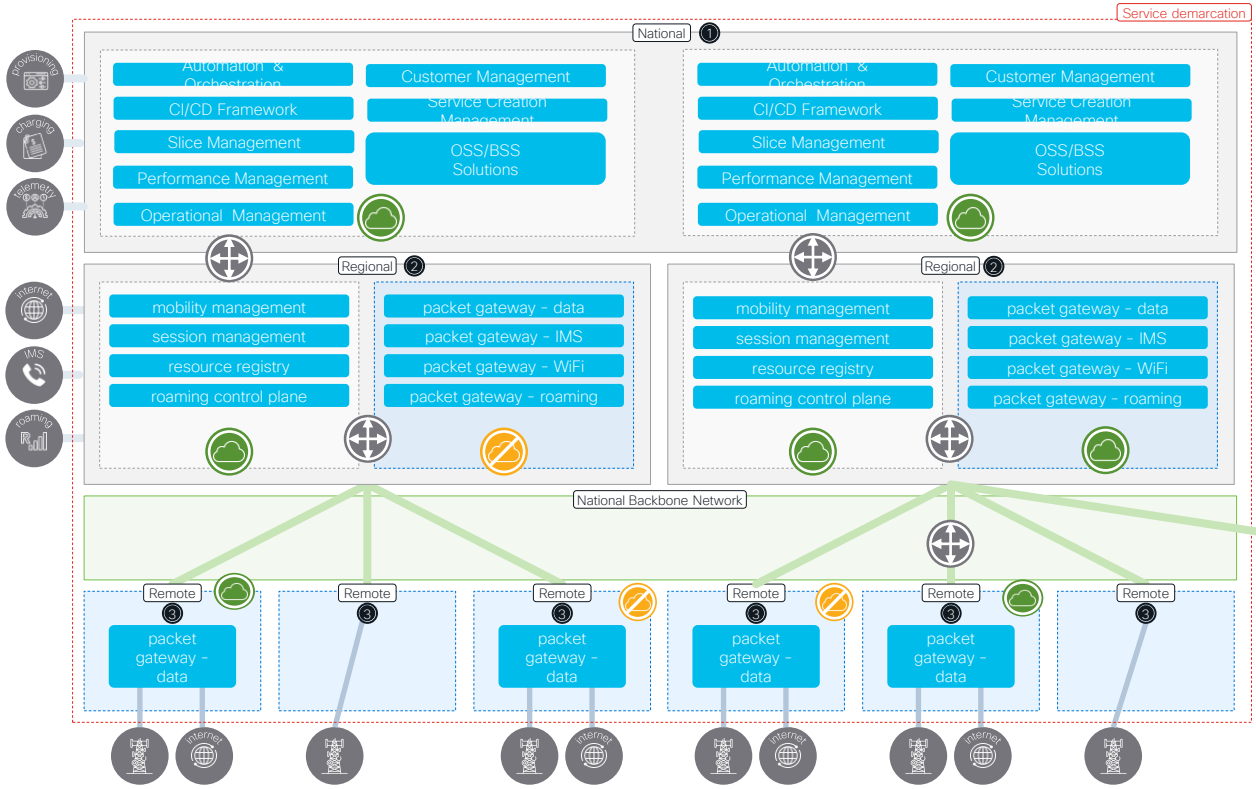
Introduction of Private wireless Service

Services & Personalization based on a Slicing/UPF on Prem Architecture



- Local Breakout for on-Prem UPF (Bearer) for Centralized (Sliced) Converged Core
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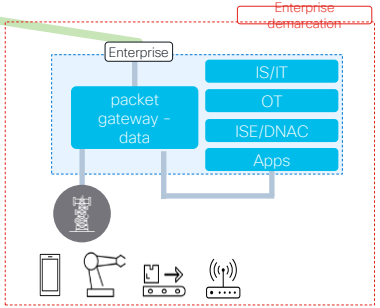

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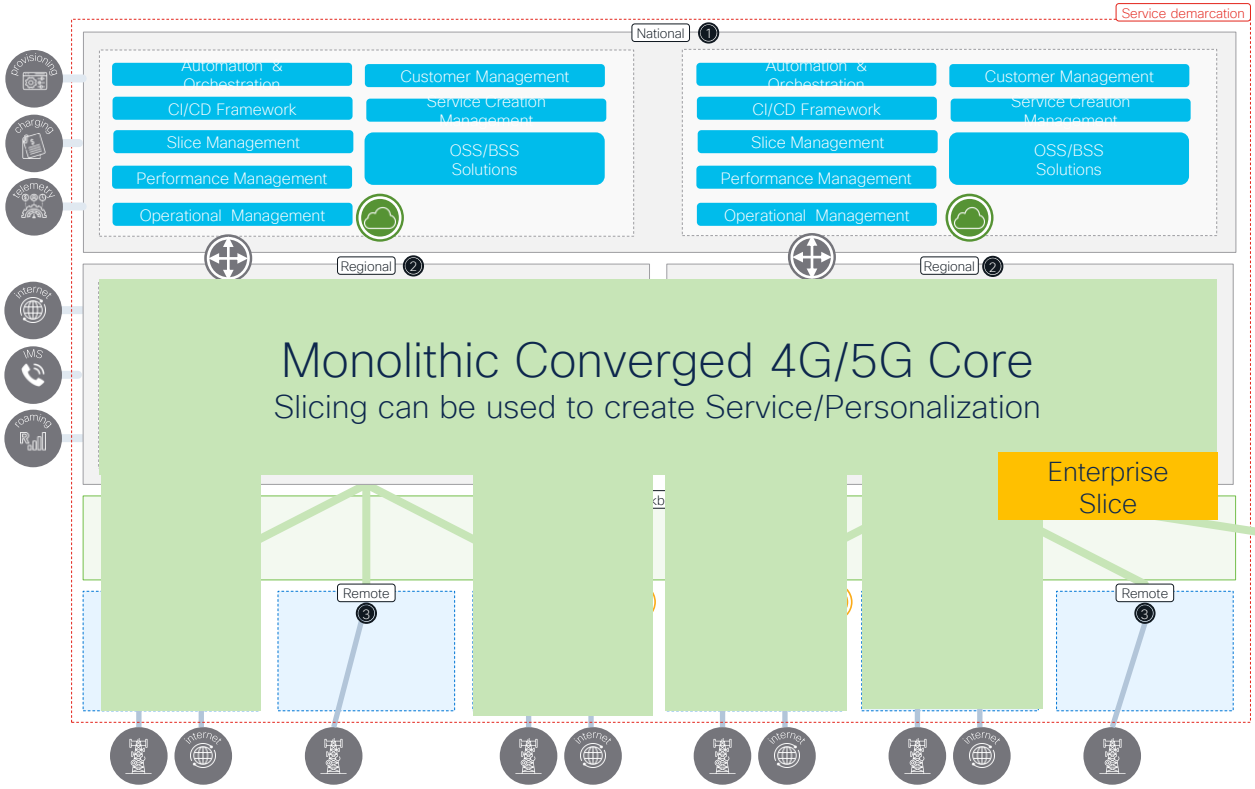
Services & Personalization based on a Slicing/UPF on Prem Architecture



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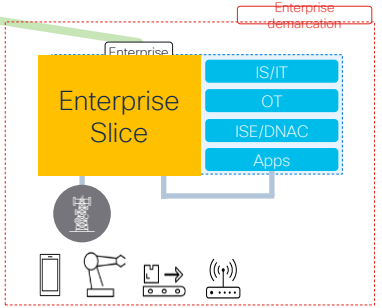

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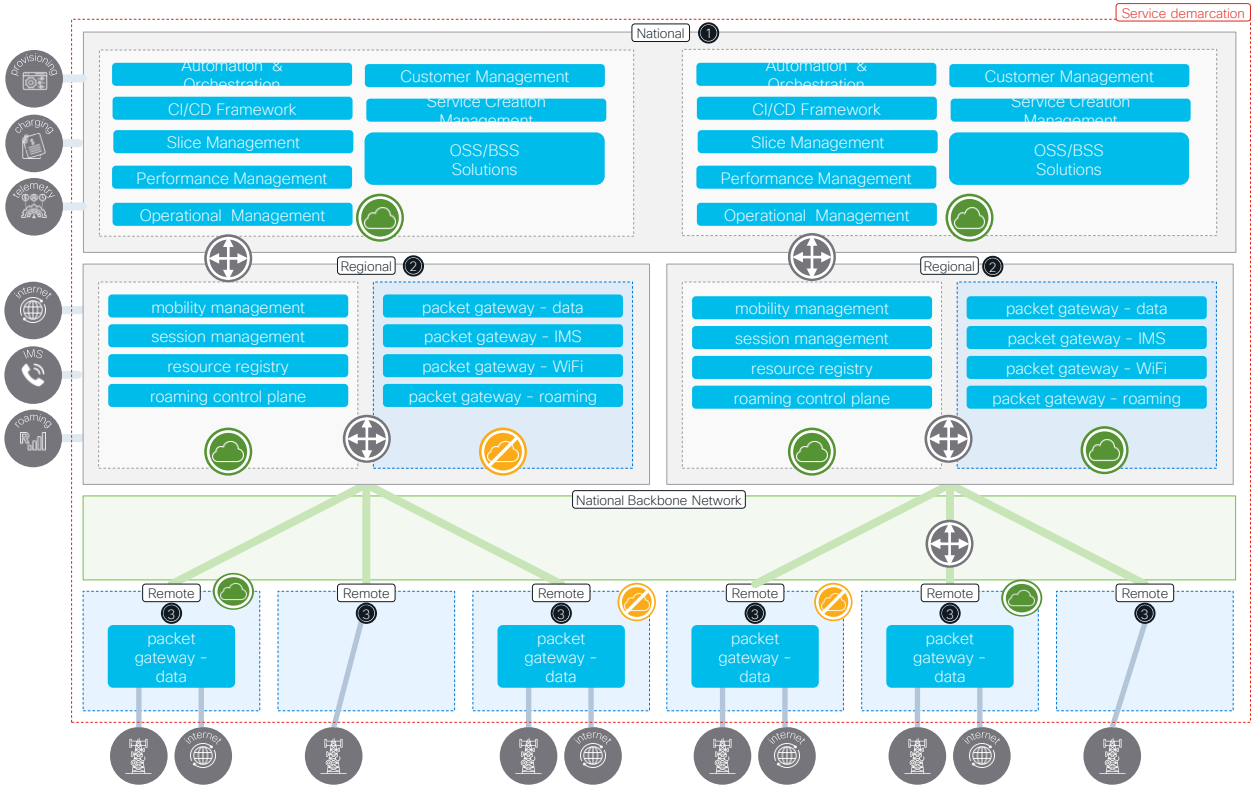
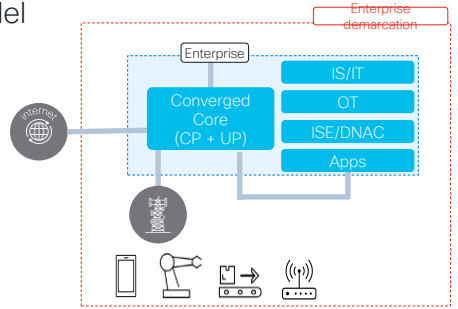
Introduction of Private wireless Service

Services & Personalization based on a Polylithic Core Architecture



- Polylithic Converged Core, 1 per Enterprise customer --> Personalized
- Control Plane + User Plane traffic now part of the Enterprise Customer domain
- Service Creation and Management is now external to the service delivery → Follow a multi-tenant-based Portal management framework.
- MSP does not have to integrate their backbone network with Enterprise Customer
- Enterprise adoption approaches a SaaS model



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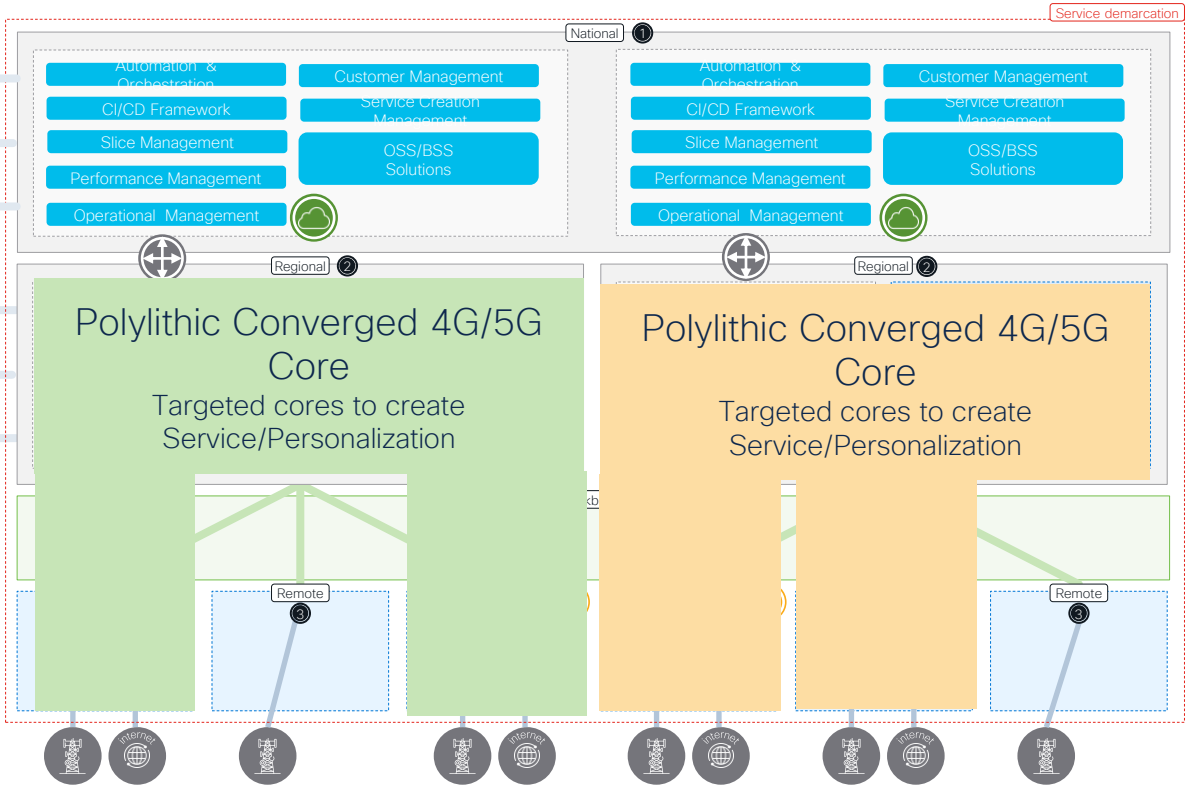
Introduction of Private wireless Service

Services & Personalization based on a Polylithic Core Architecture



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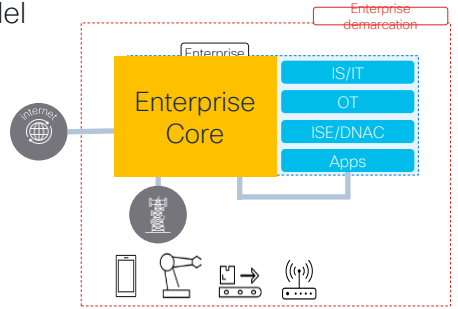

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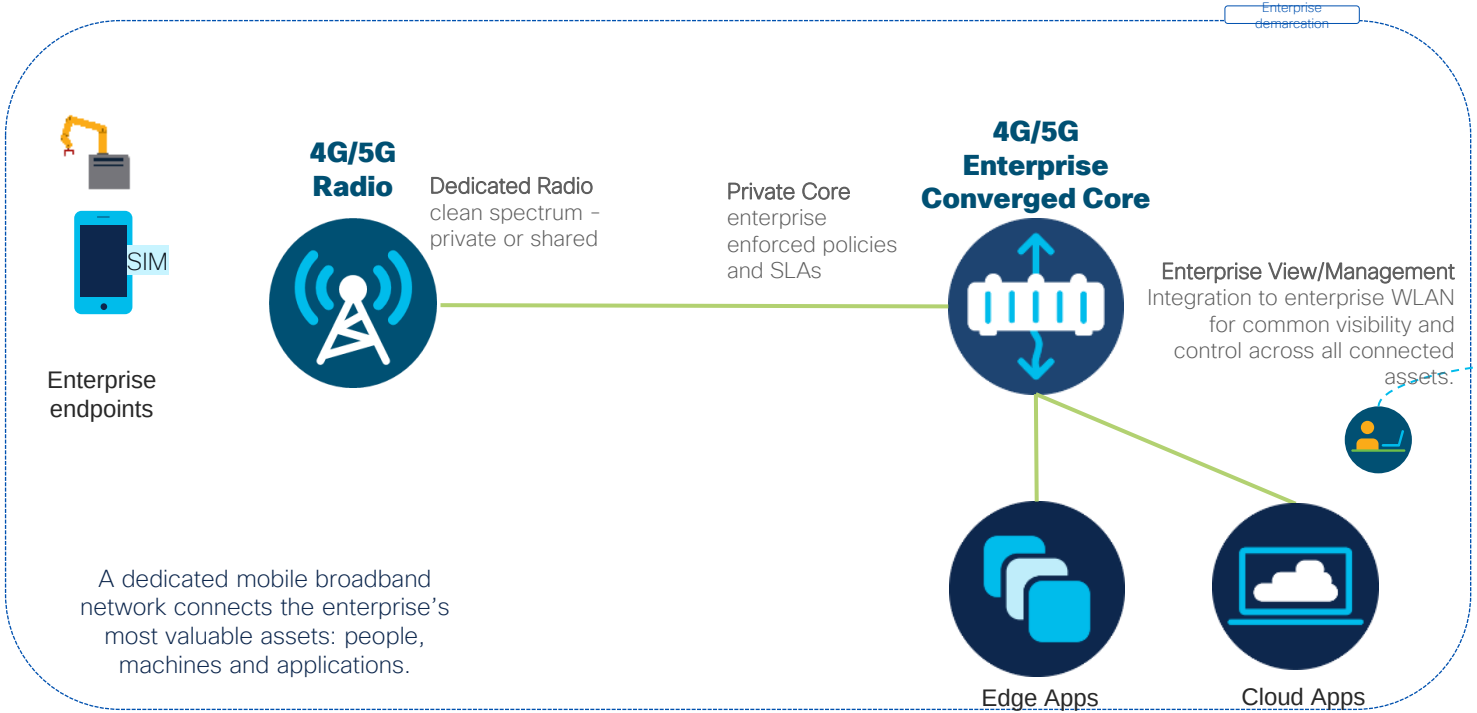
Cisco P5GaaS Offer

Based on Polylithic Cores + SaaS model



Cisco P5GaaS Control Center

Constant Upgrades & Enhancements
SaaS model enables rapid launch of new services

Network and Device Management

Simplified Management UX/API
Project Carrier functions & Capabilities to Enterprise.

Cisco Cloud

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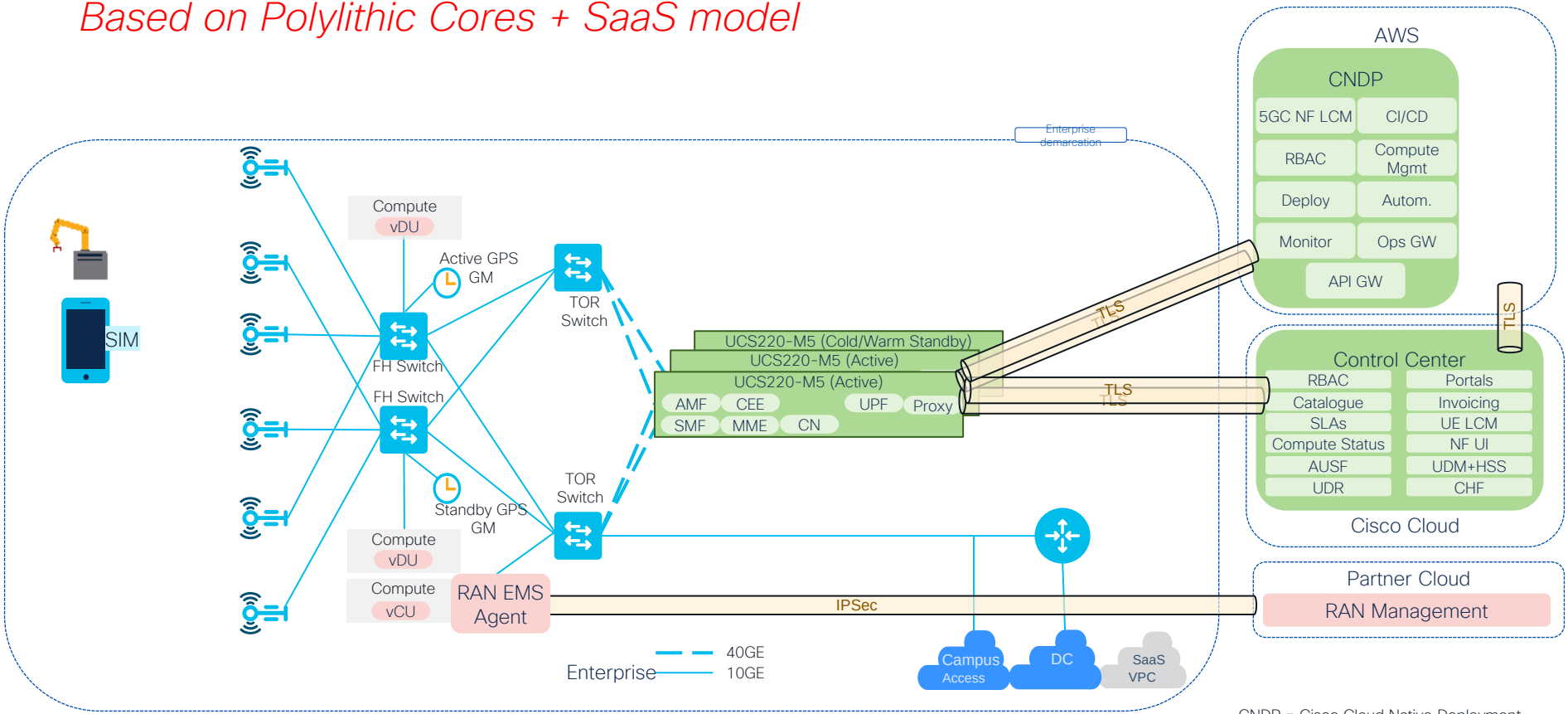
Cisco P5GaaS Offer (Detailed)

Based on Polylithic Cores + SaaS model



CNDP = Cisco Cloud Native Deployment Platform

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As a Result: Polylithic Cores & SaaS Models

Alternative Deployment Models

Use case driven

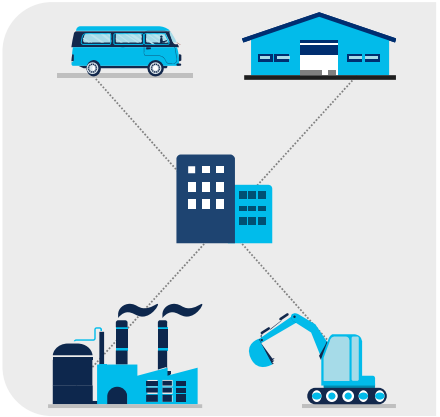
Start from the use cases, focus on cost, complexity and TTM don't not force-fit technology

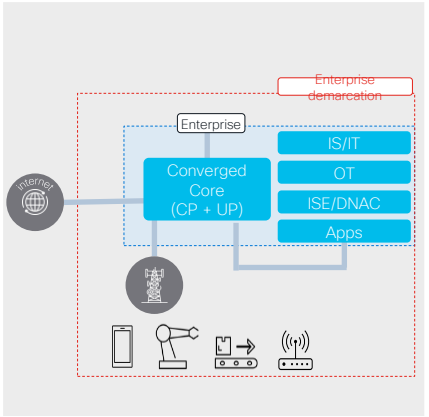
Polylithic Cores

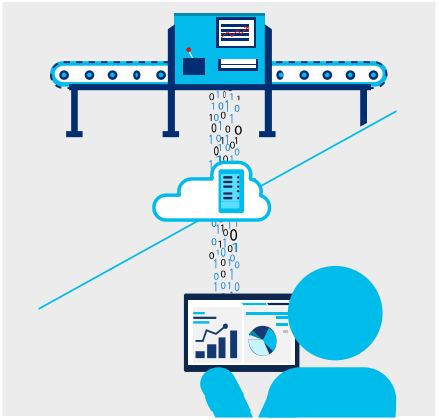
Every "solution" has its best applicable domain & Cost/Profit formulae which leads to rapid deployment & profits

SaaS Model

MSP are on a constant Build-Cycle: Rise of SaaS deployment strategies allows MSP to control both OpEx and CapEx







Where's the ARPU? Diverse use cases naturally asks for to multi-access technologies & distinct "Core" functions to optimize cost

Each use-case represents a different approaches & constraints, a "one-size" fits all might be ideal, but not timely

Market adoption of services is based on results: IT and OT integration mean private and personalized (core) services

Consumption of services by high-ARPU customers needs to focus on a SaaS model as the leading adoption model

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