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The bridge to possible

Monolithic or Polylithic Packet Cores?

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

Derick Linegar, Technical Solutions Architect

BRKSPG-3004

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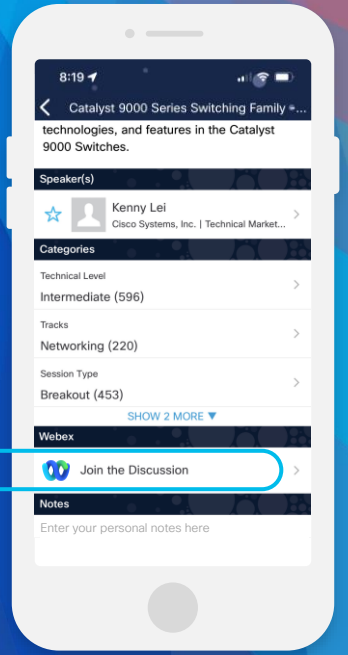

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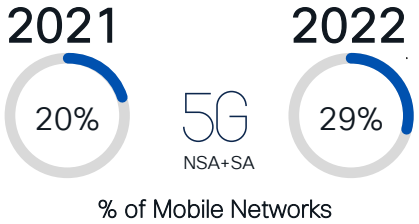
Agenda

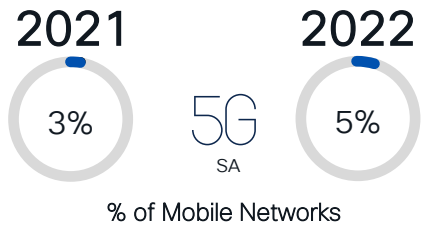
- 5G Status & Deployment Challenges
- 5G Monolithic Core & Slicing Approach for Services
- “Polylithic” Cores as an alternative Approach for Services
- Example PWN Service Creation

5G Commercialization: Status



Sources: GSMA Intelligence, December 2021, 5G Data provided by TeleGeography & 5G Americas as of 01/16/2023. 5G SA Data from Counterpoint Research 5G SA Core Tracker, January 2023. Total Worldwide MNO data from GSMAi, February 2023.

5G SA Commercialization: Status



Sources: GSMA Intelligence, December 2021, 5G Data provided by TeleGeography & 5G Americas as of 01/16/2023. 5G SA Data from Counterpoint Research 5G SA Core Tracker, January 2023. Total Worldwide MNO data from GSMAi, February 2023.

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

5G Mobile Architecture

A Foundational Shift in how Services is delivered to Consumers/Enterprises

5G Introduces Radical Shifts in the following key areas for Operators:

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

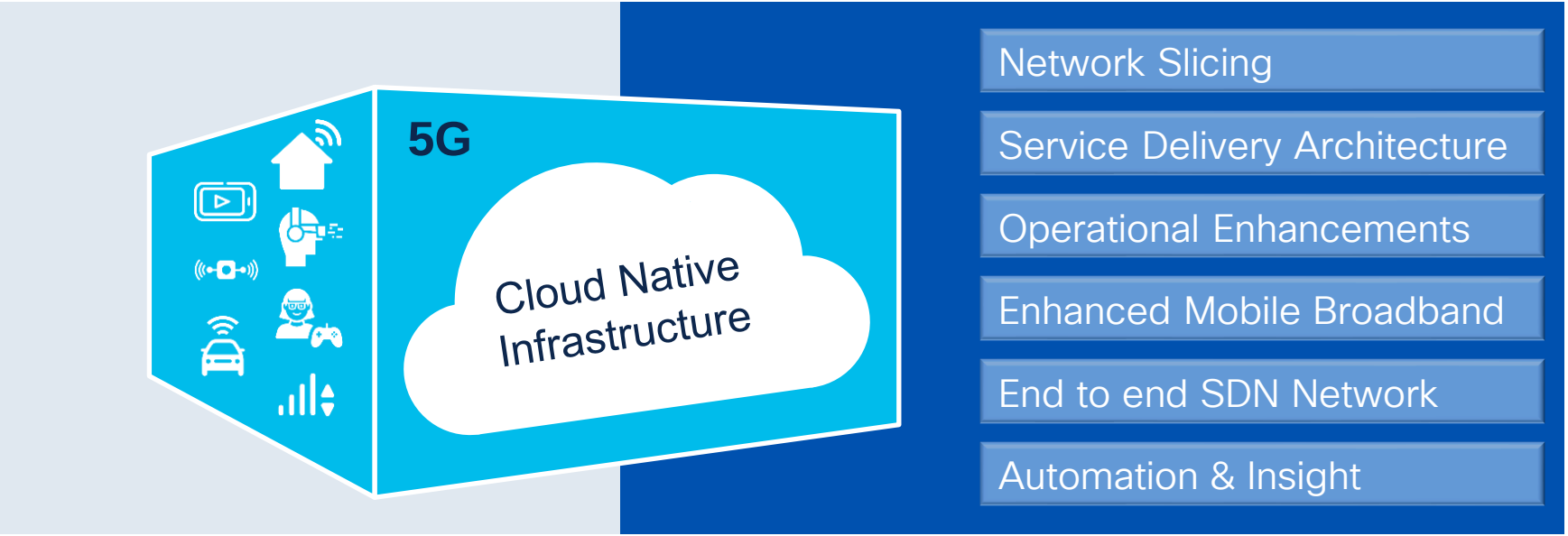
Closed Loop
Multi Domain
Network Slicing
Service Assurance

5G & WiFi-6/7 — 3GPP Mobile Core

Recipe for today's Next Generation SP Networks

5G Utilizes a Cloud-Native Architectural Approach

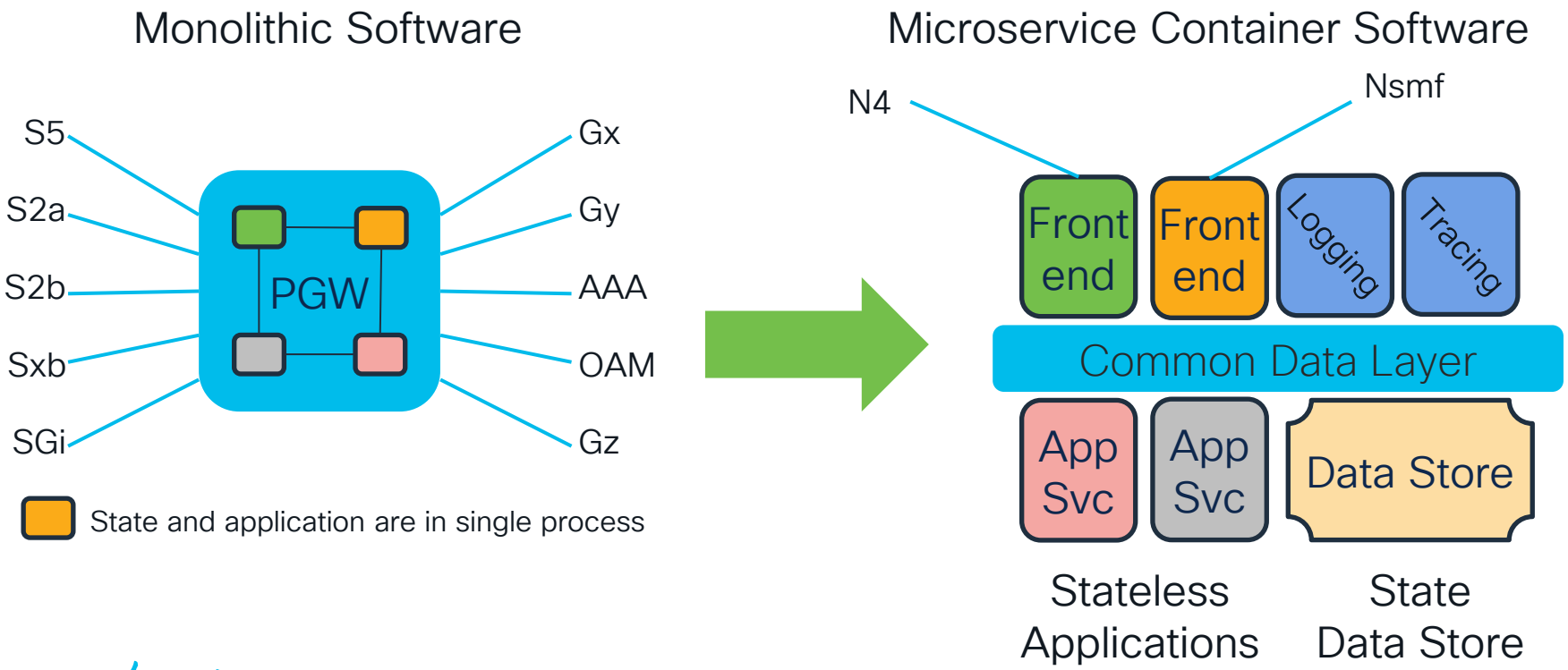
Foundation for Scale, Speed and Flexibility



Scalable Distributed Programmable

Result: 5G Cloud Native Mobile Core S/W Principle

Software Process Separation



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

Result: 5G NF Micro Services

SMF NF Pod List

- Each Network Function (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

5G Cloud-Native Approach: Accelerate Service Creation

The Future Calls for Rapid and Personalized Services

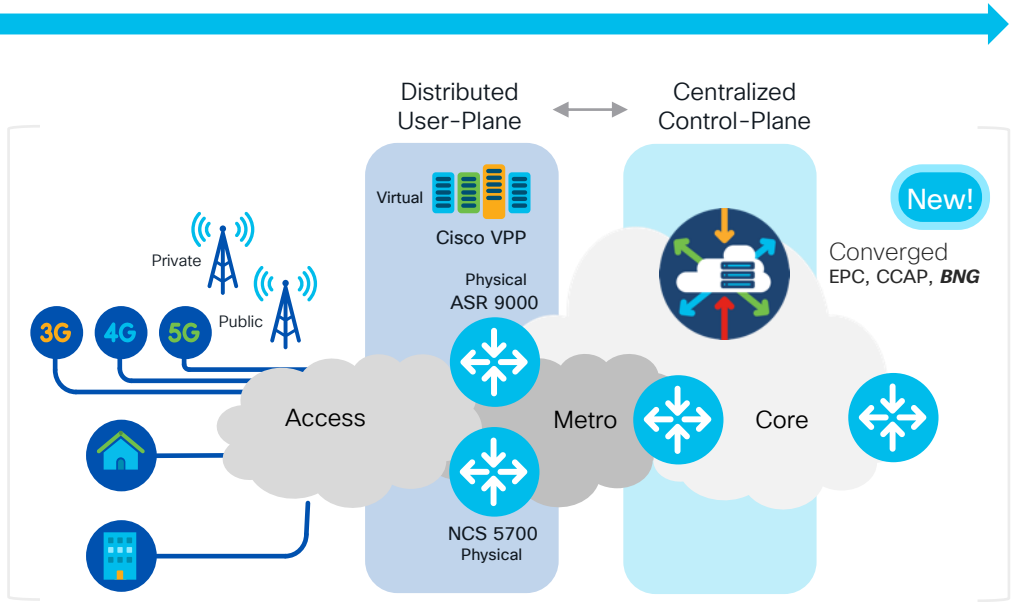
Architectural Improvements

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

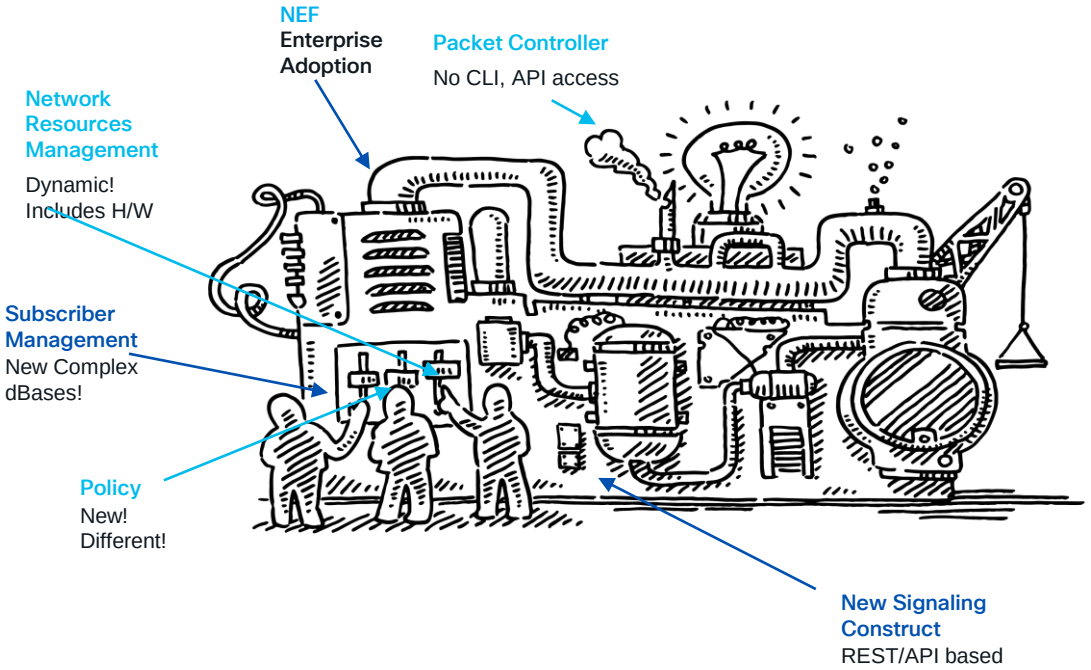
Expand to MNO or MVNO

Enterprise Use-cases

Private LTE & 5G

Seismic Shift in How MSP Now have to Operate Networks

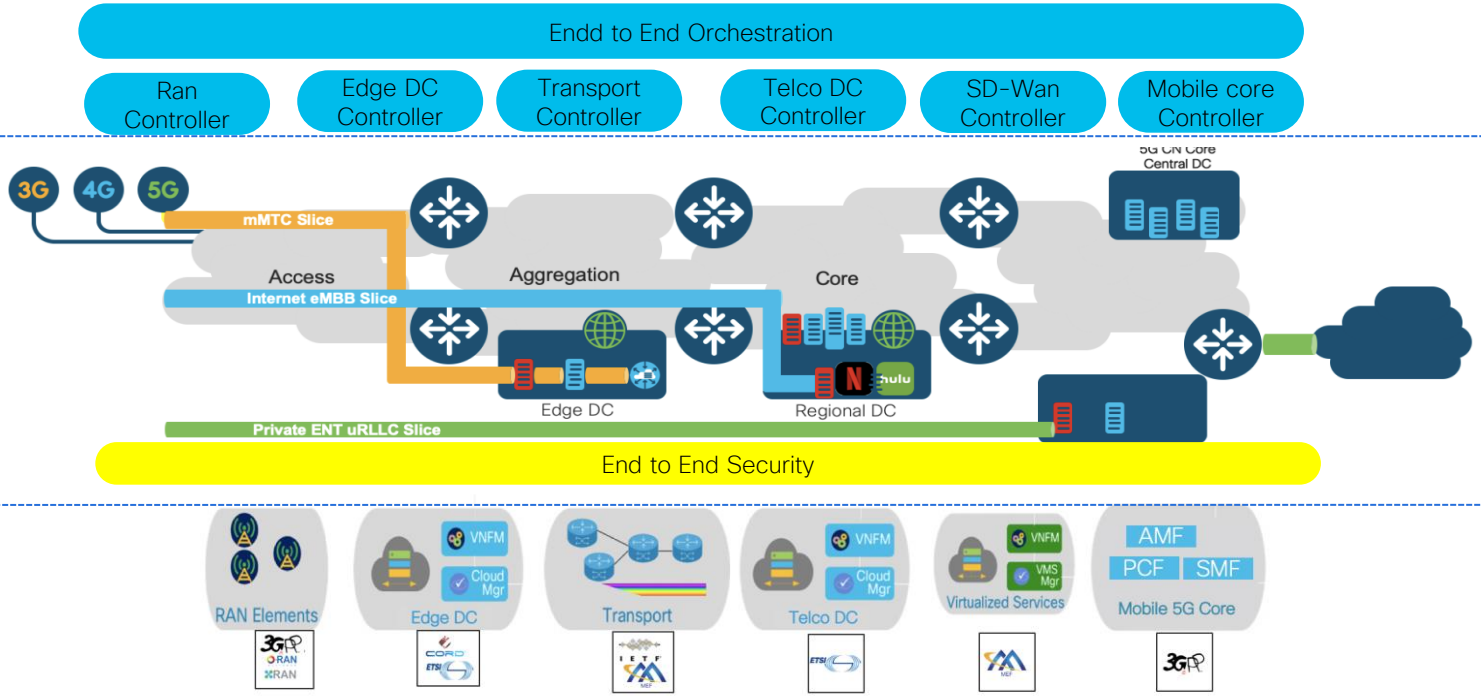
- In this world having an API is not OAM!
- Horizontal Scaling! But hos is Cost handled?
- Now you have a Zoo of Micro Services. Management is different.
- The scale of Micro services means more complexity and associated Risk
- **Result:** All ancillary and support systems will have to change!



By The way, 5G Services Deployment Approach

Based on End-to-End Slicing Concept.....

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



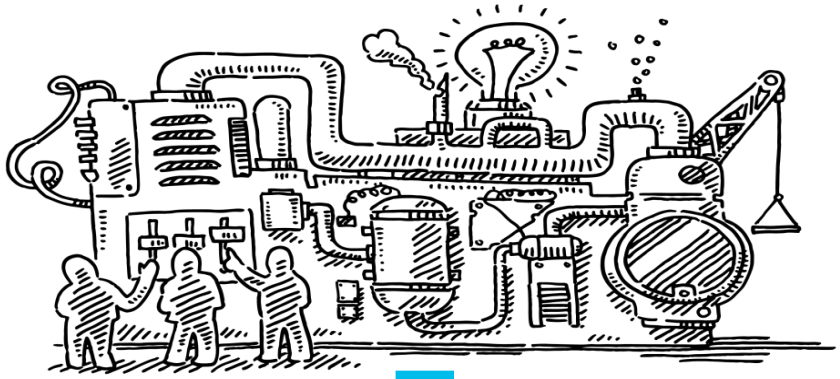
Orchestration offering Network as a Service

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

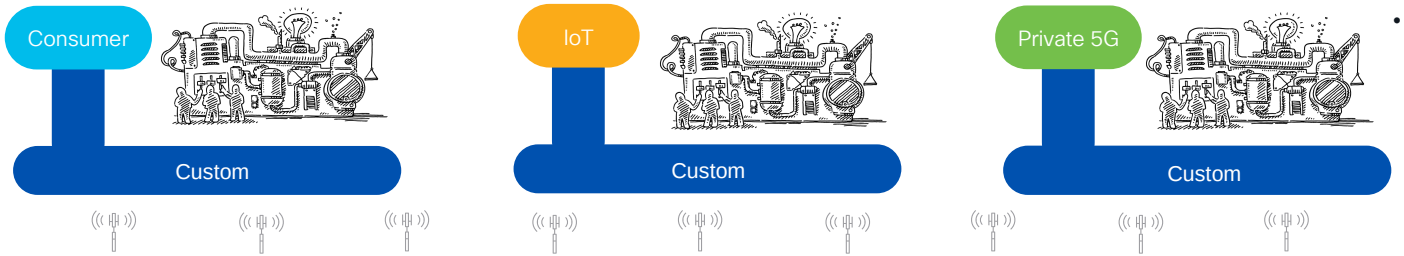
Cross Domain Service based on Multiple standard

New Reality of Dealing with Multiple Use-Cases

5G-SA Core + Network needs to ”slice”…?!?



BSS & IT



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 increases with dis-aggregation.

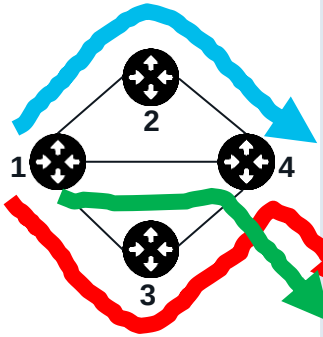
3GPP Network Slicing Promise is Enticing!

End-to-end treatment of traffic for different traffic types.

Slice #1

Slice #2

Slice #3



NSSF

UDM

NRF

AMF

AMF

SMF

UPF

SMF

UPF

SMF

UPF

PCF

IPS/IDS

PCF

5G

User ***Access*** ***Transport*** ***Monolithic Core Functions***

Sooo… Network Slicing is the answer?

What is in a Slice?

3GPP Definition:

*A given User Equipment (UE) may access to multiple **slices** over the same Access Network (e.g. over the same radio interface). Each **slice** may serve a particular service type with agreed upon Service-level Agreement (SLA).*

Short Version:

Slice(x) = Connectivity + Service Treatment + SLA

Example:

Slice(x) = [ip traffic from “a” to “b”] +
[traffic inspection, NAT, FW, DDoS, etc.] +
[within 5ms @ 6x9 of availability]

Some Network Slicing Observations...
From a Casual Networking Architect's point of view

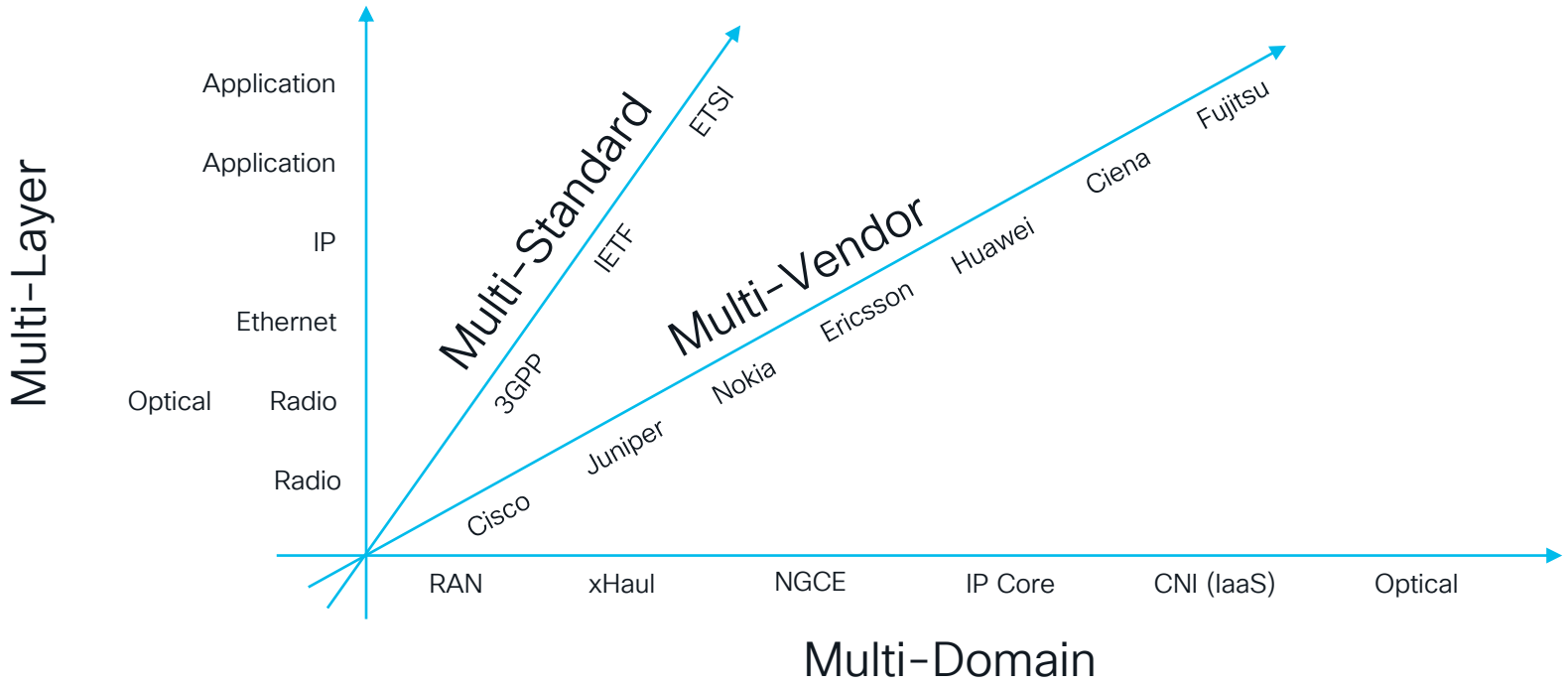
Very Important Notes:

- "Slicing" (at least in the context of 3GPP) is a user (or device/app) initiated function, not a network-initiated function (but it _could_ be if you are not a 3GPP fanatic ☺
- A user/device/app can belong to more than one slice (not always evident)
- The intermediate points in a slice do not matter unless they are specified in the service itself
- A slice can evolve (it is not an immutable concept, or is it?)

Operationally, to make slicing happen, an SP can use three approaches:

1. Pre-create slices with pre-defined SLA's (GOLD/SILVER/BRONZE) then assign the devices/users/apps to that slice
2. Pre-create slices, pre-create SLA profiles, and associate SLA to slice depending on the request
3. Create slices and SLA profiles on-demand, assign on demand...
4. Do nothing, just ***overbuild the heck*** out of the network and let generic QoS DiffServ, etc. sort it out...

The 4D of Slicing: Lots of Moving Parts



Status of Slicing for a “Monolithic-Core” approach

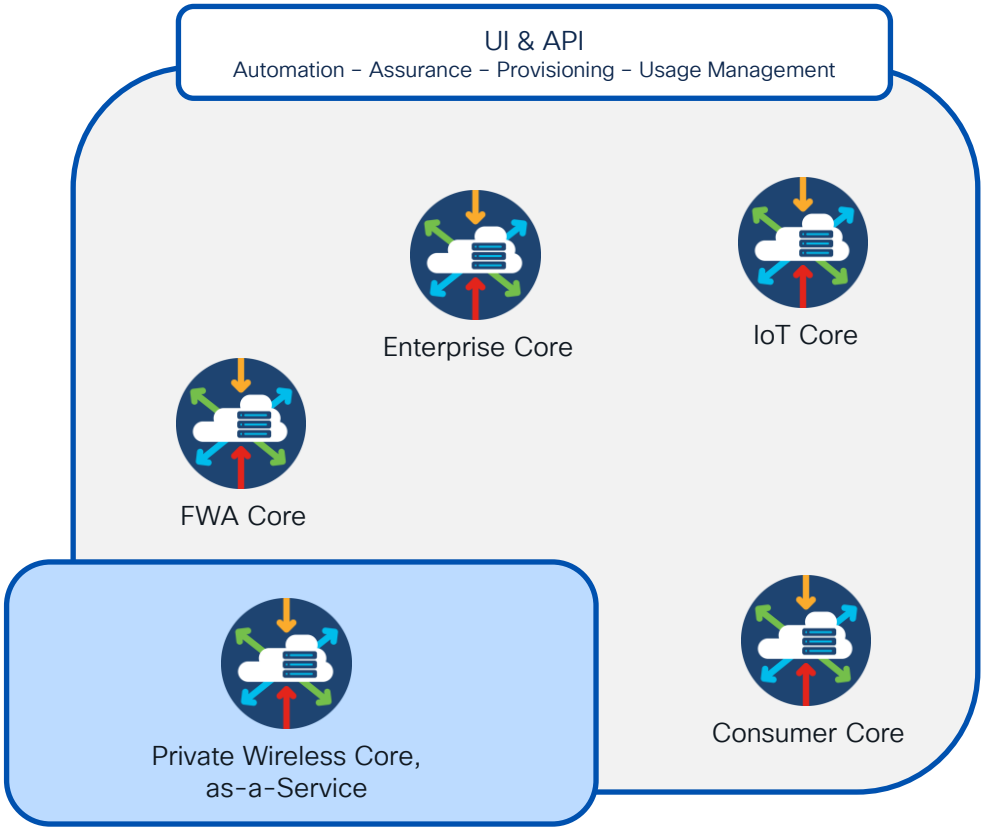
- Eco-System is still developing, some say in its infancy
- Handsets/UE not implementing optional parameters, forcing delays in implementation
- Slicing has to be implemented EVERYWHERE to be ready and useful
- Automation/Orchestration complexities & challenges, which is preventing rapid adoption
- Multi-Standard Cooperation and Coordination
- Cost… Cost… Cost…

Network Slicing

Alternative Approach: Polylithic Mobile Cores

Utilize a "best-of-breed" approach

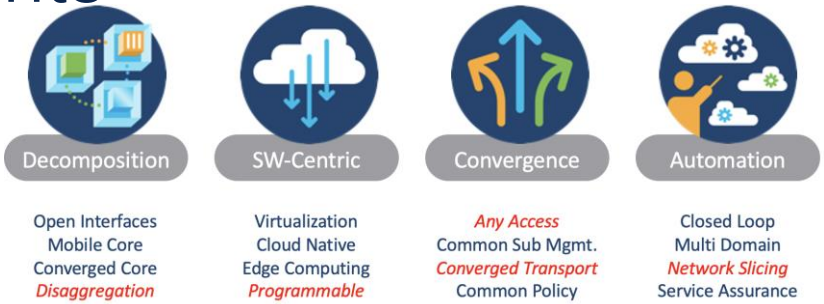
- Use multiple "standalone", or Polylithic (Cloud Native-based) Mobile Cores focused on specific use cases (FWA, PWN, URLLC, IoT)
- Complexities of having a fully-backed slicing infrastructure are not needed
- Automation "solves" the many core operational costs → No slicing is required! MSP can now pick 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.

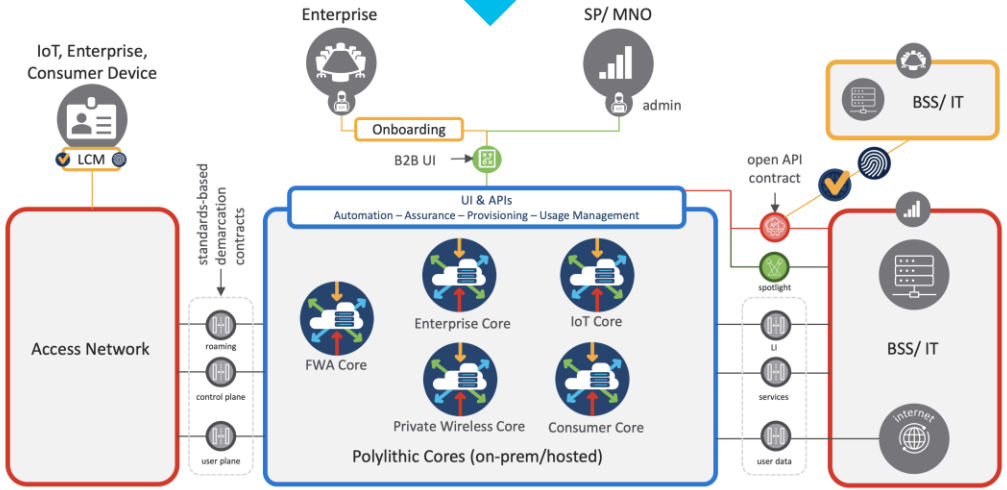


Polylithic Cores Deployments

Benefits

- The approach is not new (done in 4G/EPC) successfully for years.
- 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.

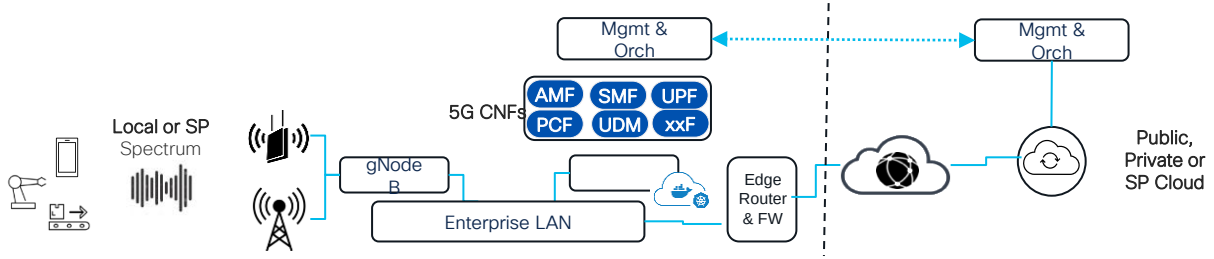




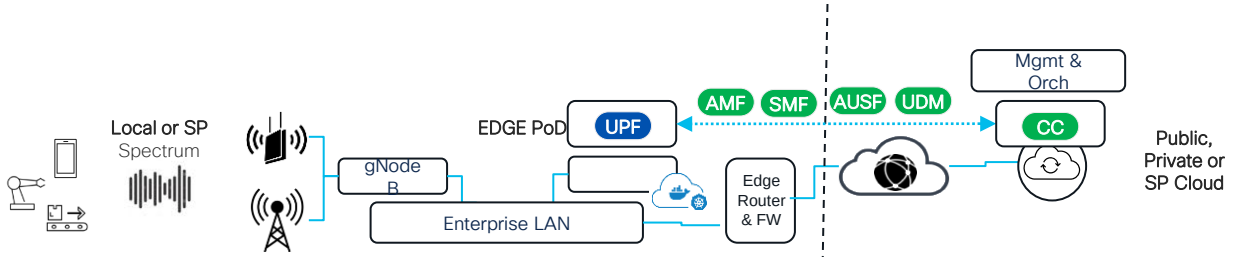
Why Do I Care? Approach Choice Determines Suitability

Example: Private-5G Services

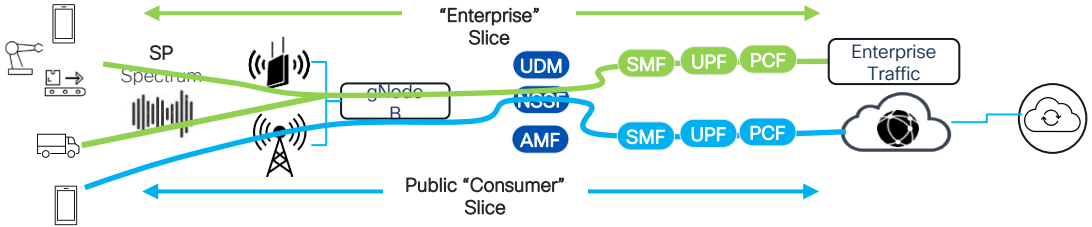
"True" Private 5G Deployment



Polylithic Private 5G Deployment

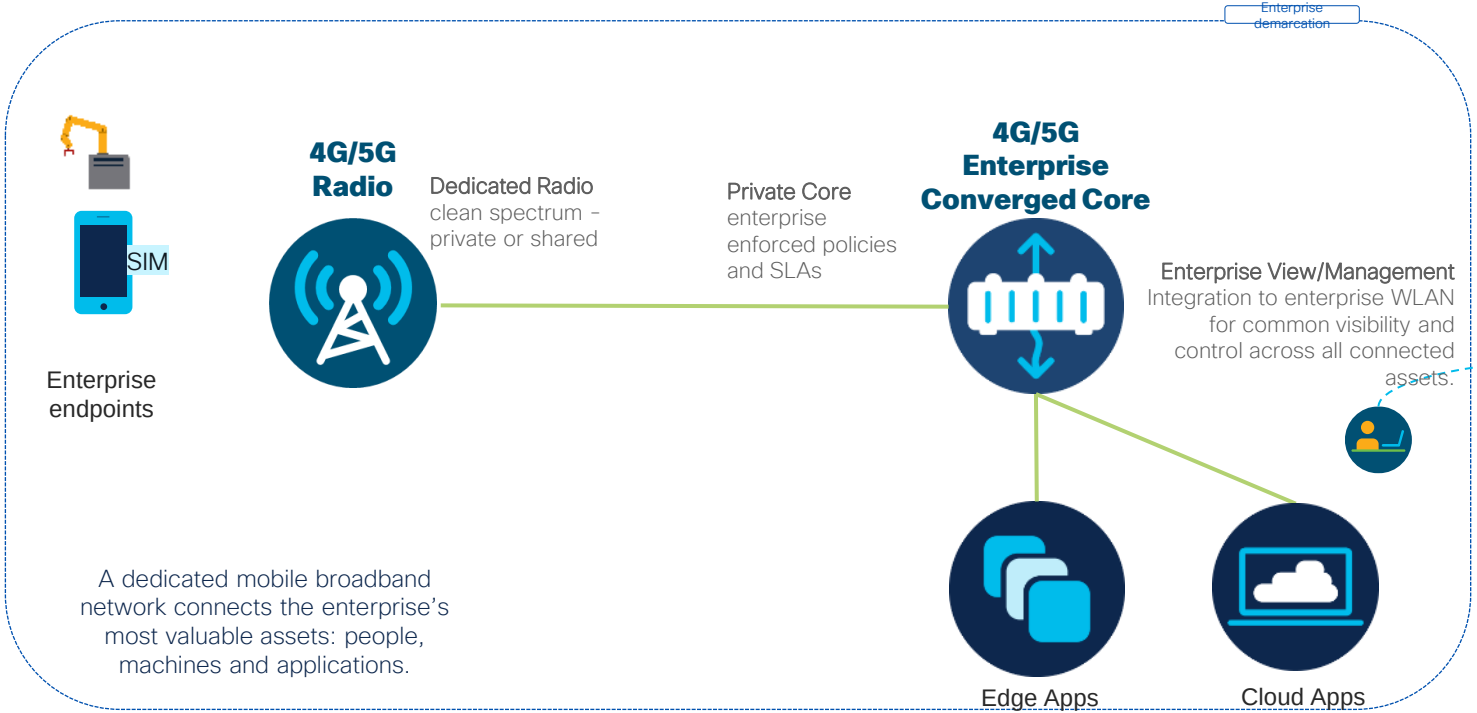


MSP Slice 5G Deployment



Example of a Polylithic based Approach: Cisco P5GaaS

Based on Hybrid/Polylithic Cores + SaaS model



Cisco P5GaaS Control Center

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

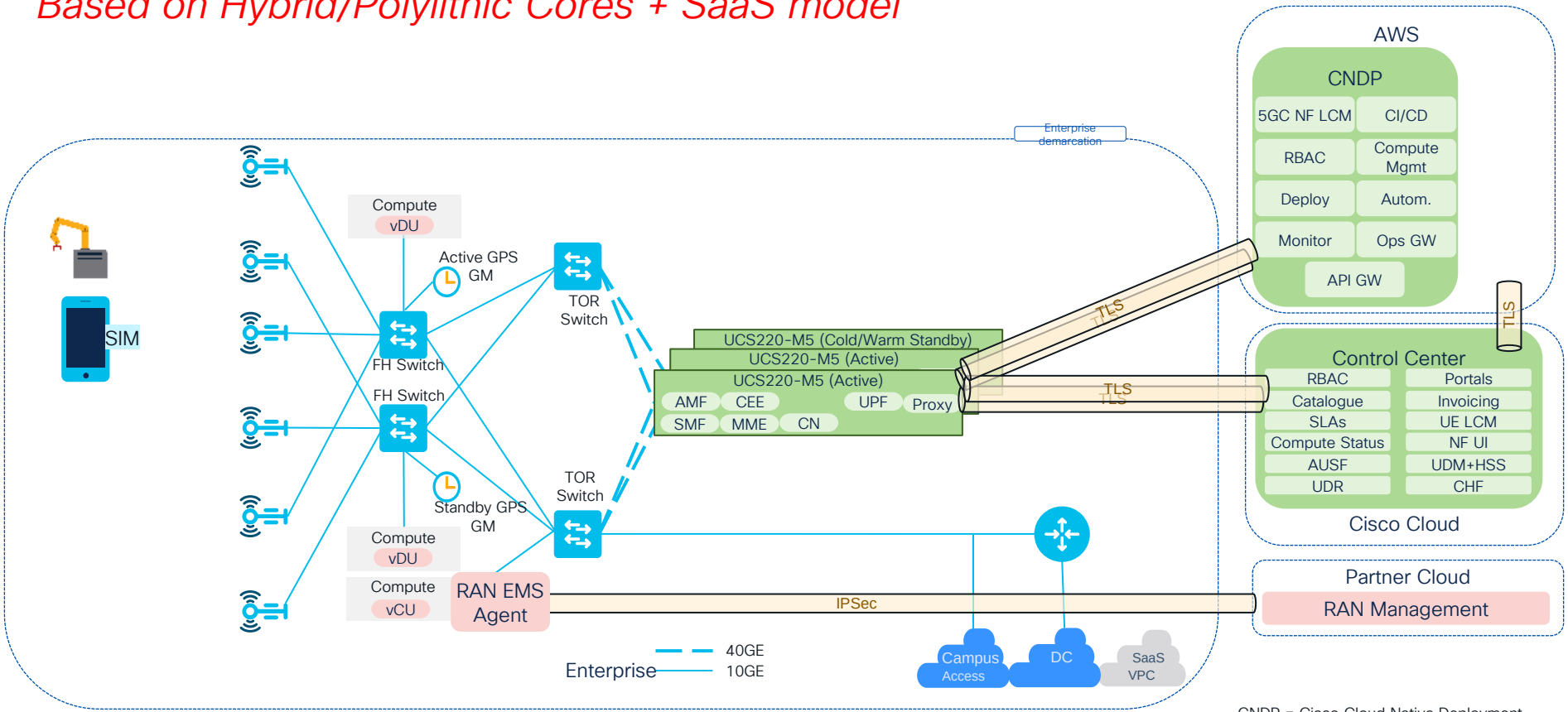
Network and Device Management

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

Cisco Cloud

Cisco P5GaaS Offer (Detailed)

Based on Hybrid/Polylithic Cores + SaaS model

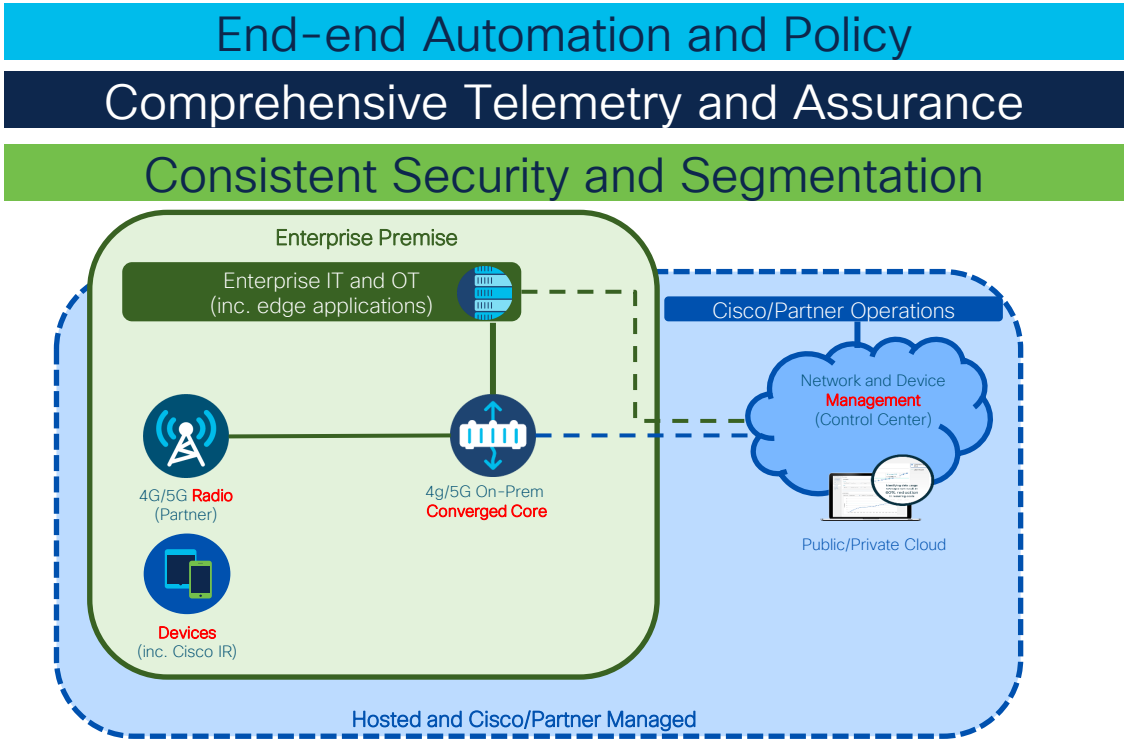


CNDP = Cisco Cloud Native Deployment Platform

Polylithic Approach for P5G: Best-of-Breed Benefits

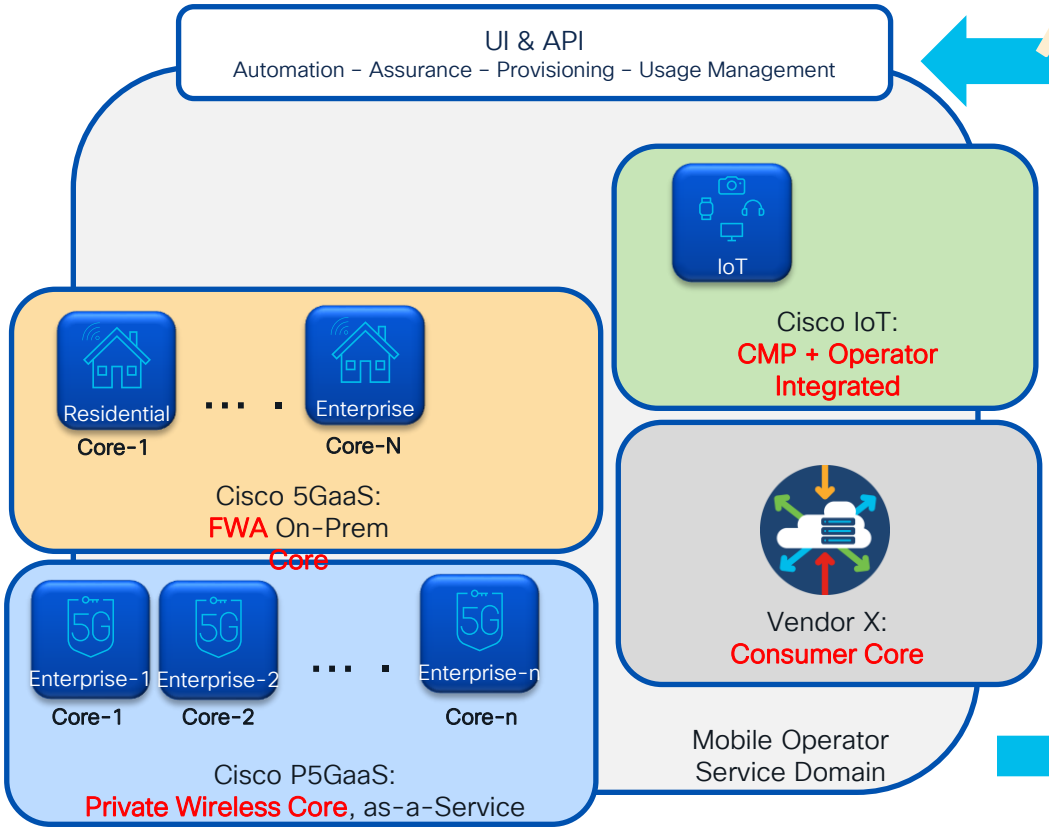
Addresses needs of the Enterprise, now!

- Independent from the Consumer Core
- Enterprise Private Transport
- Common Enterprise Policy
- Enterprise Security Integration
- Cisco Endpoint/IoT GW Integration
- Consolidated Insights & Analytics
- Unified Identity Framework
- Private & Public Mobility
- Unified Enterprise Operations



SP adoption of Polylithic Cores: TTM and Risk Containment

Exampe of Fixed Wireless 5G



- Operator "Chooses" a new Service: FWA
- By following the ethos of a Polylithic Core Deployment model, an FWA optimized aaS is chosen

- Benefits: TTM, cost-reduction, consumption-driven "no surprises" OpEx/CapEx, and architecture simplification (best-of-breed selection and operations) based on proven approaches

Polylithic Cores facilitates adoption aaS Options for SP's

Massive Time to value improvement

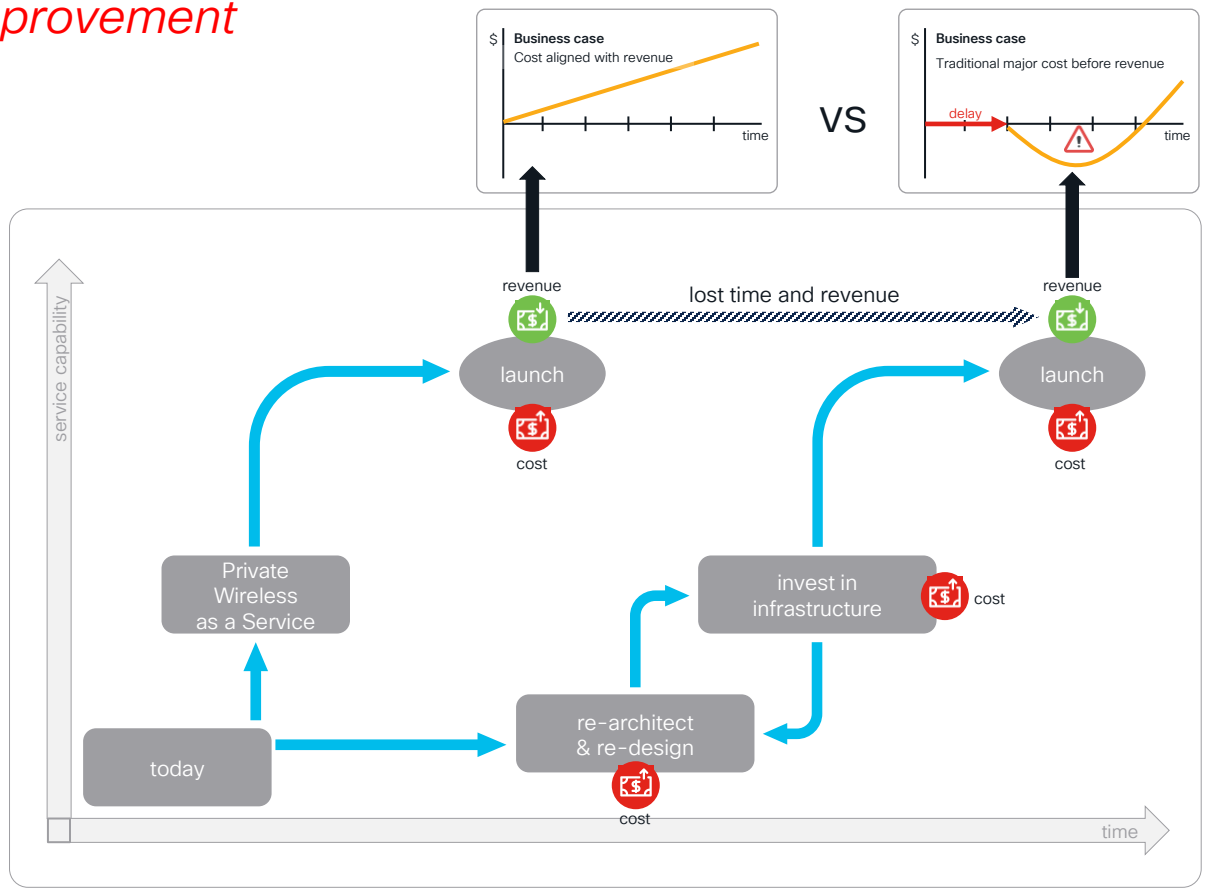
Benefits:

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)



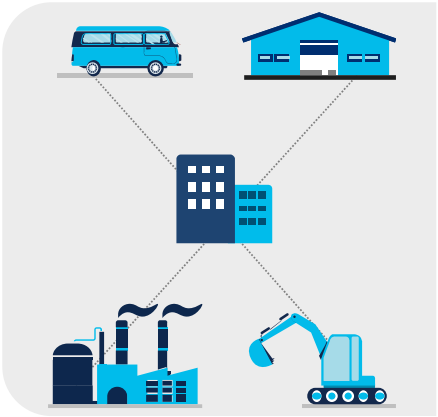
Summary: Polylithic Cores Approach & aaS Models

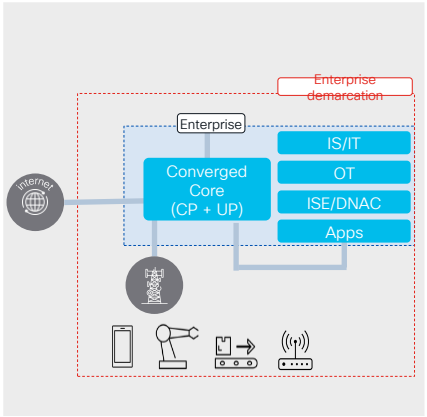
Use-Case driven Services tied to Flexible Architecture

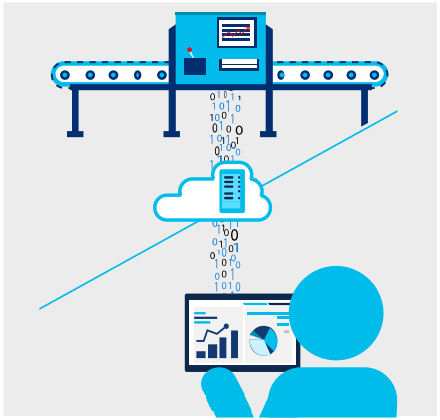
Use case driven
Start from the use cases, focus on cost, complexity and TTM don't not force-fit technology

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

aaS 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

Questions?

Fill out your session surveys!

Attendees who fill out a minimum of four session surveys and the overall event survey will get **Cisco Live-branded socks** (while supplies last)!

Attendees will also earn 100 points in the **Cisco Live Challenge** for every survey completed.

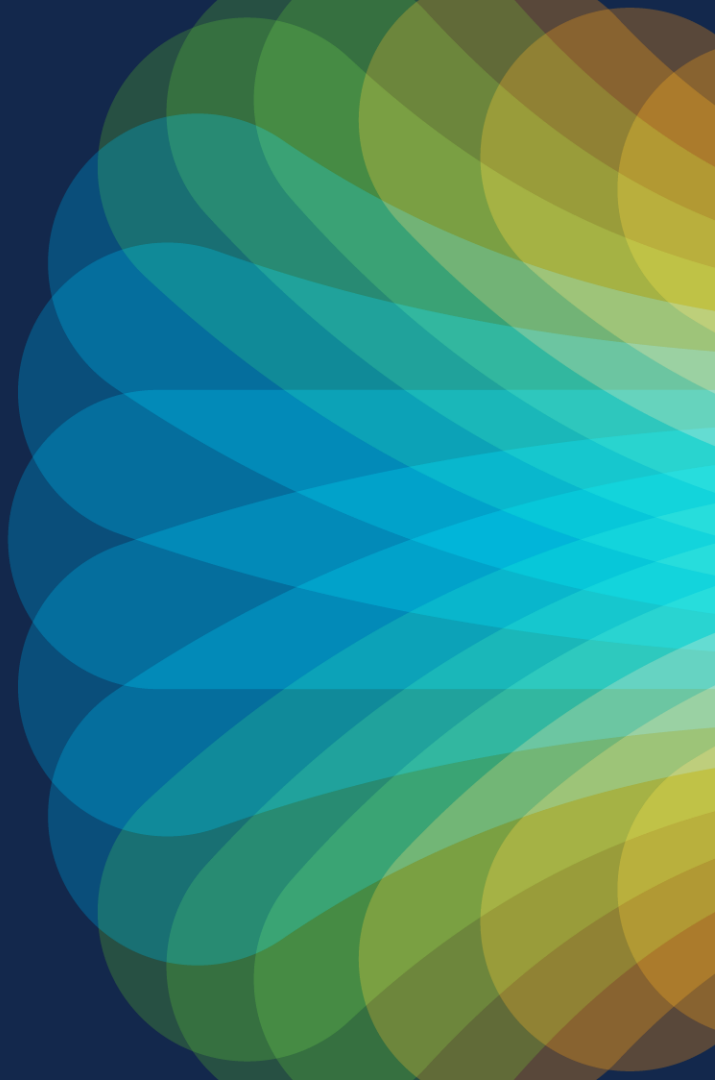
These points help you get on the leaderboard and increase your chances of winning daily and grand prizes

Continue your education

- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand

The bridge to possible

Thank you



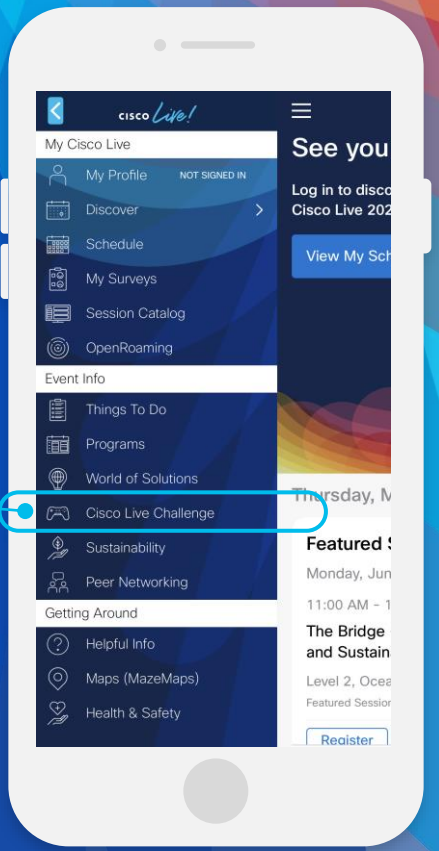
Cisco Live
Challenge

Gamify your Cisco Live experience!

Get points for attending this session!

How:

1. Open the Cisco Events App.
2. Click on 'Cisco Live Challenge' in the side menu.
3. Click on View Your Badges at the top.
4. Click the + at the bottom of the screen and scan the QR code:



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Let's go
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