Cisco “5G Ready” Transport

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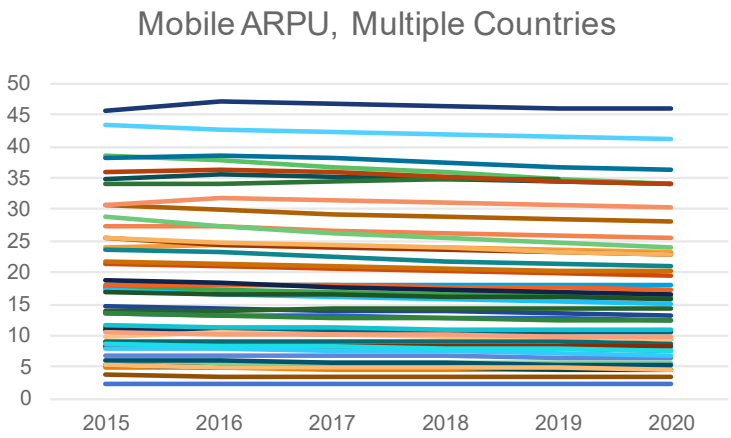
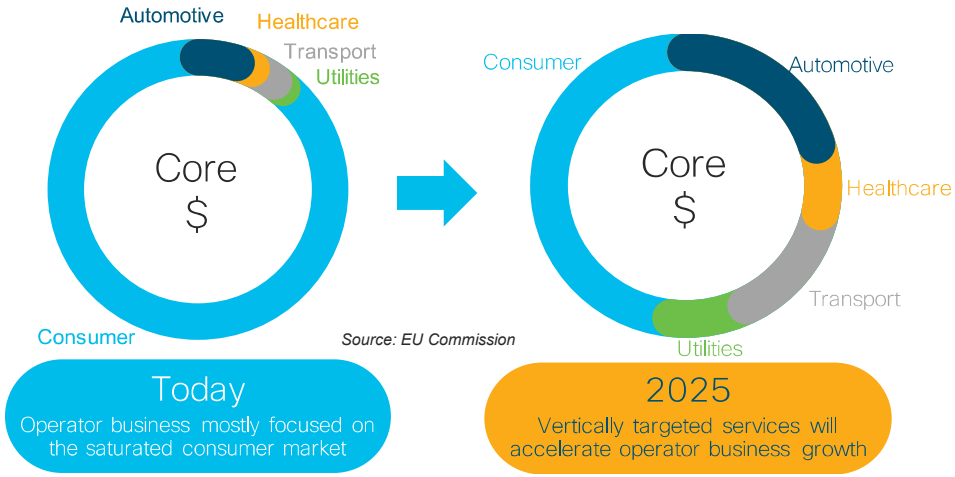
Agenda

- Welcome & Introduction
- 5G challenges for transport
- A 5G transport ready infrastructure
- Timing and synchronization
- Summary

Business Landscape



Consumer ARPUs are Declining or Flat



B2B or B2B2x Market Has Future Growth

Emergence of
Low Latency Need for
better QOE and to Enable
New Applications

5G challenges for transport

5G Key Use Case Categories

Enhanced Mobile Broadband (inc. Fixed Access) → Increased Bandwidth and Capacity

- Extra capacity delivered through new 5G frequency bands
- Not too concerned with connection density or latency.

IoT/massive Machine Type Communications → Slicing, Flexible deployment, NFV/Virtualisation

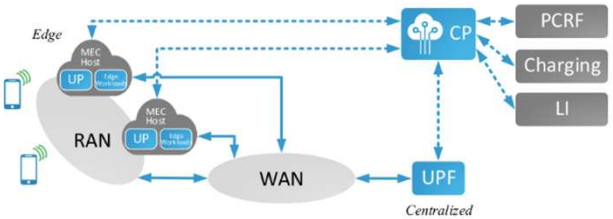
- Focused on low power wide area NB-IoT with high connection density and energy efficiency

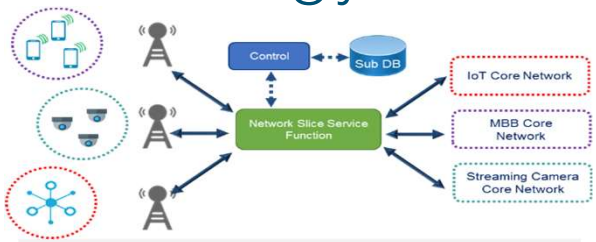
Ultra-Reliable Low Latency → Push data plane to the edge, Intelligent in Network

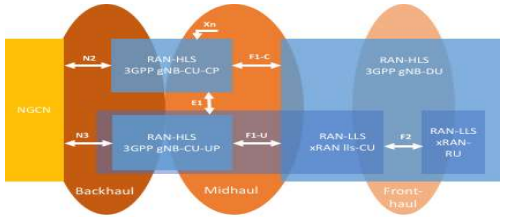
- For mission critical use cases (self driving, Public safety, ...)
- Desired 1ms access time only refers to radio interface and would be most useful in near field mission critical apps

Source: Recommendation ITU-R M.2083

5G Transport – Technology Evolutions







MEC/CUPS

Distributed workloads to the edge of the network driven by low latency applications, lower transport costs, QOE

Any-to-any connectivity between distributed UPFs and with centralized UPF&CP

Network Slicing

Ability to run multiple logical networks as virtually independent

Simultaneous support of **strict SLA & best effort** traffic over same infra

Dynamic and flexible slicing creation/modification

CRAN

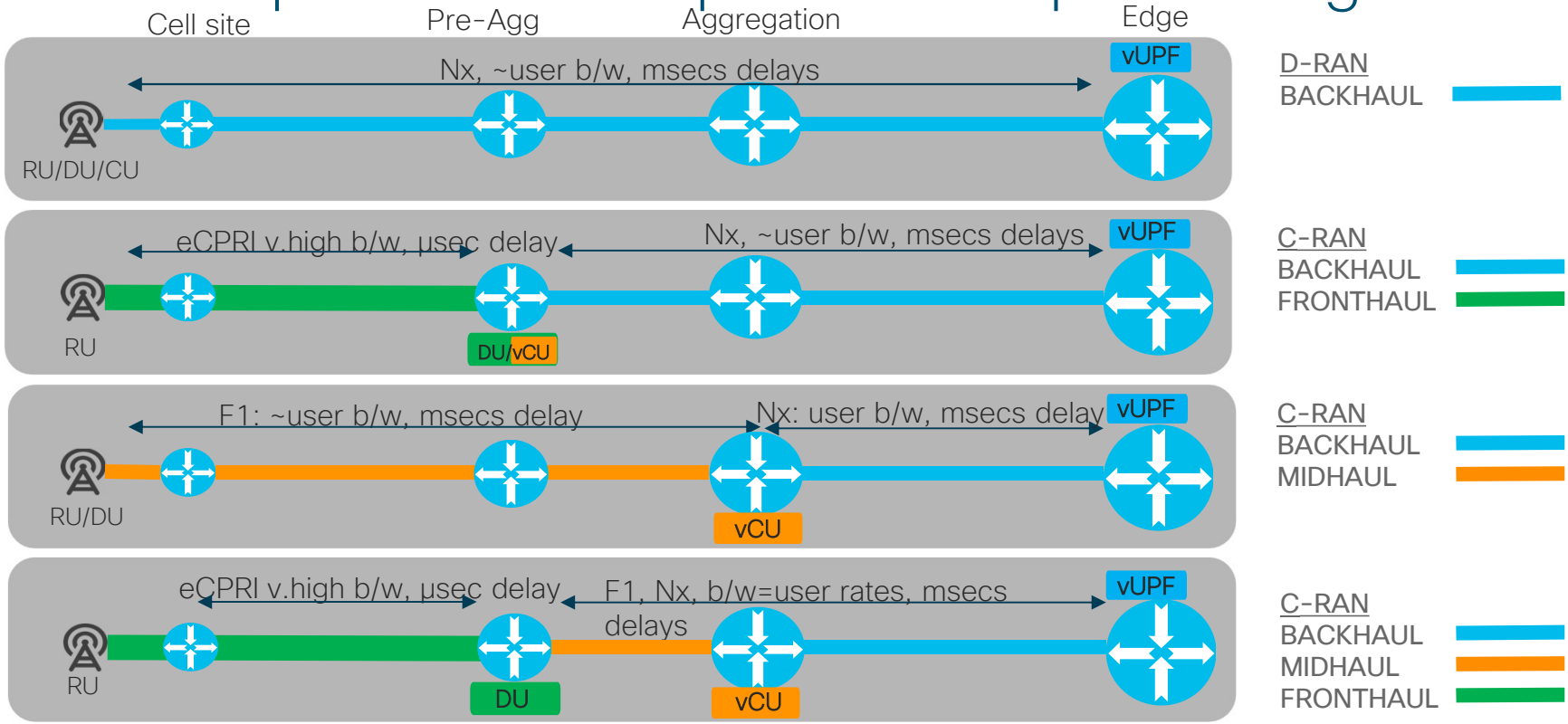
Introduction of RAN splits and virtualization of RAN workloads

Low latency and high throughput access networks

Distributed workloads to different levels of the transport network

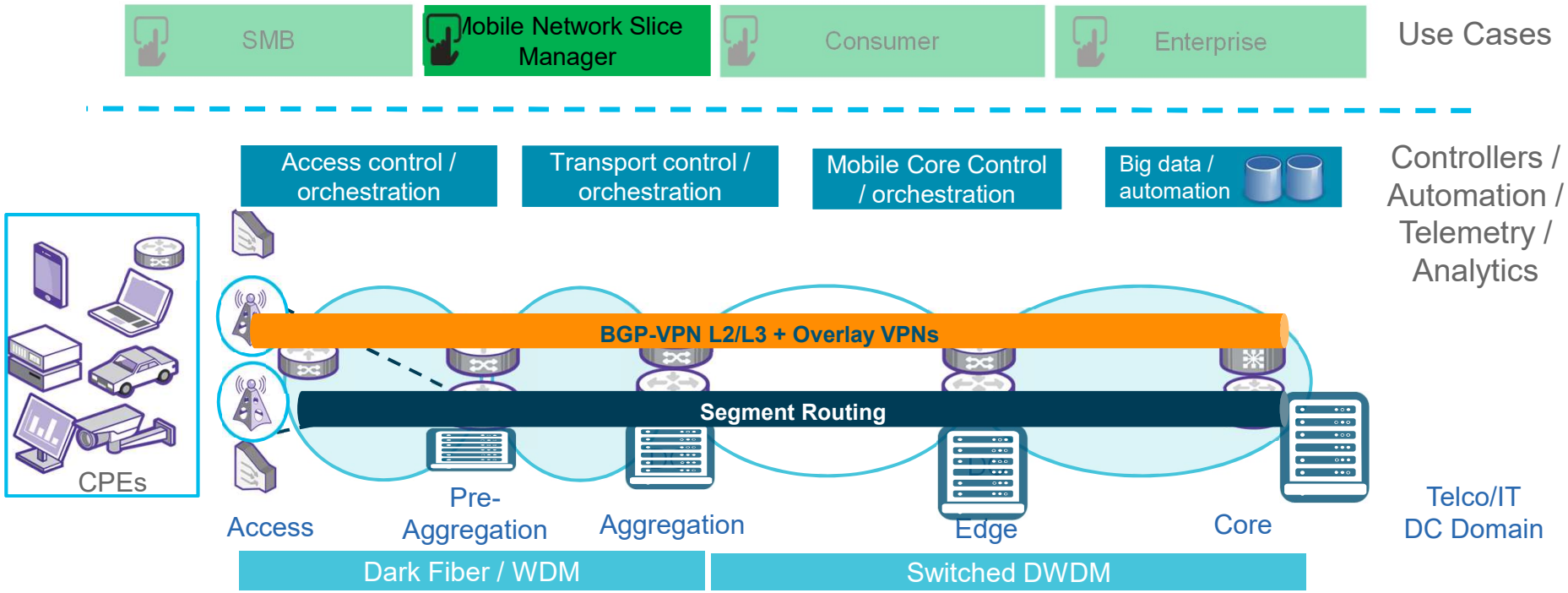
Unified Network Fabric, Network Programmability & Automation, Strict QoS, Convergence

5G Transport - RAN impacts Transport Design



5G ready transport architecture

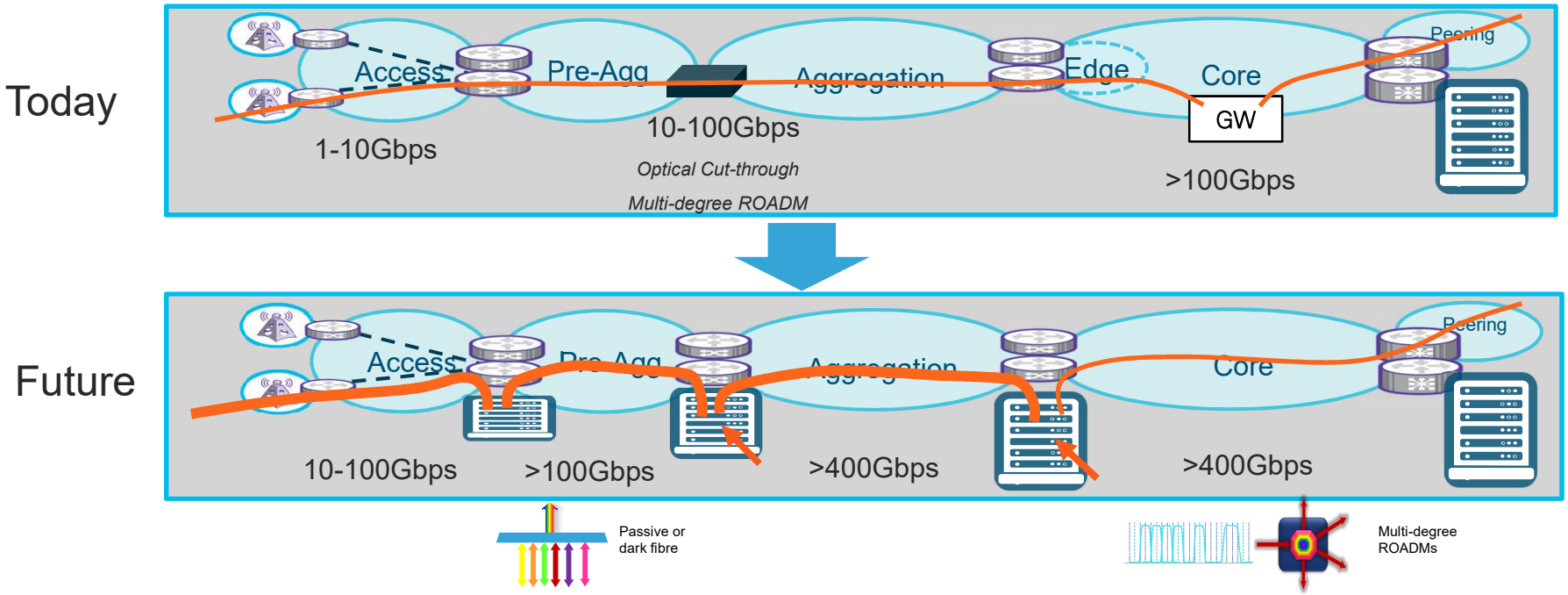
Cisco's overall 5G transport proposition



Multi-service
Flexible radio / mobile core / service placement
End2end packet infrastructure

Up to x10 radios (500k n/w devices)
x4 – x100 bandwidth than 4G
Multi-Access Edge Compute

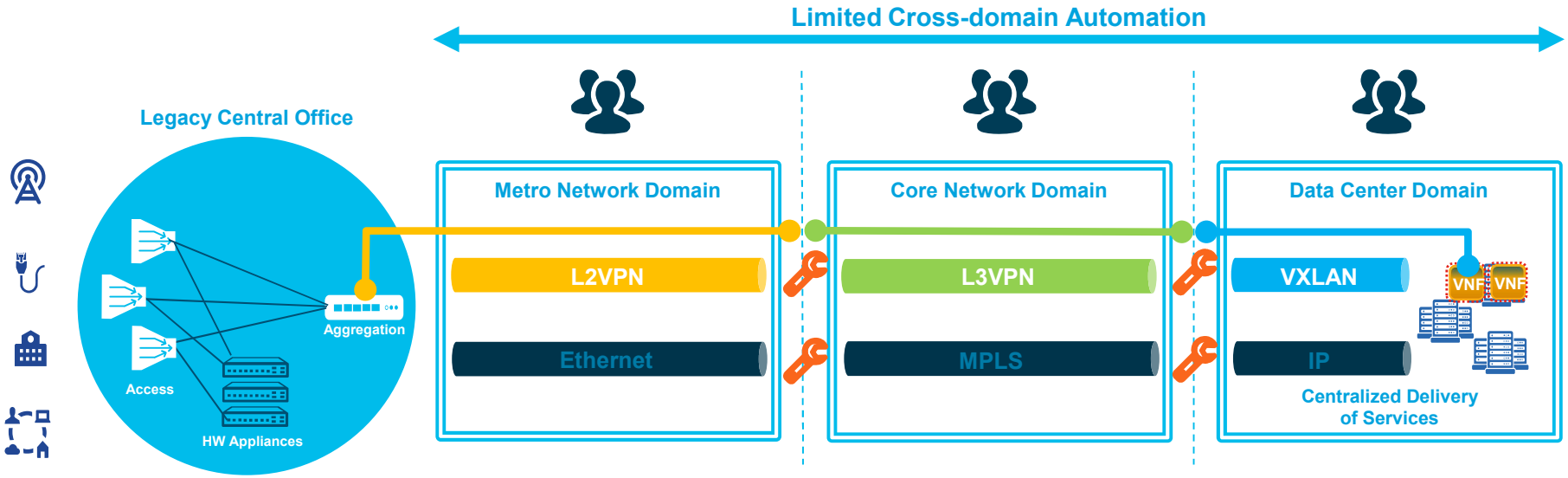
Physical Network Evolution



- MEC demands IP switching capabilities where ever there is DC
- Traffic demands are lambda level and above
- MEC creates discrete optical domains, reduces optical drive distances and simplifies optical infrastructure

- Open ROADM, pluggable DWDM optics driving new round of IP optical integration

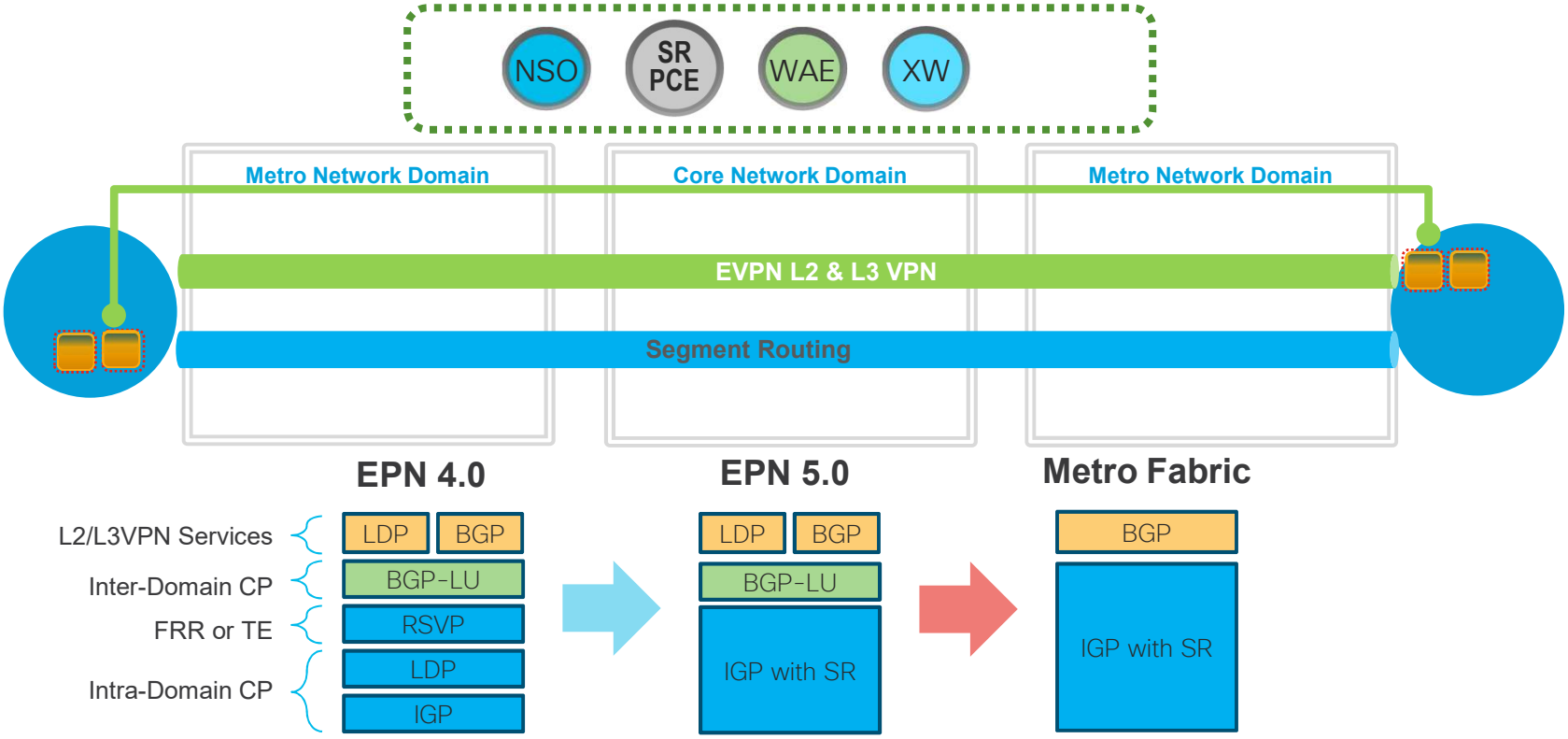
Logical Network Evolution: Todays Service Creation



E2E service provisioning is lengthy and complex:

- ✓ Multiple network domains under different management teams
- ✓ Manual operations
- ✓ Heterogeneous Underlay and Overlay networks

Logical Network Evolution:5G Infrastructure



5G Transport: Why Segment Routing

Network Resiliency
TI-LFA and automated 50ms protection

Network Simplification
Eliminate LDP, RSVP and other protocols
Stateless core devices

End to End path control
Shortest Path
Flex-algo
Multi–domain TE
SR-PCE + Distributed CP

Simplified Service Creation
Concurrent support for network and overlay VPNs

Service Aware underlay
Traffic Steering
Automated Traffic Steering

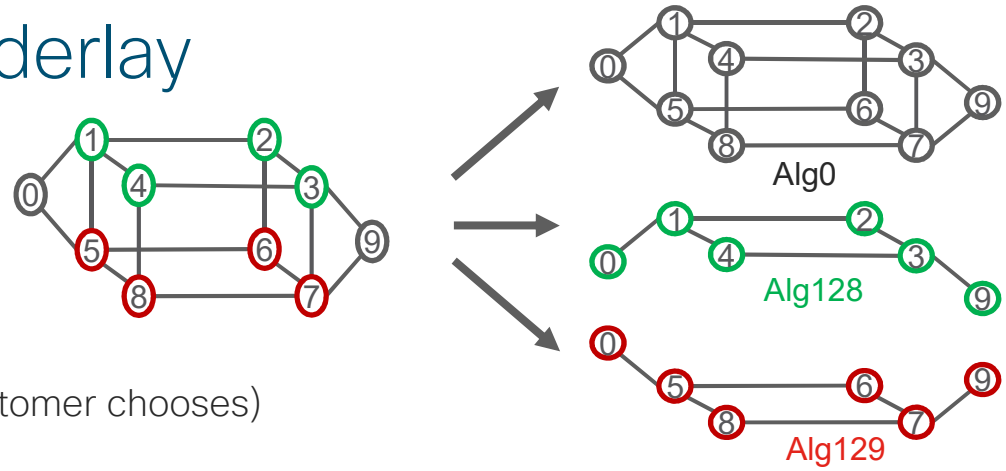
OAM and performance management
Underlay and service monitoring
Real time adjustments based on PM

Scalability
Multidomain architecture
On-Demand Nexthop (ODN)
Stateless within core

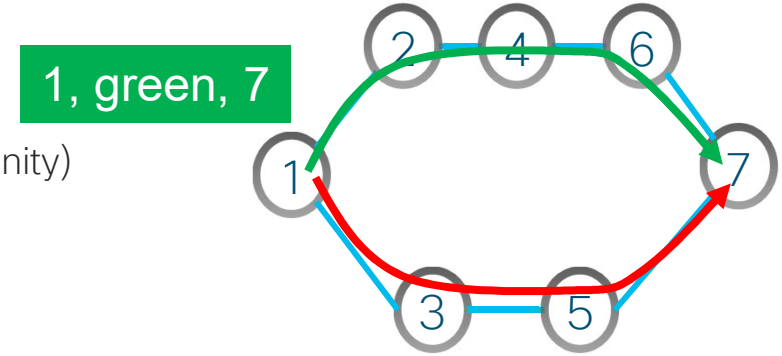
Standards Based
No vendor lock-in

SR: Engineering the Underlay

- Flex-Algorithm
  Builds domain level forwarding tables
  IGP distributes multiple metrics / affinities
  Multi-algorithms operational in network
  SPF, Low Latency, constrained nodes / links (customer chooses)
  TiLFA per algorithm



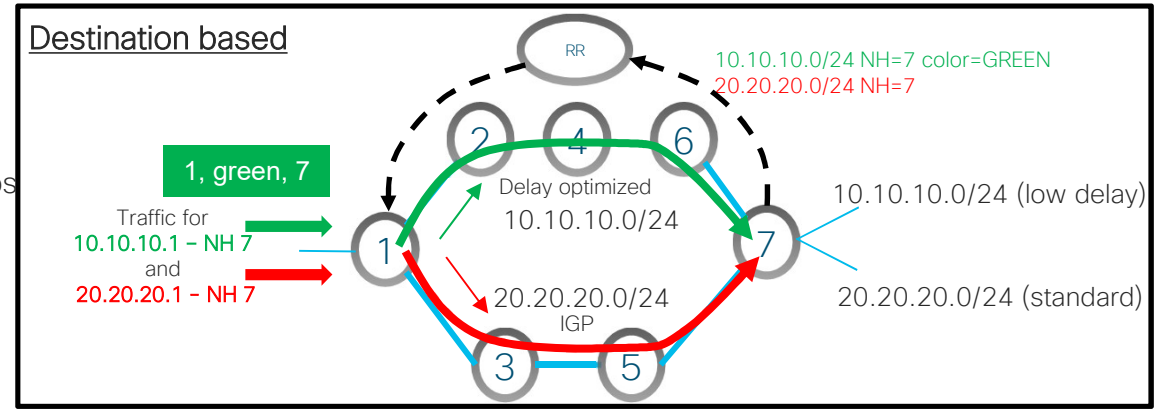
- SR Policies (or SR-TE)
  Builds paths between nodes
  Path computation based multiple constraints (b/w, latency, affinity)
  Calculated by head-ends or an SR-PCE
  Multi-domain / disjoint paths require SR-PCE



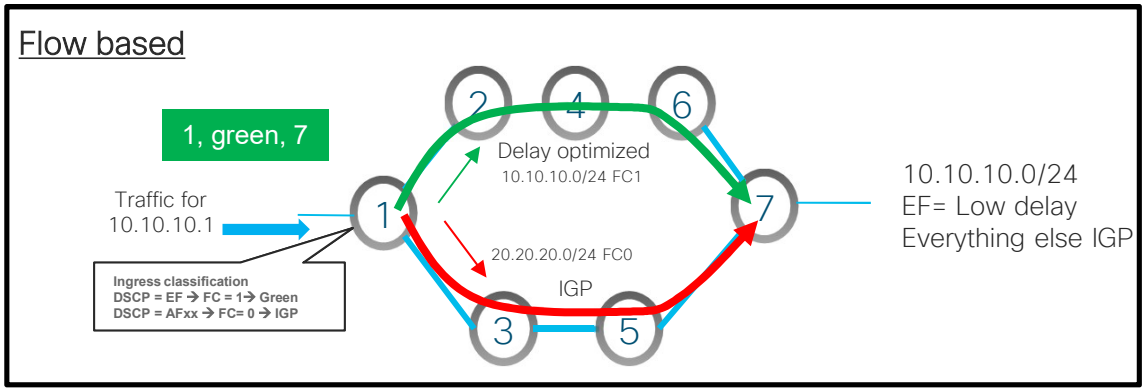
Example Green: Low latency, Red: IGP path

Segment Routing – Service Aware Traffic Steering

- Traffic Steering
  - Mechanism on source router to steer traffic
  - By default traffic uses IGP path
  - Can steer traffic into a SR policy or specific Flex-algos
  - Destination TS : destination only
  - Flow based TS : destination + QoS criteria



- Automated Traffic Steering
  - Hints on SR policy conveyed in overlay route updates
  - Significantly reduces configuration
  - Uses BGP color extended community (RFC 5512)



SR Path Computation Element (SR-PCE)

SRTE Head-End

Distributed Mode – SR-TE Head-End
Visibility is limited to its own IGP domain

Solution

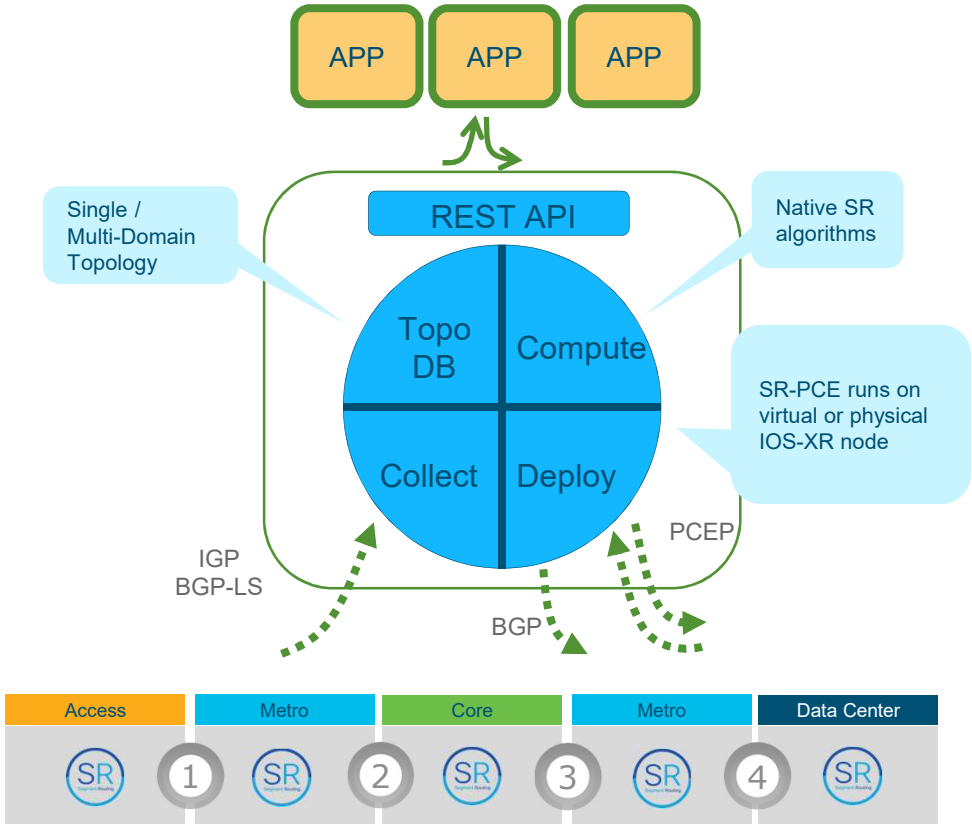
Multi-Domain SRTE Visibility
Centralized SR-PCE for Multi-Domain Topology view

Integration with Applications
North-bound APIs for topology/deployment

Delivers across the unified SR Fabric the SLA requested by the service

Benefits

Simplicity and Automation
End-to-End network topology awareness
SLA-aware path computation across network domains
Disjoint paths
Multi-domain path computation and ODN



Is Diffserv QoS “Good Enough” for 5G

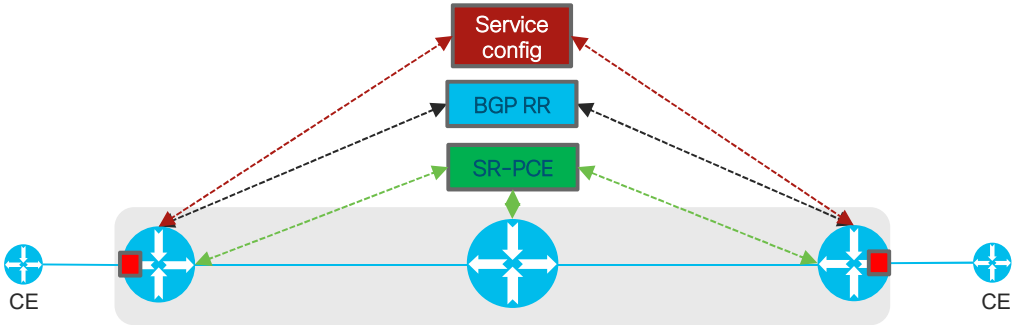
- Yes, as a transport QoS strategy!
  - Slice b/w / class protection through ingress conditioning and marking
  - Class separation and protection with core scheduling
  - Bandwidth reuse
  - QoS aware capacity planning
- FOR LOW LATENCY SERVICES THE OVERALL DESIGN NEEDS CONSIDERATION

Network delay = propagation delay + switching delay + scheduling delay + serialization delay

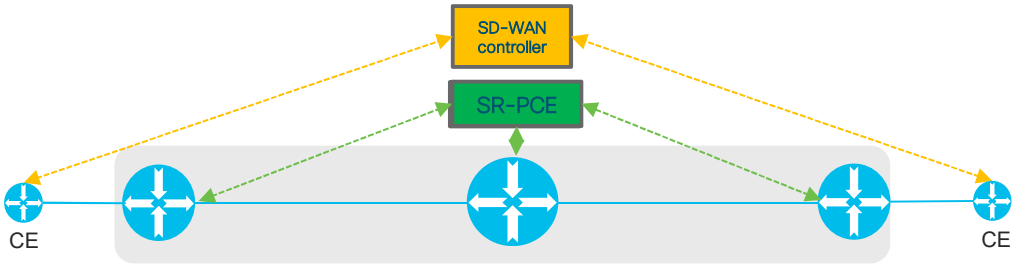
- Proximity of gateway functions to users
  - Reduce propagation delay and OEO delays
- Proximity of applications to users
  - Reduce propagation delay and OEO delays
- Serialization delay is a consideration for fronthaul applications (TSN)

Service Infrastructure

- Network based VPNs
  - 5G based VPNs

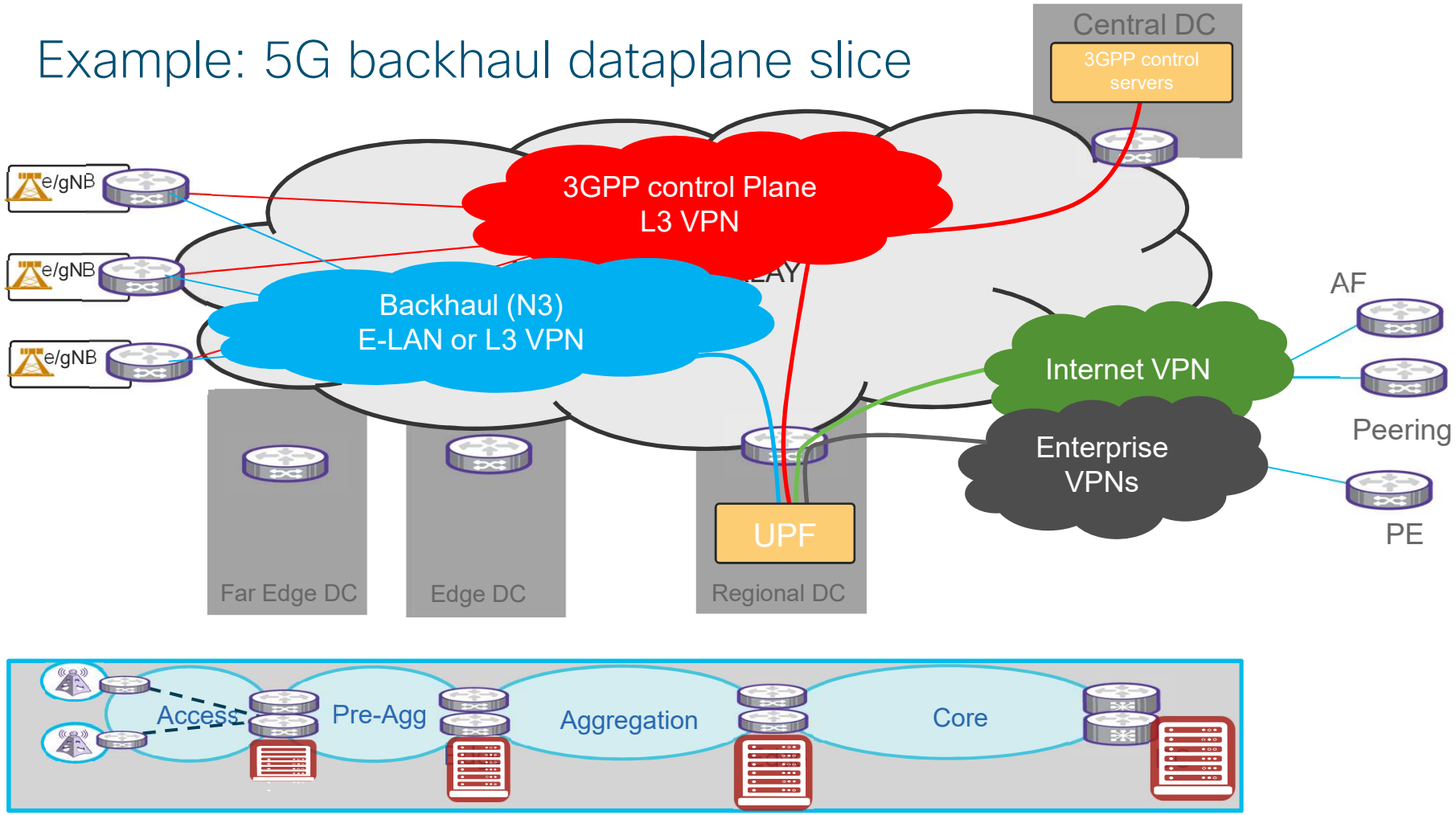


- Overlay / SDN-WAN based VPNs
  - Enterprise services
  - Inter-DC communications

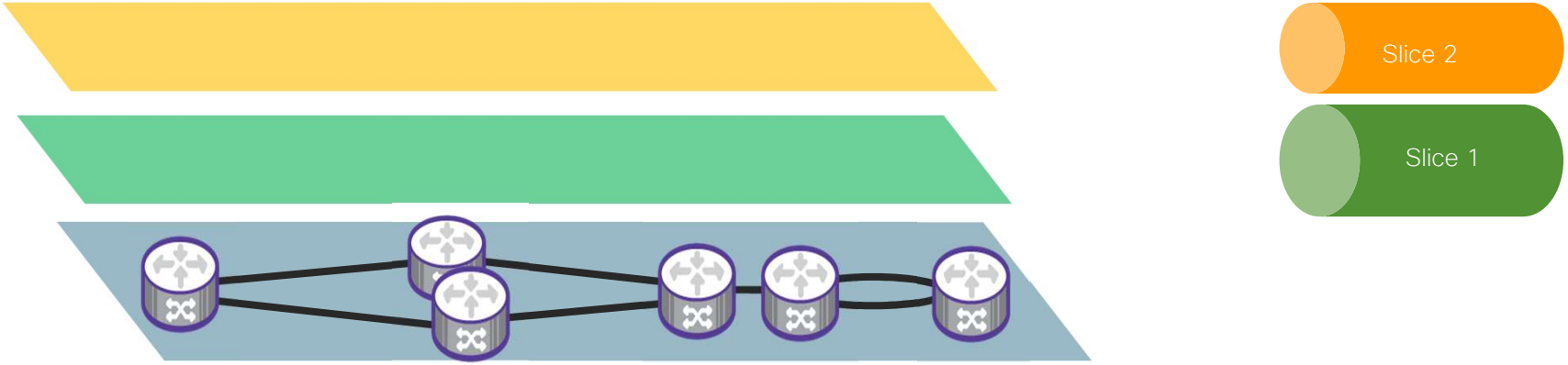


Transport level 5G slicing

Example: 5G backhaul dataplane slice

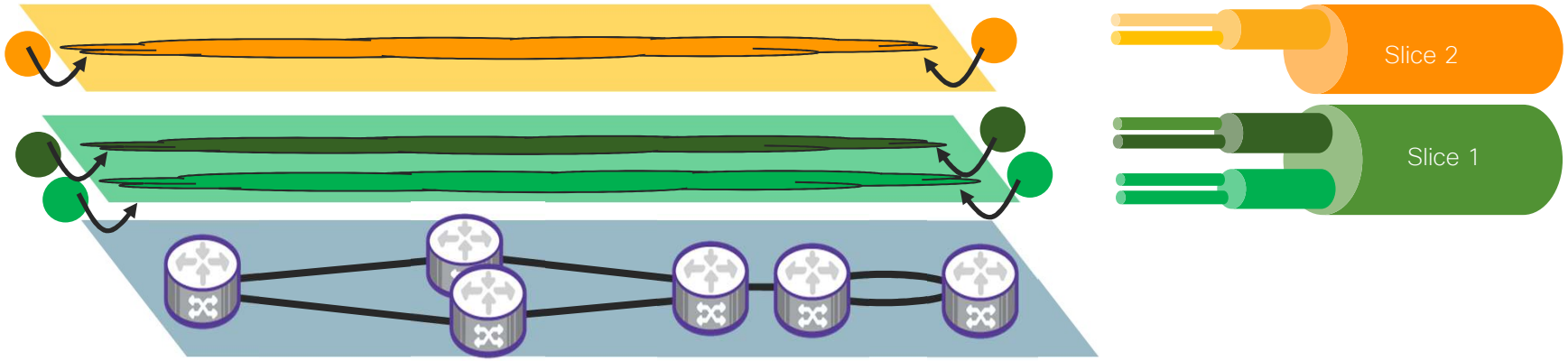


Slicing in the Underlay Based on SLA Requirements



- Small number of slice planes defined in underlay (across domains)
  - 5G mobility slices (eMBB, URLLC, mIOT, signalling, etc.)
  - Major Service Type (Wholesale, MVNO, Enterprise, Content, etc.)
- Diffserv QoS enabled network
- Each Slice plane characterized by
  - Optimization + constraint objective : latency, bandwidth, reliability,
- Based on a flex-algorithm (SPF included) or pt-2-pt SR policies

Mapping Customers to Underlay Slice Planes

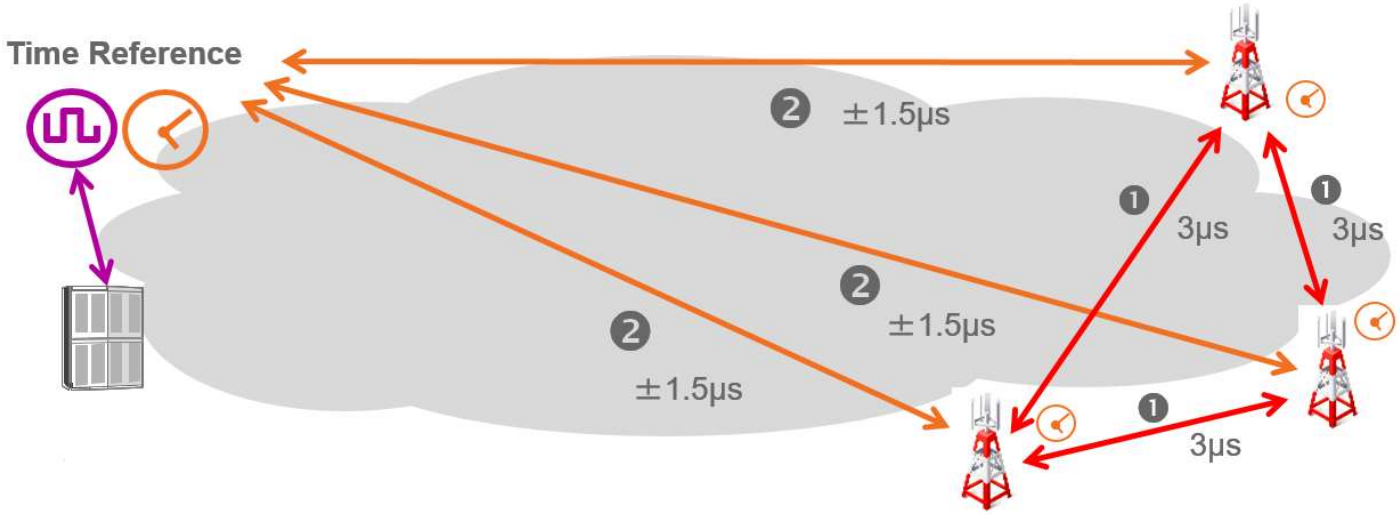


- L2/L3 VPNs used for customer and service separation
- Potentially large numbers
- Traffic classified and controlled on ingress
- Automated Steering place VPN traffic into correct underlay slice plane

Timing and Synchronization

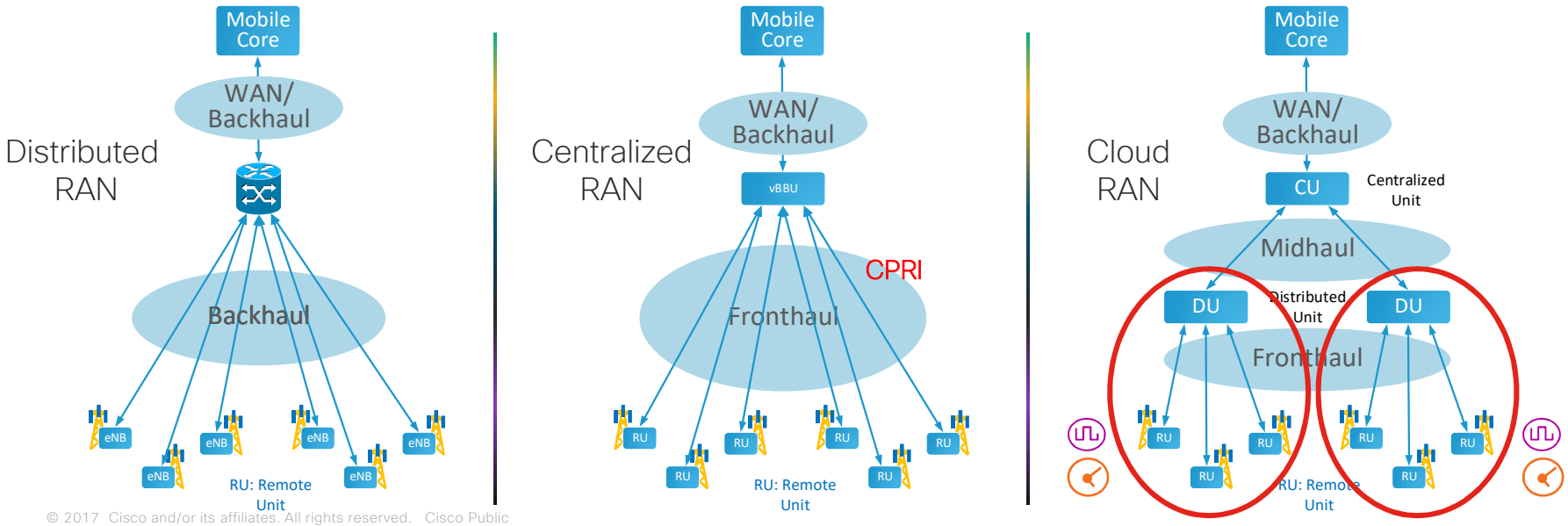
Timing and Synch – New Phase Requirements

- 5G (like modern LTE-A networks) requires phase synchronization
- New 5G TDD radios definitely require it:
  - ❶ 3GPP: 3μs between base stations (for TDD, LTE-A radio co-ordination)
  - ❷ Radio backhaul network: ±1.5μs from reference time

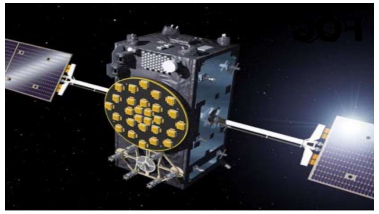


Timing and Synch – Fronthaul

- 5G is also re-engineering the Fronthaul network towards Cloud RAN:
  - CPRI to packet-based Fronthaul/Midhaul impacts timing
  - Much tighter requirements for phase alignment budget



Timing and Synch – Solutions



GNSS (GPS, Galileo) Receivers

- Effective solution where site conditions allow (Sky view, $$)
- Susceptible to jamming (and increasingly spoofing)
- Time source for cell sites, PTP GM's and monitoring equipment

→ Include GNSS receivers inside routers where appropriate

PTP/1588 and SyncE in Transport Network

- Great solution: G.8275.1 with "on path support" for PTP
- Needs good network design in combination with SyncE
- End-to-end timing "budget" with accurate boundary clocks

→ Routers as high performance T-BC boundary clocks with Class B/C G.8273.2 performance

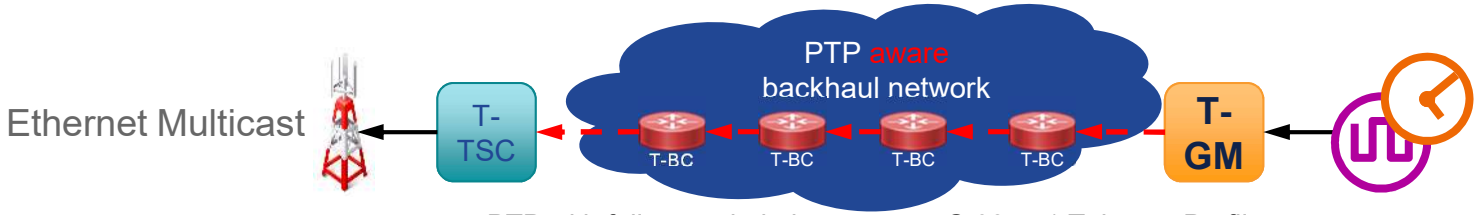
All of the Above

- PTP/SyncE as a backup to GNSS receiver outages
- GNSS where it's cost effective, PTP everywhere else

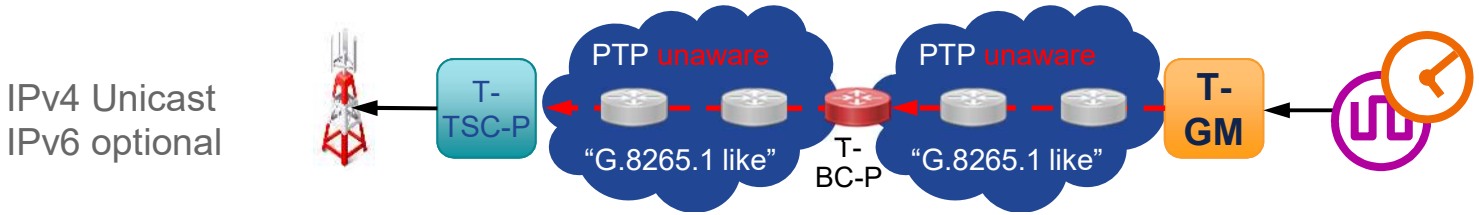
→ Flexibility in the design of the equipment allows them to be used in any situation

Timing and Synch – PTP Profiles for Phase

- There are various profiles available for use
  - Most operators looking at G.8275.1 – the best timing solution
  - Supported across ASR900, ASR920, NCS500, NCS5500, ASR9K range



PTP with full on-path timing support, G.8275.1 Telecom Profile



PTP with partial timing support, G.8275.2 Telecom Profile

Summary

Summary

- 5G brings new requirements and challenges to transport network
- Cost and simplicity is critical
- Outlined Cisco approach to 5G transport networking
- Streamlining network structure and packet optical integration
- Segment Routing for engineering and simplifying the underlay
- Concurrent support for BGP based VPNs and SD-WAN solutions
- Timing and synchronization is a vital component of the radio network
- Operators are investing in 5G-ready networks now!!

The End

Need more information??

Cisco's SP Mobility Page: https://www.cisco.com/c/en/us/solutions/service-provider/mobile-internet/index.html

5G xHaul White Paper:

https://www.cisco.com/c/m/en_us/network-intelligence/service-provider/digital-transformation/converged-5g-xhaul-transport.html

Compass "Metro Fabric Design" https://xrdocs.io/design/

EPN5.0 & EPN4.0: https://www.cisco.com/c/en/us/solutions/enterprise/design-zone-service-provider/programmable-network.html