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The bridge to possible

RAN Transformation and Edge DC

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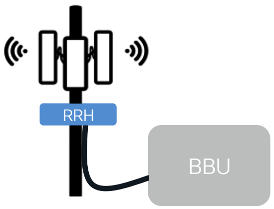
BRKSPM-2000

Agenda

- Open RAN Overview and Standardization
- Open RAN Technical Requirements
  - Transport
  - Synchronization
  - Telco Cloud
  - Automation
- Conclusion

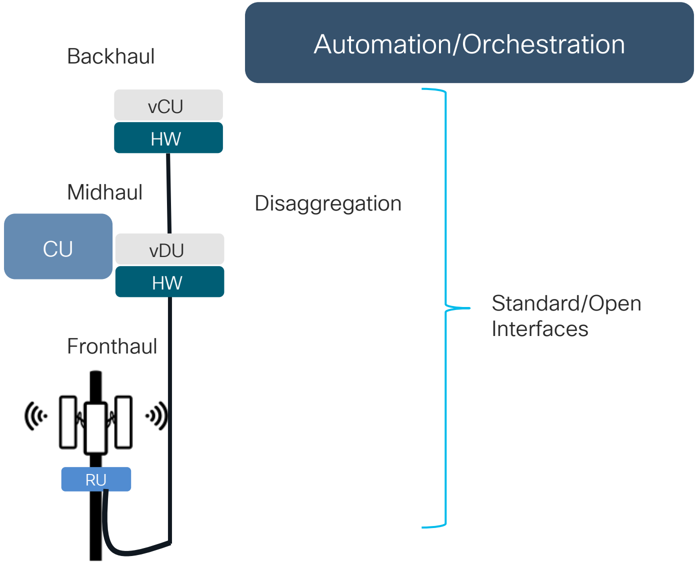
RAN Architecture Evolution

Distributed RAN



Traditional Deployment
All RAN functions @cell site
All RAN components from same vendor
Monolithic solution – HW+SW one block

Open RAN



Decompose BBU in RT and NRT functions
Disaggregate SW and HW
Standard Packet based interfaces
Open APIs for Automation&Management

What’s vRAN, CRAN, Open RAN

vRAN

Disaggregation and virtualization of the BBU functions that run on generic HW platforms

(independent of RAN stack splits)

Cloud RAN (cRAN)

Decomposition of the RAN stack in virtualized subfunctions and their flexible placement and centralization

(leverage cloud design benefits to the RAN)

Open RAN (ORAN)

True multivendor system enabled by open/standard interfaces for the RAN decomposition, disaggregation and northbound management/orches tration

RAN Splits

RT and NRT Functions

Real Time PHY functions
(Low L1)

frequency/time domain conversion
beamforming

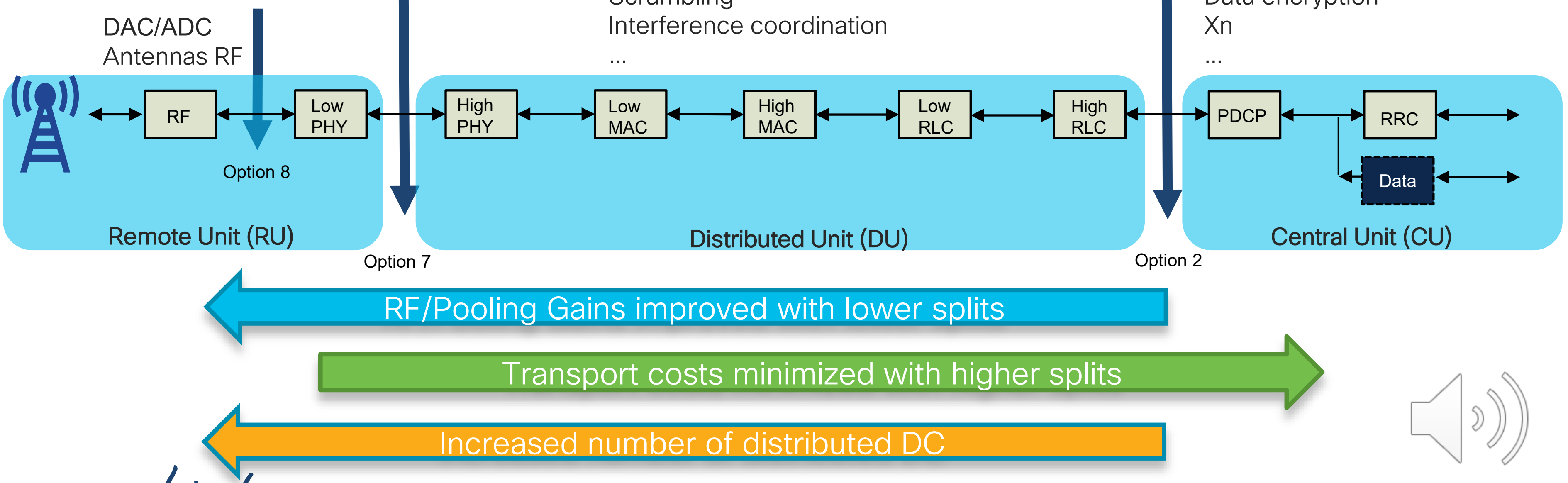
DAC/ADC
Antennas RF

Real Time functions
(L2/High L1)

Scheduler
Modulation & coding
Scrambling
Interference coordination
...

Non-Real Time Functions
(L3/High L2)

OAM
Handovers
Data encryption
Xn
...



Standardization Bodies, Consortiums, Forums

Who is defining Open RAN

O-RAN ALLIANCE

- Standardization Organization, Operator Lead
- Bring virtualization, decomposition, disaggregation and multi-vendor to the RAN
- Standardizes internal and external interfaces and architecture for fully interoperable system

3GPP A GLOBAL INITIATIVE

- Defined HLS Option 2, F1 interface – not fully specified
- LLS generically agreed to be option 7, but no standardization work is ongoing

CPRI Common Public Radio Interface

- Industry consortium, RAN vendors lead
- Defined eCPRI, a multi-vendor encapsulation header to carry option 7 split messages
- eCPRI used by ORAN as the chosen encapsulation for fronthaul interface
- Does not define option 7 fully standard split/interface

TELECOM INFRA PROJECT — TIP OpenRAN

- Operator Lead Community – Vodafone & TEF announced OpenRAN plans
- Concerned most with the disaggregation of h/w and s/w and virtualization
- Does not define standards

IEEE Advancing Technology for Humanity — NGFI

- Defines encapsulation and mapping of Radio protocol over ethernet (RoE) - enables CPRI transport over packet network
- Used by O-RAN as optional encapsulation for fronthaul interface

IEEE Advancing Technology for Humanity — 802.1CM

- Specifies Time Sensitive Network (TSN) profiles for packet based Fronthaul interface – goal is to achieve latency, jitter and synchronization required by LLS

Liaisons between Organizations

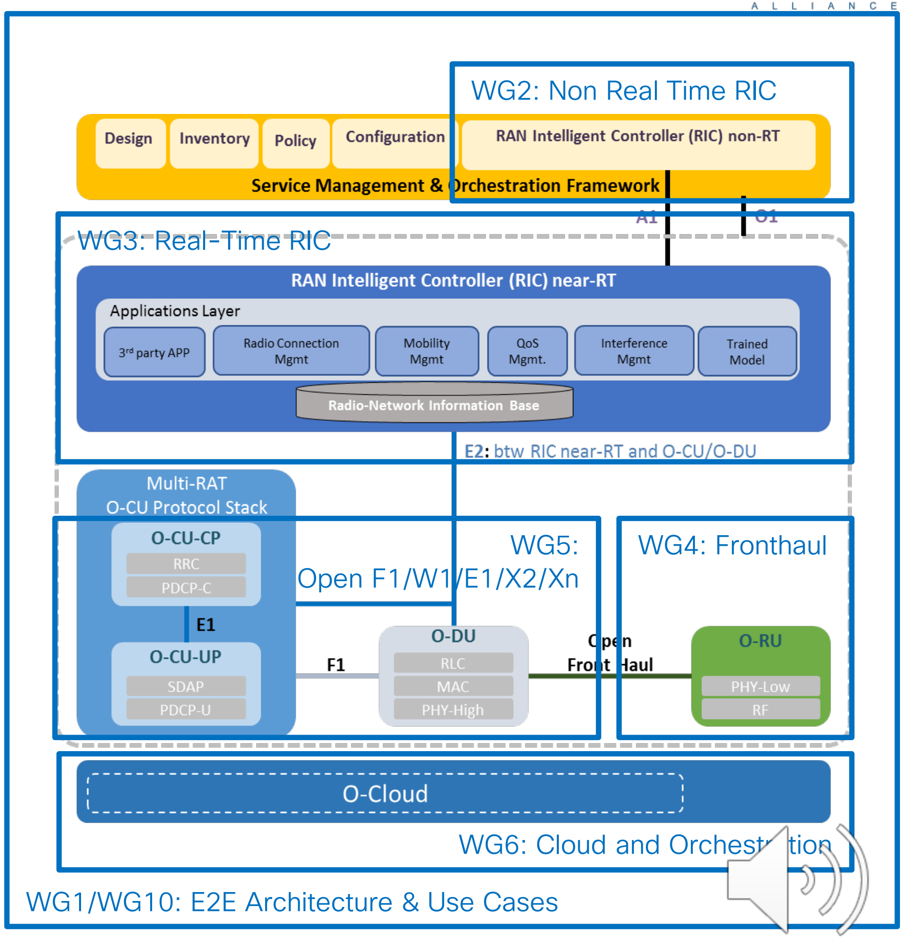
O-RAN Alliance Overview

- O-RAN Alliance formed in February 2019 – Members 27 Operators & 200+ Contributors
- Standardizes all aspects of LLS option 7.2x, including Control Plane, User Plane, Synchronization Plane and Management Plane
- Covers standardization gaps in 3GPP defined interfaces, such as, F1 interface (HLS option2), X2 and Xn, to enable multi-vendor interoperability (multivendor NSA)
- Open up RAN Automation and Management with open APIs and Yang models, ONAP based telemetry
- Specification work has been divided into 10 technical workgroups (WG)

WG7: Whitebox HW

WG8: Stack Reference Design

WG9: xHaul Transport



O-RAN Alliance - Transforming the RAN

- Last published standards in November 2020
- Definition of non-RT/near-RT RAN Intelligent Controller (RIC) with AI/ML
- ORAN SW Community (collaboration between ORAN and Linux Foundation) driving open source SW for RAN
- Published interoperability documents with mandatory and recommended compliance and test list
- Second world wide multi-vendor plug-fest in October 2020
- Liaison agreements with TIP, GSMA, ITU-T, ONF, SCF

Open RAN Policy Coalition

Beyond the Technical Specs

Mission: Advocate for government policies supporting the development and adoption of open and interoperable solutions in the Radio Access Network as a means to create innovation, spur competition and expand the supply chain for advanced wireless technologies including 5G.

Launched in May 2020
58 members today – Cisco is a founding member

Bring a policy-focused complement to what others are developing in terms of technical standards.

Why Open RAN for SP

Choice

Expand RAN vendor options
Pick best-in-class for each RAN component

Reduce Costs

Operational and investment costs with automation and optimized use of resources

Why ORAN

Speed

Fast & Scalable deployments
Quick to bring new features to market

Innovate

Advanced services with granular control of radio resources, API exposure, programmability

Open RAN Industry Status

Leading SPs in Europe publicly commit to Open RAN investments

European operators sign MoU and commit to Open RAN

Total Telecom, Jan2021

Governments support and fund Open RAN

Open RAN projects in line for massive German government funds: Report

TelecomTV, Jan2021

House unanimously passes $750 million Open RAN 5G bill

RCR Wireless News, Nov 2020

£28m for UK 5G OpenRAN projects

eeNews, Jan2021

Analysts predict by 2025 Open RAN represents 25% of RAN business - $11B in 2025

Operator vRAN spending will reach to USD11 billion by 2025, which is approximately 25% of the total RAN vendor revenue

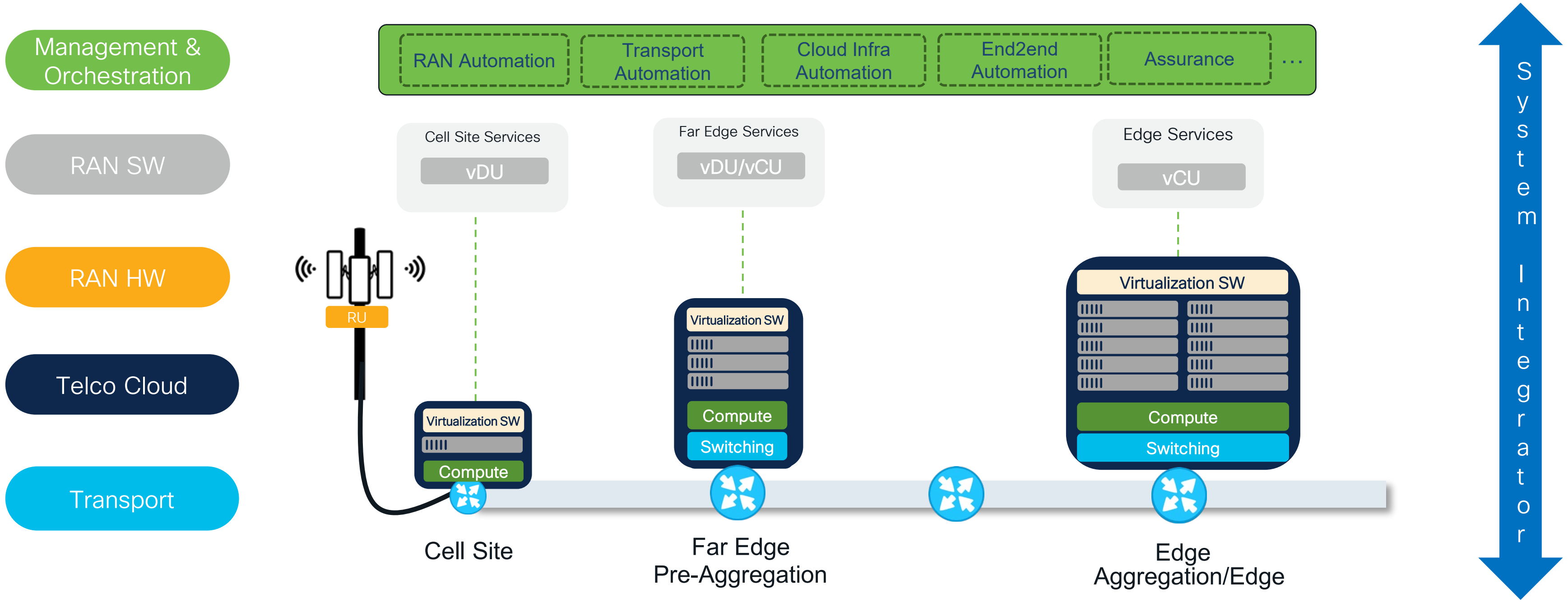
Analysys Mason

Multiple announcements of live trials around the world and greenfield deployments (Rakuten, Dish)

O-RAN Technical Requirements

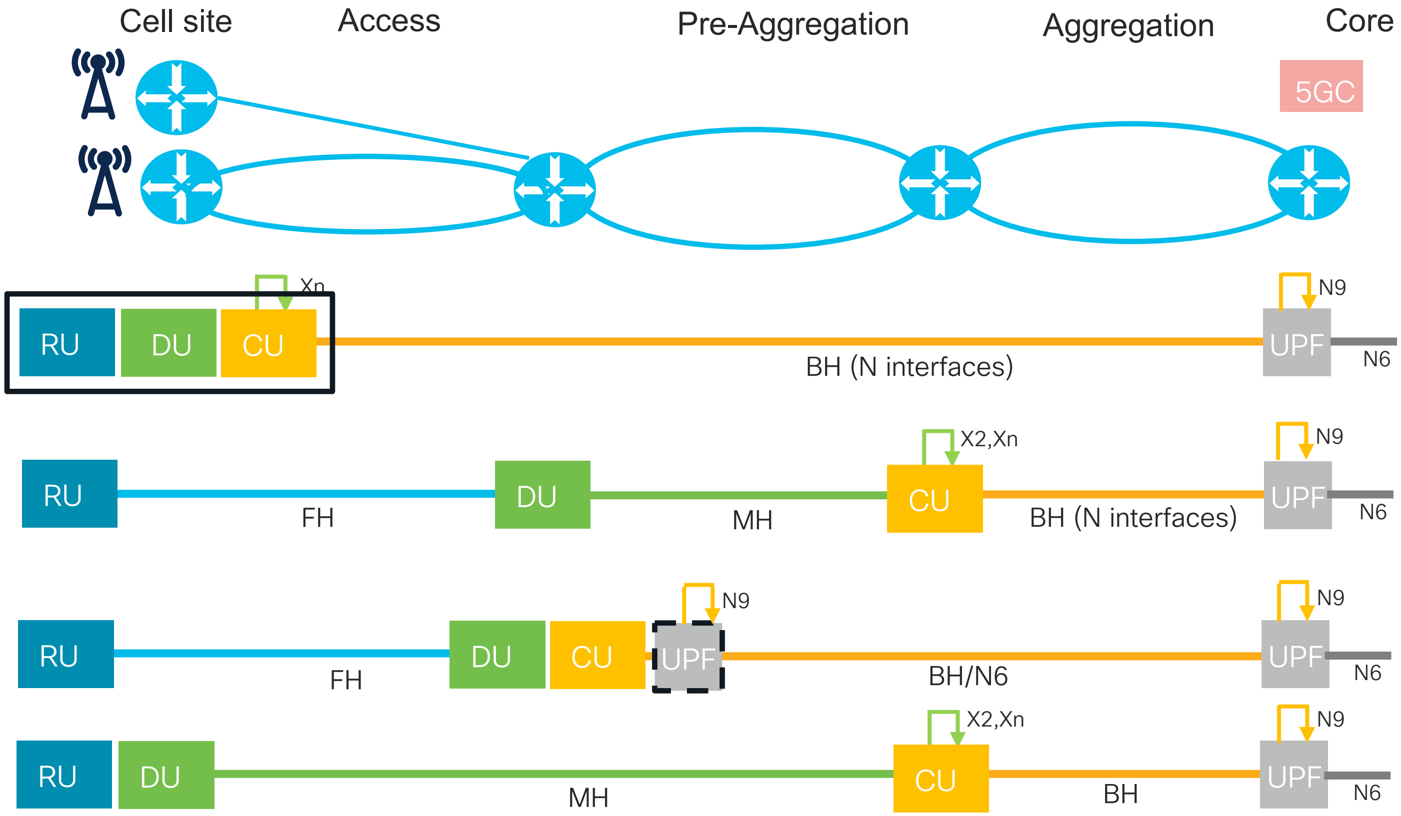
Open RAN Architecture Overview

Domains



Multiple Architectural Options

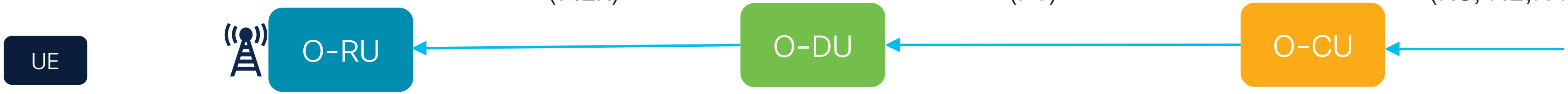
Flexible workload placement



O-RAN Transport Requirements

BW, Latency

Radio | Fronthaul (7.2x) | Midhaul (F1) | Backhaul (N3, N2,N4,etc)



UE Peak DL Throughput 4Gbps
(100MHz, 8 layers, 254QAM)

Peak BW ~13,7Gbps* (+ 10-16% OH)
One Way Latency ~100usec 4G
~1.5msec** 5G

Peak BW ~4Gbps (+ 20% OH)
One Way Latency <25msec
(depends on the service)

Peak BW ~4Gbps (+ 10-14% OH)
One Way Latency – 10's msec
(depends on the service)

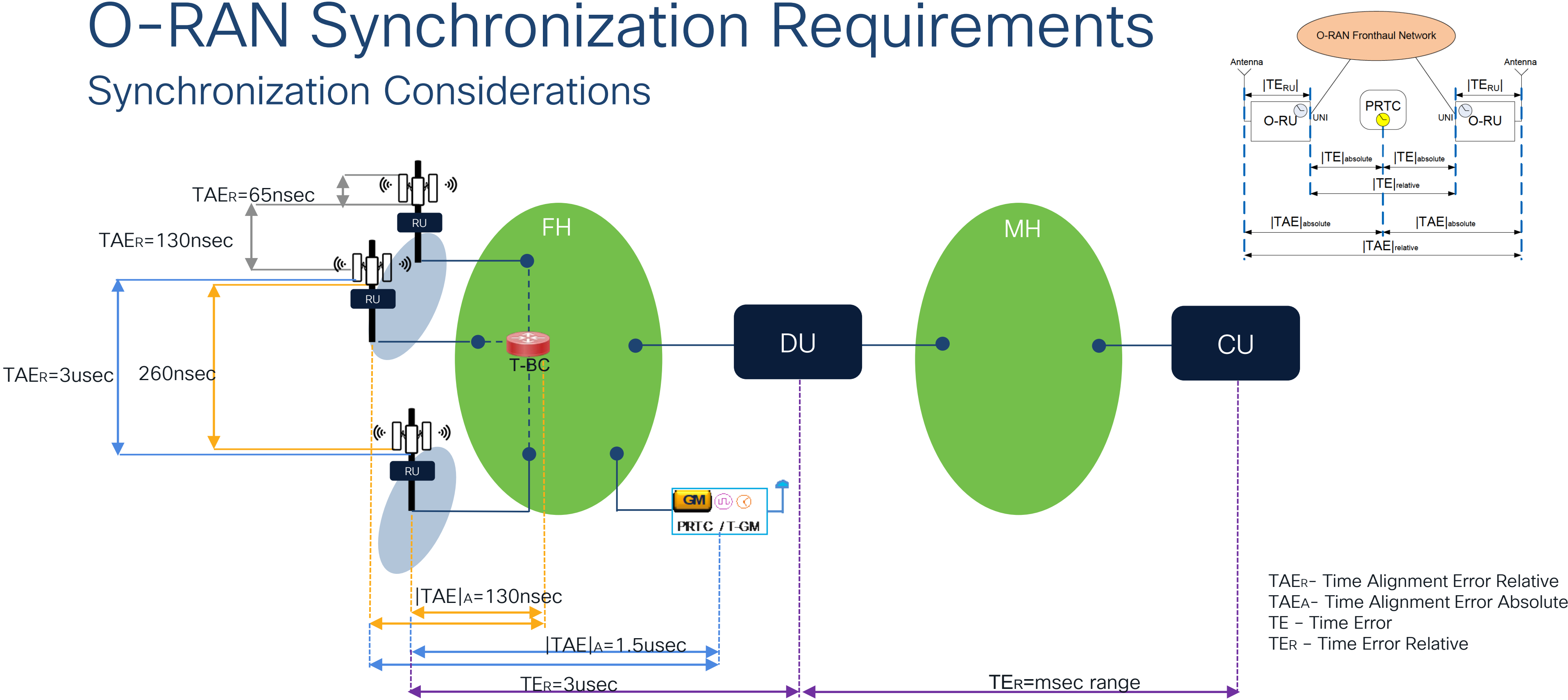
Bandwidth Dimensioning for FH/MH/BH
- All interfaces are packet based allowing stat mux gains
- Transport BW depends on carrier channel BW, MIMO order, # sectors
- Apply NGMN recommendation rules for a 3 sector site
- FH has a min BW usage even with no UE traffic (usually <10% of peak)

FH Latency
- Depends if 4G or 5G
- O-RAN defines O-DU/O-RU categories that determine transport latency

*O-RAN O-DU CatA, Mantissa=9, Exponent=8, Block Floating Point
** NR FR1, FR2 req lower latency

O-RAN Synchronization Requirements

Synchronization Considerations



TAER- Time Alignment Error Relative
TAEA- Time Alignment Error Absolute
TE – Time Error
TER – Time Error Relative

Radio sync requirements and infra sync requirements
FH requires strict synchronization phase accuracy, but cluster relative sync can be used

O-RAN Synchronization Requirements

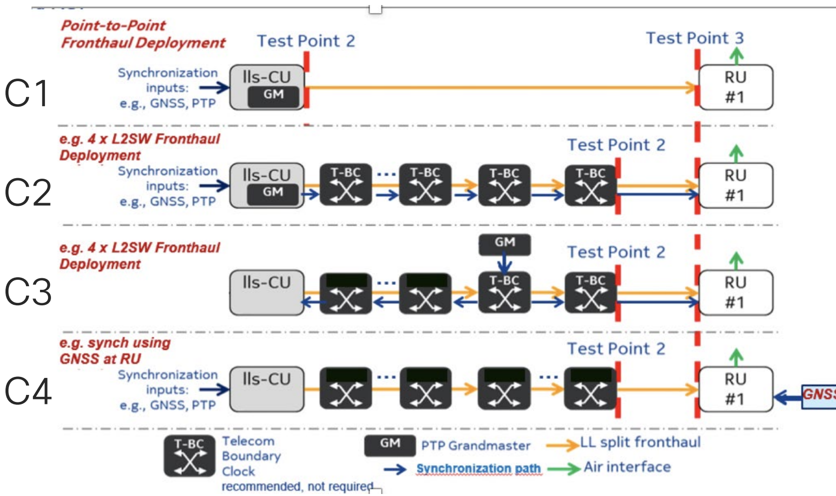
Synchronization Specification

O-RAN defines S-plane (synchronization plane) to address sync between O-DU and O-RU. Defines 4 topologies for sync distribution in the FH

- C1 and C2 O-DU is the time source for the O-RU
- C3 considers the PRTC/T-GM is provided by the transport network
- C4 considers GNSS source is used for the O-RU

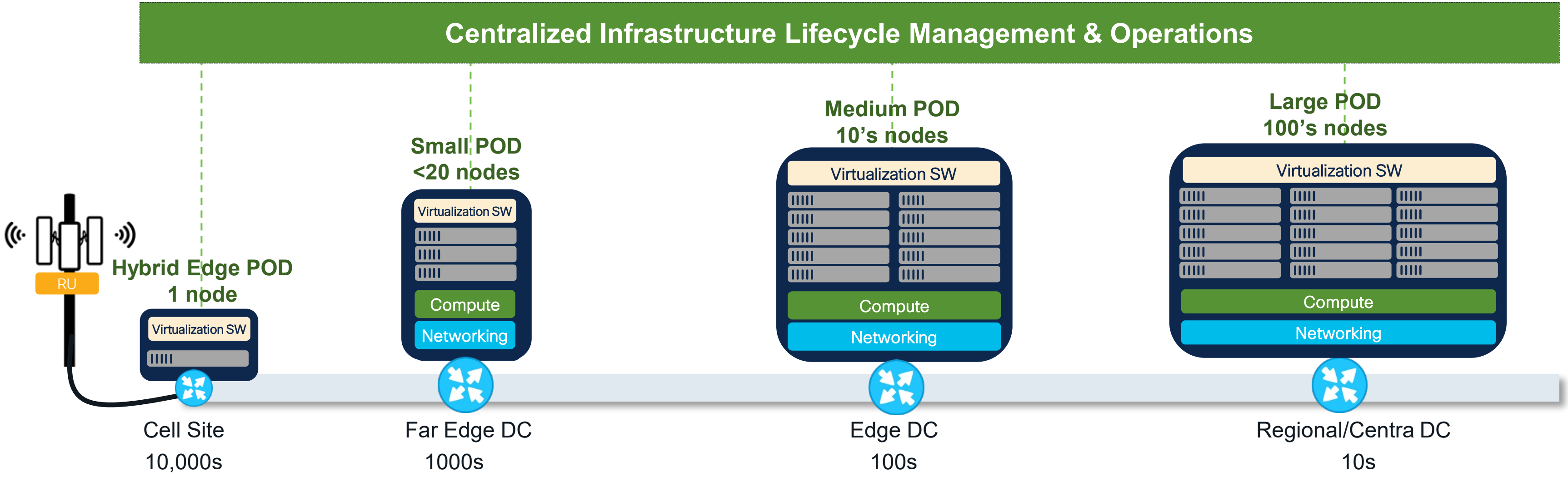
FH Phase accuracy requirements are according to 802.1CM Timing Categories which determine the network error contribution

Synchronization network distribution in the FH uses profile 8275.1 for accurate phase, SyncE for frequency, 8273.2 for T-BC classes and follows 8271.1 defined network limits



O-RAN Cloud Platform Requirements

Distributed Telco Cloud Platform



Optimized Footprint – Minimize HW overhead but keep DC autonomous

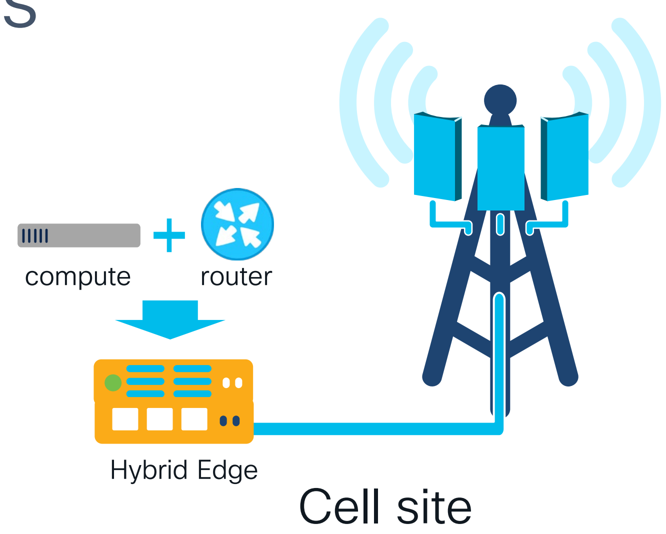
Data Plane Performance & Real Time Application – HW accelerators & SW fine tuning to support intense low latency DP

DCN and WAN integration – consistent cross domain policy; reduce HW footprint with WAN/DCN function merge (PE+ToR)

HW&SW evolution – next gen CPUs and accelerators, and SW containerization promise optimized power and performance

Cell Site Design Considerations

- Simplify and standardise cell site design for reduced OPEX/CAPEX – 10 000’s cell sites in a SP
- Future proof design – no cell site visits to scale capacity, enable new use cases, evolve with ORAN spec
- Number and type of interfaces depend on radio technology and spectrum, number of antennas/RUs, RAN vendor portfolio
- Extended temperature optics and HW are required
- Highly accurate timing support (i.e, HW level)
- Detailed visibility for automation and operations systems

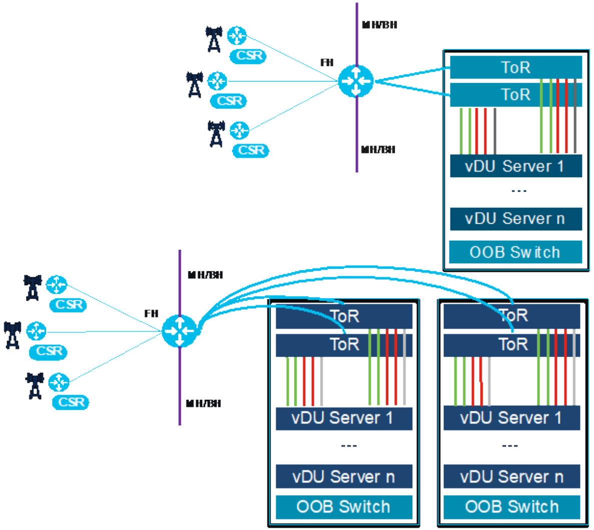


For vDU@cell site a combined, hardened compute + router platform (Hybrid Edge) provides many benefits:

- Optimised space and power
- Less cabling
- Reduced port (optics) usage
- Increased security and reliability
- Integrated and simplified operations
- NPU based performance

Far Edge DC Design Considerations

vDU@Far Edge – Split 7.2x



- vDU cloud platform dimensioning
  - depends on the RF planning outputs, carrier(s) bandwidth, number of sectors, MIMO layers
  - translates into number of CPU cores required, density and type of ports for DCN, aggregated FH and MH/BH capacity, power limits per rack
- Cell sites have to be within a fiber distance of <20km from vDU
- Build an architecture that provides improved redundancy than traditional RAN by integrating and automating RAN, cloud and transport resiliency mechanisms

Define far edge design templates following the principles:

Simple and cost efficient

Repeatable

Minimize footprint

Scalable

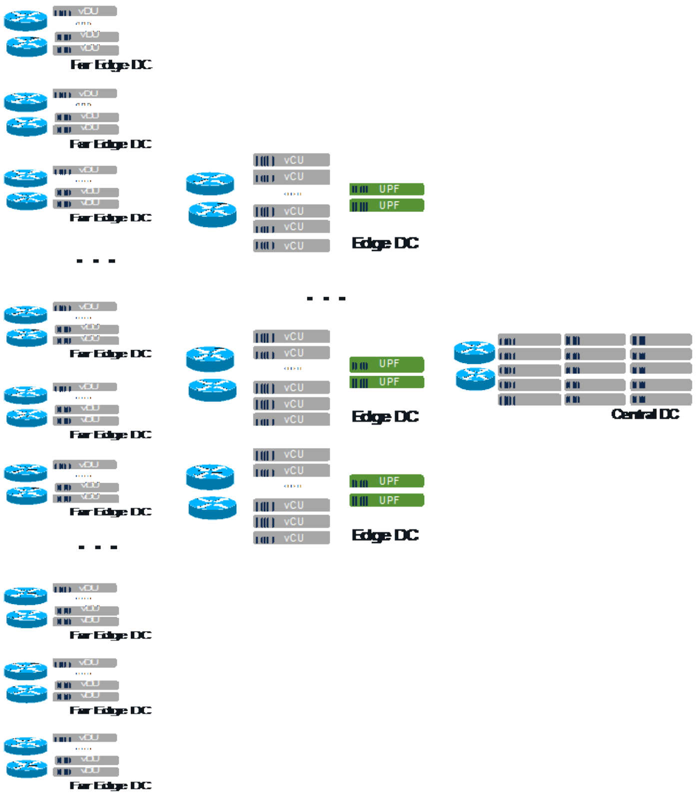
Redundant and limited blast radius

Synchronization built-in

Edge DC Design Considerations

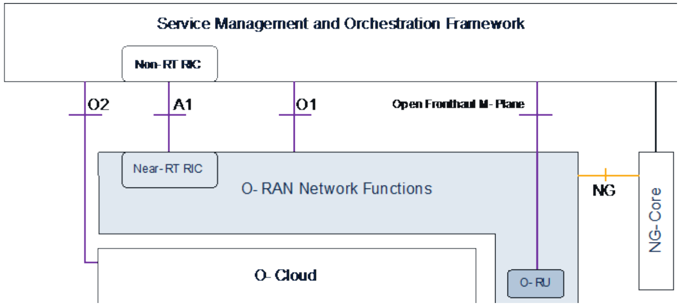
vCU@Edge

- vCU can be placed higher in the network
  - vCU aggregates multiple vDU sites providing resource pooling benefits
  - Far edge sites are space and power constrained
- Redundancy architecture for vCU can leverage central/regional DCs since latency requirements are not as strict
- vCU co-located with UPF avoids SecGW for the backhaul which optimizes cost and simplifies the network
- Evolution of use cases (e.g, URLL), introduction of RAN network slicing and possibility to decompose the CU into CU-CP and CU-UP enables flexible/distributed placement of CU-UP while keeping CU-CP centralised



O-RAN Automation Requirements

- Huge number of DC instances requires very efficient and scalable automation components, security and access control
- Modularity of the system is key – not all customers have the same use cases, infrastructure, mode of operation, etc
- ORAN automation requires consolidated management of multiple infrastructure domains
- Centralized monitoring, storage, lifecycle management and software mgmt to minimize time, footprint and operations at far edge sites



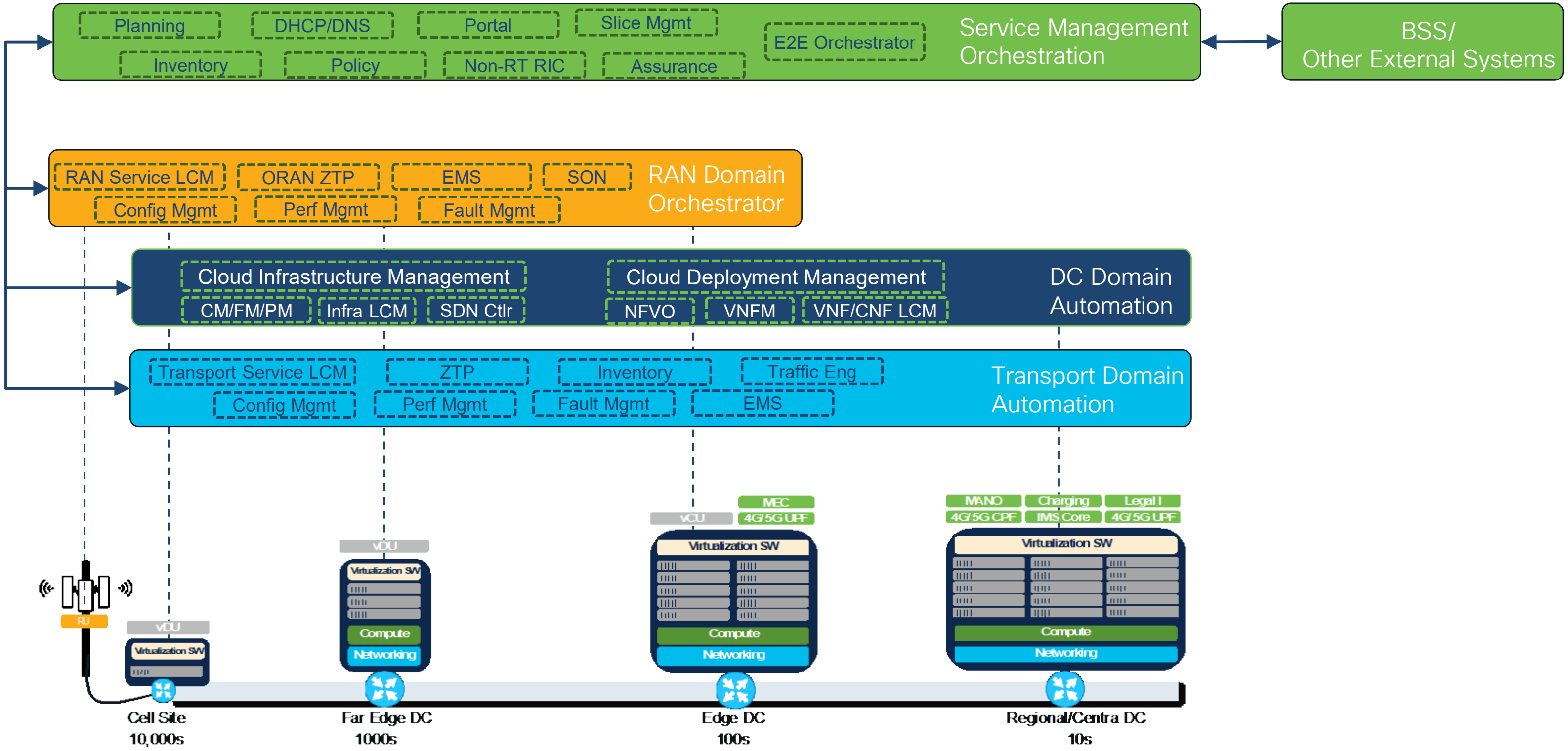
Automation is a key component of ORAN architecture – standardization is nascent

Needs deep system integration with multiple vendors

Requires both RAN and cloud skills

O-RAN Automation Architecture

Multi-Infrastructure Domain Automation

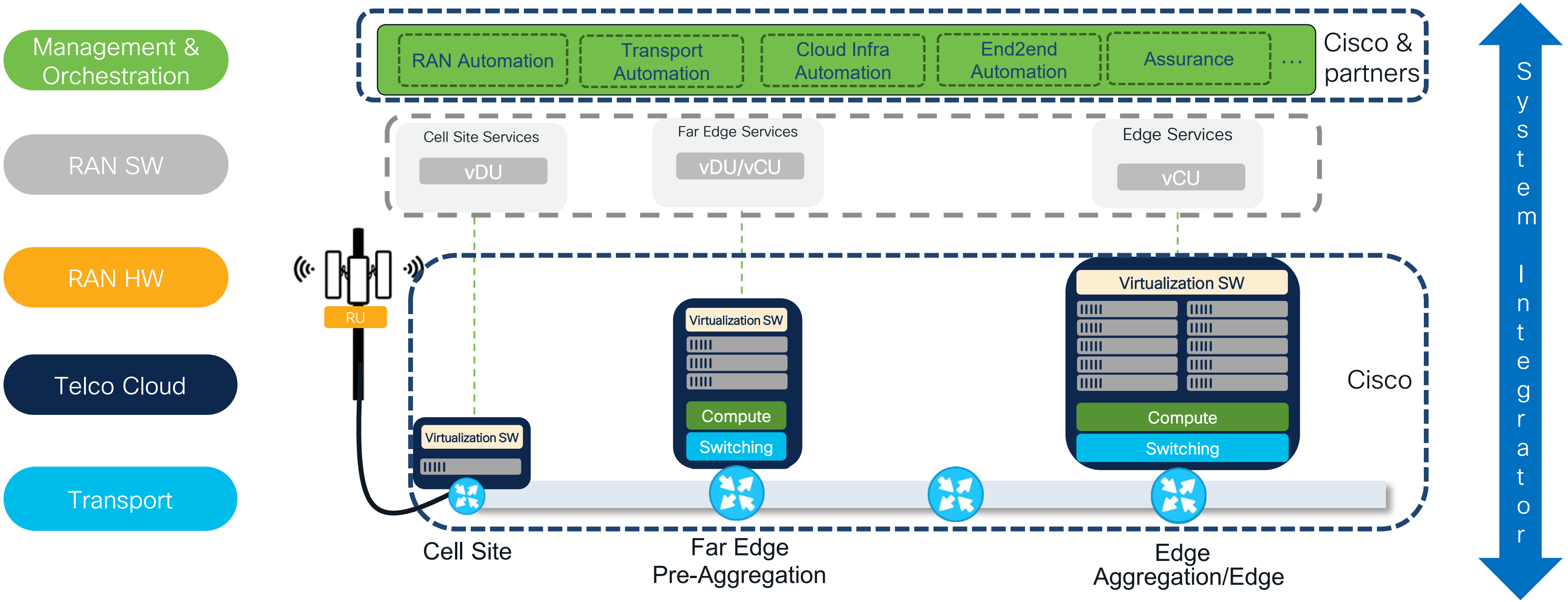


Cisco Contributions to O-RAN

Standardize	Accelerate	Deploy
Active contributor to multiple work groups in O-RAN alliance co-authoring standards (WGs 1, 4, 5, 7, 9), and co-chairing WG4	Building an ORAN testing/validation center to accelerate 4G/5G Open RAN deployments	Program & architecture management office in Rakuten E2E, still the only massive live deployment of ORAN
Developed first Yang models for RAN operation & automation	Engaged in multiple ORAN POC/trials around the world	Virtualisation platform, IP transport, Automation

Cisco Contributions to O-RAN

Domains



Conclusion

Open RAN –“The new reality”

- Open RAN is a profound disruption in the way radio networks are built and managed – DC/virtualisation, networking & automation skills are equally important to the RAN system as radio skills
- O-RAN Alliance leads the standardization work of Open RAN architecture, components and interfaces in close collaboration with 3GPP, TIP, GSMA and other organizations through formal liaisons
- Open RAN architecture choice (split) has a significant impact in the infrastructure requirements/build-out, affecting transport, telco cloud and automation design
- Market interest is quickly building up, with tier-1 SPs committing to deploy and invest, governments supporting and financing, multiple PoCs and live trials ongoing across all regions EMEAR, US and Asia

Related sessions

- BRKSPG-2018 Orchestrating 5G End to End
- BRKSPM-2001 5G Converged SDN Transport
- BRKSPG-2065 Packet Based Front Haul
- BRKSPG-2060 5G Transport: Design Strategies, Considerations and Best Practices
- BRKSPG-2035 Telco Cloud Evolution to Support 5G, Egde Computing & Open RAN

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