Qualcomm


# How to build high-performance 5G networks with vRAN and O-RAN?

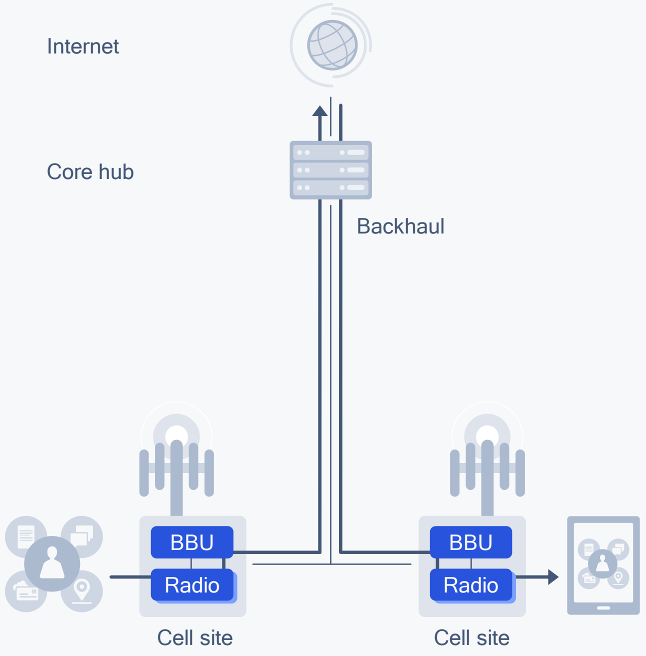
17 February 2021

@QCOMResearch

# Evolving the 5G network

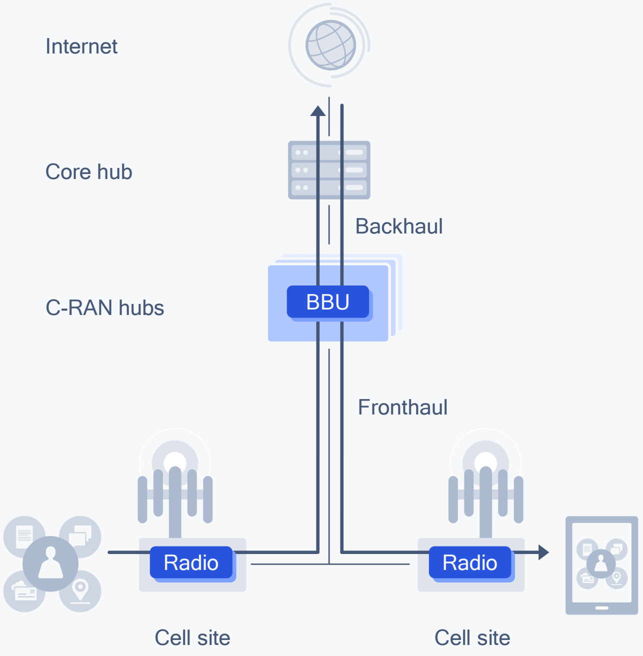
## Traditional RAN

Combined baseband processing unit + Radio unit



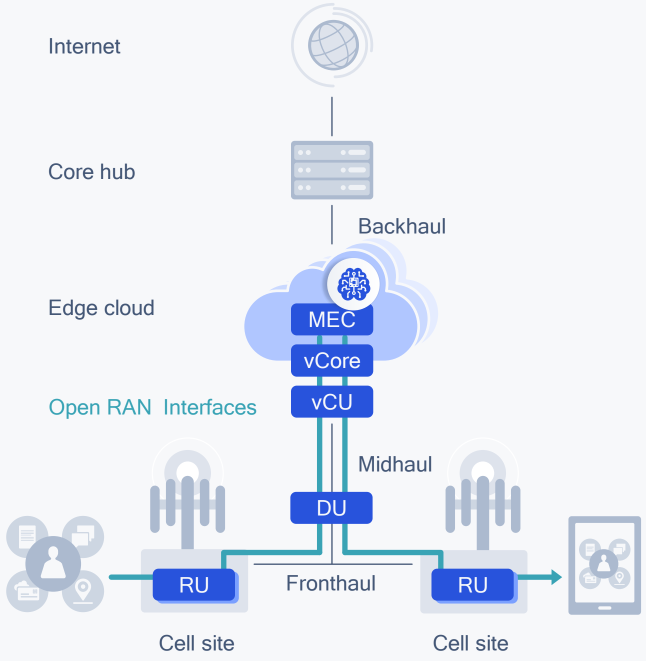

## Centralized RAN (C-RAN)

Centralized baseband processing unit




## Virtual RAN (vRAN) + MEC

Virtualized baseband processing unit with disaggregation




For better coordination, scalable capacity, faster deployments, lower latency, and new use cases

BBU: Baseband unit; DU: Distributed unit; vBBU: Virtual baseband unit; vCore: Virtual core network; vCU: Virtual central unit; MEC: Multi-access Edge Computing

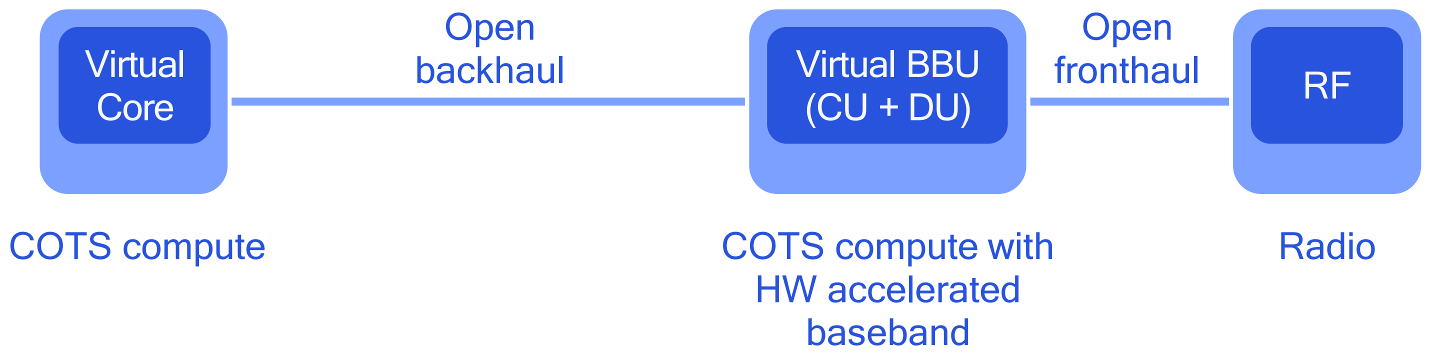
# Disaggregation can create a more open and interoperable virtual RAN


BBU: Baseband unit; COTS: Commercial off-the-shelf; CP: Control plane; CU: Central unit; DU: Distributed unit; UP: User plane; vCore: Virtual core network; vCU: Virtual central unit

5G vRAN

# Disaggregation can create a more open and interoperable virtual RAN

## Disaggregate RAN hardware and software with COTS HW

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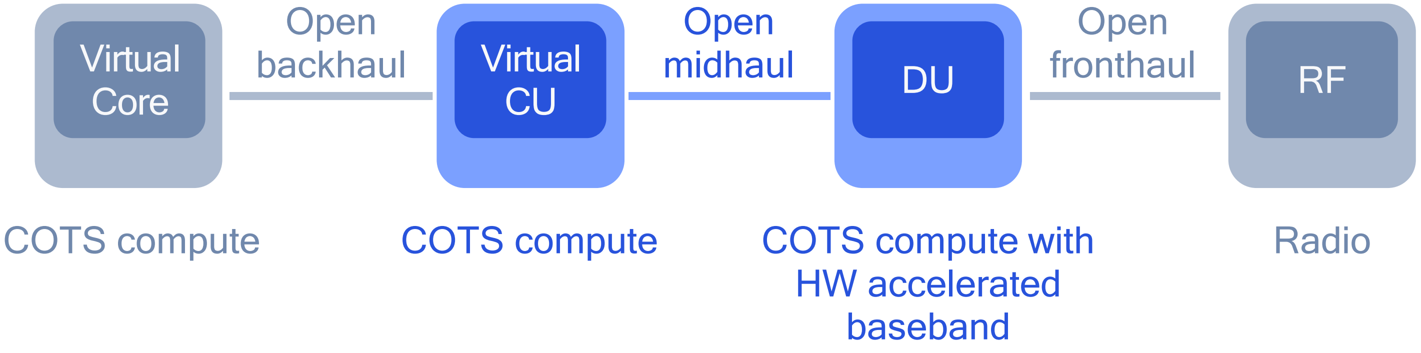
5G
vRAN

# Disaggregation can create a more open and interoperable virtual RAN

## Disaggregate layers of the protocol stack

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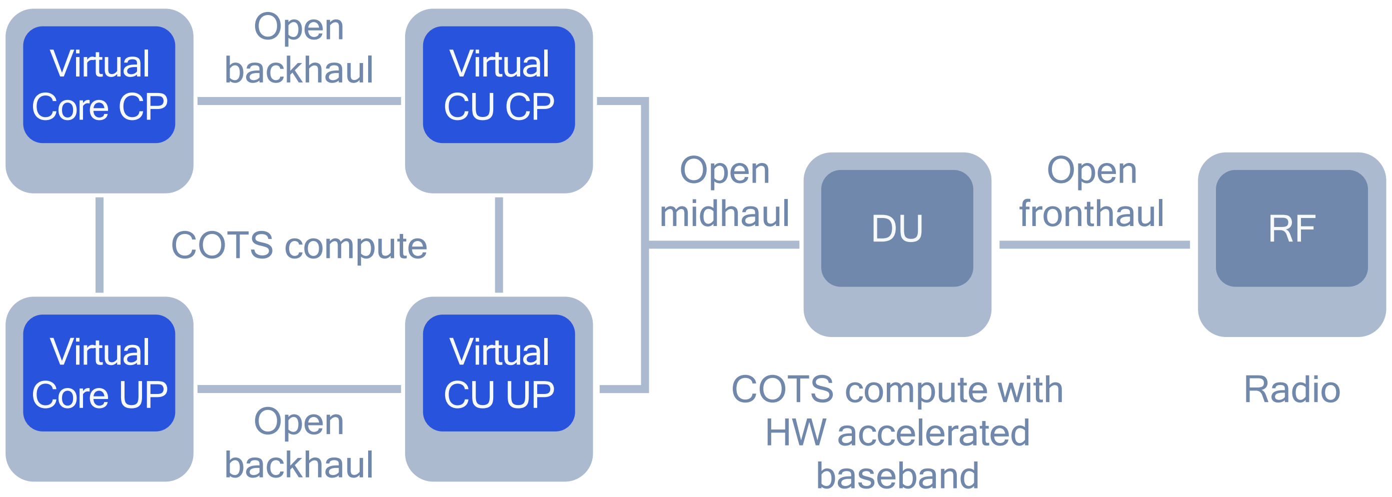
5G vRAN

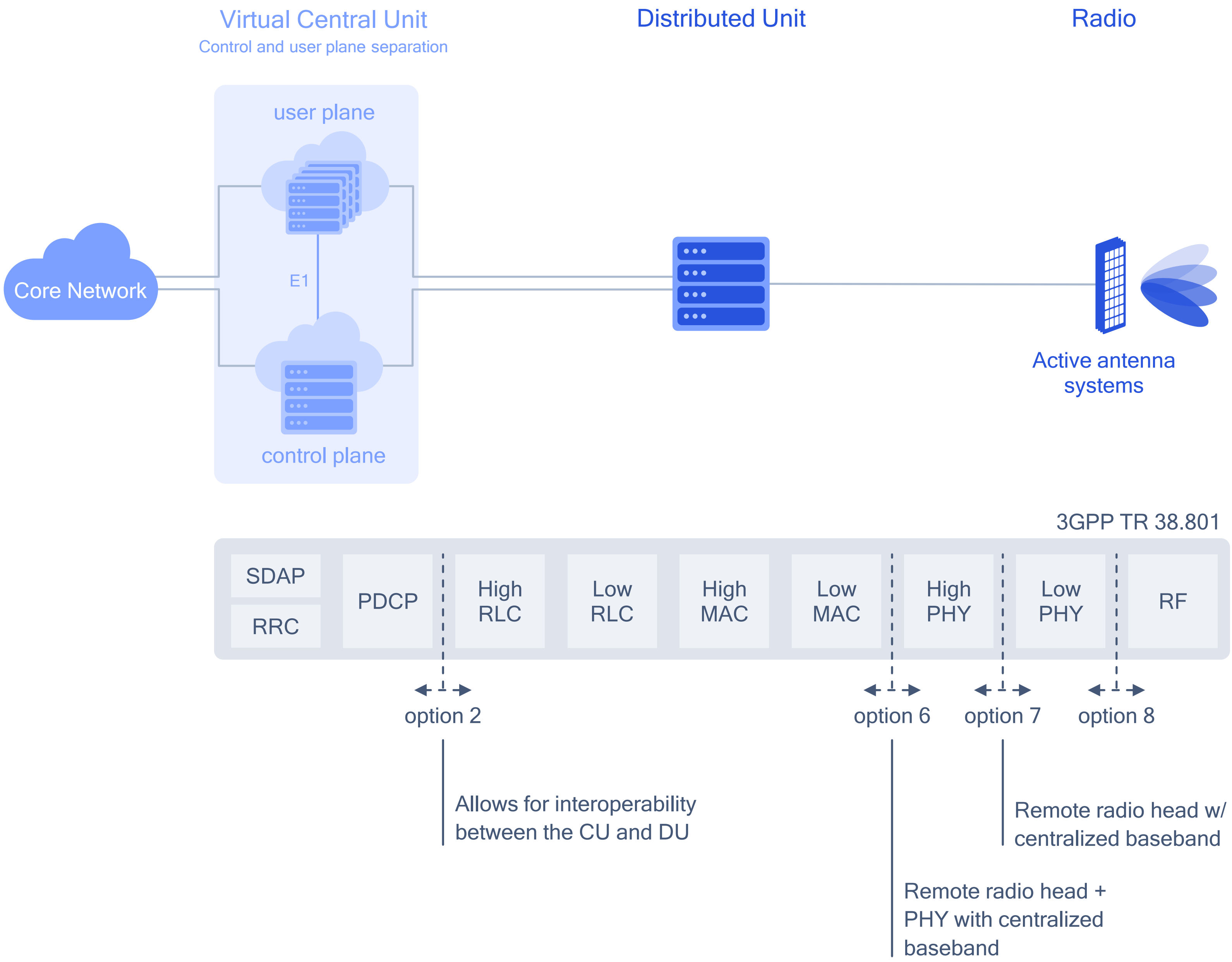
# Disaggregation can create a more open and interoperable virtual RAN

## Disaggregate control plane and user plane functions



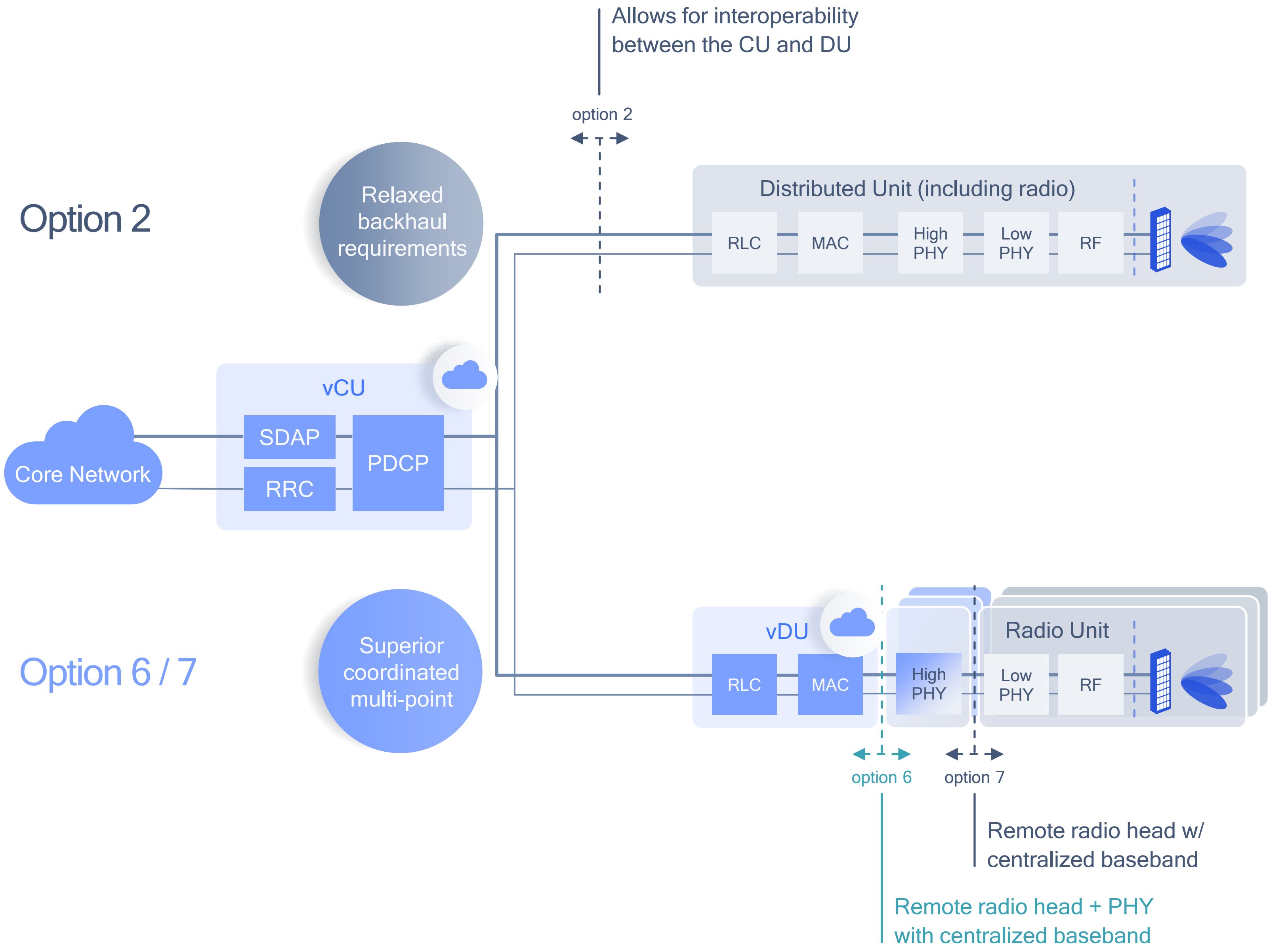

BBU: Baseband unit; COTS: Commercial off-the-shelf; CP: Control plane; CU: Central unit; DU: Distributed unit; UP: User plane; vCore: Virtual core network; vCU: Virtual central unit

# Designed for unprecedented flexibility and cost-effective network deployments



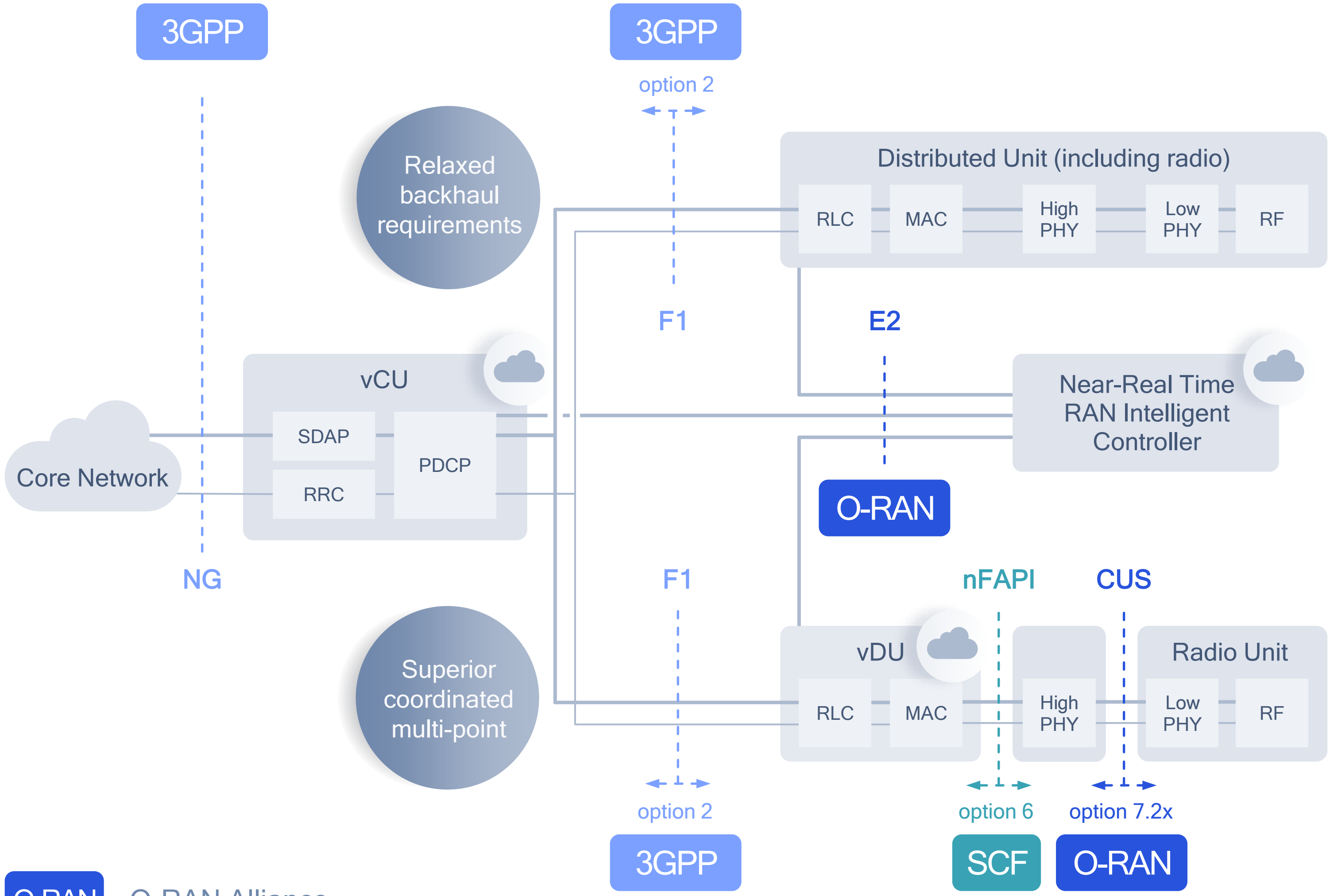

CU: Central unit; DU: Distributed unit; MAC: Medium access control; PDCP: Packet data convergence protocol; PHY: Physical layer; RF: Radio frequency; RLC: Radio link control; RRC: Radio resource control; SDAP: Service data adaptation protocol

# Designed for unprecedented flexibility and cost-effective network deployments




SON: Self-optimizing networks; nFAPI: Network functional application platform interface


# Broaden the interoperable ecosystem with standardized open interfaces




| | |
|---|---|
| O-RAN | O-RAN Alliance |
| SCF | Small Cell Forum |
| 3GPP | Third Generation Partnership Project |

CUS: Control, User and Synchronization plane
nFAPI: Network functional application platform interface

# Disaggregate to maximize the benefits of virtual RAN

Disaggregate RAN hardware and software with COTS HW

Disaggregate layers of the protocol stack

Disaggregate control plane and user plane functions

**5G vRAN**

Support different deployment scenarios

Improve resource scalability and utilization

Efficiently deploy new services

Build denser networks

Ride the innovation wave

5G
vRAN

### Support different deployment scenarios

- Place processing and analytics where it is needed
- Simplify orchestration

### Improve resource scalability and utilization

- Improve cost and energy effectiveness with trunking gains from resource pooling
- Rapidly scale virtual resources for additional capacity

### Efficiently deploy new services

- Support lower end-to-end latency
- Evolve and upgrade components separately
- Tailor dimensioning and features to suit the use case with 5G private networks

### Build denser networks

- Reduce cell-site footprint by relocating disaggregated functions to data centers
- Build a denser network by accessing more locations with compact installations

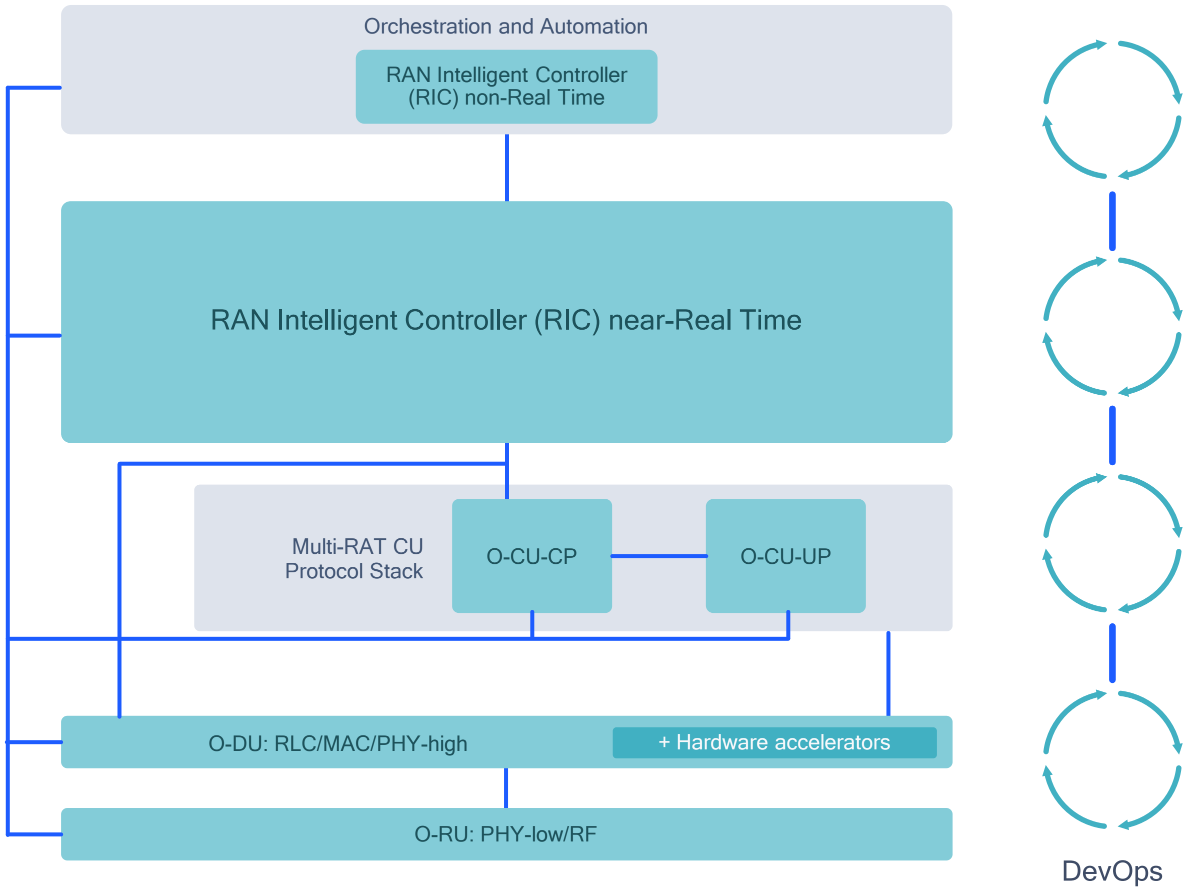
### Ride the innovation wave

- Broaden the ecosystem for competition
- Spur innovation with vendor diversity
- Select best-of-breed network components

# Deploy networks faster with vRAN and disaggregation

# Accelerate 5G innovation with modular components and standardized open interfaces

## O-RAN architecture




Drive distributed development and operations (DevOps) with modular network components

Set the foundation for interoperability by design with standardized open interfaces

**Leverage a broader ecosystem for high-performance 5G with best-in-class functionality**

**Accelerate feature development, problem resolution and product differentiation**

**Build a common platform for public networks and the growing private network market**

CU: Central unit; DU: Digital unit; eMBB: Enhanced mobile broadband; NF: Network function; mMTC: Massive machine type communications; O-: ORAN-; RIC: RAN intelligent controller; RU: Radio unit

# Optimize architecture for application with O-RAN

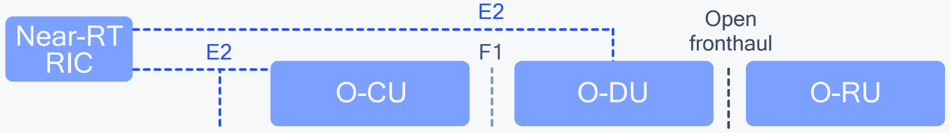
Application-specific constraints influence network topology

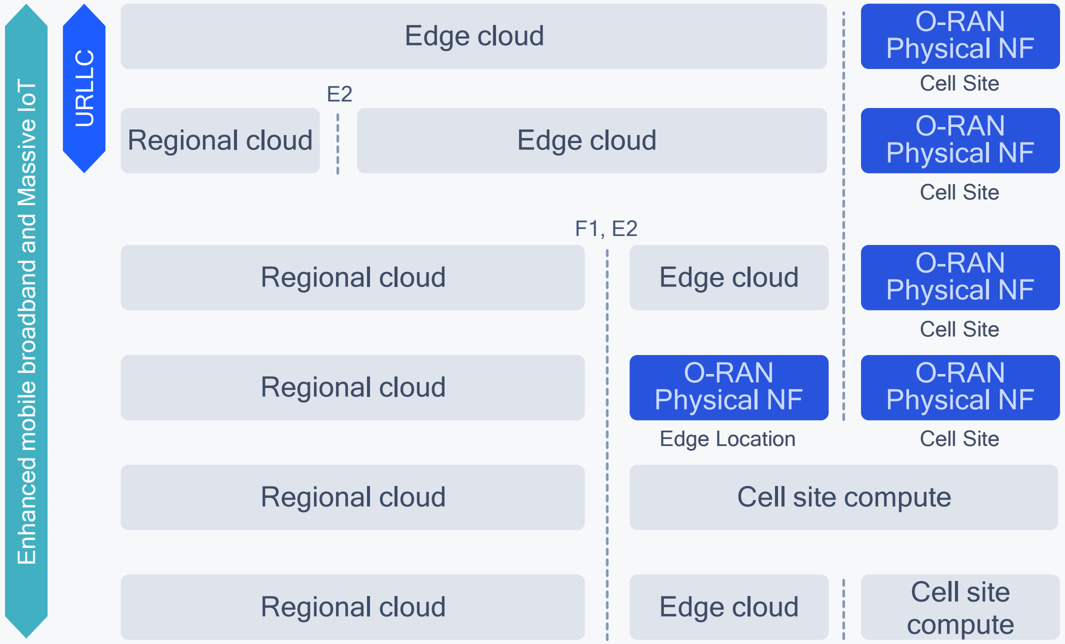
O-RAN offers a comprehensive set of network architectures for different application constraints

CU: Central unit; DU: Digital unit; eMBB: Enhanced mobile broadband; NF: Network function; mMTC: Massive machine type communications; O-: ORAN-; RIC: RAN intelligent controller; RU: Radio unit

## One-way distance and delay constraints

| | O-CU to O-DU | O-DU to O-RU |
|---|---|---|
| Enhanced mobile broadband (eMBB) | 625 µs (125 km) | 100 µs (20 km) |
| Massive IoT (mMTC) | 625 µs (125 km) | 100 µs (20 km) |
| URLLC control plane | 625 µs (125 km) | 100 µs (20 km) |
| URLLC user plane | 100 µs (20 km) | |

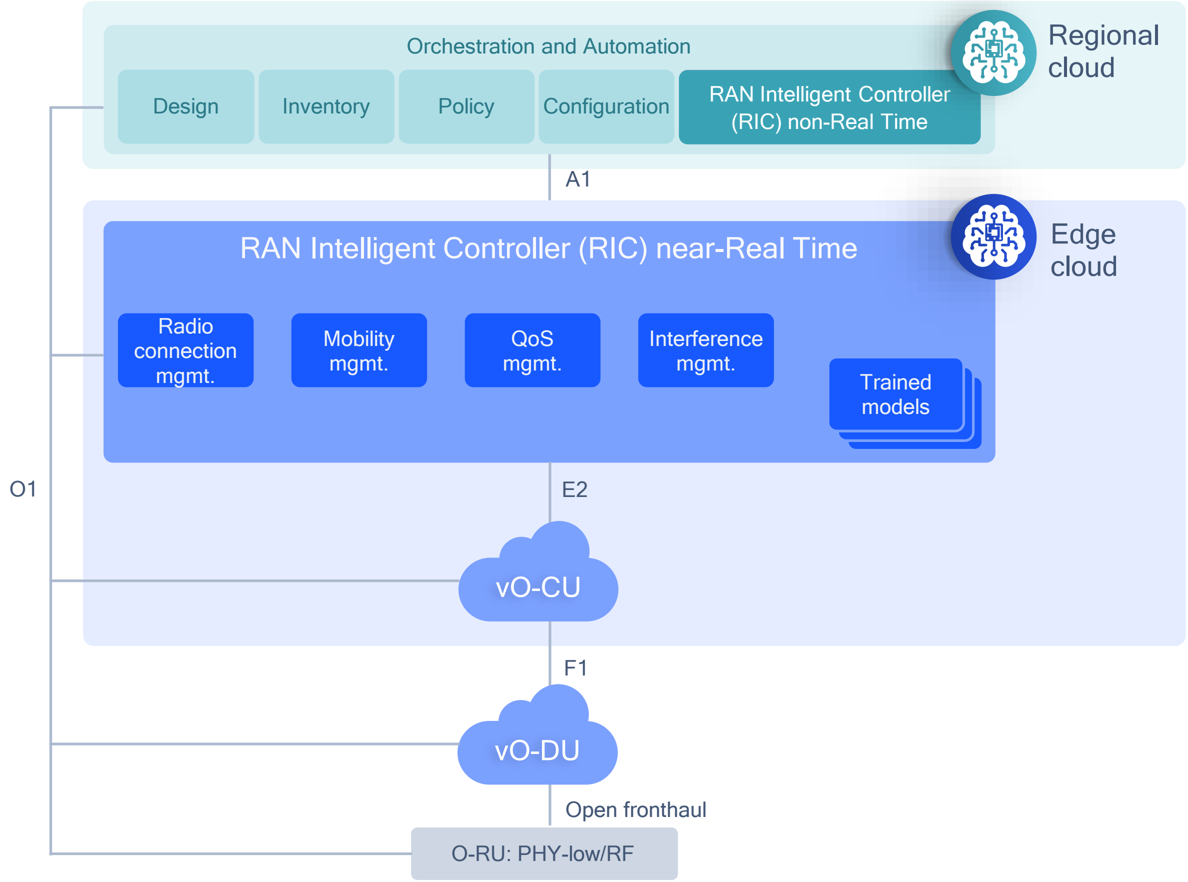



Physical topologies

# RAN Intelligent Controllers (RIC) unlock new capabilities for the intelligent RAN

O-RAN architecture




## Non-Real Time RIC

- Robust RAN analytics for wide area networks
- Train machine learning models at scale
- Enforce intelligent policy control

## Near-Real Time RIC

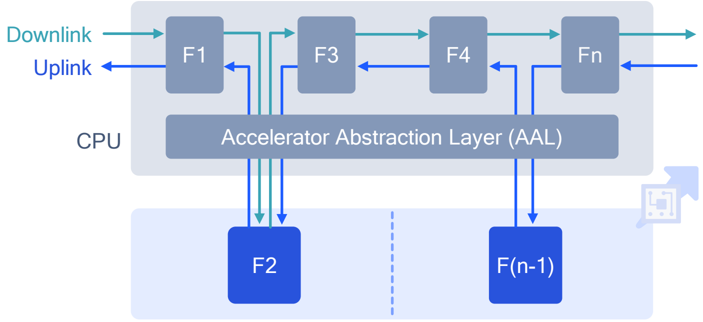
- Deep learning with fine-resolution data
- Drive AI/ML-based performance optimization for complex, interdependent RAN algorithms

## Scale intelligence securely with the network

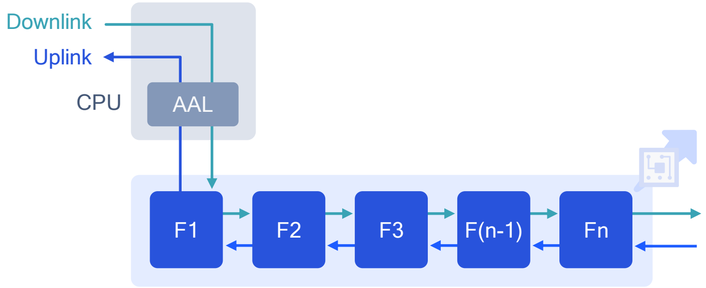
- Add RAN Intelligent Controllers to the vRAN COTS platform
- Dimension network intelligence with network capacity
- Ensure secure access to training data

COTS: Commercial off-the-shelf; O-CU: O-RAN central unit; O-DU: O-RAN distributed unit;
O-RU: O-RAN radio unit; QoS: Quality of service; RAT: Radio access technology; RT: Real-time

## Two CPU offload architectures

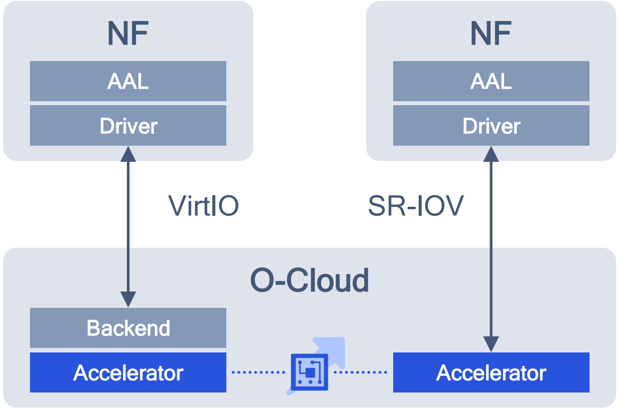



Look-aside HW accelerator
for offloading functions selectively




Inline HW accelerator
for offloading functional chains

## Two accelerator deployment models




Abstracted accelerator model

Pass through accelerator model

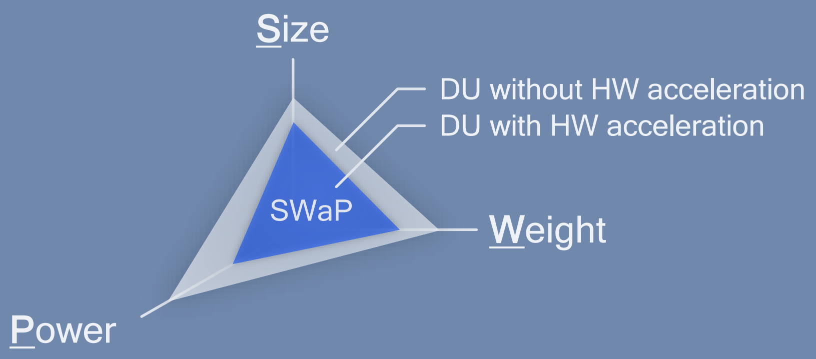
- Abstracted accelerator model fully decouples HW and SW for maximum flexibility with virtualized or containerized network functions
- Pass-through accelerator model reduces latency between latency-sensitive or real-time network functions and hardware accelerators

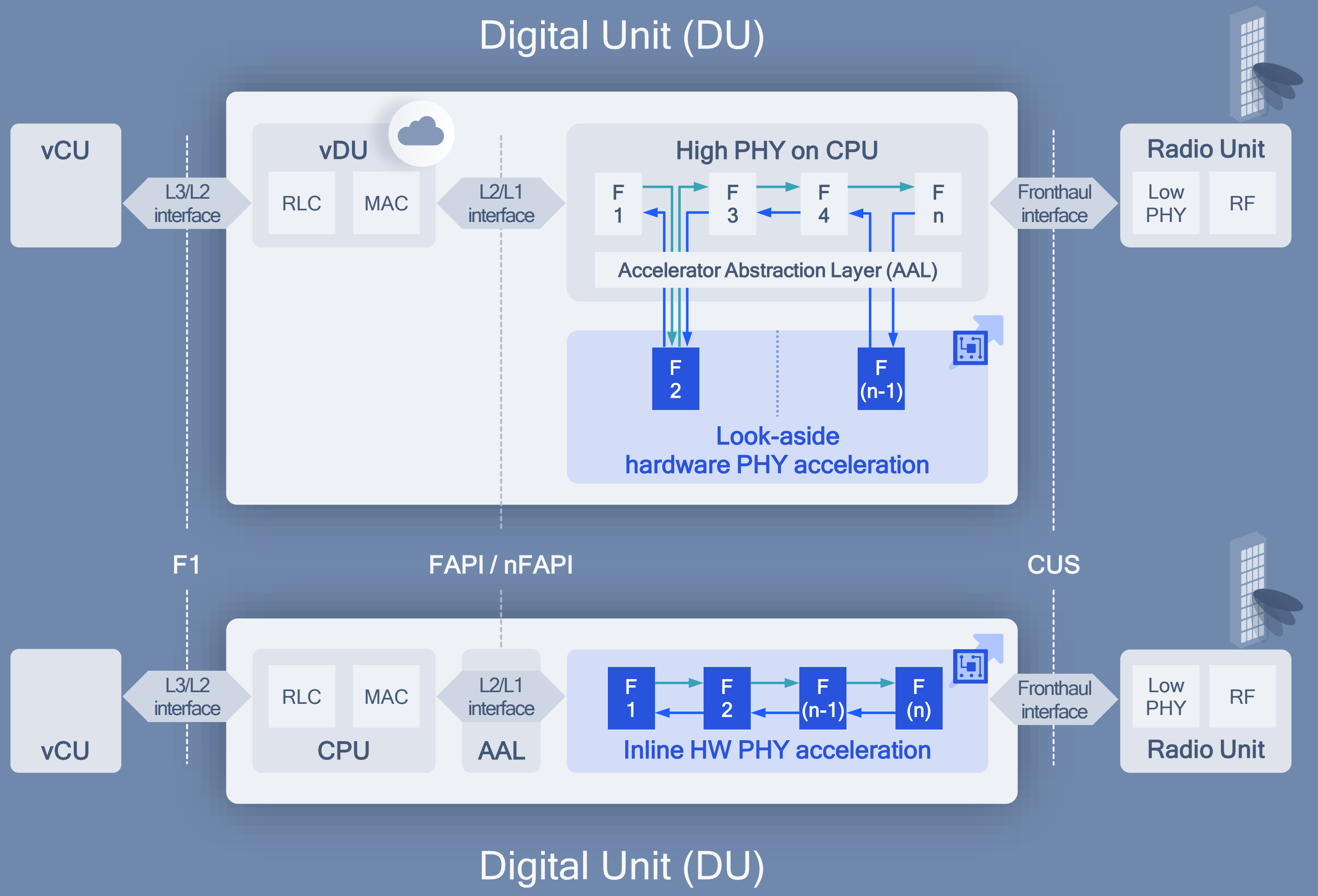
AAL: Acceleration abstraction layer; NF: Network function; O-Cloud: O-RAN cloud; OFH: Open fronthaul

# Drive vRAN performance and efficiency with hardware accelerators

O-RAN architecture

# Reduce DU SWaP with HW-accelerated real-time functions




Modularize with nFAPI for L2 on COTS HW and a fully-accelerated inline PHY

Optimize physical parameters for PHY layer efficiency with HW accelerators

Efficiently handle multiple functions with inline accelerators

COTS: Commercial off-the-shelf; CUS: Control, User and Synchronization plane; L1: Layer 1 - PHY; L2: Layer 2 - MAC and RLC;
MAC: Medium access control; nFAPI: Network functional application platform interface; RLC: Radio link control; SWaP: Size, weight and power

# Digital intelligence in the cloud will drive the enterprise of the future

**IDC FutureScape:**
**Worldwide Future of Digital Infrastructure 2021**

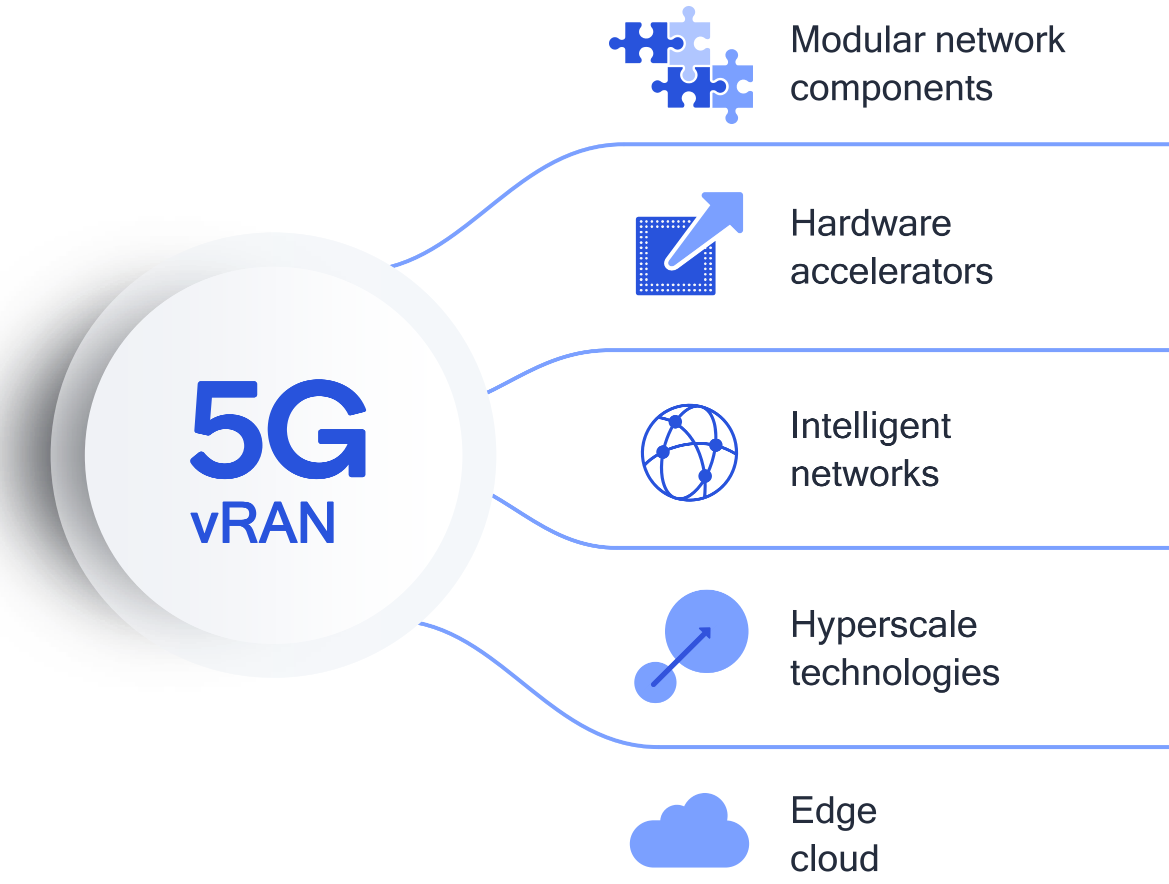
**55%**
embedded AI functions in their business-critical workloads

**75%**
cloud-native architectures for core business applications

**60%**
automated digital infrastructure for business resiliency and security

## Enterprises in 2024

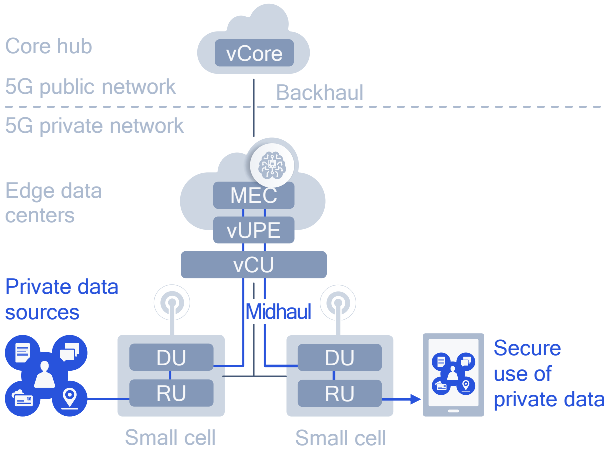
Source: https://www.idc.com/events/futurescape



# Transform industry and enterprise with 5G, vRAN and MEC

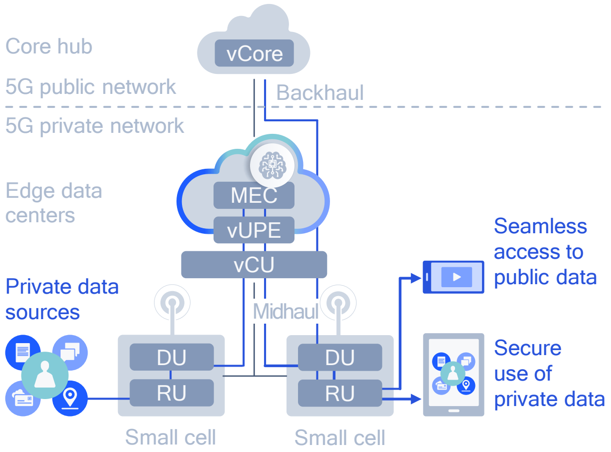
## Reduce end-to-end latency

with 5G and MEC for industrial IoT and delay-sensitive applications, e.g. Boundless XR



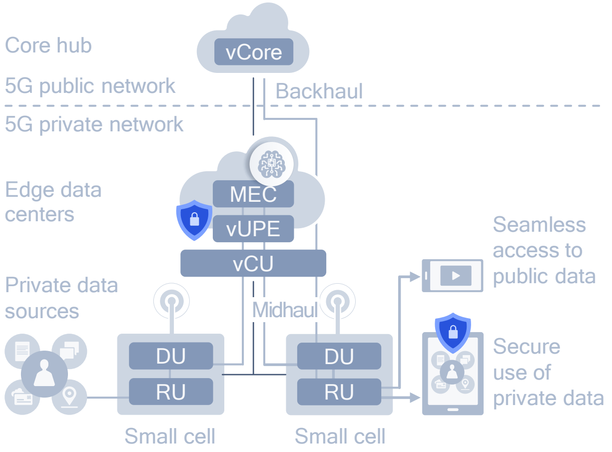

## Support multiple services

by deploying network and compute resources opportunistically for various latency, throughput and reliability needs



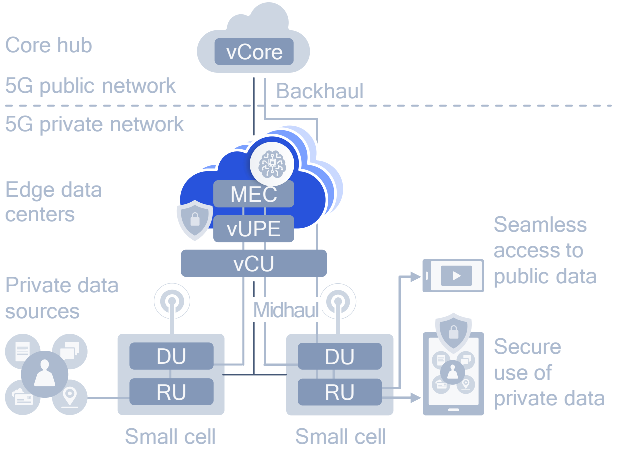

## Increase data security and privacy

by keeping data local and physically secure




## Increase availability and scalability

- by using common edge compute resources for both vRAN and MEC
- by independently scaling resources for control plane and user plane traffic




DU: Distributed unit; MEC: Multi-access edge compute; PHY: Physical layer; RU: Radio unit; vCore: Virtual core network; vCU: Virtual central unit; vRAN: Virtual radio access network; vUPF: Virtual user plane function

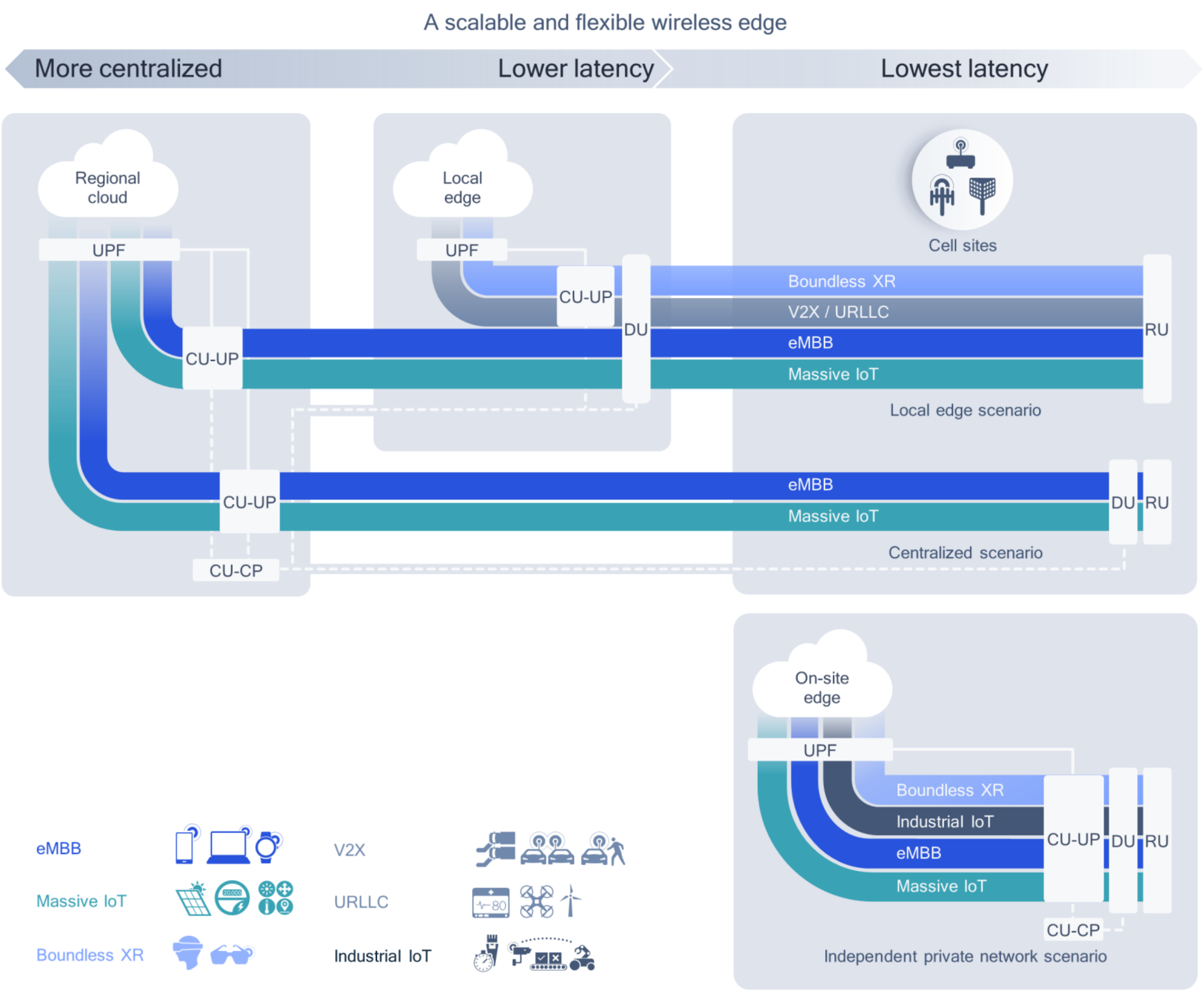
# Advance 5G with network slicing

Protect end-to-end QoS between services and sandbox new services

Tailor network architecture to service-specific latency needs

Position resources to suit deployment constraints

Build one private network with an on-prem edge for multiple use cases



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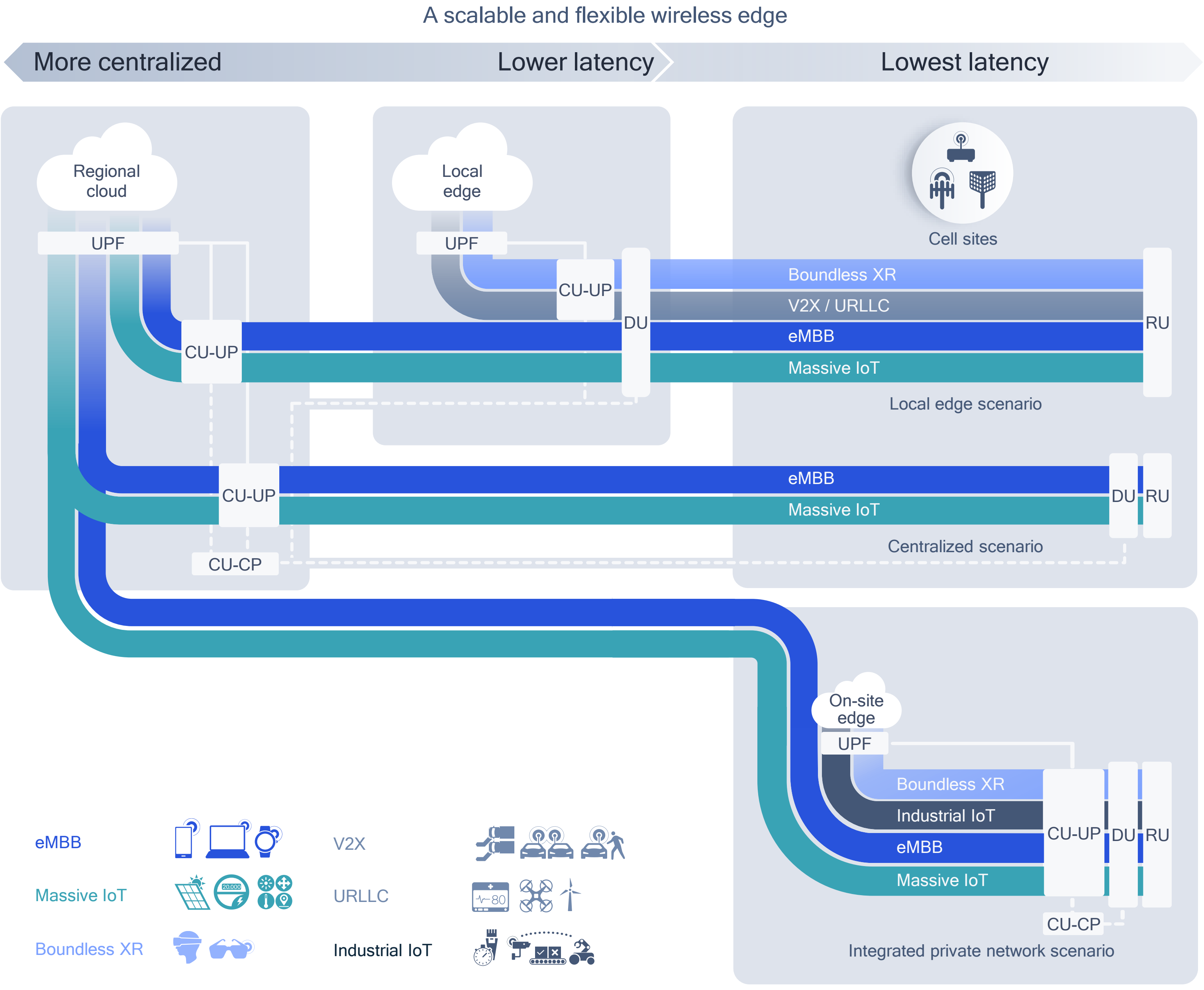
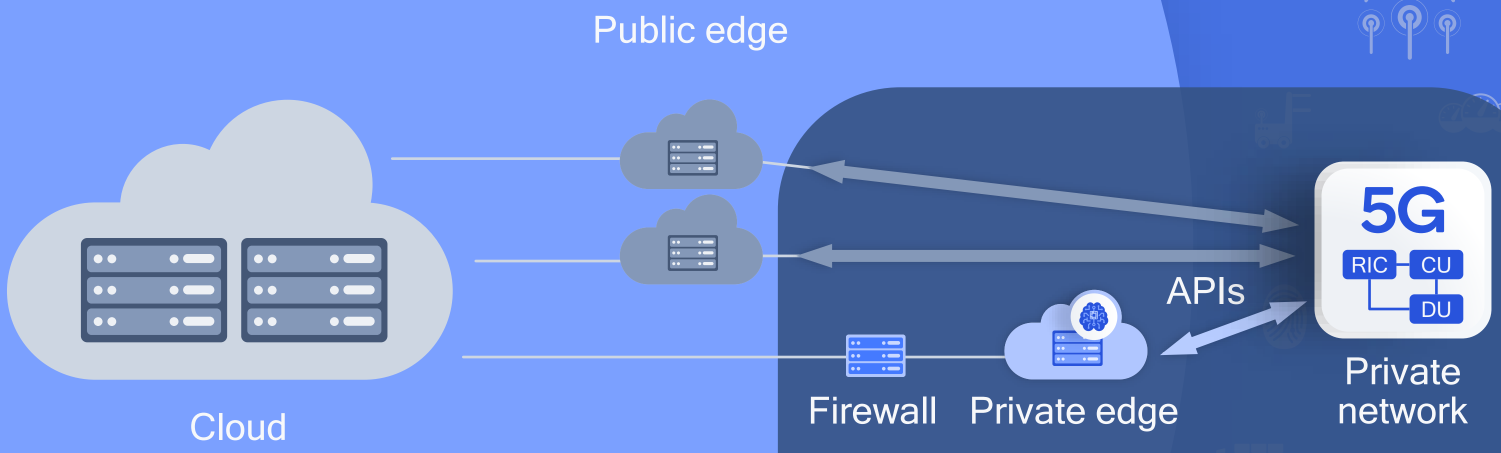


# Drive new efficiencies and innovation with an integrated 5G private network and edge




5G network APIs open interfaces with the private edge to facilitate:

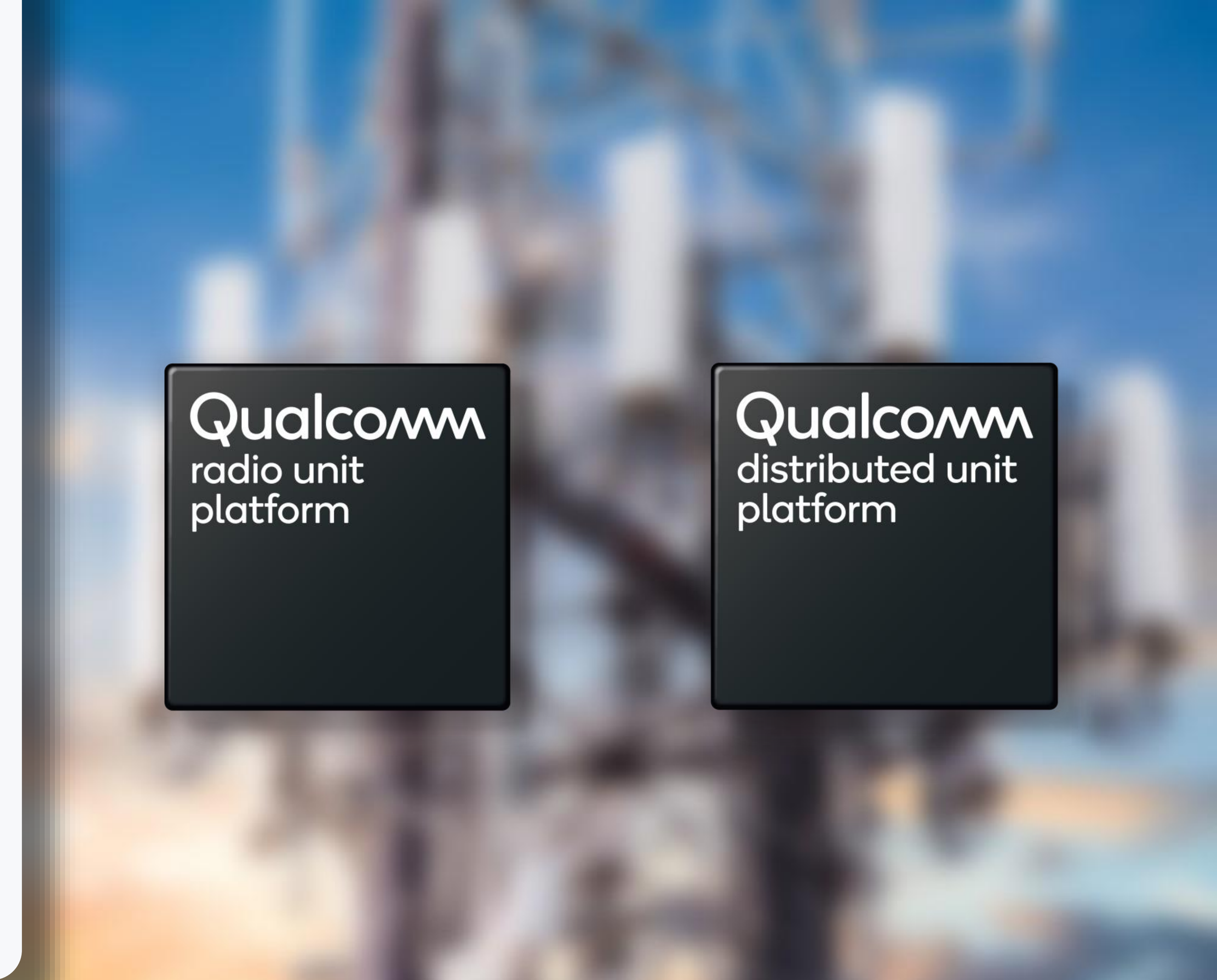
- Responsive interactivity
- Distributed AI
- Cloud processing




API: Application programming interface

# Qualcomm® 5G RAN Platforms

Building open and innovative cellular infrastructure with high performance Modem-RF System.




Qualcomm Radio Unit Platform, and Qualcomm Distributed Unit Platform are products of Qualcomm Technologies, Inc. and/or its subsidiaries.


# Powering the future of the 5G networks

High Performance Modem-RF System

Flexible, scalable, O-RAN compatible

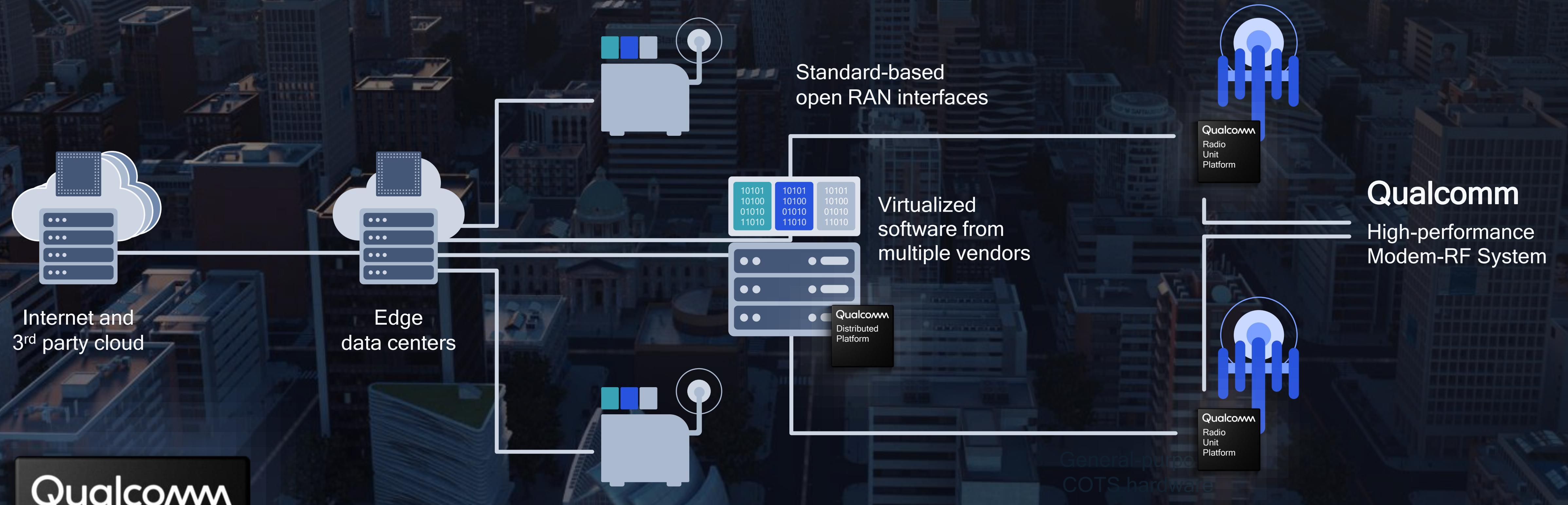
Designed for Macro and Small cells

vRAN with hardware acceleration

Integrated mmWave & Sub-6 GHz solution with Global band Support

# Driving transition to Infrastructure 2.0

## Powered by extended portfolio of Qualcomm® 5G RAN platforms




**Qualcomm**
5G RAN
Platforms

High performance Modem-RF

Virtualization with hardware acceleration

Flexible, scalable, O-RAN compatible

From Macro to Small Cells

Integrated Sub-6 and mmWave solution

Qualcomm

# Thank you

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