Intel® Network Builders Insights Series

Intel SOCs for MEC, Access and Security Infrastructure and Servers

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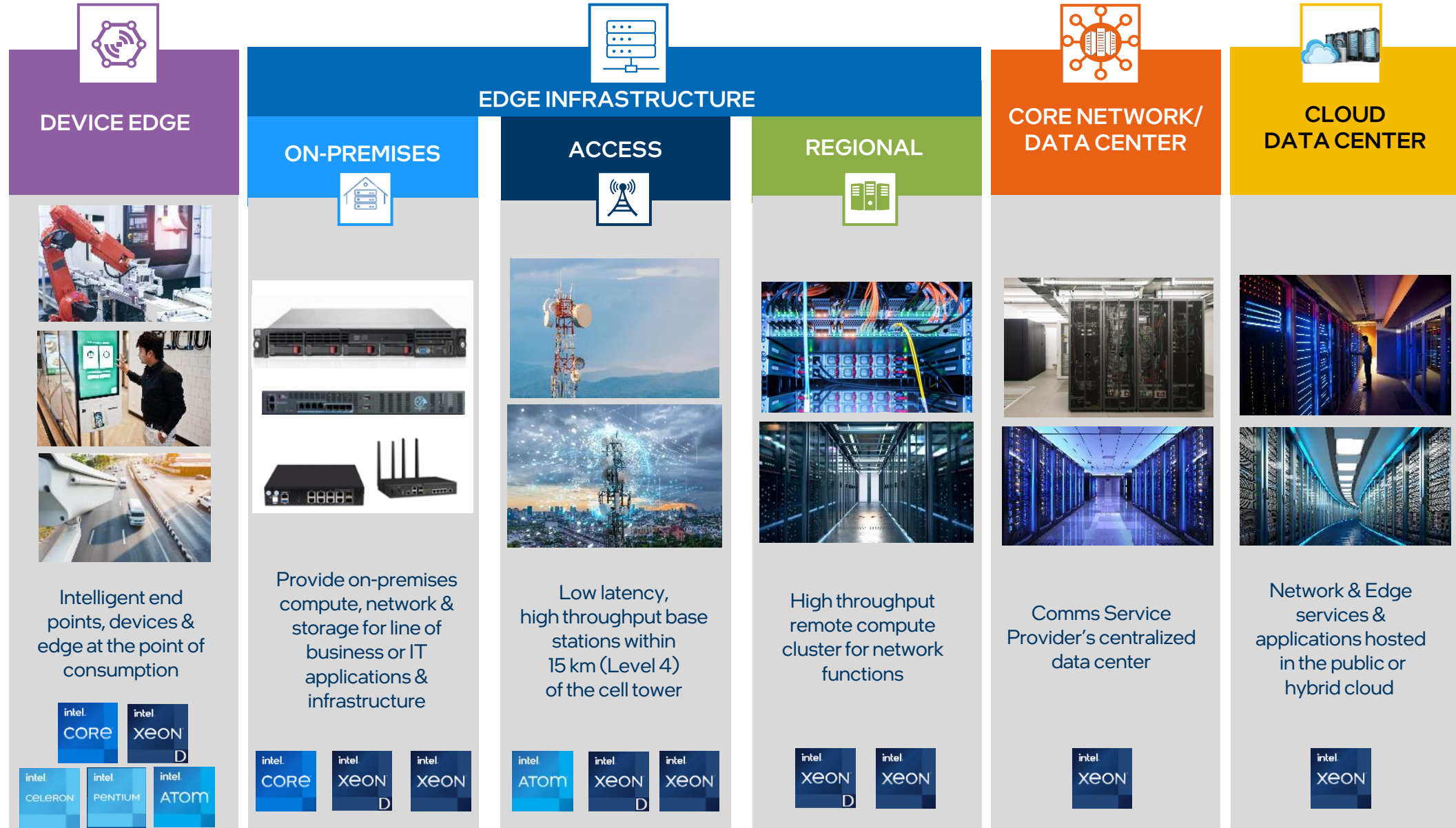
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Network & Edge Solutions Group IA Mapping By Location

DEVICE EDGE	EDGE INFRASTRUCTURE			CORE NETWORK/ DATA CENTER	CLOUD DATA CENTER
	ON-PREMISES	ACCESS	REGIONAL		

DEVICE EDGE

Intelligent end points, devices & edge at the point of consumption

intel CORE — intel XEON D
intel CELERON — intel PENTIUM — intel ATOM

ON-PREMISES

Provide on-premises compute, network & storage for line of business or IT applications & infrastructure

intel CORE — intel XEON D — intel XEON

ACCESS

Low latency, high throughput base stations within 15 km (Level 4) of the cell tower

intel ATOM — intel XEON D — intel XEON

REGIONAL

High throughput remote compute cluster for network functions

intel XEON D — intel XEON

CORE NETWORK/ DATA CENTER

Comms Service Provider's centralized data center

intel XEON

CLOUD DATA CENTER

Network & Edge services & applications hosted in the public or hybrid cloud

intel XEON

VRAN Trends to Watch

- VRAN systems projected to reach $3B-$4B by '26 with a 50% CAGR '21-'26 while traditional only growing 4%

- Average RAN revenues over the period '21-'26 projected to approach $40B-$42B system revenue per year

- Open RAN will comprise ~15% of total RAN revenue by '26

- Drivers:
  - More available spectrum vs prior driving migrations
  - Technology progress increasing confidence in Open RAN working for some segments
  - Progress on full virtualization is ramping up with commercial announcements (Dish Networks)
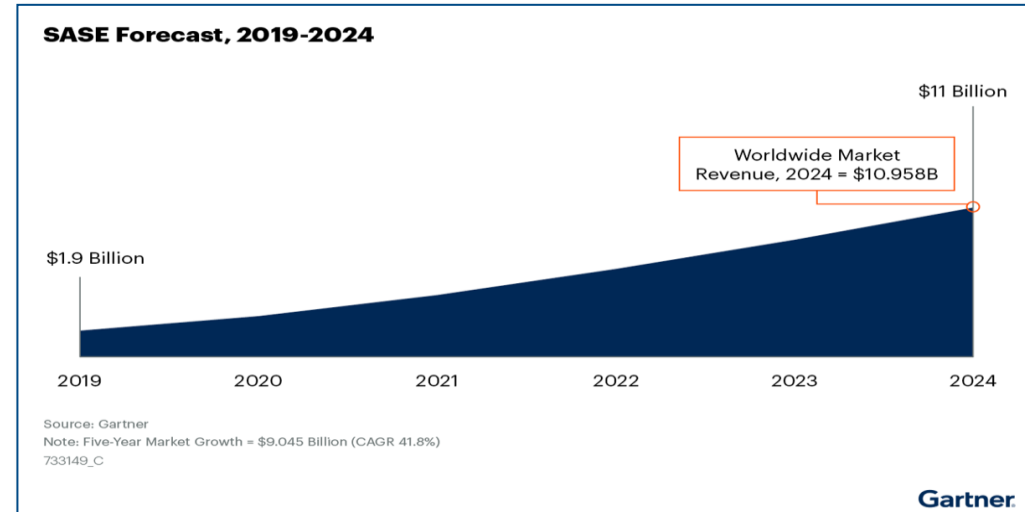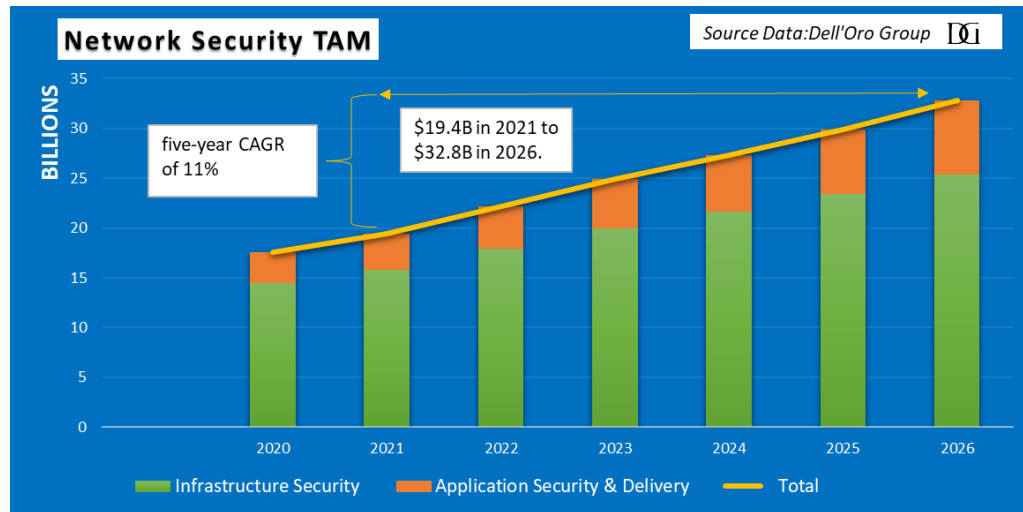 - Public policy to stimulate Open RAN

Source: Dell'Oro 2022

Open vRAN revenue, Europe, Middle East, and Africa, 2021–26

Legend: ■ Open vRAN — % of total RAN
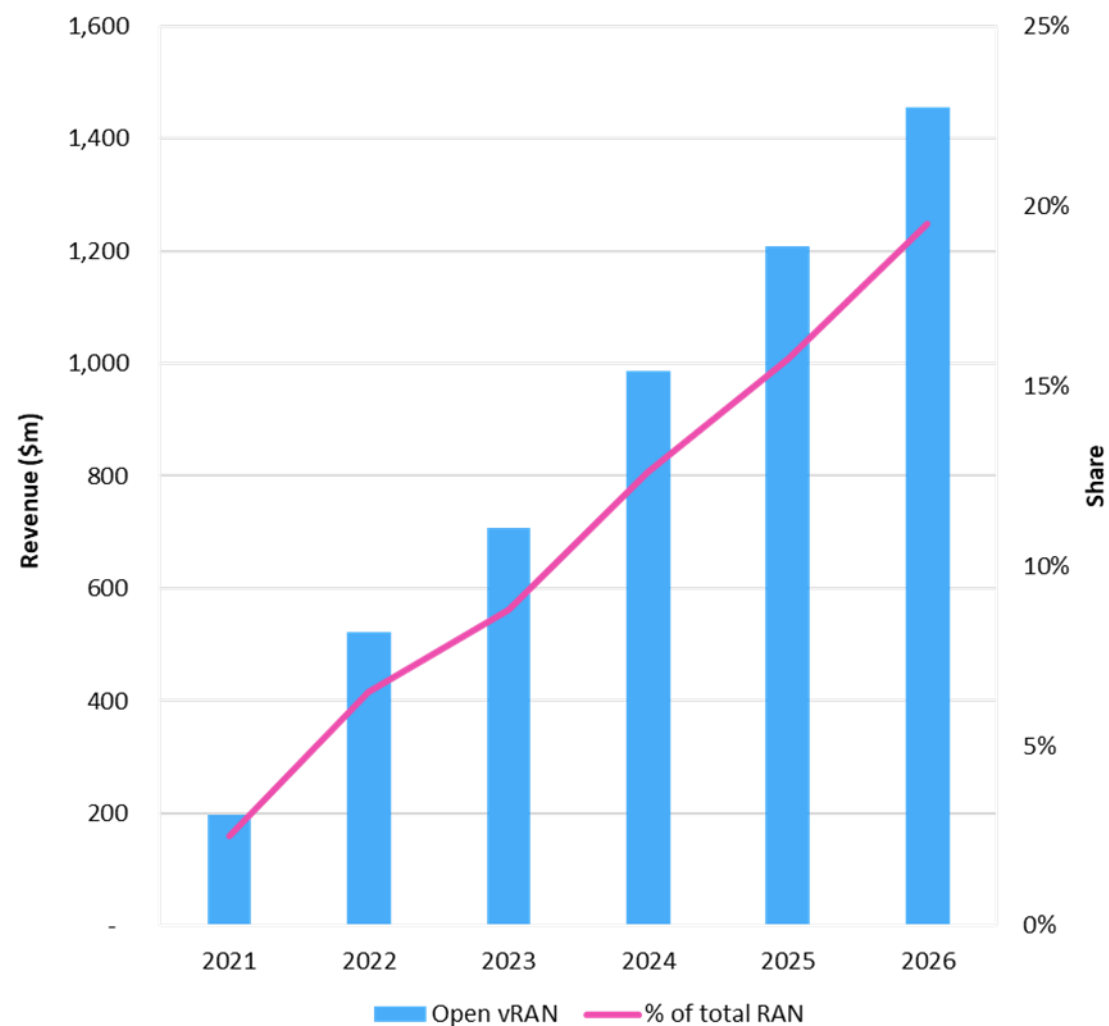
Source: Omdia

© 2022 Omdia

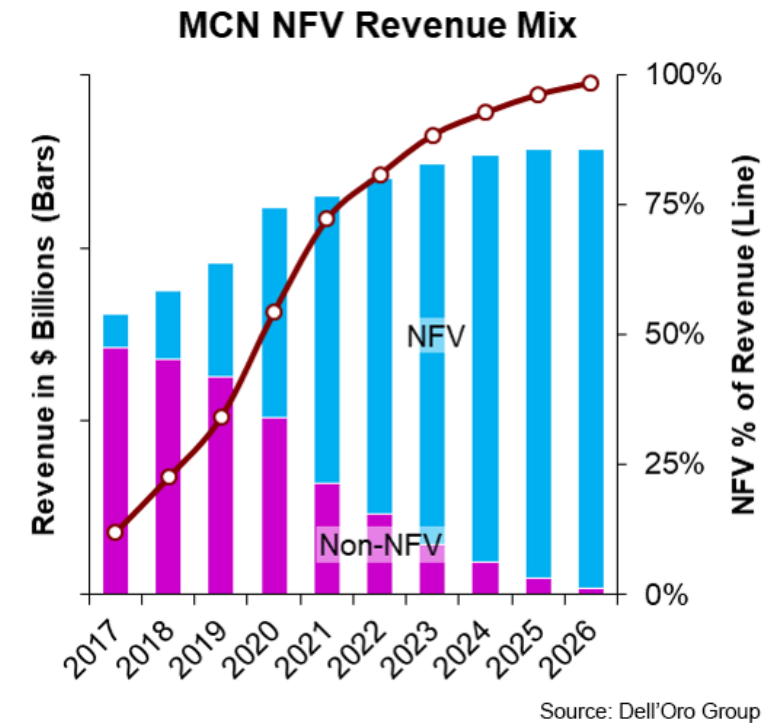intel. 4

Market View on Security

Major Trends

- Network Security solutions TAM is growing at a robust rate.

- Increase in SASE (Secure Access Service Edge) deployments is facilitating growth in SaaS based & Unified SSE (Security Service Edge) solutions.

- Increasingly hybrid workforce causing demand in user to application segmentation, accelerating a move to Zero Trust Architecture (ZTA) from a traditional Network Perimeter security-based architecture.

- When campuses open back with the hybrid workforce, expectation is further acceleration of this move.

- Regulatory organizations converging on spec for ZTA. NIST Special Publication 800-207

Network Perimeter Security → Network Edge Security (Software Defined Perimeter) based on ZTA
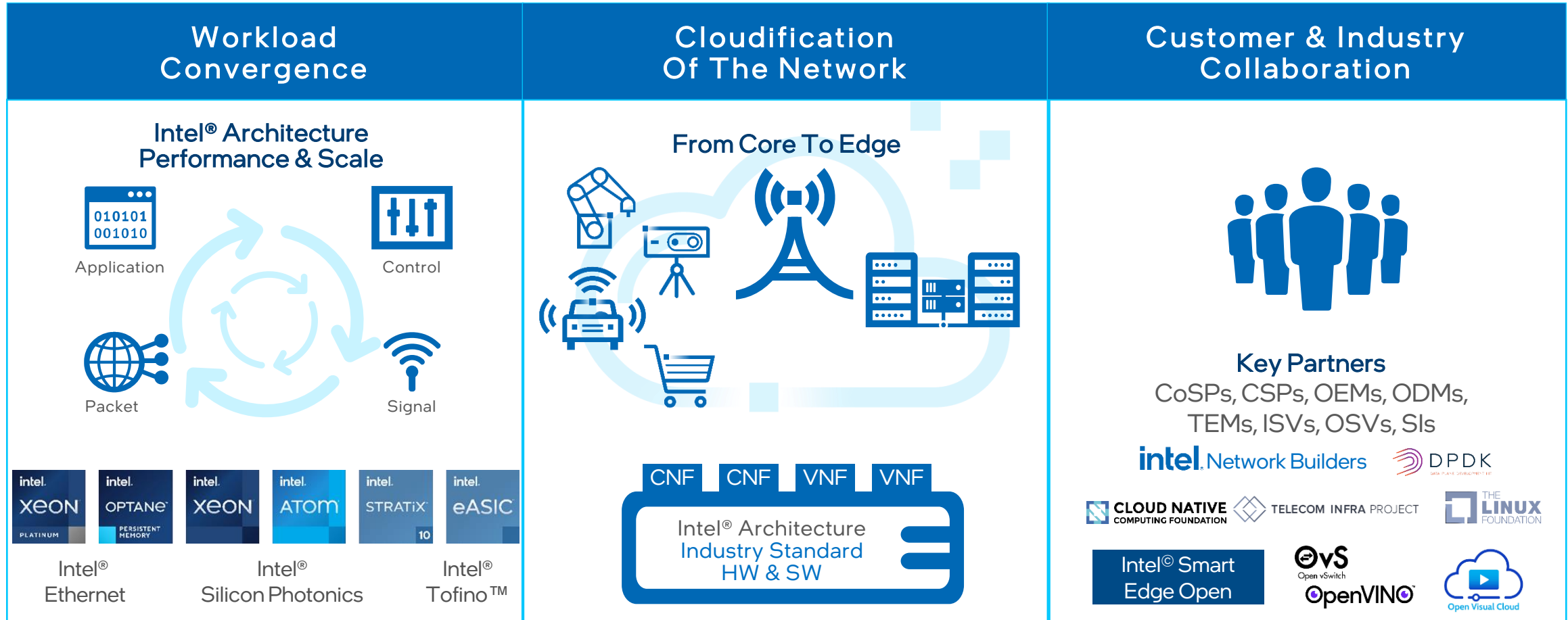
Multi Access Edge Computing Market Trends(MEC)

- MEC is projected to grow >60% CAGR '21-'26

- MEC need is driven by 3.5 forces
  1. Physics
  2. Governance
  3. TCO
  3.5 Location/redundancy/survivability

- MEC is in the early stages with <10% of User Plane Function revenue in Q2'22

- China is driving the transition to MEC with ~70% of spending

MCN NFV Revenue Mix

NFV

Non-NFV

Source: Dell'Oro Group

Source: Dell'Oro Group August 2022 MCN & MEC Forecast Report

The Network Runs Best on Intel

Workload Convergence

Intel® Architecture Performance & Scale

Application

Control

Packet

Signal

Intel® Ethernet

Intel® Silicon Photonics

Intel® Tofino™

Cloudification Of The Network

From Core To Edge

CNF CNF VNF VNF

Intel® Architecture
Industry Standard
HW & SW

Customer & Industry Collaboration

Key Partners
CoSPs, CSPs, OEMs, ODMs,
TEMs, ISVs, OSVs, SIs

intel. Network Builders   DPDK

CLOUD NATIVE COMPUTING FOUNDATION   TELECOM INFRA PROJECT   THE LINUX FOUNDATION

Intel© Smart Edge Open   OvS Open vSwitch
OpenVINO   Open Visual Cloud

vRAN

vRAN Solutions

intel®

Transforming the Network for 5G Open RAN

Existing System

- Antennas
- Single Band Radio Unit
- Baseband Unit
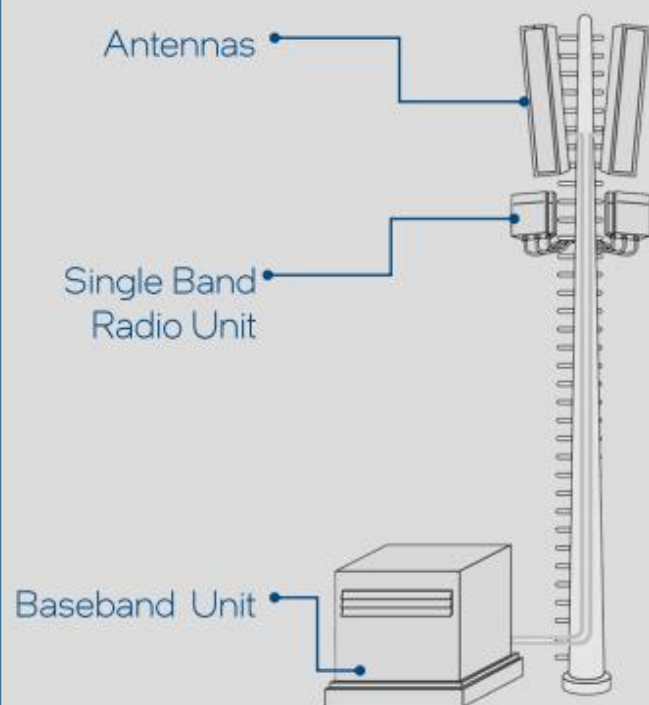
NEW System – Cloud RAN

- Cloud Native for Flexible Network Infrastructure
- Centralization for improved pooling gains
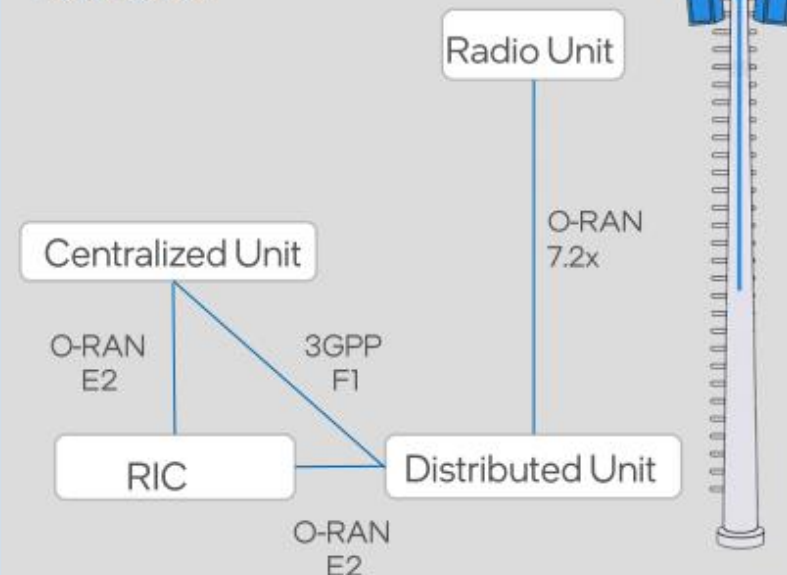
RRU
Multi-band RRU,
Antenna **Integrated** Radios

Virtualized Centralized Unit — COTS HW

Virtualized Distributed Unit — COTS HW

NEW System – Open RAN

- Open Interfaces for domain innovation
- RIC for cloud based Network AI

Radio Unit

O-RAN 7.2x

Centralized Unit

O-RAN E2

3GPP F1

RIC

Distributed Unit

O-RAN E2

CloudRAN Deployment Considerations

CRAN	vDU Characteristics	DRAN
Sized for Consolidation of Cells	Key Performance Target	Right-sized for Cell Sites
Driven by Incumbent Base Stations	Cost	Driven by Incumbent Base Stations
Resource Consolidation & Workload Scaling	Power Optimization Path	Right-sized Solution & Workload Scaling
Low number of large ports with high BW (front haul is 4x-10x of mid-haul)	NIC Port Requirements	Large number of point-to-point ports to radios
Controlled Environment	Nominal Environment	Uncontrolled & Outdoor
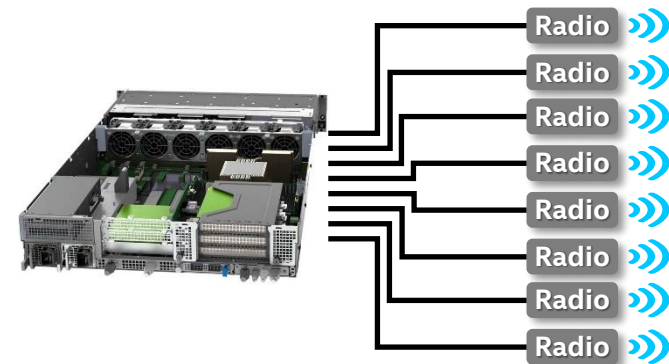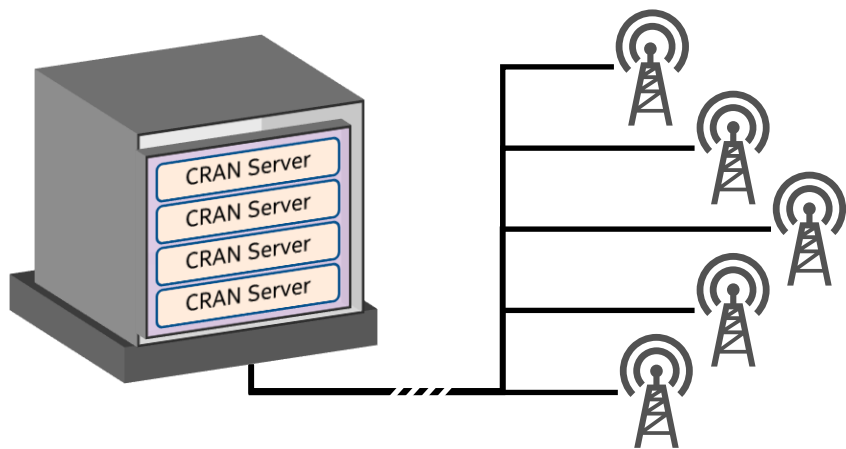
CloudRAN System – Key Considerations '22/'23

	Consideration	Reasoning
Performance	Adequate compute capacity with virtualization capability to meet vRAN capacity (#of cells, …) Support for acceleration offload to free up compute cores	Capacity and Consistency across generations reduces Software Complexity
Integration	Integrated FEC/FFT	Latency, Power, Area Reduction, Cooling & BOM Simplification.
	Integrated NIC	Latency, Power, Area Reduction
Ethernet	Timing Interfaces	vDU server acting as Timing Master at Cell site
	Design Approach	LAN on Motherboard (LOM)/Integration allows re-use of single clocking solution across multiple GbE Controllers
	Radio/Front-Haul Ports	N x 10-25GbE, 1-2 ports per Radio.
	Core/Back-Haul/Mid-Haul Ports	2x25G to 2x100G

Intel vRAN Solutions: Enabling an Si Arch <u>Agnostic</u> Cloud RAN

FlexRAN™ SW
Source Code Released under Intel Architecture license free of charge

FlexRAN SW Consumption Models

Usecase 1: baseline for stack which is added to, enabling commerical RAN on Intel Arch only

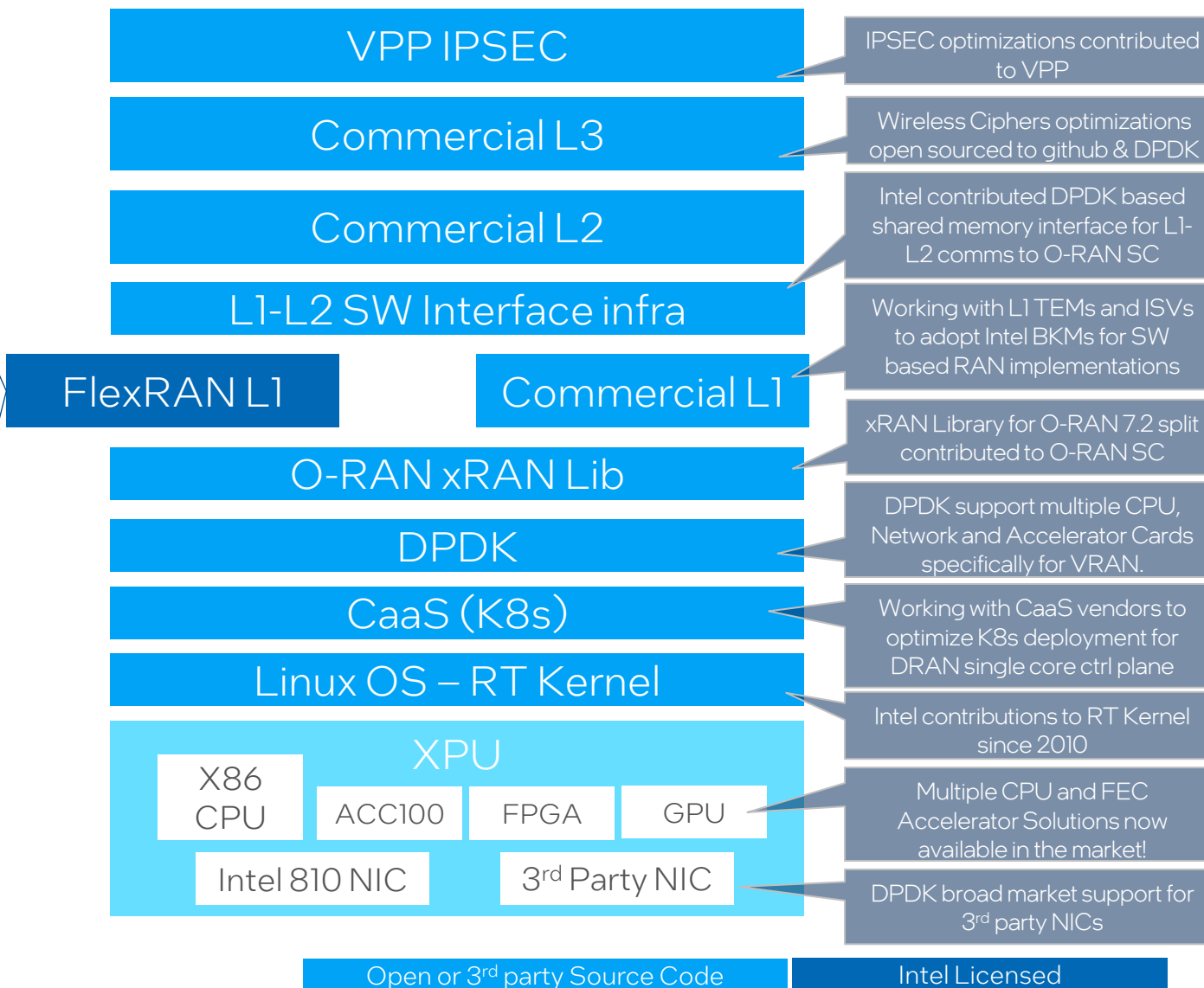**Usecase 2:** consume some modules to augment own IP

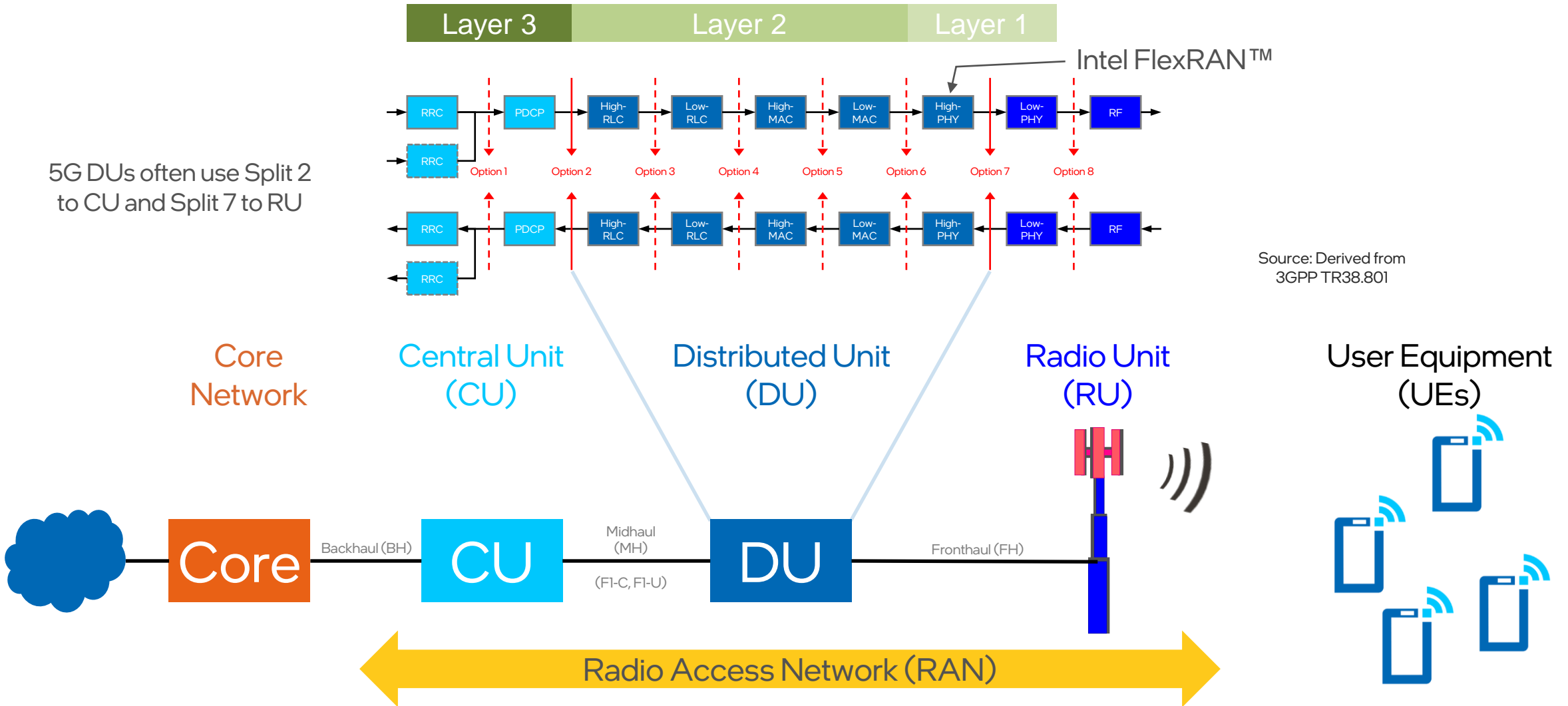**Usecase 3:** Research and benchmarking - no SW use

Ecosystem – vRAN Ecosystem consumes all BKMs for developing a SW Based vRAN Solution
- HW OEMs
- System Integrators
- O-RU Integrations
- C/C++ Software Development Optimizations and ISA abstraction
- HW / SW Abstraction
- ISA/Cache/Memory etc..

VPP IPSEC — IPSEC optimizations contributed to VPP

Commercial L3 — Wireless Ciphers optimizations open sourced to github & DPDK

Commercial L2 — Intel contributed DPDK based shared memory interface for L1-L2 comms to O-RAN SC

L1-L2 SW Interface infra — Working with L1 TEMs and ISVs to adopt Intel BKMs for SW based RAN implementations

FlexRAN L1 | **Commercial L1**

O-RAN xRAN Lib — xRAN Library for O-RAN 7.2 split contributed to O-RAN SC

DPDK — DPDK support multiple CPU, Network and Accelerator Cards specifically for VRAN.

CaaS (K8s) — Working with CaaS vendors to optimize K8s deployment for DRAN single core ctrl plane

Linux OS – RT Kernel — Intel contributions to RT Kernel since 2010

XPU
| X86 CPU | ACC100 | FPGA | GPU |
| Intel 810 NIC | 3rd Party NIC |

— Multiple CPU and FEC Accelerator Solutions now available in the market!

— DPDK broad market support for 3rd party NICs

Open or 3rd party Source Code | **Intel Licensed**

5G Network Architecture

- Pieces can be aggregated or disaggregated as needed

Layer 3	Layer 2	Layer 1

Intel FlexRAN™

5G DUs often use Split 2 to CU and Split 7 to RU

| RRC | PDCP | High-RLC | Low-RLC | High-MAC | Low-MAC | High-PHY | Low-PHY | RF |

RRC

Option 1 | Option 2 | Option 3 | Option 4 | Option 5 | Option 6 | Option 7 | Option 8

| RRC | PDCP | High-RLC | Low-RLC | High-MAC | Low-MAC | High-PHY | Low-PHY | RF |

RRC

Source: Derived from 3GPP TR38.801

Core Network

Central Unit (CU)

Distributed Unit (DU)

Radio Unit (RU)

User Equipment (UEs)

Core — Backhaul (BH) — CU — Midhaul (MH) (F1-C, F1-U) — DU — Fronthaul (FH)

Radio Access Network (RAN)

Small Cell Reference Design

- Carrier Board hosts both the compute module and one or two RF antenna modules
    - FR1: 1.8–6 GHz (+ 0.6-1.8 GHz option)
    - FR2: 26-29 GHz (+ other options)
- Development system and reference design for mass-production opportunities
    - ODMs customize for market needs
- Runs full FlexRAN™ stack, just like macro base stations
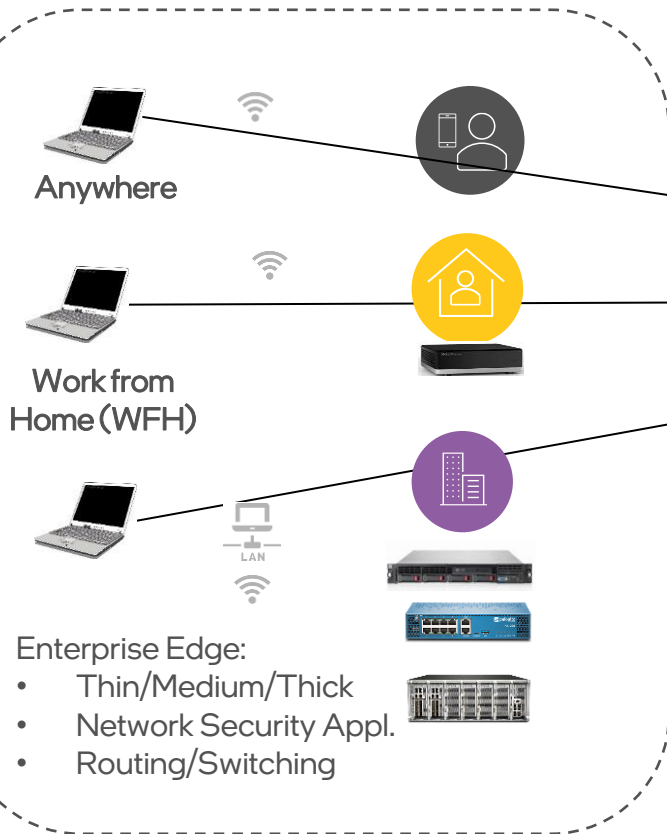- Supports a variety/combination of usage models

CU → DU → RU → mmWave
CU → DU → RU → sub-6 GHz
CU DU RU mmWave
CU DU RU sub-6 GHz

CU ↔ DU ↔ RU mmWave
CU ↔ DU ↔ RU sub-6 GHz
CU DU ↔ RU mmWave
CU DU ↔ RU sub-6 GHz

Split 7-2

ICX-D
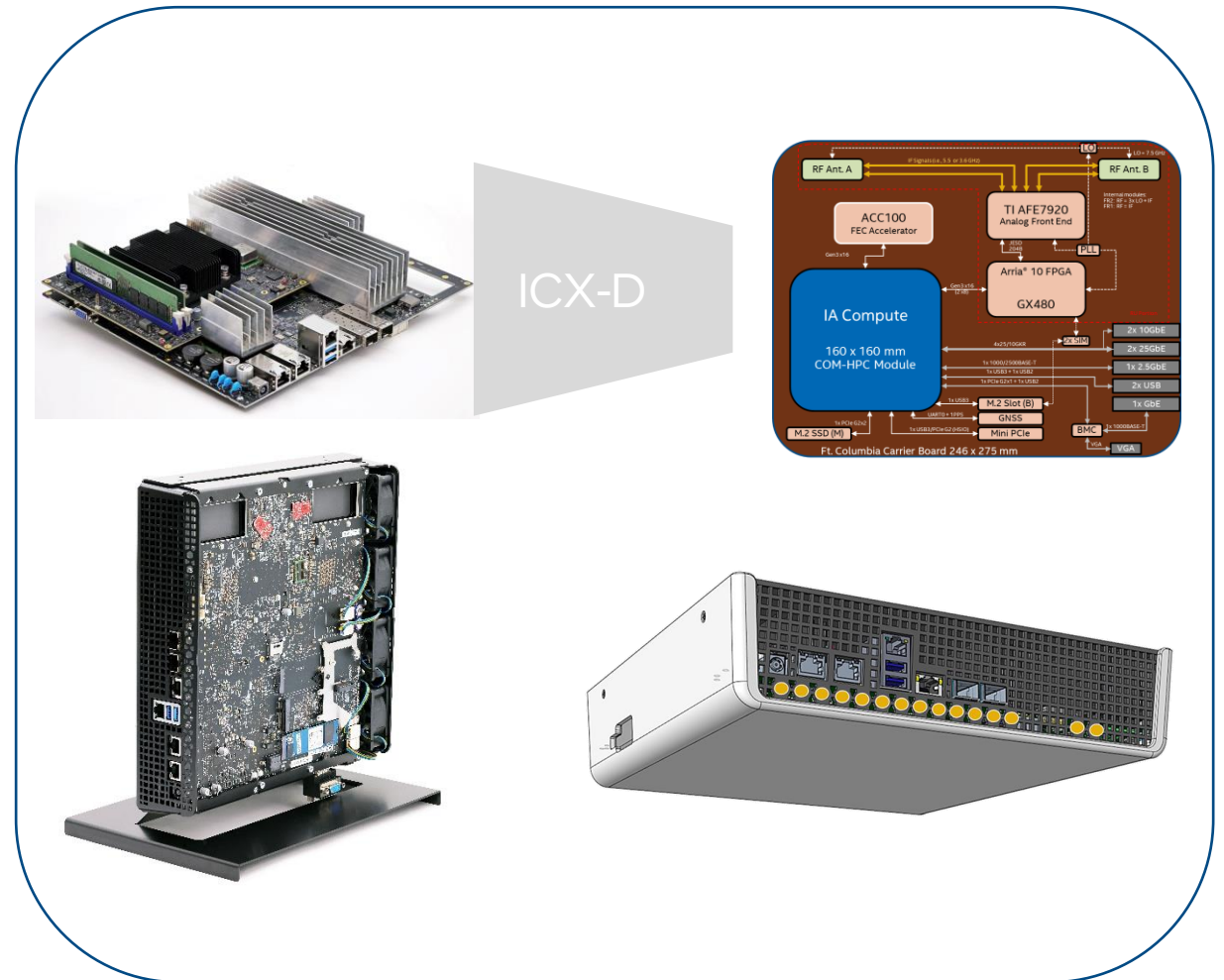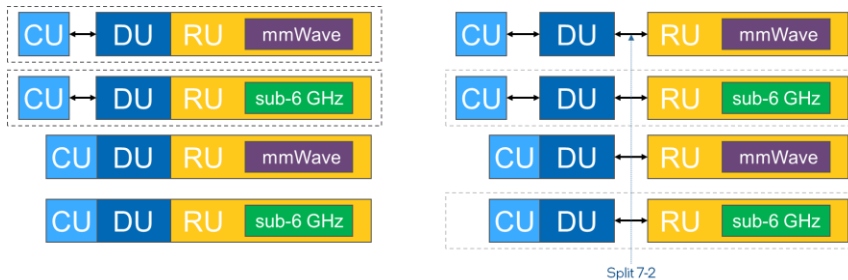
Enterprise Edge/SASE

Security Solutions

intel®

Enterprise Edge-Cloud Landscape

Enterprise Edge/On Prem.

Cloud Edge/POP

Public Cloud

Anywhere

Work from Home (WFH)

Enterprise Edge:
- Thin/Medium/Thick
- Network Security Appl.
- Routing/Switching
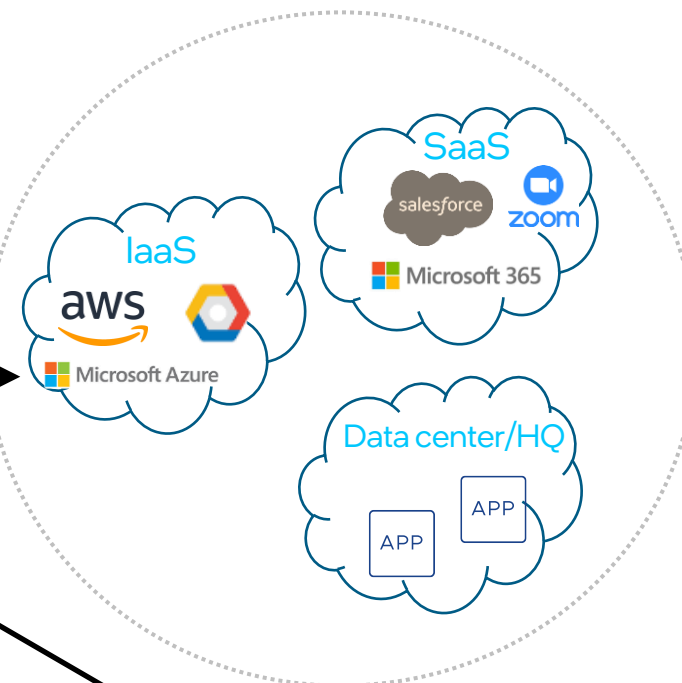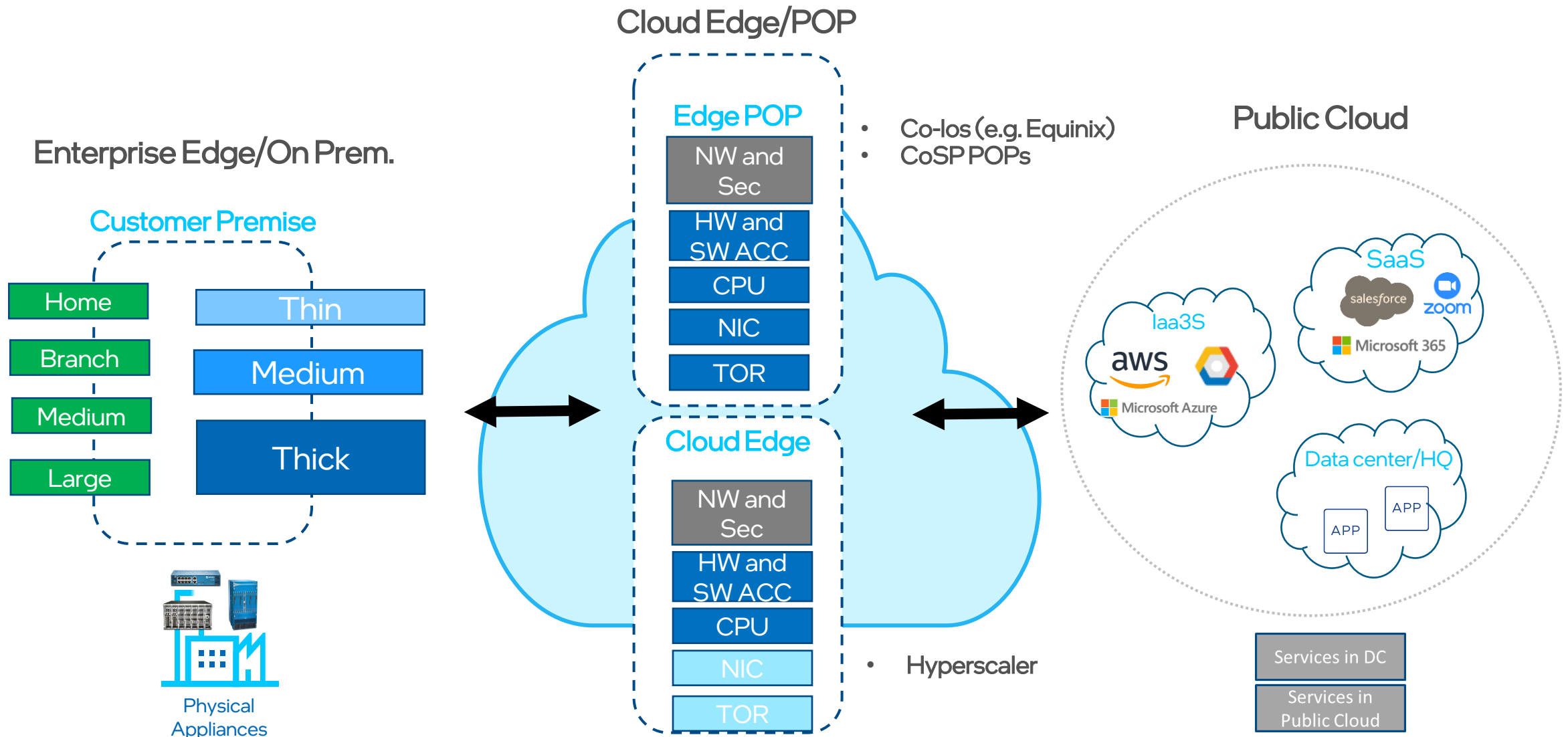
64% of companies have either adopted SASE or are thinking of adopting SASE within the next year.
Mckinsey Global Post-COVID Workforce Survey, 2021
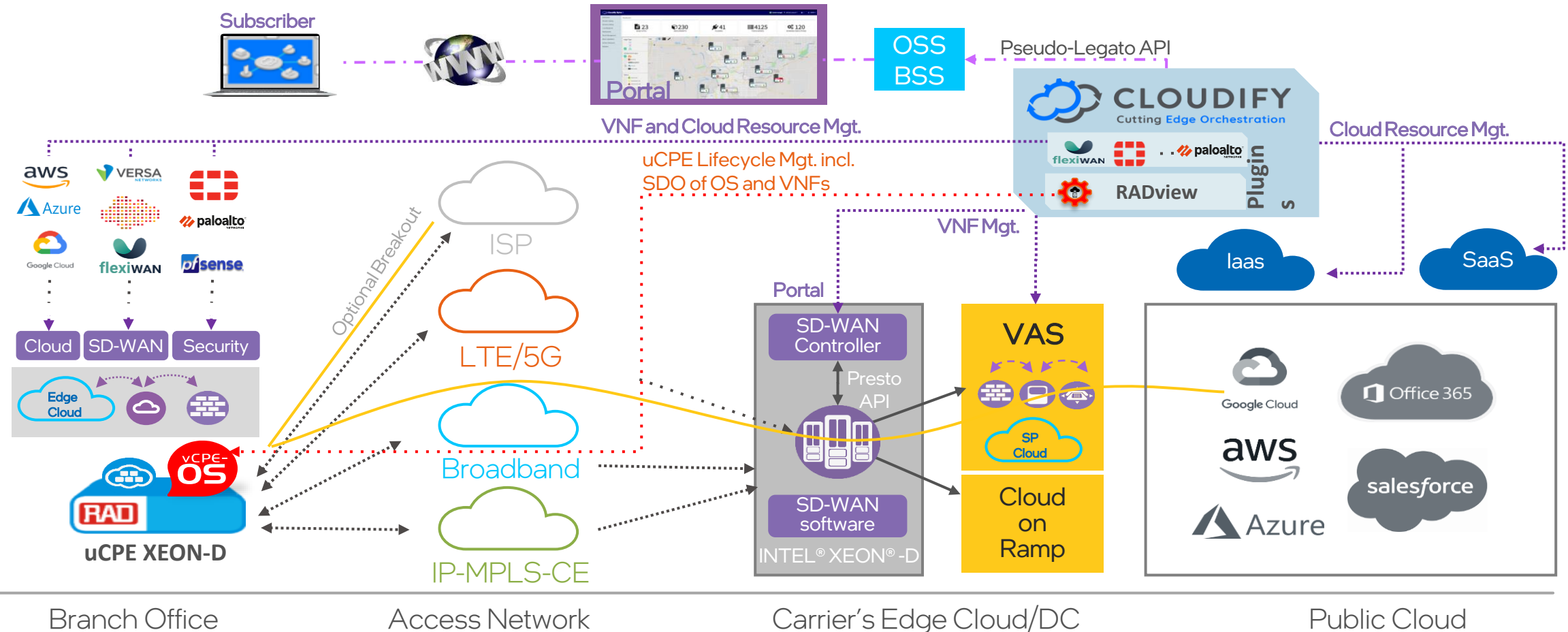
Edge to Cloud Architecture

Cloud Edge/POP

Enterprise Edge/On Prem.

Public Cloud

Customer Premise

Edge POP

NW and Sec
HW and SW ACC
CPU
NIC
TOR

- Co-los (e.g. Equinix)
- CoSP POPs

Home		Thin
Branch		Medium
Medium		Thick
Large		

Physical Appliances

Cloud Edge

NW and Sec
HW and SW ACC
CPU
NIC
TOR

- Hyperscaler

Iaa3S

aws

Microsoft Azure

SaaS

salesforce

zoom

Microsoft 365

Data center/HQ

APP

APP

APP

Services in DC
Services in Public Cloud

Intel Portfolio for Edge2Cloud Networking

1 Scalability
in Edge/DC/Cloud

intel ATOM ↔ intel XEON D ↔ intel XEON PLATINUM

Thin/Thick Edge, DC, Cloud
Same infra, same software

2 Consistency

Edge ↔ Private Cloud ↔ Public Cloud

Same infra, same software &
workload movement flexibility
across the Edge, DC, Public Cloud

3 Performance

intel XEON PLATINUM | intel OPTANE PERSISTENT MEMORY | intel XEON | intel ATOM | intel STRATIX 10 | intel eASIC

Room to Grow
Reliable High Performance

4 Security/analytics offloads & SDKs

Intel QuickAssist Technology | DPDK DATA PLANE DEVELOPMENT KIT | Hyperscan | OpenVINO | oneAPI | AES-NI | IPDK | VNNI

5 Network Specific
NICs/Accelerators

intel XEON PLATINUM | intel OPTANE PERSISTENT MEMORY | intel XEON | intel ATOM | intel STRATIX 10 | intel eASIC

NIC/PAC/FPGA/P4

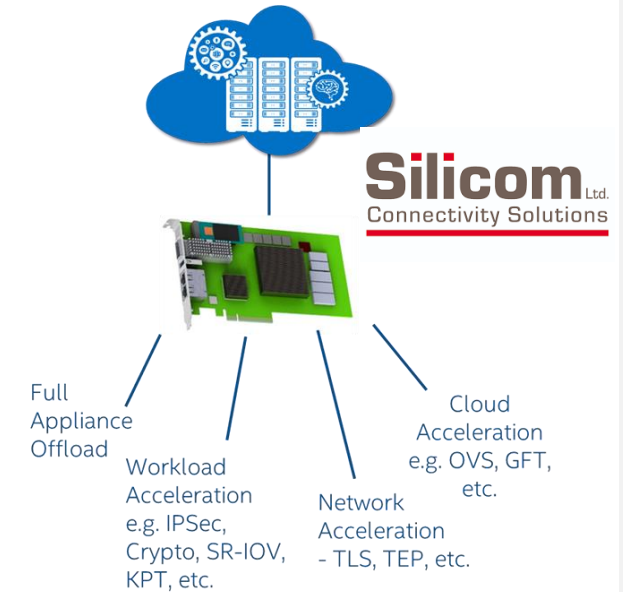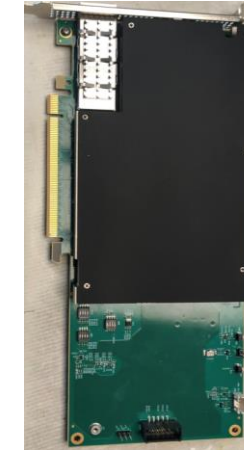# Edge Reference Solution
Cloud Native Edge with Cloudify & RAD

The Integration of Cloudify with RAD Enables a Transition from NFVi to Cloud Native
https://networkbuilders.intel.com/solutionslibrary/cloudify-rad-develop-reference-stack-for-mass-ucpe-deployment

Intel® NetSec Accelerator Reference Design

Intel reference designs for a PCIe-based Server on a card with full Orchestration and Management to drive Acceleration/Offload of compute intensive workloads

Silicom (IAONIC Series) products based on NetSec Accelerator Reference Design

- Intel Atom® 57xx (Atom SoC with Switch Mode)
  - 8 or 16C
  - Integrated Network Acceleration Complex (NAC)
    - LAN/NIC interface to SNR compute complex
    - Switch for port-to-port switching
    - Inline crypto for IPsec
  - Integrated Intel® QuickAssist Technology (Intel® QAT) for lookaside crypto
- Host Connection via E810
  - "Back-to-back" NICs
  - 50 or 100GbE to SNR
  - PCIe G4 x8-x16 to host
- Not Shown: Boot Disk, DRAM, BMC, (Q)SFP Cage, …

Full Appliance Offload

Workload Acceleration e.g. IPSec, Crypto, SR-IOV, KPT, etc.

Network Acceleration - TLS, TEP, etc.

Cloud Acceleration e.g. OVS, GFT, etc.

- **Software Scalability:** Allow applications to become modular and migrate easily from one system level to the other to improve overall system performance

- **Architecture Consistency**: IA feature/architecture consistency with network acceleration, and PCIe end-point (IO) capability

Deployment Model	Market Segments	Workloads Offloaded
Network Accelerator aka Partial Appliance Offload	Network and Security Appliances	IPsec, SSL, IDS/IPS, NGFW
Full Appliance Offload aka Distributed Appliance	SASE, Network Edge Security	SD-WAN, Head End and Far Edge
(Limited Use for) **Cloud Infrastructure Offload** aka SmartNIC	Next Wave Cloud	Network infrastructure: virtual switching, TEP, IPsec

Intel® Smart Edge

Smart Edge Solutions

intel®

Intel® Smart Edge

Edge-native software to unleash services at the edge

Accelerate development and deployment of highly optimized, secure, and scalable edge platforms, services, and solutions

Edge-native distributed computing platform

Built on an open framework

Optional support and turnkey capabilities as a service
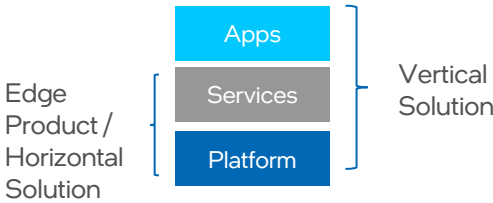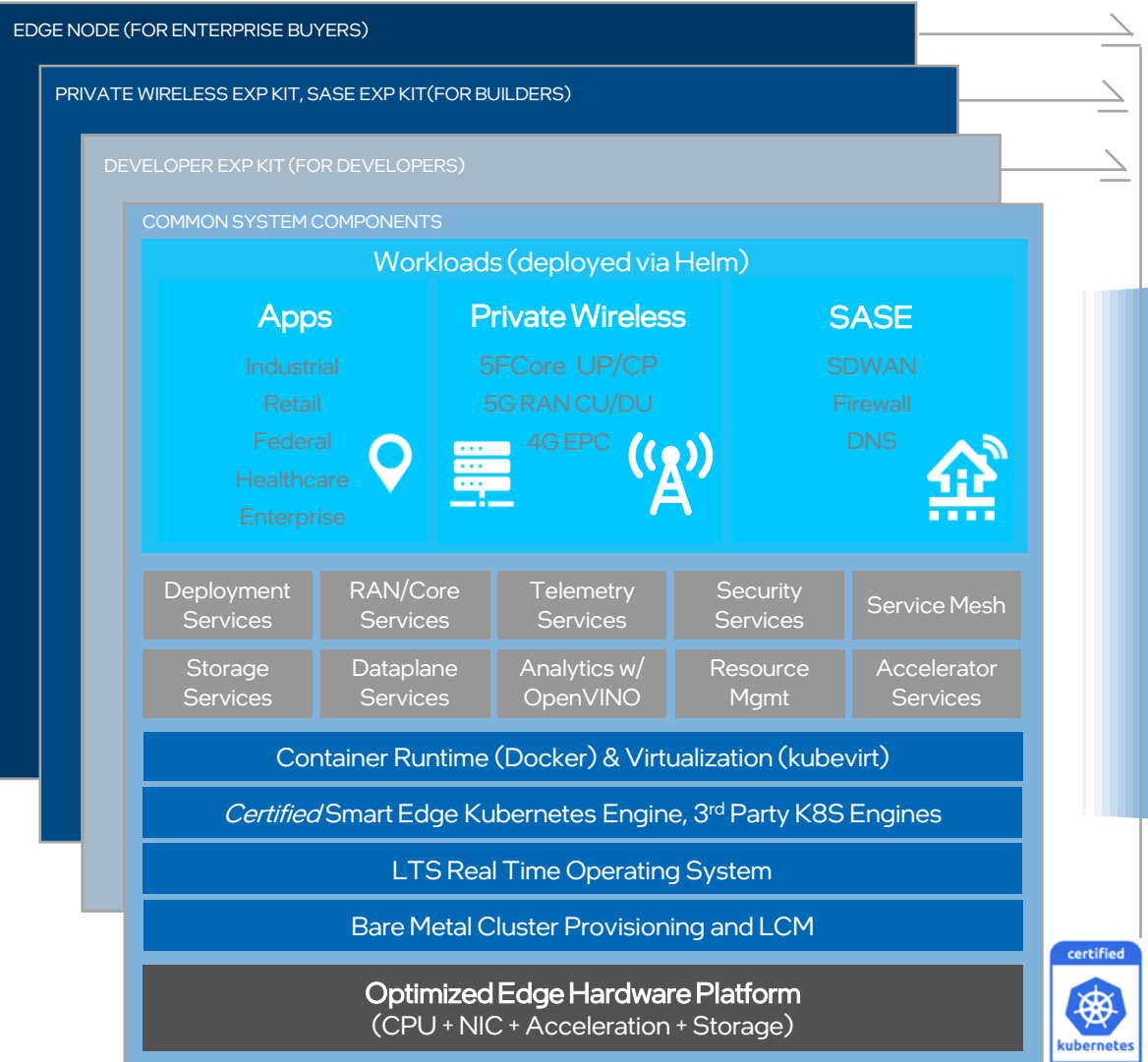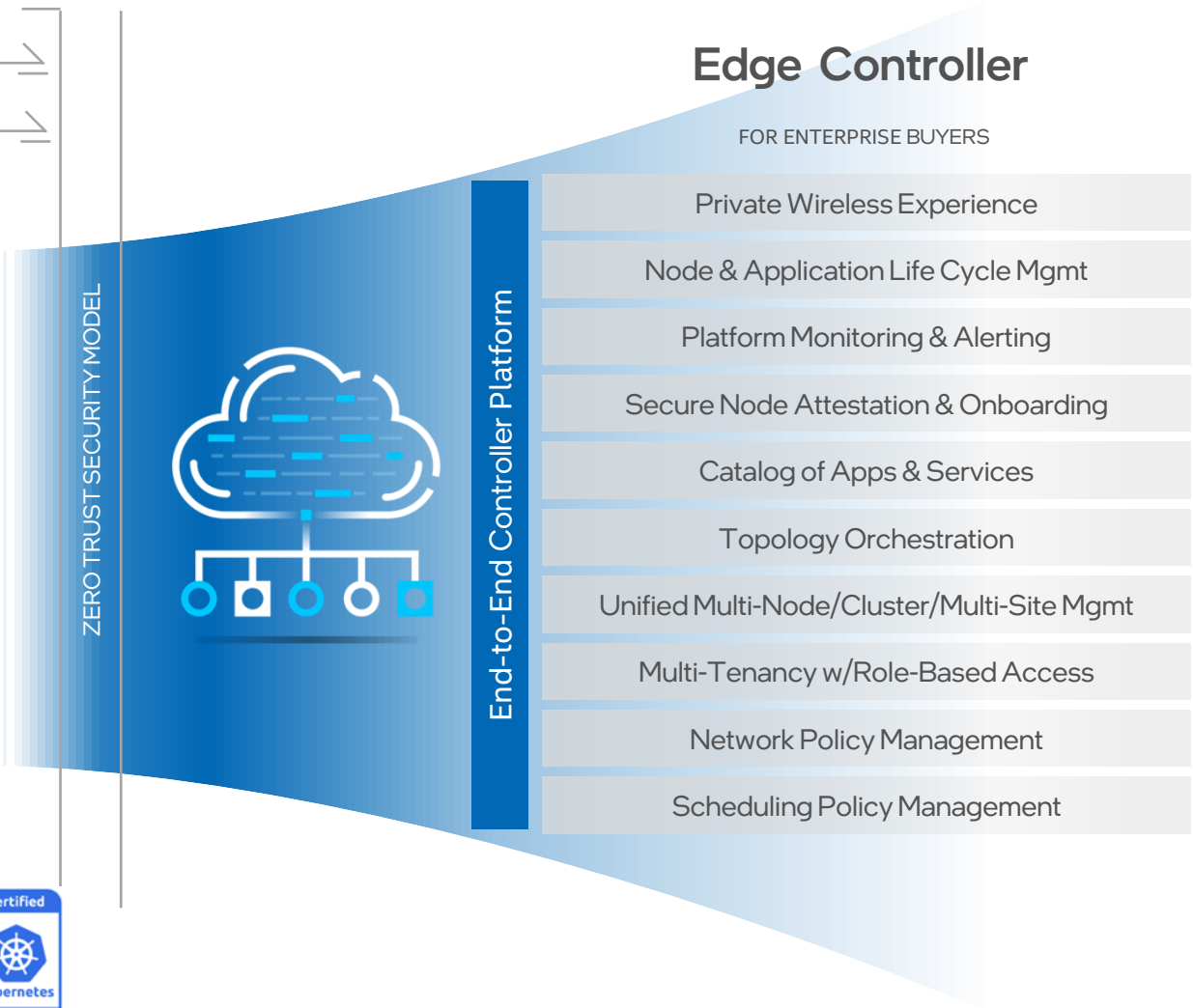
Performance   Security   Manageability   Sustainability

Intel® Smart Edge Architecture

Apps
Services
Platform

Vertical Solution

Edge Product / Horizontal Solution

EDGE NODE (FOR ENTERPRISE BUYERS)

PRIVATE WIRELESS EXP KIT, SASE EXP KIT(FOR BUILDERS)

DEVELOPER EXP KIT (FOR DEVELOPERS)

COMMON SYSTEM COMPONENTS

Workloads (deployed via Helm)

Apps	Private Wireless	SASE
Industrial	5FCore UP/CP	SDWAN
Retail	5G RAN CU/DU	Firewall
Federal	4G EPC	DNS
Healthcare		
Enterprise		

Deployment Services	RAN/Core Services	Telemetry Services	Security Services	Service Mesh
Storage Services	Dataplane Services	Analytics w/ OpenVINO	Resource Mgmt	Accelerator Services

Container Runtime (Docker) & Virtualization (kubevirt)

Certified Smart Edge Kubernetes Engine, 3rd Party K8S Engines

LTS Real Time Operating System

Bare Metal Cluster Provisioning and LCM

Optimized Edge Hardware Platform
(CPU + NIC + Acceleration + Storage)

certified
kubernetes

ZERO TRUST SECURITY MODEL

End-to-End Controller Platform

Edge Controller

FOR ENTERPRISE BUYERS

Private Wireless Experience

Node & Application Life Cycle Mgmt

Platform Monitoring & Alerting

Secure Node Attestation & Onboarding

Catalog of Apps & Services

Topology Orchestration

Unified Multi-Node/Cluster/Multi-Site Mgmt

Multi-Tenancy w/Role-Based Access

Network Policy Management

Scheduling Policy Management

Intel® Smart Edge Engage Delivers in-venue Personalization

Driving Customer Engagement In-Venue

Challenge: Consumers want a more personalized experience with brands in-venue. Businesses are investing in their digital frameworks and want to deliver amazing and relevant experiences to customers while creating incremental revenue from new sources. Intel worked with Wireless Guardian as a key integrator enable the solution.

Solution: By leveraging customer data signals at the edge, like gender, age range, and precise location, venues can engage customers with personalized content in real-time on multiple devices by delivering a combination of programmatic and sponsored ads and offers in real-time on digital screens and other connected devices.

- The solution included 5 security and 3 retail apps and the Smart Edge Controller

- The architecture includes the Intel Xeon® hardware platform, digital screens with Core i7s, Media Players, IP and Security cameras

Business Impact:

- Smart Edge provides hardware consolidation, streamlined deployment, manageability and security

- Edge compute for latency sensitive apps (all)

- Lower overall costs as opposed to app servers and/or cloud based

Marketing Intelligence Store Reference Architecture
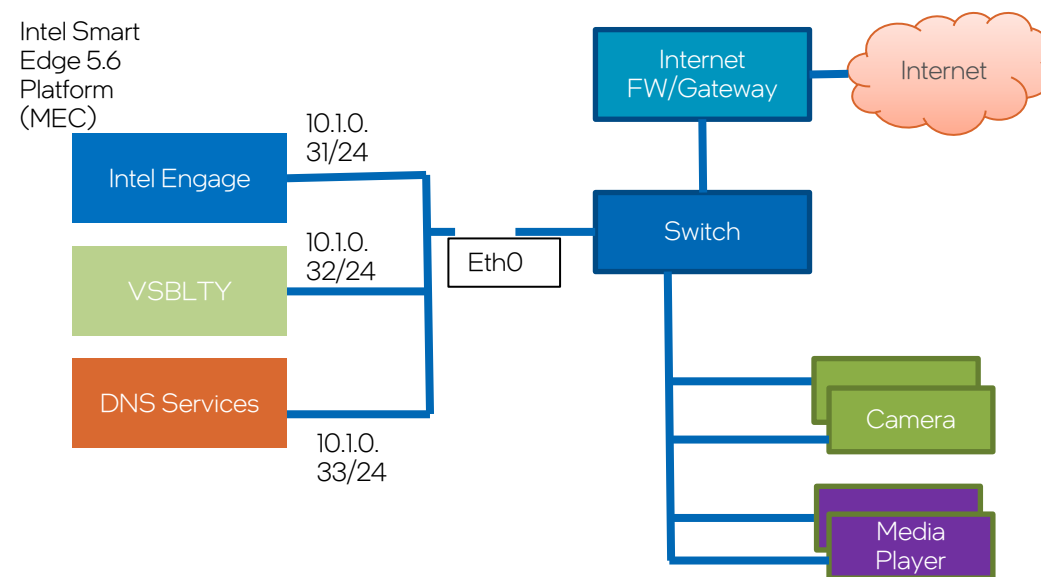
* **Live in-venue pilot results have shown increases in advertising revenue per screen of 266% and fill rates increased 115%.**
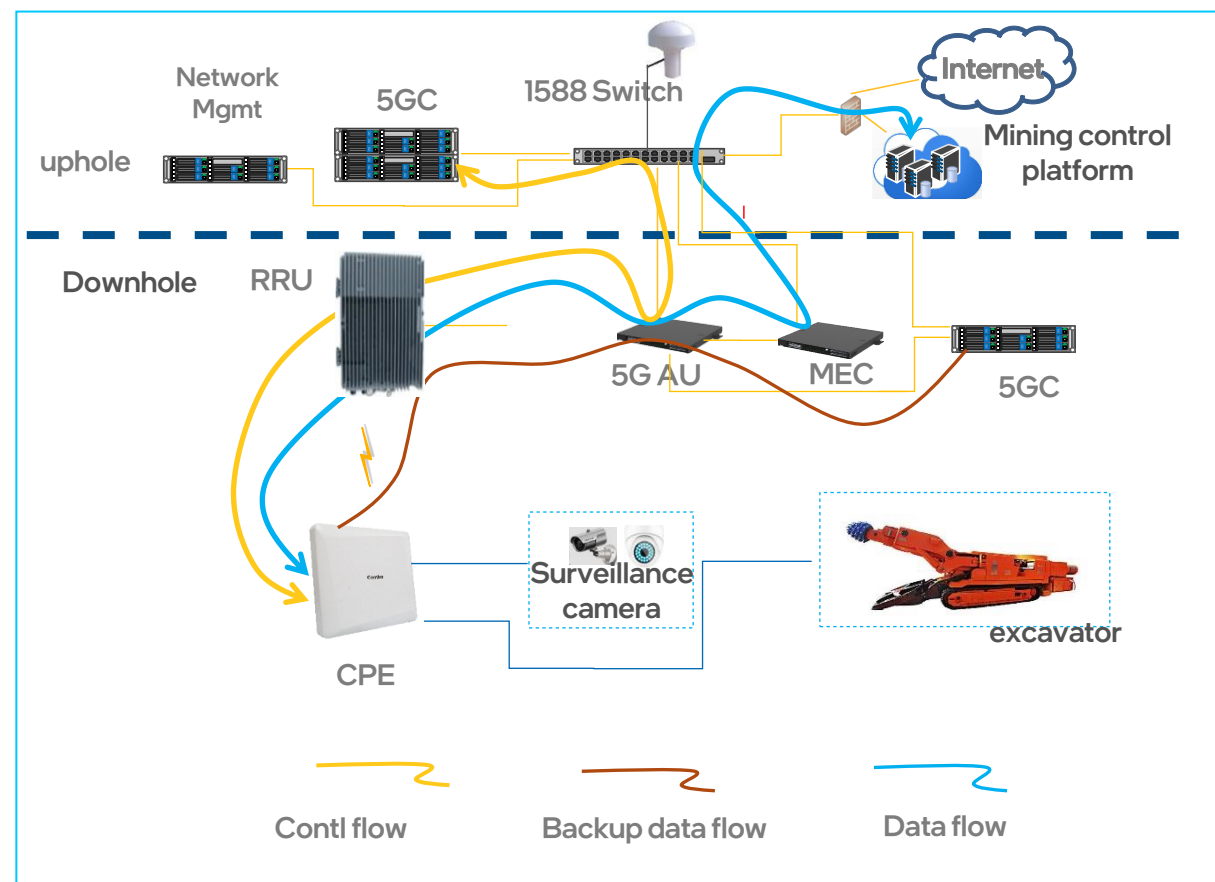
Comba Private 5G Network on Mining

Comba

Comba provides PWEK based Private 5G network on Mining
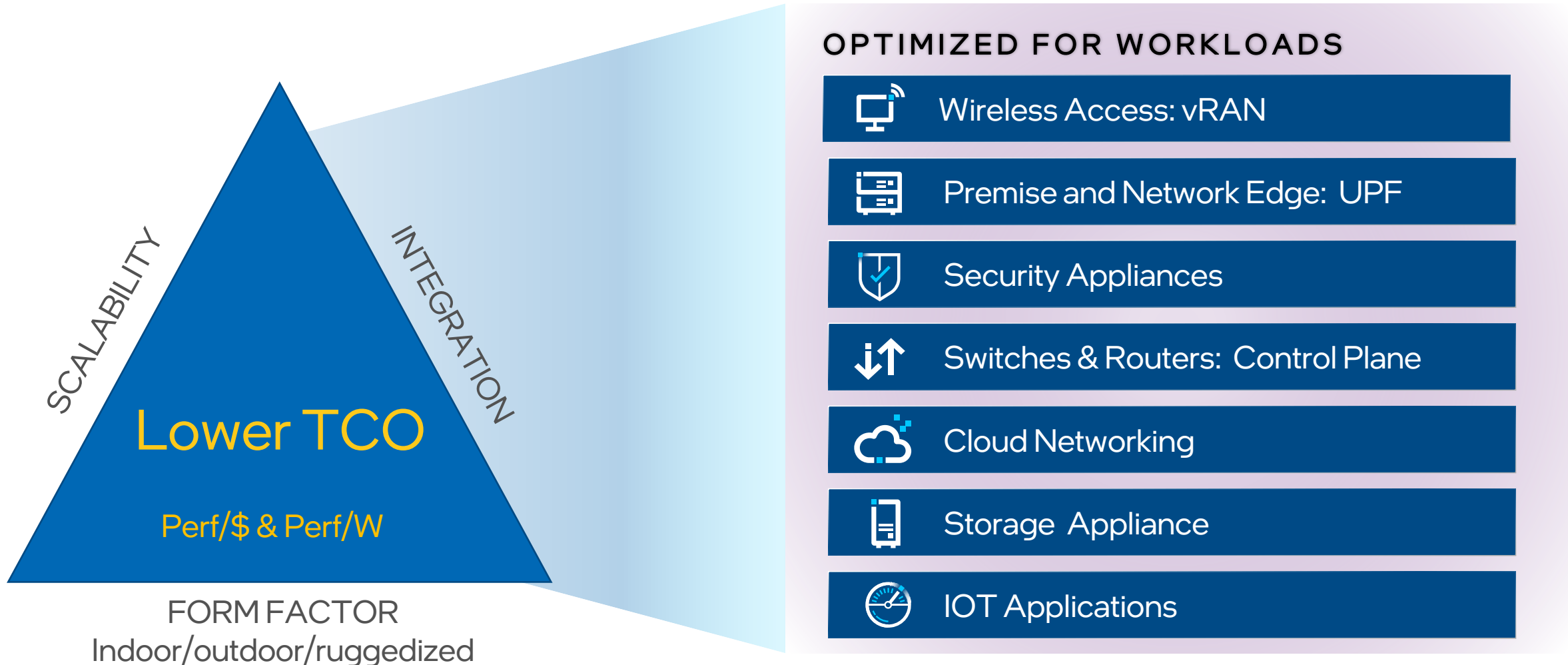
Challenge: Comba partnered with Intel to enable Container Native Network Functions for the RAN and Core with optimization on IA and abstraction of the underlying HW complexity.

Solution: Intel® Smart Edge for Builders with Comba 5G RAN and 5GC enabled a Private Wireless Experience Kit (PWEK) solution offering which provided:

- Cloud Native SW framework to help ease of on-boarding and orchestration of Comba RAN and Core Container Network Functions (CNFs) and with optimization on IA
- Acceleration to Comba vRAN workload through ease of access to Intel® eASIC™ FEC accelerators such as ACC100, acceleration for IPSec workload between the CU and UPF through Intel® QuickAssist Technology (Intel® QAT), High-performance Data Plane through DPDK
- Ease of access to Intel NIC cards (such as CVL) with SR-IOV features to optimize the usage of the NIC cards
- Comba Base Band Unit (BBU) uses Intel® SKL-D 2177 & ICX-D 1747 CPU @ 1.90GHz and ACC100 Chip CPU
  - Intel® Advanced Vector Extensions 512 (Intel® AVX-512) helps with signal processing acceleration for 5G
  - Intel® QAT enables IPSec Crypto Acceleration
- Remote Radio Unit (RRU) uses Intel® FPGA A10
- Comba RAN SW uses FlexRAN™.

Intel® Xeon® D SoCs: Built for Edge

SCALABILITY

INTEGRATION

Lower TCO

Perf/$ & Perf/W

FORM FACTOR
Indoor/outdoor/ruggedized

OPTIMIZED FOR WORKLOADS

- Wireless Access: vRAN
- Premise and Network Edge: UPF
- Security Appliances
- Switches & Routers: Control Plane
- Cloud Networking
- Storage Appliance
- IOT Applications

Questions?

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Join Us Next Time
November 2nd @ 8am PDT

Intel® Network Builders Insights Series
Making Cloud Native Work for 5G Core

Chandresh Ruparel, Senior Director, Wireless Core Network Division, Intel
Eoin Walsh, Senior Architect, Wireless Core Network Division, Intel

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