Driving 5G performance with Cloud RAN

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Confidential

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5G Future X - Breakthrough network performance and cost reduction

Quantum leap in radio economics

3x increase of cell site throughput, slashing energy costs
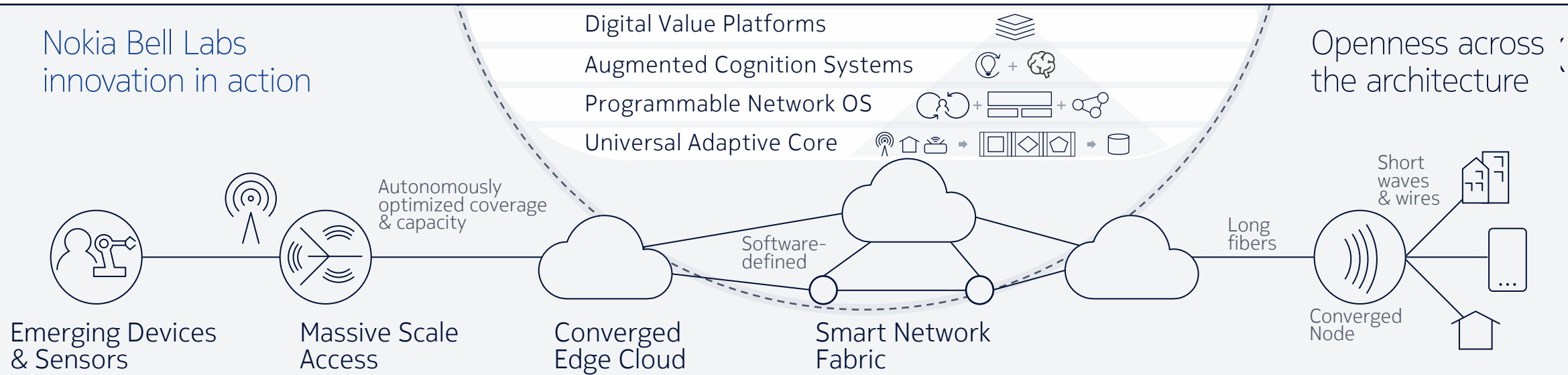
Embedding AI into the architecture

Zero-touch network optimization in ns

Cloud-native architecture

Web-scale capacity and programmability

Fully automated network slicing

30% TCO savings

Nokia Bell Labs innovation in action

Digital Value Platforms
Augmented Cognition Systems
Programmable Network OS
Universal Adaptive Core

Openness across the architecture

Autonomously optimized coverage & capacity

Software-defined

Long fibers

Short waves & wires

Emerging Devices & Sensors

Massive Scale Access

Converged Edge Cloud

Smart Network Fabric

Converged Node

The importance of the edge cloud

1 Latency, slicing, applications, content and processing at the edge

2 Platform for webscale collaboration

Low Latency applications

Far Edge

Aggregated Edge

OTT applications

CSP strategies

OTT ambition

Why far edge and 5G latency reduction?
Control becomes digital and wireless

~18ms average

ms

Speed	1 ms	Distance Traveled 10 ms	100 ms
1 m/s	1 mm	1 cm	10 cm

Chart (y-axis in ms, 0 to 10):

- LTE: >10 (~18ms average)
- FDD LTE with Rel-15 enhancements*: 9
- FDD 2-symbol minislot: 2
- Low band FDD 15kHz SCS: 5.1
- Mid band TDD 30kHz SCS: 4.2
- Low band FDD 15kHz SCS + 2 symbol Minislot: 1.8
- High band TDD 120kHz SCS: 1.5
- Mid band FDD 30kHz SCS + 2 symbol Minislot: 1

Categories:
- LTE
- 4.9G
- 5G**

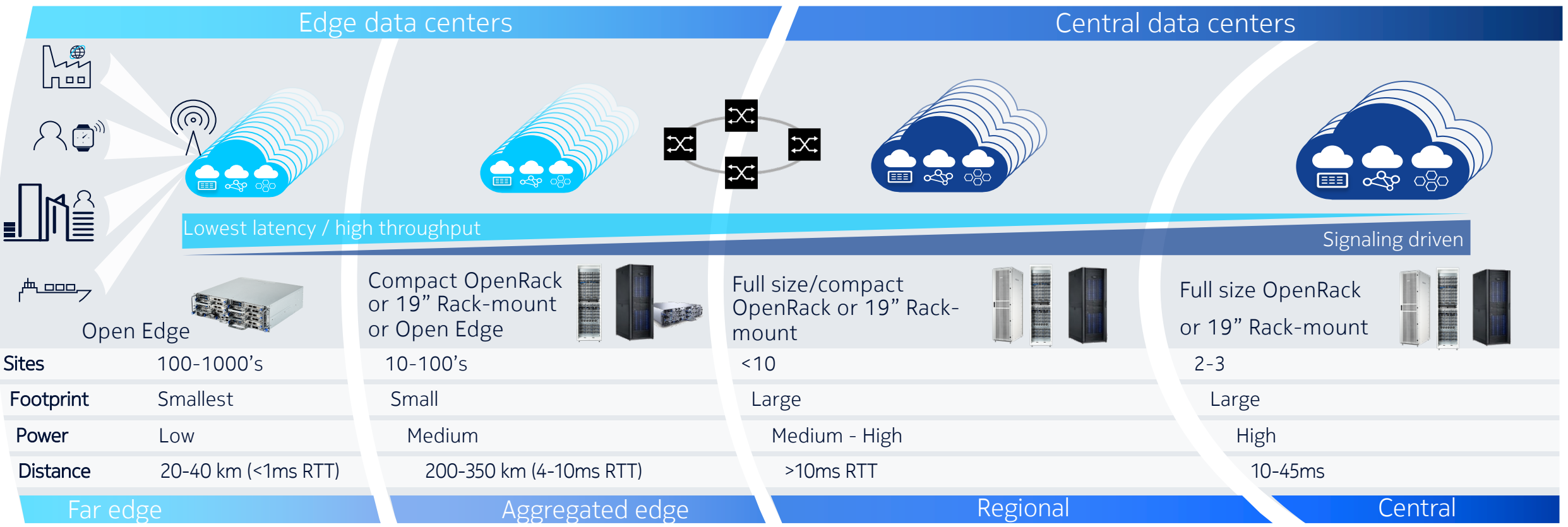# How does the Nokia Edge Solution Support the Vision?
Datacenter portfolio for all deployments from Far Edge to HyperScale

Edge cloud enables new business opportunities

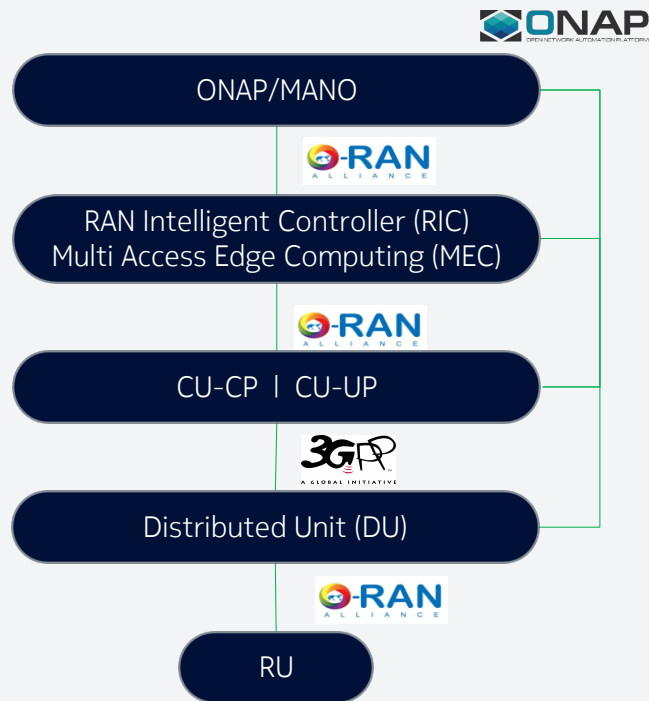Layered architecture enables lowest latency and data locality

Transport cost optimization can be achieved with layered architecture

Centralized data centers offer best cost efficiency

Edge data centers

Central data centers

Lowest latency / high throughput

Signaling driven

Open Edge

Compact OpenRack or 19" Rack-mount or Open Edge

Full size/compact OpenRack or 19" Rack-mount

Full size OpenRack or 19" Rack-mount

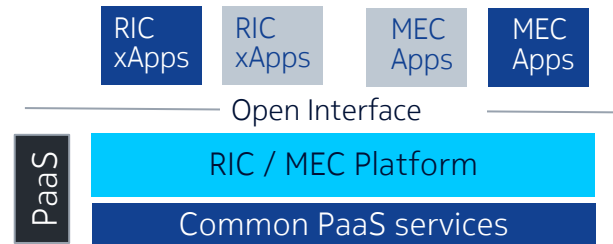|			
Sites	100-1000's	10-100's	<10	2-3
Footprint	Smallest	Small	Large	Large
Power	Low	Medium	Medium - High	High
Distance	20-40 km (<1ms RTT)	200-350 km (4-10ms RTT)	>10ms RTT	10-45ms

Far edge

Aggregated edge

Regional

Central

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RAN Openness and Converged Edge Cloud enables new services @ Edge

ORAN is bringing openness and programmability to the Cloud RAN

- ONAP/MANO
- RAN Intelligent Controller (RIC) Multi Access Edge Computing (MEC)
- CU-CP | CU-UP
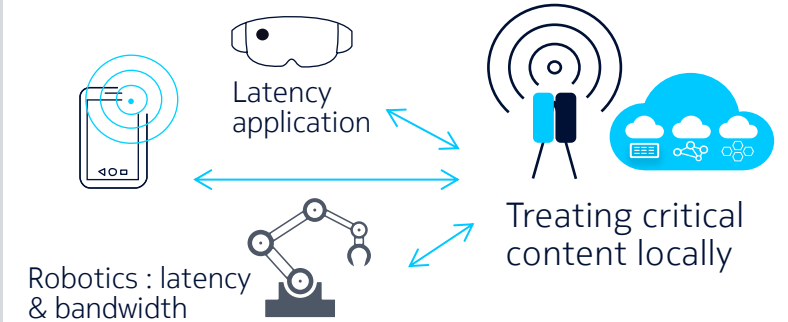- Distributed Unit (DU)
- RU

RAN Openness for 3rd party applications with RIC and MEC

RAN Programmability for Customization, Slice management, Service optimization and Artificial intelligence
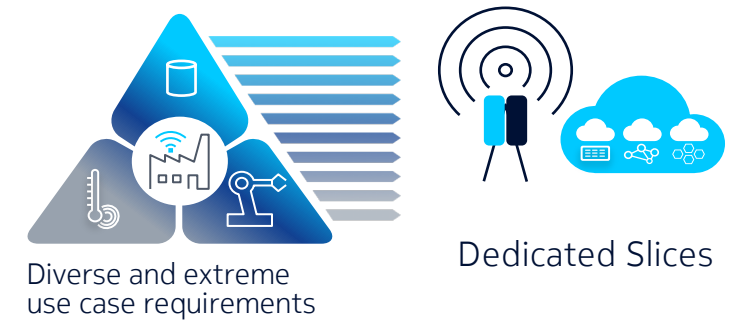

| RIC xApps | RIC xApps | MEC Apps | MEC Apps |

Open Interface

PaaS
- RIC / MEC Platform
- Common PaaS services

GTI Global TD-LTE Initiative — Innovative Mobile Service and Application Award 2019 for MEC Application

MEC Application @ Edge

Latency application

Robotics : latency & bandwidth

Treating critical content locally

ORAN/RIC based xAPP @ Edge

Diverse and extreme use case requirements

Dedicated Slices

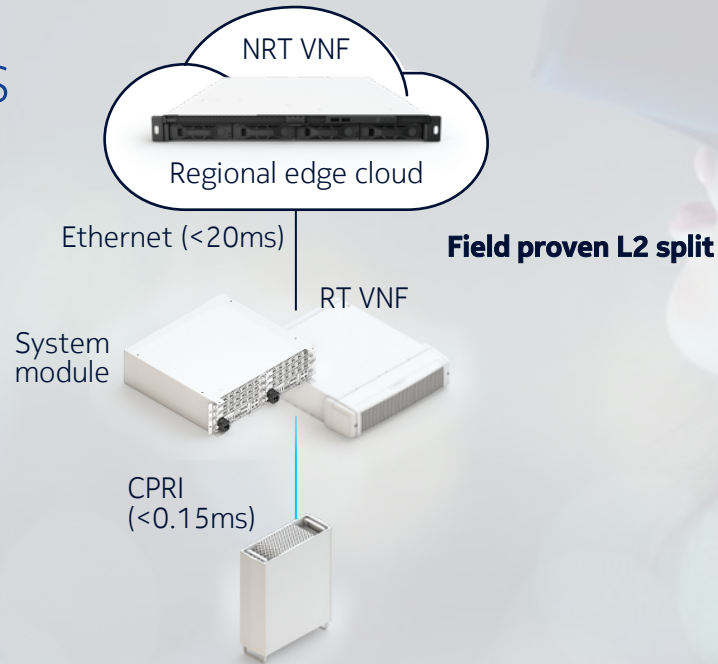NOKIA

Architectures working in parallel for any needs
AirScale All-in-Cloud BTS with fully virtualized and flexible baseband

AirScale Cloud BTS

NRT VNF

Regional edge cloud

Ethernet (<20ms)

Field proven L2 split

RT VNF

System module

CPRI (<0.15ms)

C-P(L3)
L2-NRT
L2-RT
L1
RF

New

AirScale All-in-Cloud BTS

NRT VNF

Regional edge cloud

Ethernet (<20ms)

RT VNF

AirFrame open edge server incl. FH gateway

Ethernet (<0.3ms)   CPRI (<0.15ms)

- NRT functions tolerate longer latency & support Ethernet-based backhaul
- Time-critical functions at the cell site
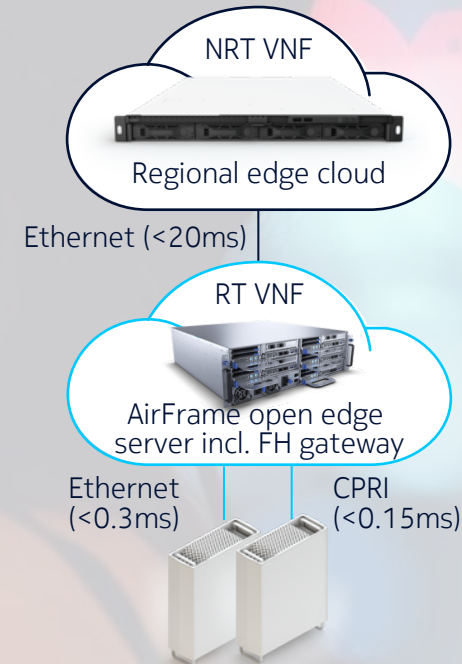- Non-real-time functions centralized
- Use existing transport

- Enables monetizing lowest latency applications
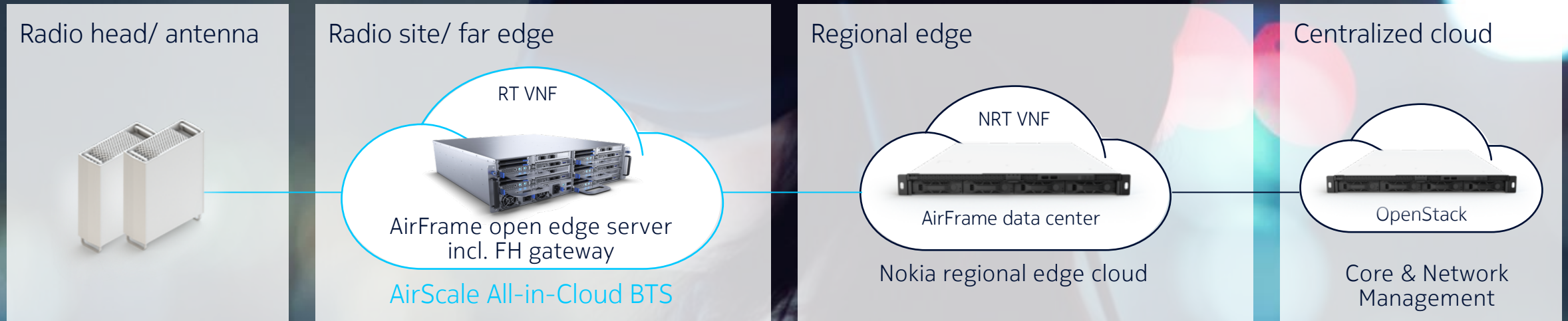- More flexibility, extended scalability and pooling
- Cell site efficiency, easier site solutions & rollout
- Reduced OPEX
- E2e network slicing

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AirFrame open edge server- first data center solution designed for the edge

Radio head/ antenna	Radio site/ far edge	Regional edge	Centralized cloud

Radio site/ far edge

RT VNF

AirFrame open edge server incl. FH gateway

AirScale All-in-Cloud BTS

Regional edge

NRT VNF

AirFrame data center

Nokia regional edge cloud

Centralized cloud

OpenStack

Core & Network Management

Fits to existing radio sites

Scales depending on processing capacity needs

Brings OCP benefits to edge deployments

Real-time acceleration

For real-time & bandwidth critical services

Content stays close to the end user

Enables lowest latency

No need to send big data towards the core network
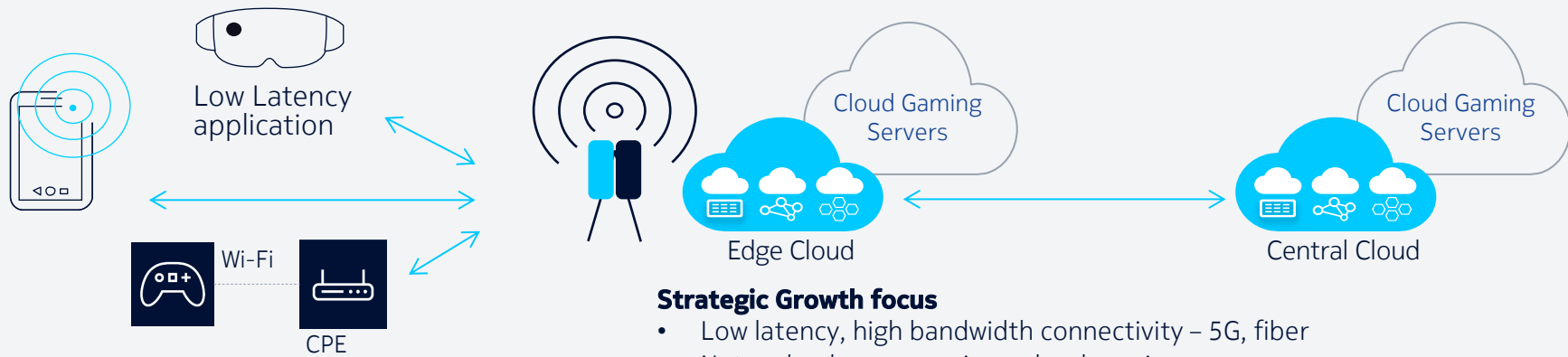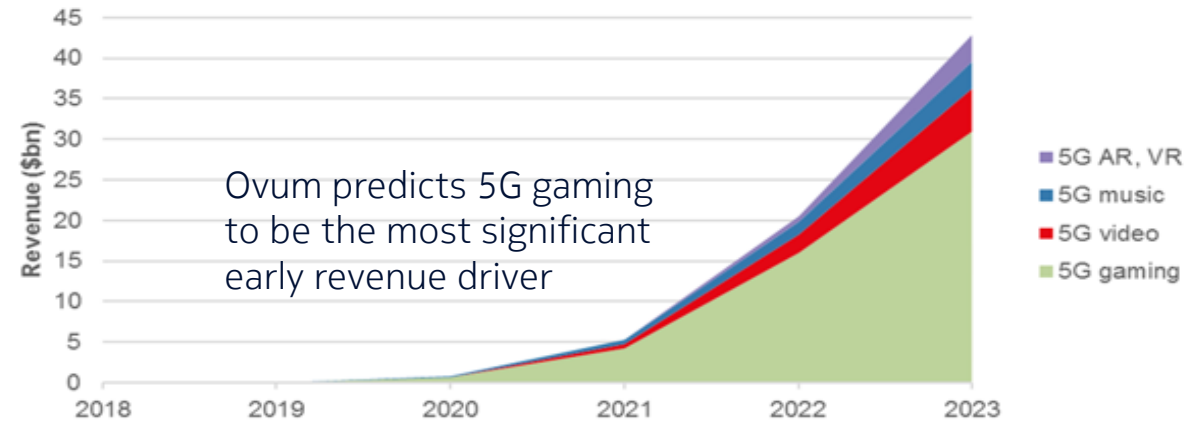
Saves backhaul resources

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Example: Solution for Cloud Gaming & Entertainment @ Edge

Gaming as a Service – Thin Client, Cloud-based gaming

- Heavy graphical processing at the cloud in real-time
- Cloud gaming consumes 20-47Mbps constantly (on PC)
- Latency requirement are <30ms

Operator's opportunity with gaming partnerships and content

Ovum predicts 5G gaming to be the most significant early revenue driver

Revenue ($bn) chart, 2018–2023:
- 5G AR, VR
- 5G music
- 5G video
- 5G gaming

Low Latency application

Wi-Fi

CPE

Edge Cloud

Cloud Gaming Servers

Central Cloud

Cloud Gaming Servers

Strategic Growth focus
- Low latency, high bandwidth connectivity – 5G, fiber
- Network edge processing – cloud gaming
- Network edge analytics – visual and other analysis
- Data security for transmission and storage

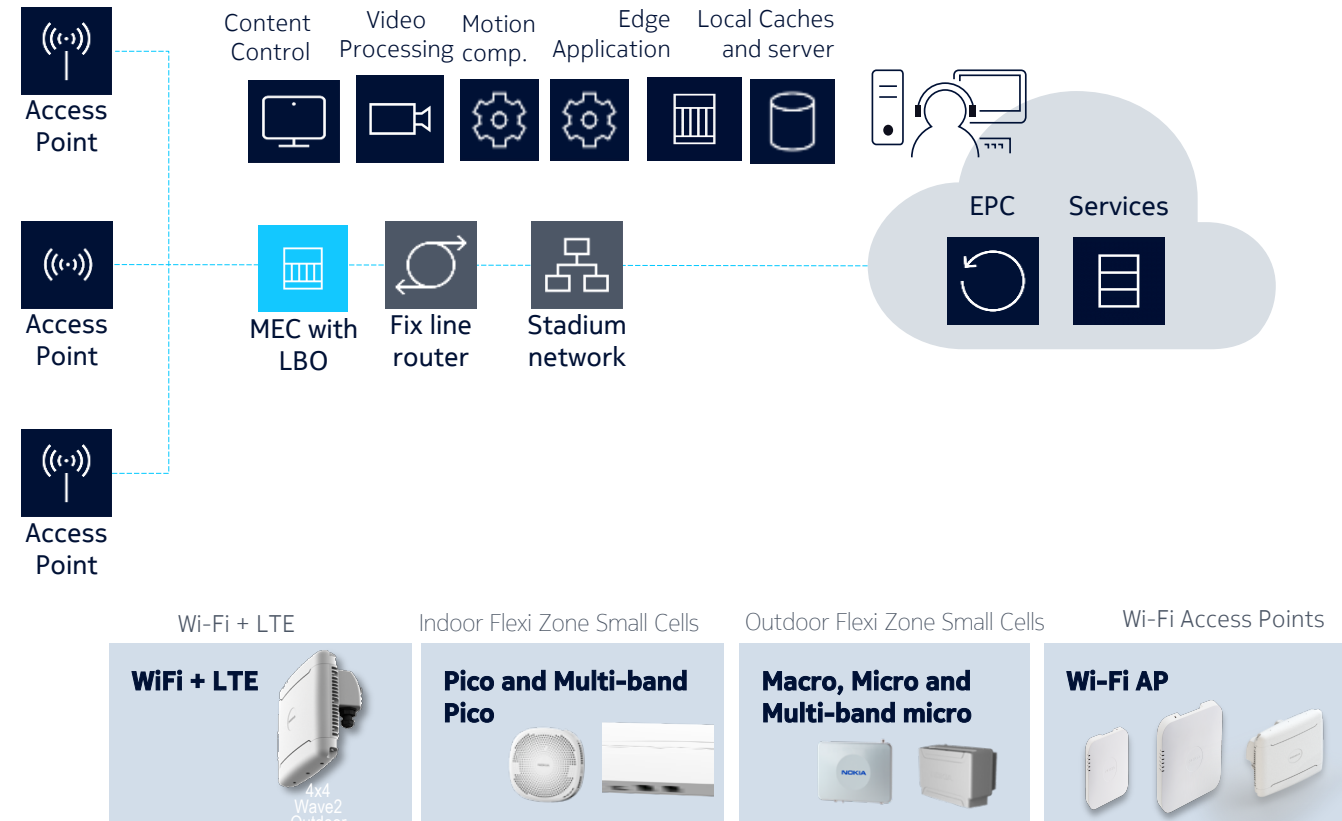Nokia DC solution includes On-server Storage, NICs & Accelerators for Cloud Gaming

- Open Edge
- 1U and 2U sled
- Open Rack
- NIC Cards
- Nvidia Tesla GPUs
- Solid State Disks
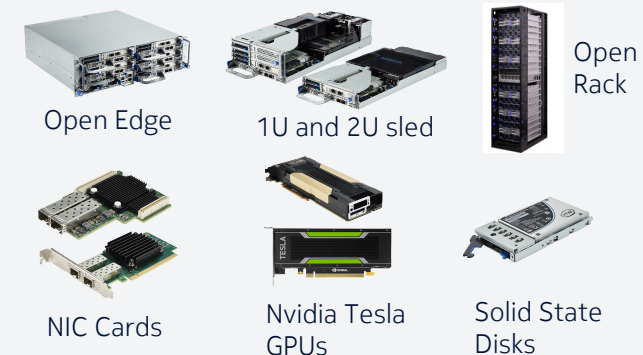
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Example: Solution for Digital venue and Edge Video Orchestration

Nokia provided a 5G-like experience powered by small cells and MEC for Digital Venue

Digital venue delivers a unique digital experience to venue visitors, drives visitor engagement, and allows for efficient venue management

Multi-access Edge Computing (MEC) with local content

Access Point

Access Point

Access Point

Content Control · Video Processing · Motion comp. · Edge Application · Local Caches and server

MEC with LBO · Fix line router · Stadium network

EPC · Services

Wi-Fi + LTE
WiFi + LTE
4x4 Wave2 Outdoor

Indoor Flexi Zone Small Cells
Pico and Multi-band Pico

Outdoor Flexi Zone Small Cells
Macro, Micro and Multi-band micro

Wi-Fi Access Points
Wi-Fi AP

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Nokia AirScale Cloud RAN proven capability

World´s first 5G Cloud RAN in commercial use-extensive field trials with leading CSPs globally

Launch of world´s largest 4G/5G Cloud RAN field trial in Xiong'an

AirScale Cloud BTS field trial on commercial network in Ningbo, Zhejiang

World's first Cloud RAN on commercial network

AirScale Cloud BTS on large scale field trial on commercial network in Poland

World´s first over-the-air data session with AirScale All-in-Cloud BTS in Carpinteria, CA

AirScale Cloud BTS live in Verizon's 5G network

Chunghwa Telecom Cloud RAN trial in Taipei lab

AirScale RNC commercial deployment in Bulgaria

Cloud RAN trial for macro networks in Vodafone´s testing facility in Italy

First in Finland to test Cloud RAN

Live Cloud RAN trial in Italy

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