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OPEN EDGE ECOSYSTEM DEVELOPMENT

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Open edge ecosystem development

Topics

- Edge data centers - positioning
- Edge use cases – applications
- Edge requirements – rationale for new form factor
  - Environmental requirements
  - Facility constraints
  - Characteristics inherited from Open rack design
- Edge solution building blocks – What is needed
  - Rack – Indoor, Outdoor
  - Power feed options
  - Thermals and cooling
  - Server
  - Storage
- Edge solution building blocks – continued…
  - Commodities
  - Accelerators
  - Clock and synchronization
  - Switches, SDN
  - Firmware
  - Edge cloud infrastructure SW
  - Open management
- Nokia proposal for open edge
- Collaborative effort needed
- Open edge sub-group under Telco project

Nokia is a Platinum Member of the Open Compute Project and an OCP Solution Provider

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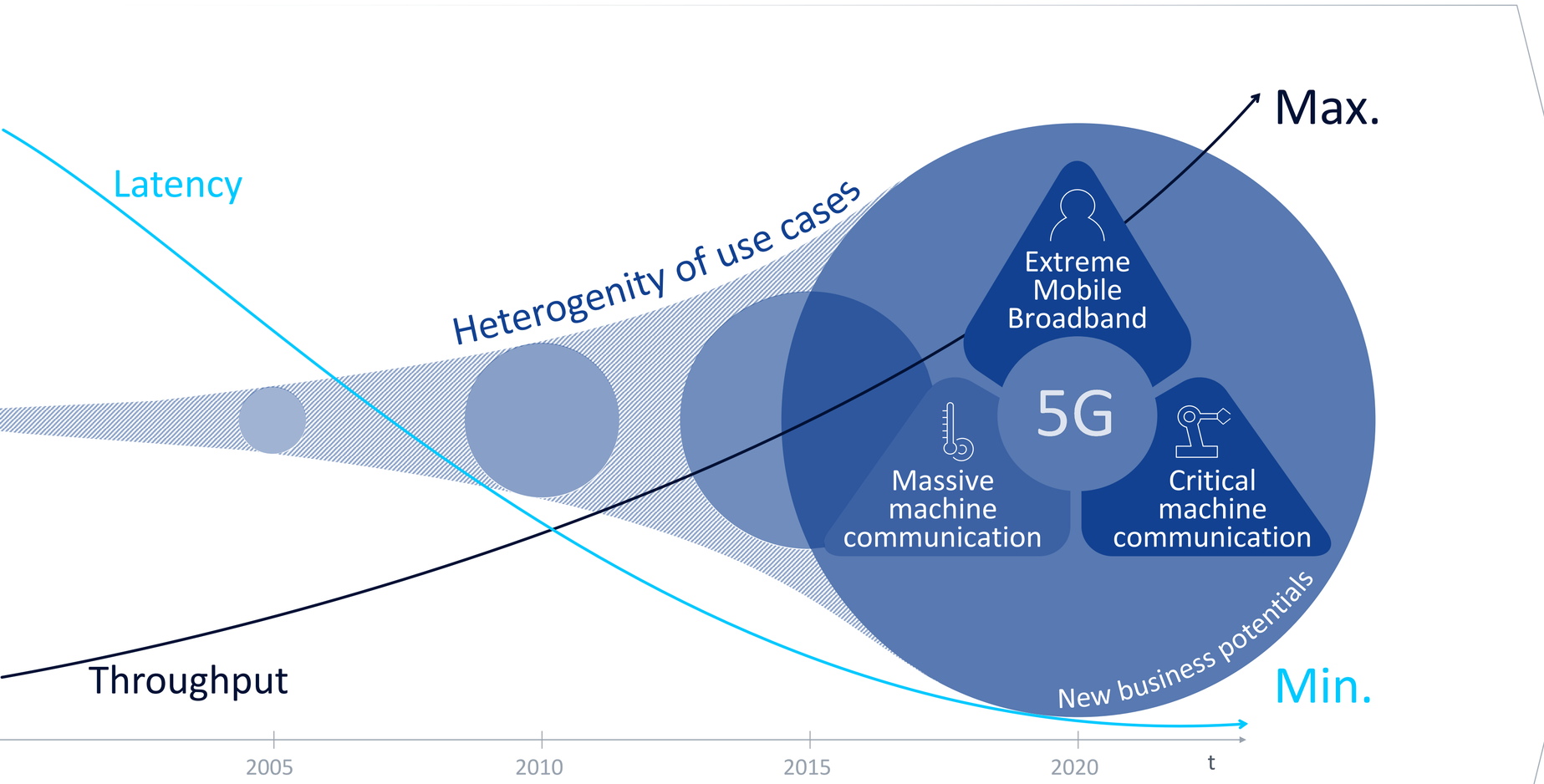
Edge data centers - Positioning

Pushing the limits to reach the next level

Addressing capacity demand while driving down latency



Efficient capacity

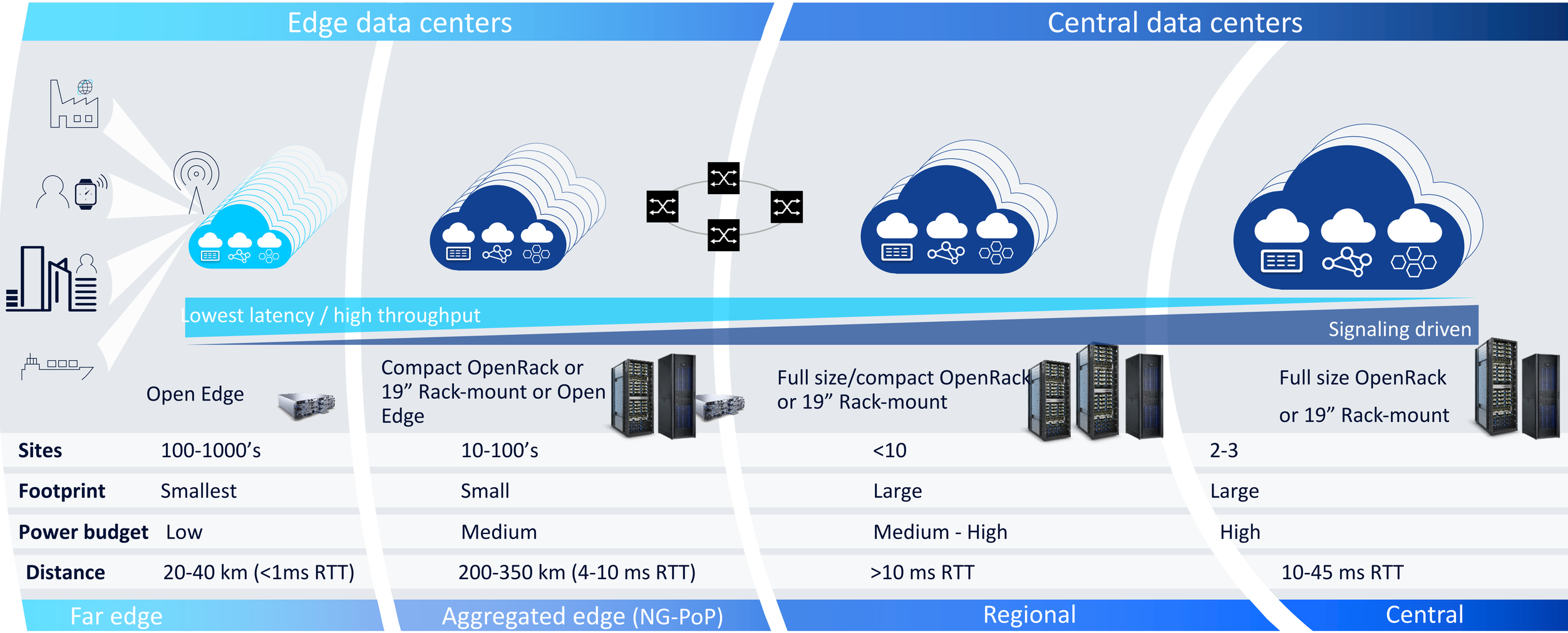
CENTRALIZED DATA CENTERS

Low latency & efficient transport

EDGE DATA CENTERS

Managing the lowest latency/cost trade off with a layered architecture

Datacenter portfolio for all deployments from Far Edge to HyperScale

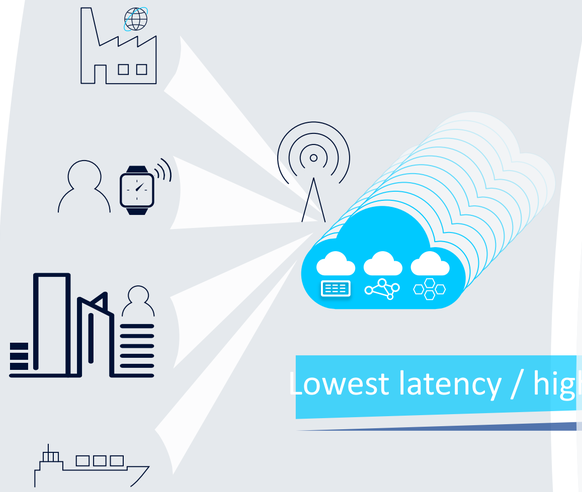


Managing the lowest latency/cost trade off with a layered architecture

First data center solution designed for the edge

Edge data centers

Central data centers



Lowest latency / high through

Content stays close to the end user

Enables lowest latency

No need to send big data towards the core network

Saves backhaul NW resources

Signaling driven

	Far edge	Aggregated edge	Regional	Central
Sites	100-1000’s	10-100’s	Few	~3
Footprint	Smallest	Small	Large	Large
Power budget	Low	Medium	High	High

Open Edge Server

Rackmount or OCP

Rackmount or OCP

Rackmount or OCP

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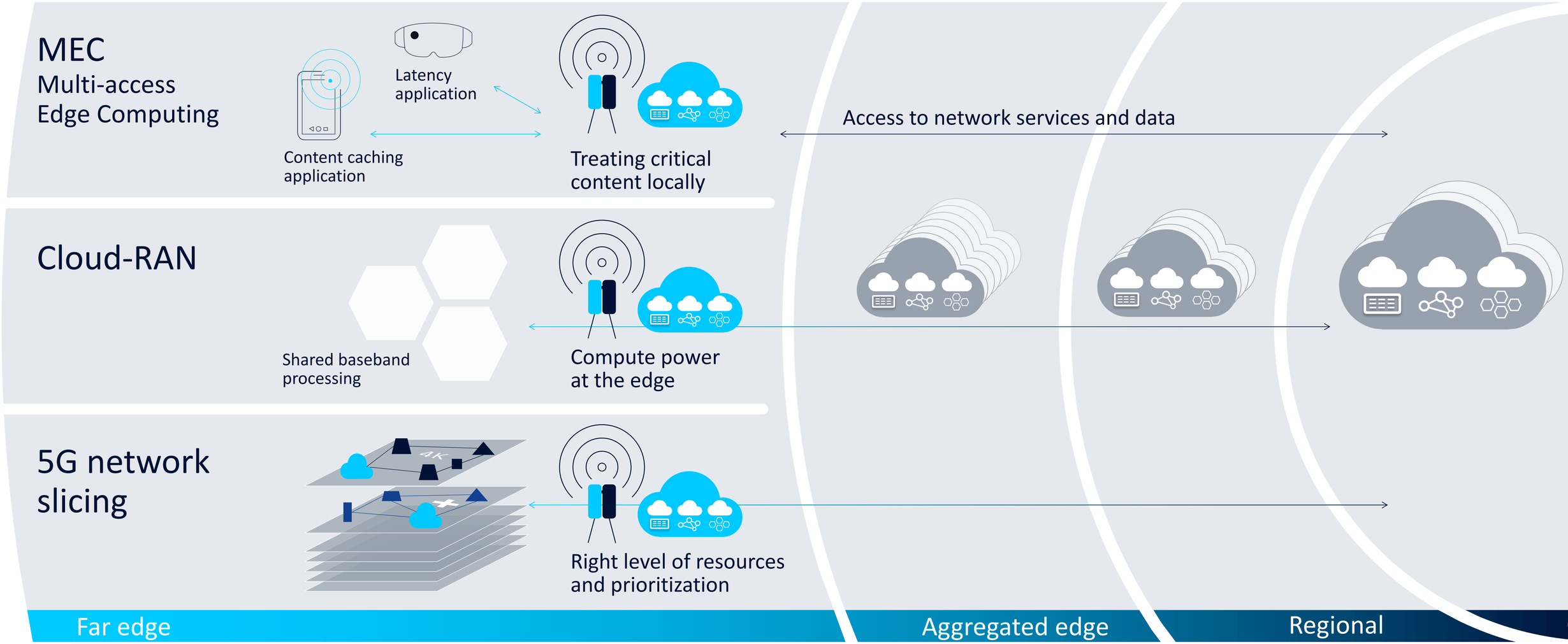
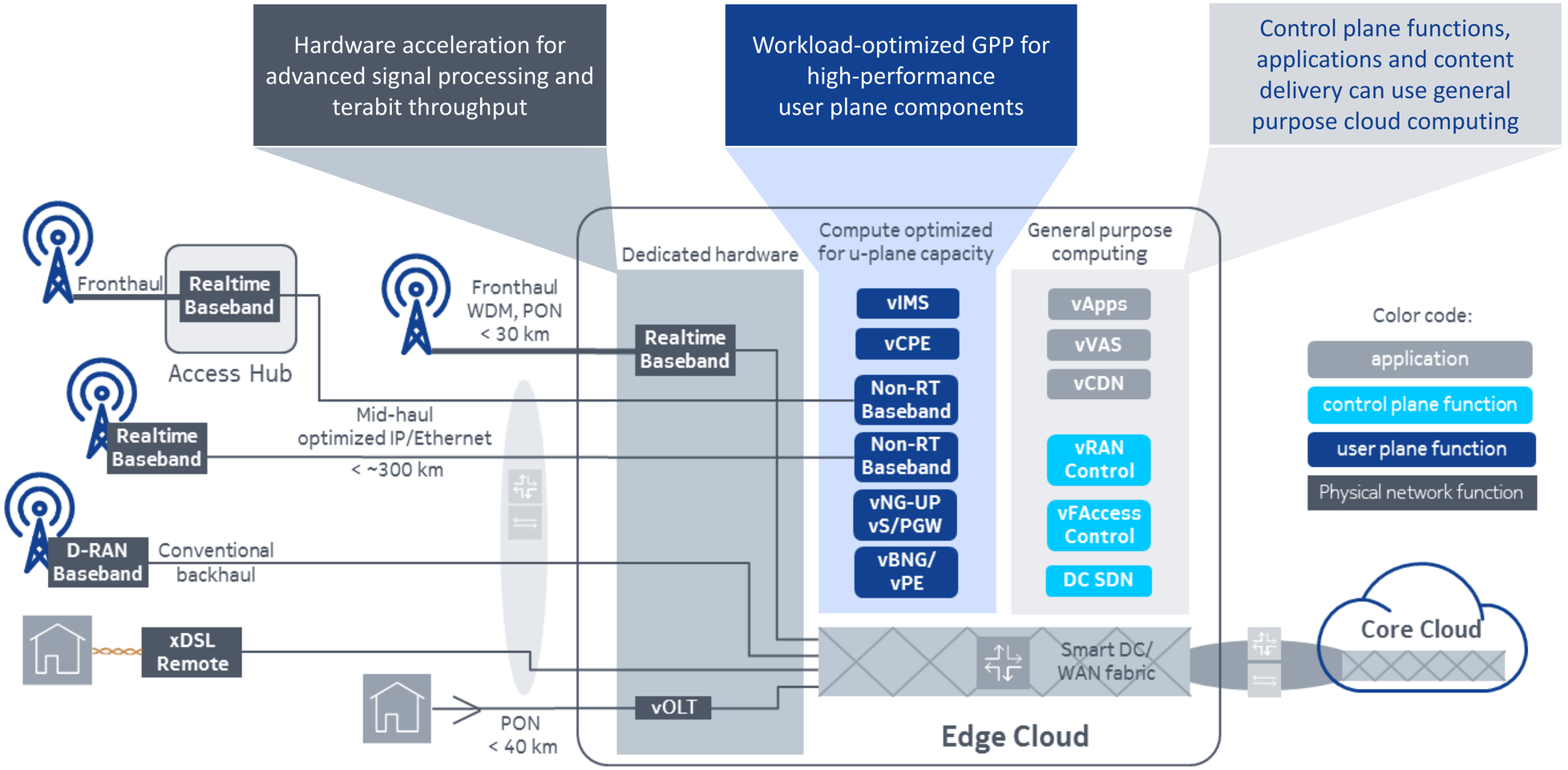
Edge use cases – Applications

Edge cloud is enabling new latency dependent use cases like AR and VR



Edge cloud – local infrastructure for low latency, high performance



- **Latency, bandwidth, and security critical use cases (IoT, MEC)**
  - Live VR with 4K video, Gaming, AR, Autonomous vehicles, …
- **RAN Cloudification & Evolution to 5G**
  - VRAN
- **Virtualized & distributed IP Edge**
  - EPC, 5G core, BNG, …
- **Fixed Access Network Transformation**
  - vOLT, …
- **Public/Private Cloud and open ecosystem for innovation moving to Edge**
  - New innovative services to the edge

Converging all access and IP edge functions in the edge cloud

Landscape for edge computing is expanding

- ETSI MEC
- Open Edge Computing
- OpenFog
- TIP Edge
- Linux Foundation Akraino
- Public Cloud players
- Different verticals
- IoT

*ETSI defines MEC as: "**Multi-access edge computing (MEC)** that offers application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the mobile network. This environment is characterized by **ultra-low latency and high bandwidth as well as real-time access to radio network** information that can be leveraged by applications."*

Ref: https://www.etsi.org/technologies-clusters/technologies/multi-access-edge-computing

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Edge requirements – Rationale for a new form factor

Facility constraints

Edge facilities are often existing radio or central office sites with constraints related to space, power and cooling.

- Fully equipped Open Rack v2 weight is >800 kg → >1200 kg/m2
  - Floor load capacity often limits the configurations.
- Rack depth is limited in most edge locations.
  - Old telco central office sites limit rack depth to 600-800 mm
  - Edge sites are typically existing radio sites where rack depth is max 600 mm
- 19’’ rack infrastructure often exists in the sites and new equipment needs to be installed into existing racks.
- Old sites typically also have limitations due to
  - Elevator capacity
  - Delivery path height (door openings) and delivery path floor load capacity.

Facility constraints

- Old telco sites typically have -48V DC power feed infrastructure with battery rooms
- Several AC power feed options for global use cases are needed, e.g.
  - 110VAC, 208VAC, 230VAC, 380VAC, single phase, three phase, 50/60 Hz, different wattages, different connectors, …
- Power cabling from top and bottom (raised floor) both need to be supported
- Edge site power budgets quite often limit size of installations
  - Limitation can be as low as 4 kW per rack
- Edge site cooling capacity often limits rack configurations
  - Limitation can be as low as 4 kW per rack
  - Existing cooling design may require front to back or back to front airflow

Environmental requirements

Standard telco equipment environmental requirements are still mandatory in most cases. For example:

- **Safety**: IEC 62368-1:2014, EN60950-1: 2006 + A2:2013 and IEC 60950-1 for safety, including national deviations, GR-1089-CORE.
- **EMI/EMC**: EN300386 (v1.6.1), CFR 47, FCC 15, class A, CISPR 22 Class A and CISPR 24, TEC/EMI/TEL-001/01/FEB-09 and TEC/IR/SWN-2MB/07/MAR-10, GR-1089-CORE
- **Temperature tolerance**: ETSI EN300 019-1-3 Class 3.1, ETSI EN300 019-1-3 Class 3.2, GR-63-CORE, section 4.1.
- **Seismic tolerance**: GR-63-CORE, section 4.4 Zone 4
- **Transportation and storage**: ETSI EN 300 019-1-2 v.2.2.1 class 2.2, EN 300 019-1-1 [20] Class 1.2, EN 300 019-1-2 [21] Class 2.3
- **RoHS**: EU RoHS directive 2011/65/EU Article 7b (EN 50581 (2012))
- **WEEE**: EU WEEE (Waste Electrical & Electronic Equipment) Directive 2002/96/EC and recast WEEE Directive 2012/19/EU
- **REACH**: EU REGULATION (EC) No 1907/2006 (Registration, Evaluation, Authorisation and Restriction of Chemicals)
- **Fire resistance**: ANSI T1.307-2007 and the requirements specified in GR-63-CORE chapter 4.2.3, GR-63-CORE chapter 4.2.2 Shelf-Level Fire-Resistance Criteria.
- **Energy efficiency**: ATIS-0600015
- **Acoustic noise**: GR-63-CORE, section 4.6

Design target: Taking OCP benefits to the edge

Fit to edge physical limitations

Open
Modular
Ecosystem
Energy efficient
Vanity free
Toolless
Dense

Preserve OpenRack benefits

Fully front operated

Open rack like tool-less serviceability

Vanity free design

Centralized power supply

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OCP design for serviceability

Top serviceability benefits of OCP based design:

1. 4x faster completion of required HW tasks
2. 65% more servers handled per operational person*
3. 61% less of productive employee time lost*
4. 38% less time needed to resolve unplanned downtime*

* Source:IDC OCP study

Why do we need a new form factor for the edge data centers?

Summary

- Existing data center equipment designs (e.g. most EIA 19’’ Rackmount systems and OCP Open Rack v2 systems) are targeted to “real” data center facilities and as such these designs are considered too heavy weight for the edge locations.
- Due to constraints of edge environments we need a form factor that that fits to edge locations and fulfills the requirements of edge applications in a cost efficient manner.
- OCP design principles combined with edge requirements create a good basis for edge form factor implementation.

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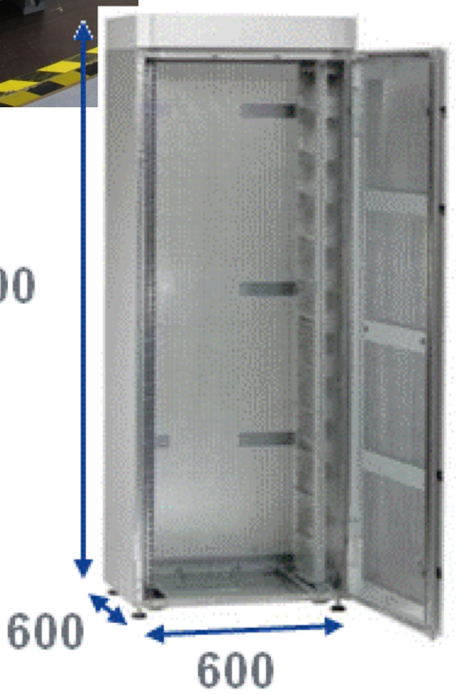
Edge solution building blocks – What is needed

Rack – Indoor, Outdoor

Requirements for edge solution building blocks

- Rack shall not be a mandatory component of an edge solution
  - Existing sites often have existing EIA 19’’ infrastructure where the edge server has to fit in
  - Scalability from small (few servers) to full rack configurations needed (>50 servers/rack)
- Indoor and outdoor installations are possible for edge equipment
- Indoor rack maximum footprint is 600 x 600 mm, including doors
- Back to back or back to wall rack installations need to be supported
- Racks may be closed from the rear side i.e. the equipment must be fully front operated.
- Outdoor cabinet solutions can vary a lot but in general the equipment must support outdoor installation by using an outdoor cabinet.



Power feed options

Requirements for edge solution building blocks

- Several power feed options are needed to support use of edge equipment globally.
- Rack level power feed requires following components
  - Rack level power distribution units (PDU)
  - Rack level or equipment level power supply units (PSU)
- Centralized power supply (for more than one server) is preferred due to better efficiency.
- Typically required PDU voltage input options are:
  - -48 VDC
  - 208 VAC 3-phase
  - 230 VAC 1-phase
  - 400 VAC 3-phase
  - 400 VAC 3-phase NAM
- Typical PSU voltage input options are:
  - -48 VDC
  - 100/200 – 240 VAC
- Power feed is required to be redundant.

Thermals and Cooling

Requirements for edge solution building blocks

- Equipment must support
  - Extended operating temperature range: -5C..+45C [ETSI EN300 019-1-3 Class 3.2]
  - Short term operating temperature range: -5..+55C [NEBS]

- Due to rack installation options (e.g. back-to-back and wall-mount) all edge equipment must support:
  - Front to rear cooling
  - Rear to front cooling

Server

Requirements for edge solution building blocks

- General purpose servers are the main building block of edge data centers.
  - Server performance requirements may vary depending on the planned workloads

- High performance servers are required to run NFV edge cloud VNFs
  - Min 20 CPU cores per server is needed to be able to run e.g. OpenStack / KVM cloud effectively
  - Single CPU socket servers fit better to the shallow depth server chassis.
  - Single CPU socket server works better for high throughput packet processing applications.
  - Min 400W power budget per 1RU server.

- Server chassis must fit into standard EIA 19’’ rack that is 600 mm deep.

- Server chassis maximum depth is 450 mm.
  - This enables cabling and efficient cooling within the 600 mm total depth of the rack

- Redundant hot swappable power supply, redundant fans and redundant connectivity shall be supported.

Storage

Requirements for edge solution building blocks

- Storage requirements in edge are modest for most applications (Telco VNFs)
  - Some applications, e.g. CDN, have higher storage requirements

- For robustness purposes storage solution should be hot-swappable and should have RAID support.

Commodities

Requirements for edge solution building blocks

- Servers and storage nodes shall use standard commodities:
  - Networking is to be implemented with PCIe NICs and OCP mezzanines
    - Typically 100 GbE connectivity per server needed (OCP mezz + PCIe x8/16 slots on server)
  - Mass memory is to be implemented with standard 2,5’’ SATA or NVMe SSDs (U.2) and M.2 SSD cards.
  - New NGSFF / EDSFF NVMe form factors fit well to the small edge form factor.
  - RAM memory is to be implemented with standard DDR4 DIMM modules
  - NVDIMM technology can be used for large memory use cases.

- Support for commonly used commodity form factors is mandatory due to
  - Good availability
  - Supported by wide ecosystem
  - Many kinds of use cases / technologies are available
  - Cost efficiency
  - No lock-ins

Accelerators

Requirements for edge solution building blocks

- In telco today many functionalities are done with special purpose HW using
  - FPGAs, DSPs, Network / packet processors, ASICs, GPGPUs

- In general the trend is virtualization (software based implementations) but acceleration in edge data centers is becoming a must for
  - Radio baseband processing
  - Packet processing
  - Security, encryption
  - AI/ML, training and inference
  - Video, AR
  - Etc.

- The edge HW solution must be able to support heterogenous computing requirements including accelerators for different purposes.
- Support for high end accelerators (FHFL double-wide PCIe) is needed for e.g. AI/ML use cases.

Clock and synchronization

Requirements for edge solution building blocks

- The system needs to have access to high precision grand master clock.
- Servers need to have high precision synchronization that is required by mobile networks applications (esp. Radio related).
- IEEE 1588 PTP can be used to provide synchronization information to the servers.
- Switches should also support SyncE for accurate timing.

Switches, SDN

Requirements for edge solution building blocks

- Server to switch connectivity is typically 100 GbE or more.
- Edge data center networking design is typically based on a redundant spine and leaf topology (Clos network architecture).
- Number of switches per rack is typically three or more (2 x leaf + HW management switch), depending of the size of the deployment.
- Amount if cabling in a rack is huge and DAC cables (e.g. 100G QSFP28) are currently the most cost efficient way to implement rack internal connectivity.
- Switch must fit into standard EIA 19’’ rack that is max 600 mm deep.
- Switches should be fully front operated, incl. power feed.
- Switch chassis maximum depth is 450 mm.

Firmware

Requirements for edge solution building blocks

- Full remote management capabilities are required
  - Edge data centers are typically unmanned
  - Distance from the operations center may be hundreds of kilometers/miles
  - One operations center can control hundreds of edge sites with thousands of servers

- All equipment is preferred to be managed in a similar fashion through BMC
- Standard management interface is required to hide heterogeneity
  - DMTF Redfish is proposed to be used as the HW management API
- Secure management interface is a must.

- Firmware must be able to provide high quality self diagnostics in case of issues.
- Firmware must support self healing of the system.

Edge cloud infrastructure SW

Requirements for edge solution building blocks

- Telco applications deployed in edge data centers are VNFs running on a cloud infrastructure.
- Proposed edge cloud solution characteristics are:
  - Real-time support through software optimization & hardware accelerators
  - Flexible scalability from single server edge cloud to multi-rack system with SDN
  - Interoperable and open, supporting 3rd party VNFs
  - Carrier grade high availability with sub-second reaction time, auto-recovery
  - Deployment & update/upgrade automation with remote capability, runtime configuration management & open APIs
  - Hybrid infrastructure for hosting and running containerized and/or virtualized applications
  - OPNFV verified offering - leveraging and scaling open source

- Nokia cloud infrastructure supports above characteristics
  - Shown in booth A26

Open management

Requirements for edge solution building blocks

- In open ecosystem support for multivendor environment is a mandatory requirement.
  - This requires open APIs between different layers
  - RSD defines a good framework for data center gear management architecture

- Server management interface standardization is needed
  - IPMI is insecure and too low level with a lot of vendor specific extensions.
  - DMTF Redfish is a standard preferred management interface for edge equipment

- Switch management is typically done using SNMP and CLI
  - No common way to manage switches today.
  - BMC in switches simplifies HW management of switches.
  - Redfish for HW management is proposed to be used for switches also.

Why new hardware form factor is needed for edge data centers?

Edge site limitations and new requirements - Summary

- Edge sites are often existing telco central office or radio sites.
- Traditional data center gear is too heavy and large for edge sites - equipment needs to be more compact in terms of depth, height and weight.
- NEBS compliance is mandatory in terms of thermal requirements, seismic tolerance, humidity tolerance, etc.
- Power budgets are limited and support for variety of power feed options for all continents and locations is needed.
- Network functions virtualization (NFV) is driving cloudification of all services also in network edge. General purpose CPU servers are preferred for the virtualization platform.
- New telco 5G and mobile edge computing applications can benefit from acceleration capabilities for processing and networking.

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Nokia proposal for open edge

Nokia proposal: Open edge server

x86 solution designed to fully support edge / far-edge cloud deployments

ARCHITECTURE

- 19” compatible: fits in any 600mm deep cabinet
- Compact form factor: ranging from 2RU to 7RU high chassis
- Sleds either 1RU or 2RU high
- Fully front-operated (cabling, open rack-like tool less serviceability)
- Support for high end accelerators
- High availability: redundant fans, hot swappable storage
- Air flow configurable front to rear/rear to front

ENVIRONMENTAL

- Full NEBS compliancy, seismic zone 4 [GR-63-Core, GR-1089-Core]
- Extended operating temperature range: -5C..+45C [ETSI EN300 019-1-3 Class 3.2], short term range: -5..+55C [NEBS]

DIMENSIONS

- 130.55 (3RU) x 440 x 430 mm (H x W x D)
- Ca. 12.0 kg / 46.5 lbs. (Chassis with PSU’s and RMC)

POWER

- 2N redundant AC & DC power supplies
- Power fed to sleds through backplane
- 400W per 1U sled
- 700W per 2U sled

MANAGEMENT

- RMC manages chassis power feed.
- All sleds managed through single interface in RMC unit (acts as an ethernet switch connecting the server slots)
- On board BMC in server sleds (RMC does not manage servers)

COMMODITY

Supports standard commodities like DIMMs, NICs, HBA cards, HDD/SSD/NVMe disks, M.2 disks, GPGPU cards, etc.

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Collaborative effort needed -
Open edge sub-group under Telco project

Invitation to the community

- Collaborative effort is needed to define a solution that fulfils edge use cases and that is supported by a large ecosystem of suppliers and adopters.

- We invite the OCP community (suppliers and adopters) to work with us on edge data center solutions.

→ Open edge sub-group to be created under OCP Telco project.

- Nokia aims for a truly open, collaborative open edge HW development

→ Target is an open OCP solution for the edge.

Open edge sub-group under OCP Telco project - proposal

Charter proposal:

- The Open Edge project shall create specifications, standards, support documentation or reference designs which enable global adoption of the Open Edge Computing solution that meets the requirements of Telco Providers.
- Participants in this project are expected to be from across the entire eco-system including Telco Service Providers (adopters), OCP solution providers (suppliers), ODM/OEM manufacturers, and key technology providers.
- To ensure that the wider OCP community is involved and to ensure that relevant expertise is utilized, the project will solicit input and provide technical presentations to the other OCP projects/committees especially the Rack and Power, Server and Networking groups.

Goals:

- The Open Edge project shall focus on standardization and definition of the critical interfaces, operational parameters, and environmental conditions that enables adopters to have access to a non-proprietary multi-vendor supply chain of Open Edge.

Scope:

- The project will gather requirements and specifications for the Open Edge computing platforms from the adopters. This will include dimensions, power budgets, cooling requirements, and networking requirements. Adopters who are actively deploying or planning to deploy the Open Edge requirements will be more valued than other input.
- OCP accepted designs (full design packages) will be provided to ensure critical dimensions are adequately specified.

Out of scope:

- Generic 19in rack “small foot print” servers.
- Cooling solutions are not included in the server sleds.

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Thank You!

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Come and visit us at Nokia booth A26

Experience world’s first open edge server and edge cloud infrastructure!

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