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FOR BUSINESS.
OPEN EDGE ECOSYSTEM DEVELOPMENT

Mika Hatanpää/Head of Data Center R&D/Nokia
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
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
First data center solution designed for the edge

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<th>Sites</th>
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Lowest latency / high throughput

Signaling driven

Footprint: Open Edge Server
Power budget: Rackmount or OCP

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Managing the lowest latency/cost trade off with a layered architecture
First data center solution designed for the edge

- **Sites**: 100-1000’s
- **Footprint**: Smallest
- **Power budget**: Low

**Edge data centers**
- **Content stays close to the end user**: Enables lowest latency
- **No need to send big data towards the core network**: Saves backhaul NW resources

**Central data centers**
- **10-100’s**: Small, Rackmount or OCP
- **<100’s**: Medium, Rackmount or OCP
- **Few**: Large, Rackmount or OCP
- **~3**: Large, Rackmount or OCP
Edge use cases – Applications
Edge cloud is enabling new latency dependent use cases like AR and VR.

**MEC**
Multi-access Edge Computing

- Content caching application
- Latency application
- Treating critical content locally

**Cloud-RAN**

- Shared baseband processing
- Compute power at the edge

**5G network slicing**

- Right level of resources and prioritization

**Access to network services and data**

- Far edge
- Aggregated edge
- Regional
Edge cloud – local infrastructure for low latency, high performance

Hardware acceleration for advanced signal processing and terabit throughput

Workload-optimized GPP for high-performance user plane components

Control plane functions, applications and content delivery can use general purpose cloud computing

Converging all access and IP edge functions in the edge cloud
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
- Old sites typically also have limitations due to
  - Elevator capacity
  - Delivery path height (door openings) and delivery path floor load capacity.
- Old telco sites typically have -48VDC 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 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
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))


- **REACH**: EU REGULATION (EC) No 1907/2006

- **Fire resistance**: ANSI T1.307-2007 and the requirements specified in GR-63-CORE chapter 4.2.3, GR-63-CORE chapter 4.2.2.2 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

- Open
- Modular
- Ecosystem
- Energy efficient
- Vanity free
- Toolless
- Dense

Fully front operated

Open rack like tool-less serviceability

Vanity free design

Centralized power supply

Fit to edge physical limitations

Preserve OpenRack benefits
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 Open rack v2) are targeted to real data center facilities.
• Due to limitations of edge environments we need a form factor 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.
Edge solution building blocks – What is needed
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 cloud effectively
  • Single CPU socket servers fit better to the shallow depth server chassis.
  • 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
  • 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.
  • NVDIMM technology ...
  • RAM memory is to be implemented with standard DDR4 DIMM modules

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

- Acceleration in edge data centers is becoming a must for
  - Radio baseband processing
  - Packet processing
  - Security
  - AI/ML
  - Video, AR
  - Etc.

- The system 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.
• IEEE 1588 PTP can be used to provide synchronization information to the servers.
• Switches should 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).
- Amount of 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.
- 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 also 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.
Why new hardware form factor is needed for edge data centers?

Edge site limitations and new requirements - Recap

- Edge sites are often existing telco 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.
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

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)

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)

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

• 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 HW development

  ➔ Target is an open OCP solution for the edge!
Open edge sub-group under OCP Telco project - practices

<Proposal for open edge sub-group practices to be added according to agreements with OCPF. Target to add this by mid September>

<We launch today a new open edge sub-group under OCP Telco project. Initial members of the sub-group are Nokia, Intel, Flex and Quanta. All OCP members are invited to join the sub-group work>
Thank You!
Come and visit us at Nokia booth A26

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