FAQ SHEET

intel

Accelerating the 5G Fronthaul Gateway

Q What type of acceleration is crucial in 5G networks?

A Both 5G RAN and core networks can benefit from acceleration. Intel offers solutions for the following use cases:

- Fronthaul gateway (FHGW). The fronthaul network refers to the connection between centralized BBUs and geographically separated RRHs. Here, the accelerator provides a fronthaul interface and can offload complex I/O connectivity to the radio units. It can also be used to offload Split 8, Split 7 and fronthaul processing functions such as compression/decompression, precoding and Low L1.
- CU/DU acceleration for turbo codes and LDPC.
- RRH acceleration for DFE, BF and Low L1.
- Core accelerators such as NFVi, UPF, TCP.

Q Why do we need a programmable acceleration solution for FHGW in 5G?

A 5G is driven by all-IP networks. The traditional hardware components of the network are replaced with software that virtualizes the network using the common IP protocol. With 5G, optical and wireless networks solutions converge to flexibly connect different types of RAN solutions to the core network. At the same time, we see 4G and 5G RANs that use multiple radio access technologies and that support various 5G fronthaul splits (Split 7.x and Split 8). In this way, the RANs can connect to different 4G/5G RRHs. A field programmable gate array (FPGA)-based FHGW allows for a programmable xHaul solution, which enables future upgrades in the field to address new requirements without hardware changes.

Accelerate the Network with Intel® Technology

The Intel® FPGA Programmable Acceleration Card (Intel® FPGA PAC) N3000 is programmable and allows the optimization of data plane performance to achieve low costs while maintaining a high degree of flexibility. The N3000 can handle both FEC offloading and I/O connection. In many use cases, this two-in-one solution can reduce the use of the limited PCIe slots on the server, thus reducing the total system cost.

What are the primary FHGW usage scenarios?

The FHGW can be deployed either as a packetized fronthaul transport system or as a fronthaul interworking system to enable O-RAN adoption.

In packetized fronthaul mode, the FHGW essentially carries various fronthaul service flows over a deterministic Ethernet mechanism. This ensures consistent jitter and guaranteed latency delivery. For CPRI-based fronthaul interfaces, additional processing is required to adapt CPRI into Ethernet frames. Such processing could leverage IEEE 1914.3 RoE or eCPRI 2.0 IWF.

In fronthaul interworking mode, various CPRI-to-O-RAN processing functions must be implemented in programmable silicon within the FHGW. For example, Intel® programmable silicon is integrated into Ciena's 5G xHaul Router portfolio. The key processing functions include mapping and processing CPRI-centric IQ data, control words and synchronization and management with their equivalent in the O-RAN C/U/S-Plane and M-Plane specifications. The key applications for an FHGW in interworking mode are:

- Dynamic Spectrum Sharing deployment with an O-RAN DU and using existing CPRI-based RRH assets
- Evolution to an O-RAN-based architecture and framework

What are the drivers of deploying an in-building O-RAN system?

In-building O-RAN systems are being driven by several industry trends:

- **Increased interest in private 5G networks.** In several countries, such as Japan and Korea, private 5G networks are expected to proliferate, using FR1 or FR2 frequencies. Legacy in-building antenna systems would not be able to handle several 5G NR requirements—including network slicing and larger spectral bandwidth. By deploying an in-building O-RAN system, private 5G networks can be built cost effectively and can support various deployment models. For example, an enterprise could self-build the network using a shared/assigned spectrum. Alternatively, networks managed by MNOs could use network slicing, with key in-building mobile assets owned by the MNOs.
- **Demand for more choice.** Deploying an in-building O-RAN system enables mixing and matching of network components from different vendors. RUs, DUs, CUs, and associated transport networks between them don't all have to be purchased from the same vendor. All that is necessary is that the components are O-RAN compliant. Such an open ecosystem (similar to today's Wi-Fi ecosystem) can lead to price reduction and increased innovation, enabling best price and performance.
- **Desire for less complexity**. By using a common in-building vDU/vCU to coordinate all in-building cells, you can significantly reduce the number of building-to-external macro cell coordination interfaces—sometimes down to just a single coordination interface.
- **Need for easier and faster deployment.** Virtualized in-building O-RAN systems can take advantage of Intel's compute acceleration technologies to enable "5G-in-a-Box." This type of system can greatly reduce the complexity of rolling out such in-building O-RAN systems—thereby enabling quick deployment.

Q Why is RAN compute at the far edge or macro site required?

A Several benefits accrue from deploying RAN at the far edge:

- It allows the use of common off-the-shelf x86 infrastructure that meets telco requirements, powered by Intel® acceleration technologies to broaden the choice of hardware at the macro site.
- It allows easier deployment of 3GPP slicing on the midhaul by easily supporting various software functions enabled by hardware acceleration. For example, consider IPsec. The RAN compute could originate a secured network slice with IPsec, which is enabled by Intel® acceleration technologies. In contrast, in a proprietary system, either external IPsec encryption hardware or vendor-specific implementation is required—driving up system complexity.
- It allows faster adoption of O-RAN or 3GPP radio features through a software update to the virtualized DU elements.
- It enables the deployment of distributed 5G core elements like the UPF and enables MEC applications to be instantiated at the far edge/macro site. This will likely be required for some ultra-low-latency mission-critical applications or low-latency augmented reality and virtual reality applications.

Interested in learning more? Read Ciena's article about 4G and 5G fronthaul networks, and view the webinar, Key Considerations for Acceleration Solutions in 5G Networks.

Glossary

3GPP	3rd Generation Partnership Project
ASIC	application-specific integrated circuit
BBU	baseband unit
BF	beamforming
BTS	base transceiver station
CPRI	Common Public Radio Interface
CU	central unit
DFE	digital front end
DPDK	Data Plane Development Kit
DU	distributed unit
eCPRI	Enhanced CPRI
FEC	forward error correction
FHGW	fronthaul gateway
FPGA	field-programmable gate array
FR	frequency range
IP	internet protocol
IWF	Interworking Functions
L1	Layer 1
LDPC	low-density parity-check
MEC	multi-access edge computing
MNO	mobile network operators
NFVi	network functions virtualization infrastructure
NR	new radio
O-RAN	OpenRAN
PCIe	Peripheral Component Interconnect Express
RAN	radio access network
RoE	Radio over Ethernet Encapsulations
RRH	remote radio head
RU	radio unit
TCP	transmission control protocol
UPF	user plane function
vCU	virtual centralized unit
vDU	virtual distributed unit

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