SILICOM INTEL® AGILEX™-BASED N6010/N6011 SOLUTION

Silicom's Layer 1 Offload N6010/N6011 SmartNIC for 4G/5G O-RAN Distribution Units

SOLUTION BRIEF

Silicom Ltd.
Connectivity Solutions

ABOUT OUR COMPANY

WELCOME TO SILICOM

Silicom Ltd. is an industry-leading provider of high-performance networking and data infrastructure solutions. Designed primarily to improve performance and efficiency in Cloud and Data Center environments, Silicom's solutions increase throughput, decrease latency and boost the performance of servers and networking appliances, the infrastructure backbone that enables advanced Cloud architectures and leading technologies like NFV, SD-WAN and Cyber Security. Our innovative solutions for high-density networking, high-speed fabric switching, offloading and acceleration, which utilize a range of cutting-edge silicon technologies as well as FPGA-based solutions, are ideal for scaling-up and scaling-out cloud infrastructures.

Silicom products are used by major Cloud players, service providers, telcos and OEMs as components of their infrastructure offerings, including both add-on adapters in the Data Center and stand-alone virtualized/universal CPE devices at the edge.

Silicom's long-term, trusted relationships with more than 200 customers throughout the world, its more than 400 active Design Wins and more than 300 product SKUs have made Silicom a "go-to" connectivity/performance partner of choice for technology leaders around the globe.
Silicom Ltd.'s shares trade on the Nasdaq Global Select Market under the symbol SILC.

CONTENT

ABSTRACT

This paper provides an overview of the N6010/N6011 SmartNIC as a Layer 1 offload engine in today's O-RAN architecture LLS logical split 7-2x and 8. It describes the architectural elements, design criteria, technology choices and key chipset employed to build a layer 1 offload with built in advanced timing synchronization SmartNIC for a DU in a 4G/5G RAN rollout for any market. With O-RAN Alliance's drive to move towards an open ecosystem and interoperable building blocks, Silicom has created an O-RAN standards-compliant Layer 1 High PHY solution over an open, fully programmable platform based on an FPGA, and implemented it as a PCIe add-in card. This paper aims to demonstrate a design example of this advanced integration and the benefits it can bring to Network Infrastructure Solutions providers.

BACKGROUND

5G continues to gain traction around the world. According to a new report from technology analyst PwC, 5G had achieved 75% coverage of the US by January 2021, and the percentage will soon rise to 80%. According to the Dell'Oro Group, cumulative Open RAN revenue from 2020-2025 could be as high as $15 billion, with Open RAN revenues accounting for more than 10% of the overall RAN market by 2025.

While the proportion of devices using 5G is considerably lower (according to PwC, reaching only about 12% by July 2021), a tipping point is expected to arrive in 2023. Usage rates are expected to increase strongly and steadily as customers reach the tech refresh point in their mobile device upgrade cycles and mobile network operators (MNOs) solve their 5G deployment challenges.

This is desirable because 5G holds such great promise. 5G is needed to enable new types of applications well beyond today's voice communications and internet access services: powerful virtual and augmented reality applications that will only become practical when the Internet of Things (IoT) becomes more responsive and reliable.

As such, MNOs are looking for more effective ways to implement 5G technology. They will have to make choices regarding how to configure the architecture, implement virtualization, and manage their operations. For many MNOs, the right decision will be to build out an Open RAN platform rather than to use a proprietary radio access network (RAN).

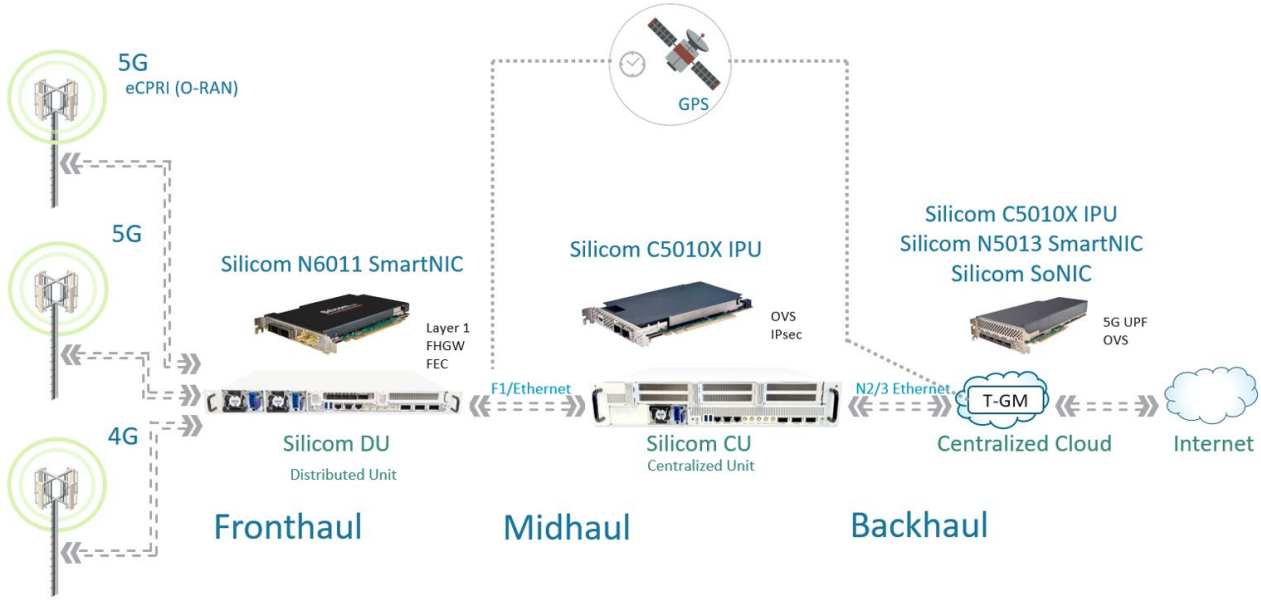


Figure 1 5G RAN network design using Silicom N6011

That is why Open RAN is gaining momentum. Open RAN is a series of standards managed by the O-RAN Alliance and 3GPP that support disaggregation, open APIs and multi-vendor interoperability, all attractive features for MNOs seeking to build flexible, responsive networks. Since it enables a new level of flexibility in network configuration and supports multi-vendor deployments, it has been embraced by an extensive ecosystem of companies, who are now designing products and solutions for the Open RAN environment. In addition, the fact that Open RAN is designed for building virtualized RAN (vRAN) systems enables RAN software to be run on commercial off-the-shelf (COTS) servers.

In previous cellular communication generations, RAN platforms deployed a baseband unit installed on a proprietary vendor specific hardware platform to handle signal processing and to communicate with individual remote radio units (RRUs) installed at or near the cell tower. The RAN, including its RRUs, made up the bulk of the cellular base station.

SILICOM INTEL® AGILEX™-BASED N6010/N6011

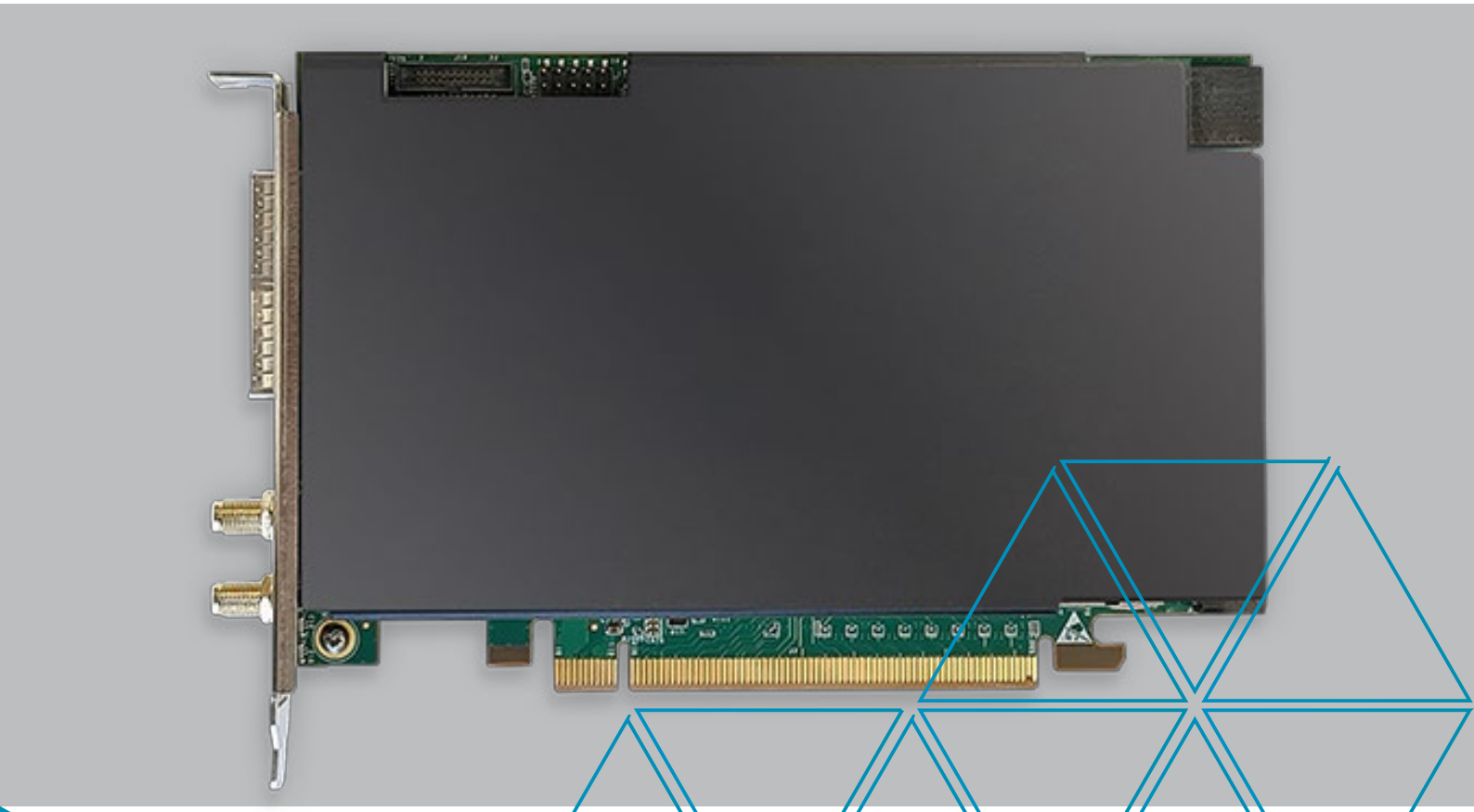
Silicom N6010/N6011 FPGA SmartNIC platform is based on the Intel® Agilex™ F-Series FPGA and implemented as a PCIe add-in card code-named N6010 and N6011. Two primary versions are offered to address customer requirements for performance and power.

Flexible Multi-port Ethernet Intel® Agilex™-Based SmartNIC

With the Open RAN standard, the baseband unit is disaggregated into a centralized unit (CU) and one or more distributed units (DUs), with the DU software handling real-time L1 and L2 scheduling functions while the CU is responsible for non-real-time L2 and L3 processing. DU software can be installed on an Intel® architecture server at the cell site, or in an edge cloud data center. The CU software is likely to be installed in a regional cloud data center.

Silicom, an Intel® Platinum and Network Builders ecosystem partner, offers a layer 1 offload engine platform code-named N6011: an Intel® architecture-based platform designed for use in the DUs of OpenRAN environments. The platform is based on the latest Intel® PSG FPGA Agilex™ and employs the processor performance, acceleration, memory, and precise time synchronization needed to support high-density DU deployments.

SILICOM INTEL® AGILEX™-BASED N6010/N6011



LLS

LLS (Lower Layer Split) – RAN is comprised of two components, the vRAN software (DU/CU) that runs on COTS servers, and the Remote Radio Head (RRH) or RU. The 3GPP has defined the LLS, a logical split configuration that an operator can set by deployment scenario to determine the functionality of the O-DU (O-RAN Distribution Unit) and O-RU (O-RAN Radio Unit). The interface between them is known as fronthaul, and it uses the CPRI protocol.

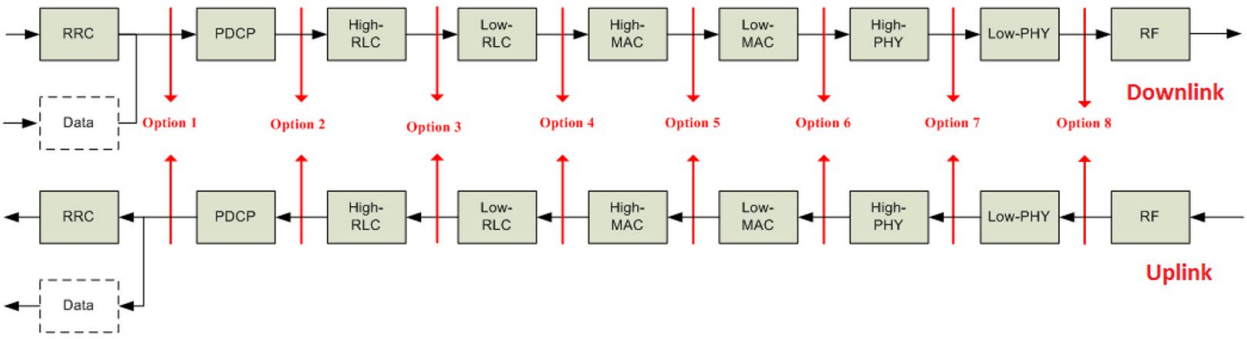
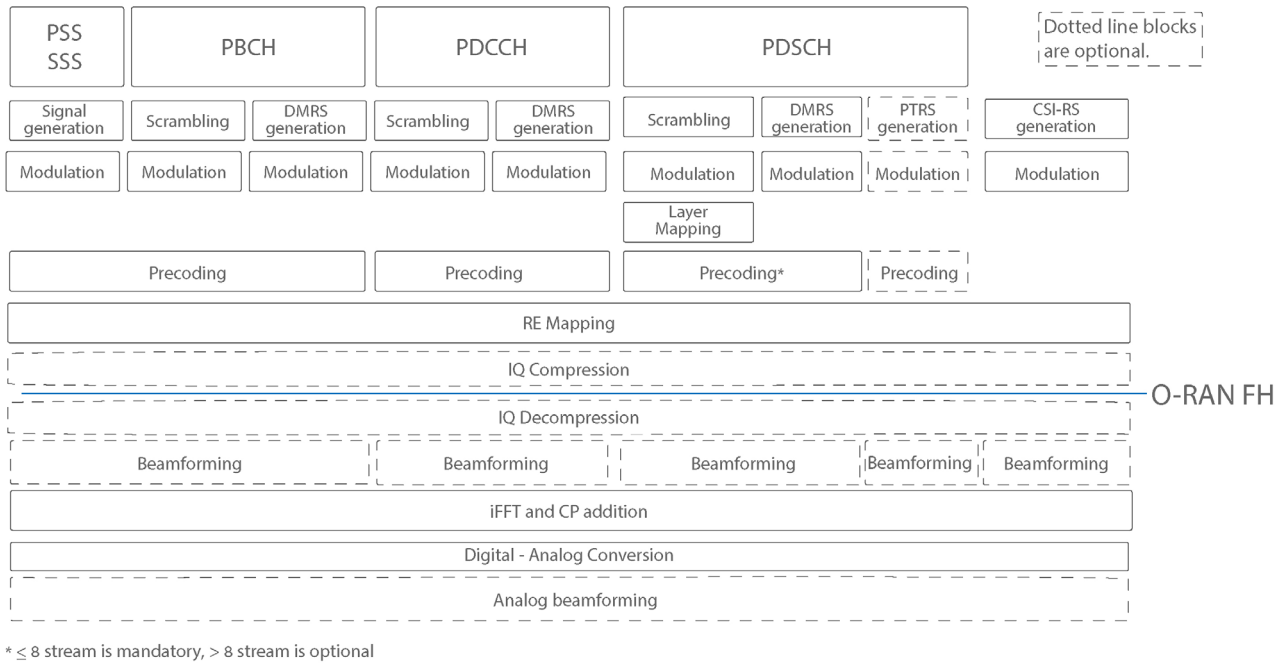


Figure 2 3GPP Low Level Split options block diagram

As illustrated in Figure 3, the most common deployment scenario in today's RAN environment is a 7-2x split (dotted boxes are optional). The O-RAN Alliance has defined a multi-vendor fronthaul interface between DU and RRU based on a 7-2x Split. In O-RAN terminology, RRU is denoted as O-RU, and DU is denoted as O-DU. The fronthaul specifications include (CUS) Control (traffic management functions), User (carries the network user traffic) and Synchronization (responsible for the timing and sync aspects between the O-DU and O-RU) & (M) Management (management functions to set parameters on the O-RU side as required by the C/U-Plane and S-Plane) plane protocols.



* ≤ 8 stream is mandatory, > 8 stream is optional

Figure 3 Download Split Description between O-DU and O-RU

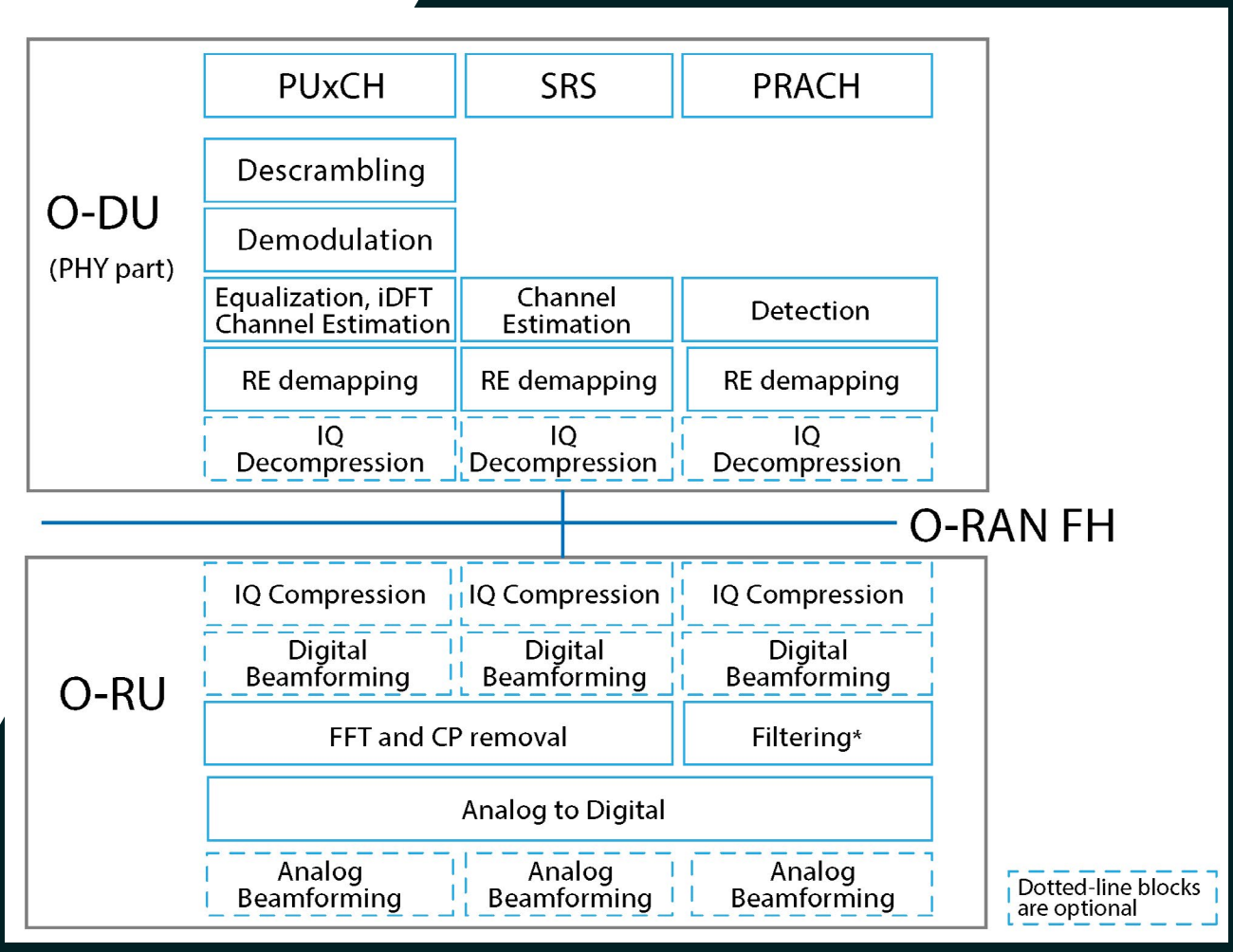


Figure 4 Upload Split Description between O-DU and O-RU

SILICOM N6010/N6011

Silicom N6010/N6011 FPGA SmartNIC platform is based on the Intel® Agilex™ F-Series FPGA and implemented as a PCIe add-in card code-named N6010 and N6011. Two primary versions are offered to address customer requirements for performance and power. Silicom N6010/N6011 includes Agilex™ AGF 014 device with 1.4M Logic Elements (LEs) and E810-CAM1 (N6011 only), HPS (Hard Processor System) - Quad-core ARM Cortex-A53, DDR4 memory for logic(16GB) and HPS (1GB), 2x QSFP56 supporting up to 2x 100GbE and Precision clock (supporting SyncE) and timing circuitry supporting LLS-C1, C2 and C3 timing architecture with front panel SMA connection for 1PPS and 10Mhz.

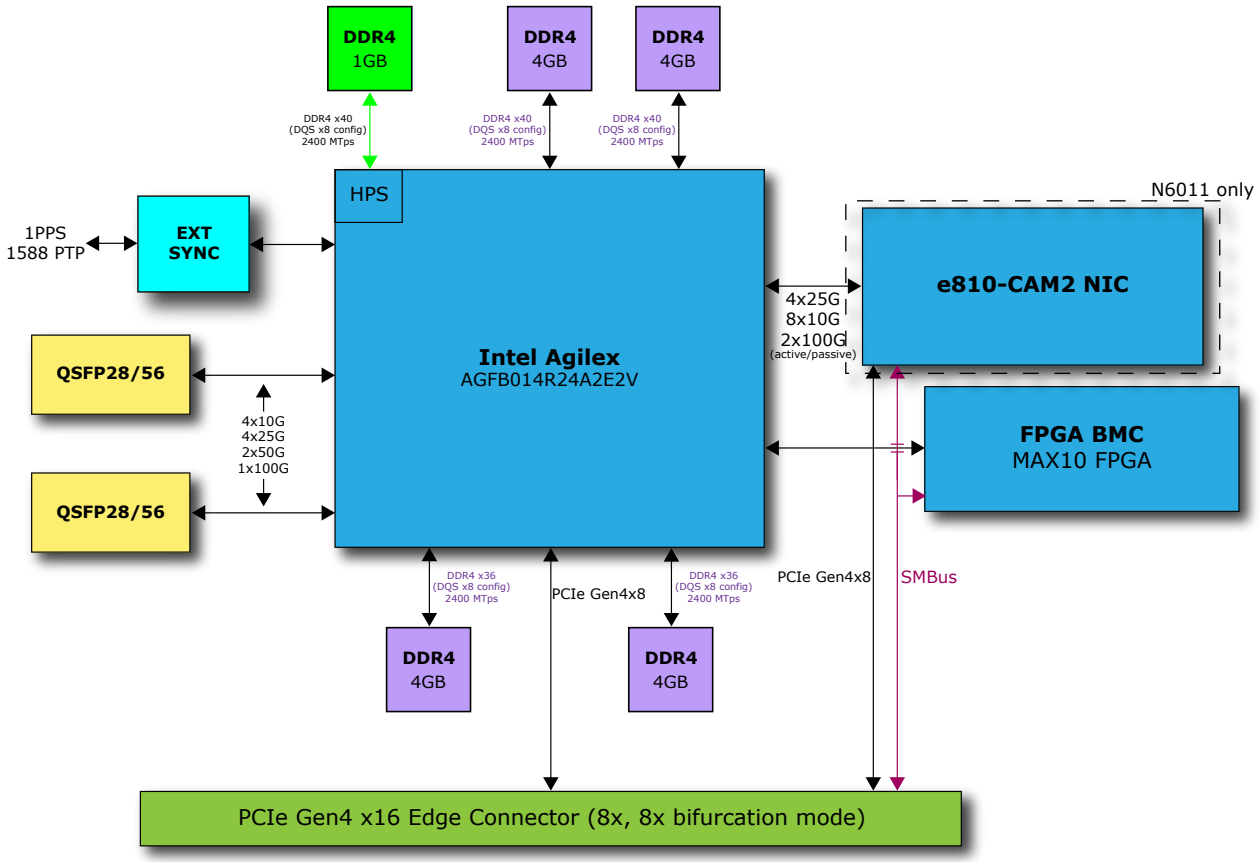


Figure 5 N6010/N6011 High Level Block Diagram

USE CASES

While the focus of this solution brief is vRAN use case, the N6010/N6011 SmartNIC is designed to address NFV use cases such as: vRouter, OVS and UPF. In this brief we will focus on the following use case:

FEC only

xHaul* with FEC

What are the benefits?

as O-RAN continues to evolve and cell site costs decline, Silicom's N6010/N6011 is uniquely positioned to offer a platform that can lower O-DU costs by reducing the number of CPU cores and memory required for Layer 1 processing. N6010/N6011 is NEBS compliance to support Telco thermal environment requirements.

Solution

The combination of Silicom's IP and SmartNIC platform makes it much easier for vRAN solution providers to implement a complete High PHY, saving them the need to integrate and test all its modules separately. It also reduces the risk and time-to- market of a final product, while delivering the required per-user performance defined by IMT2020. Silicom's IP is designed to meet mMIMO and URLLC performance requirement in O-RAN.

Precise synchronization timing is a significant technical challenge for 5G DU deployment. LTE networks - and

Layer 1/High Phy offload

xHaul* gateway (CPRI to eCPRI)

even 5G networks on frequency-divided (FDD) spectrum - can survive a loss of synchronization of above an hour. However, on time-division duplex (TDD) spectrum, 5G requires synchronization on the order of microseconds to prevent interference. For carrier aggregation and other use cases, the time synchronization accuracy must be within 65 nanoseconds.

N6010/N6011 supports Silicom Time Sync Technology (STS) through its I/O interface enabling support for all time synchronization configurations (C1, C2, C3). Silicom STS is available in several configurations. It offers Synchronous Ethernet (G.8261, G.8262) combined with IEEE 1588 precision time protocol (PTP) and can serve as a transparent clock, boundary clock, and a grandmaster clock, accurate to the nanosecond level. It ensures synchronization within the physical and protocol layers.

*(xHaul=FH,MH,BH)

CONCLUSION

The fact that RAN functionality in MNO 5G networks has become open and virtualized brings the potential for greater agility and lower costs, but the increased integration effort makes the selection of the right hardware platform—one that offers both performance and customization—crucial. Silicom's N6011, an Open RAN platform based on open Intel® technologies, is custom designed to meet the real-time processing needs of 5G DUs. With the latest generation Intel® FPGA Agilex™, MNOs can configure N6011 for a wide range of network deployments, including urban locations that need processing power for large groups of users. Silicom has designed N6011 to be the choice of MNOs seeking a cost-effective self-contained server that bridges flexibility with simplicity.

LEARN MORE

Silicom N6010/6011 SmartNIC

Silicom Palma

Lisbon ACC100

Silicom Time Sync and Acceleration Adapters

Intel® Network Builders

Intel® Xeon® Scalable Processors

Intel eASIC devices

Intel® Agilex™ Device

https://www.rcrwireless.com/20211230/opinion/readerforum/open-ran-adoption-accelerates-in-2022-and-beyond-a-growing-ecosystem-reader-forum

https://www.pwc.com/us/5g

https://www.3gpp.org/news-events/2150-open_ran

https://www.o-ran.org/specifications

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