Universal Hardware Platform for OpenAir5G

OpenAir5G

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From BUPT

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1. Preface

1.1 The Future of Wireless Communication

- Compared to its predecessors, 5G is more than just another generational leap, It will go well beyond the current mobile experience, with 1000X network capacity for 100X the number of connected devices and machines—all the while connecting to a more diverse set of end-user applications.

- To meet these requirements, 5G is looking to employ existing and potentially technologies , such as Massive MIMO along with new deployment scenarios like cloud-based RAN, yet still remain a cost-effective solution for practical implementation.

- A likely deployment scenario for 5G is a cloud-based radio access network, or C-RAN, that employs a centralized datacenter-like architecture for baseband processing of a larger number of remote radio heads.
- But while the demands of 5G are sure to be enormous, the specific technologies that will be used to meet these demands still remain uncertain.

1. Preface

1.2 Challenges of 5G

With the Internet of Things approaching, the number of wireless connected devices is set to explode, and a diverse set of connectivity types will be needed for a significantly larger amount of diverse applications. Because of this, 5G will require:

- Reliable data throughput from 1 Gb/s with peaks up to 20 Gb/s
- Near-zero time latency for applications such as vehicle-to-vehicle communication
- Support for reliable massive capacity for wireless machines nearing the hundreds of billions
- Flexibility in data rates and duty cycles for different applications

1. Preface

1.2 Challenges of 5G

As of now, there are a myriad of proposed solutions and technologies to meet the challenges of 5G.

These include:

- Cloud-based radio access networks, or virtualized RAN
- More advanced solutions in multiple access and coding/modulation schemes
- New baseband and RF architectures
- New beamforming techniques
- Advanced RF domain processing for efficient and flexible use of spectrum

1. Preface

1.2 Challenges of 5G

However, it is uncertain which combination of these technologies will provide the most complete and cost-effective solution for the demands of 5G.

For those reasons above, we design some universal hardware platforms helping designers to develop and verificate their 5G applications.

These Platforms provide a flexible, standards-based solution that combines soft-ware programmability, multi-standard and multi-band hardware optimization, and any-to-any connectivity with the security needed for 5G networks.

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2. Universal Platform for Baseband Unit(BBU)

2.1 Hardware Specifications

- CPU：Intel X86，16 cores，2.0GHz
- Memory：16GB DDR4, 2400M
- SATA SSD：16GB
- FPGA1, FPGA2：Xilinx ZU21DR；

  PS memory：2GB DDR4 , 2400M；PL memory：2GB DDR4, 2400M
- FPGA3：Xilinx VU9P ； memory：6GB DDR4, 2400M
- Clock：GPS or OCXO , 1588v2.
- Interconnect：

  CPU and FPGA：PCIe 3.0，X4；SGMII X1；

  FPGA and FPGA：25G Arura X8；
- 14 SFP28 optical interfaces

2. Universal Platform for Baseband Unit(BBU)

2.2 Supported verifications of 5G functions

- Flexible CU/DU partition in C-RAN architecture.
- Flexible PHY layer and high layers split between the BBU and RRU.
- Emerging SDN/NFV network infrastructure.
- Delivering the dynamic balance of hardware/software processing .

2. Universal Platform for Baseband Unit(BBU)

2.2 Supported verifications of 5G functions

- Integrated Soft-Decision Forward Error Correction (SD-FEC) hardware cores.
- LDPC codec (SD-FEC) to meet 5G standards and support for custom codes.
- Flexible, high performance connectivity for 10G eCPRI/GbE and expansion into 16G & 25G CPRI in fronthaul.
- Signal/packet processing hardware accelerators in backhaul.

2. Universal Platform for Baseband Unit(BBU)

2.2 Supported verifications of 5G functions

- 10GbE and expansion into 25GbE in backhaul.
- uWave wireless backhaul and fronthaul with radio card.
- Physical layer and high layers workload acceleration.
- Mobile Edge Computing (MEC) functions.
- Many Cards can be centralized to a a large pool of processing resources that accomplish the virtualized NodeB functionalities.

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3. Universal Platform for Remote Radio Unit(RRU)

3.1 Specifications

- CPU: ARM9/ ARM contex A53(SOCs)
- DDR: DDR3/DDR4 2GB
- OS: Linux
- FPGA: Xilinx K7 / k7U / RFSoc (future)
- Frequency : below 6G
- Output power: 33 dBm/antenna
- RF bandwidth: 100M/200M(future)
- MIMO: 4Tx&4Rx

- The RRU platform along with the BBU platform above, comprise of a complete verification platform for 5G applications.

3. Universal Platform for Remote Radio Unit(RRU)

3.2 Functions

- L1 partial beamforming to reduce fronthaul throughput to baseband
- Flexible 10GbE/eCPRI expansion to 16 or 25Gb CPRI fronthaul
- Flexible L1 and high layers partitions along with BBU platform.
- TDD and FDD support.
- CPRI IQ Compress/Decompress.
- L1 Offload and acceleration.
- Radio Digital Front-End (DFE) include:
  Digital Up Conversion (DUC)
  Digital Down Conversion (DDC)
  Crest Factor Reduction(CFR)
  Digital PreDistortion (DPD)

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4. Accelerate Cards

In early development of 5G, the researchers establish their prototyping systems by multi-core general purposed processors (GPPs) (e.g. intel X86 processors) to rapid verify their systems.

But the GPPs usually do not have hardware accelerators and appropriate interfaces for 5G verifications.

So we design the Acceleration cards to satisfy the needs of 5G development verification with the GPPs.

4. Accelerate Cards

4.1 Specifications

- CPU: ARM9/ ARM contex A53(SOCs)
- DDR: DDR3/DDR4 2GB
- OS: Linux
- FPGA: Xilinx K7 / k7U/Zynq
- Interface: PCIE/10GbE/25GbE
- Clock reference: GPS/OCXO/TCXO

4. Accelerate Cards

4.2 Functions

- Supporting hardware acceleration for L1 and high layers, signal or package processing acceleration.
- PCIE2/PCIE3 X4 interface to the GPPs for high speed data transport.
- 4 optical module interface for CPRI fronthaul and backhaul.
- Flexiable partitions of L1 and high layers between BBU and RRU.
- The bridge from GPPs to other cards(e.g. Radio cards).

The Ending

Our hardware platforms offer an ideal platform to realize split Layer 1 processing, flexible 10GbE/CPRI connectivity and signal/packet processing hardware accelerators in the fronthaul and backhaul and dynamic hardware acceleration for virtualized network functions in the baseband pool of 5G C-RAN applications.