DU vRouter

One of the biggest differences between 5G and 4G architectures is the separation of the traditional cell tower base station into separate Radio Unit (RU), Distributed Unit (DU), and Centralized Unit (CU) nodes within the Cloud Radio Access Network (C-RAN). The DU is primarily responsible for aggregating and parsing traffic from the RU and then forwarding that traffic on to CU.

This seems like a simple task, but in the C-RAN architecture, that forwarding requires a router to send the traffic to any number of different CUs that are located throughout the 5G access network. The addition of a cell site router (CSR) to the data path increases both capital and operating expenses.

Solution Highlights

- Router-on-FPGA-NIC saves physical space, power consumption, and CPU cores
- Eliminates need for cell site routers
- L2 traffic management and L3 routing in a single compact card
- Fully integrated vRouter software or third-party software offload via DPDK APIs
- Integrated Ethernet controller – no need for ASIC-based DMA
- Flexible configurations

A better option would be to incorporate virtual routing (vRouter) software into the DU server. Most mobile operators intend to employ the concept of Network Function Virtualization (NFV) and use disaggregated NFV software to handle the primary DU functions of Hi PHY, MAC, and RLC in software, which will take up the vast majority of the server's CPU cores, leaving no capacity for a vRouter.

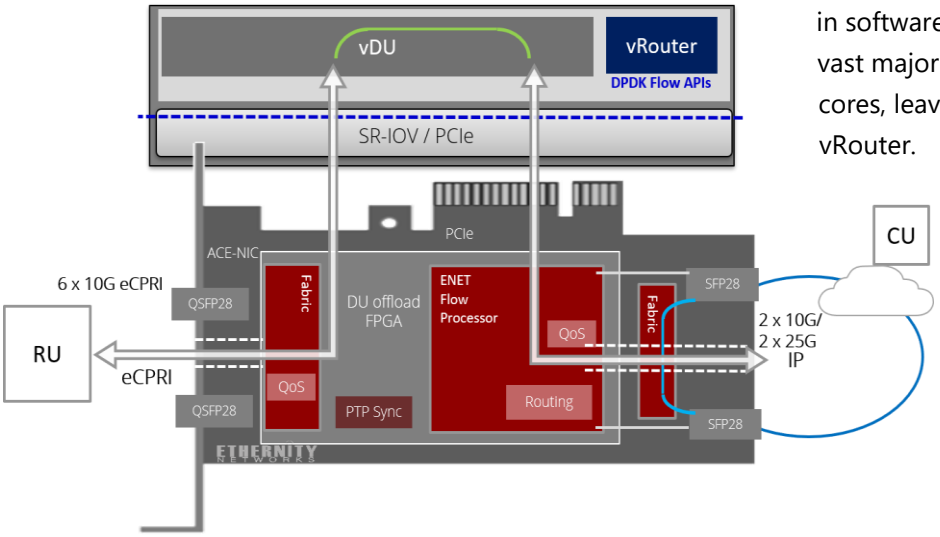

Figure 1: Ethernity's DU vRouter offload solution using the ACE-NIC100 FPGA SmartNIC

Ethernity Networks, therefore, offers its DU vRouter solution, which utilizes its ACE-NIC100 FPGA SmartNIC in place of a standard NIC in the DU. The ACE-NIC100 offers Ethernity's fully integrated Router-on-NIC software capabilities or, alternatively, full 3rd-party vRouter offload (using DPDK), to eliminate the need for cell site routers within the 5G C-RAN network for DU to CU connectivity.

A single ACE-NIC100 can aggregate up to 150Gb of data arriving from the RUs through six 10G/25G eCPRI ports and can then provide 25Gbps of routing in a ring topology toward the CUs. The ACE-NIC offers mandatory clock synchronization, as well as standard DU traffic management features of packet classification, buffering, and OAM, and then adds routing features such as L2/L3 VPN and MPLS.

Ethernity's Unique Router-on-NIC

Both traditional routers and virtual routers use network protocol software to calculate forwarding rules. While a physical router uses a dedicated packet processor in hardware to forward traffic, a virtual router performs the same forwarding functions in a software instance. Virtual routers typically run on commodity servers, and usually come alongside other virtual network functions.

In contrast, Ethernity offers FPGA SmartNICs with Router-on-NIC that contain true packet processing and forwarding capabilities of a physical router implemented on an FPGA-based network interface card. It includes all standard NIC functionality and delivers all the benefits of a traditional router. This unique, compact offering is enabled by Ethernity's patented packet processing and traffic manager design ported onto an FPGA.

Ethernity's Router-on-NIC feature provides a high-performance router data plane that is ideal for any application requiring the agility of a virtual router with the performance of a physical router appliance.

Carrier Ethernet Switch Router

Ethernity's patented ENET Flow Processor is embedded in the FPGA on the ACE-NIC100 and offers comprehensive traffic management, including Carrier Ethernet Switch/Router, 3-level Hierarchical-QoS shaping, packet classification, buffering, policing, OAM/CFM, and IEEE 1588 PTP time sync.

Truly Disaggregate the 5G Network

FPGAs are programmable hardware that is optimized to handle networking and security traffic, which can be incorporated in a white box edge device such as a DU server by way of a SmartNIC.

FPGA SmartNICs like the ACE-NIC100 are an ideal platform for truly disaggregating hardware at the network edge, continuing the trend that was begun with NFV. FPGAs perfectly address the concerns regarding the use of proprietary ASIC-based hardware platforms, while also improving performance, avoiding vendor lock-in, and futureproofing the network, thereby saving on long-term operating expenses and reducing total cost of ownership.

Utilizing Ethernity's ENET-D DMA

ENET-D is Ethernity's implementation of an Ethernet adapter and DMA engine for PCIe, eliminating the need for a proprietary ASIC serving as the Ethernet controller, to allow complete disaggregation of the Ethernet controller on an FPGA SmartNIC.

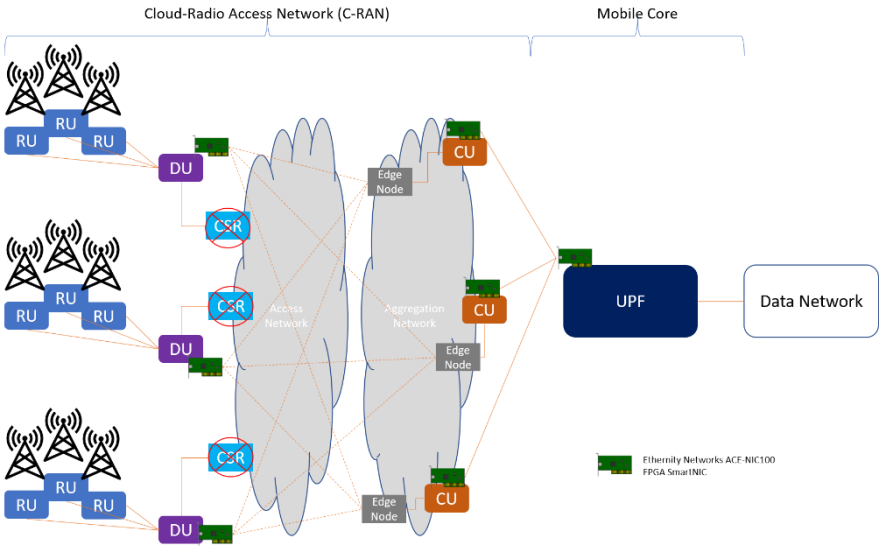

Figure 2: FPGA SmartNICs can be used throughout the 5G architecture for aggregation and offloading of CPU-intensive functionality. Only Ethernity's ACE-NIC100 also offers virtual routing directly on the NIC.

The ENET-D can be combined with Ethernity's ENET Flow Processor and run on Ethernity's cost-optimized and affordable ACE-NIC100 FPGA SmartNIC to deliver Router-on-a-NIC with integrated Ethernet controller, capable of connecting to multiple virtual machines, containers, or virtual networking functions.

Specifications

Interface
- Jumbo Frames (>9600 bytes)
- Broadcast Storm Protection
- RMON

Ethernet/Carrier Ethernet
- 802.3 Bridging
- Hardware MAC Learning
- 802.1Q VLANs
- 802.3ad LAG
- 802.1ad QinQ
- Provider Bridging
- Ring & Path Protection
- MEF CE 1.0/2.0 Compliant
- E-Line, E-LAN, E-Tree, E-Access
- MEF 9,10 & 14

IP Routing/Gateway
- IPv4 / IPv6 Routing
- NAT/NAPT
- Virtual Routers
- Policy-Based Forwarding
- VRRPv2/v3
- ECMP

Multicast Routing
- IPv4/IPv6 Multicast
- IGMP v1/v2/v3
- MLDv2

MPLS
- MPLS LER/LSR
- Segment Routing
- L2/L3 VPN
- Seamless MPLS

L2/L3 VPN & Tunneling
- GRE/NVGRE
- VxLAN
- PPPoE/L2TP/L2TPv3

Quality of Service (QoS)
- Deep Packet Buffering
- Hierarchical Queuing/Shaping
- Strict Priority Queuing
- Weighted Fair Queuing (WFQ)
- WRED
- Policing (1r3c, 2r3c)
- 802.1p
- PFC
- DiffServ
- MPLS EXP Bits

OAM
- IEEE 802.1ag Connectivity Fault Management
- ITU-T Y.1731 (DM, SLM, and Throughput)
- IPv4/IPv6 BFD
- TWAMP Initiator/Reflector
- Ingress Port/Flow Mirroring
- Egress Port/Flow Mirroring
- NetFlow/sFlow Statistics

Sync and TSN Support
- 802.1CM-2018 TSN for Fronthaul
- 802.1AS Timing and Synchronization
- 802.1Qav
- 802.1Qci
- 802.1Qcr

Security
- Multi-tuple ACLs
- DDoS attack detection

SW Package
- ENET SDK including driver, CLI and Hal (HW abstraction layer), and DPDK APIs
- Ethernity vRouter SW package (optional)

System Configurations Proposed

1 x ACE-NIC100	6 x 10G interfaces 2 x 10G/25G interfaces in ring topology
2 x ACE-NIC100	6 x 10G interfaces 4 x 25G interfaces 2 x 10G/25G interfaces in ring topology