FLEXCRAN: Cloud Radio Access Network Prototype using OpenAirInterface

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Abstract—**In this demo, we describe the realization of cloud radio access network (C-RAN) prototype using OpenAirInterface (OAI) software and commodity hardware. The deployment of the centralized baseband processing on the remote cloud center (RCC), and the remote radio units (RRU), connected over Ethernet fronthaul is demonstrated. Further, the demo illustrates the flexibility in deploying several cellular radio access network protocol split architectures using OAI.**

I. Introduction

Cloud or Centralized radio access network (C-RAN) is an innovative cellular network architecture where the traditional base station functionality is split into baseband processing units (BBUs), that are pooled in a cloud data center, and remote radio heads (RRHs), that are present at cell sites. C-RAN has drawn significant attention as the emerging architecture of future generation cellular networks, due to its noticeable performance benefits for cellular operators [1]. In C-RAN, each RRH will forward the user information to the central cloud processor (BBU pool) using high bandwidth, low latency fronthaul link, and thereby relies on the BBU pool to perform the compute intensive baseband functions. Cellular operators can achieve reduction in the CAPEX and OPEX through efficient and scalable cloud-based solutions for BBU pool that serves a set of geographically distributed RRHs.

From the network implementation perspective, the BBUs are pooled in a data center and run using virtual machines (VMs) on physical cores using hypervisor technology, or as separate containers on top of the host operating system [2]. These VMs or containers adaptively share the processing resources depending upon the non-uniform traffic load experienced at RRHs. Apart from network virtualization, centralization also enables practical implementation of cooperative communication across RRHs.

Traditional C-RAN architecture make use of CPRI/OBSAI [4], [5] to carry transport (radio samples) and synchronization information between RRHs and BBU. However, CPRI based deployments does not meet the scalability and performance requirements towards realizing 5G network architecture. Next Generation Fronthaul Interface (NGFI) [6] redefines the fronthaul transport network architecture, and the baseband processing split between BBU and RRHs to meet performance requirement targets for future cellular networks. According to NGFI terminology, BBU is redefined as radio cloud center (RCC), and RRH is known as remote radio unit (RRU) due to increasing functionality retained at cell sites. This also alleviates the tight requirements on the fronthaul transport network. This architecture is illustrated in Fig. 1. In this demo, we show a prototype implementation of NGFI based C-RAN architecture.

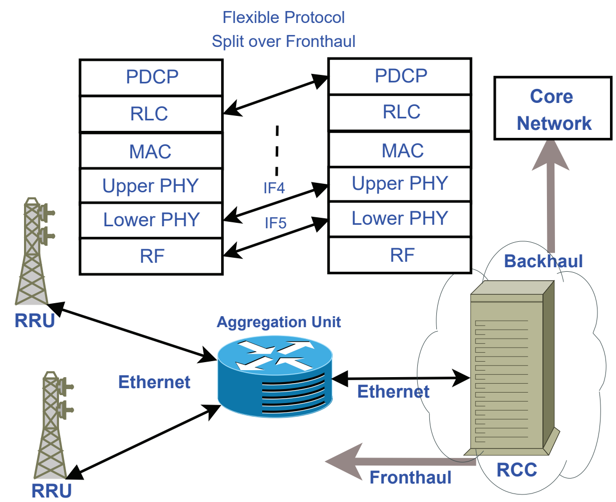

Fig. 1. NGFI based C-RAN architecture with protocol splits

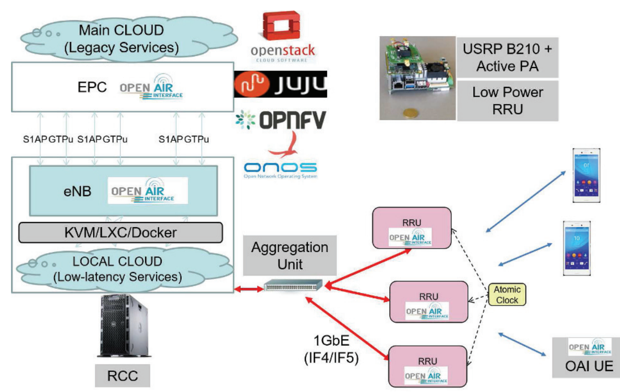

Fig. 2. C-RAN features realized using OAI software [3]

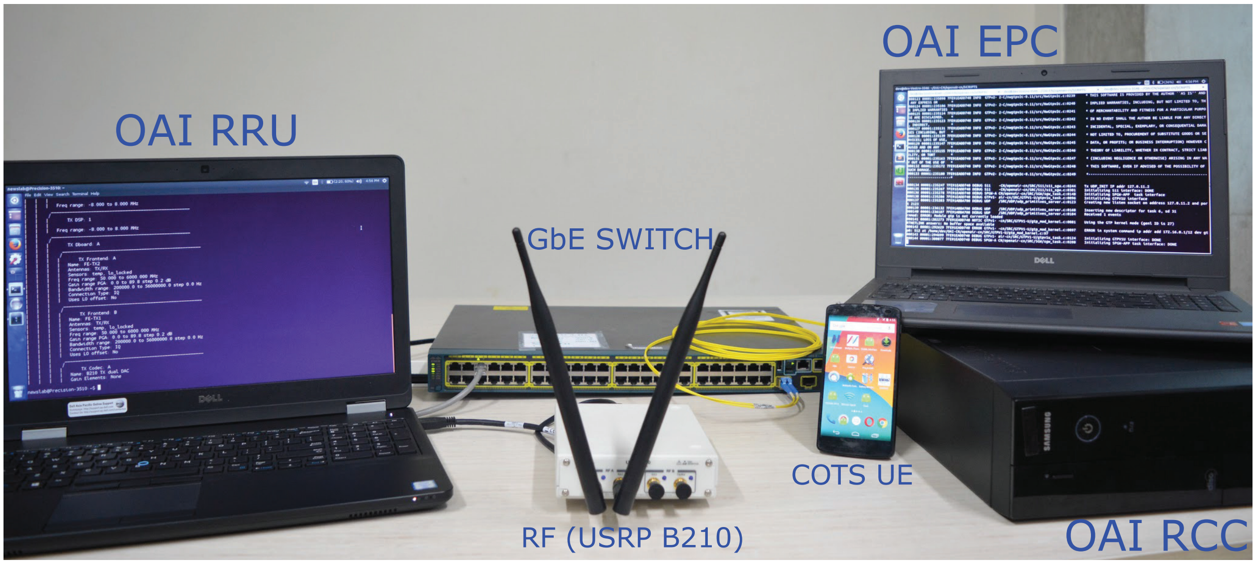

Fig. 3. C-RAN demo setup

II. Demo Description

Several C-RAN features that can be realized using OpenAirInterface (OAI) software [3] and NGFI based C-RAN architecture are illustrated in Fig. 2. OAI is an open-source and 3GPP standards compliant software implementation of LTE and LTE-Advanced features. In this demonstration, we propose to show some of these realizable features of C-RAN using OAI and commodity hardware. The RCC is deployed on a commodity Intel x86 PC and connected to RRUs deployed on commodity Intel x86 PCs through a Gigabit Ethernet (GbE) switch. Please note that, although we can use OAI software and orchestration tools to deploy the baseband processing functions on powerful server grade machines, for the purposes of this demonstration, a scaled down setup as shown in Fig. 3 will be used.

The RRU which is also realized on an Intel x86 PC is connected with commodity RF front-end devices such as USRP B210/B200mini. The RCC-RRU exchange packetized I/Q samples over raw Ethernet or UDP over the GbE fronthaul link. Two possible LTE eNodeB protocol splits are realized across RCC-RRU running the OAI lte-softmodem using openairinterface5g [7]. They are summarized as follows.

1) Time-domain I/Q split (IF5): RCC and RRU exchange time-domain I/Q samples as Ethernet packets across the fronthaul link.
2) Frequency-domain I/Q split (IF4): RCC and RRU exchange frequency-domain I/Q samples across the fronthaul link. In this split architecture, RRUs perform some of the lower PHY layer processing, namely FFT/IFFTs. Additionally, A-law compression is employed on the I/Q data that is transported across the Ethernet fronthaul links. This reduces the fronthaul link capacity requirement to $\approx$28% of the time-domain I/Q split case. Hence, a 20 MHz RRU can be provisioned using 1 GbE link between RRU and RCC.

The core network functional components i.e., S/P-GW, MME and HSS, are also realized using openair-cn [8]. Commercial off-the-shelf (COTS) mobile client (LG Nexus 5 in Fig. 3) is used to test the functionality of the C-RAN prototype.

Through experimental results (not shown here due to lack of space), it is verified that the strict latency constraints on the fronthaul are satisfied by commodity Ethernet hardware. It is also shown that the compression scheme employed across the fronthaul transport does not cause any noticeable throughput degradation.

III. Conclusions

In this demo, we presented a C-RAN prototype developed using OAI software and commodity hardware. Further, the demo illustrated the potential for using OAI to experiment with future cellular network architectures.

Acknowledgement

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