Cloud Radio Access Network (C-RAN): A Step Towards a 5G Wireless Network

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Goal

Proving via demonstration that C-RAN more efficiently utilizes computing and communication resources (CPU, RAM, I/O, etc) than a traditional mobile network (RAN) through the concept of *virtualization and dynamic allocation of resources* [1]

Motivations and Objectives

Motivations

- Current cellular networks are ineffective in dealing with dynamic data demand (e.g., due to the so-called *tidal effect* [2])
- Ever increasing need for network bandwidth in order to (i) support multimedia traffic and (ii) give access to more and more users
- Reduced power consumption (“towards green comms”) and ease of upgradability to future wireless standards

Objectives

- Develop a testbed using Universal Software Radio Peripheral (USRP) boards in conjunction with OpenBTS to dynamically allocate resources based on traffic utilization
- Compare resource utilization with varying traffic loads between a conventional wireless cellular network architecture *(Traditional RAN)* and a *C-RAN*

Research Challenges

- Setting up a base station (BS) in a virtual environment (BS → VBS)
- Methods for generating realistic traffic (voice, data)
- Configuring SIM cards for use with OpenBTS
- Dynamically allocating necessary resources to Virtual Machines (VMs)
- Real-time profiling of the (computing and communication) resources used by the VMs

Acknowledgement

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Methodology

- Configuring GNURadio and the Ettus USRP Hardware Driver (UHD) to enable the USRPs to transmit/receive data
- Dynamically allocating resources to the VBSs through VMware Workstation
- Configuring OpenBTS on the VBSs to create a C-RAN
- Compare power consumption between Traditional and Cloud RAN

```
OpenBTS> tmsis
IMSI            TMSI IMEI            AUTH CREATED ACCESSED TMSI_ASSIGNED
310260668964407 -    356706055330410 1    21s     21s      0
311480018932664 -    990001201811350 1    5m      170s     0
001012345678901 -    355477047109030 1    286s    170s     0
```

Results

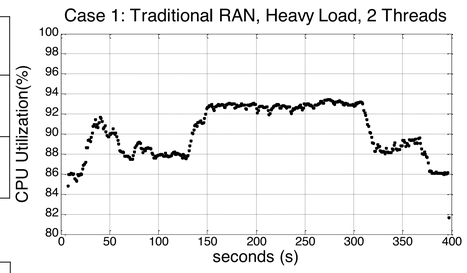
Traditional RAN

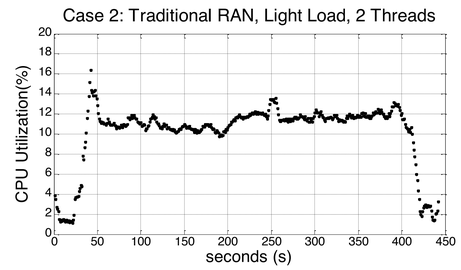
	Power Usage	CPU Utilization	Resource Utilization
Case 1	78.75W	77.47%	1.23GB, 2 Threads
Case 2	65.06W	10.13%	1.26GB, 2 Threads

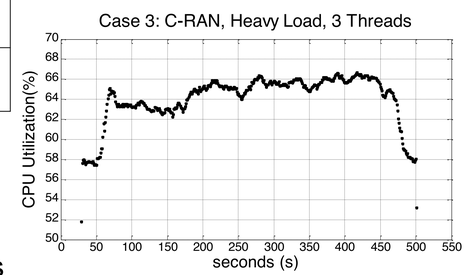
C-RAN

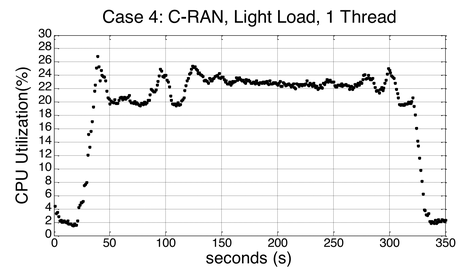
Case 3	82.31W	57.04%	1.13GB, 3 Threads
Case 4		18.85%	1.12GB, 1 Thread

- In the Traditional RAN 143.81W is consumed, while only 82.31W is consumed in the C-RAN
- Preliminary results show potential benefits of deploying a larger C-RAN









Future Work

- Upgrade testbed network from GSM to LTE by switching to OpenAirInterface
- Configure SIM cards to work with OpenAirInterface
- Upgrade VMware Workstation to VMware vSphere for dynamic memory and CPU utilization

References

[1] D. Pompili, A. Hajisami, H. Viswanathan, “Dynamic provisioning and allocation in Cloud Radio Access Networks (C-RANs),” *Ad Hoc Networks (Elsevier)*, vol. 30, pp. 128-143, July 2015

[2] A. Hajisami, H. Viswanathan, and D. Pompili, “Cocktail Party in the Cloud: Blind Source Separation for Co-operative Cellular Communication in Cloud RAN,” Proc. of *IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS)*, Philadelphia, PA, Oct. 2014