FED4FIRE

Federation for FIRE Plus

Energy-aware Autoscaling of Virtualized Radio

Access Networks(V2GRAN)

Call identifier: F4Fp-08

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FEC11 Experiment Review

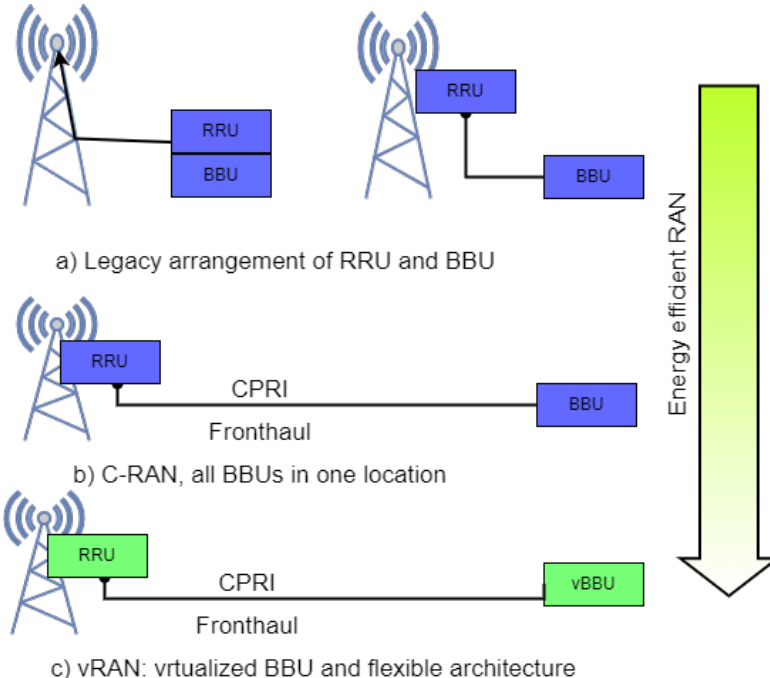*Online, 1905/2022*

OUTLINE

- Experiment Description
    - Concept and objectives
    - Background and motivation
    - Experiment set-up
- Project Results
    - Measurements
    - Lesson learnt
- Business Impact
    - Impact on Walton Institute
    - Impact on Experimenter/researcher
- Feedback

Experiment description

Concept & Objectives

EVOLUTION TOWARDS VRAN

a) Legacy arrangement of RRU and BBU

b) C-RAN, all BBUs in one location

c) vRAN: vrtualized BBU and flexible architecture

PROJECT OBJECTIVES

- Providing more felxibility and scalability to RAN

- Migration of vBBU to a new geographical location

- Improving energy efficiency

- Automation of vBBU scaling using graph neural network

Background & Motivation

BACKGROUND

Results gathered by V2GRAN will help stimulating new ideas and improving existent solutions for energy consumption in the cellular network, particularly Radio Access Network of 5G and B5G network.
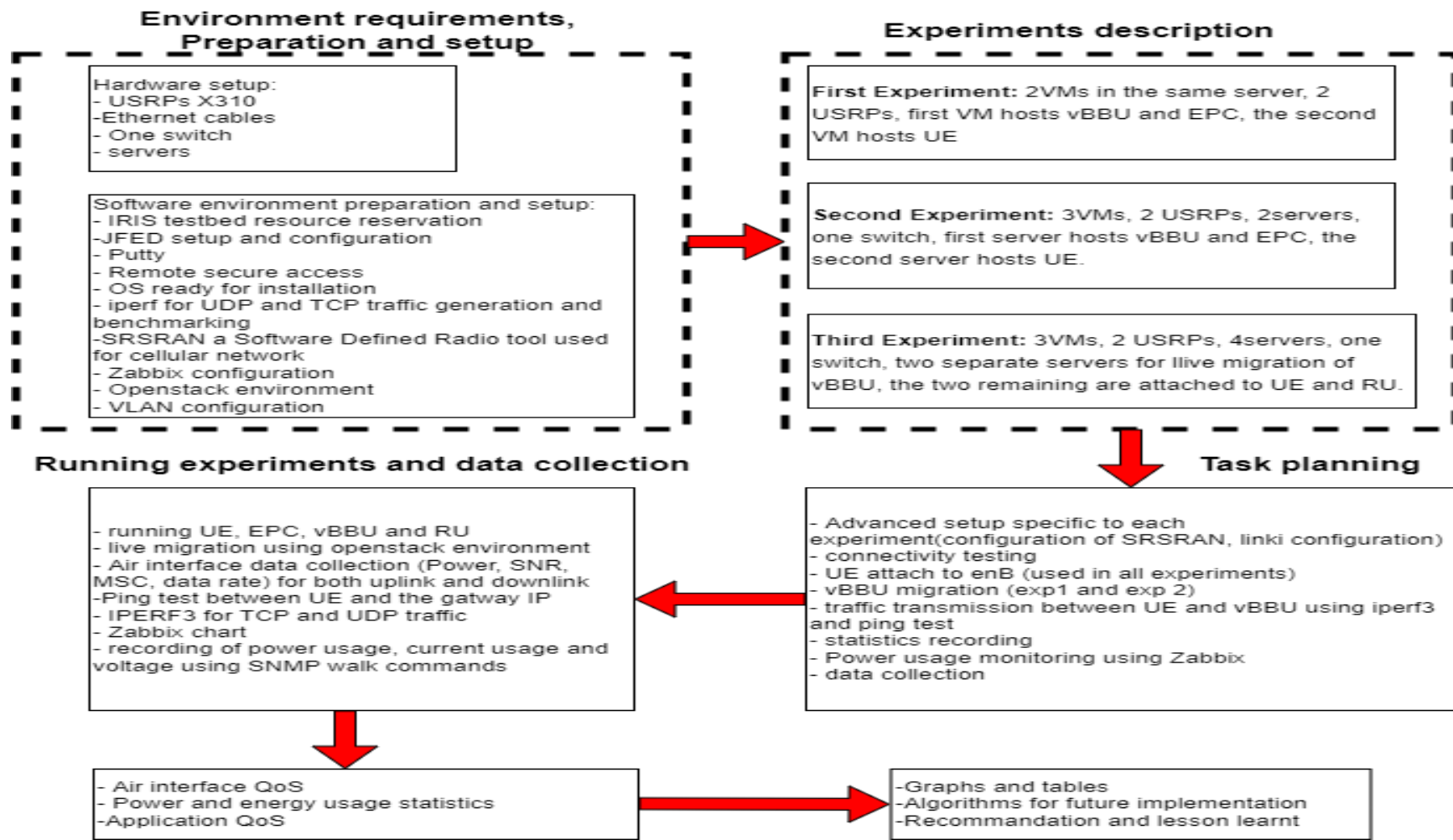
Based on results of V2GRAN we will boost our activities in modelling ext generation network such as B5G and 6G

Supporting energy aware procedures

MOTIVATION

- Ropose a feasability study of BBU migration

- Add more flexiblity to vBBUs in vRAN

- Reduce energy consumption without impact on QoS

FLOWCHART OF EXERIMENT SETUP AND TESTS

Environment requirements, Preparation and setup

Hardware setup:
- USRPs X310
- Ethernet cables
- One switch
- servers

Software environment preparation and setup:
- IRIS testbed resource reservation
- JFED setup and configuration
- Putty
- Remote secure access
- OS ready for installation
- iperf for UDP and TCP traffic generation and benchmarking
- SRSRAN a Software Defined Radio tool used for cellular network
- Zabbix configuration
- Openstack environment
- VLAN configuration

Experiments description

First Experiment: 2VMs in the same server, 2 USRPs, first VM hosts vBBU and EPC, the second VM hosts UE

Second Experiment: 3VMs, 2 USRPs, 2servers, one switch, first server hosts vBBU and EPC, the second server hosts UE.

Third Experiment: 3VMs, 2 USRPs, 4servers, one switch, two separate servers for llive migration of vBBU, the two remaining are attached to UE and RU.

Task planning

- Advanced setup specific to each experiment(configuration of SRSRAN, linki configuration)
- connectivity testing
- UE attach to enB (used in all experiments)
- vBBU migration (exp1 and exp 2)
- traffic transmission between UE and vBBU using iperf3 and ping test
- statistics recording
- Power usage monitoring using Zabbix
- data collection

Running experiments and data collection

- running UE, EPC, vBBU and RU
- live migration using openstack environment
- Air interface data collection (Power, SNR, MSC, data rate) for both uplink and downlink
- Ping test between UE and the gatway IP
- IPERF3 for TCP and UDP traffic
- Zabbix chart
- recording of power usage, current usage and voltage using SNMP walk commands

- Air interface QoS
- Power and energy usage statistics
- Application QoS

-Graphs and tables
-Algorithms for future implementation
-Recommandation and lesson learnt

TOOLS USED@ IRIS TESTBED

	installation	configuration	Testing
JFED and PUTTY	Installation of JFED and PUTTY	- Configuration SSH and secure remote access - Configuration of PUTTY, secure access, - Creation of RSPEC and setting up duration of experiments	- Access to VMs - Running experiments - remote access to collected data
SRSRAN	Installed on VM, it includes srsue, srsenb and srsepc	Configuration performed by accessing the following config files: - Ue.config - eNB.config - epc.config to access and change, the command vi /etc/srsran/element.conf is used for more stability of RF frontend a number of RB=25 is used	On VM vBBU: launching - Srsepc - Srsenb - Tracing using t command On UE VM Launching - srsue - tracing using t command - recording of message flows on UE, eNB and EPC
Iperf3	Installed on both vBBU VM and UE VM(server and client)	Command lines to generate traffic	-Generation of UDP or TCP traffic -Benchmarking at both side server and client iperf3 -s iperf3 -c 172.16.0.1 -u -b 0.5m -t 20 (example of UDP traffic)
snmpwalk	apt-get update && apt-get install snmp snmpd snmp-mibs-downloader	Make SNMP listen to all interfaces	Selection of OID relatives to power consumption. snmpwalk -v2c addr -c public OID
Output results		- Manual when relevant - automated in some tests	command |& tee -a output.txt is used when experiment start to show and store results. Results will copied to the remote machine using SCP command

Prject results

3 expriments
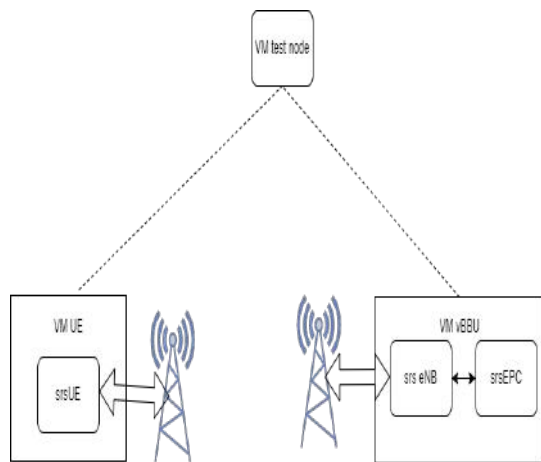
First Experiment:
testing srsRAN, iperf3
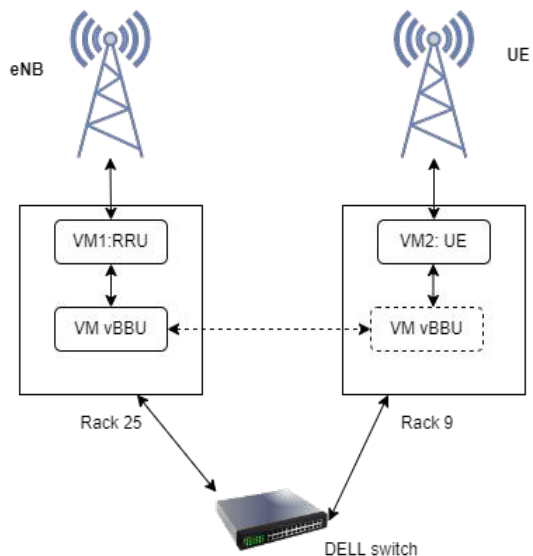
Second Experiment:
migration of vBBU
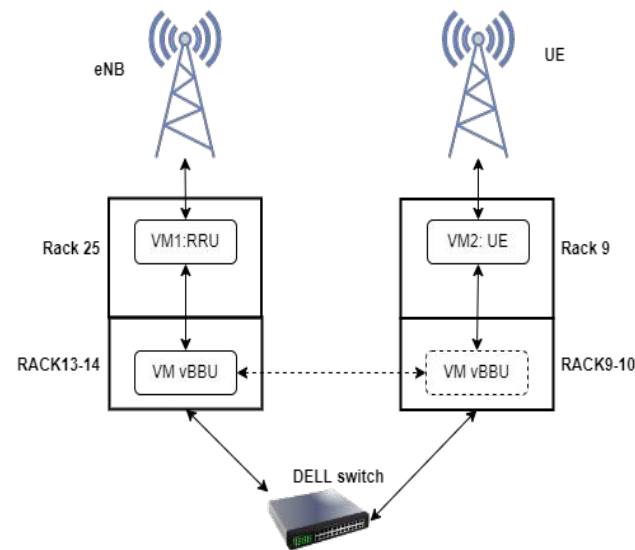
Third experiment
Migration of vBBU

Project results

COLLECTED DATA

Data collected	Description
EPC data	Messages showing all messages flow from the the initiation of EPC located at vBBU VM to the UE detach, the detach can be caused due to the vBBU migration or a normal detach
eNB data	- eNB message: configuration, random access, link failure, link re-establishment - DL: Radio Access Technology(RAT), Radio Network Temporary Identifier (rnti), Cell Quality Indicator (cqi), Modulation and Coding Scheme (mcs), bit rate(brate), frames ok frame nok, Block Error Rate (BLER) (%) - UL: Physical Uplink Shared Channel (pusch); Physical Uplink Control Channel (pucch), power headroom (phr) mcs brate , frame ok, frame nok, BLER (%) Buffer Status Reporting(bsr) PHR= UE Max Transmission Power – PUSCH Power
- UE data	- Signal characteristics and frequencies: cc, pci, rsrp, pl, cfo - DL: mcs, Signal To Noise Ratio (snr), iter, brate, bler, ta_us - UL: mcs, buff, brate, bler
UDP transmission statistics	Data collected using IPERF tool, by setting up a traffic generator, and transmission : Instantaneous data rate, jitter, packet loss
Ping statistics	Ping test performed to test connectivity between UE and SPGW, delay metrics reflect the impact of migration on network QoS
SNMP statistics of power usage	Used to collect attributes for power consumption, collected data from servers are: - powerUsageTable: 1.3.6.1.4.1.674.10892.1.600.60 - powerUsagePeakWatts: 1.3.6.1.4.1.674.10892.1.600.60.1.9 - powerUsageIdlePower: 1.3.6.1.4.1.674.10892.1.600.60.1.15 - powerUsageMaxPotentialPower: 1.3.6.1.4.1.674.10892.1.600.60.1.16 - powerUsageInstantaneousHeadroom: 1.3.6.1.4.1.674.10892.1.600.60.1.20 - powerUsagePeakHeadroom: 1.3.6.1.4.1.674.10892.1.600.60.1.21

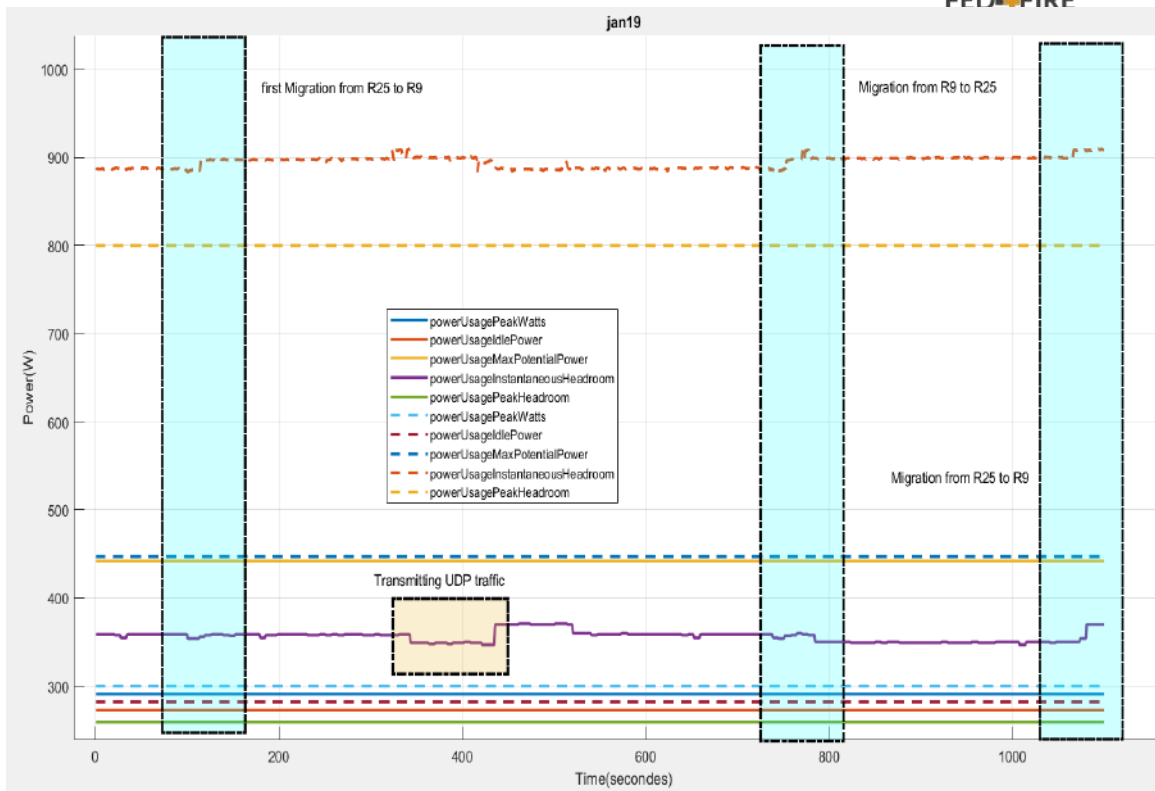# Migration of vBBU in Exp2

Live igration of vBBU using openstack and seamless connectivity

Impact on Delay

WWW.FED4FIRE.EU

Migration of vBBU in Exp2
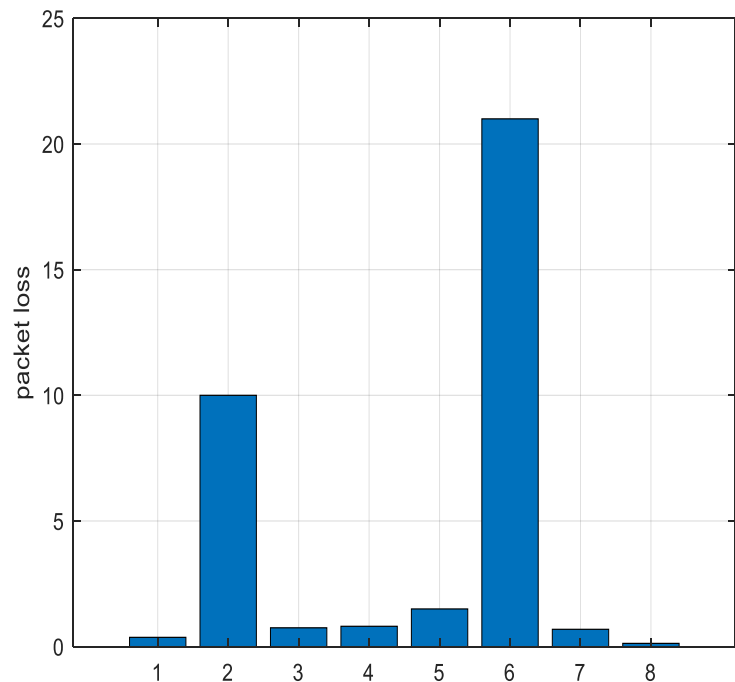
Impact on packet loss

Impact on power consumption

Migration of vBBU in Ex3

Live migration of vBBU using openstack

Migration of vBBU in Exp3
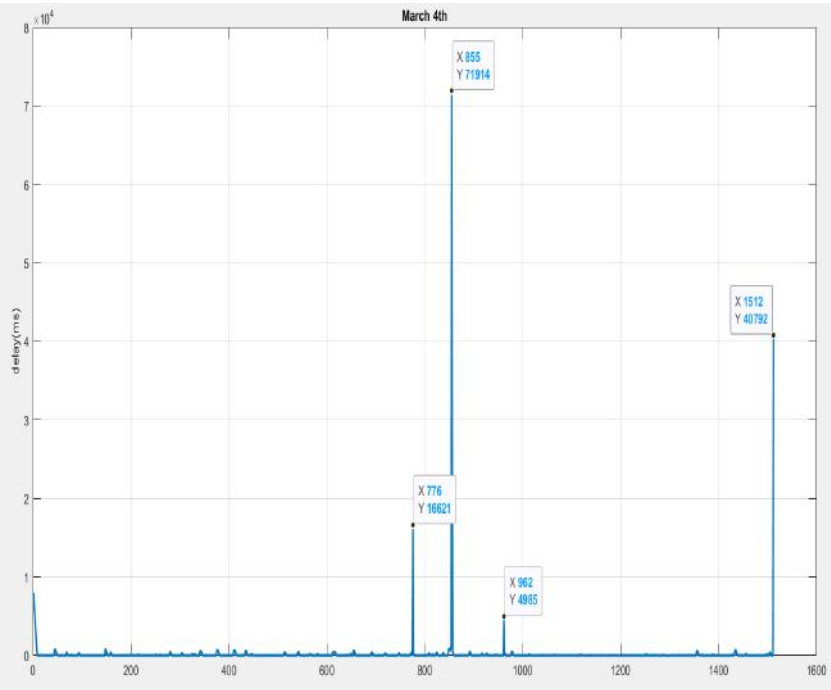
Impact on delay
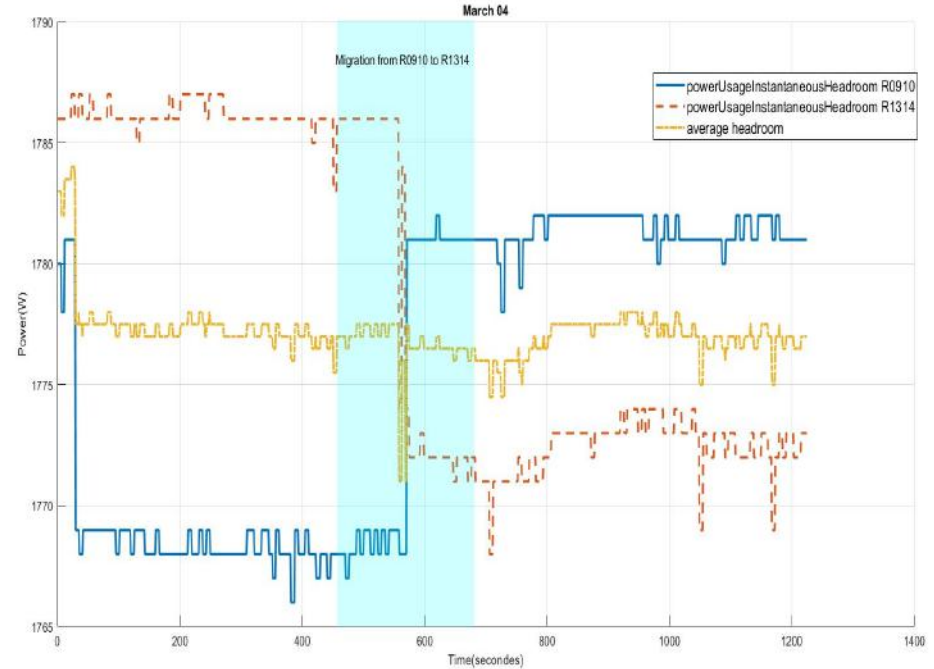
Impact power consumption

Lessons learnt

BACKGROUND

- Migration of vBBU from one locaton to a new locations proved through this project

- Advanced migration can be applied based on information collected: power consumption, CPU and memory

- Advanced algorithms based on AI can be applied to automate migration using collected data

Business Impact

Business Impact

IMPACT ON WALTON INSTITUTE

- V2GRAN project is aligned with WALTON institute objectives and research activities, results will foster researches on B5G and 6G

- Research activities in ENL division of WALTON institute focus on new emerging technologies such as 5G, B5G and 6G, V2GRAN output can help researchers developping new ideas inspired by the project and improving network simulators

- developping new wireless testbed for WALTON such as massive MIMO and wireless testbed for agriculture use case

Business Impact

IMPACT ON EXPERIMENTER

- Stimilating new ideas related to energy efficiency in RAN

- Writing papers focussing on Energy consumption and exploiting renewable energy to reduce consumption cost

- A good starting point to engage in proposals writing in the field of impact of power consumption reduction on QoS and QoE

- I joined this project as I carried previous theoretical studies on energy efficiency in RAN, now I can link between modelling and carrying experiments to validate previous studies

Feedback

Feedback

TOOLS USED

- 2 NI USRPs X310

- Ethernet switch

- 1G and 10G cables

- Servers to host VMs

- Openstack

- Zabbix

- Iperf3

- JFED for experiment virtualization

- SDR srsRAN

- Ubuntu OS

- MATLAB

https://www.fed4fire.eu/testbeds/iris/

Feedback

VALUE ADDED TO FED4FIRE

- Feasibality study, proof of concept and a good starting point to develop automatic migration using machine learning techniques

- Using new version of srsRAN as SDR, freedom of configuration and re-configuration

- FED4FIRE will be acknowledged in any paper using genrated dataset

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