Pacific Northwest
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PNNL-32754

5G Open Core Hardware

September 2021

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U.S. DEPARTMENT OF ENERGY

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Abstract

This project aimed to develop an experimentation platform for 5G using commercially available software, firmware and hardware that is being used to standup experimental 5G Stand Alone (5G SA) networks. The commercially available systems are not natively set up for experimentation design and this work would develop a system capable of performing experimentation. This platform will need to be easily reconfigurable for each experiment, capture all configurations across key equipment before running an experiment, record and store the data during an experiment and be able to recall settings and data from prior experiments while being able to emulate and replay prior experiments. This project began the process of creating this platform.

Acknowledgments

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Contents

Figures

No table of figures entries found.

Tables

No table of figures entries found.

1.0 Introduction

The AWC Innovation Studio was brought online in January of 2021 with the Verizon Network on Wheels (NOW) being its initial 5G offering. The NOW provides limited options for true experimentation because of contractual reasons and some limited technical capabilities. To fill this gap we purchased , through the RSI process, several pieces of hardware and software that needed to be configured, installed, and understood. This LDRD supported that effort and brought us to a level of capability that supported several new projects in 5G research and development.

The 5G Stand-Alone Core (5G SA) introduces a distributed architecture, network slicing and a host of optional settings within the 5G Core[1]. 5G Stand-Alone Radio Access Networks (RANs) have a host of options available to them including virtualization of 5G New Radio signal processing, the ability to support multiple cores for venue-owned infrastructure, and open interfaces to allow a mix and match of vendor equipment in deployed 5G networks[2]. Our sponsors have requirements for answering questions on how the different options regarding 5G SA and 5G RAN technologies affect network security, current policies, their ability to adopt 5G networks, and their operational missions.

The hardware, software and firmware that is purchased for the Open5GCore[3], which we are calling ALOHANet5G, are components that would be parts of typical 5G communication systems. As such they are designed for operational use instead of experimental use. Typically, for a RAN they would be configured and optimized once for a specific environment after being stood up and only reconfigured during major updates/upgrades or if there were issues. The settings of a core are developed along with the business case for an enterprise and core settings would undergo extensive testing before they would be put into a production system. To create a flexible experimental platform with components that are designed to be setup for a particular purpose we will need to develop capabilities to track settings, and make reconfiguring, snapshotting, debugging and capturing data easy for experimenters. This will enable repeatability, and the ability to analyze results with the knowledge of the settings that were used.

2.0 Progress and Implications

While we had high expectations of getting the equipment in and creating the experimental platform we were met with some key obstacles. With supply chain issues it took much longer to acquire the needed hardware and that left little time to make headway on our development plans. One key piece of hardware did not arrive until the second to last day of the FY and we spent the last day of this funding putting it together. Additionally, the systems we purchased are newly designed and built and not necessarily designed for our usage and configuration and installation took much more effort than anticipated. We were successful in getting equipment stood up and made initial advances towards an experimental platform, but more work is needed.

3.0 List of Equipment

The following is a list of equipment that was installed and is up and running in the Innovation Studio.

3.1 User Equipment

- Samsung Galaxy S20 & S21
- iPhone 12 Pro Max
- Inseego M1000
- Cradlepoint E3000
- Cradlepoint W4005
- iPad Pro 12.9
- Dell Latitude 9520
- Waveshare Pi Hat for RPi 4
- Telit FN980m w/Eval Board
- BladeRF Micro 2.0 x4/x9 w/UE
- Valid8 64 Devices UE Emulator

3.2 Radio Access Network

Airspan OpenRANGE AirVelocity 2700

- Dell R740 w/ AirSpan DU Software
- Intel R2208WFTZSR w/AirSpan CU software
- BladeRF Micro 2.0 w/ eNodeB software
- USRP x310 w/ eNodeB software
- Qu Wireless AP5G2 MIMO Antennas
- Valid8 Radio Access Emulator

3.3 4G/5G Core

- Open5GS Core (Openg5Gs.org)

- Kamailio IMS (Kamailio.org
- Valid8 5G SA Core (Valid8.com)

3.4 RF and Network Monitoring

- Keysight FieldFox N9952B up to 50GHz with 4G/5G Demodulation Software
- Keysight Infiniium MXR up to 6GHz, 8 Channel with 4G/5G Demodulation Software
- Keysight Infiniium UXR0404AP up to 110GHz with Demodulation Software
- Security Onion 2
- Rsync log server
- RSPAN on managed switches
- ESXi in promiscuous mode
- Android SDK for rooted phones
- Cradlepoint NetCloud Manager
- Software Defined Radios

3.5 Edge Compute

- Gigabyte R282-Z93 w/Tesla V100 GPU
- On-site servers
- Cloud compute connections
- Raspberry Pi 4

3.6 Additional Tools

- SIM Card Reader/Writer
- 5G Programmable SIM Cards
- TRENDnet 8 port 10GigSm art Switch
- Uniquiti EdgeRouter 6p

4.0 References

1. https://www.ericsson.com/en/blog/2019/7/standalone-and-non-standalone-5g-nr-two-5g-tracks
2. https://www.viavisolutions.com/en-us/solutions/5g-ran
3. https://www.open5gcore.org

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