Implementation of Short Message Services (SMS) Communication on 4G Networks Using Universal Software Radio Peripheral (USRP) B210 Devices

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Abstract. 4G networks are currently growing in many countries. Some of the advantages of 4G networks include superior data speeds, low latency, and greater capacity compared to previous networks. OpenBTS is a BTS technology component that utilizes software as an open source and is cost-effective, making it easy to access and implement by anyone. OpenBTS offers communication services including Short Message Service (SMS) or short messages. In addition, it can be an alternative telephone service if there is signal interference or difficulty connecting when making a phone call. In this study, the Universal Software Radio Peripheral (USRP) B210 device was used to provide short message services based on 3GPP communication standards based on 4G. The hardware used is USRP B210.

Keywords: USRP B210, OpenBTS, Short Message Service (SMS), 4G Network, LTE.

1 Introduction

Communication technology continues to evolve rapidly from the 2G to 3G era and now 4G has become the network standard used in many countries. 4G networks offer higher data rates, lower latency and greater capacity compared to previous networks. In addition, the greater network capacity of 4G technology allows more users to connect and interact on the network. With these developments, the communication experience can be expanded and enriched in ways that have never been done before [1]. Advances in communication technologies such as the internet, mobile phones and various other media have changed the way we communicate. Now, information can be exchanged and relationships can be established with others without having to meet in person.

srsRAN (Software Radio System Radio Access Network) communication is a development of mobile network architecture that focuses on centralization and centralized control. srsRAN introduces the concept of decentralization and virtualization. srsRAN supports mobile operators to build more flexible, scalable, and cost-effective networks

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by moving network functions to cloud servers, so srsRAN is very suitable to be the architecture for OpenBTS [1].

OpenBTS can be used as a RAN aggregator to manage multiple virtual RAN (vRAN) nodes in srsRAN architecture. 4G (LTE) communication with srsRAN as an OpenBTS alternative opens up new possibilities in cellular networks, especially for the implementation of open and flexible wireless networks. OpenBTS is a new part of BTS technology that is very economical both in terms of funds and resources because openBTS is based on opensource software so it is easily available, OpenBTS uses the latest supporters such as UMTS technology which is a digital system cellular phone technology (4G) [2].

A USRP (Universal Software Radio Peripheral) is a flexible radio device that can be programmed for various purposes, such as research, development, education, and experimentation. Universal Radio Peripheral (USRP) is a very affordable and highly flexible board used for Software Define Radio (SDR). This device can be used to create a very powerful wireless network prototype with the help of a Personal Computer or Laptop. USRP is made of components such as motherboards with FPGAs that can perform signal processing at high speed [3]. USRP can be used to build wireless communication devices, such as BTS (Base Transceiver Station) USRP B210. USRP B210 is a USRP device that supports 4G LTE technology.

In previous research, the implementation of OpenBTS for eNB using RAN architecture, OpenBTS was used as an eNB to communicate data with srsUE. Another research experiment Performance Evaluation of OpenBTS in an srsRAN Network This research evaluates the performance of OpenBTS in an srsRAN network. These researchers found that OpenBTS can meet the basic performance requirements for 4G cellular networks.

Based on the background description, this research will discuss: “Implementation of 4G Short Message Services (SMS) Communication with srsRAN as Evolved Node B Using Universal Software Radio Peripheral (USRP) B210 Device”. This report discusses the implementation of 4G communication with SRSRAN architecture using USRP B210 device which aims to show that USRP B210 can be used to build OpenBTS using srsRAN which shows the open-source paradigm can affect the telecommunications industry.

2. Theoretical Basis

2.1. Long Term Evolution (LTE)

LTE is a next-generation mobile communication technology. It offers download speeds of up to 100 Mbps and upload speeds reaching 50 Mbps, according to its standards. LTE is expected to bring significant advantages to cellular networks. Its architecture is referred to as SAE (System Architecture Evolution), marking an advancement over previous systems. LTE utilizes EPS (Evolved Packet System) technology, which consists of three key components: UE (User Equipment), E-UTRAN (Evolved UMTS Terrestrial Radio Access Network), and EPC (Evolved Packet Core) [3]. Figure 1 LTE Architecture illustrates the network structure of Long Term Evolution (LTE).

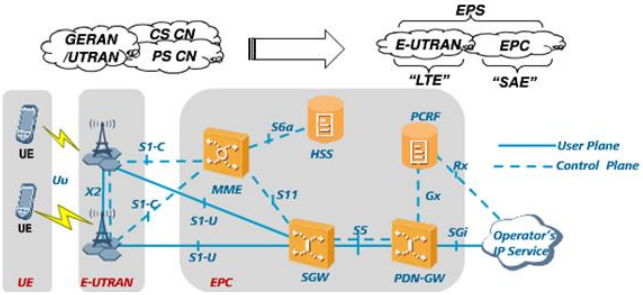

Fig. 1 Arsitectur LTE [3]

2.2. Software Radio System Radio Access Network (srsRAN)

Software Radio System Radio Access Network (SRSRAN) is a radio access network concept that implements cellular network functions using software (software-defined) on top of programmable hardware (software-defined radio, SDR). SRSRAN aims to improve the flexibility, scalability, and efficiency of cellular networks by separating radio hardware with software that can be reconfigured and upgraded. SRSRAN is one of the important innovations in the evolution of cellular networks that has the potential to change the way cellular networks are configured, managed, and operated by utilizing more adaptive and flexible software technolog [5][6].

2.3 OpenBTS

OpenBTS is an open-source GSM solution designed for rapid deployment, often used as an emergency network in disaster zones or remote locations lacking coverage from traditional cellular operators. OpenBTS research is generally conducted to provide communication services in the form of telephone and SMS [7][8]. Like cellular operator networks, the SIM cards used in the research are special SIM cards that have been previously configured so that cellular phones can automatically connect to the OpenBTS network. However, users can also use SIM cards belonging to a cellular operator, with the requirement that the user must manually select the cellular operator network to be used, in this case the OpenBTS network [7]. OpenBTS is an open-source GSM network software. OpenBTS adopts all commercial GSM functions and protocols by replacing the functions of several hardware components with software [9]. OpenBTS has a relatively different architecture from BTS in general. In GSM networks, traffic from BTS will be forwarded to the Mobile Switching Center (MSC) and various other devices [9][10]. OpenBTS has licensing constraints where the working frequency used is already owned by existing telecommunications operators in the country. However, OpenBTS technology can still be used for research with the limitation of not interfering with the ARFCN channels of telecommunications operators in Indonesia. Although still constrained by 2 permits, OpenBTS technology is expected to be used as a solution for building BTS that is much cheaper and easier to design for remote areas in the future. Figure 2 OpenBTS Architecture illustrates the network structure of OpenBTS, which enables GSM communication using software-defined radio (SDR).

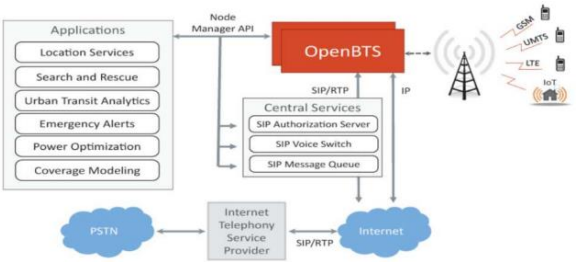

Fig 2. Arsitectur OpenBTS [10]

2.4. Universal Software Radio Peripheral (USRP)

USRP is a radio hardware that utilizes high-speed digital signal processing to function as a GSM signal transceiver (both transmitter and receiver) [11]. It operates based on Software Defined Radio (SDR) technology for signal processing. The USRP consists of two primary components:

1. Motherboard (Main Board)
2. Daughterboard (Child Board)

USRP is designed to support the development of affordable radio software. It operates by connecting the main computer through USB or high-speed Gigabit Ethernet. This connection enables the software to control the USRP and manage the necessary signals for sending and receiving data between the device and the user.[12]

Fig 3. USRP B210 [12]

The USRP B210 is a compact in figure 3, all-in-one software-defined radio (SDR) platform that covers a wide frequency range from 70 MHz to 6 GHz. Tailored for affordable experimentation, it integrates the AD9361 RFIC for direct conversion, features an open and reusable Spartan 6 FPGA, and offers high-speed USB 3.0 connectivity. With full compatibility with the USRP Hardware Driver (UHD), users can quickly start developing with GNU Radio, build their own GSM base stations using OpenBTS, and seamlessly transition to more advanced, industry-grade USRP platforms.[13].

3. Research Methods

The research method used in this study is the experimental method, which is employed to implement 4G short message services communication with SRSRAN as the ENodeB using the Universal Software Radio Peripheral (USRP) B210 device. Referring to this research method, the author approaches the research activities within the experimental method, which includes :

3.1. Diagnosing

Conducting diagnosis is the first step taken in this research, where the researcher identifies the main problem underlying this study, which is the implementation of 4G communication with SRSRAN as ENodeB using Universal Software Radio Peripheral (USRP) B210 devices.

3.2. Action Planning

In this second stage, the researcher understands the main issues underlying this study and then proceeds to implement 4G communication with SRSRAN as the ENodeB using the Universal Software Radio Peripheral (USRP) B210 device.

3.3. Action Taking

At this stage, the researcher will implement 4G communication with SRSRAN as ENodeB using the Universal Software Radio Peripheral (USRP) B210 device, where the author will detect signals from OpenBTS with the USRP B210. The testing of the generated signals will also be conducted through Wireshark to verify whether the signals are indeed the result of the OpenBTS development with SRSRAN.

3.4. Evaluating

The evaluation stage is conducted after the implementation stage (action taking), where the researcher will assess the results of the 4G communication with SRSRAN as OpenBTS using the Universal Software Radio Peripheral (USRP) B210 device that has been carried out. At this stage, the author evaluates the 4G signal constructed with SRSRAN as OpenBTS.

3.5. Learning

This learning stage is the final part of the cycle that has been completed by reviewing the phases of the research that have concluded, allowing this research to be completed.

4. OpenBTS Connection Testing

Testing the OpenBTS connection involves service requests from users to evaluate the functionality of the OpenBTS network. Users will search for the radio signal broadcasted by the USRP and establish a connection once the signal is detected. After users connect to the OpenBTS network, they will be assigned an IMSI number, which they will then register in the OpenBTS database [14[15].

5. Result And Discussion

At this stage presents the results of the implementation of short message services using Universal Software Radio Peripheral (USRP) B210. The purpose of this data collection is to ensure the procedures or techniques used for 4G short message transfer using USRP B210. The following content presents the findings and analysis obtained

from the research conducted. The hardware used in this communication system only includes the USRP B210 and Antenna 900 in figure 4.

Fig 4. USRP B210

Software development is done on laptop or PC devices that utilize the Dragon R26 operating system. Here are the stages in implementing short messages:

1. **Build UHD (USRP Hardware Driver**), which functions as a liaison between USRP and server. After UHD is installed on the server laptop, new communication can be run and the server laptop can recognize USRP. Figure 5, here are the steps for installing UHD:

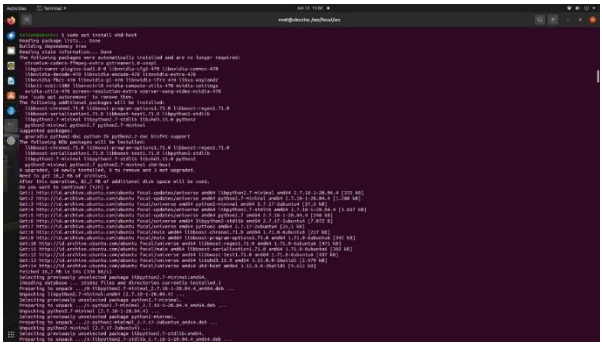

Fig 5. Progress Install UHD

The UHD installation process is complete. At this point, the server can identify the USRP.

2. **Install docker. D**ocker is a powerful tool that simplifies the software development process by combining various software files and their dependencies into a single container, illustrates figure 6.

    a) Update the existing packages on the dragon operating system.
    b) Next, install some packages using HTTPS transport.
    c) Then, add the GPG key for the official docker repository to the system.
    d) Add repository docker to APT sources.
    e) Next update the newly added docker repository database package. Make sure the installation is on the docker repository.
    f) Next, Install Docker.
    g) To run docker and the daemon started. Then the process is activated at boot by running the following command.
    h) If the Docker installation is successful, it's time to check whether Docker can see the existing subcommands type with the following command.

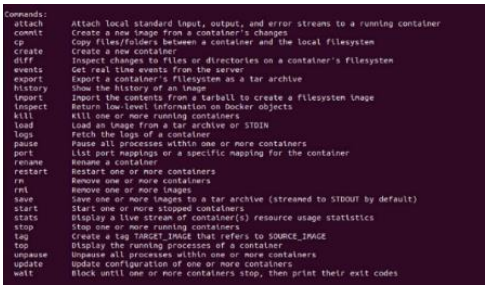

Fig 6. Subcommands pada docker

Next, check whether Docker can access and download images from Docker Hub, in figure 7.

Fig 7. Docker run hello-world

3. **Install webui open5gs**. open5gs acts as a 4G core network on openBTS. The open5gs webui is a database for registering device IMSIs so they can communicate with each other. Figure 8 Structure of 4G/5G NSA Core illustrates the architecture of a Non-Standalone (NSA) 4G/5G core network, which integrates both LTE and 5G technologies.

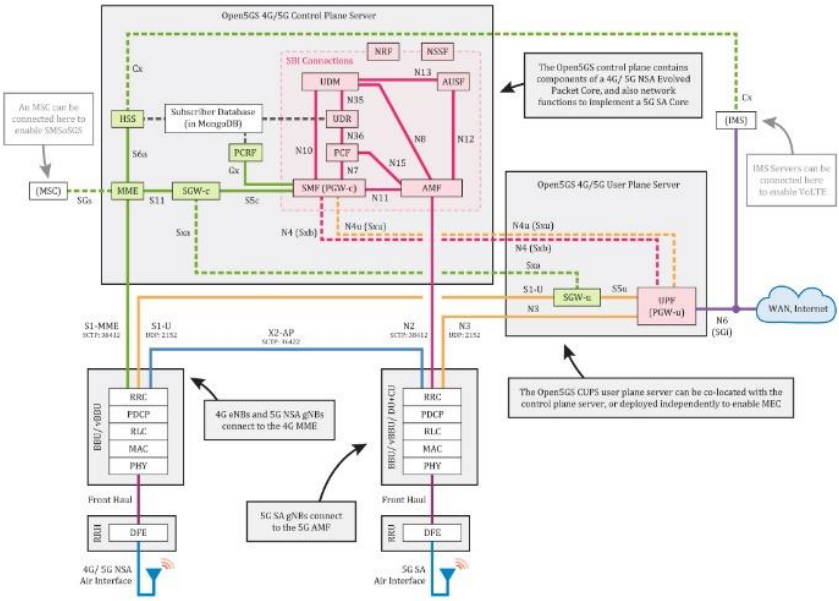

Fig 8. Structur 4G/5G NSA Core

Next, install Open5GS using a package manager. In a 4G network, Open5GS functions as the core network. Begin by importing the public key required by the package management system. Then, create a file list at /etc/apt/sources.list.d/mongodb-org-6.0 and adjust it according to the Ubuntu version. Proceed with the installation of MongoDB packages, followed by the installation of Open5GS. Finally, install the WebUI for Open5GS to manage and register devices within the network.If successful installation of web ui open5gs, please go to localhost:9999. Enter username admin and password 1423 as shown below in figure 9:

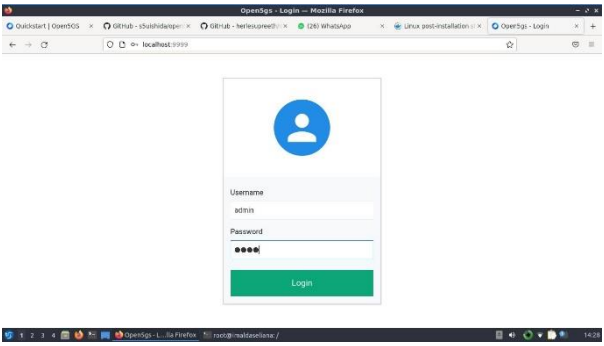

Fig 9. Login Open5gs

Next, go back to the terminal and run the srsenb command to share the 4G signal, in figure 10.

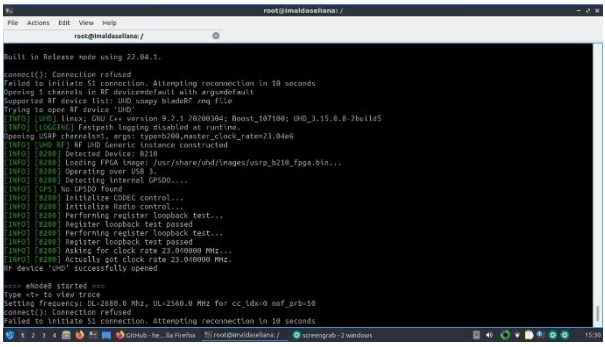

Fig 10. Srsenb

4. **Connecting OpenBTS Network.** To establish a connection with the OpenBTS network, the user will manually search for the OpenBTS network and select the network named TelkomBTS, TestPLMN 00101, or 00101 based on the Shortname, MCC, and MNC settings. After successfully connecting, the device will detect the IMSI number which will then be entered into the open5gs webui database. Figure 11 and figure 12 illustrates the user's method in building an OpenBTS network.

Fig 11. 4G OpenBTS detected

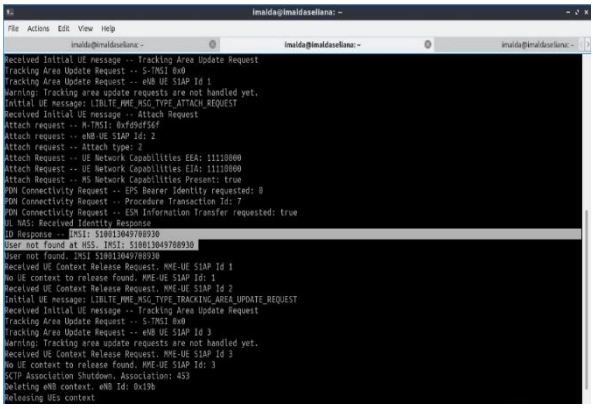

Fig 12. IMSI detected

5. **Signal Testing on Wireshark, t**o perform a 4G signal test on Wireshark, first open the Wireshark application. When wireshark is connected, wireshark will automatically detect the 4G OpenBTS signal that has been transmitted. Then the signal will be captured and proven that the 00101 4G signal transmission indicates a signal generated from USRP B210 for eNB/OpenBTS, in figure 13.

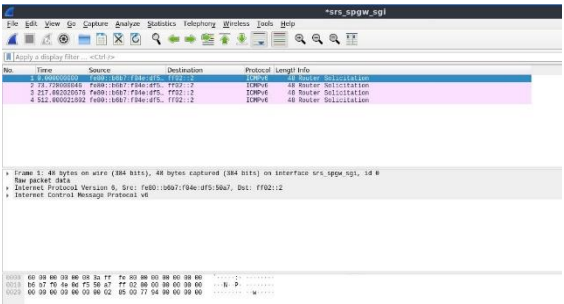

Fig 13. Sinyal 00101 4G in Wireshark

6. Summary

The following are the conclusions obtained from the results of testing and implementing this research.

1. Short Message Services (SMS) Communication on 4G Networks Using Universal Software Radio Peripheral (USRP) B210 Devices has been successfully implemented to transmit 4G signals.
2. SRSran acts as an architecture used to run openbts so that short messages can be realized.
3. The development of Open5gs Webui as a Core Network for 4G signals in OpenBTS was successfully carried out with evidence that users can access to login to the localhost WebUi Open5gs.

References

[1] Standardised Radio Access Network (SRSRAN): An Overview and Future Directions" oleh Dr. Samih El-Husseini (2023).

[2] Aufa Rifky Fernanda, Sigit Kusmaryanto, and Dwi Fadila Kurniawan, 'Rancang Bangun OpenBTS Menggunakan USRP N210 Berbasis *Asterisk* Untuk Layanan SMS Dan LMS', Jurnal Mahasiswa TEUB, 8.3 (2020).

[3] H. Kaaranen, A. Ahtiainen, L. Laitinen, S. Naghian, V. Niemi,"UTRAN *Networks, Architecture, Mobility, and Services*", John Wiley & Sons, ltd, ISBN 0471 48654 X.

[4] 3GPP TR 25.913: "*Requirements for Evolved* UTRA (E-UTRA) *and Evolved* UTRAN (E-UTRAN)"

[5] Danaryani, Sri. "Sistem Komunikasi Bergerak". Politeknik Negeri Jakarta. Jakarta. 2021

[6] Castells, M., Fernandez-Ardevol, M., Qiu, J. L., & Sey, A. *Mobile Communication and Society*: *A Global Perspective*. MIT Press, (2020).

[7] Burgess, David A., and Harvind S. Samra. "*The OpenBTS Project*" (2022).

[8] Mpala, Jacqueline, and Gertjan van Stam. "*Open* BTS, a GSM *experiment in* rural Zambia," *In e-Infrastructure and e-Service for Developing Countries*, pp. 65-73. Springer Berlin Heidelberg, (2022).

[9] Elvanno Hatarongan, Tutun Juhana, "*Mobile Phone Auto Registration to OpenBTS-based Celluler Network in Disaster Situation*," *Internal research report,* (2020).

[10] Elvanno Hatarongan, Tutun Juhana, "*Mobile Phone Location Logging to OpenBTS-based Celluler Network in Disaster Situation*," *Internal research report,* (2019).
[11] Reed, J.H, "Software Radio: *A Modern Approach to Radio Engineering*", Prentice Hall, New Jersey, (2021).
[12] Bhattacharya, S., & Gopalan, A. (2019). *Universal Software Radio Peripheral (USRP) in LabVIEW Environment: An Introduction. International Journal of Computer Applications*, 975, 8887.
[13] Wiatr, K., Maslennikov, R., & Piotrowski, P. (2019). *Analysis of Ettus Research USRP B210 Application in Radar Systems*. 2017 *Progress In Electromagnetics Research Symposium* - Fall (PIERS - FALL), 678–684.
[14] D. A. Putra, *Implementasi Short Message Service* (SMS) pada jaringan GSM Menggunakan OpenBTS V 5.0, Bandung: Proyek Akhir, 2019.
[15] Utama, "Perancangan Dan Instalasi SIP Sebagai Sarana Komunikasi Audio Visual Dengan Asterisk Sebagai IP PBX Server", Jurusan Teknik Elektro Fakultas Teknik Universitas Diponegoro, Semarang, 2019