

# Evaluation of 5G Based Network Using ns-3

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## Article Info

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## Abstract:

Due to the rapid growth of the internet, a new revolution of 5G technology can solve problem of high demand bandwidth and internet usages in Malaysia. It also will give a huge impact in many areas such as healthcare, manufacturing and media as it offers many features that will ease and benefits to others. This paper focused is evaluation of 5G based network using ns-3. This work will design 5G cellular network and simulate it using ns-3. However, ns-3 does not have 5G module so it is needed to add external module to run it. The design will be developed using C++ and running in ns-3 simulator. The performance of design network will be evaluated by the specified parameter. Parameter of performance will be measured on speed, latency, bandwidth and energy consumption. The result can be analyzed from the data and graph collected.

## Article History

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## I. INTRODUCTION

### A. Research Background

Rapid growth of internet user and smart devices all over the world be a challenge to telecommunication company in providing a good internet service. The percentage of smart devices is predicted to be 10-100 times and traffic volume will rise to 1000 in the future. There are many evolutions of wireless technology such as 1G, 2G, 3G and 4G before 5G being introduce.

What is 5G? G is stand for generation cellular technology. Fifth generation wireless network technology is providing various features and improvement from previous generation which make it perfect wireless for real world. 5G also related to Internet of Thing where it is enabling object to communicate data with connected devices. IoT systems are designed to improve the quality of everyday life through combining smart home technologies into urban ecosystems such as home automation , buildings automation and cities automation [16].

There are several possible future applications for IoT such as media, transportation, healthcare,

infrastructure, environment and energy conservation [4]. In [14] states that 5G will offers higher bandwidth, high-quality, error-free service and provides high quality, bi-directional forming of wide bandwidths. 5G also will provide an increase in data rates and reduce energy consumption. Furthermore, it is also expected to reduce the latency of the critical device as small as one millisecond in real time, enabling more efficient signaling for Iot connectivity.

5G mobile services will be implemented in 2020, according to global telecom operator's estimation [10]. Expected that 5G wireless technology will be the next powerful technology in future [15]. Implementation of Fifth generation wireless technology in Malaysia will give impact to Malaysian Internet Industries or Internet of Things [17]. An extreme revolution in the creation of a 5G mobile radio network is necessary to fulfill the demand from the users and to overcome the challenges presented in the 5G framework [1]. This research was created to study and evaluate the performance of 5G based on data rate, latency, bandwidth, and energy efficiency using ns-3 simulator.

### B. Problem Statement

With many people using more data on more devices, mobile data traffic is expected to increase. Current networks such as 3G and 4G cannot frequently encounter user demands for data especially in times of heavy use such as emergencies. Users will experience slow speeds, unstable connection and delays in times of heavy use. Moreover, the increases number of internet connected devices such as smartwatches and smart meters that let users to monitor and control their activities through a mobile device. 5G technology was designed to improve the current mobile network to support high demand of bandwidth and support internet connected devices.

### C. Research Objectives

Objectives of this work are:

- To design and simulate 5G cellular networks using ns-3
- To evaluate the performance of the design network using ns-3

### D. Research Scope

The scopes of this work are:

- To design, simulate and evaluate the performance of 5G cellular network
- Performance measured using ns-3 are:
  - Speed
  - Latency
  - Bandwidth
  - Energy consumption

### E. Research Limitation

Limitations of this project are:

- The result from simulator might not be accurate compare to real deployment.
- By default, ns-3 does not have 5G module but can add external module after interpreted it.

## II. LITERATURE REVIEW

### A. Introduction

The purpose of this chapter is to find as much information as possible and have value to the proposed project. As 5G will be upcoming mobile cellular technology, the efficiency of networks has to be reliable in different environments. This is because to control the behaviour of a new mobile network before actual deployment in a real-time. It is also important to do a simulation before deployment to avoid dangerous for user and providers. So, with the right software and technology, it will help this project run well.

### B. ns-3

Network Simulator 3 (ns-3) is one of tools and library that can be used to predict mobile network behavior without having real devices or physical infrastructure in place. ns-3 have various inbuilt libraries and modules within a directory. It is free software that can be used by the public for research and development to testing the network. ns-3 can be download from the website. The simulation can be installed in Linux operating systems. Besides, ns-3 is written in C++ and can also be used as an interface for Python Programming Language. The user also can combine ns-3 with other code and add the 5G module in ns-3. So, it is can be integrated with the existing features. Ns-3 is easier compare to ns2 where it based on C++ on its core system and use Tcl script to control the simulation [11]. Moreover, by using this simulator, 5G network behavior can be checked in different network scenarios. ns-3 also widely used to simulate many of wired, wireless network, protocol and algorithm.

### C. Review Paper

One of the key features measured in 5 G technologies is low latency [4][8] [20]. Latency in 5G technology important because of the increasing number of automated productions in manufacturing and application of Internet of Things (IoT) devices. In some situations, the latency needed is as small as 1 ms with the rate of packet loss not reaching 10<sup>-2</sup>.

Low latency can be achieved when applying drastic changes in several network architecture. There are three solutions have been discussing in [2] to reach low latency. Many considerations for achieving low latency in RAN have been discussed, such as short frame/packets, modern waveform formats, multiple access technologies, modulation and coding systems, control channel methods, methods for symbol recognition, communication techniques, mmWave amplification, cloud RAN, QoS and QoE enhancement and location [2]. To reach low latency in 5G, SDN, NFV and MEC network technologies have been reviewed for the core network. It was proposed to find the cache and spread data to eliminate site retrieval latency in storage, delivery and centralized caching by multiple tradeoffs.

Millimeter wave wireless transmission systems greatly minimize the wireless transmission range within the 5G wireless communication network [19]. In [6], the writers suggested MmWaves for stationary network devices, and the use of frequencies below 6 GHz for mobile services. They have noticed certain criteria, and it is easier to use lower frequency bands when considering lack of communication and transition in Doppler. Besides, higher frequencies are preferred for greater spectral efficiency and total radio connection capability. Highest transmission rates can be reached using frequencies above 6 GHz but it a bit costly because need to place the base station at short distances from one another. From the observation, it is appropriate to pick 3.4-3.8 GHz or 25.5-27.0 GHz bands for mobile internet networks between fixed network stations and devices travelling indoors at low speeds. While using either the lower frequency 694-790 MHz, or the 3.4-3.8 GHz band to reach sufficient capacity with many network applications is preferred for devices travelling at medium velocity. Using the lowest 694-790 MHz band is suitable for users who travel at medium and high frequencies.

With the growing demand for wireless digital connectivity, the power limitation of the battery has become a real concern in smart devices [3] [18]. 5G aims to reduce energy consumption without

compromising the quality of service through a variety of techniques [13]. In [9], the authors proposed a new architecture structure for a heterogeneous, decentralized green network. The architecture helps to maximize and improve the use of the network, energy usage and QoS in 5G networks. Distributed processing of the baseband helps to reduces power usage and allows aggregated power distribution and decentralized resource distribution. For cell edge users, cooperative radios greatly enhance e the SE and EE scheme. This will be the core tools that can help improve the overall capacity and distribution benefits of HetNets, as well as saving energy.

In this article [3], author was examined Random Access Network (RAN) on WLAN and LTE network in terms of delay and throughput. The author also mentioned that one of the main data transmission quality depends on network access mechanism such as Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA). This test works on the implementation of the File Transfer Protocol (FTP) and the HyperText Transfer Protocol (HTTP). WLAN is better in terms of latency than LTE network. The CSMA / CA device is looking in microsecond for idle time slot. However, if the quantity of stations is expended, there is a slight increase in system delay.

In this article [4], author presented strategies for optimizing the ultra-dense 5G cellular network and explored the radio resources blocks for D2D users. The author mentions about some problems with the distribution of radio source. They can be categorized in two ways. First, percentage of mobile users is much higher than the number of users in D2D. Secondly, mobile user figures are lower than D2D application. The solution to this problem is first to assign radio source block and then consider D2D.

The authors in [7], present ten keys enabling 5G-defined wireless software technologies, network virtualization features, millimeter wave spectrum, massive MIMO, high-density network, big data and mobile cloud computing, scalable Internet of Things, high-mobility device-to-device connectivity, green

communications, and new radio access techniques. The authors also have elaborated requirement for 5G that cover high data rates, low latency, cost-effective energy consumption, high scalability, enhanced connectivity and high network security. Strength and limitations of technologies were analyzed in depth.

The author presented the description and features of the GK-5 mobile communication network in this article [11] and assessed the performance of the GK-5 G mobile technology network based on data analysis through the simulation of the system level. Simulation results showed that using large antenna structure and beamforming technologies on patch antenna series, a mobile technology system based on mmWave could achieve capability enhancement that could tackle the evolving traffic avalanche. Therefore, the spread limit range gaps in the mmWave-based mobile communication network are solved by installing the relays and it is possible to achieve network coverage for an effective contact service and more capability enhancement.

Based on article in [13], the author noted that the major challenges in assessing mmWave's end-to-end efficiency are the need to collect data channel features, link layer adaptation and network infrastructure, that can have a huge effect on upper layers. The author suggests their simulation framework which includes complex measurement and ray-tracing 3D channel models with dynamics builds on numerical channel structures based on actual calculations, beam forming and monitoring algorithms, link layer scheduling and retransmission processes, core network latency and bandwidth limitations. This paper further aims to explore how LOS, NLOS and Outage impact the system layer on an individual mmWave basis.

In article [14], a demonstration on a newly developed full-stack mmWave module implemented in the frequently used accessible-source simulator ns-3 is provided. The authors address performance patterns based on available mmWave channel models and advanced 5 G architectural structure applications. Specific performance mmWave stack

specifically designed to use the mmWave channel effectively.

The authors in [17], focus to analyse and improve the Bit Error Rate (BER) performance of Orthogonal Frequency Division Multiplexing (OFDM) and General Frequency Division Multiplexing (GFDM). There are two channels has been proposed: UHF channel 50 and UHF channel 52 has analyzed for digital television. The simulation has been done using Matlab in order to measure GFDM's optimum performance with OFDM. The results obtained show that the receivers have improved their efficiency by growing the signal-to-noise ratio in the theoretical curve. In the case of digital television, BER output was measured in relation to the signal-to-noise ratio and the possible power rates transmitted by receiver utilizing UHF channels. Response obtained reveals that when considering Zero Forcing Receiver (ZFR) equalization GFDM does better in terms of interferences.

The author in [22] introduces the first-of-its-kind, open-source simulation platform for mmWave cellular networks using ns-3 simulator. The authors have suggested mmWave frame structure orthogonal frequency-division multiplexing (OFDM) in this article. Channel versions are equipped with a physical or MAC-layer configurable application that can be interfaced with the higher-layer protocols or core network model from the ns-3 LTE module to simulate end-to-end communication.

In this article [24], the authors mention a few main things on the 5G and focus on the important 5G areas which give impact on Malaysian industries and the challenges of the future as well. The author also made some of comparison from the previous wireless network technologies such as 1G, 2G, 3G, and 4G. The article discusses about 5G impact on Malaysia industries and future in term of better connectivity, healthcare services, education and learning, home entertainment, connected commuting, workplace and retail. Some challenges in 5G also be mentioned related to data traffic volume, IoT and number of connected devices, increasing capacity without increasing cost, diverse

requirement and coping with augmented reality. It is estimated that traffic volumes will increase by 1000 times, and the percentage of smart devices will be 10-100 times higher than expected with unrestricted access to information and data sharing available to anyone and anywhere and at any time.

Based on article in [25], the author presents a 5 G K-SimNet model to test the end-to-end efficiency of 5G. Author proposed new modules of ns-3 which is 5G K-SimNet supports 5 G NR, 5 G standard, multi-RAT protocol, multi-connectivity traffic management, and SDN/NFV. It can also support existing simulators like LENA and mmWave ns-3. Channel model have been updated in ns-3 to support cross polarization antenna model. This article also adds the analog beamforming system describe in the full dimension-multiple input multiple output (FD-MIMO). To provide multi-path transmission on multi-connectivity infrastructure, author have implemented multi-RAT protocol and break bearer. Furthermore, authors also design a new secondary node (SN) switch handover protocol, which is not defined in 3GPP specification but is ideal for low latency interactions.

In [27] authors present a comparison of the performances, considering a train equipped with two mmWave antennas (front and rear), running over two 1.4 km rail lines, with several mmWave access points (APs) located at the trackside. This paper also investigates the effect on achievable efficiency of beamforming, frequency band (26GHz and 60GHz) and cell radius. Author use MatLab for measure the parameter. Seamless networking can be obtained from the simulation outcome even when APs are positioned 800 m apart at the trackside. Using maximum selection of beams has greatly improved performance of the throughput. The highest workable bandwidth was measured at around Gbps 4.7. According on the study, the beam diameter of 20 ° is sufficient to support most MS points in the AP's vicinity.

In [29], the author suggested a two-level, system-level simulator cloud-based architecture to meet the requirements. The launch of a new air interface and

network topology allows a very high demand for convergence and performance in 5 G simulation. The two-level simulator will ideally integrate specific simulation situations and technologies by separating the function from the system view into layers. In addition, simulation performance can be greatly enhanced using cloud computing. Authors has mentioned five general typical scenarios in channel such as indoorhot-spot(InH), Urbanmicro-cell(UMi), Urban macro-cell (UMa), rural macro-cell (RMa), suburban macro-cell (SMa), with different set of parameters influencing large-scale and small-scale parameters.

Based on article in [30], the author presents a 5G K-Simulator consisting of a link-level simulator (5G K-SimLink), a system level simulator (5G K-SimSys), and a network simulator (5G K-SimNet). The 5 G K-Simulator is an open source for wireless network infrastructure management and performance review to address the waste of human and material resources consumed in simulator creation. The 5G K-Simulator software was designed using a modular and scalable approach to allow users to change it quickly or customize it to suit their purpose.

#### *D. Comparison of Related Article*

Serial	Title	Significance of the study	Highlights	Parameters Observed
1	5G mobile technology: A survey	Several methods for the expected 5G technology	To analyze the characteristics, efficiency, functionality, and service offerings in the cloud	Analysis of an optimized OFDMA model for energy efficient D2D communication
2	5G Wireless Technology: A Primer	Discuss about three main features in 5G	The benefit, challenges and application of 5G	application of 5G
3	A Survey on Low Latency Towards 5G: RAN, Core Network and Caching Solutions	Three main keys have been discussing to achieve low latency	There are several approaches to achieve low latency in RAN, core and caching.	Discuss more on low latency
4	Recommended 5G frequency bands evaluation	Evaluation to choose the frequency band for 5G networks based on each parameter	Considering propagation loss and the change in Doppler it is preferred to use lower frequency bands, it is desirable to use higher frequencies in order to achieve greater spectral efficiency and total radio communication ability	Mobility, latency, connection density, area traffic capacity, peak data rate, spectrum efficiency
5	An Energy Efficient and Spectrum Efficient Wireless Heterogeneous Network Framework for 5G Systems	Collaborative green heterogeneous networking framework for 5G mobile communication systems	New heterogeneous network framework for the evolution of 5G wireless technology is predicted to enhance energy and spectrum efficiencies	Spectrum efficiency Energy efficiency Quality of service
6	End-to-End Simulation of 5G mmWave Networks	This paper provides a review on a newly developed full-stack mmWave module implemented into the widely commonly used ns-3 simulator open source	Discuss about results trends based on the mmWave channel models architectural features offered and implementations of advanced 5G architectural features	Performance custom mmWave stack specific designed to make efficient use of the mmWave channel.
7	5G roadmap: 10 keys enabling technologies	Review of 10 main 5G enabling technologies	The problems and limits of each development are treated in details	Requirement of next generation cellular network
8	A Case Study Review: 5G on Future Malaysian Industry	Comparison from the previous wireless network technology	Impact of 5G on Malaysian industries and Future, Challenges in 5G	
9	Performance Evaluation of LTE and 5G Modeling over OFDM and GFDM Physical Layers	This paper aims to analyse and optimize the Bit Error Rate (BER) performance of Orthogonal Frequency Division Multiplexing (OFDM) and General Frequency Division Multiplexing (GFDM).	Result obtained show that GFDM works better in terms of interferences when considering equalization with the Zero Forcing Receiver (ZFR)	Measure throughput between of OFDM and GFDM for 5G and digital TV in AWGN channel
10	Performance Evaluation of mmWave in 5G Train Communications	This paper presents an efficiency performance assessment, the impact of beam forming, frequency and cell radius in the mmWave rail environment.	Simulation of performance result of a mmWave network in a rail environment at 26GHz and 60GHz. Fast and efficient networking be done even if APs are positioned 800m apart at the trackside	Output measurement, the difference between the Aps, the frequency band and beamforming device influences the output of the throughput
11	Performance Evaluation and Overview of 5G Mm Wave Cellular Networks	Authors discuss about features of "5 G" focused primarily on system level simulations.	This paper discuss several way to reduce the ultra-dense 5G cellular system and review about the radio resources blocks should be offered to D2D users.	
12	Architecture and Performance Evaluation of MmWave Based 5G Mobile Communication System	This paper provided a review of GK-5G mobile communication network and its functionality	Results showed that using large antenna structure and beam forming technologies on patch antenna collection, mmWave dependent mobile communication network will achieve enhanced capabilities that can handle the changing traffic avalanche	Evaluated performance of the GK-5G mobile communication system by simulation at system level taking into real data information
13	Transport Layer Performance in 5G mmWave Cellular	Analysis of TCP congestion control of mmWave networks in the next generation	The structure can include comprehensive mmWave channel models, beamforming and tracking algorithms, and builds on numerical channel models get from real calculation	This paper proposes to gather how link transition between the LOS, NLOS and Outage states change the application layer in a standalone context of mmWave

14	Performance Evaluation of WLAN 802.11x and LTE Network for 5G Handover	Performance evaluation between WLAN and LTE	Benefits of CSMA/CA is that any stations can connect to the network by waiting for idle channel. The result shows that the delay on WLAN increases slightly when station numbers are increased	This paper compares WLAN and LTE in terms performance such as delay, and throughput.
15	A Framework for End-to-End Evaluation of 5G mmWave Cellular Networks in ns-3	This paper presents the first-of-its-kind, open-source simulation platform for mmWave cellular networks using ns-3 simulator	The authors have suggest mmWave framework orthogonal frequency division multiplexing (OFDM)	Interference, number of paths, propagation loss per path, delay per path
16	5G K-SimNet: End-to-End Performance Evaluation of 5G Cellular System	Authors propose 5G K-SimNet simulator for evaluating end-to-end performance of 5G.	5 G K-SimNet supports 5 G NR, 5 G standard, multi-RAT protocol, multi-connectivity traffic management, and SDN/NFV, which we have developed using ns-3.	Metric performance and the performance of specific protocol
17	Challenges of System-Level Simulations and Performance Evaluation for 5G Wireless Networks	The paper presents the challenges of developing a 5 G application system with new technology and network architectures	Two level simulator can combine multiple simulation situations and technology by breaking system function into layers from the device perspective. Additionally, the simulation performance with cloud computing can be greatly enhanced.	Heterogeneous Network - High-Rise Building - D2D Communication - bandwidth - energy consumption
18	5G K-Simulator: 5G System Simulator for Performance Evaluation	This paper present 5G K-Simulator, a system level simulator and network simulator	The 5 G K-Simulator is an open source for the management and performance analysis / verification of wireless communication technology to resolve the waste of human and material resources used in the creation of simulators	The 5 G K-Simulator code is designed using a modular and scalable approach to allow users to change it quickly or expand it to fit their intent

Table 1: Comparison of Related Article

### III. METHODOLOGY

#### A. Introduction

In the implementation of research and task administration, methodologies are often used to refer to the collection of proposed processes and are then followed by preparation materials, academic assignments, worksheets, and illustrative applications. These would be more accurately referred to as methodology. This chapter provides a summary of the research methodology and approach used to do in the research.

#### B. Waterfall Model

Methodology that used in this simulation is Waterfall model. There are 5 phases method in this model which is analysis gathering, network system design, simulation scripting and preparation, running simulation scenario and collecting results, analysis and comparison of results. Figure 1 shows the waterfall model.

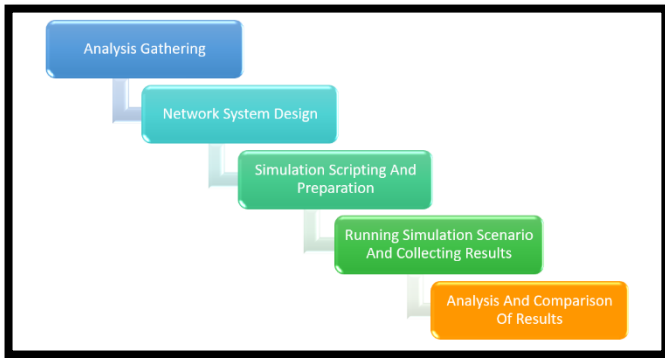


Figure 1: Waterfall Model

Waterfall is a linear sequential life cycle model. It is the earliest SDLC approach to developing software. It is very simple to understand because it is straightforward. Waterfall model process usually divided into separated phases through the whole process. The development activity phases, and each phase consist of series tasks has different objectives. This model will not have overlapping phases, since each phase must be done before the next phase can start. In analysis gathering phase, all possible systems to be developed are captured in this phase and documented the requirements in a specific document. In this phase it will start planning the system and create a Gantt chart to ease illustrate how the project will run. Data gathering from analysis gathering phase are analysed and a network system design is prepared from it. The network system design also helps identify software that will be used in this work. This phase will start with design the coding, and design overall architecture. In simulation scripting and preparation, installation of software will be done in this phase. The installation will start with Ubuntu then follow by ns-3 simulator. After the successful of software installation, work will be proceeded running the coding that have been design from the design phase. The coding will be test and if the coding successful it will show the result. All the data and result that gathered will be analyse and recorded for the documentation.

### C. Software Requirement

#### 1) Ubuntu

Ubuntu is a Debian-based free and open-source Linux distribution. It is use as a platform to install ns-3 simulator.

#### 2) ns-3

Network Simulator 3(ns-3) is one of a tool and library that can be used to predict mobile network behavior without having real devices or physical infrastructure in place. ns-3 has various inbuilt libraries and modules within a directory. It is free software that can be used by the public for research and development to testing the network. ns-3 can be download from the website. The simulation can be installed in Linux operating systems. It is implemented using C++ and Python. C++ is used as a core language while python is used as a glue language/ binding language.

#### 3) Visual Studio Code

Visual Studio Code is a source code editor for Windows, Linux, and macOS created by Microsoft. It provides debugging support, Git and GitHub embedded command, syntax highlighting, intelligent code completion, snippets and code refactoring. It is free and open source software and published under the permissive MIT License. Visual Studio Code is a code editor which can be used in many operating systems. It allows users to access one or more files instead of just a project system, which can then be stored in the workspace for possible reuse. It is also supports several languages for programming and a collection of features that vary in each language.

### D. Flowchart

This phase will begin with the installation of software, the design of the coding and the design of the entire system architecture. Figure 2 shows the flowchart of the Evaluation of 5G Based Network Using ns-3. This flowchart will show how the system work and react when meet certain situation. This project will start with the installation of the Ubuntu as the Linux platform. Then, install the ns-3 simulator in Ubuntu and add external module in ns-3. After that, design the network topology and the

coding. Run the coding after the designing phase and troubleshoot if there are any error appears

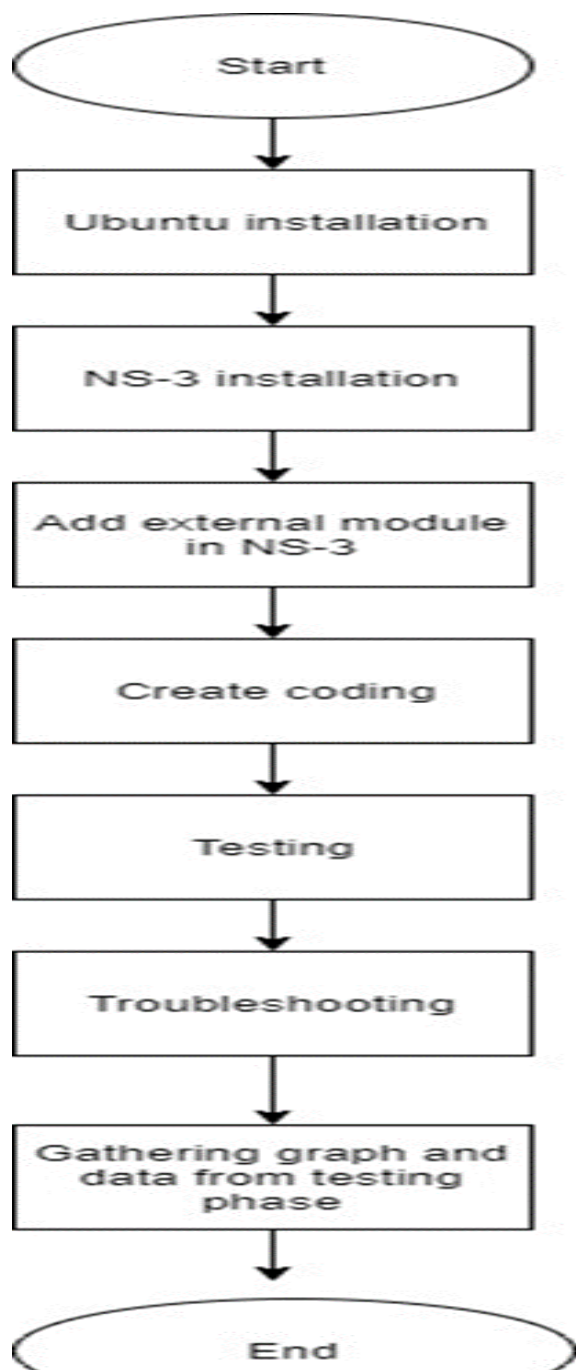


Figure 2: Flow chart

## IV. RESULT AND DISCUSSION

### A. Introduction

To generate the result of this project, ns-3 was used along with the mmWave module. The mmWave software is compatible with the ns-3

module, which together with the ns-3 network simulator must be built in order to connect the 5G network simulation features with the existing features.

### B. MmWave Module

MmWave module is used to provide the basic application for millimetre wave users and network systems. There are some key design features in this module such as simulating 5G networks with nodes and base stations, support time division duplexing (TTD), cross-layered architecture of 5G networks, customizable OFDM-based control and data channels frame structure, supports Uplink and downlink MAC scheduling, frequency spectrum management, frequency spectrum of more than 6GHz and fully developed in C++.

The following steps are used to work with the mmWave module in the ns-3 network simulator with LTE support:

```

$ sudo apt install git build-essential (Activation of the Repository and the Packages)
$ git clone https://github.com/nsnam/ns-3-dev-git ns-3-dev (Cloning and Fetching the Library of ns-3)
$ cd ns-3-dev/src (Moving to the SRC Directory in ns-3)
$ git clone https://github.com/nyuwireless-unipd/mmwave mmwave (Activation, Cloning and Fetching the mmwave with ns3)
$ cp mmwave/ns-3-patches/patch-for-lte.diff lte (Initialization of LTE)
$ cd lte
$ patch -p1 -N -E -i patch-for-lte.diff
$ rm patch-for-lte.diff
  
```

Figure 3: Installation command for mmWave module

The mmWave module is available for simulating the cellular network scenarios with the ns-3 network simulator in order to test multiple factors and parameter. The formation and behavior of the network can be viewed through the integration of the graphical user interface (GUI) in ns-3.

Figure 4 shows comparison time lag of HTTP and FTP implementation on WLAN from article [3]. Delay is calculated when a packet frame sends from a station to AP. At first attempts, delay is counted up until the packet frame reaches the AP. Graph below shows that FTP delay is higher compare to HTTP

application. Moreover, FTP delay is slightly induced when station numbers increase.

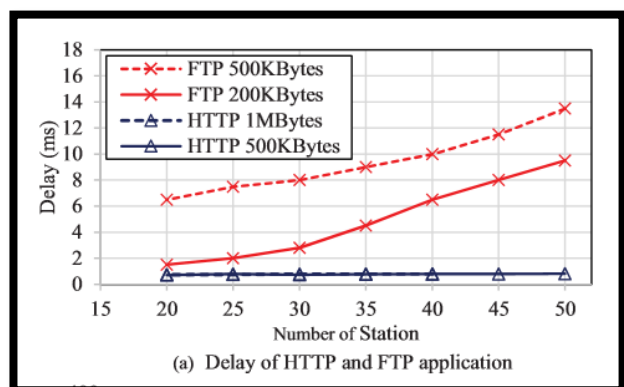


Figure 4: Delay of HTTP and FTP application

Figure 5 shows result throughput on HTTP and FTP application from article [3]. The throughput is the actual data rate measured from the transmitter to the receiver. HTTP throughput is estimated 10 times higher than the FTP application with WLAN technology. This work is ongoing to consider similar results in various different cases and settings.

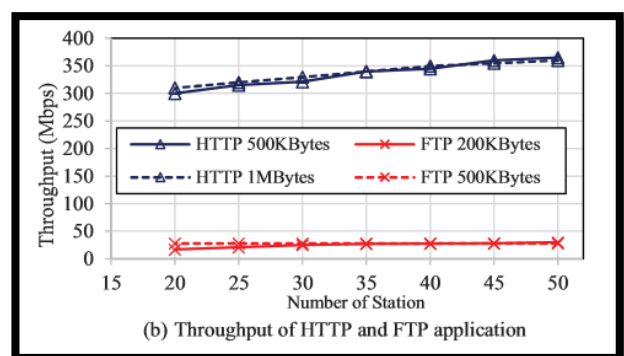


Figure 5: Throughput on HTTP and FTP application

## V. CONCLUSION

As a conclusion, in this review article, it is targeted to evaluate some of parameters of 5G using mmwave module in ns-3 as a part of the complex simulation project ongoing as a preparation of setting 5G in Malaysian perspective. Mobile access networks will have a huge impact on the upcoming 5G cellular network. The volume of traffic is expected to rise by 1,000 million, and the number of connected devices is predicted to be 10-100 times

greater than at present in a networked environment with open access to information and the data communication accessible to anyone else anywhere at any time. 5G targeted to provide high throughput, increase spectrum efficiency, low latency, better mobility support and high connection density. The results from the simulation can give benefits for all researcher and developer before the real development of 5G. Implementation of 5G in Malaysia also can increase productivity in many fields such as manufacturing, transportation, healthcare services, education and learning.

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