



Design and Performance Analysis of Wireless Campus Network Using Delay Parameter

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Abstract

The Wireless Campus Network is a network covering University or business campus. It is a network in a small geographical region with several interconnected local area networks. To build a network for wireless devices, wireless local area networks use infrared or radio waves to allow users to relay data to each other without wire to cable limitations in the coverage area. Quality of Service (QoS) is considered one of the key challenges in wireless networks because of the bottleneck and the competition between different modes of traffic flow on the network. In this paper a wireless Campus Network design was developed to compare the QoS performance improvement of Wireless Campus Network using delay parameter. Two models (Short-Term and Long-Term) were designed and simulated using Optimized Network Engineering Tool (OPNET), OPNET IT GURU Academic Edition with linked between wireless workstations suitable for implementation to determine network delay performance. The two models contain the same number of wireless workstations but with some additional access points and multiples processors in the long-term model a Point-to-Point Protocol (PPP) were employed to connect the access points with the routers and the cloud while 100BaseT cable was used to connect the servers and the firewalls. The wireless network delay were obtained in each case. The results obtained from these models showed that the Long-Term Model experiences much lower wireless network delay compared to the short-Term Model. Even though the number of wireless workstations are the same in both model but the topology of the long-term model contains additional Access Points and double processors which resulted to the observed minimum delay.

Keywords: WLAN, QoS, Delay, Wireless Workstations and OPNET IT GURU

1. Introduction

Zubair and Mike (2015) noted that increasing the strength and capacity of computers and increasing network applications are the prevailing trends in computing. Graphics, animation, pictures, voice and other multimedia streams are used for applications over the network. To serve the users without performance degradation, all such data requires high bandwidth. The type of network traffic varies from the best effort of data traffic to delay bound media outlets and interactive speech. This move has prompted us to investigate whether the current network could support VoIP (Voice-Over-IP) or videoconferencing type applications. The study identified the performance of the campus network and measured it. This project consists of two parts. The first part deals with the quantification by simulated testing of campus network results. The second section deals with the implementation of innovative algorithms for improving real-time speech traffic over Version 4 (IPv4) networks of the existing Internet Protocol. Using different testing methods, the goal is to evaluate campus network effectiveness, isolate possible hot spots in the network, and assess the suitability of the campus network for multimedia applications. OPNET will then usefully and quantifiably investigate and interpret the results of multiple changes and complex configurations. IT Guru facilitates the analysis and compilation of useful statistics on the creation of a virtual network (Zubair & Mike, 2015).



Zhang and Yu, (2013) designed a Wireless Local Area Network (WLAN) for the college with a view to its possible implementation to determine the best performance. This is a great step toward alleviating problems of having internet services to end users. The studies describe how the designed and the implementation of this WLAN help the end users with desired network

Among the different types of Local Area Network (LAN), I decide to use the Wireless Local Area Network. High-speed wireless LANs can have the benefits of network access without the disadvantages of being linked to a location or connected by cables. There are several contexts in which this becomes interesting, including the following: In cases where laying cables is expensive or prohibitive, wireless connections may enhance or replace a wired infrastructure. Temporary installations are one example of when a wireless network could be beneficial or even required. The use of wiring may be prohibited by certain types of buildings or building codes, rendering wireless networking a vital option. And of course, the "no new wires" phenomenon has been a major catalyst for home networking and wired home experience, along with telephone line networking and even electric power line networking (Cicconetti et al . , 2016).

Quality of Service (QoS) is considered one of the key challenges in the Wireless Network because of the bottleneck and the competition between different modes of traffic flow on the network. In this paper a wireless Campus Network design will be develop to compare the QoS performance improvement of Wireless Campus Network using delay parameter. Two models (Short-Term and Long-Term) will be design and simulate using Optimized Network Engineering Tool, OPNET, IT GURU Academic Edition that will link between 250-750 users, suitable for implementation. Simulate the designed network and to determine network delay performance. The models will contain the same number of wireless workstations but with some additional access points in the long-term model. For both models, a point-to-point protocol (PPP) will be employed to connect the access points with the routers and the cloud while 100BaseT cable will be used to connect the servers and the firewalls.

2. Related Works

Using laptop computers and wireless NICs, portable access to wireless networks can be achieved. It allows the user to move to different places and still have access to their networked data: conference rooms, halls, lobbies, cafeterias, classrooms, etc. The user will need to have awkward cabling without wireless networking and discover a network tap to plug in. Connections to the Internet and even business sites could be made accessible through public wireless "hot spots" networks outside the corporate campus. To provide this service, airports, restaurants, train stations, and open areas in towns may be provided. Maybe meeting a customer at their corporate office when the travelling employee reaches his or her destination, and restricted access can be given to the user via the local wireless network. The network will identify the user from another business and build a link that is disconnected from the local corporate network, but enables the visiting user to have internet access (Frank et al. 2013).

WLAN Technology has a rapid exponential growth over the past few decades. This evolution in the field of internet where computers can be connected or networked together to make online connections. The increased demands for flexibility and mobility in our daily life demands have led to this development. Users have interconnected computers with Local Area Networks (LANs) and they have much more information, data and applications at their disposal now (Foukalas, F. et al.,2018). Wireless technology has made networking simpler by allowing multiple device users to concurrently share resources without external wiring, such as broadband Internet access, network printers, data files, and even streaming audio and video in various settings such as home workplace, educational institutions and business (Foukalas, F. et al . , 2018).

The wireless communications market has steadily grown since the implementation of 802.11 wireless local area networking (WLAN) standards in the late 1990s, according to Leith et al. (2015). The flexibility and scalability of WLANs, and the relative ease of incorporating wireless networking with existing network resources such as servers, printers and Internet connections, are valued by business enterprises. WLANs fulfil the need for seamless networking, versatility and mobility from the customer.

In certain industries, Wireless Local Area networks have unique advantages. Second, Wi-Fi is more versatile and mobile than wired networks, and it will not be obstructed by cables. In real time, users can have access to or



receive information about any network coverage (Wang & Zhuang 2019). Second, good scalability is available for WLANs. In order to satisfy the needs of specific applications and installations, users can add more APs to effectively expand the network. Third, a lot of wires and cables are no longer needed for WLANs, which will decrease the network cabling workload. Finally, it is easier to set up a wired WLAN than a wired one and the natural environment or disasters would not easily affect it (Wang & Zhuang 2019).

Czhusbaick (2005) presumed that a WLAN enables workstations to connect and use radio frequency as the communication medium to reach the network. As an extension, the wireless LAN may be connected to an existing wired LAN or can form the basis for a new network. Wireless LANs, while they are adaptable to both indoor and outdoor conditions, are particularly ideal for indoor locations such as office buildings, factory floors, hospitals and universities. The wireless LAN's fundamental building block is the cell. This is the atmosphere where there is wireless communication. The area of cell coverage depends on the intensity of the radio signal being propagated and on the shape and layout of the walls, partitions and other physical features of the indoor environment. Workstations, notebooks and pen-based computers based on PCs can travel in the cell easily.

Singh and Sharma (2012) made certain points that the performance of a network can be measured in a variety of ways, including transit time, which is the amount of time taken to transfer a message from one device to another, and response time, which is the elapse time between an investigation and a response. But a network's performance is best calculated by the two metrics of networking, which are performance and delay. More output is required and there is less delay. However, these two specifications are often contradictory. We can improve throughput if we attempt to send more data to the network, but we improve the delay because of traffic congestion in the network.

3. Materials and methodologies

To achieve the above aims and objectives, the simulation tool known as Optimized Network Engineering Tool, OPNET, IT GURU Academic Edition will be used and also Access points, Router, Wireless workstations will be use. Finally, point-to-point protocol (ppp) will be used to connect the Access points, Router, Wireless workstations and the cloud and 100BaseT will be used to connect the servers with firewall to obtain the best connection that will satisfy the objective of the research.

3.1 OPNET

Optimize Network Engineering Tool, OPNET; consist of modules each of which addresses different network design aspects. In particular a modular module is used to design and simulate networks. It allows the user to do network capacity plan, network configuration and activity and network trouble shooting. The user can model the behaviors of an entire network. OPNET IT Guru Academic Edition will be used in this design as a simulator. It is unique because of its ability to model the entire network (Mittal, 2012).

IT Guru helps one to build a virtual network consisting of suitable software for hardware, protocols and applications (OPNET Company, IT Guru Fast Start slide 2, 2004 power point presentation). In an IT Guru virtual network, networking hardware can be duplicated. From just a network of two workstations, it can be scaled to one representing tens of thousands operating on a WAN.

If a virtual network is formed, it can be manipulated in various ways, such as adding or subtracting routers, adding or discarding the Web server in either direction. It is then possible to usefully and quantifiably investigate and interpret the results of different modifications and complex configurations. IT Guru enables one to learn and collect valuable statistics from it about a virtual network construction. IT Guru not only helps apps to create a virtual network, but also offers it (Yasukawa et al. 2019).



3.2 Wireless Network Components

Client computers, access points, wireless network adapters, wireless routers, wireless controllers, and wireless antennas are the key components of WLANs. Server devices are classified as stations as well. As client devices, all final devices with wireless capabilities, such as cell phones, laptops, can serve. Also known as wireless adapters, network interface cards serve as WLAN interfaces, and devices use them when they want to access WLANs. Network interface cards, including PCMCIA, PCI and USB, are available in three different forms. PCMCIA cards are intended for laptops and allow hot swapping, which means that without shutting down the machines, users can replace or insert network interface cards. For desktop computers, PCI cards are acceptable, while USB sticks are suitable for both desktop computers and laptops (Zhang & Yu, 2013). In this research the USB network interface cards was used to access the WLANs.

The wireless router can operate either as a standard router or as a point of entry. For home users, most of the wireless routers are built. To secure home users from being hacked, wireless routers have a firewall inside. Even if wireless routers vary in several different ways, an entire family usually needs only one router. A bridge between wireless devices and wired networks acts as the entry point. In large buildings, APs are used extensively to establish a wireless local area network that stretches to a wide range of areas. If home users choose to expand their network, they can add an AP, but not a router, and office users can add more than one AP to extend the network to the whole house. Wireless controllers provide load balancing, identification of the entire coverage, and correction and identification of interference (Zhang and Yu, 2013).

Wireless controllers are used to automatically manage and configure a set of APs. The wireless avoidance attributes. Furthermore, WLANs also have antennas. Wang and others (2007). Transmitting and receiving electromagnetic waves is the function of antennas, and users may use antennas to expand wireless LAN coverage. The transmission rate is significantly reduced when wireless devices are far from the AP or other devices, and antennas are helpful for improving the signal and simultaneously speeding up the transmission rate.

3.3 Overview of Simulation Processes

The workflow method of OPNET is divided into four steps: developing new network models; gathering statistics on individuals; running simulations; and data viewing / analysis. For both the expected short-term and long-term models, network models have been created. From the object palette, the necessary network components were chosen and generated inside the workspace. Parameters and framework parameters for the network component were then chosen to include host IP addresses, packet and buffer sizes, etc. The network was then formulated for the various applications needed, as well as prepared for the statistics necessary for performance evaluation.

Next, from worldwide statistical pools, including simulation duration and values per metric, custom Wireless Campus network implementations were chosen and set. The delay parameters are set to run for 240 minutes for both designs in this article. The simulator windows have revealed all of the simulation errors found during the simulation. If simulation errors occur, the simulation process is repeated from Step 2 of the simulation process in Figure 2 (set network function parameters and pick the application). In the simulation level, the absence of mistakes brings us to the next step. In order to assess outcomes and determine performance and any network problems, the results obtained were analyzed. When the desired results are obtained, the simulation process is complete; otherwise, as illustrated in Figure 1, the whole procedure (from step 2) is repeated.

3.4 Setup and Configurations for simulation

The first part of this section presents the Optimized Network Engineering Tool, OPNET IT GURU Academic Edition that link wireless workstations suitable for implementation. Overview of the simulation process and criteria for the quality of service used to simulate and evaluate network performance. This is accompanied by explanations and QoS output comparisons between both the short-term and long-term models proposed. Finally,

the section defined the comprehensive parameters of the simulation and the scenarios planned for both the short-term and long-term models proposed.

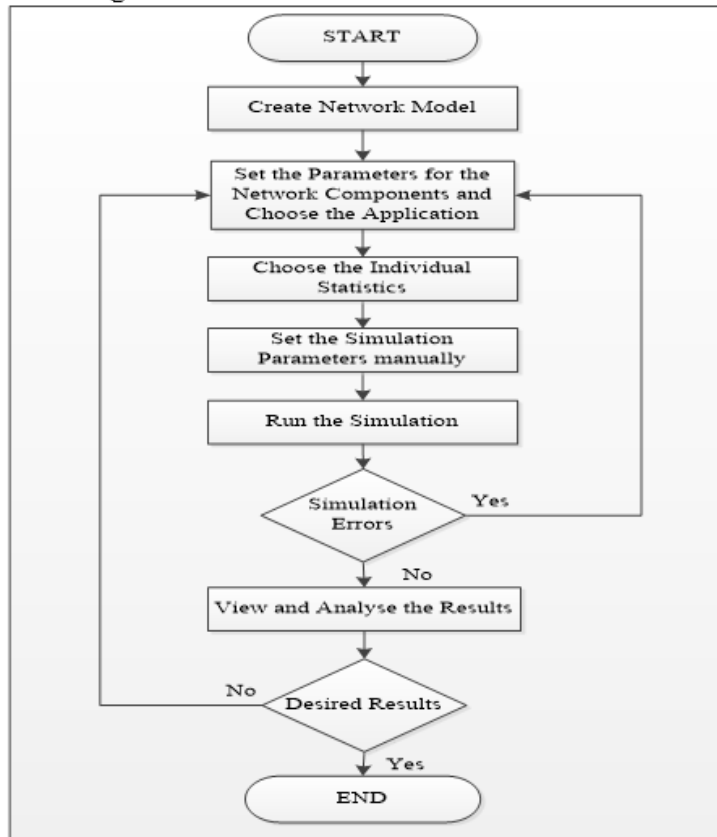


Figure 1. Overview of Simulation Processes

3.4.1 Scenarios for Short-Term Model

In scenario 1 of the short-term Model, the campus was divided into two (2) separate sites (old site and new site) with two hundred and fifty wireless workstations each network having its own access point single processor. The two access points are connected together using a point-to-point protocol (PPP) employed to connect the access points with the routers and the cloud while 100BaseT cable was used to connect the servers and the firewalls. In scenario2, scenario3 and scenario 4 of the short- term Model the wireless works were increased to three hundred and fifty, five hundred and fifty and seven hundred respectively. All other parameters configuration remained as configured in scenario1 as describe in figure 2.

3.4.2 Scenarios for Long-Term Model

In this scenario 1 of the Long-Term Model, the campus was also divided into two (2) separate sites (old site and new site) with and additional subnet to each site consisting of two hundred and fifty wireless workstations, each network having one access point with double processor. The four access points are connected together using a point-to-point protocol (PPP) employed to connect the access points with the routers and the cloud while



100BaseT cable. In scenario2 of the Long- term Model the wireless workstation were increased to five hundred and fifty respectively. All other parameters configuration remained as configured in scenario1 as describe in figure 3.

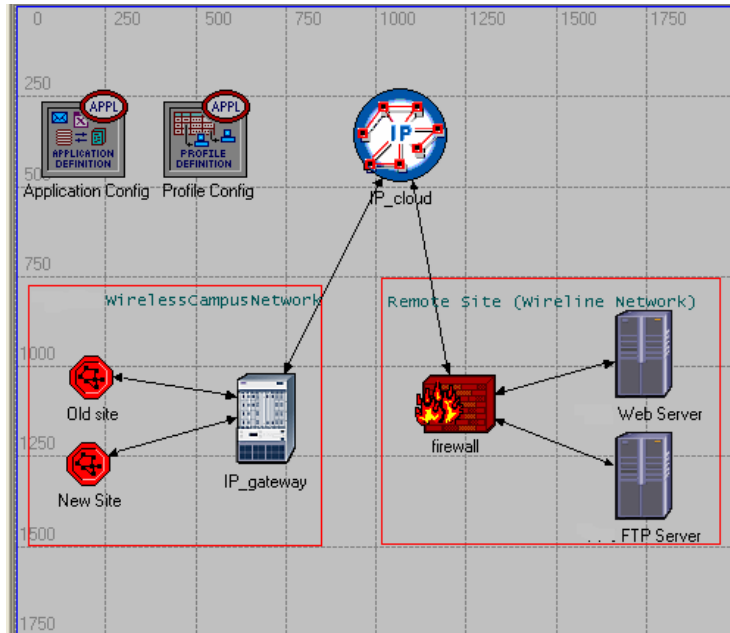


Figure 2. Wireless Campus Network Design for Short-Term Model

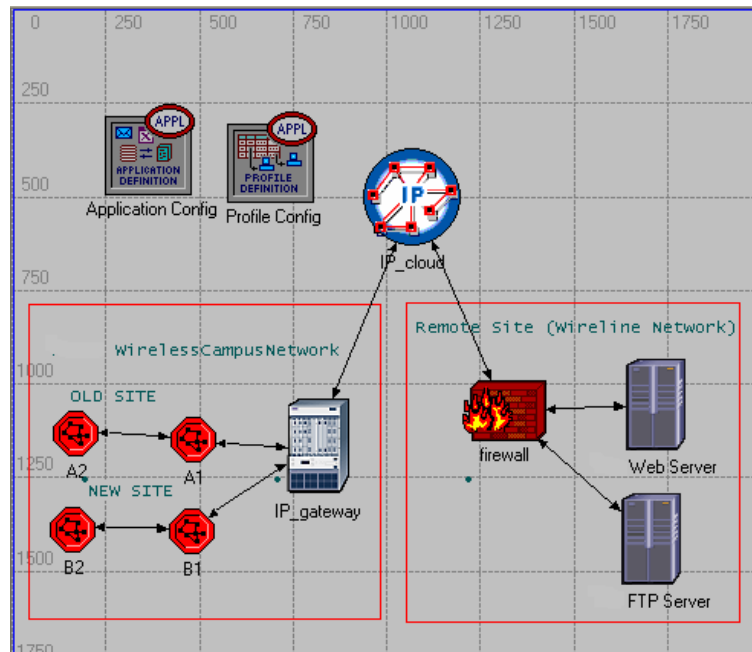


Figure 3. Wireless Campus Network Design for Long-Term Model

4. Results and Discussion

The study of the outcomes obtained as a result of the simulation of the various network designs for the short-term and long-term models was discussed in this section. It shows all the statistical graphs obtained as a result of the



simulation. Discussion of the results of the observations was carried out in relation to each other. Important results were given attention.

4.1 Observed Delay in Wireless Campus Network

The results of the global statistics known as the Wireless Campus Network Delay for scenario1 is summarized in the table 1 below. The simulation run for 240 minutes in both the short-term and long-term models.

Table 1. Wireless Campus Network Delay for Scenrio1

S/N	Simulations Time (Mins)	Short-Term Model(ms)	Long-Term Model(ms)
1.	60	1.28	0.86
2.	120	1.85	1.08
3.	180	2.72	1.40
4	240	3.35	1.80

4.2 Scenario1 Simulation Results for Delay Comparison

It can be seen from Figure 4 that, relative to the short-term model, the long-term model experiences significantly lower wireless network delays. This may be due to the fact that while the total number of wireless workstations are the same (two hundred and fifty wireless workstations) in scenario_1 of the short-term and the long-term, the topology of the long-term model involves additional access points and double processors that resulted in the minimum delay observed. The delay of the short-term and long-term model is represented in figure 4.

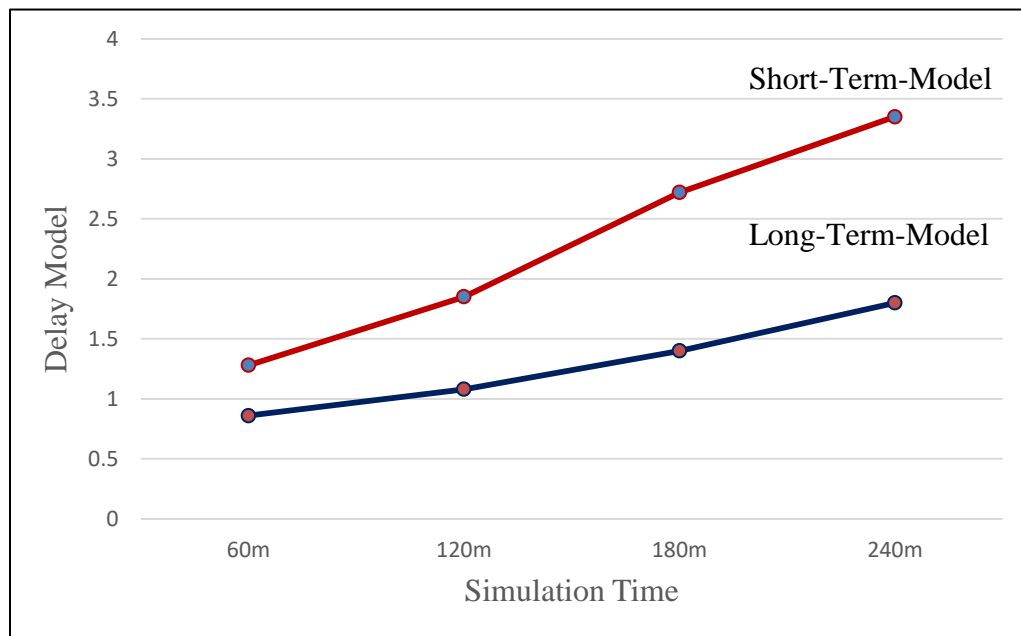


Figure 4. Wireless Campus Network Delay for Short-term and Long-term Models



4.3 Observed Delay in Wireless Campus Network

In scenario_2 of the two models, the results of the global statistics known as Wireless Campus Network Delay for The results of the global statistics known as the Wireless Campus Network Delay was summarized in the table 2 below. The simulation run for 240 minutes in both the short-term and long-term models.

Table 2. Wireless Campus Network Delay for Scenrio2

S/N	Simulations Time (Mins)	Short-Term Model(ms)	Long-Term Model(ms)
1.	60	2.25	1.25
2.	120	2.92	1.58
3.	180	4.32	2.22
4	240	5.42	3.32

4.4 Scenario2 Simulation Results for Delay Comparison

Figure 5 described the statistical simulation results for delay obtained from the two models. The results indicate that the Long-Term Model experiences much lower wireless network delay compared to the short-Term Model.

Even though the total number of wireless workstations are the same in both model (five hundred and fifty wireless workstations) in scenario_2 the topology of the long-term model contains additional Access Points and double processors which resulted to the observed minimum delay.

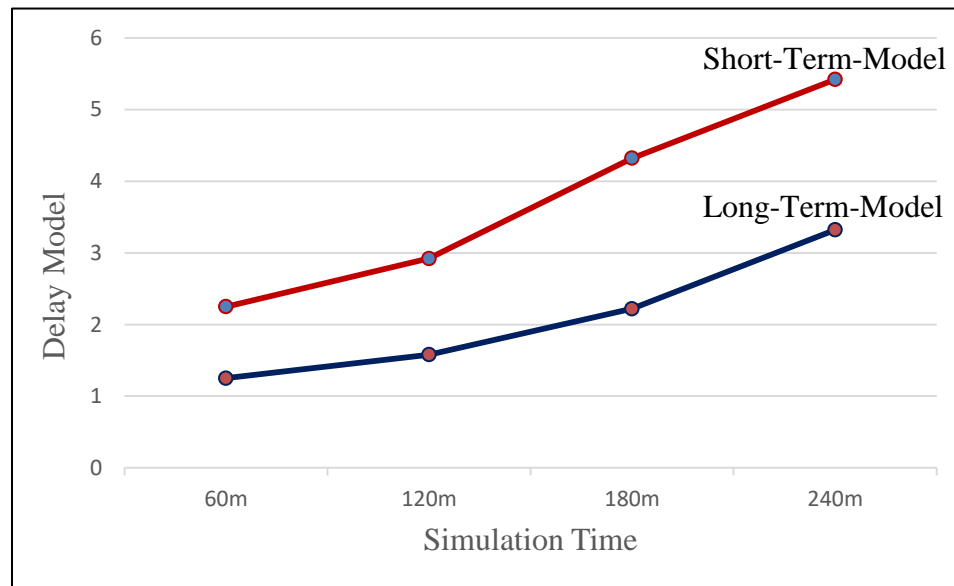


Figure 5. Wireless Campus Network Delay for Short-term and Long-term Models

5. Conclusions

In order to compare two models (Short-Term and Long-Term), a wireless Campus Network design was suggested. In the long-term model, the devices contain the same number of wireless workstations but with some additional



access points. In the short-term model, two access points and a single processor were used while in the long-term model, four access points and double processors were used. For both models, a point-to-point protocol (PPP) was employed to connect the access points with the routers and the cloud while 100BaseT cable was used to connect the servers and the firewalls. The two models were simulated using OPNET IT Guru Academic Edition. One of the most important networking metrics, Delays were observed for the two models. Although the delays of both the short-term and long-term models did not reach the minimum level of 120ms that is the maximum of 5.42ms and 3.32ms in scenario2 respectively, the long-term model was found to experience minimum delay.

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