International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 6 (2015) pp. 15035-15047

http://www.ripublication.com

Wi-Fi Implementation of Self Accessing Internet of Things

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Abstract

In this paper various performance metrics of WirelessLAN is analyzed using Network Simulator Tool, OPNET. WirelessLan network is used to create a self configurable network. We analyzed that the multiple devices can communicate information using their own operating environment. This work will form a supplement to the earlier work titled "Self Powered Energy Aware Internet of Things", embedded things with IP address and the ability to communicate self using mailbox/message concept.

Keywords: Internet of Things, Wi-Fi, Hotspot, OPNET simulation tool.

Introduction

With the growth of Internet of Things (IoT), the number of sensors deployed around the world is growing at a rapid pace. [2]. The Internet of Things allows people and things to be connected anytime, anyplace, with anything and anyone, ideally using any path/network and any service [2].Any system, no matter it is a system for IoT, WSN or M2M communications can be considered as a box with inputs, outputs and internal messages/logic. This leads to comparison of the operations of a computer operating system or mobile operating systems where each application shares resources from CPU, memory and sensors.[1]. With the continuous growth of mobile devices in its popularity and functionality the demand for advanced ubiquitous mobile applications in people's daily lives is continuously increasing. The IoTs technology can be used for creating new concepts and wide development space for smart homes in order to provide intelligence, comfort and improved quality of life. Smart home is a very promising area, which has various benefits such as providing increased comfort, greater safety and security, a more rational use of energy and other resources thus contributing to a significant savings.[4].The paper[16] analyze the network in terms of

users, Access Points (APs) and traffic. Automation systems, mobile personal gadgets, building-automation devices, cellular terminals, the smart grid, and so on all benefit from interacting with other objects close to them or halfway around the globe.[19]

The Internet of Things in recent times

The research paper [5] discussing the present day condition of Internet of Things clearly indicate that the Internet of Things is still maturing, in particular due to a number of factors, which limit the full exploitation of the IoT.

- No clear approach for the utilization of unique identifiers and numbering spaces for various kinds of persistent and volatile objects at a global scale.
- No accelerated use and further development of IoT reference architectures like for example the Architecture Reference Model (ARM) of the project IoT-A.
- Less rapid advance in semantic interoperability for exchanging sensor information in heterogeneous environments.
- Difficulties in developing a clear approach for enabling innovation, trust and ownership of data in the IoT while at the same time respecting security and privacy in a complex environment.
- Difficulties in developing business which embraces the full potential of the Internet of Things.
- Missing large-scale testing and learning environments, which both facilitate the experimentation with complex sensor networks and stimulate innovation through reflection and experience.
- Only partly deployed rich interfaces in light of a growing amount of data and the need for context-integrated presentation.
- Practical aspects like substantial roaming-charges for geographically large-range sensor applications and missing technical availability of instant and reliable network connectivity.

Hotspot an overview

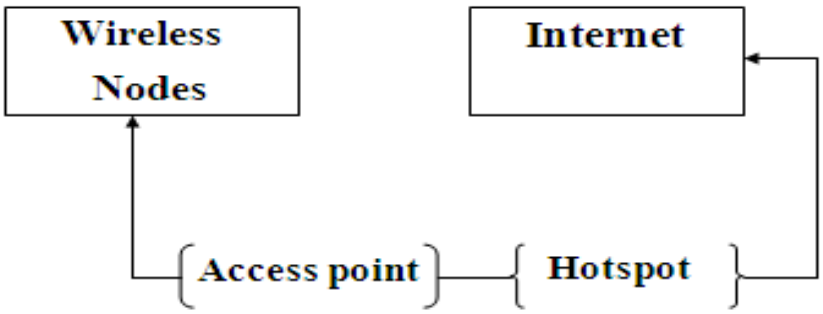

Figure1: Hotspot

[20]In 2010, Cisco and industry leaders formed the Hotspot 2.0 Task Group in the Wi-Fi Alliance. The goal was to rally the industry around a common set of standards

that would vastly improve an end user (subscriber) hotspot experience and fully support service provider business objectives. The research paper [11] discusses about the importance of Hotspot and its usage clearly. Capacity and ease of deployment are only the first steps in enabling a carrier-class solution. The industry is now focused on improving the Wi-Fi user experience while roaming. The goal being to allow users to connect to visited networks as easily as they can connect to their home network. And the easier it is to get connected to a network, the more likely it is to be used. This work is known as Hotspot 2.0 and is being driven by the Wi-Fi Alliance (WFA). The IEEE 802.11u protocol enables a mobile device to have a dialog with a Wi-Fi AP "pre-association" to determine the capabilities that the network can support. The two protocols that 802.11u uses to make this happen are the generic advertisement service (GAS) and the access network query protocol (ANQP). These protocols run on top of 802.11 and enable the Hotspot 2.0 experience (Figure 2) .When a user with an HS2.0 capable mobile device comes within range of a Hotspot 2.0 capable AP, it will automatically open up a dialog with that AP to determine its capabilities. This is done using ANQP packets that are carried at layer 2 by the GAS service (Note: the device has not yet attached and does not yet have an IP address). It is the exchange of ANQP packets that allows the mobile device to automatically learn the capabilities of an AP.

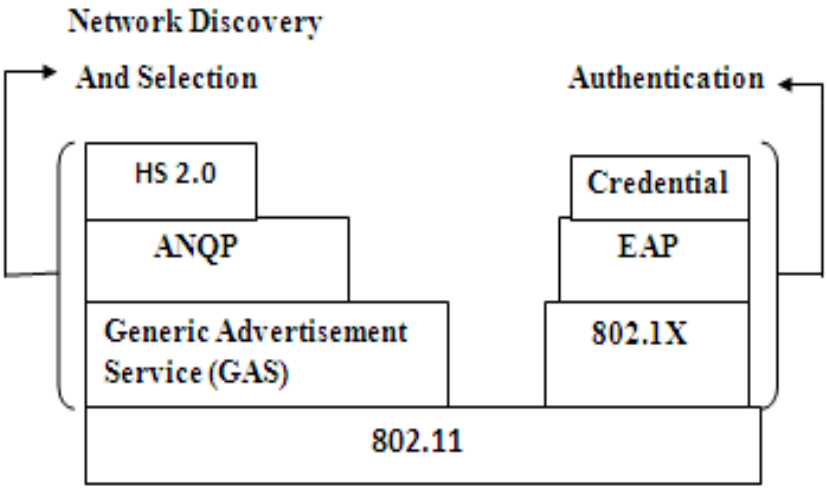

Figure 2: Hotspot 2.0 Protocol stack

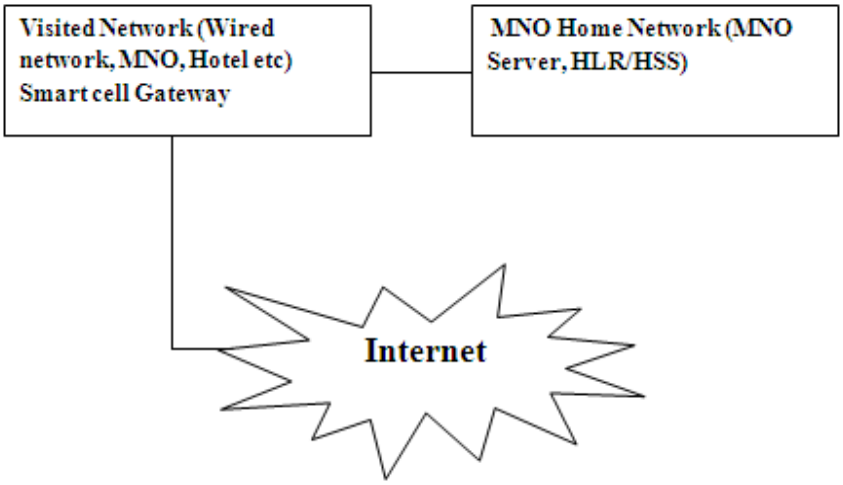

Figure 3: Authenticating A Roaming User To Their Home Network

[11]Hotspot 2.0's impact on the industry will be enormous. At the top of their list are technologies like Wi-Fi and LTE small cells. Cable and wire line operators are taking advantage of their backhaul capabilities to rapidly build-out an extensive Wi-Fi footprint. This technology has also been extensively deployed in public venues like hotels, airports, stadiums, hospitals, etc. With Hotspot 2.0, it will now be possible to link together this huge footprint of Wi-Fi APs through a web of roaming arrangements (Figure 3). The paper [17] discusses challenges like authentication, security, coverage, network management, billing, and interoperability of Wi-Fi Hotspot.

Related Works

In the research paper [4], an internet based smart home system that can be controlled remotely upon user authentication is proposed and implemented. Any android supported device can be used to install the smart home app, and control and monitor the smart home environment. A low cost smart home system has been developed which does not require a PC as all processing is handled by the microcontroller. The paper[6] is discussing that Smart grid is one of the main applications of the Internet of Things (IoT) paradigm as well as this paper addresses the efficient energy consumption management of heating, ventilation, and air conditioning (HVAC) systems in smart grids with variable energy price.

In this paper [7], they analyzed the solutions currently available for the implementation of urban IoTs and they discussed technologies are close to being standardized, and industry players are already active in the production of devices that take advantage of these technologies to enable the applications of interest. This paper [12] discuss about mail communication between IoT nodes.

Research paper [8], focus towards an alternative architectural model for the Internet of Things1 as a loosely coupled, decentralized system of *smart objects* — that is,

autonomous physical/digital objects augmented with sensing, processing, and network capabilities. In contrast to RFID tags, smart objects carry chunks of application logic that let them make sense of their local situation and interact with human users. In [9], the researchers are analyzing the Internet traffic at various tiers of service providers is essentially a superposition or active mixture of traffic from various sources. The research paper [10] is to review identity management technologies and analyze their ability to support trusted interaction in Internet and mobile computing. The paper [13] concludes that 802.11u and Hotspot 2.0 are bridging opportunities in public access networks everywhere, and their impact will have broad implications for end-users, small businesses and carriers. As this technology proliferates, the reality of secure and universal wireless connectivity will become more tangible. The research paper[15] introduce algorithmic solution, in which a Neural Network-based traffic predictor makes use of historical traffic traces to learn network traffic conditions and predicts traffic loads on each of 802.11 b/g channels. The goal of this paper [18] is to create an architecture that is both ergonomic and flexible in order to meet the need for connection and client mobility.

Design And Implementation

Figure 4 shows the communication between nodes based on Hotspot. Any wireless nodes can act as internet of things because of Wi-Fi base hotspot.

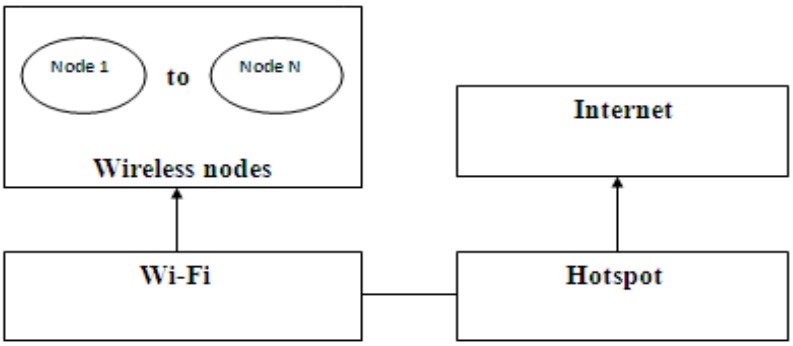

Figure 4: Hotspot based Communication between nodes

Packet Transmission:

Packet transmission occurs between Access point and several nodes based on priority as clearly indicated in the Figure 4a.

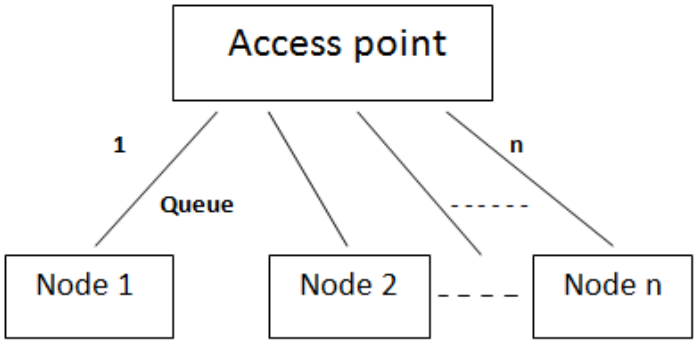

Figure 4a: Packet transmission between nodes

Performance Metrics

In the traffic data, parameters to be discussed are distribution of packet inter-arrival times, Packet sizes and burst of traffic. Figure 5 shows schematic diagram of performance metrics. A simulation bench is setup to capture the Wi-Fi access traffic data for some of the applications, and analyze the data in terms of packet size, throughput vs. time for uplink and downlink.

Burst Duration is the difference of arrival times between the first and last packets in a specified burst.

Burst Size is the sum of all data packets in a burst. The packet has application data, and headers of transport, network and MAC levels.

Packets per Burst are the total number of packets in a specified burst.

Burst Inter-arrival Time is the time duration between the arrival time of the last packet of a burst and arrival time of first packet of the next burst is referred as the burst inter-arrival time.

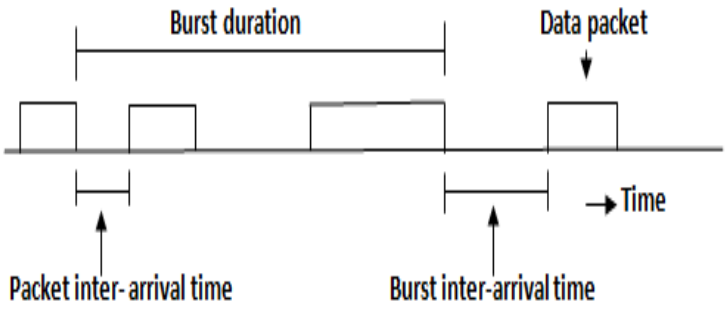

Figure 5: Schematic diagram of Performance metrics

System Requirements

Standard PC with Windows XP, Pentium III, 256 MB RAM, 2 Network cards (USB or Ethernet network card), 2 network cables, Wi-Fi access point or router and Working

internet connection. We need not to have IP address between hotspot node and internet as Hotspot node and Wi-Fi are connected with IP address.

Experimental Setup

In this paper, the system performance of the proposed WLAN hotspot network infrastructure is measured using OPNET Modeler simulation software. The OPNET™ Riverbed Academic edition software used for creating a simulated network and analyzing its networking metrics. We can simulate any network with a variety of equipment, including workstations, routers, switches, servers, and links between the devices.OPNET is a graphical network simulator. It is generally used for simulation of both wired and wireless communication networks. For our proposed set up, the infrastructure include: Five mobile nodes, Http Server, 100 BaseT and Access point and its important attributes are tabulated as in Table 1.

Table 1: Wireless Lan Attributes

Nodes	Model	Trajectory	Address
Mobile node 0	Wlan_wkstn_adv	Trajectory_2	Client address: Auto assigned
Mobile node 1	Wlan_wkstn_adv	Trajectory_1	
Mobile node 2	Wlan_wkstn_adv	Trajectory_3	
Mobile node 3	Wlan_wkstn_adv	Trajectory_4	
Mobile node 4	Wlan_wkstn_adv	Trajectory_5	
Access point	Wlan_ethernet_slip4_adv_1_upgrade	---	Server Address: Auto assigned
Http Server	Ethernet_server	---	

In Figure 6, the proposed WLAN system model utilizes the infrastructure components and attributes outline in the table 1. A Http server has the role authenticating and monitoring the overall network for efficient service delivery. Application Definitions were used for the creations of applications for traffic generation on the network. Profile Configuration used for the activity applications and always used by users through a period of time. After setting up the our model, a simulation was carried out to generate our graphical plots shown in this work

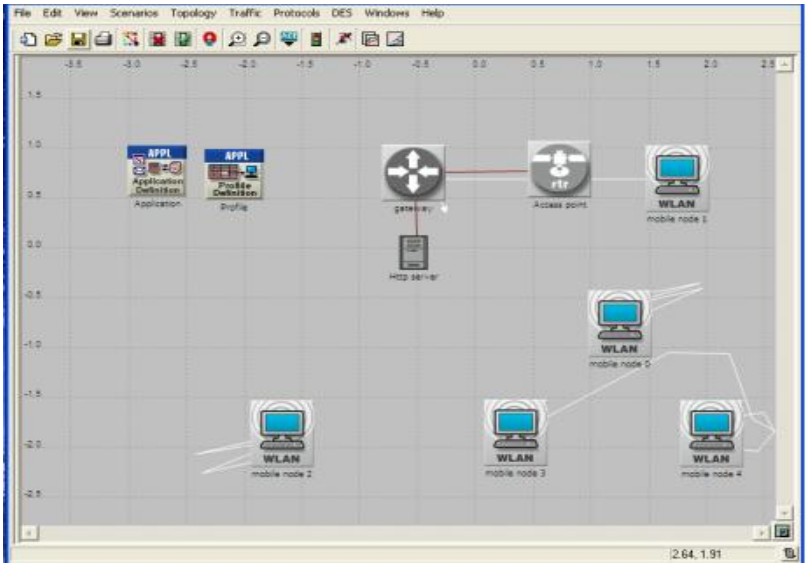

Figure 6: WLAN nodes setup with Server and Access point

Result & Discussion

Figure 6 shows the WirelessLan network used to create a self configurable network. WLAN access point (AP) is capable of relaying traffic coming from any of its neighbors. The metrics like wireless LAN average queue size, wireless LAN average load, average (in wireless Lan Data Traffic Received (bits/sec)), average(in wireless Lan Data Traffic sent(bits/sec)), throughput, delay and retransmission attempts have been used for performance analysis of the wireless computer networks using simulation through OPNET Modeler.

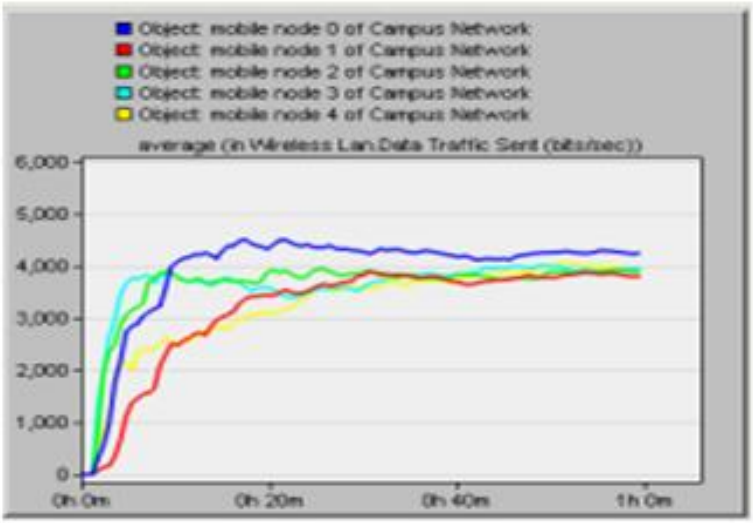

Figure 7: Average Data Traffic Sent (bits/sec) in Wireless Lan

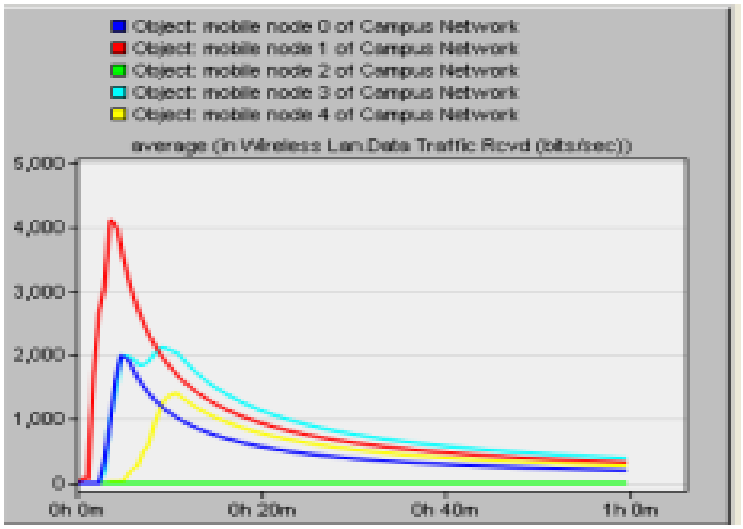

Figure 8: Average Data Traffic Received (bits/sec) in WLAN

Figure 7 & 8 shows the average data sent and received by mobile nodes in wirelessLan where all mobile nodes are using different trajectories (Table 1). The amount of data sent and received by the mobiles depends on their distance and its movement from the server. Figure 9 shows the overall load of the network when five mobile nodes are moving in different directions. Figure 10 indicates the throughput in wirelessLan network. In a wireless LAN, throughput is defined as the fraction of time that a channel is used to transmit payload bits successfully. Figure 11 shows WirelessLan Queue size (packets). Queue size can be studied based on the factors such as size, priority or time of arrival of data within queues. Average Retransmission Attempts in WirelessLan (packets) is shown in Figure 12.

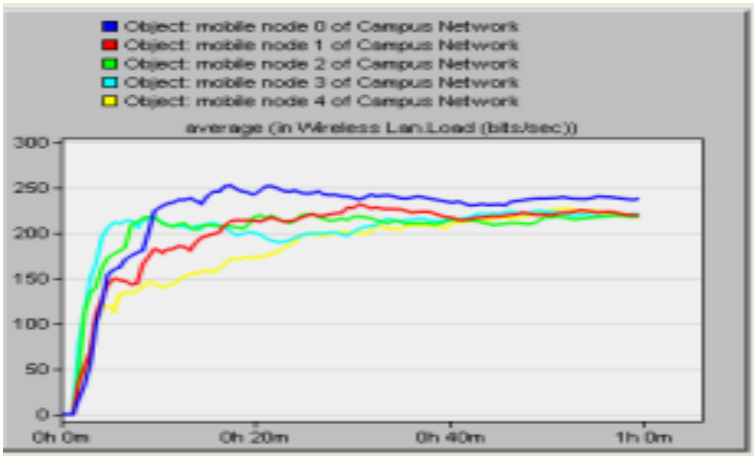

Figure 9: Average Load (bits/sec) in Wireless Lan

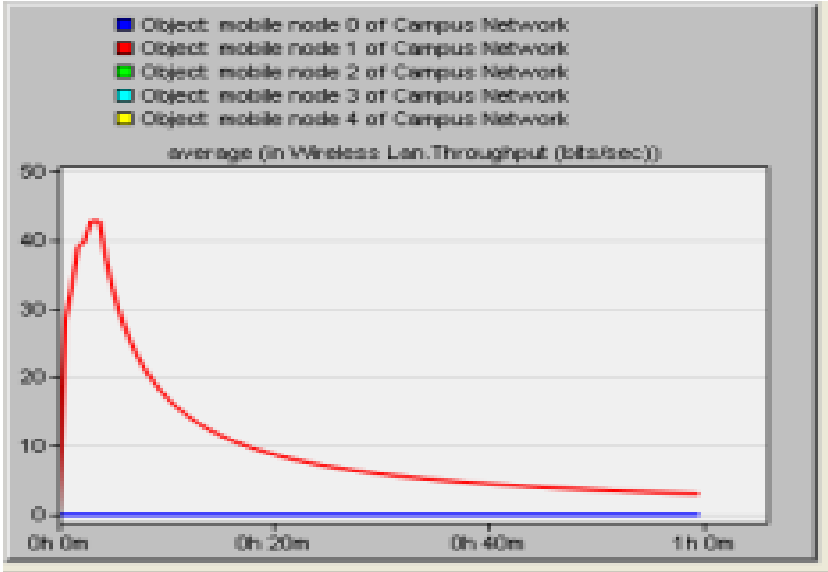

Figure 10: Average Throughput in WirelessLan (bits/seconds)

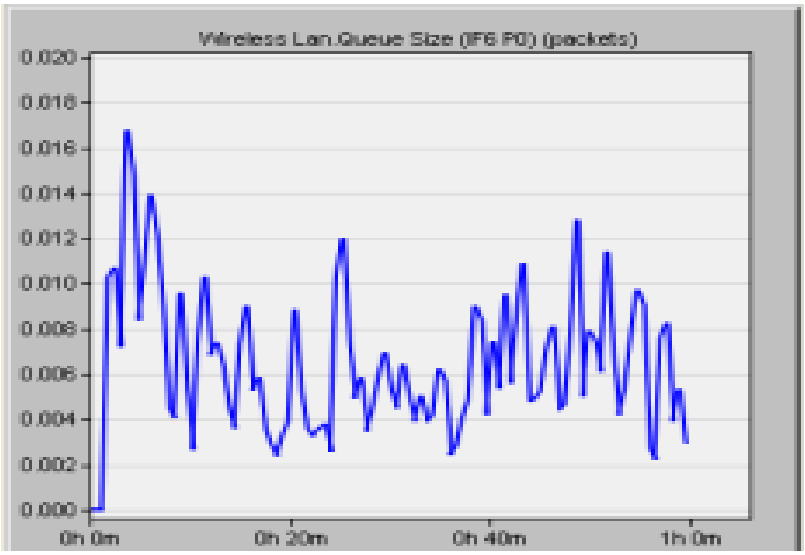

Figure 11: WirelessLan Queue size (packets)

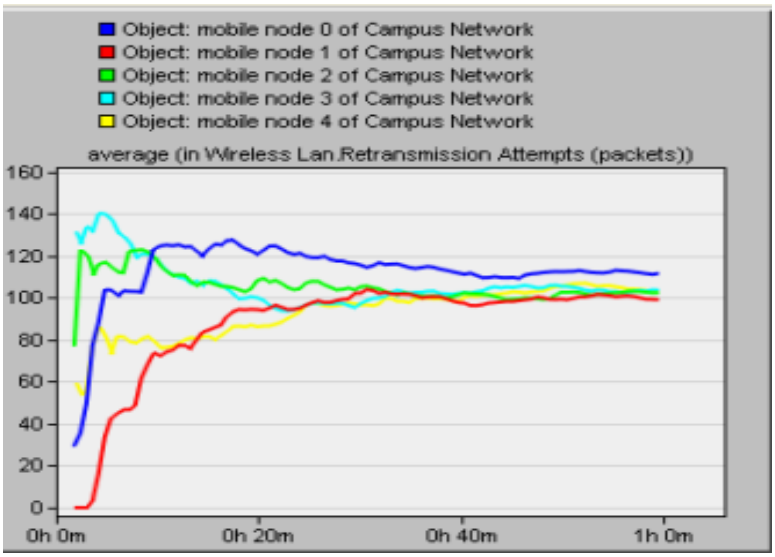

Figure 12: Average Retransmission Attempts in Wireless Lan(Packets)

Conclusion

In this paper, Wi-Fi access traffic of hotspot nodes for internet of things is studied. In our study various performance metrics of Wireless LAN is analyzed using Network Simulator Tool, OPNET. The simulation results show that IEEE 802.11b Wireless LAN is scalable within the specified limits of number of users. To obtain good quality of service of the network, an access point should always maintain limited number of nodes connected to it. We know that if load will increase, delay time also increase. When the load in a network is increased, the throughput also increases. So that packets are delivered without any distortion and retransmission rate is also very minimum. We observed possible impact of operating system (OS) or device on the wireless access traffic. Our paper (focusing the Wi-Fi based hotspot network) is mainly based on the simplification of the traffic. As well as packet loss is one of the main factor that limits the throughput of the Wi-Fi Hotspot traffic. Future study will concentrate to minimize the packet loss problem and power consumption.

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