Performance Metrics of WLAN for Different Applications using OPNET

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Abstract
Wi-Fi provides its users with the liberty of connecting to the Internet from any place without the hassles of plugging in the wires. It is quicker than the conventional modem for accessing information over a large network. This paper presents various performance metrics of WLAN in a simulated office environment for different applications namely File Print and Database Access using a Network Simulator Tool, OPNET. Multiple scenarios with varying number of workstations have been created with either one or two access point deployed to cater to the needs of these user workstations. From the simulation model suggested, we concentrate on our efforts to find out metrics namely network delay and throughput by varying numbers of user and data traffic. The results have been simulated by setting different parameters to optimize the performance of this Wi-Fi network. The simulation results show that IEEE 802.11b WLAN is scalable within the reasonable limits of number of users i.e. its performance for different applications like file print and Database access doesn't deteriorate even for increased number of users.

Keywords: WLAN, File Print, Database Access, Delay, Throughput, OPNET.

I. INTRODUCTION

The evolution of wireless networks in late nineties of previous century, technologies based on IEEE 802.11 has flourished resulting in wireless LANs (WLANs) getting deployed almost ubiquitously. These deployments have changed the way people think about networks, by offering users freedom from the constraints of physical wires. Mobile users are interested in exploiting the full functionality of the technology at their fingertips, as wireless networks bring closer the "anything, anytime, anywhere" promise of mobile networking.

Technically Wi-Fi is referred as the 802.11 communications standard for WLAN (Wireless Local Area Networks). IEEE 802.11b, IEEE 802.11a, IEEE 802.11g and IEEE 802.11n are the various standards developed to meet customer's variable needs [1]. To meet our objectives, we have used OPNET (Optimized Network Engineering Tool) that provides a comprehensive development environment supporting the modeling of communication networks and distributed systems [2, 3, 4, 5, 6]. In this paper, we have concentrated our efforts on 802.11b having a data rate of 2 Mbps operating on 2.4 GHz frequency band. [7, 8]

II. RELATED WORK

Wi-Fi network simulation analysis has drawn a lot of attention recently. There have been a large number of researchers using simulation approach to predict the nature and performance metrics of the networks using various simulation tools resulting in literature full in both quality as well as quantity.

Cathy Zhang *et al.* in [9] which represents a Wi-Fi network and a subnet is created to represent the office wireless network. Within the subnet, one or two Access Point (AP) is used as a wireless router to transmit wireless signals, and various numbers of workstations according to different scenarios. The AP is connected to a switch and then connected to a server which provides applications used for the workstations. But in our study AP is directly connected to the server without using switch.

Another researcher Onubogu O.J. et. al in [10] shows the simulation study of the performance of IEEE 802.11b using protocol parameters such as data rates, RTS/CTS threshold, fragmentation threshold and buffer size on the performance metrics — throughput, delay, dropped data and retransmission

attempts using OPNET IT Guru Academic Edition 9.1.

III. PROPOSED SCENARIO DESIGN

In this particular paper, we have considered 100m x 100m office area network for our simulation study purpose. Here, multiple scenarios have been created with either one or two access points and a variable number of workstations.

Our study has been based on infrastructure operation mode. In this mode, the wireless network consists of at least one AP (access point) connected to the wired infrastructure. All the wireless stations are connected to the AP. An AP controls encryption on the network and also route the wireless traffic to a wired network.

Table 1 Simulation parameters

Wi-Fi Parameters	Value
Data rate	2 Mbps
Physical characteristics	Frequency Hoping
Transmitted Power	7.33 E-14 W
Bandwidth	2.4 GHz

3.1 SIMULATION SCENARIOS

Case 1: Single AP and Two Workstations

This scenario is to monitor the performance for a simple structure with only one AP and two workstations. Throughputs and MEDIA ACCESS delays are analyzed for two applications applied to the workstation gradually.

Configurations are as following:

Applications: File Print, Database Access (all with high load).

Simulation Duration: 3 hours

Simulation Running Time: different for each scenario.

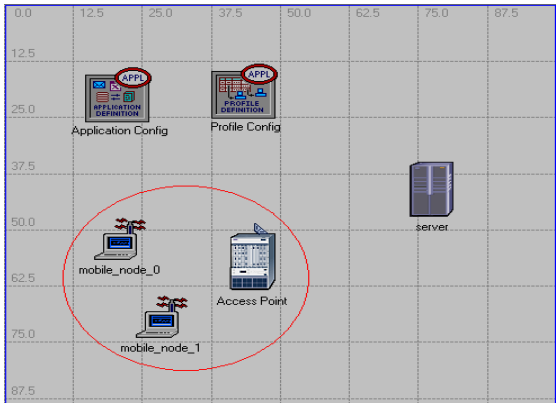

Fig.1 Scenario with 1 AP and 2 Workstations

Case 2: Single AP and Multi-Workstations

In case 2, we break our work into several sub-cases, and each sub-case consists of few scenarios, so we can investigate the AP delay time due to different situation arising because of multiple workstations. We would also determine the means to limit the AP performance in order to reduce the AP delay time.

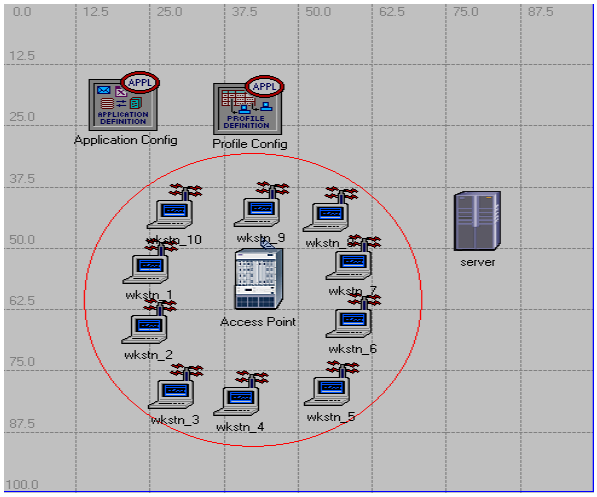

Fig. 2 Scenario with 1 AP and 10 Workstations

Sub case 1: 10, 20 workstations with same applications

In this sub-case, we are running 2 scenarios by increasing the number of the workstations from 10 to 20.

Simulation Duration: 3 hrs for each scenario.

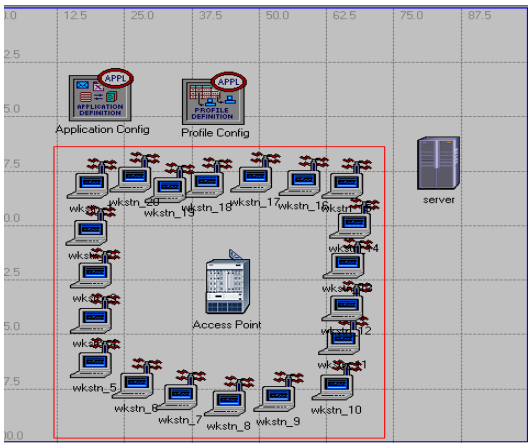

Fig. 3 Scenario with 1 AP and 20 Workstations

Sub case 2: 20 workstations & 2 AP's with same applications

In this scenario, we have a server connected to 2 access points and 20 workstations with 10 work stations are connected equally to each of its closet access point by assigning the correct BSSID. This is the special case of delay reduction. This delay reduction happens because of the less load on each of the access point as both access points supplement each other in sharing load. As the number of work stations decrease, load on the access point decrease resulting in improved performance and reduction in the delay time.

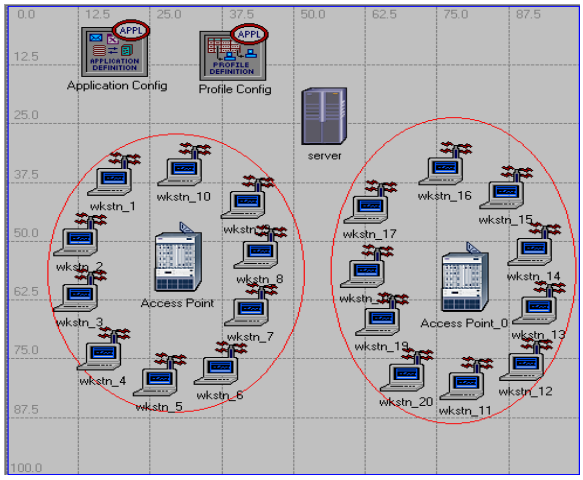

Fig.4 Scenario with 2 AP's and multiple Workstations

IV. RESULTS

This section presents selected results from our OPNET simulations. To validate the expected performance improvement, we compute expected throughput and Media Access delay for our designed project

4.1. Throughput

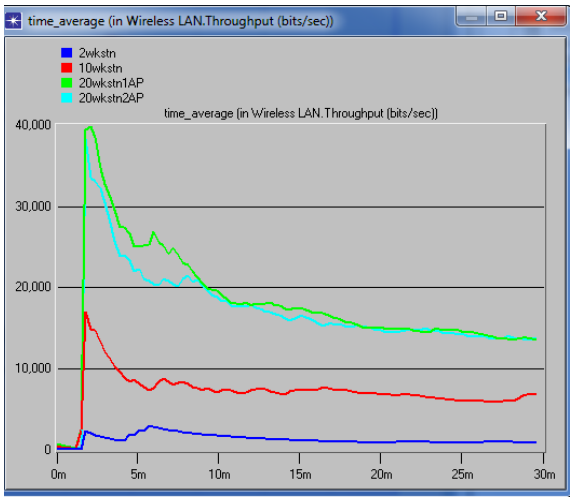

Fig. 5Throughput for File Print Application

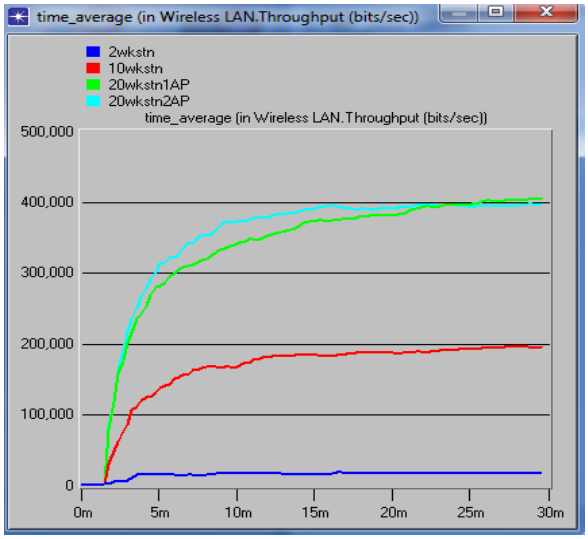

Fig 6 Throughput for Database Access Application

Figure 5 & 6 indicates the average throughput for different number of workstations attached to the access point; we can be observed that the average throughput increases as the number of nodes goes up.

This can be validated easily as more nodes mean more traffic which in turn increases the throughput as long as the network connection capacity has not been exceeded. In this case, all workstations are running FP (file print), and database access (all with heavy load).Maximum value of throughput for 20 workstations reaches up to approximately 40,000 bits in case of file print and approximately 400,000 in case of database access. The throughput is not only limit on what application we are running; it is also limited by the AP bandwidth and delay time. More workstation joined into network will use more bandwidth; therefore single station throughput is dropping by increase the total number of workstations in the network. Results show that throughput increases as the number of users increases which is similar for all applications.

4.2. Media Access Delay

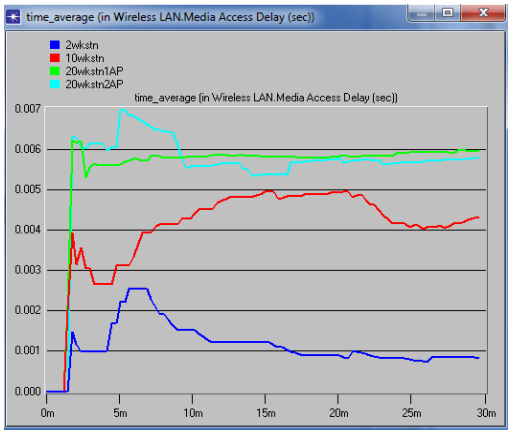

Fig.7 Media Access Delay for File Print Application

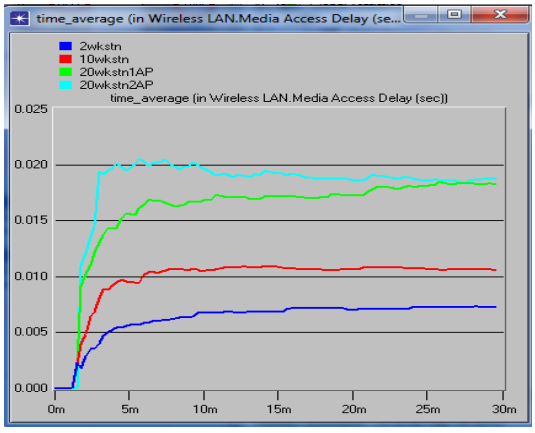

Fig.8 Media Access Delay for Database Access Application

The results in the Fig. 7 and 8 are for media access delay for different number of workstations. The media access delay for scenario with 20 workstations and 1 AP is maximum of the order of 0.007 sec with file print application, 0.020 with database access. At the beginning of 20 workstation scenario, the decrease of delay time is because the AP don't know how much data that 20 workstation is going to transfer, AP limit the workstation throughput and slowly increased to reach the maximum bandwidth where AP has the maximum delay. Media access delay for scenario with 2 AP's and 20 workstations is minimum. So, results reveal that the scenario with 2 AP's and 20 workstations is preferred over scenario with 1 AP and 20 workstations.

V. CONCLUSION

In this paper, we have greatly experienced the use of network simulation software – OPNET. We have simulated many different scenarios in infrastructure mode –1 AP and multiple work stations; 2 APs and multiple work stations; etc. By analyzing these scenarios we have concluded that, the delay time of an access point dependent on the amount of traffic load it has. The higher the load, the greater is the delay time. Therefore, an access point should always keep a limited number of work stations connect to it in order to maintain a good quality of service for the network.

VI. REFERENCES

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