

ENSC 895 - II: COMMUNICATION NETWORKS

FINAL PROJECT PRESENTATION

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OPNET Simulation of IEEE 802.11(WiFi)
and IEEE 802.16(WiMAX) in a small area

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ROAD MAP

- Introduction
 - WiFi
 - WiMAX
- Comparison
- Scope of this project
- Project setup
- Scenarios and results
- Conclusion
- Future Works



INTRODUCTION - WiFi

- In the past few years Wireless Local Area Network (WLAN) has been the most popular choice of communication.
 - Offers mobility and flexibility
 - Convenient and increases productivity
 - Relatively low cost to users

- WLAN is based on the IEEE 802.11 standard, also known as Wireless Fidelity (WiFi).
 - Introduced in the 1990s
 - Best-effort packet access network without using wires
 - Uses an unlicensed band
 - Quickly expanded into the consumer market and be embedded in many portable devices

INTRODUCTION - WiFi

- Today, millions of homes, offices, hotels, restaurants, airports and other public locations have WiFi high-speed WLAN connectivity.
- Wi-Fi usage popularity has increased by more than 4 times from year the 2004 to 2009 in every market around the world.

Table 1: Wi-Fi Users by Region (in thousands)

	2004	2005	2006	2009
Asia Pacific	32,937	55,341	81,048	168,193
Western Europe	16,681	24,877	33,546	63,746
Central and Eastern Europe	2,109	3,172	4,383	9,875
Latin America	2,386	3,401	4,528	8,331
Africa/Middle East	287	664	1,096	2,747
North America	20,570	30,235	40,454	74,174
Total	74,969	117,690	165,056	327,066

“Wi-Fi Gaining Traction,” *BusinessWeek*, Pyramid Research, Mar. 5, 2010. [Online]. Available: http://www.businessweek.com/technology/tech_stats/wifi051003.htm (Accessed: April 2010).

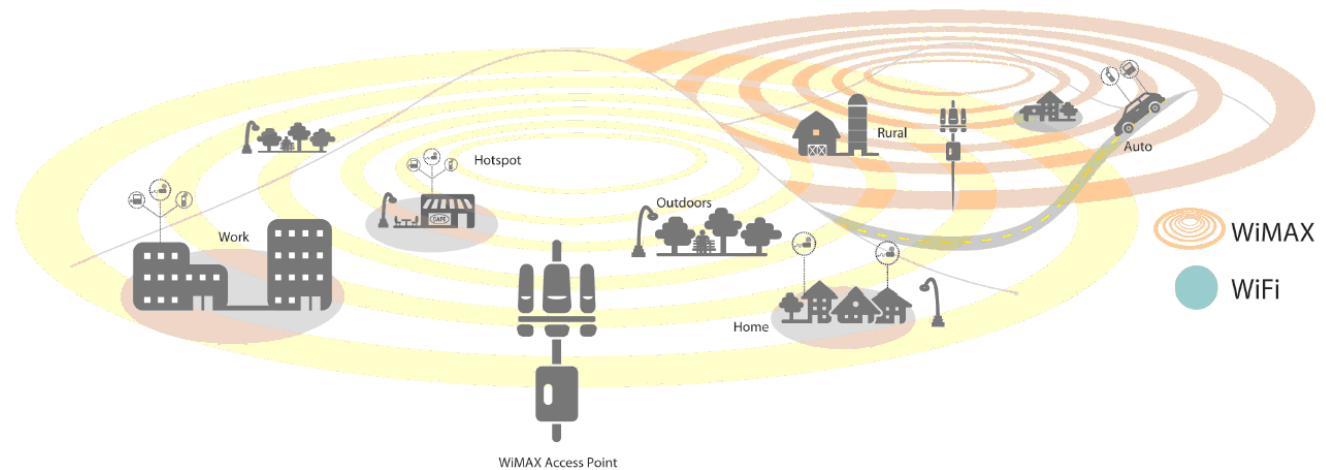


INTRODUCTION-WiMAX

- Worldwide Interoperability for Microwave Access (WiMAX), which is based on IEEE 802.16 standard, has similar general principles as WiFi with larger coverage and higher data rate.
- WiMAX Forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL"[8].
- WiMAX is a standard for providing wireless broadband access to large areas.
 - Can be easily and cost effectively deployed
 - Can support fixed and mobile users simultaneously
- In March 2008, WiMAX forum has projected there will be approximately 133 million WiMAX subscribers by the year 2012 [2].

WiFi & WiMAX COMPARISON

- Under optimal conditions WiFi has maximum of 54 megabits/second and WiMAX has about 75 megabits/second data rate.
- WiFi range is in order of tens of meters while WiMAX range is in the order of kilometers.



Motorola and Intel, WiMAX and WiFi Together: Deployment Models and User Scenarios, White paper [Online].

Available: [http://www.motorola.com/staticfiles/Business/Solutions/Industry%20Solutions/Service%20Providers/Wireless%20Operators/Wireless%20Broadband/wi4%20WiMAX/Document/StaticFile/WiMAX and WiFi Together Deployment Models and User Scenarios.pdf](http://www.motorola.com/staticfiles/Business/Solutions/Industry%20Solutions/Service%20Providers/Wireless%20Operators/Wireless%20Broadband/wi4%20WiMAX/Document/StaticFile/WiMAX%20and%20WiFi%20Together%20Deployment%20Models%20and%20User%20Scenarios.pdf) (Accessed: March 2010)



COMPARISON *continued*

- Although WiMAX greatly outperforms WiFi, user devices such as desktops, laptops and cell phones need to have WiMAX capability to be able to connect to WiMAX sources.
- Currently only few users have WiMAX-enabled devices.
- The majority have WiFi capability.



SOLUTION FOR USING WiMAX

- ❑ The best way to enjoy the advantage of the WiMAX system is to combine the WiMAX and WiFi systems together.
- ❑ By combining these two standards service providers can offer a more complete high speed broadband service to more users in different geographical areas.
- ❑ Users could purchase a WiMAX-WiFi router and then send data to their computers via WiFi.



SCOPE OF THIS PROJECT

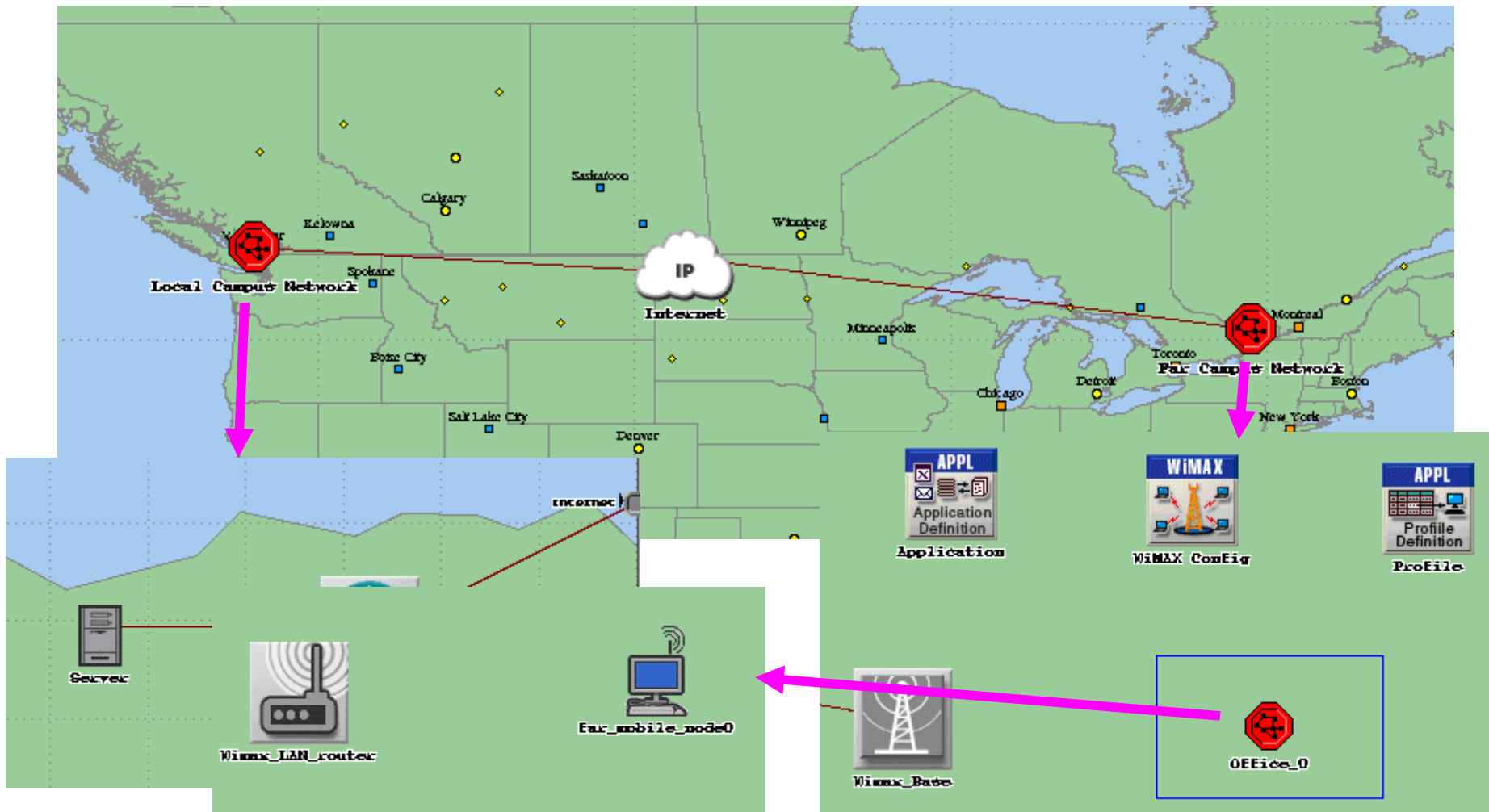
- For this project a WiMAX-WiFi link is setup.
- MPEG4 Video is streamed from a Server to the WiFi users, through WiMAX link.
 - Video is chosen for overloading the Wireless link.
- The MPEG4 Video used in this project is the Matrix III video [2].
- The performance of having 2 to 8 WiFi users connecting to a single Access Point (AP) is analyzed.
 - Delay
 - Throughput
 - Data dropped (Buffer overflow)
 - Jitter



SCOPE OF THIS PROJECT

- The effect of the different Multipath models are examined.
 - Vehicular & Pedestrian
- The maximum range of the WiMAX link and WiFi link, under optimal conditions with “Free Space” path loss model, are measured.
 - This test is done with maximum transmit power just to compare the simulation range difference of WiFi and WiMAX.

PROJECT SETUP



PARAMETER SETUP

WiFi 802.11g		
	AP (Access Point)	Mobile Node
Tx Power	0.1W	0.1W
Data Rate	11Mbps	11Mbps
Receiver Power Threshold	-95dBm	-95dBm
Buffer Size	1024000 bits	256000 bits
Short Retry Limit	7	7
Long Retry Limit	4	9
Large Packet Processing	Fragment	Fragment
Access Point Functionality	Enabled	Disabled

WiMAX		
	BS (Base Station)	SS (Subscriber Station)
Tx Power	20W	0.5W
Antenna Gain	15dBi	15dBi
Path Loss	Free Space	Free Space
Bandwidth	20MHz	20MHz

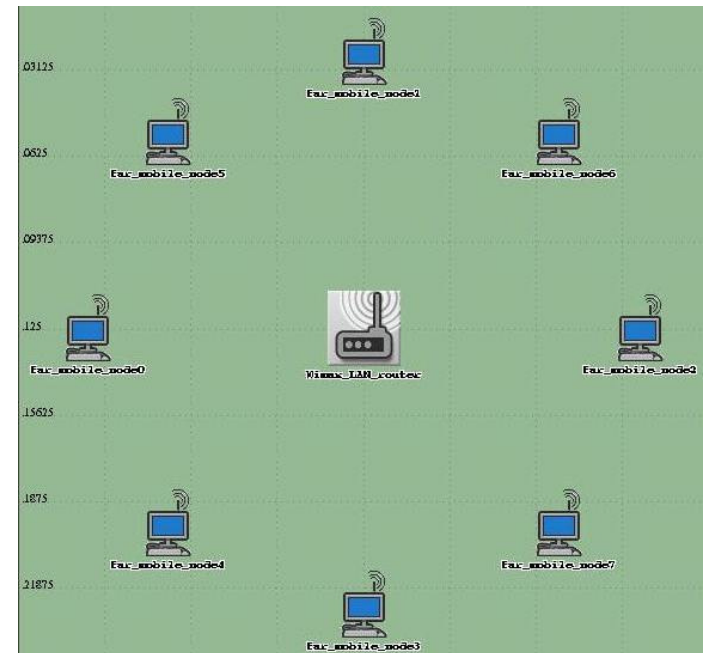
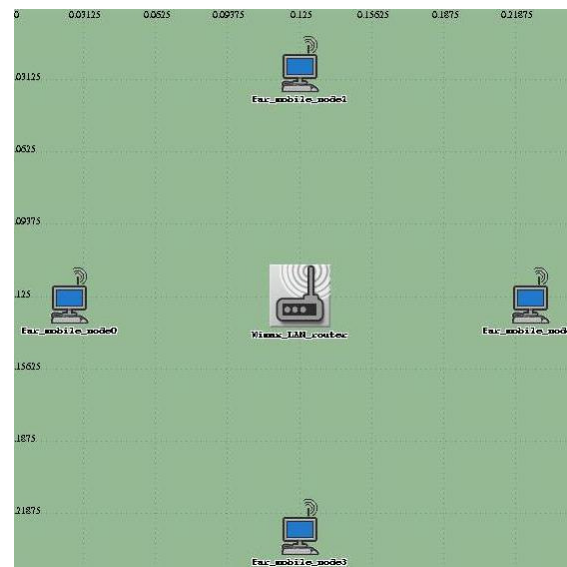
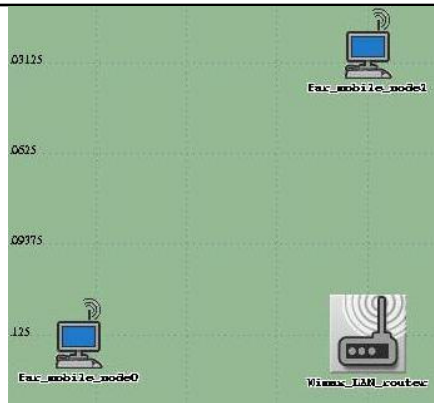
- The first 30 minutes of Matrix III movie in the MPEG-4 format was streamed from the server.



SCENARIO 1

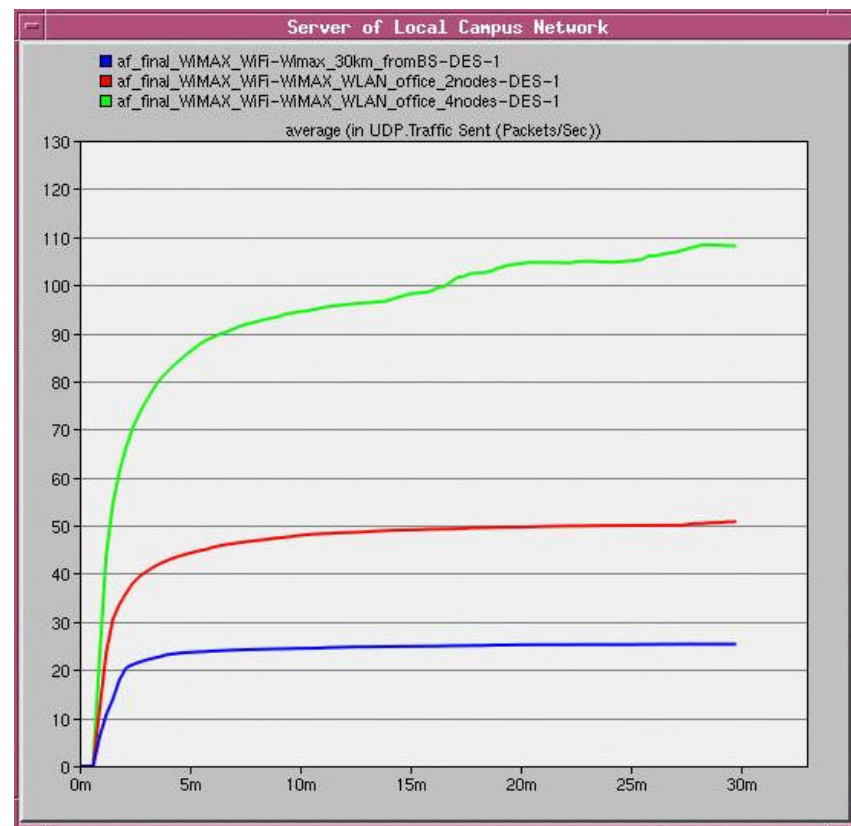
- ❑ For this Scenario the WiFi link is studied.
- ❑ Within the same office, the number of WiFi users are increased from 2 to 4 and then to 8 users.
- ❑ The distances of all WiFi mobile nodes are kept 100meters from the AP.
- ❑ Delay, Throughput, Delay-Variation and Data Packet Dropped are measured for each of the office configurations.

SCENARIO 1



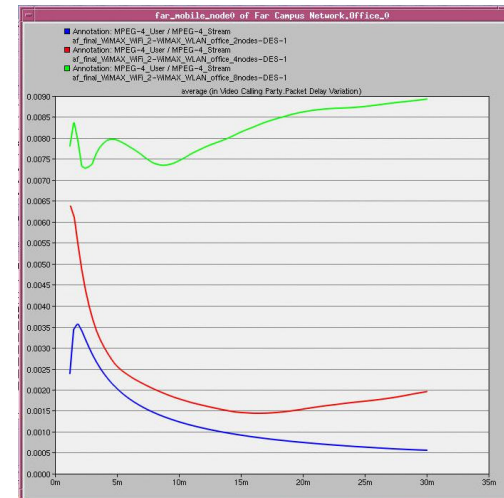
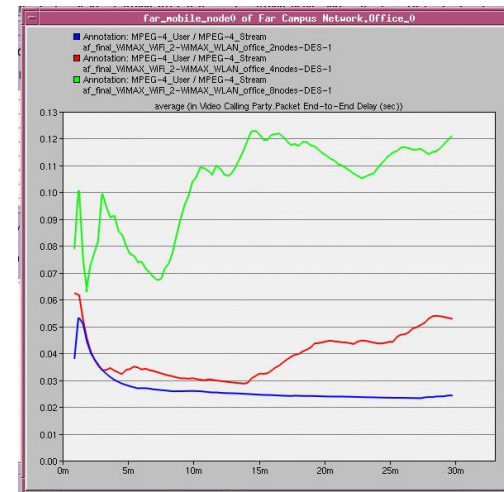
SCENARIO 1 RESULTS

- The **Average traffic sent** from the server is shown.
 - As the number of WLAN users increase from 2 to 4 the traffic sent is doubled.
 - Also as the number of WLAN users increase from 4 to 8, the traffic sent from server is again doubled.



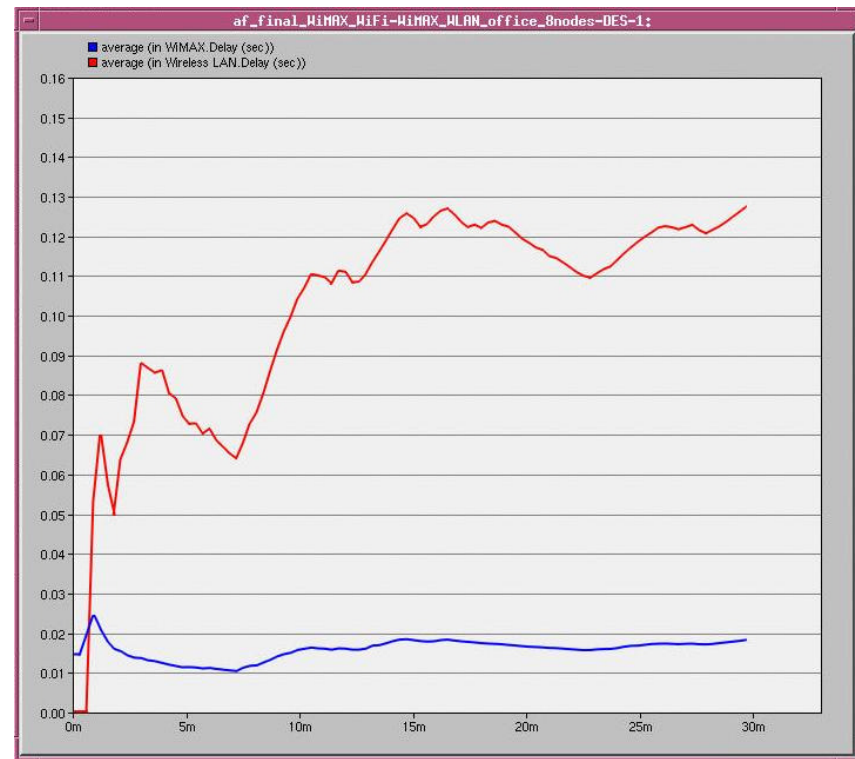
SCENARIO 1 RESULTS

- ❑ Packet end-to end delay and packet delay variation of the same WLAN user in a 2, 4 and 8 user office are compared.
- ❑ As the number of users accessing the same AP increases the end to end delay and the packet delay variations increase.



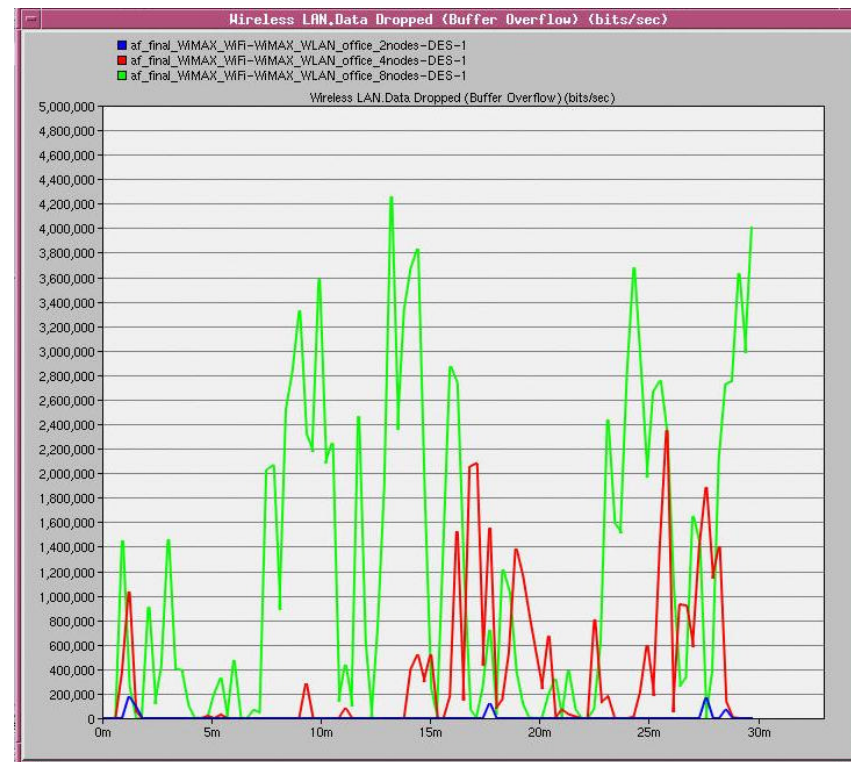
SCENARIO 1 RESULTS

- In order to prove that the delay is not caused by the WiMAX link, the **Global Statistics delay** of the **WiMAX** and **WiFi** links having 8 WLAN users are compared.
- The WiMAX delay is significantly lower than the WiFi delay. As expected, the delay is not caused by the WiMAX link.



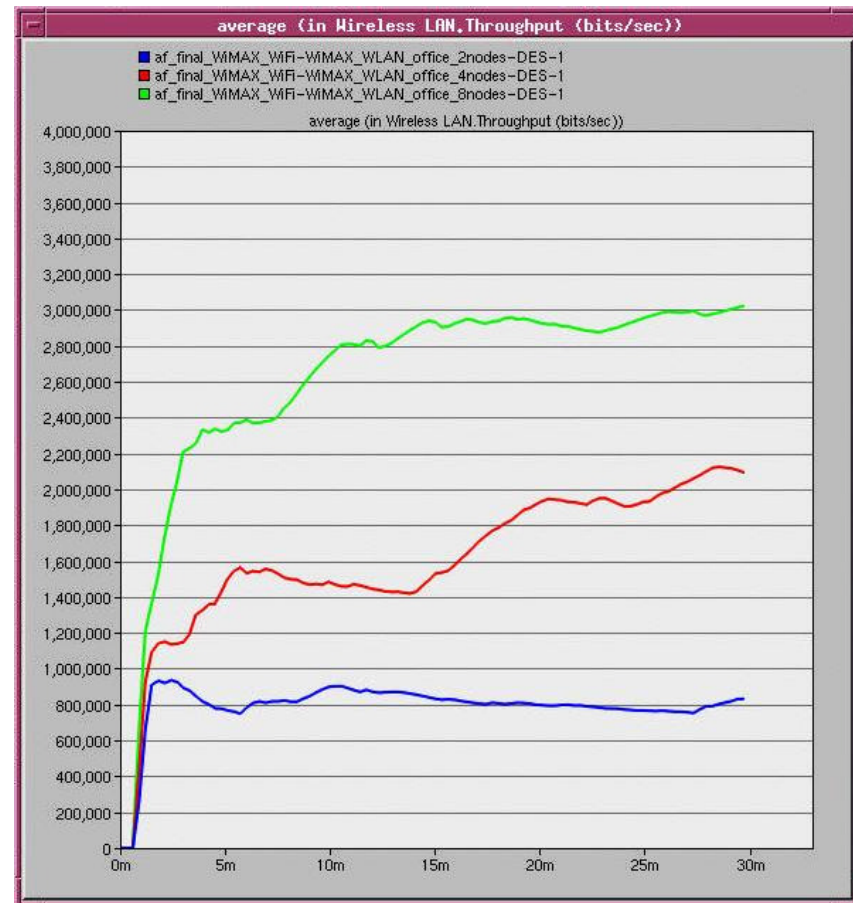
SCENARIO 1 RESULTS

- The Global statistics of the **WLAN Data Dropped (Buffer overflow) bits/sec** is shown.
- The WLAN Router Buffer size is 1024000bits. As the number of users increases the number of bits receiving at the WLAN router increases and buffer quickly overflows.



SCENARIO 1 RESULTS

- The **WLAN throughput** is shown.
- On average throughput increases approximately in the same order as the number of users increase.

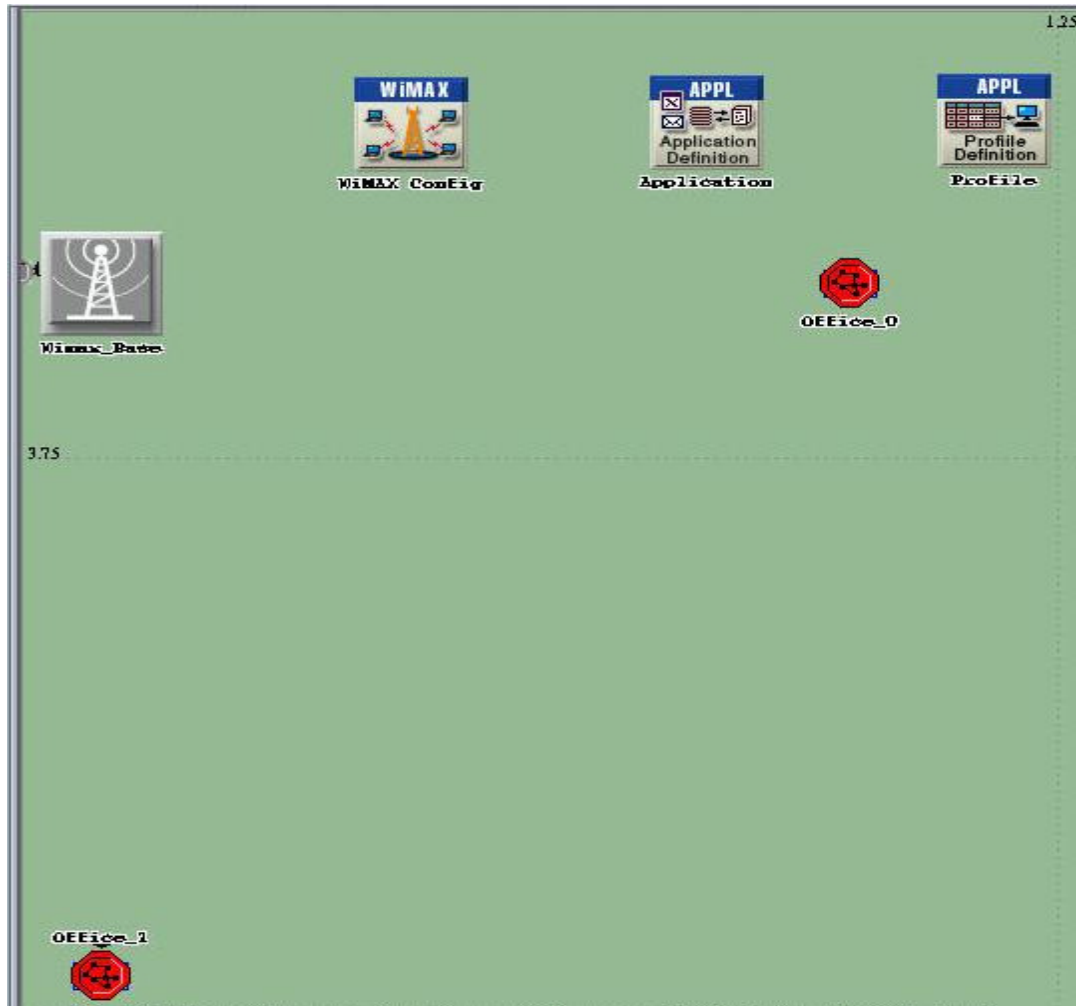




SCENARIO 2

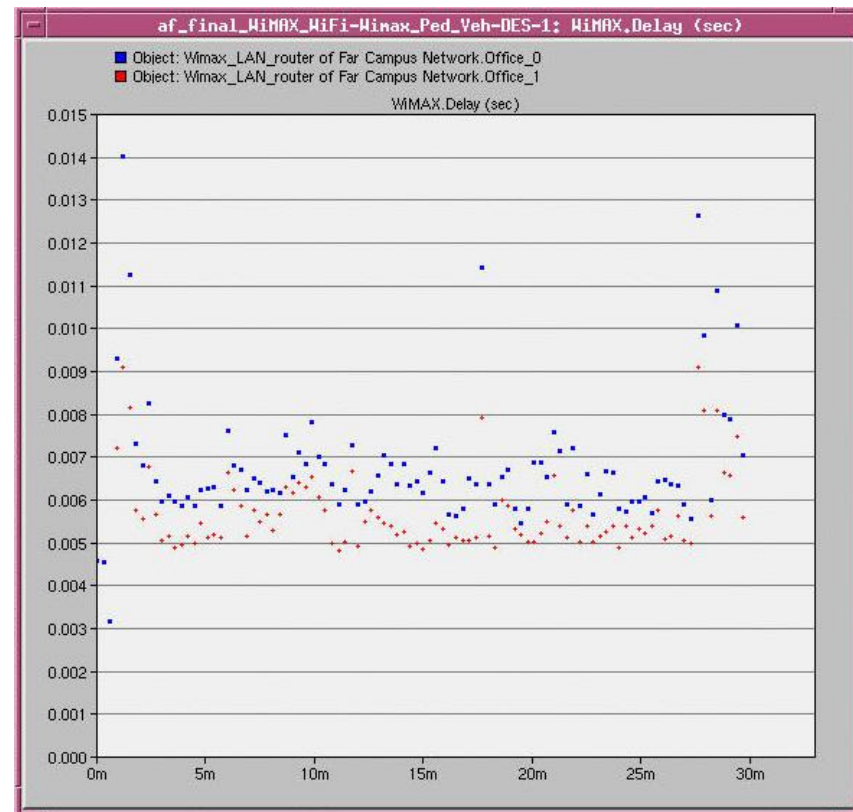
- One of the factors that affect the wireless link is the multipath effect.
- The effect of two multipath models are compared in the WiMAX link.
 - Vehicular
 - Pedestrian
- Two SS are place with 1Km distance from BS.
 - 1Km east of BS – Pedestrian multipath
 - 1Km south of BS – Vehicular multipath

SCENARIO 2



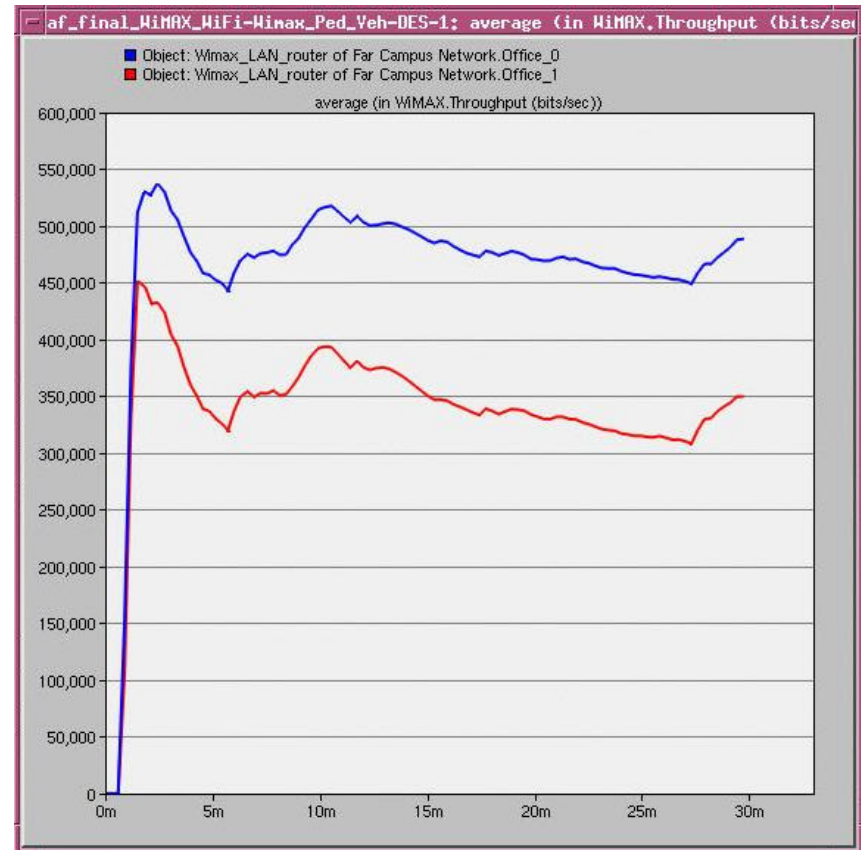
SCENARIO 2 RESULT

- The WiMAX link **delay** of the two offices are shown here.
- Although the two offices are at the exact same distance from the BS and both receive the same data with the same transmit power, The delay is not the same due to different multipath effects.



SCENARIO 2 RESULTS

- This is the **average throughput** of the two different multipath environments.
- The throughput is different as a result of multipath effects.
- For these models, on average the office with vehicular multipath has less throughputs than the one with pedestrian multipath.



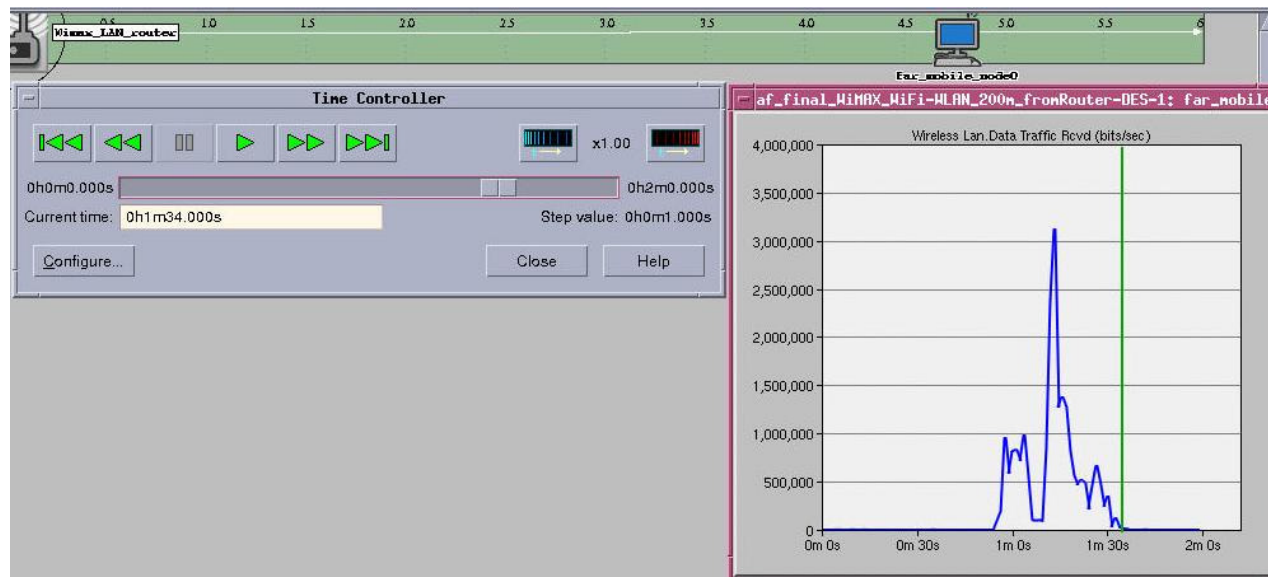
SCENARIO 3

- The Maximum range of the WiMAX link was determined by moving the SS node away from the BS with 1Km steps to find the point that data was not being received on the SS node.



SCENARIO 3

- The Maximum range of the WiFi link was determined by moving the Mobile node away from the AP by defining a trajectory.





SCENARIO 3 RESULTS

- The WiMAX link greatly outperforms the WiFi link.
 - WiMAX range was about 16 times more than the WiFi link.
- The WiFi range is 4.6Km and WiMAX range is 73Km.
 - This project is set up with an ideal situation, without having any path loss.



CONCLUSION

- In this project the effect of increasing the number of users accessing the same access point was studied.
 - In summary, as the number of users increase the overall WiFi link performance degrades.
 - The degradation is not proportional to the number of users.
- The multipath effect on the WiMAX link was observed.
 - Different Multipath environments affect the WiMAX link performance.
- The range difference of WiMAX and WiFi links were measured.
 - In my project scenario the WiMAX range was about 16 times more than the WiFi link.



FUTURE WORK

- Path loss was chosen to be “Free Space” for this project. This is not a realistic path loss. More realistic path loss model effects on the WiMAX link should be analyzed.
- The main focus was on the overloading the WiFi link and seeing the link performance effect of it. The same exercise should be done with the WiMAX link.

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