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OPNETWORK2011

Simulation and Performance Evaluation of WiFi and WiMAX using OPNET

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Roadmap

- Introduction to WiMAX and WiFi
- OPNET simulation setup
- Simulation results
- Conclusions and future work
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What is WiFi?

- Wireless Fidelity
- Based on the IEEE 802.11 standard
- It operates in 2.4 GHz frequency band and provides data transfer at maximum rate of 54 Mbps
- WiFi has two types of components: a wireless client station and an access point (AP)

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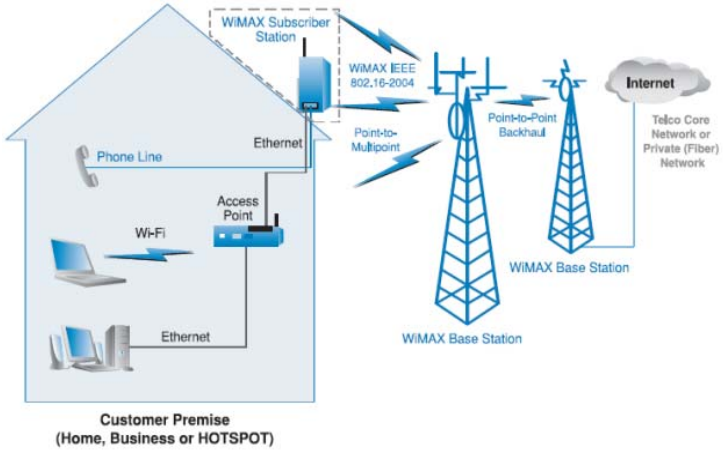
What is WiMAX?

- Worldwide Interoperability for Microwave Access
- Based on IEEE 802.16e standard
- Uses Scalable Orthogonal Frequency-Division Multiple Access (SOFDMA) rather than Orthogonal Frequency-Division Multiplexing (OFDM)
- It employs two multiple duplexing schemes: Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD)
- Provides bandwidth to hundreds of Internet subscribers with frequency band frame 10 GHz to 66 GHz



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Comparison between WiMAX and WiFi

WiFi

- Half duplex
- Used for wireless LAN applications
- Channel bandwidth of 20 MHz
- Employs modulation techniques: QPSK, BPSK, 16-QAM, 64-QAM
- Convolution code used for forward error correction
- OFDM (64-channels) radio technology
- Frequency spectrum of 2.4 GHz and 5 GHz bands

WiMAX

- Full duplex
- Used for broadband wireless access application
- Channel bandwidth between 1.25 MHz to 20 MHz
- Employs modulation techniques: QPSK, BPSK, 16-QAM, 64-QAM, 256-QAM
- Convolution code Reed-Solomon used for forward error correction
- OFDM (256-channels) radio technology
- Frequency spectrum of 2.3, 2.5, and 3.5 GHz bands

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Motivation

- WiMAX is readily available
- As of April 2011, WiMAX Forum claims there are over 582 WiMAX networks deployed in over 147 countries
- Today, one in ten people around the world use Wi-Fi at home and at work in countless ways
- Video conferencing is becoming very popular, which enables face-to-face and real-time communications

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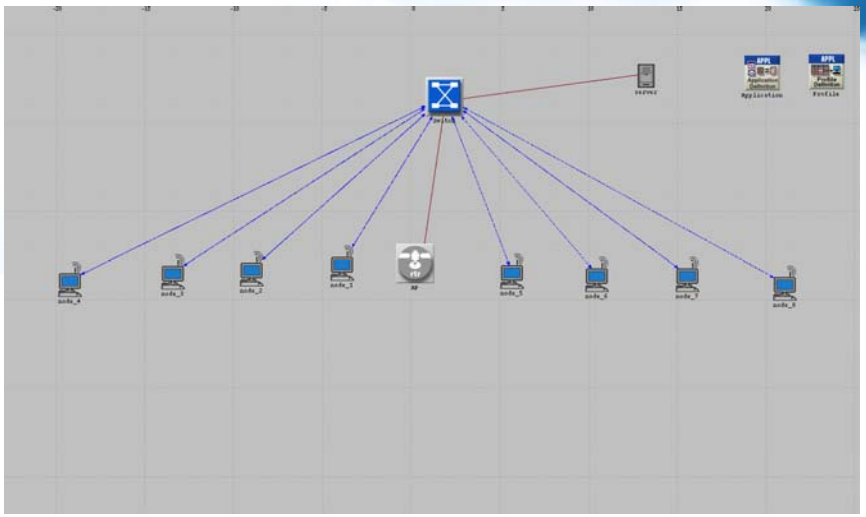
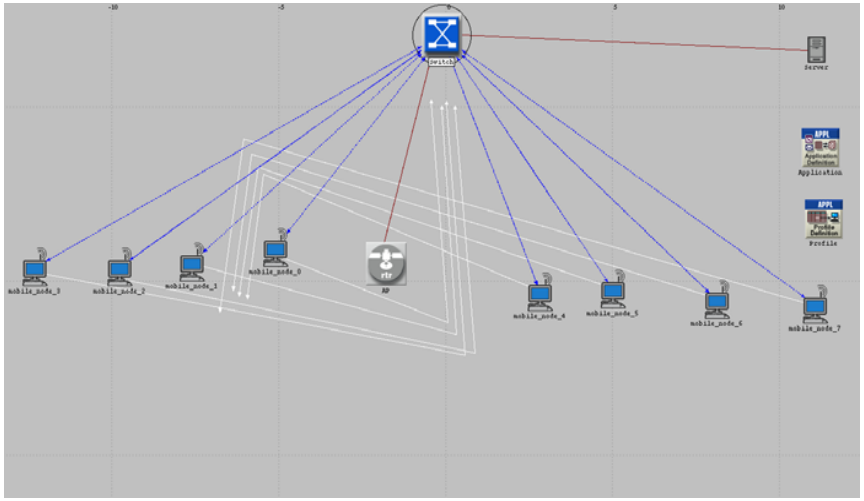
OPNET simulation setup

- OPNET models are developed for WiFi fixed and mobile stations in a small-scale network of 5 km × 5 km
- The first WiFi scenario consists of eight stationary workstations: node_0 to node_7
- In the second scenario, eight WiFi mobile stations are randomly located: mobile_node_0 to mobile_node_7
- AP is connected to the switch and to server by a link



Scenario one



Scenario two

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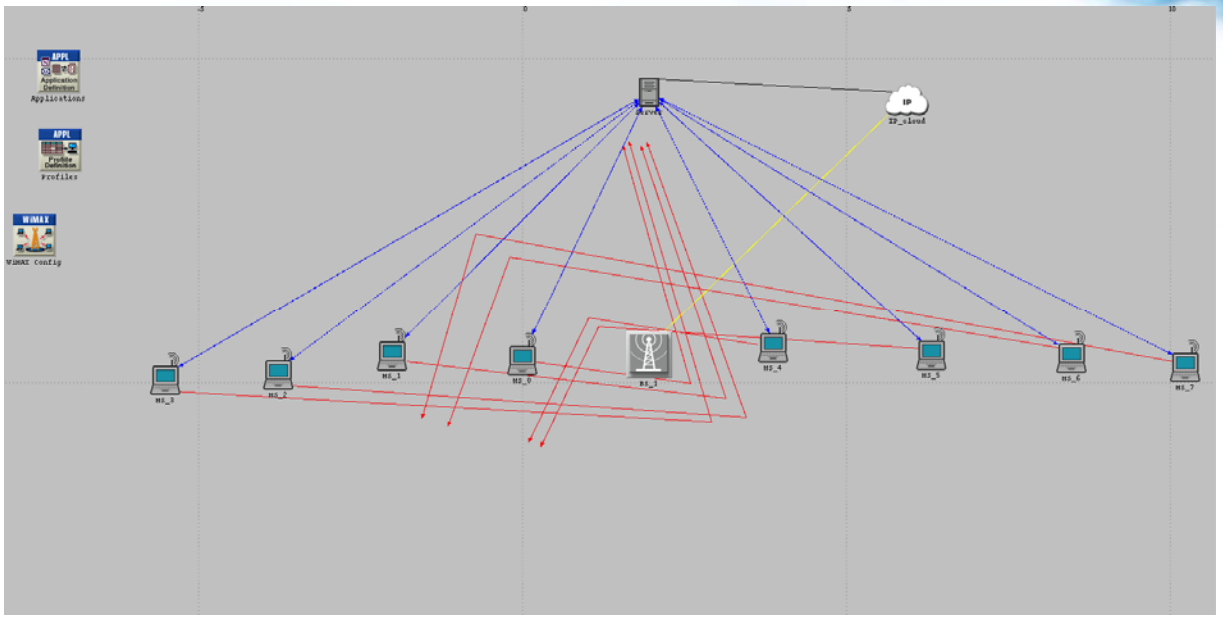
OPNET simulation setup

- WiMAX scenario with randomly located mobile stations
- WiMAX scenario has one BS and eight MS's that randomly move over defined trajectories that are identical to trajectories in WiFi scenarios



MS: mobile station
WS: work station
BS: base station

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Simulation parameters

- We applied the extended rate physical (PHY) layer (802.11g) standard for WiFi scenario with 24 Mbps date rate for both WiFi workstations and the AP
- The WiMAX parameters are:
  - antenna gain of 1 dBi
  - maximum transmission power of 2W
  - PHY profile wireless OFDMA with 5MHz
  - receiver sensitivity of -200 dBm
- The BS parameters for WiMAX scenario:
  - maximum number of SS nodes is 100
- Minimum and maximum power densities:
  - -100 dBm and -60 dBm

AP: access point

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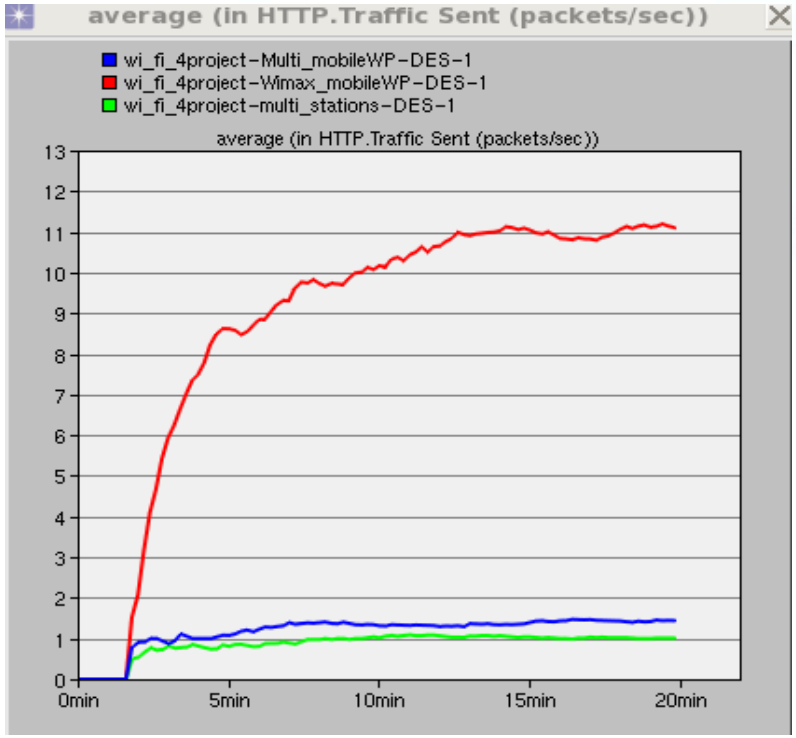
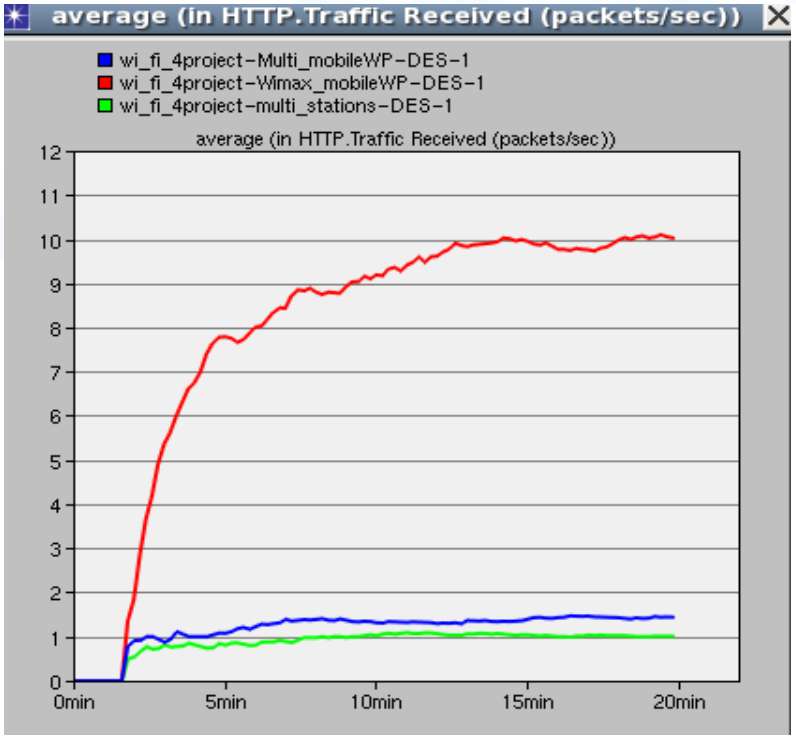
Simulation results: HTTP traffic



HTTP traffic sent by the server



HTTP traffic received by the server

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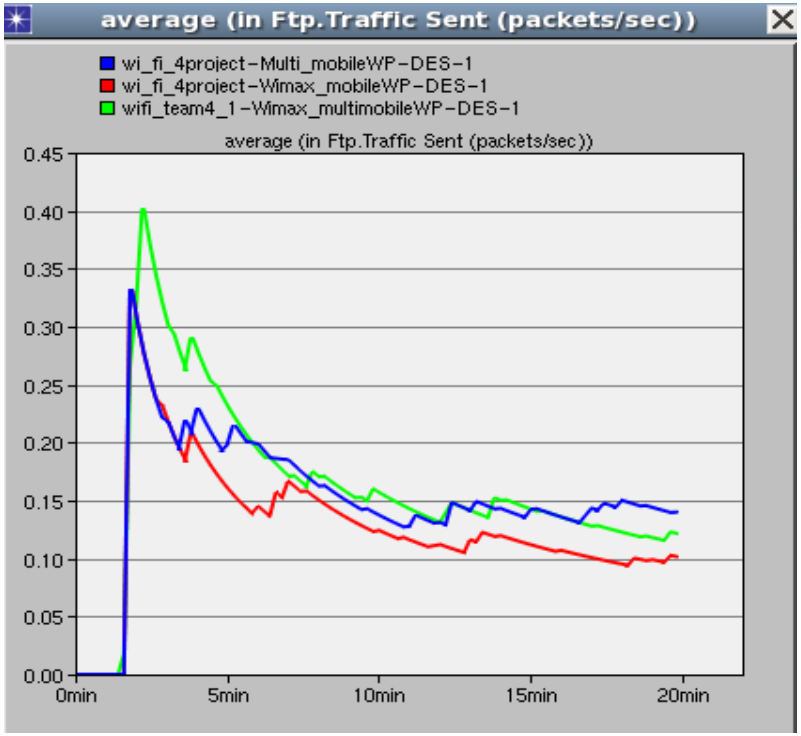
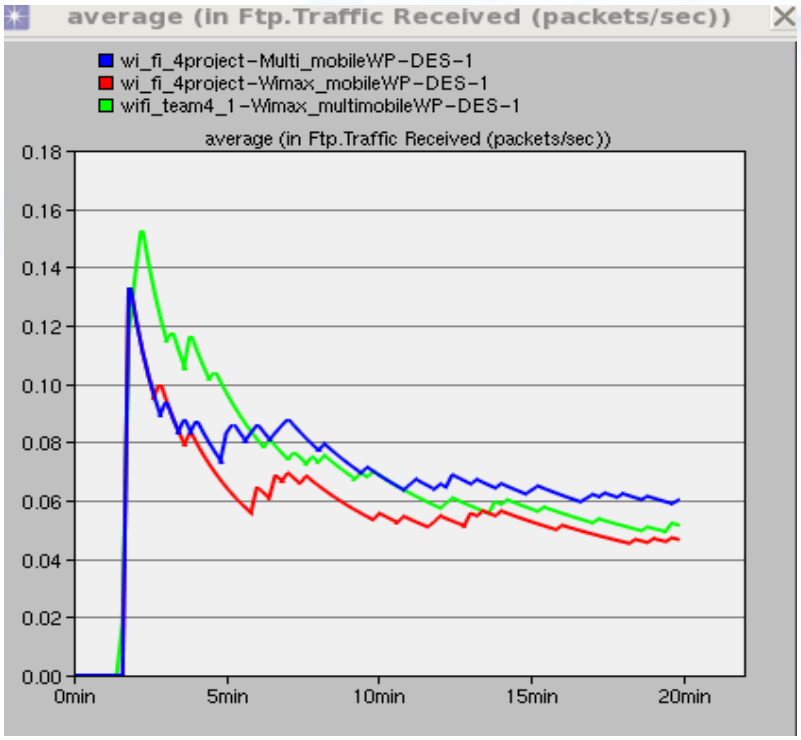
Simulation results: FTP traffic



FTP traffic sent by the server



FTP traffic received by the server

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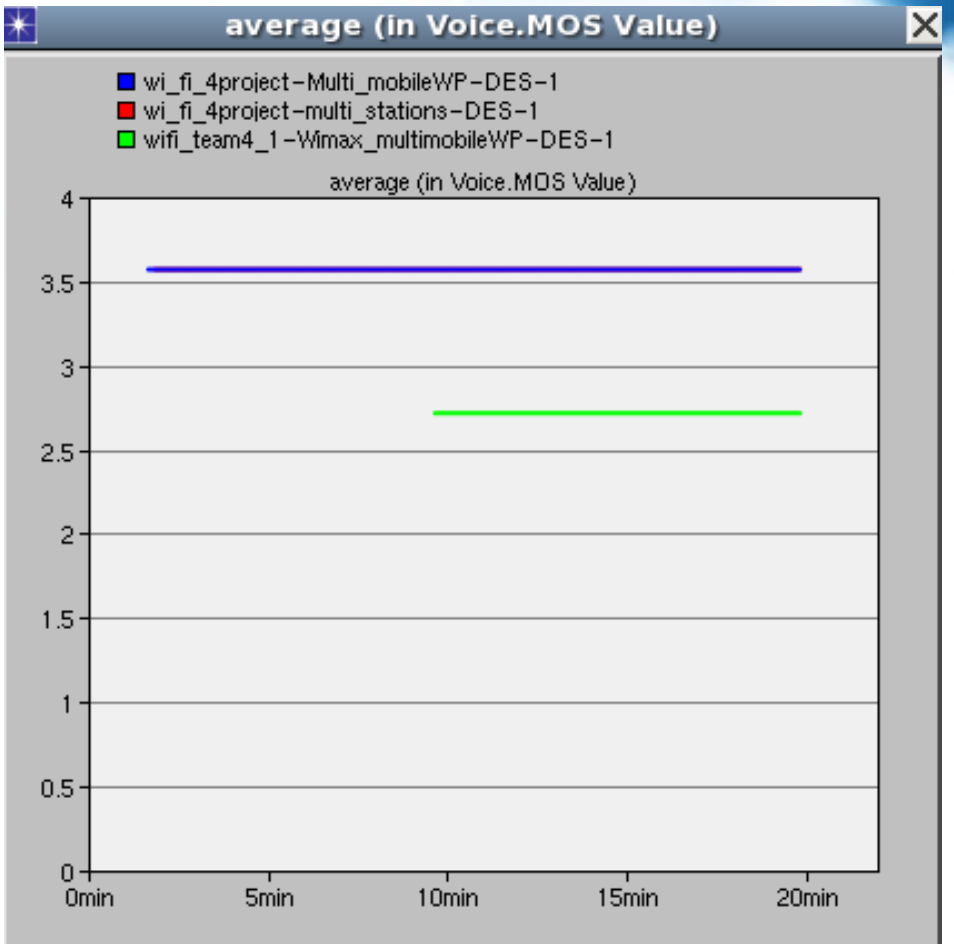
Simulation results: MOS

- Voice mean opinion score (MOS)
- MOS provides a numerical measurement of quality of voice signal transmitted
- Mobile WiFi has higher MOS value than mobile WiMAX



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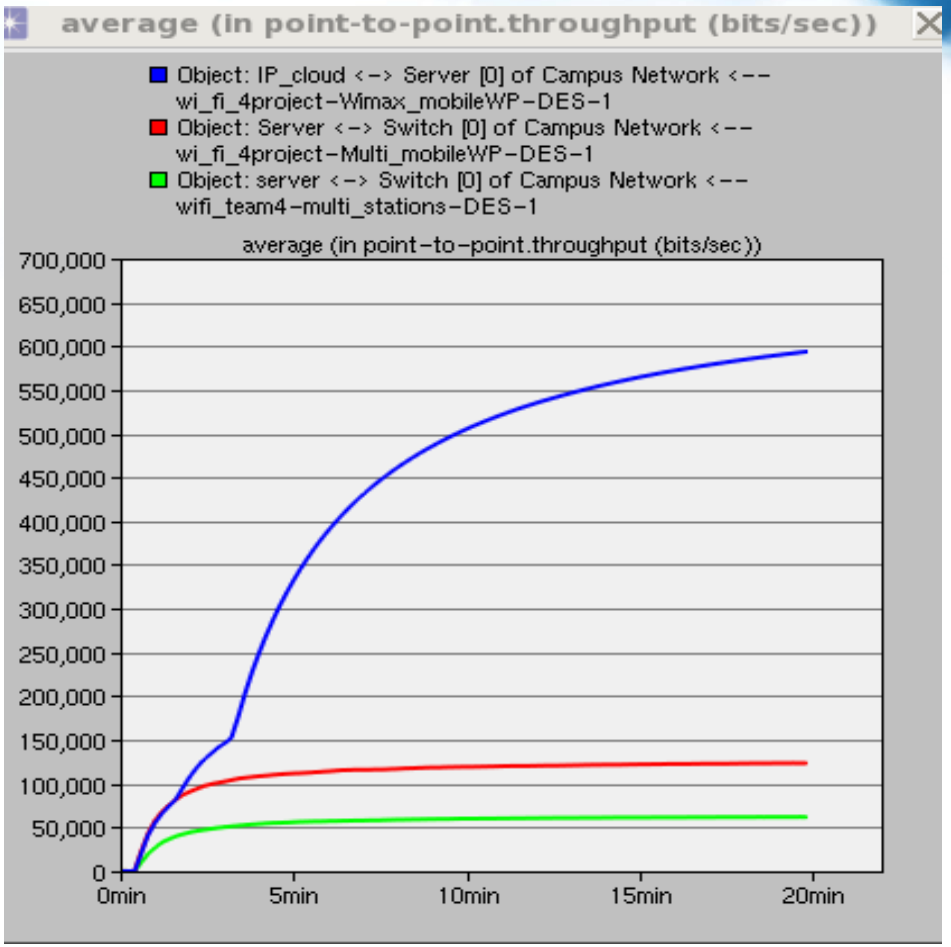
Simulation results: throughput

- Point-to-point throughput of the inward link to the server
- WiFi with moving stations has better throughput than fixed WiFi, which is due to the stations moving closer to the AP
- WiMAX has higher throughput compared to WiFi scenarios



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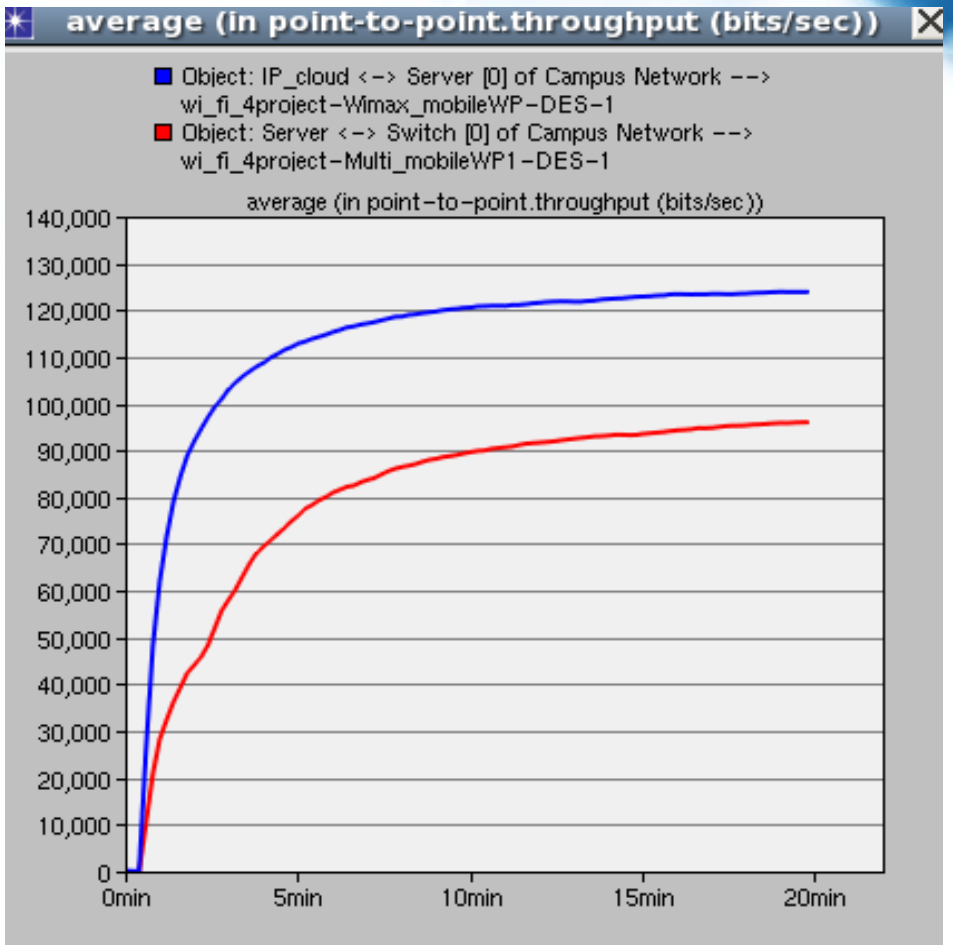
Simulation results: throughput

- Point-to-point throughput of the outward link to the server
- The throughput of the WiMAX network link that carries load from the server has higher point-to-point throughput



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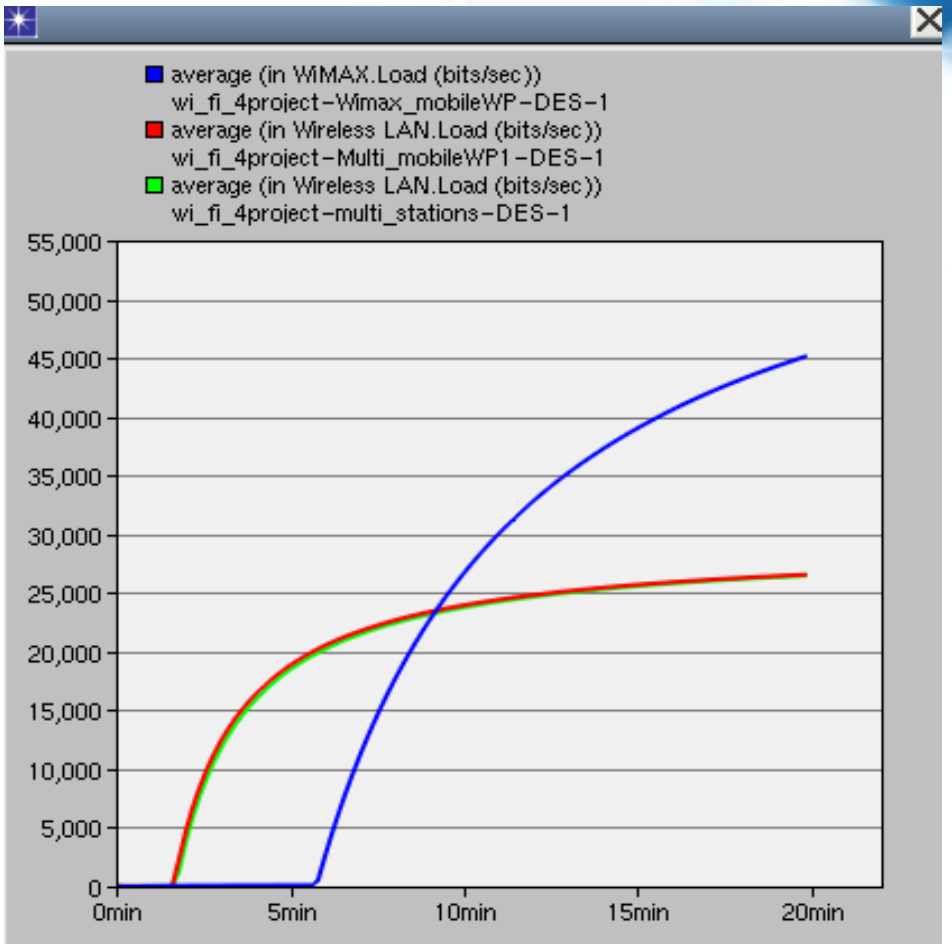
Simulation results: load

- The load carried by AP in WiFi and BS in WiMAX network
- Both WiFi networks carry 25,000 bits over the network while WiMAX carries 45,000 bits



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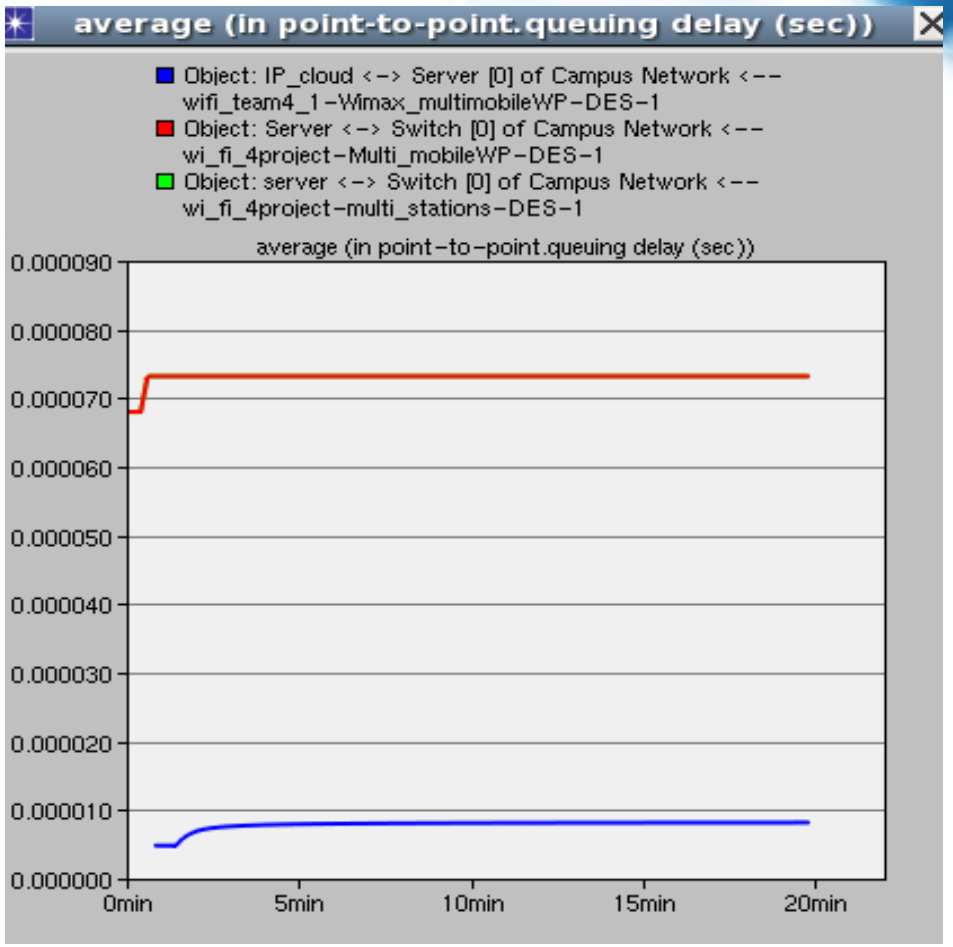
Simulation results: queuing delay

- The average queuing delay of the server to switch link in WiFi and the IP cloud to server link in WiMAX
- It represents the instantaneous measurement of packet waiting times in the queue of the transmitter channel
- Queuing delay for mobile WiMAX in a small area network is smaller compared to fixed and mobile WiFi



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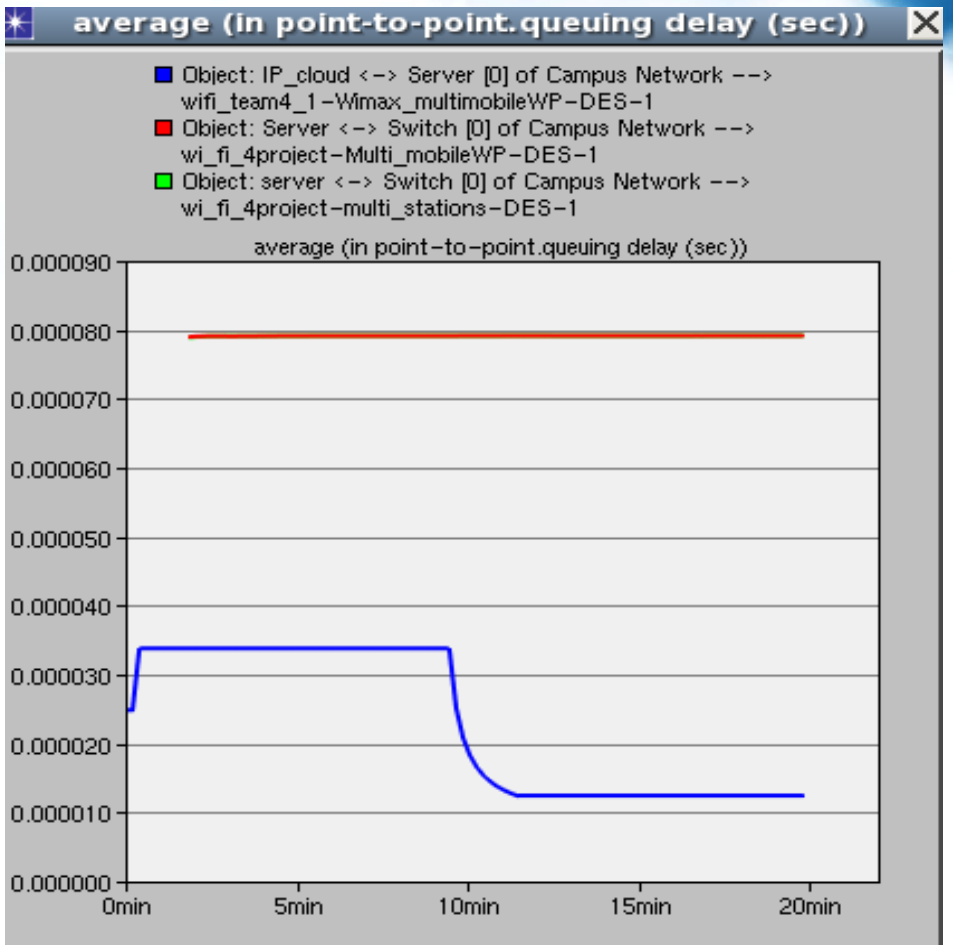
Simulation results: queuing delay

- The average queuing delay of switch to server link in WiFi and IP cloud to server link in WiMAX
- The measurements of the average queuing delay are taken from the moment when a packet arrives into the queue until the time when the last bit of the packet is transmitted
- In WiMAX scenario, the queuing delay of this link starts to decrease as the load starts to increase



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Conclusions

- Throughput of WiMAX is higher than WiFi
- WiMAX queuing delay is lower because WiMAX provides broadband service to carry heavier traffic load over the network
- WiMAX is more efficient for delivering more data with less queuing delay when compared to WiFi
- WiMAX can handle more load as compared to WiFi
- The base station and router delays in WiFi were compared and, as expected, the delay in WiFi router was higher than the delay in the base station

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Future work

- Comparison of WiFi and WiMAX in larger networks
- Handoff comparison in small network vs. large network
- Comparison of WiFi and WiMAX QoS
- Performance optimization with Request-to Send (RTS) and fragmentation

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