# ENSC 427
# Communication Networks
# Final Project Presentation
# Spring 2012

## Group 9

# Comparison of QoS between WiFi, WiMAX, and Ethernet LAN for Online Gaming Traffic



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# Roadmap

- Introduction
- Background Information
- Motivation & Scope
- OPNET Implementation
- Simulation Results
- Conclusions
- Future Work
- References

# Introduction

- Gaming is all around us
- Available through many different media
  - PCs
  - Phones
  - Portable handhelds
- Online gaming through PC represents of >4% of entire internet traffic[1]
- Mobile traffic represent ~10% of entire internet traffic[2]
  - 61% of people use mobile phones for gaming

# Introduction

Hardcore Gamers

# Introduction

Casual Gamers

# Introduction

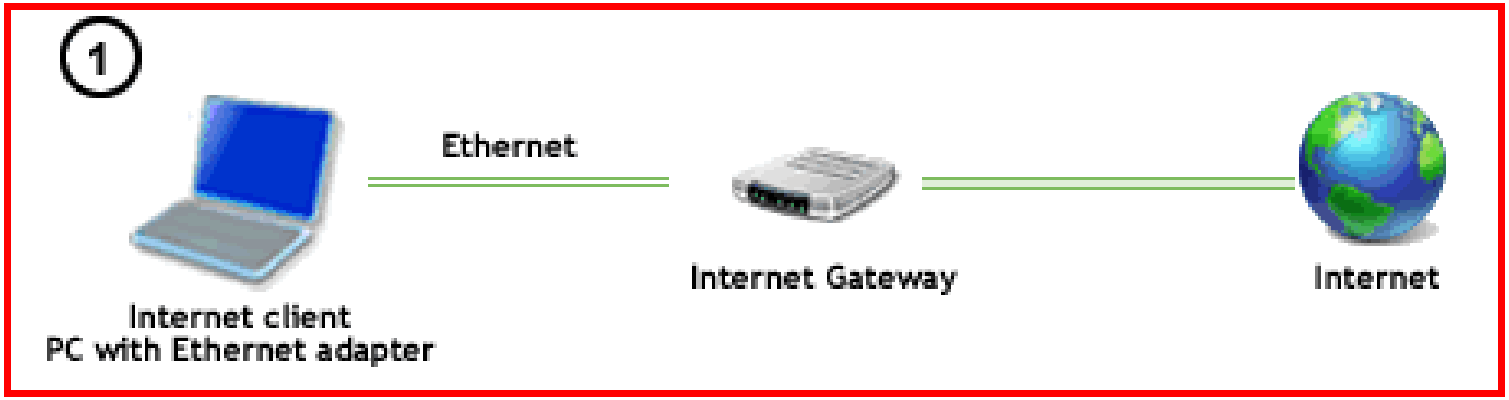
Professional Gamers


# Background Information

- Ethernet LAN (Local Area Network)
  - IEEE standard protocol for wired network communication introduced in the 1980's
    - IEEE 802.3 family
  - Allows for fastest transmission
    - Up to 100 Gbps
  - Wired communication reduces transmission errors
    - Becoming the one of the most reliable protocol for network communication

# Background Information

Ethernet cables



# Background Information

- WiFi (Wireless Fidelity)
  - Wireless LAN (WLAN) technology to allow devices to connect to the internet without any wires
    - IEEE 802.11 family
  - Using an access point or hotspot, wireless devices connect to these access points through radio waves
  - Limited range
    - Between 35 to 250m
  - Transmits up to speeds of 72.2 Mbps over a 20MHz channel or 150 Mbps over a 40 MHz

# Background Information

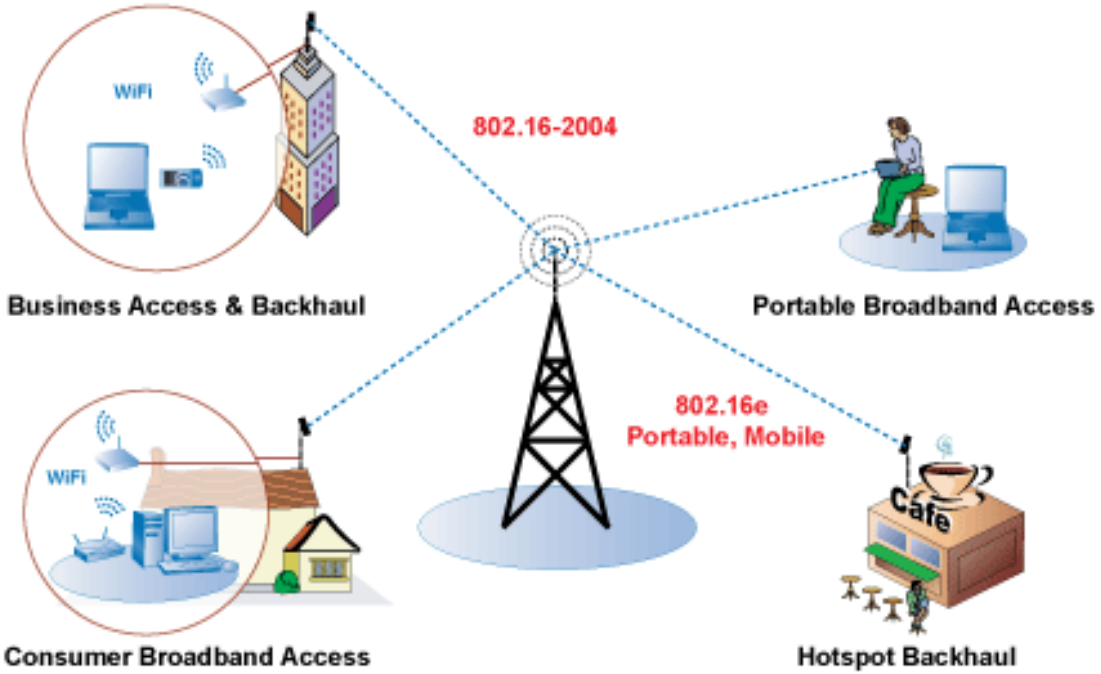
Illustration of how WiFi works

# Background Information

- WiMAX (Worldwide Interoperability for Microwave Access)
  - WLAN technology that uses base stations to transmit coverage for wireless devices
    - IEEE 802.16 family
  - Uses a WiMAX tower, similar to a cell tower, to transmit frequencies
  - Provides either high speed or far places but not both
    - Up to 365 Mbps downstream or 376 Mbps upstream through a 40MHz FDD channel
    - Up to 50 km in range through line of sight service

# Background Information

How WiMAX works



# Motivation & Scope

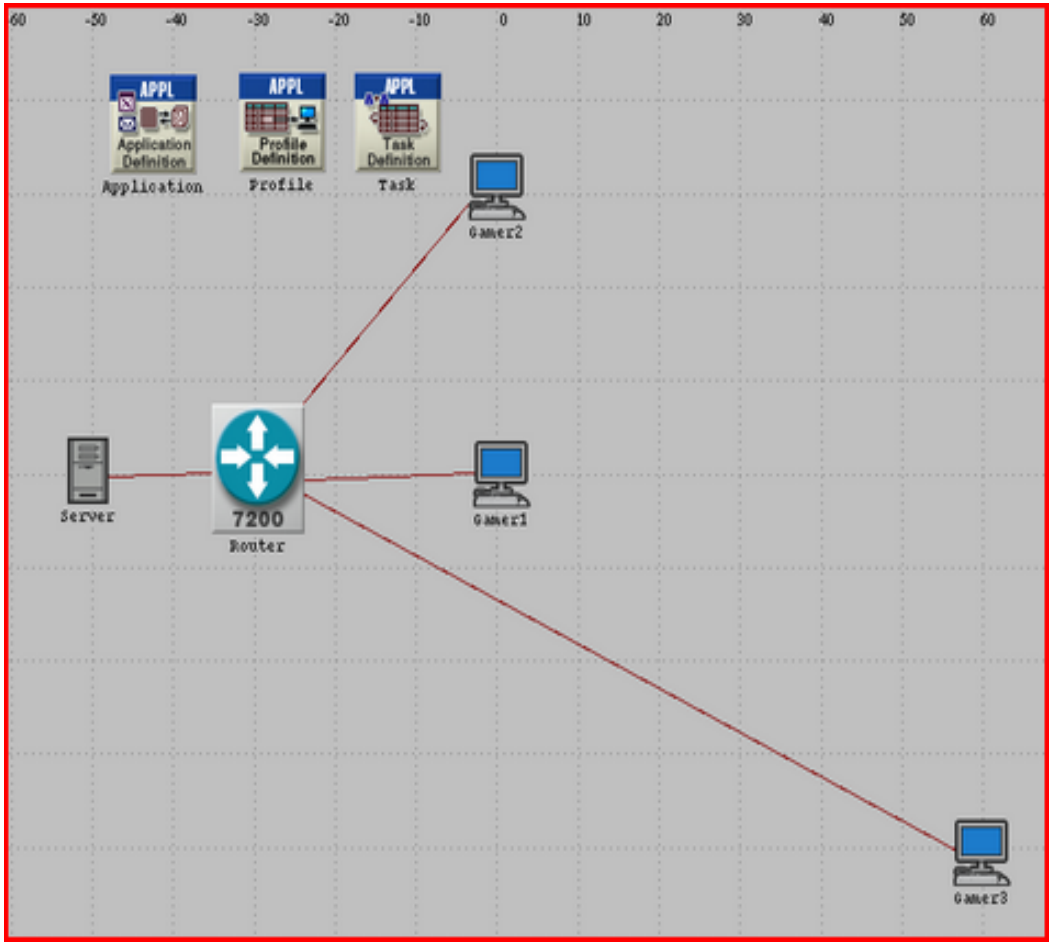
- Motivation
  - To have a better idea of how different network topologies affect our gaming world
  - To see how much better are certain technologies compared to others

- Our scope for this project is to measure the performance between Ethernet LAN, WiFi, and WiMAX
  - Ethernet LAN  acts as a baseline for the most optimal results
    - Compare network topologies together to see the difference in performance
  - Use QoS factors to analyse the performance

# OPNET Implementation

| | Ethernet LAN | WiFi | WiMAX |
|---|---|---|---|
| Model specification | IEEE 802.3u 100BASE-T | IEEE 802.11g | IEEE 802.16d |
| Data rate | 100 Mbps | 54 Mbps | 75 Mbps |
| Simulation Time | 15 minutes | 15 minutes | 15 minutes |
| Random Seed | 128 | 128 | 128 |

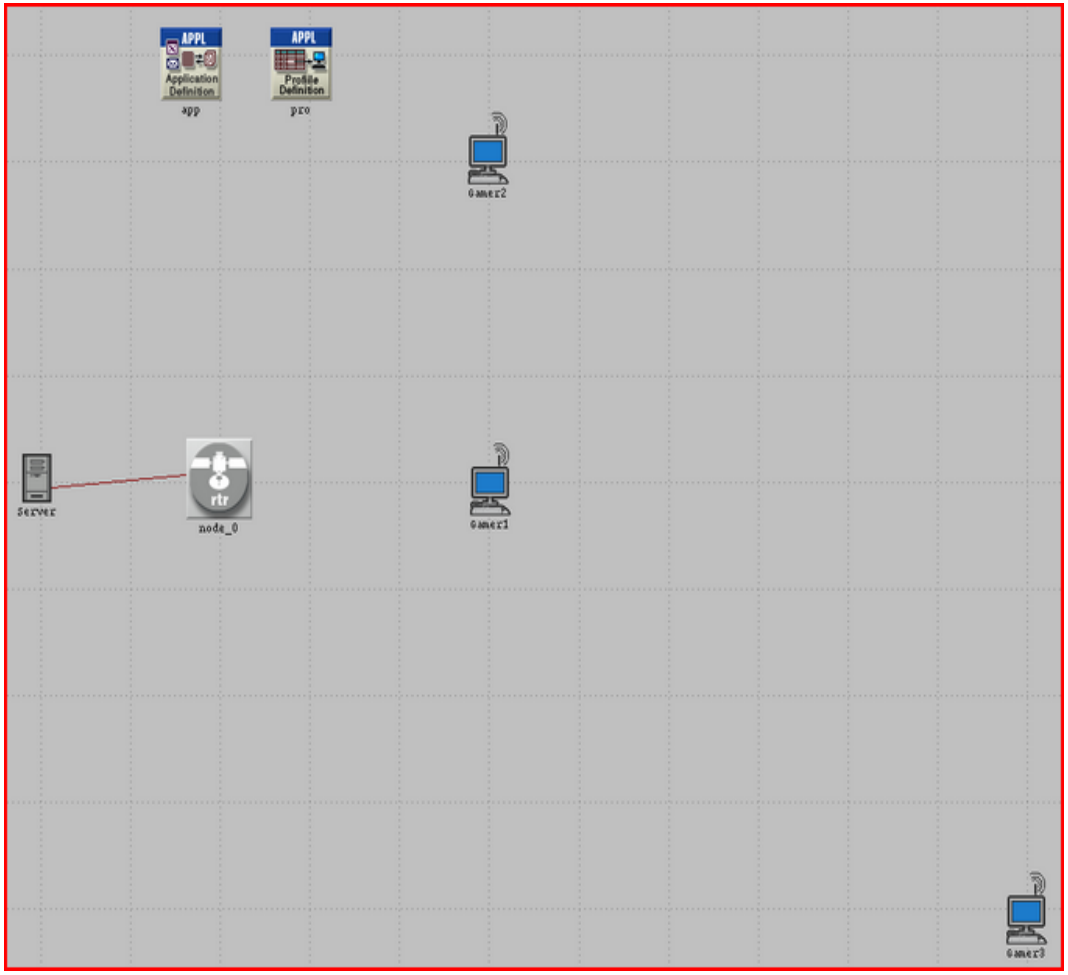
# OPNET Implementation




## Ethernet LAN Topology

- Campus network 100 x 100m
- 1 Ethernet server
- 1 router
- 3 gaming workstations
- Application, Profile, and Task Definitions

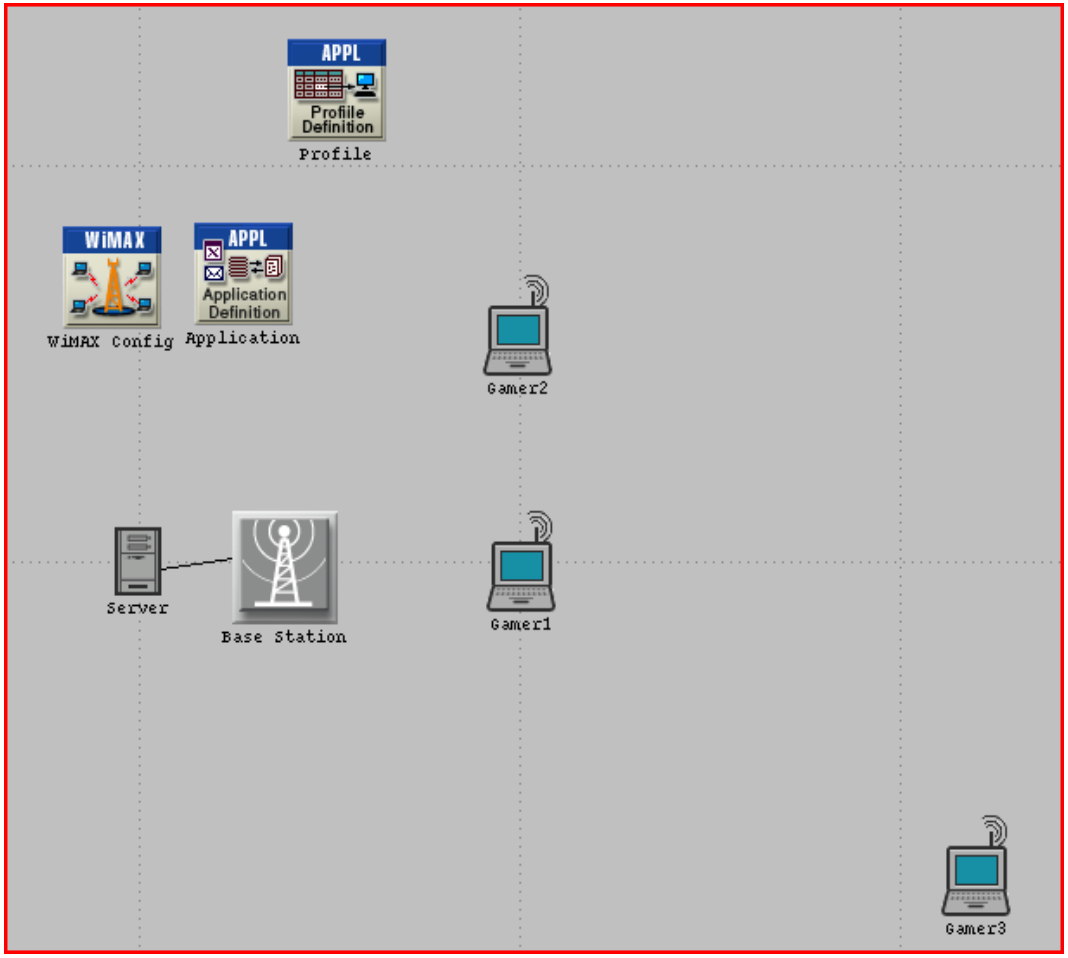
# OPNET Implementation




## WiFi Topology

- Campus network 100 x 100m
- 1 WiFi server
- 1 router
- 3 gaming workstations
- Application, Profile, and Task Definitions

# OPNET Implementation




## WiMAX Topology

- Campus network 100 x 100m
- 1 WiMAX server
- 1 base station
- 3 gaming workstations
- Application, Profile, and WiMAX Config Definitions

# OPNET Implementation

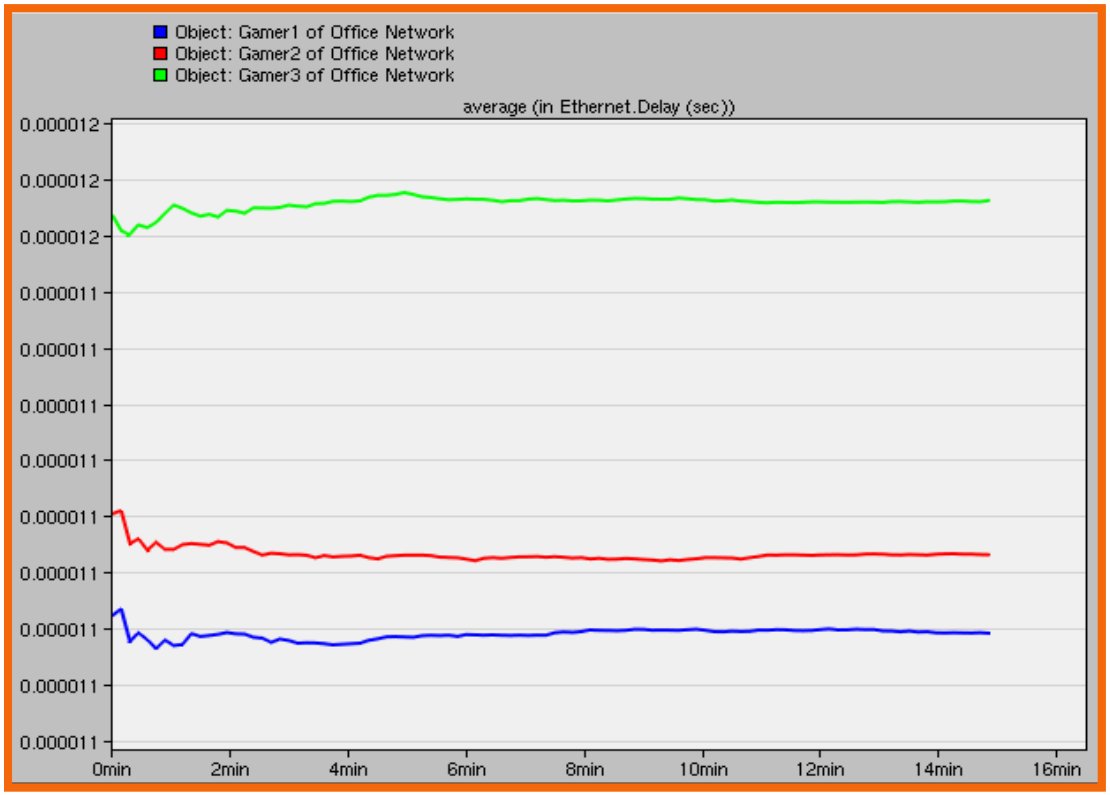
- Customized Gaming Traffic
  - According to Johannes Farber, approximation of a typical gaming server to client traffic

| Outgoing Packet Inter-arrival Time | Outgoing Packet Size | Incoming Packet Inter-arrival Time | Incoming Packet Size |
|---|---|---|---|
| Extreme (0.055,0.006) | Extreme (120, 36) | Constant (0.04) | Extreme (80, 5.7) |

- Gaming Workstations
  - Distances from the router/access point/ base station
    - Gamer 1 = 30m
    - Gamer 2 = 42m
    - Gamer 3 = 98m

# Simulation Results

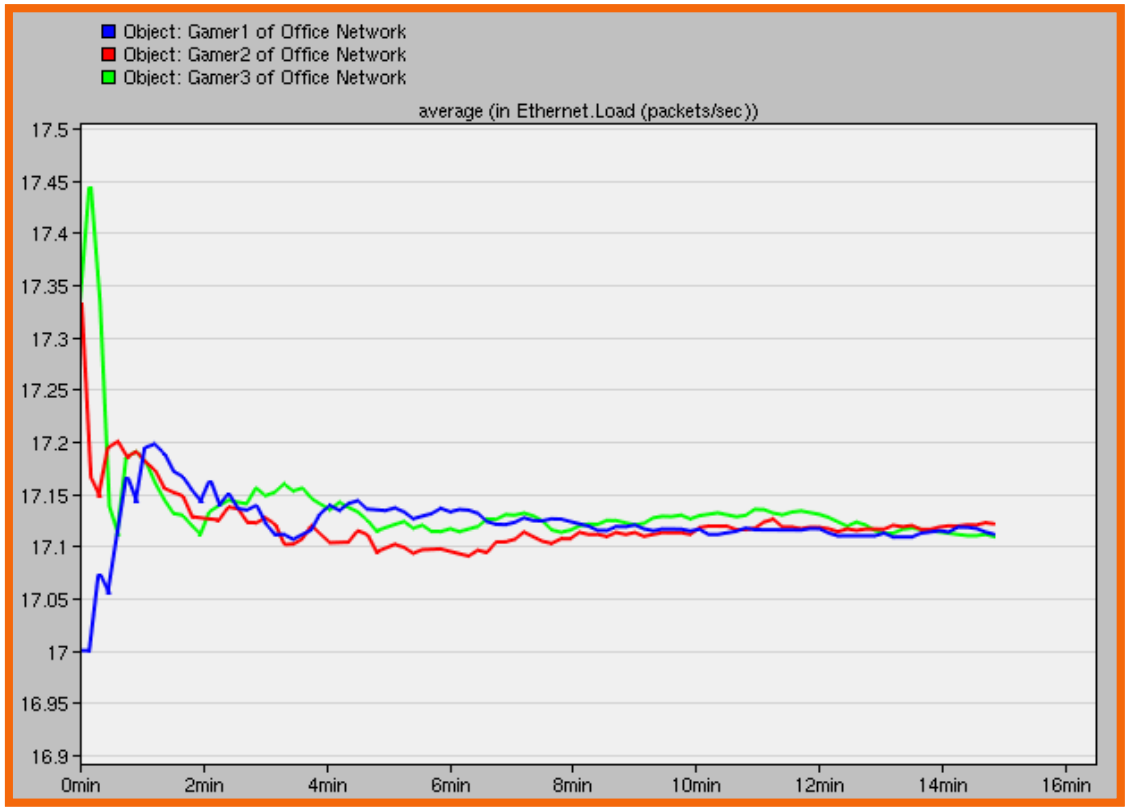
- Ethernet Topology Results – **Ethernet Delay (sec)**




- Fairly constant steady-states
- Longer distances from the router means higher delay
- Between 11-12µsec

# Simulation Results

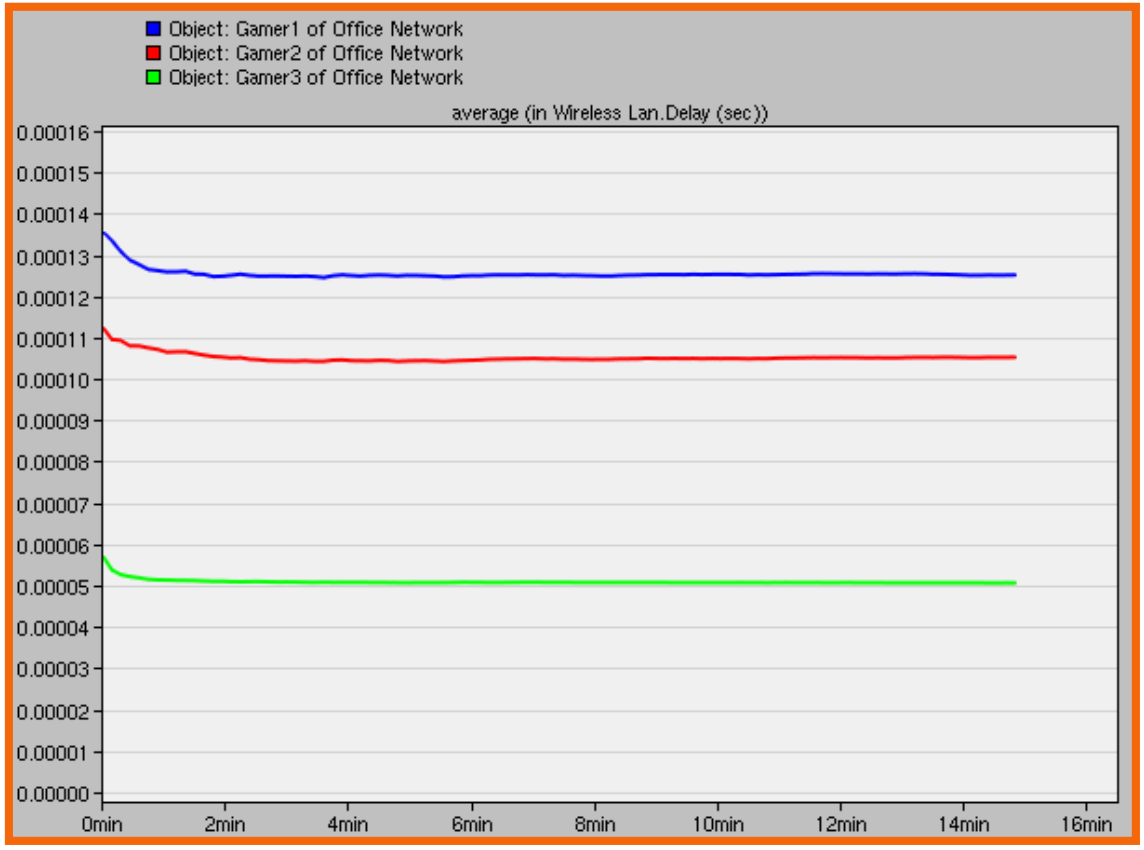
- Ethernet Topology Results – **Ethernet Load (packets/sec)**




- Converges for steady-states
- Almost even distribution of packets for all 3 gaming workstations
- Approximately 17.2 packets/sec

# Simulation Results

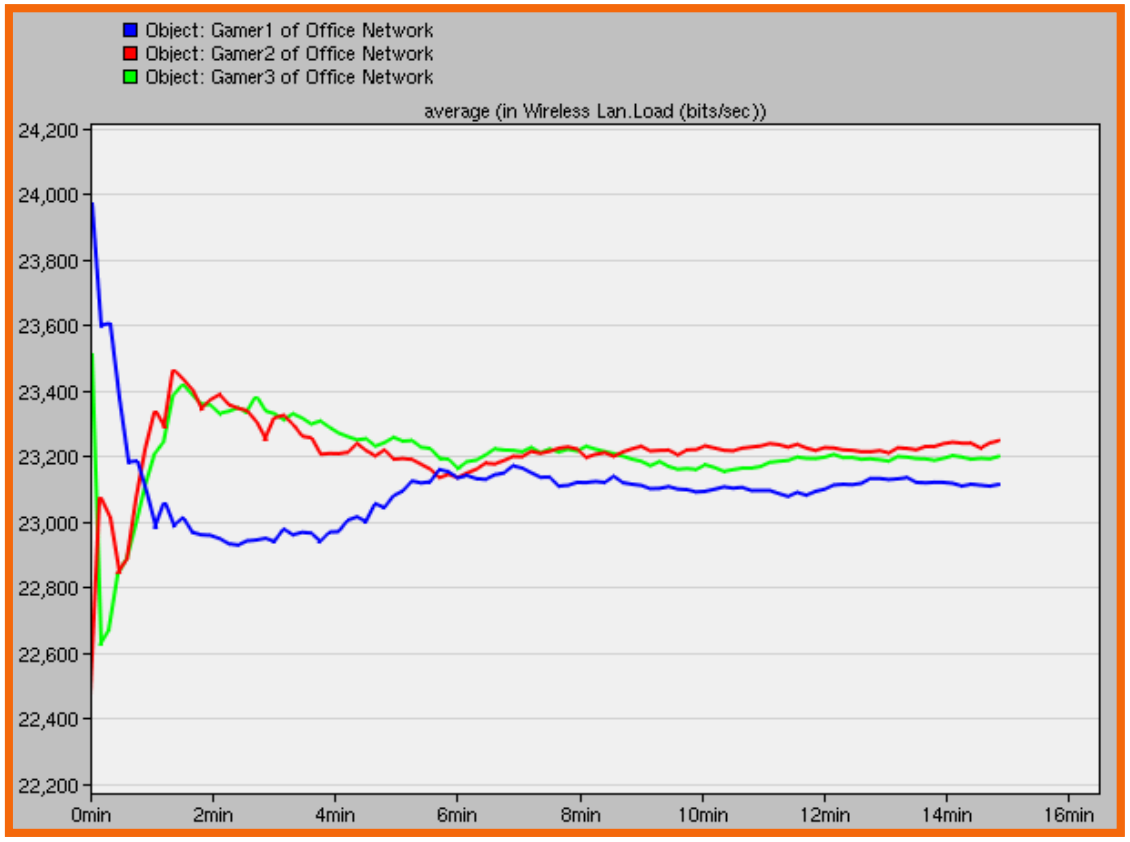
- WiFi Topology Results – **Wireless Lan Delay (sec)**




- Fairly constant steady-states
- Longer distances results in shorter delay
- Between 50-127µsec of delay

# Simulation Results

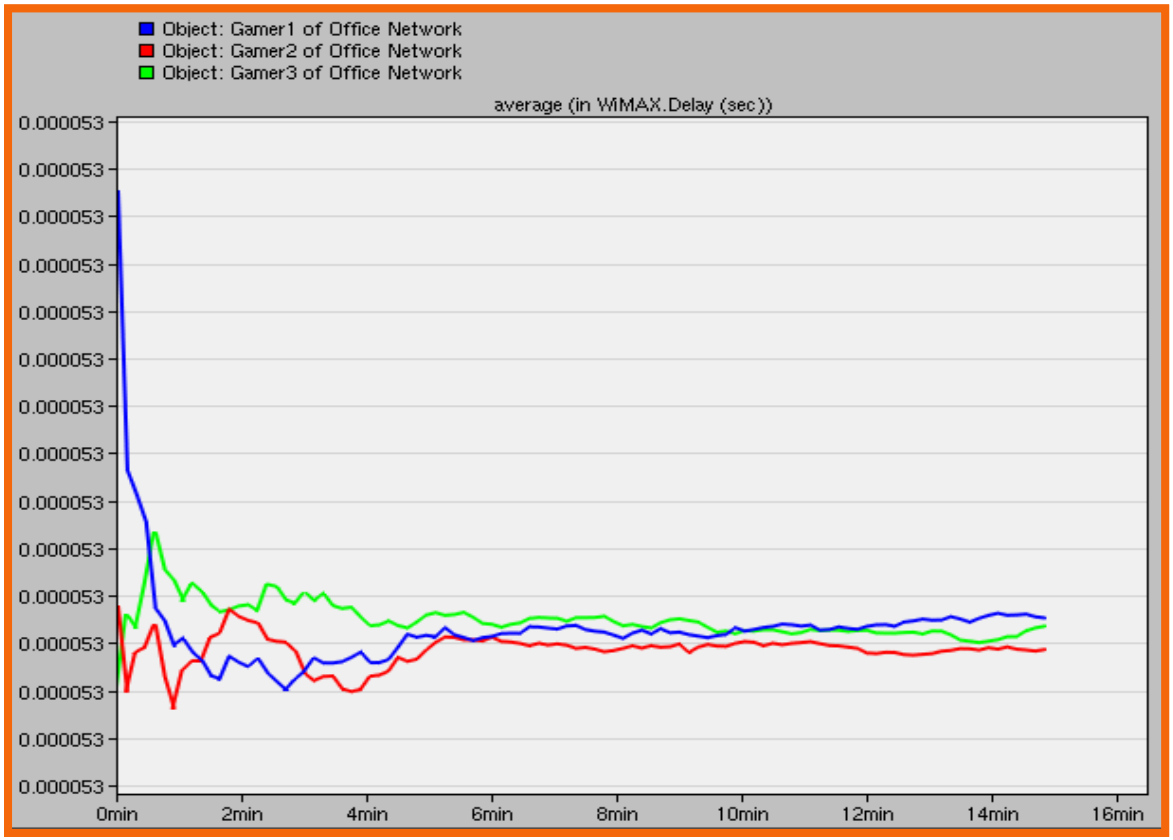
- WiFi Topology Results – **Wireless Lan Load (bits/sec)**




- Roughly similar steady-state values
- Packet distribution are nearly the same through all 3 clients
- Approximately 23,200 bits/sec

# Simulation Results

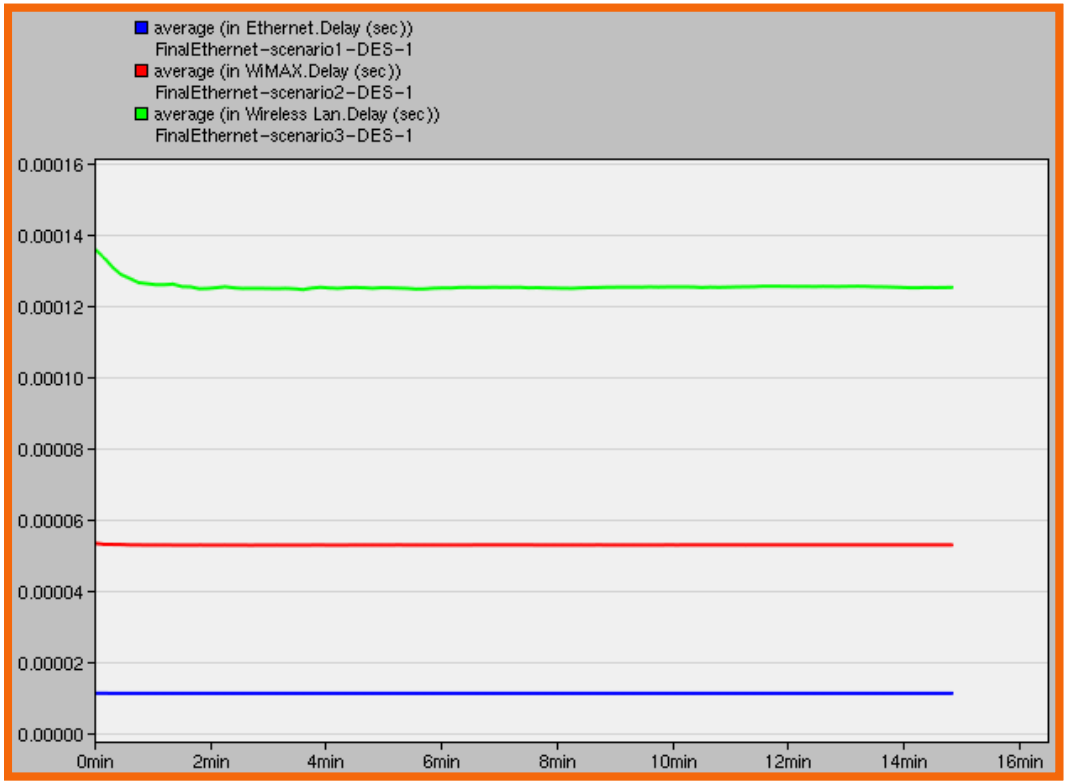
- WiMAX Topology Results – **WiMAX Delay (sec)**




- Similar steady-state values
- Almost even delay for all 3 gaming workstations
- Approximately 53µsecs of delay

# Simulation Results

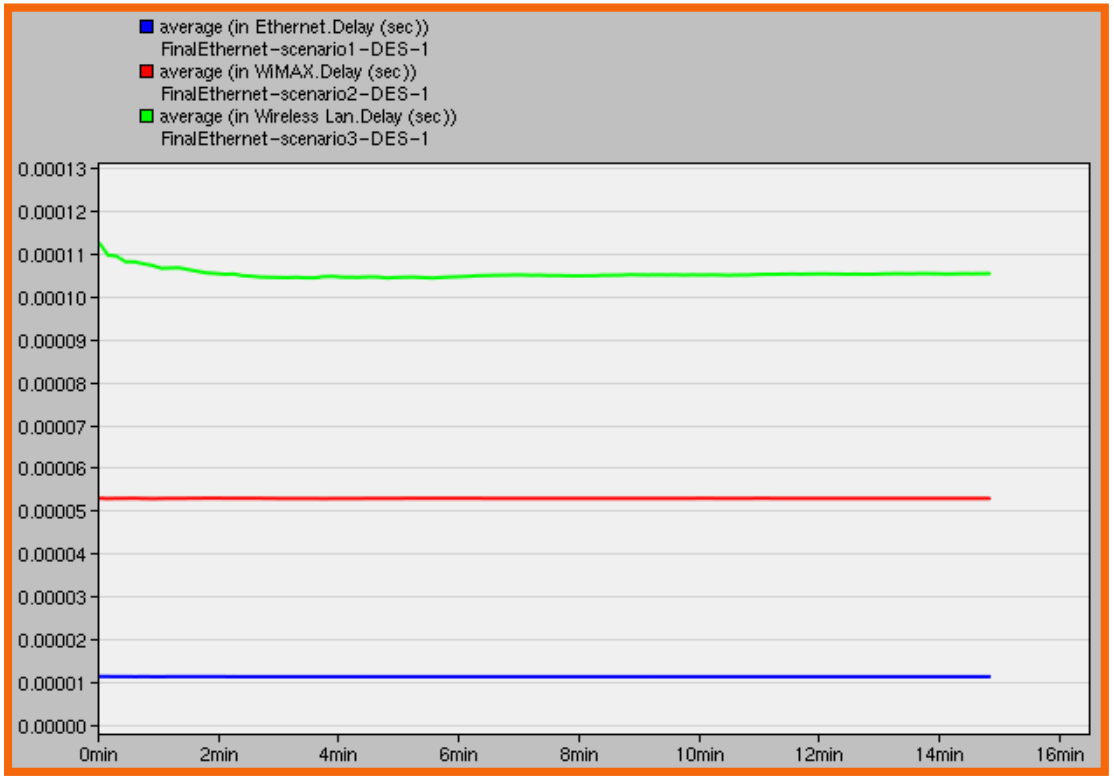
- Comparisons of 3 topologies – Gamer1




- WiFi has the highest delay for Gamer1
- Ethernet has lowest delay for Gamer1
- Constant delays

# Simulation Results

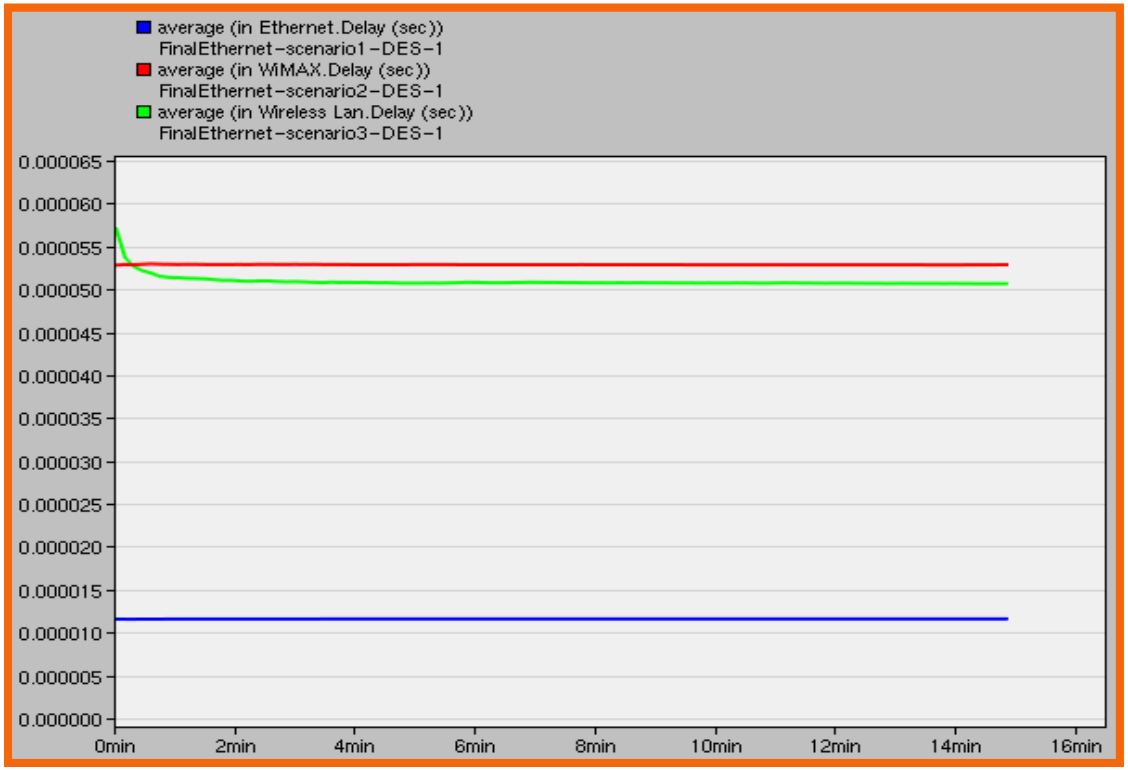
- Comparisons of 3 topologies – Gamer2




- WiFi has highest delay for Gamer2
- Ethernet has lowest delay for Gamer 2
- Constant delays

# Simulation Results

- Comparisons of 3 topologies – Gamer3




- WiMAX has highest delay for Gamer 3
- Ethernet has the lowest delay for Gamer3
- Constant delays

# Simulation Results

- Summary of Simulation Results

| | Ethernet Delay | WiFi Delay | WiMAX Delay |
|---|---|---|---|
| Gamer1 | 11.3μsec | 126μsec | 53.4μsec |
| Gamer2 | 11.4μsec | 105μsec | 53.2μsec |
| Gamer3 | 12.0μsec | 50μsec | 53.3μsec |

# Conclusions

- Using Ethernet LAN as a baseline
  - WiMAX has a better performance than WiFi overall
    - Lower end-to-end delay
  - For longer distances, WiMAX has a higher delay compared to WiFi
    - Gaming station 3 almost 100m away from the base station begins experiencing higher delay than WiFi
    - Sacrifices higher speeds for longer distances

- WiMAX's delay for all simulated gaming workstations remain fair constant
  - The coverage of WiMAX spreads throughout a large area so a small scenario of 100x100m does not vary the delays between the gaming workstations

# Conclusions

- WiFi results did not behave as expected
  - Decrease in delay time as distance away from server increases
    - Contribute this factor to the limited range of WiFi
    - As distance increases, WiFi connection begins to deteriorate

# Future Work

- Should implement newer standards of 802.3 (Ethernet LAN), 802.11 (WiFi), and 802.16 (WiMAX) for newer comparisons
- Should use real, exact traces of online games instead of approximation
- Should simulate more QoS factors for better analysis
- Simulate with more nodes in a larger scenario

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# Questions?

Thank you
For
Your time ☺