OPNETWORK2011

Comparison of WiMAX and ADSL Performance when Streaming Audio and Video Content

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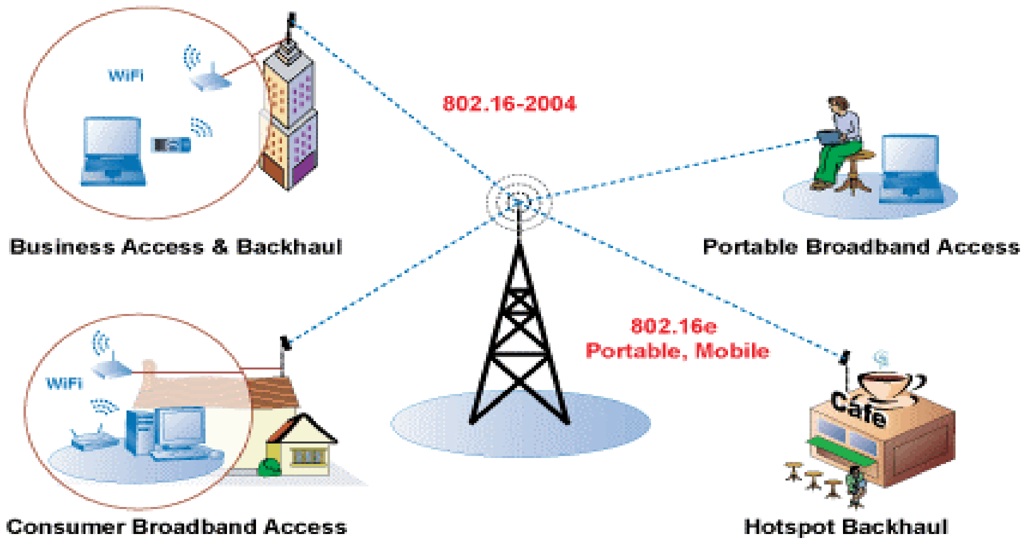
Roadmap

- Introduction
- Simulation design
- Validation
- Analysis
- Conclusions, challenges, and future work
- References

Introduction: Focus of the Study

- Compare performance of WiMAX and ADSL by streaming audio and video contents. HTTP, FTP, and electronic mail have also been used for the comparison.



WiMAX: Worldwide Interoperability for Microwave Access
ADSL: Asymmetric Digital Subscriber Line
HTTP: Hyper Text Transfer Protocol
FTP: File Transfer Protocol

WiMAX Broadband Access

- WiMAX stands for Worldwide Interoperability for Interoperability Microwave Access
- IEEE 802.16 family of standards is known as WiMAX
- WiMAX operates in 10 GHZ to 66 GHz band with LoS communications
- WiMAX cell sizes vary from 7 km to 10 km
- All IP network architecture
- Its flexible QoS supports voice and video
- It has two transmission modes: point to multi point (PMP) and mesh
- It is of two types: fixed and mobile
- WiMAX is designed to replace ADSL T1 line

Asymmetric Digital Subscriber Line (ADSL)

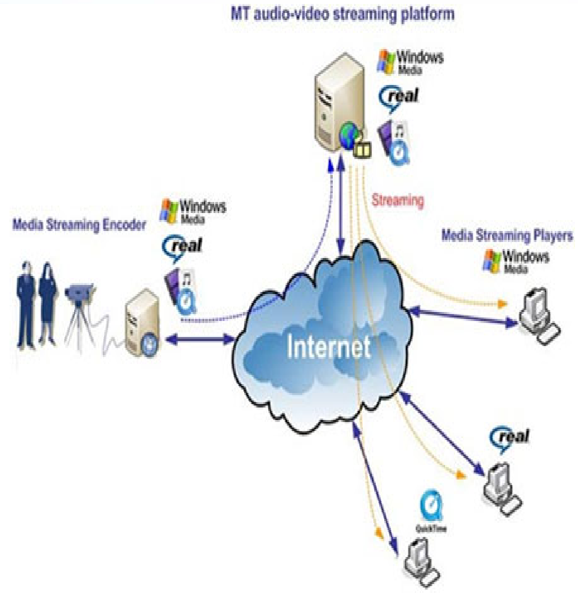
- The latest ADSL standard: ITU G.992.5 Annex M
- Bandwidth options are between 128/32 kbps and 2 Mbps/512 kbps
- Higher speed direction for the download
- Full-duplex

Traffic:

- Video and audio traffic, HTTP, FTP, and email traffic are used
- The video/audio traffic source was a two-hour MPEG-4 Matrix III movie trace that utilized a 352 × 288 frame format resolution and a 25 fps encoding rate
- HTTP, FTP, and email traffic: both the application attribute and the server were configured for heavy load traffic

Audio and Video Streaming

- Video data is accompanied with a multi-channel audio data
- Video content is organized as a sequence of frames or images for video streaming
- Audio data are structured as a sequence of audio frames
- The raw video and audio data are compressed by video/audio compression schemes such as MPEG-x and H.26x codecs
- Video frame inter-arrival rates range from 10 frames per second (fps) to 30 fps
- These frames are sent at a constant rate
- The quality of video content depends on parameters such as video format, pixel color depth, coding scheme, and frame inter-arrival rate



Other Applications

- HTTP is the foundation of data communication for world wide web and is designed to retrieve web pages
- FTP is designed for transferring files and offers faster overall throughput and better error checking
- Electronic mail is method of exchanging messages between senders and receivers

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Simulation Design

- OPNET Modeler versions 15.0 and 16.0 have been used to evaluate packet loss, delay, delay jitter, and throughput to determine whether WiMAX exhibits performance comparable to ADSL
- To evaluate communication performance between the server and the client, four metrics are used to measure streaming performance:
- Packet loss:

  1 - (number of received packets)/(number of expected packets)
- Delay:

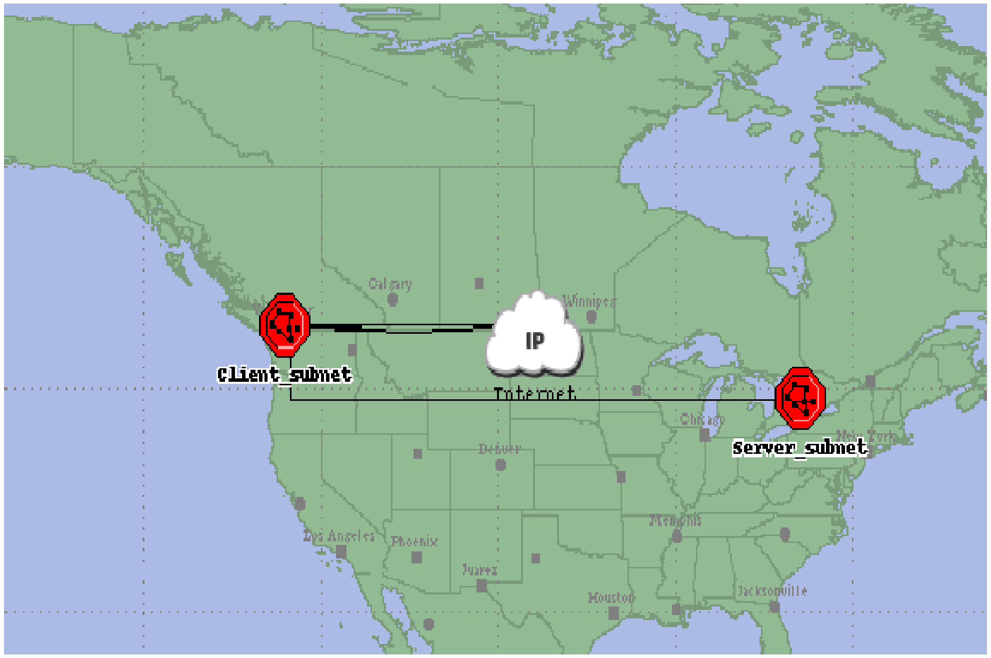
  Processing delay + propagation delay + queuing delay
- Jitter:

  Actual reception time – expected reception time
- Throughput:

  Measured in bytes/sec (or bps)

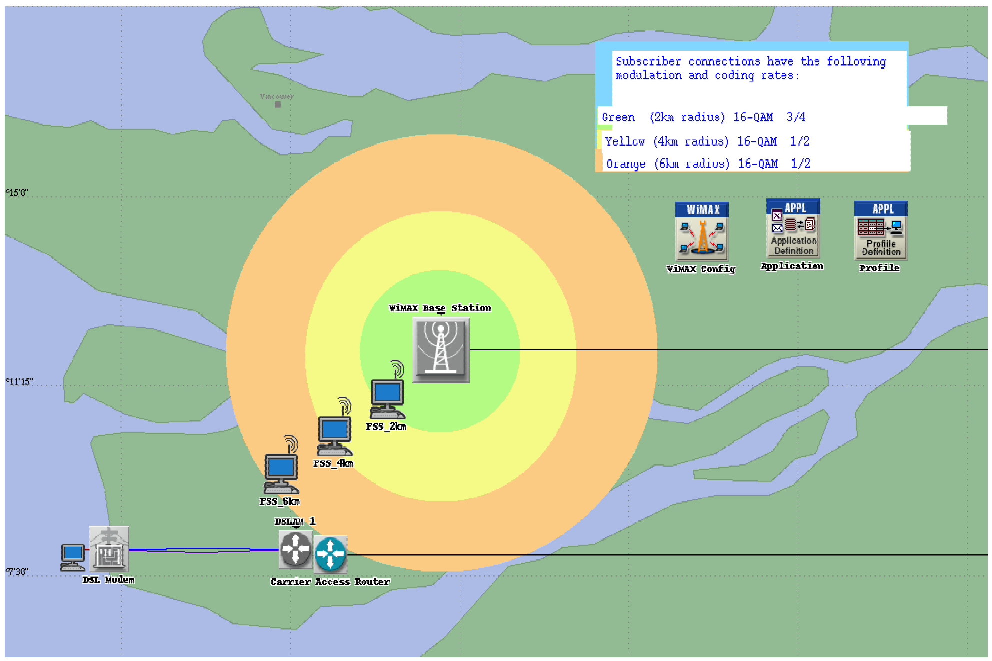
Network Topology

- The client and the server subnets are geographically separated:
  - server subnet is located in Toronto
  - client subnet is located in Vancouver
  - approximate distance between the two subnets is 3,342 km



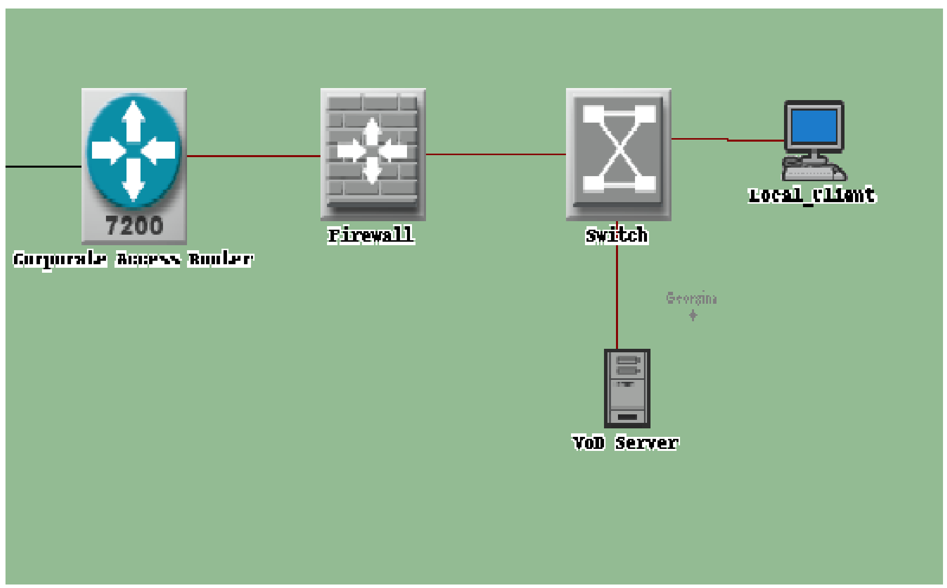
Client Subnet Topology

- Contains three WiMAX client stations, one ADSL client station
- One WiMAX base station
- WiMAX client stations are located 2 km, 4 km, and 6 km from the base station



Server Subnet Topology

- Server is configured to stream stored audio and video contents, HTTP, FTP, and email traffic
- It contains a 100 Mbps IP network and a firewall
- An access router is connected to the firewall
- Router connects the Internet cloud to the server subnet through a 45 Mbps Digital Signal (DS3) wide area network (WAN) link



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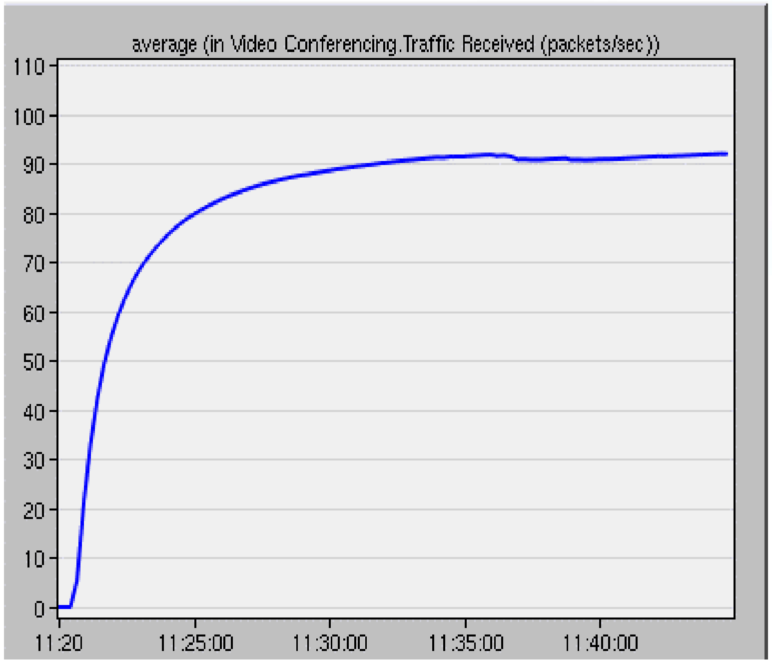
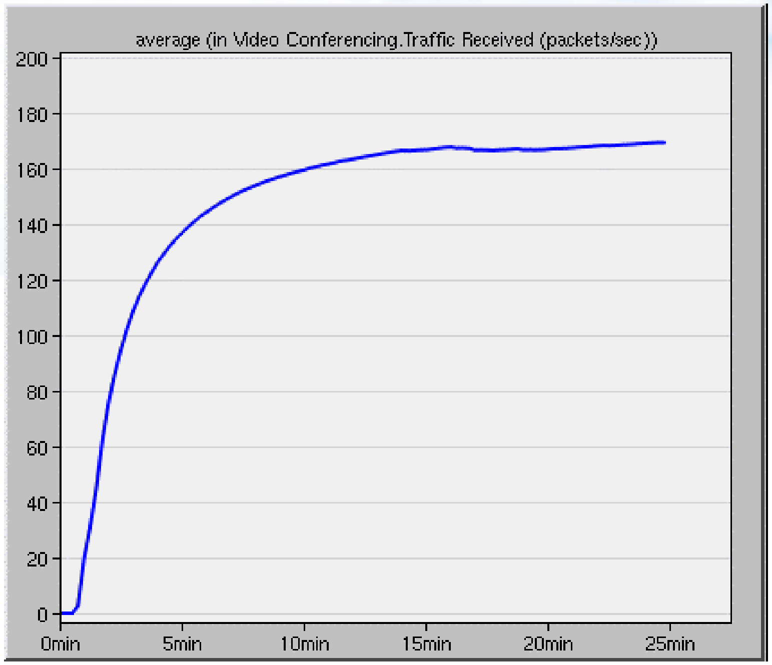
Validation



Reference model: average network traffic received



Developed model: average network traffic received

- Compare all performance factors of reference model with developed model
- Reference model shows an average of 90 packets per second (pps) while the developed model shows a significantly higher rate of 165 pps

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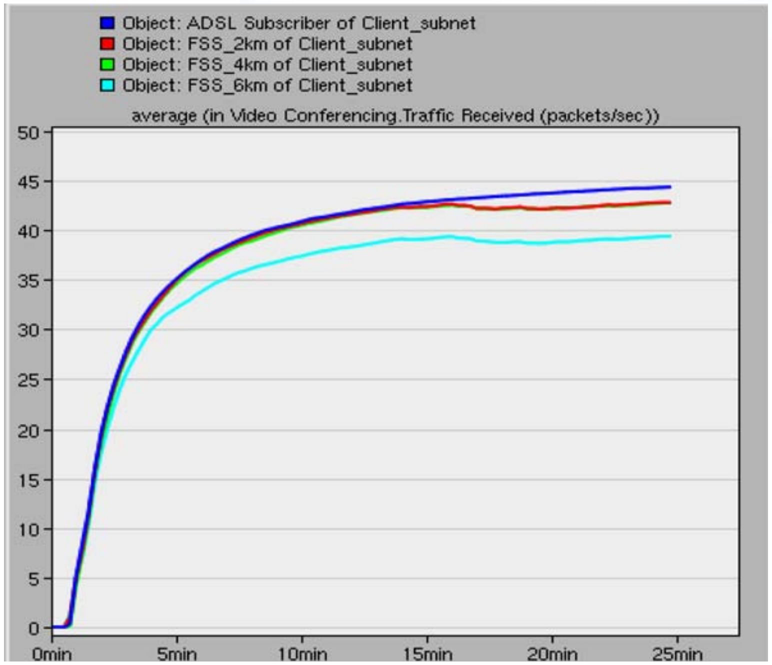
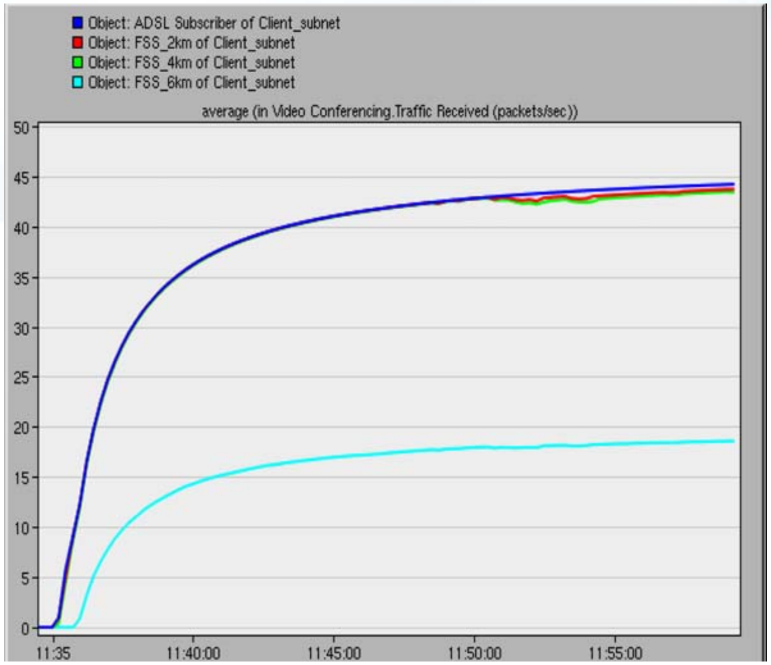
Packet Loss (average)



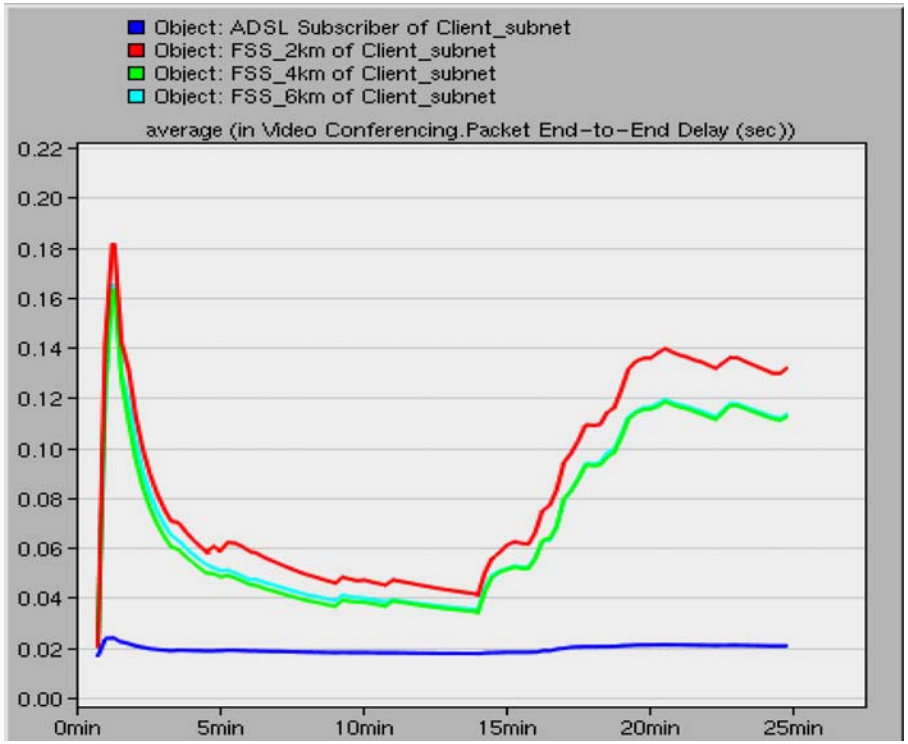
Average packet loss of four client stations: buffer size 128 Kbytes



Average packet loss of four client stations: buffer size 1,024 Kbytes

- The 128 Kbytes buffer results in MAC layer in the BS is losing a significant number of frames because the BS queue size
- The 1,024 Kbytes buffer results in MAC layer packet loss rate and, hence, it solves the buffer overflow issue

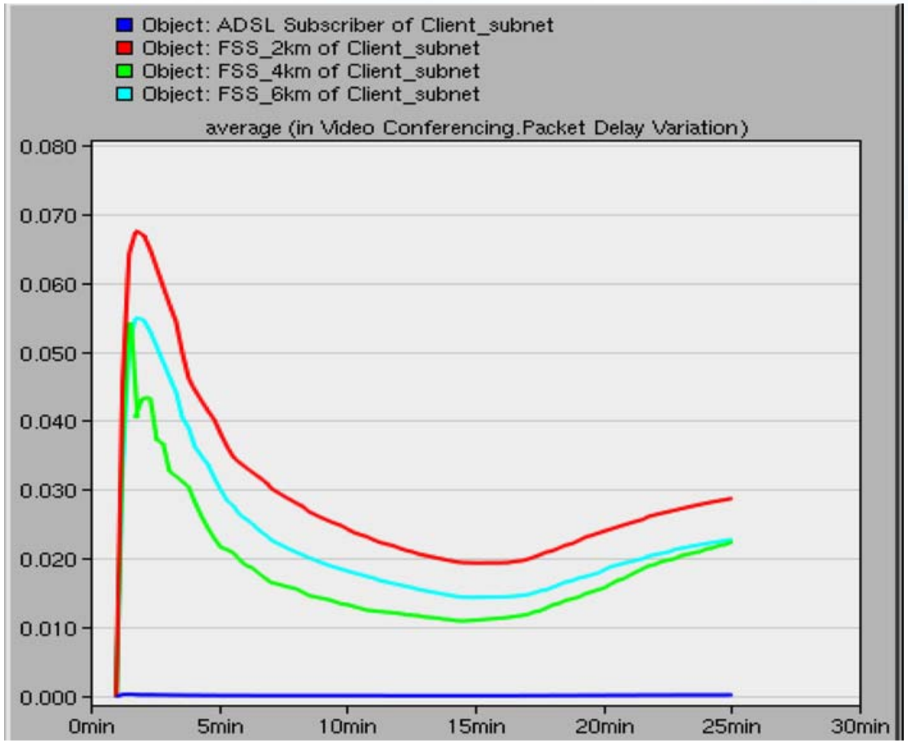
End-to-End Packet Delay



Average packets transmitted from source to destination in four WiMAX stations

- End-to-end delay for four clients over the simulation of 25 minutes movie trace show that the ADSL client experiences the delay of 10 ms

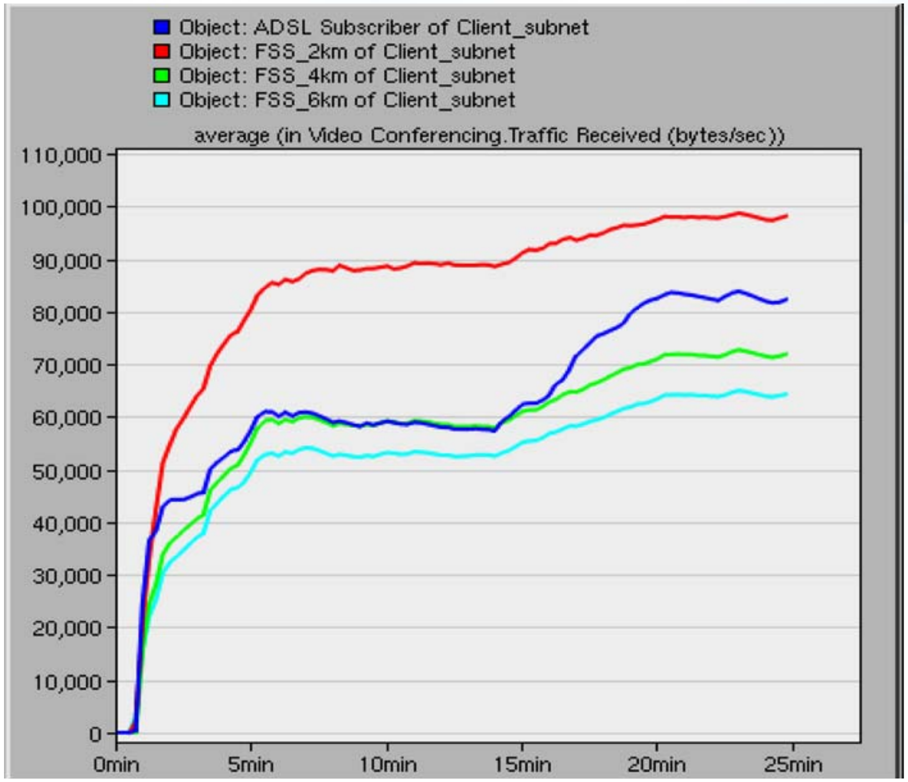
Packet Delay Jitter



Packet jitter for the four WiMAX stations

- ADSL client performs better. The four WiMAX client stations exhibit similar behavior and have 20 ms jitter for the movie duration

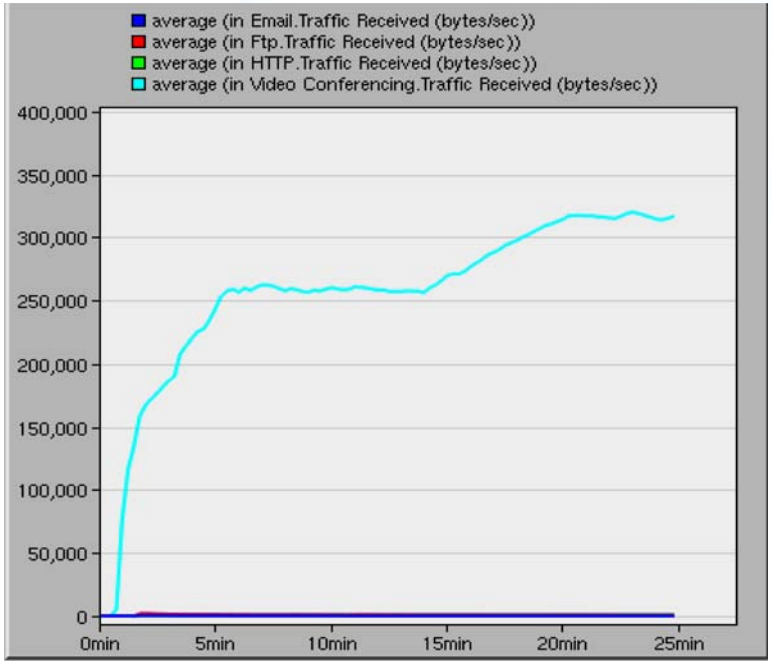
Throughput



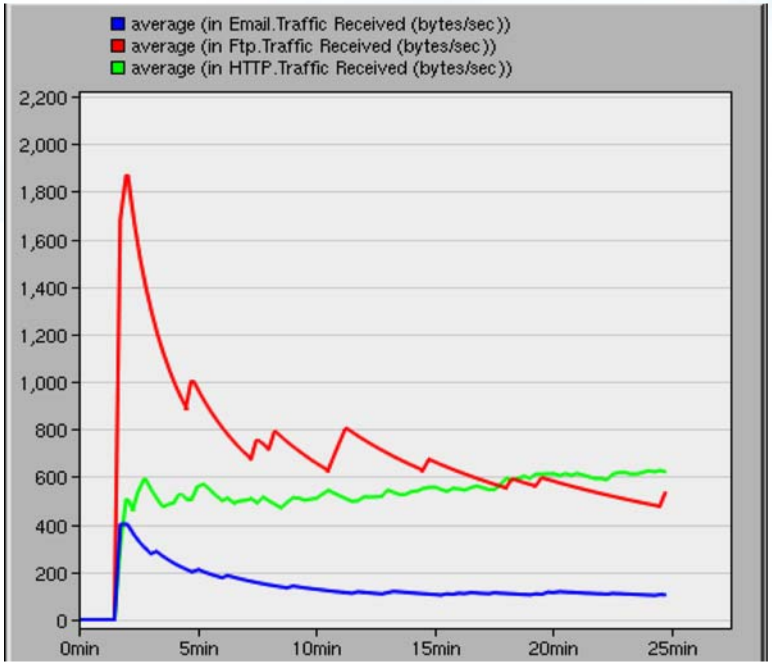
Minimum throughput

- 2 km station displays better throughput performance than the ADSL station
- The simulated throughput ranges between 0.40 Mbps and 0.72 Mbps

Throughput Comparison: All Applications



Average throughput for HTTP, FTP, email, and video/audio conferencing



Average throughput for HTTP, FTP, and email application

- The throughput of the video/audio access category is higher than the HTTP, FTP, and email access
- Throughput of access category FTP is higher than HTTP and email

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Conclusions

- Extensive simulations of ADSL and WiMAX wireless networks have been conducted to compare their performance
- Validation scenario confirms overall design of the study
- ADSL exhibited considerably better performance than the WiMAX
- Small queues reduce delay, which is essential for real-time traffic such as video and audio applications
- WiMAX satisfies the performance factors
- WiMAX packet loss significantly reduced by increasing base station buffering
- With further tuning, WiMAX demonstrated performance that was more comparable to the ADSL client station.

Challenges and Future work

- Challenges:
  - Environment (licensing, access)
  - Disk Quota exceeded
  - Learning WiMAX fundamentals within project duration
- Future work:
  - Conduct comprehensive analysis of WiMAX networks and characterize more WiMAX parameters
  - Research and refine all performance factors
  - Incorporate other applications like remote login and network printer
  - WiMAX mobility and shadowing
  - All applications were simulated using unicast traffic, multicast video traffic may have yielded better performance

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