ENSC 833: NETWORK PROTOCOLS AND PERFORMANCE
SPRING 2016

PERFORMANCE ANALYSIS OF LTE FOR VOICE AND VIDEO CONTENT

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Roadmap

- Motivation and Goal
- Introduction
- Related work
- Simulation Design
- OPNET model
- Simulation Results
- Conclusions
- References

Motivation

- LTE is a promising radio access network technology that offers a high throughput.
- An efficient end-to end QoS treatment is needed in order to guarantee a good QoS perceived by end user.
- LTE provides a unique and native QoS-aware mechanism for end-to-end service delivering based on EPS (Evolved Packet System) bearer and QCI (QoS Class Identifier).

Goal

- QoS Performance analysis of LTE for VoIP and video content.
- Study the effectiveness of the LTE standard to handle applications requirements using OPNET Modeler 18.5.

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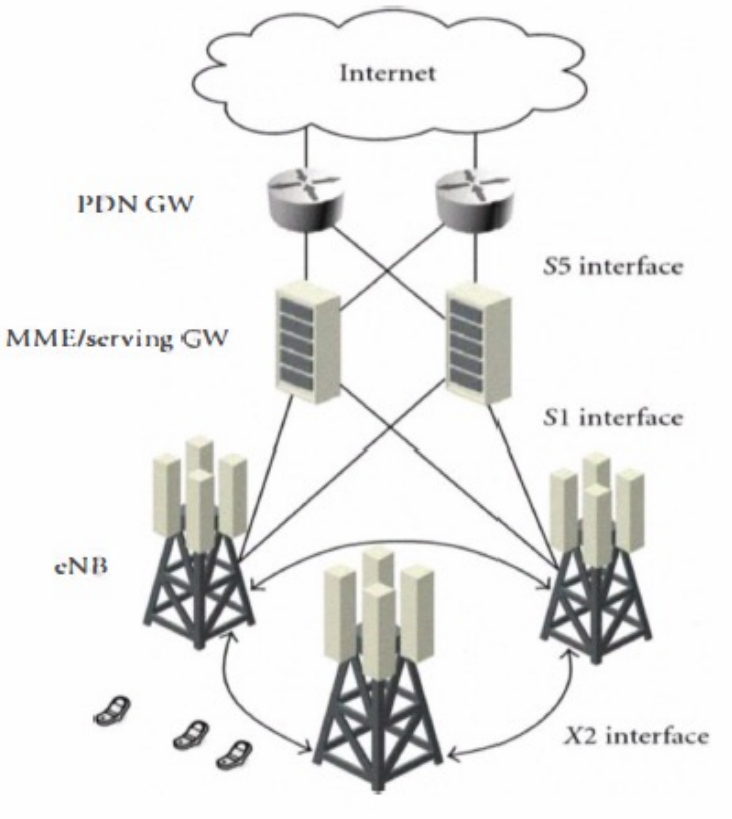
LTE Introduction

- Long Term Evolution (LTE)
- 3GPP standard for wireless transmission system
- Full IP-based
- Wireless Broadband Standard
- First proposed in 2004
- First publicly available in December 2009
- Use OFDMA for downlink, SC-FDMA for uplink

3GPP :3rd Generation Partnership Project
OFDMA : Orthogonal Frequency Division Multiple Access
SC-FDMA: Single Carrier Frequency Division Multiple Access

LTE Features



- Download rate: up to 100 Mbps
- Upload rate: up to 50 Mbps
- Bandwidth: 1,4 – 20 MHz
- Supports high speed mobility
- Typical cell size: 1 –10 km
- Flexible QoS supports voice and video

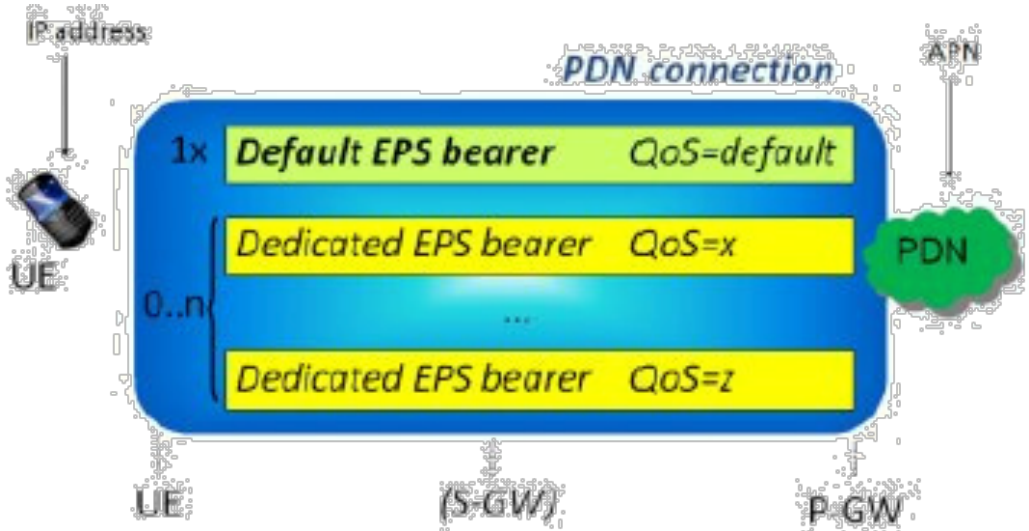
Source: D.M.Sacristan, J.F. Monserrat, J.Cabrejas, D.Calabuig, S.Gorigas and N.Cardona, "On the way towards fourth generation mobile: 3 GPPL TE and L TE advanced," *EURASIP journal on wireless communications and networking*, vol. 2009, pp. 1-10, June 2009.

QoS in LTE

- QoS determines how an IP packet flow is handled at eNodeB when it experiences congestion in terms of:
  - Scheduling policy
  - Queue management
  - Rate shaping

QoS management

- Evolved Packet System (EPS) bearers.
  - connection-oriented virtual transmission channels carried out on a single PDN connection.
  - A bearer describes how UE data transfer across the network.
- Quality of Service Class Identifiers (QCI).



Source: A.Vizzarri ,“ Analysis of VoLTE End-To-End Quality of Service using OPNET,“ *UKSim-AMSS 8th European Modelling Symposium*, pp. 452 - 457, Oct. 2014.

PDN: Packet Data Network

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Related work

- Influence of voice codec on end-to end VoLTE performance using OPNET.
  - A. Vizzarri, "Analysis of VoLTE End-To-End Quality of Service using OPNET," *UKSim-AMSS 8th European Modelling Symposium*, pp. 452 - 457, Oct. 2014.
- Video capacity for LTE in the context of real-time video was evaluated using C/C++ built simulator.
  - A. Talukdar, M. Cudak, and A. Ghosh, "Streaming video capacities of LTE air-interface," *in IEEE International Conference on Communications (ICC*), pp. 1–5, May 2010.
- Impact of differentiation and prioritization of delay-critical traffic like VoIP over other delay-insensitive intensive traffic using Matlab.
  - I. Siomina, S. Waenstedt, "The Impact of QoS Support on the End User Satisfaction in LTE Networks with Mixed Traffic," *19th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, Cannes, France, Sep. 2008.
- Analyzed the network traffic behavior of playing videos on mobile devices using a Test bed.
  - H.Nam, K.H.Kim, ,D. Calin and H. Schulzrinne, "Towards A Dynamic QoS-aware Over-The-Top Video Streaming in LTE," *Global Communications Conference (GLOBECOM 2014*), pp. 1317-1322, Austin, USA, Dec. 2014.

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VoIP Characteristics

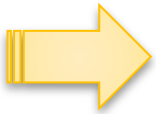
- Voice traffic is loss and delay sensitive.
- Configured Application and Profiles Nodes
- Promoted necessary statistics

Parameters	**Values**
Voice codec	G.711
Transmission rate [kbit/s]	64
Sampling frequency [KHz]	8
Voice Service	PCM Quality Speech

Source: A. Vizzarri, "Analysis of VoLTE End-To-End Quality of Service using OPNET," *UKSim-AMSS 8th European Modelling Symposium*, pp. 452 - 457, Oct. 2014.

Simulation Design

- Impact of differentiation and prioritization of traffic.



Traffic mixes have been considered:

- VoIP, FTP
- Video, FTP
- VoIP, video

Video Characteristics

- Video traffic is loss tolerant but delay sensitive
- Configured Application and Profiles Nodes
- Promoted necessary statistics
- Video trace Matrix III

Parameters	**Matrix III**
Resolution	352x288
Codec	MPEG-4
Frame Rate (frames/sec)	25
Mean Rate (Mbps)	0.637
Frame Compression Ratio	47.682

Source: W.Hrudey and Lj.Trajkovic ,"Streaming video content over IEEE 802.16/WiMAX broadband access," *OPNETWORK 2008*, Washington, DC, Aug. 2008.

Performance Metrics

- Loss: Number of packets dropped
  - 1 -(# of received packets) / (# of expected packets)
- Delay: Average time of transit
  - Processing delay + propagation delay + queuing delay
- Jitter: Variation in packet arrival time
  - Actual reception time –expected reception time
- Throughput: Minimum end-to-end transmission rate
  - Measured in bytes/sec (bps)
  - 10 kbps –5 Mbps

Source: ITU Telecommunication Standardization Sector (ITU-T) Values

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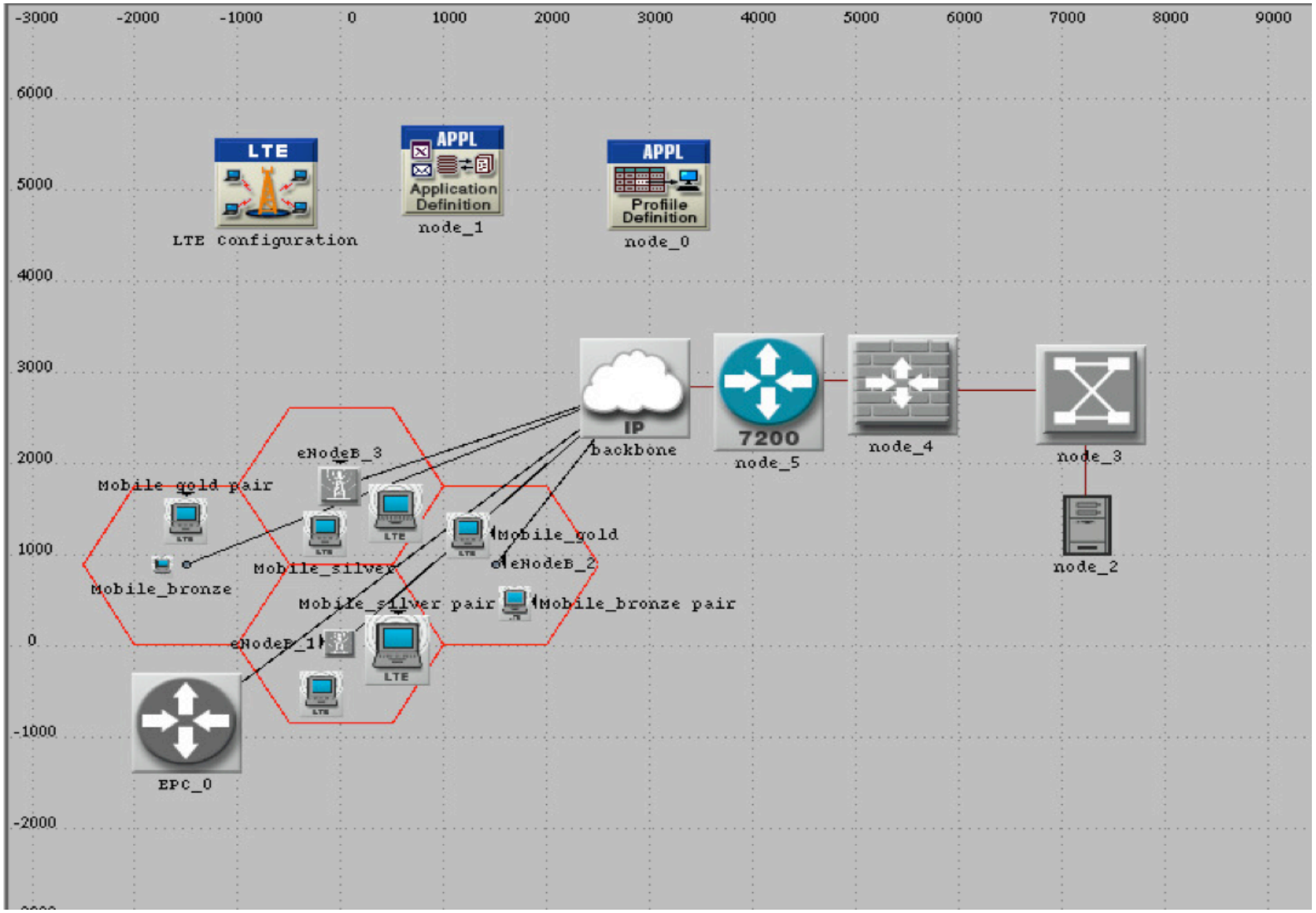
NETWORK TOPOLOGY



LTE configuration parameters

EPS bearer Def	QCI	Retention Priority	UL/DL Max bit rate voice	UL/DL bit Max rate video	Type of service
Platinum	1 (GBR)	2	378 kbps	1.5/10 Mbps	Multimedia / Interactive voice
Gold	2 (GBR)	4		1.5/6 Mbps	Excellent effort
Silver	6 (NGBR)	6		1.5/5 Mbps	Background
Bronze	7(NGBR)	7		1.5/5 Mbps	Best effort

- 20 MHz LTE bandwidth
- Duplex mode FDD
- Path-loss free space

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Simulation Scenarios

Traffic mixes that have been considered:

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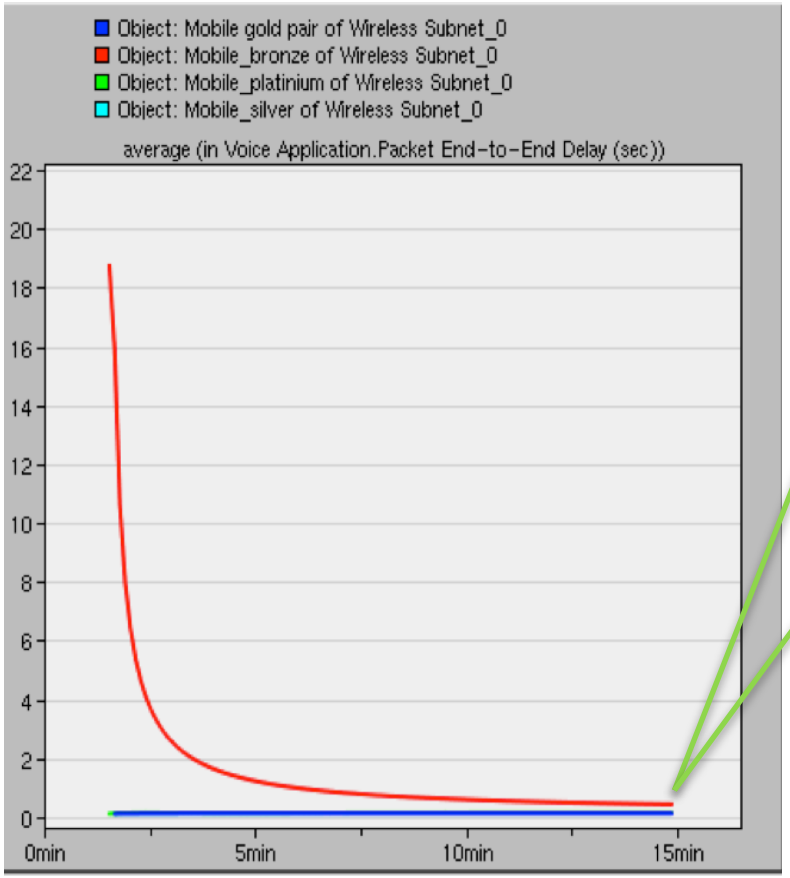
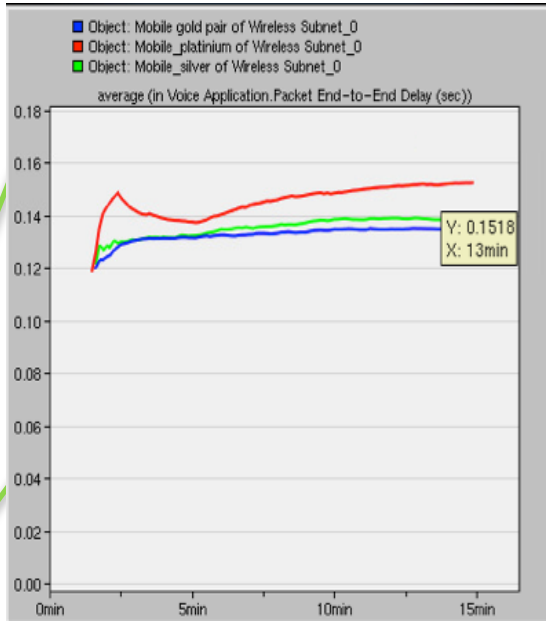
- Video, FTP
- VoIP, video

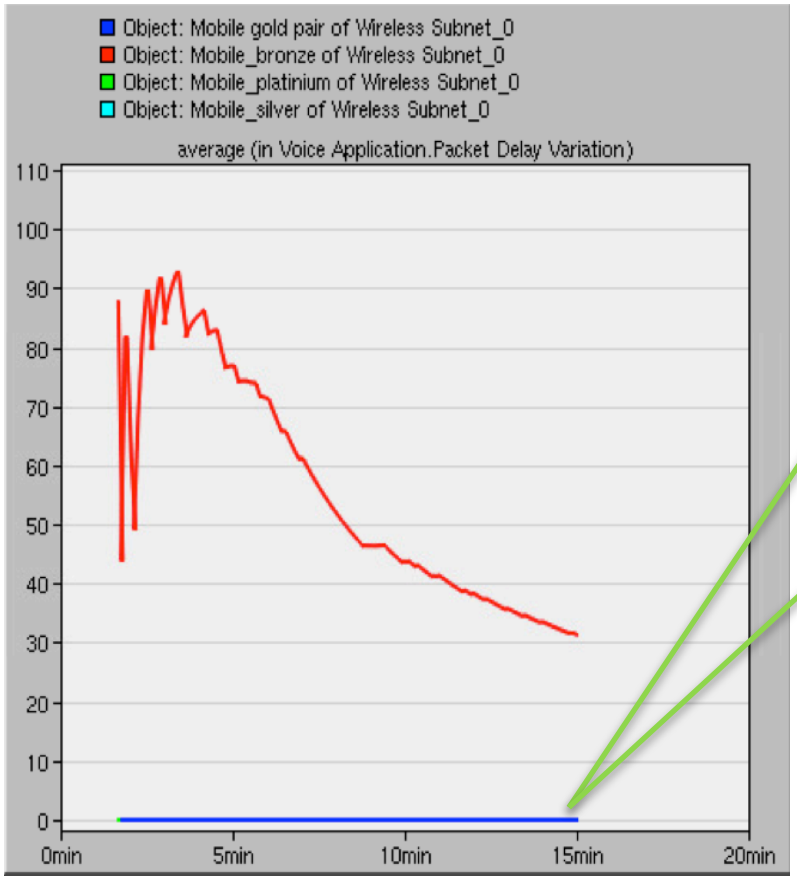
Simulation Results Voice & FTP – End to End Delay





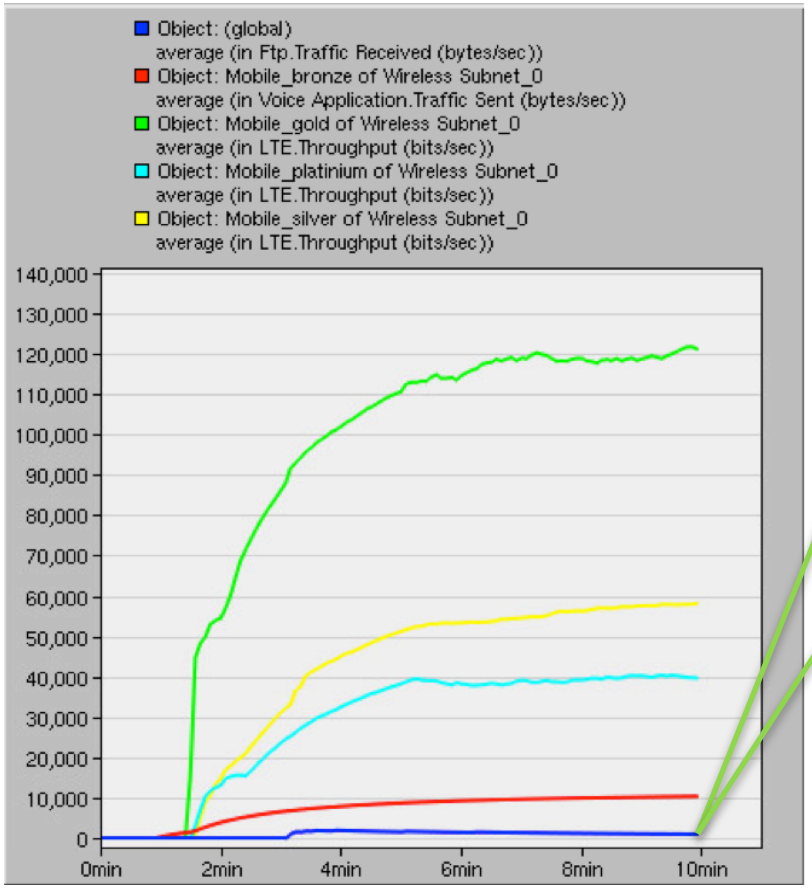
- Metric:
  - Good: < 150 ms
  - Acceptable < 300 ms
  - Poor > 300 ms

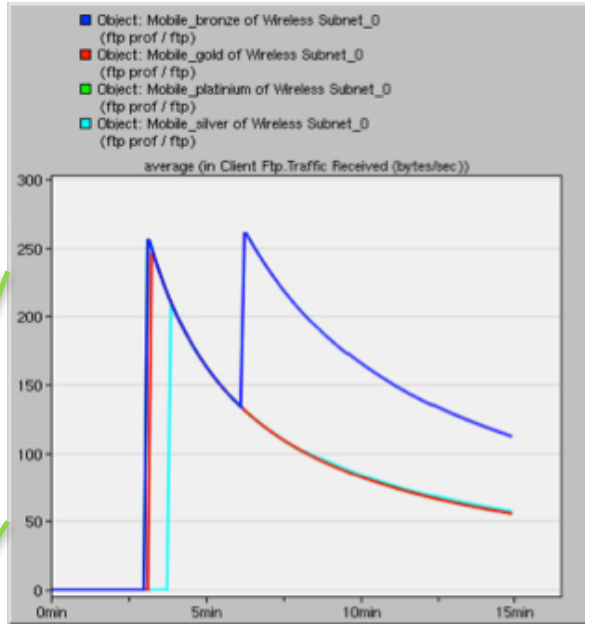
Simulation Results Voice & FTP – Jitter



- Metric:
  - Good: < 20 ms
  - Acceptable < 50 ms
  - Poor > 50 ms

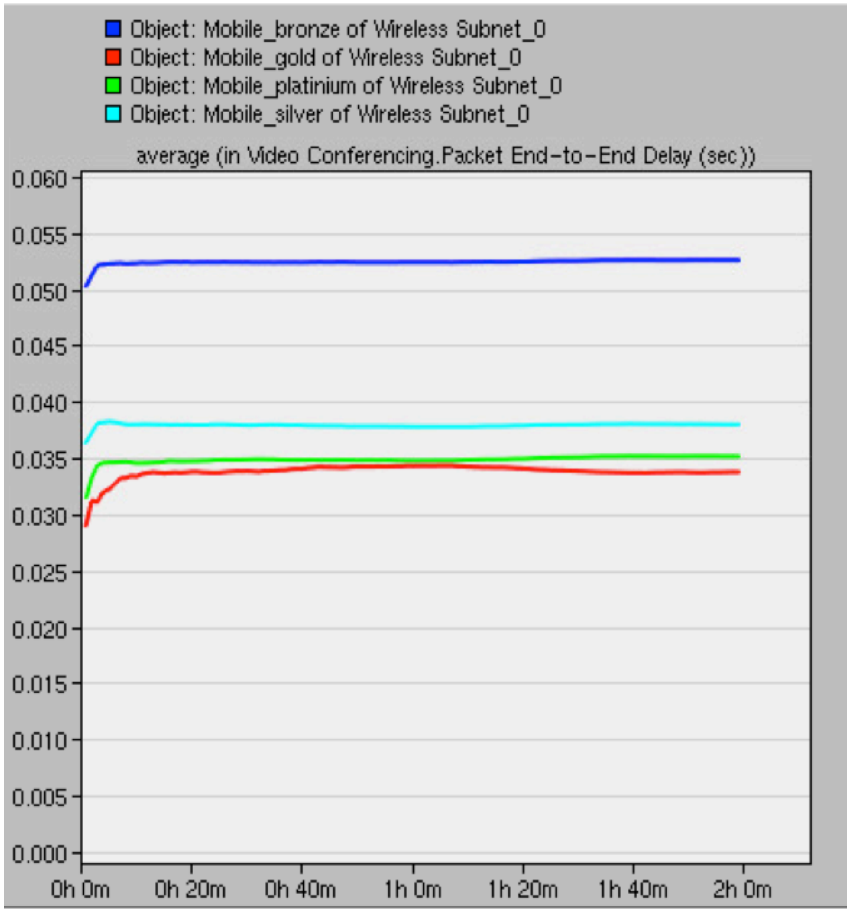
Simulation Results Voice & FTP – Throughput





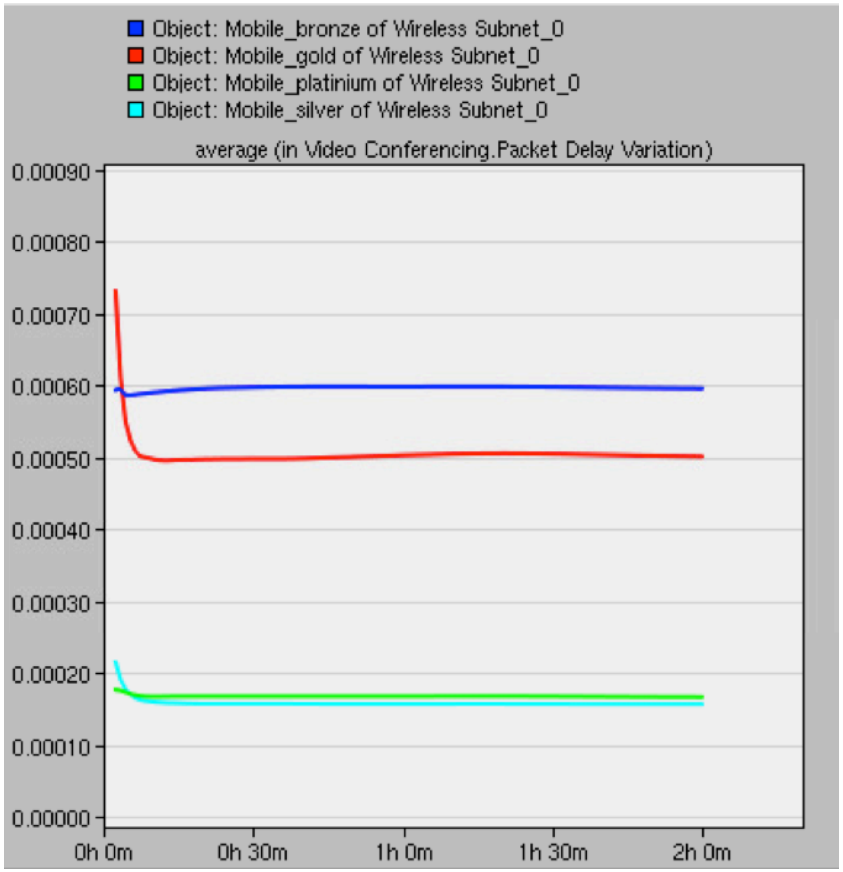
- Minimum end-to-end transmission rate
  - 10 kbps –5 Mbps

Simulation Results Video & FTP- End to End Delay



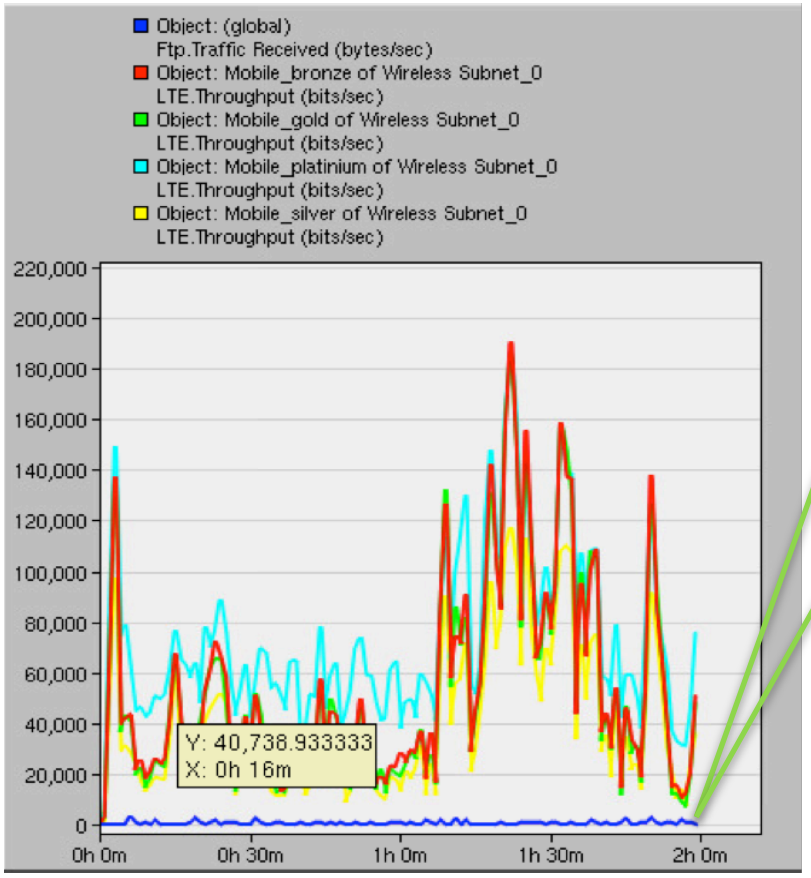
- Values are averaged over the two-hour movie duration
- Metric:
  - average: < 300 ms
  - ideal: < 10 ms

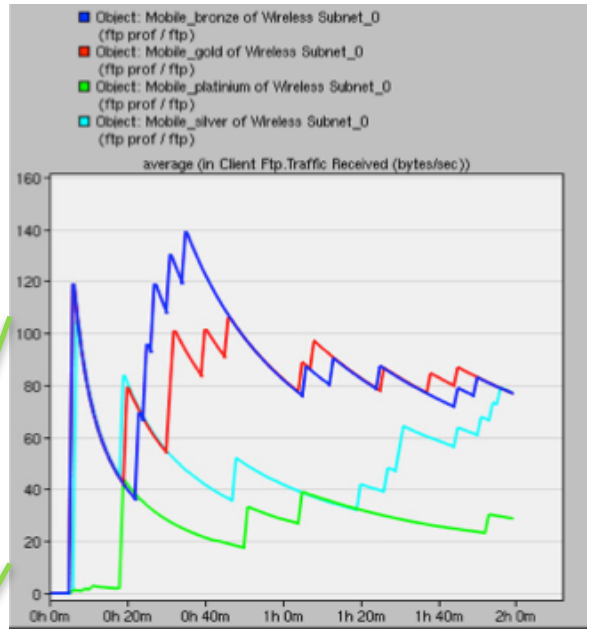
Simulation Results Video & FTP-Jitter



- Values are averaged over the two-hour movie duration
- Metric:
  - average: < 60 ms
  - ideal: < 20 ms

Simulation Results Video & FTP-Throughput

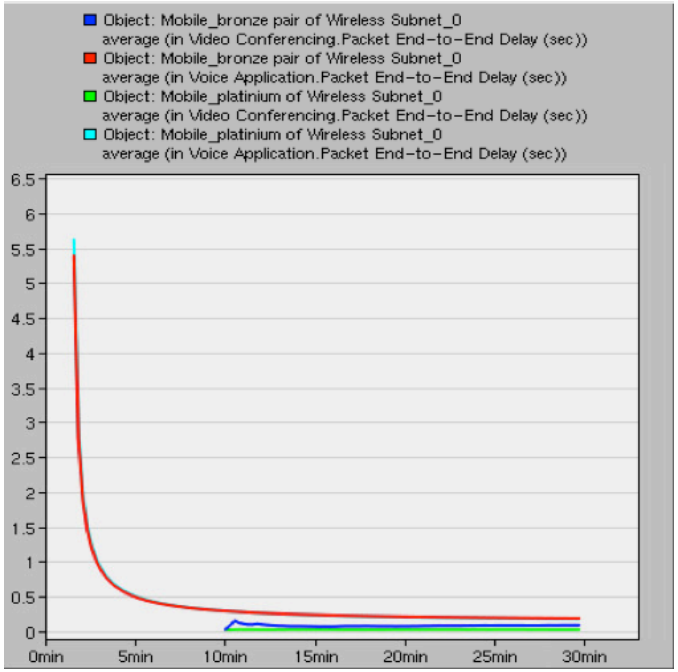




- Values are averaged over the two-hour movie duration
- Metric: 10 kbps -5 Mbps

Simulation Results Voice & Video

End to end delay



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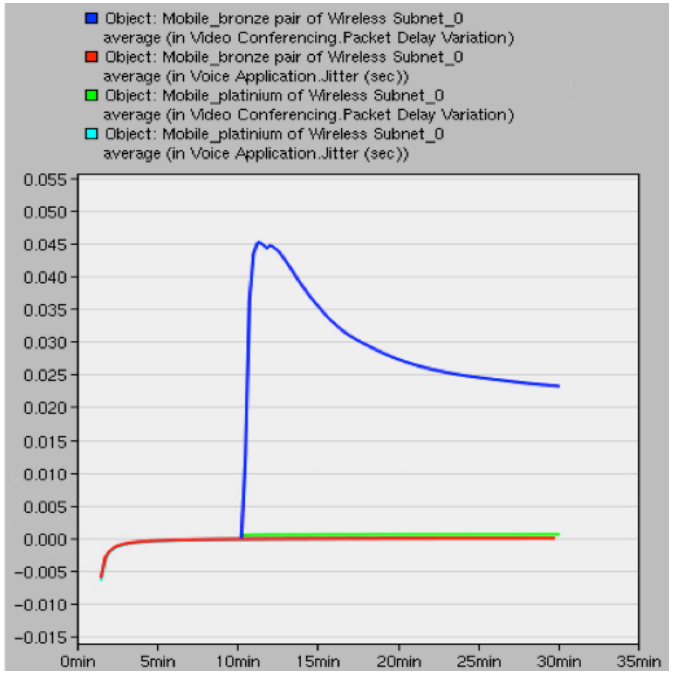
Jitter



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Conclusions

- Importance of differentiation and prioritization traffic when multiple services are concurrently running at a user terminal.
- Different levels of performance can be achieved by employing prioritization.
- Prioritization of VolP typically does not cause large quality degradation of other services due to small VoIP packet sizes.
- Validate the overall Performance of LTE for voice and video application.
- The impact of mobility.

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References

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15. H.Nam, K.H.Kim, , D. Calin and H. Schulzrinne, "Towards A Dynamic QoS-aware Over-The-Top Video Streaming in LTE," *Global Communications Conference (GLOBECOM 2014)*, pp. 1317-1322, Austin, USA, Dec. 2014.