ENSC 894 - COMMUNICATION NETWORKS - SPRING 2020

Performance of Cloud Gaming using Riverbed Modeler 17.5 Academic Version

https://cloudgamenetworking.wordpress.com/performance-of-cloud-gaming-using-riverbed-modeler/

Nadeem Khalfan, 301356518, nkhalfan@sfu.ca
Nowshin Binte Anwar, 301324355, nanwar@sfu.ca
Arbaz Ahmed, 301367520, arbaza@sfu.ca

TEAM #5

OUTLINE

1. INTRODUCTION
2. RELATED WORK
3. OBJECTIVES
4. OPNET MODEL
5. SIMULATION RESULTS
6. FUTURE WORK
7. CONCLUSION
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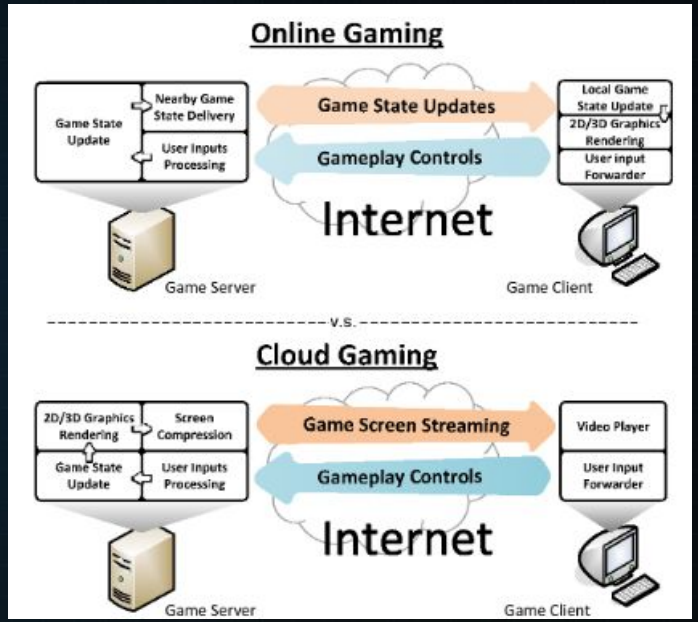
INTRODUCTION

- Modern computer games are:
  a) Expensive.
  b) Require high processing and graphical power.

- Cloud gaming (gaming in real time) allows users to play hardware intensive games without the ‘expense’. [2]

- Playstation Now
  OnLive
  GeForce Now



Comparison between Cloud and Online Gaming
Photo taken from:
https://www.iis.sinica.edu.tw/~swc/pub/qos_cloud_gaming_systems.html

INTRODUCTION

- Inputting commands over a network.
- Remote server, display being streamed to you.
- Commands sent, stream being updated.
- ms reaction time.

- Latency: How long inputs take to be registered
- Bandwidth: Maximum amount of data that can be transferred. [4]

Limitations:

- Infrastructure: Data centers filled with numerous servers.
- Remote machines: Sharing resources.

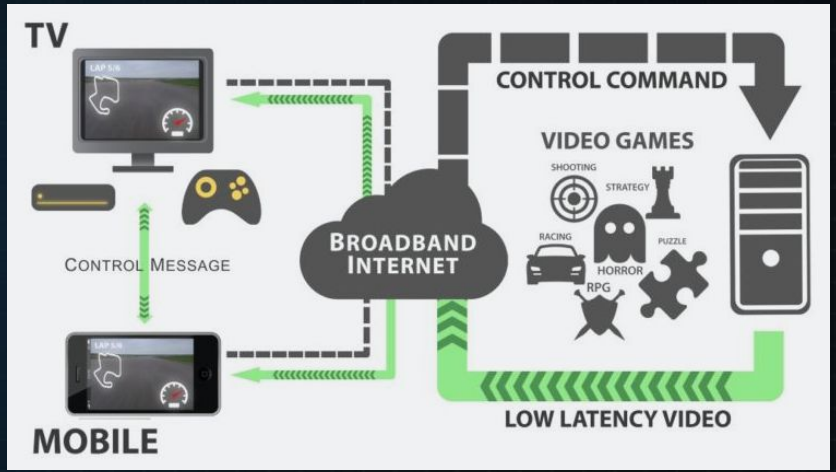


Diagram of how Cloud Gaming works [3]
Photo taken from:
https://arstechnica.com/gaming/2018/06/ubisoft-ceo-cloud-gaming-will-replace-consoles-after-the-next-generation/

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RELATED WORK

1)R. Shea, J. Liu, E. Ngai, and Y. Cui, "Cloud Gaming: Architecture & Performance", IEEE Network, pp. 16-21, 2013 - *Performance of devices.*[5]

2)Khaled Alutaibi and Ljiljana Trajković"Performance Analysis of VoIP Codecs over Wi-Fi and WiMAX Networks", 2012 [6]

3)W. Cai *et al*., "A Survey on Cloud Gaming: Future of Computer Games," in *IEEE Access*, vol. 4, pp. 7605-7620, 2016 - *Cloud Gaming Topology*. [7]

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OBJECTIVES

- Cloud gaming application is time-sensitive; yet prone to delay.
- Delay has negative impacts on Quality of Experience(QoE) and Quality of Service (QoS). [8]

Our objectives:

1) How delay varies under different practical constraints.
2) Whether improved resolution has an effect on delay/ jitter or not.
3) How adding in a voice service would add to the jitter and delay.

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OPNET MODEL

Software: Riverbed Modeler 17.5 (academic edition)

Modeling Server-side & User-side subnet

Server Side:

1. Data center
2. Firewall
3. Router

User-Side:

1. Router
2. User with workstation

Application Config: 3 applications

Profile Config: 3 profiles

Cloud gaming topology

1) Obtaining & importing gaming video traces

One 1080p & one 4k gaming trace

Length: 60 mins

1080p trace: Quantization(35) at 24 fps

4k trace: Quantization(40) at 30 fps

2) Setting up protocols

Physical Layer Technology – IEEE 802.11n

5 GHz frequency band

3) Platform used to Simulate Topology in Riverbed 17.5

Windows 10

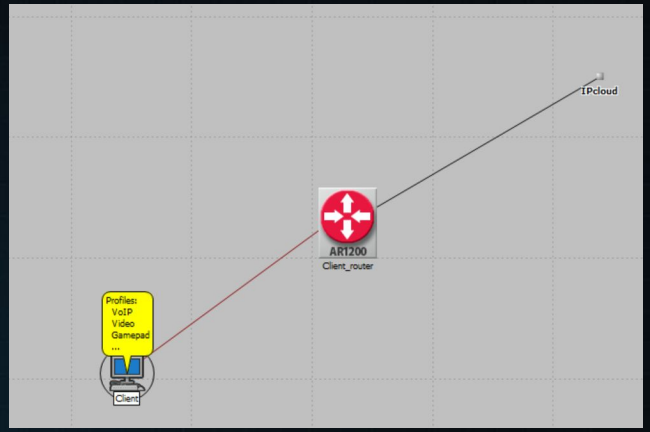
Intel i5 processor, 2GHz

8GB RAM

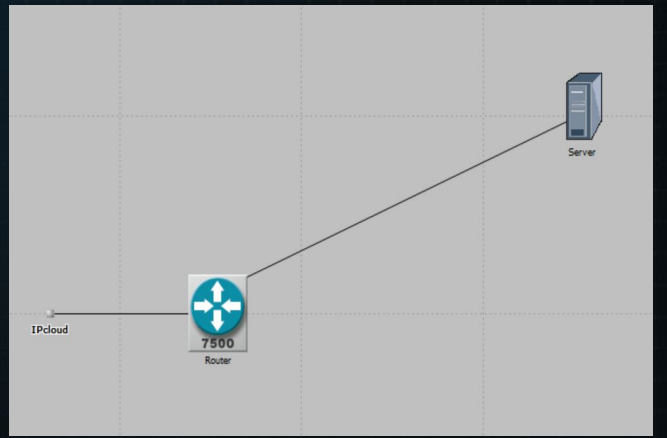
Base Configuration:

One user on the user-side subnet

- Huawei AR1200 router(supports both wired and wireless access modes)
- Ethernet workstation (client-server application running over TCP/IP and UDP/IP)
- Server (client-server application running over TCP/IP and UDP/IP)



User - side subnet



Server - side subnet

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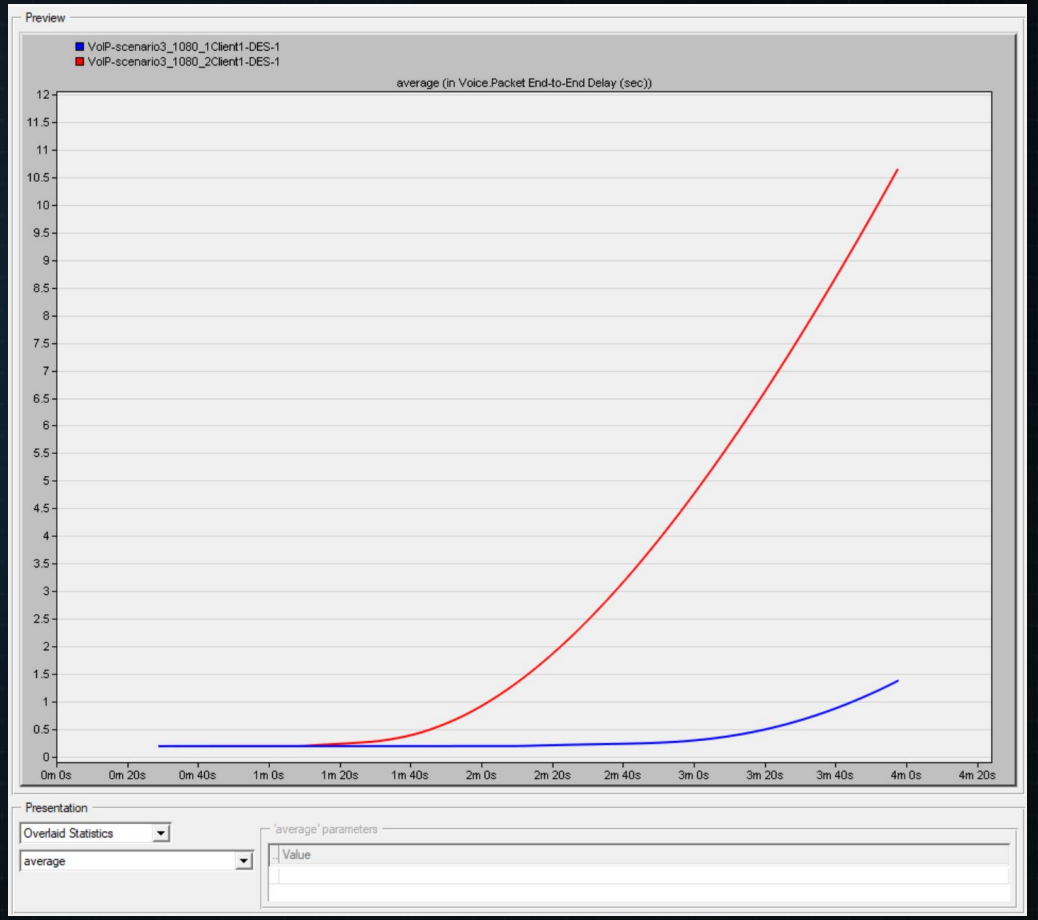
Scenario 1 (single user vs multiple users for Interactive 1080p cloud gaming)

End to End Delay :

- The delay starts from 30 seconds for both the scenarios.
- The delay for 2 clients/gamers in a subnet increases exponentially. Where the value increases from 0.2 to 10.7 seconds.
- The delay for only one client barely increases from 0.2 to 1.5 seconds.

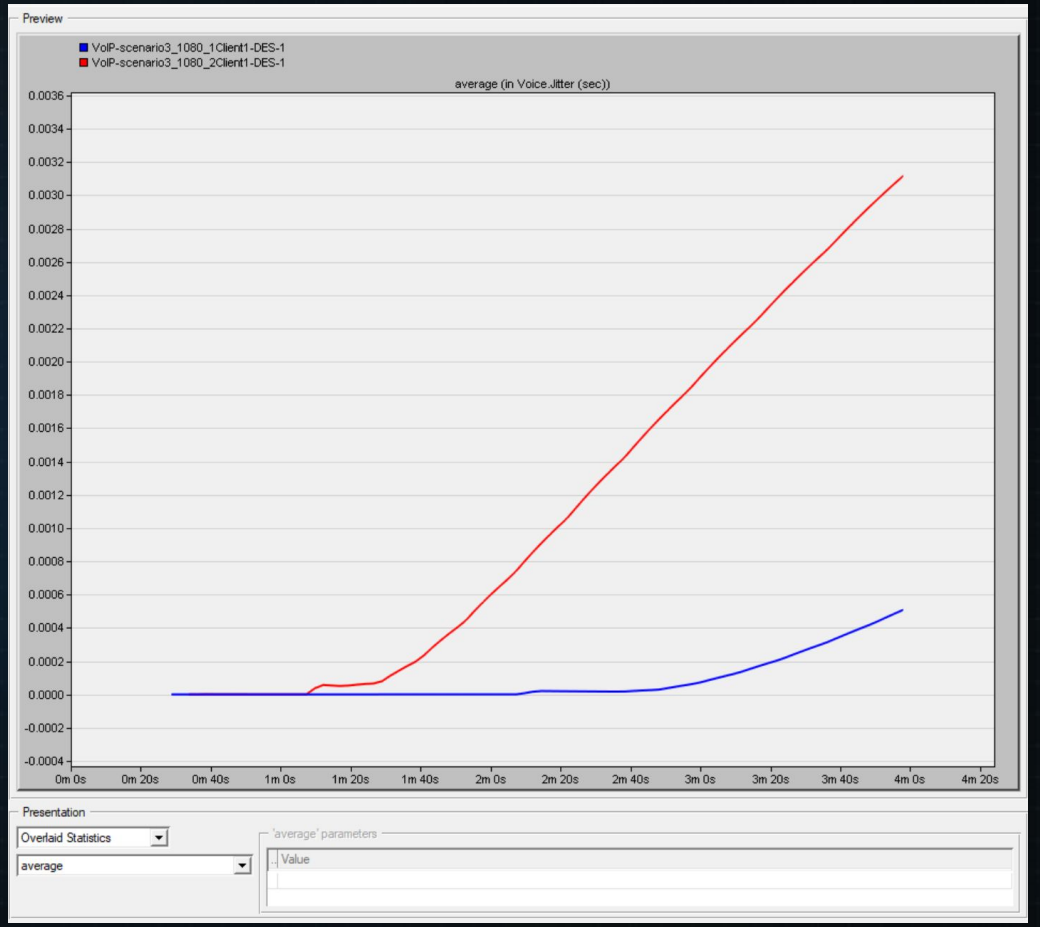


Scenario 1 (cont'd)

Jitter in voice:

- The Jitter for 2 clients/gamers in a subnet increases linearly from 0 to 0.0031 seconds.

- The delay for only one client increases rarely from 0 to 0.0005 seconds.

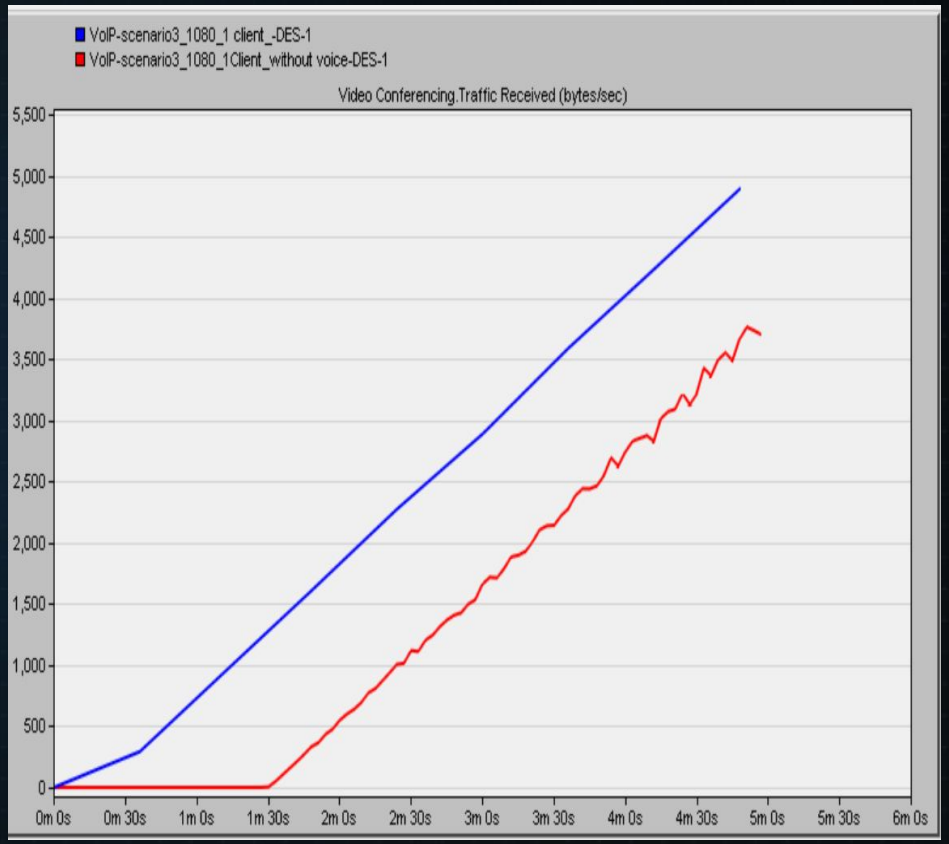


Scenario 2 (Effect of adding voice to 1080p cloud gaming)

Traffic received:

- In case of cloud gaming without voice over IP services, the number of bytes received from the server to the client increases linearly with time on an average after 1 minute 30 seconds.
- The number of bytes received by a gamer accessing cloud gaming without voice application are around 3600 bps while for interactive gamers it is about 4900 bps by the end of simulation.

1080p trace: Blue Planet(quantization 30 at 24 fps). [9]

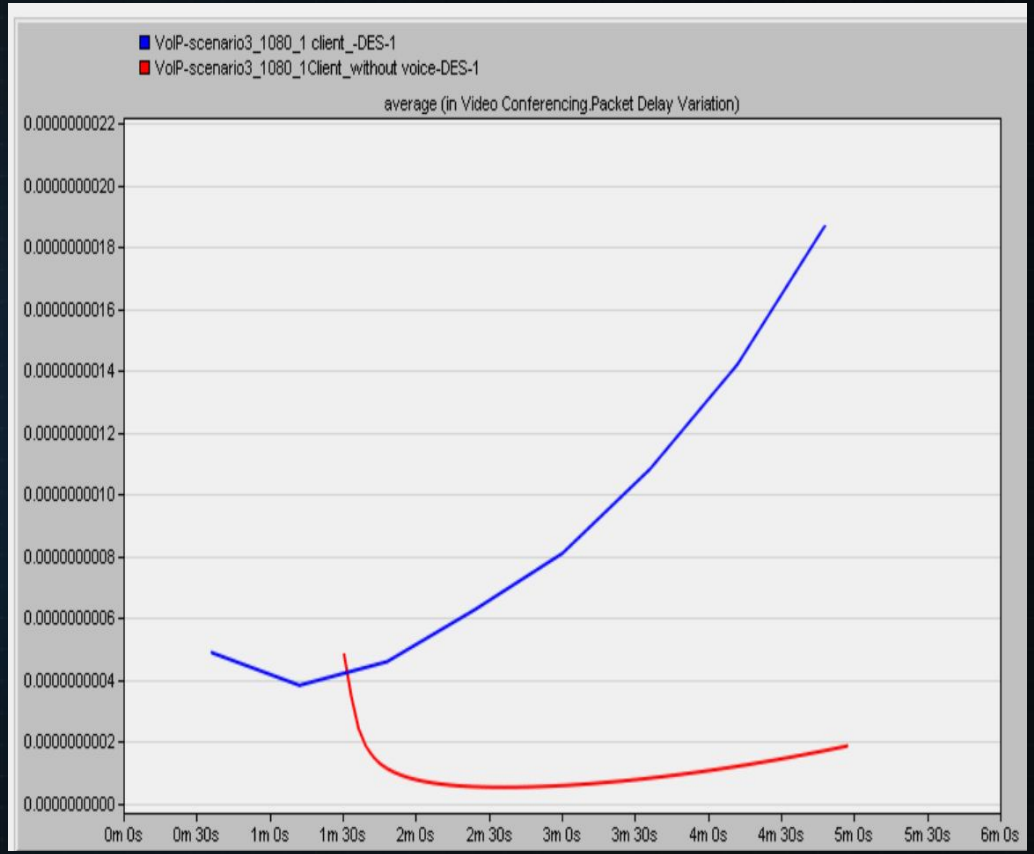


Scenario 2 (cont'd)

Packet Delay Variation:

- In case of cloud gaming without voice over IP services, the packet delay variation/jitter remains almost constant as time proceeds(except from initial couple seconds) which is expected.

- For interactive cloud gaming, the delay variation rises exponentially from 4*10^-10 to 19*10^-10 in average.

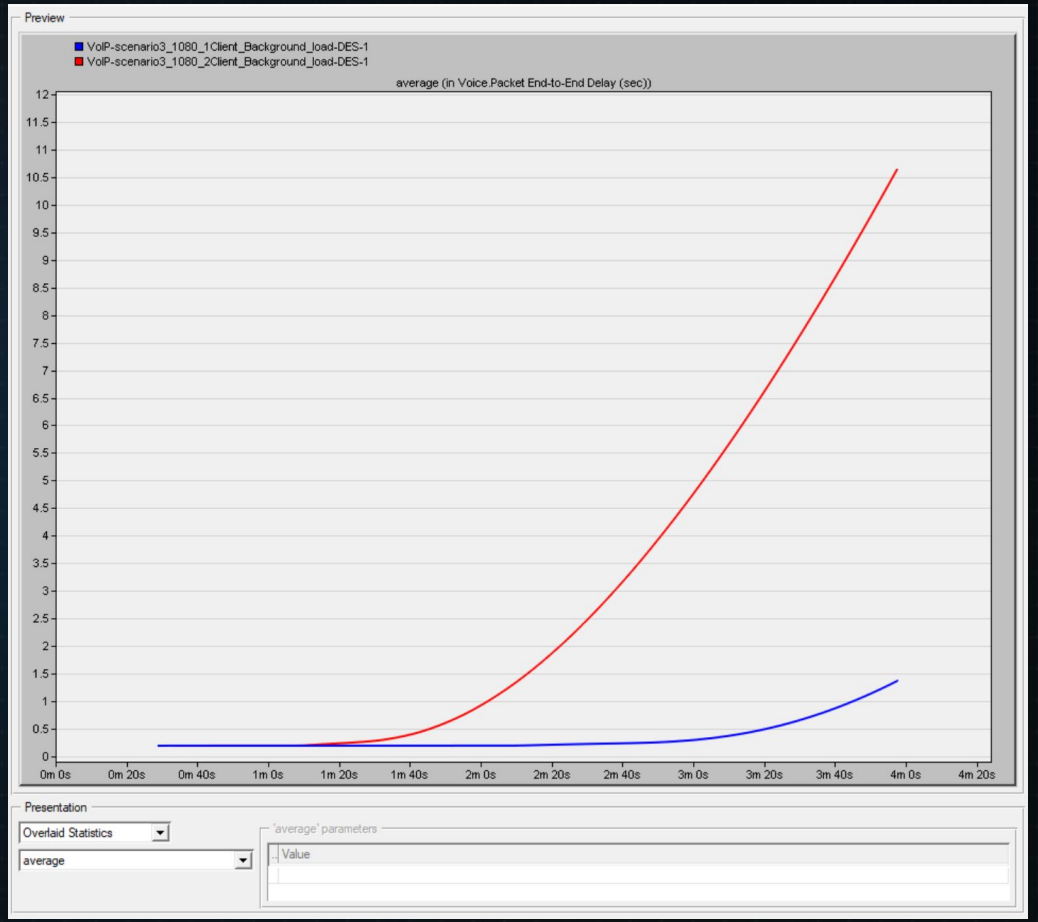


Scenario 3 (Interactive 1080p cloud gaming with background load)

End to End Delay:

- The delay starts from 30 seconds for both the scenarios.
- The delay for 2 clients/gamers in a subnet increases exponentially. Where the value increases from 0.2 to 10.7 seconds.
- The delay for only one client barely increases from 0.2 to 1.5 seconds.

- As expected, these results are almost similar to the scenario without load.

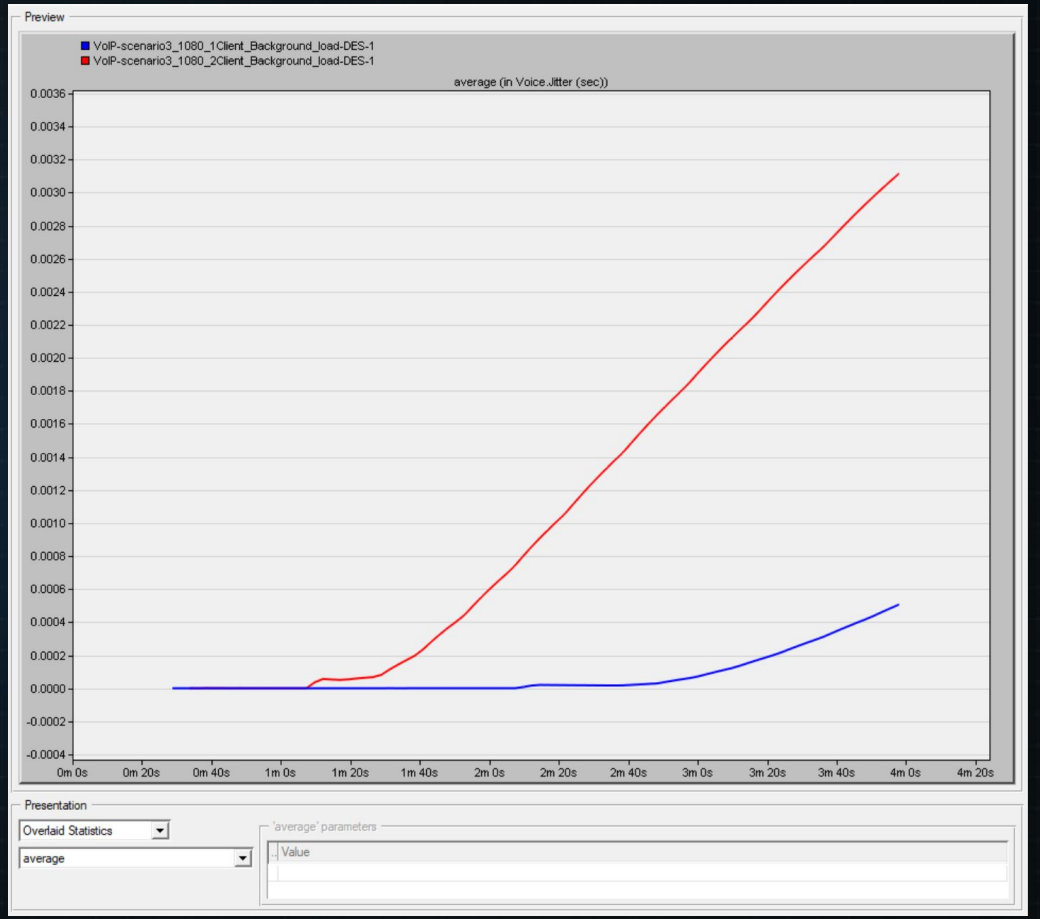


Scenario 3 (cont'd)

Jitter in voice:

- The Jitter for 2 clients/gamers in a subnet also increases linearly from 0 to 0.0031 seconds.
- The delay for only one client increases rarely from 0 to 0.0005 seconds.

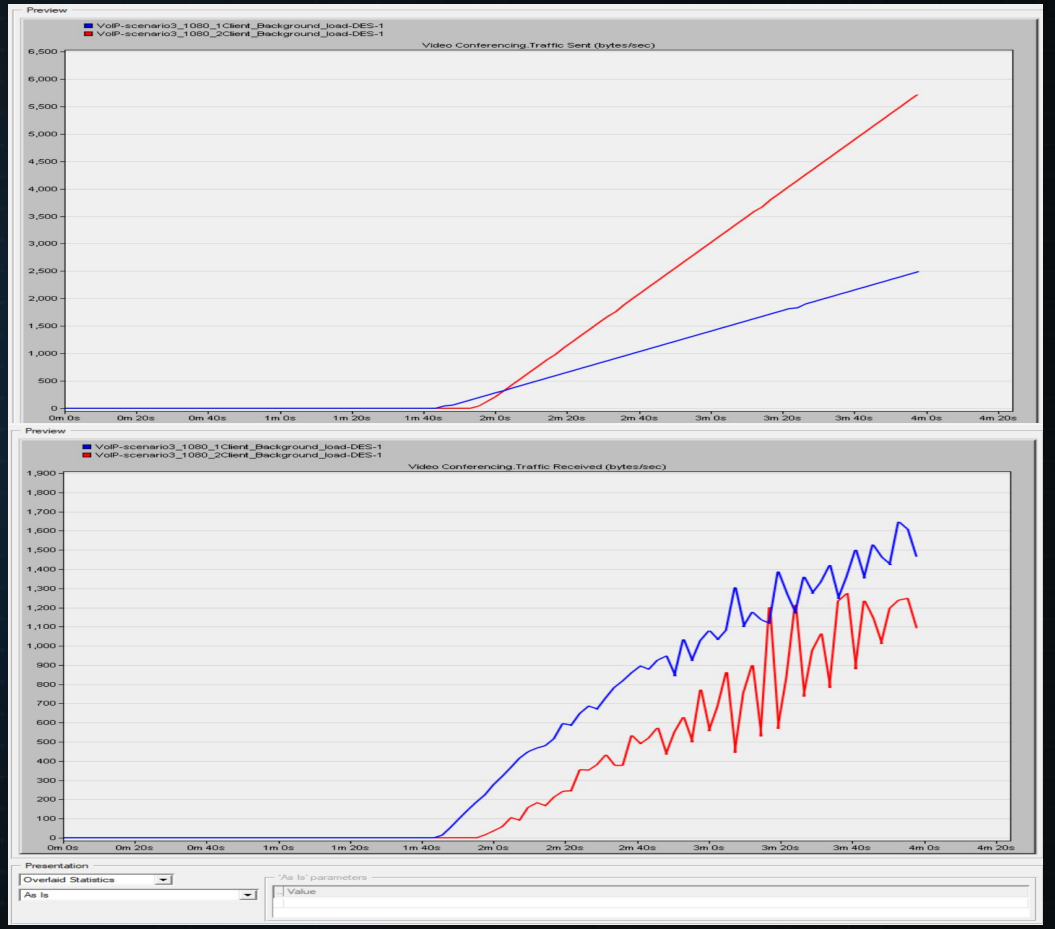
- The Jitter is also the same with minimal fluctuations on the curve.



Scenario 3 (cont'd)

Video traffic sent and received:

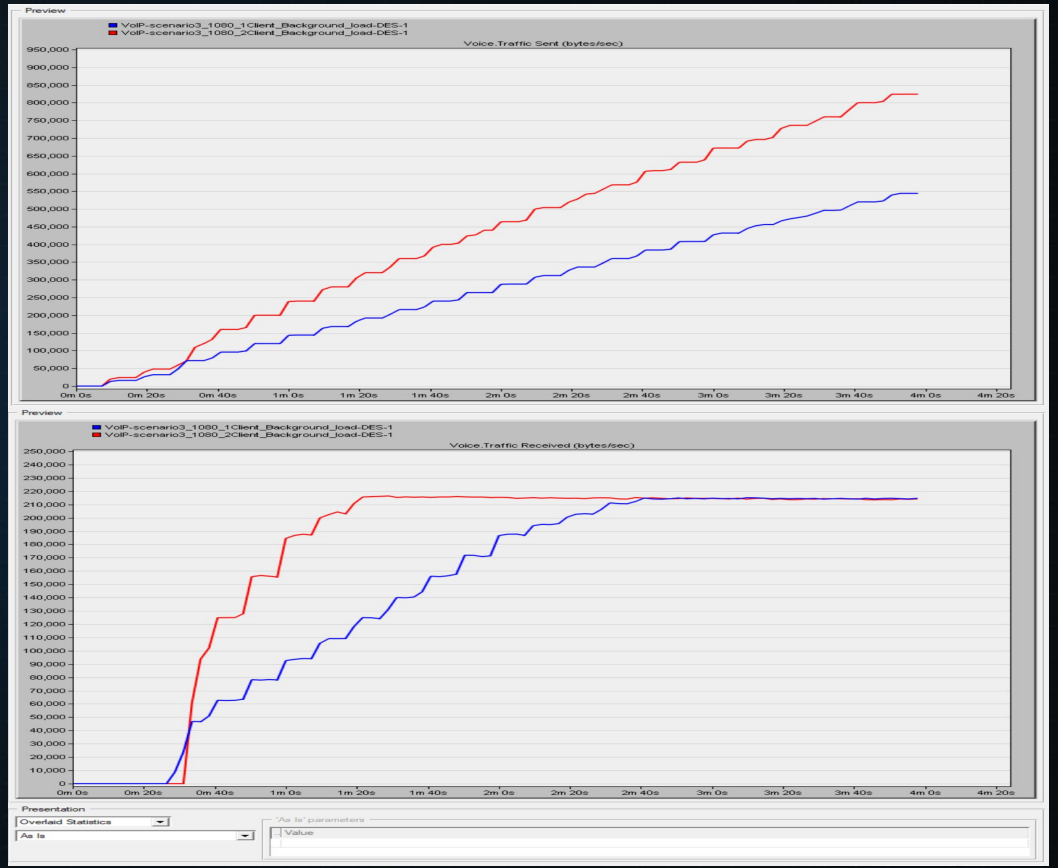
- The number of bytes sent from the client to the server increases linearly with time.
- The number of bytes sent by 2 gamers are more (5,700 bps) than the single user (2,500 bps) at the end of the simulation similar to scenario 1.
- For the receiver side, the increase is also linear but increases inconsistently and is different as compared to scenario 1 because the background load is added.
- A trace of 1080p was used for both the sending side and the receiving side.



Scenario 3 (cont'd)

Voice Traffic Sent and received:

- For voice over IP services, the number of bytes sent from the client to the server increases linearly with time on an average.
- The number of bytes sent by 2 gamers are more (825,000 bps) than the single user (550,000 bps) at the end of the simulation which is almost similar to scenario 1.
- For the receiver side, the increase looks like a step for 2 gamers whereas a ramp for 1 user after which both the comparisons settle for 215,000 bps.



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DIFFICULTIES AND FUTURE WORK

Difficulties:

1) Realism - Limited to the features of the software (Academic version)
2) Creating more scenarios.
3) Understanding the software beyond the tutorials.

Future Work:

1) 5G Topology.
2) 8K Cloud Gaming.
3) Distance of nodes (client) to the server - latency.

Next Steps:

1. Add a firewall and security attributes.
2. Test different background load to the links.

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CONCLUSION

- Cloud gaming is the future.
- Increasing the number of clients/gamers in a subnet has an effect on delay.
- Traffic sent and received is also dependent on the number of users.
- Adding voice to our topology decrease the traffic received by 15%.
- Increasing the number of Wi-fi connections will result in a more fluid gameplay regardless to the number of people connected to the router.

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4) Roach, J "*How Does Cloud Gaming Work? A Guide for 2020*" Online: https://www.cloudwards.net/how-does-cloud-gaming-work/ Accessed: 19/03/2020
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Thank you.

Question?