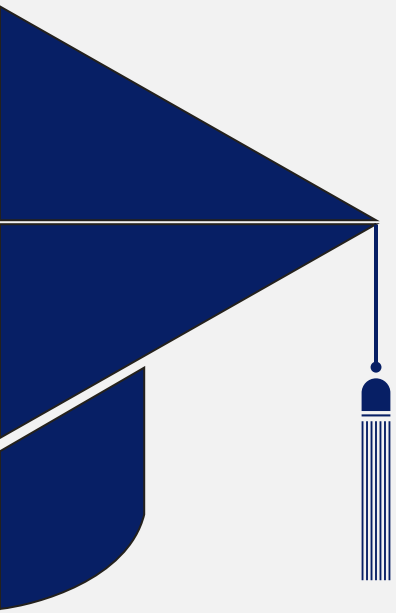
ENSC 833 NETWORK PROTOCOLS AND PERFORMANCE
SPRING 2022



Performance analysis of video streaming by Riverbed Modeler

https://lichengb.wixsite.com/sp2022ensc833team07

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Overview

- Introduction
- Related work
- Design & Implementation
- Result & discussion
- Conclusion & Improvement
- Reference

Part 1

Introduction

Introduction——Main Purpose

- Simulating and analyzing a campus network system with video streaming.
- To analyze the performance of video streaming performance with other users in the same network using light and heavy browsing.
- To analyze the effect of different data rates and Wi-Fi protocols on the performance of YouTube 1080p.
- To find the influence of the distance between the mobile node and the router and the reactions of nodes after backing into the effective distance

Introduction

YouTube

- People around the world are now watching a billion hours of YouTube's content every single day![1]
- User engagement is defined as the fraction of the total video length a user watched before the video was aborted or the video ended (100% user engagement).[2]
- YouTube primarily uses the VP9 and H.264/MPEG-4 AVC video codecs, and the Dynamic Adaptive Streaming over HTTP protocol(DASH).[3]
- Quality: 144p,240p,360p,480p,720p,1080pHD.

Introduction

Wi-Fi Campus

- Wi-Fi is the most commonly used technology in home networks.
- high absorption and work best for line-of-sight use. Many common obstructions may greatly reduce range.
- Speed: 30Mbps downstream[10]
- Wi-Fi: 2.4G/5G.
- 802.11n
- Distance: 20 meters.

https://www.lib.sfu.ca/facilities/technology/computers-silent-study

Part 2

Related Work

Related Work

- “YouTube in the move: Understanding the performance of YouTube in cellular networks” by P. Casas and his teammates, considered about the characteristics and impacts of YouTube and provided some detailed parameters to make the simulation more realistic. [4]
- D. Jain, S. Agrawal, S. Sengupta, P. De, B. Mitra and S. Chakraborty investigated the QoE of YouTube in "Prediction of quality degradation for mobile video streaming apps: A case study using YouTube”. They find that YouTube exhibits different traffic characteristics during normal streaming and when the streaming is affected due to network quality degradation.[6]

Related Work

- S. Abdallah-Saleh, Q. Wang, C. Grecos and D. Thomson conducted an experiment on mobile video streaming in heterogeneous wireless networks using Wi-Fi and WiMAX. In the paper "Handover evaluation for mobile video streaming in heterogeneous wireless networks," the results collected demonstrated performances of both horizontal handovers in terms of throughput, handover delays and packet loss. [7]

- “Performance analysis of video streaming with WiFi”, by Michael Ng, Ching Ho Weng, 2016.

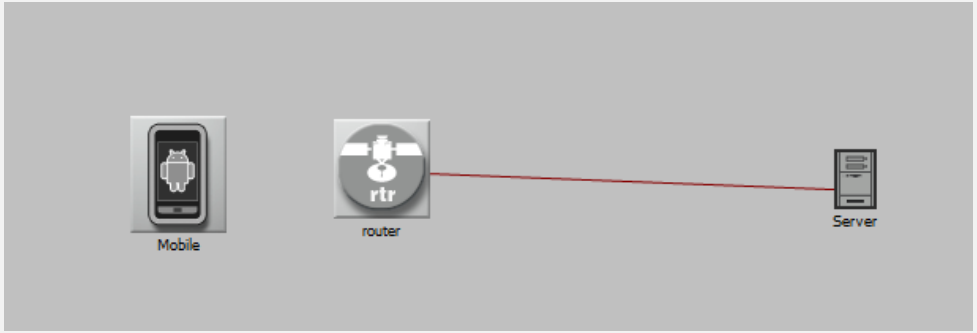
- “Performance Analysis of Video Streaming over Wi-Fi” , by Amandeep Kaur, Haotian Ye,Ashiv Rao Dhondea, 2020.

Part 3

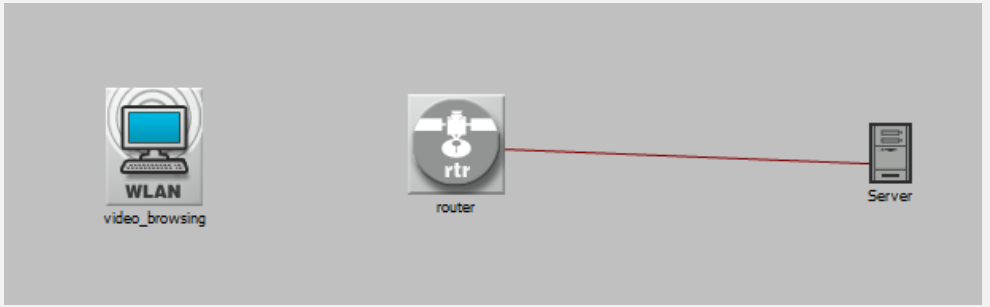
Design & Implementation

Scenario 1: Mobile node VS Computer (fixed) node

- An access point.
- One mobile node with video streaming.
- One fixed node with video streaming.



Topology with a mobile node.

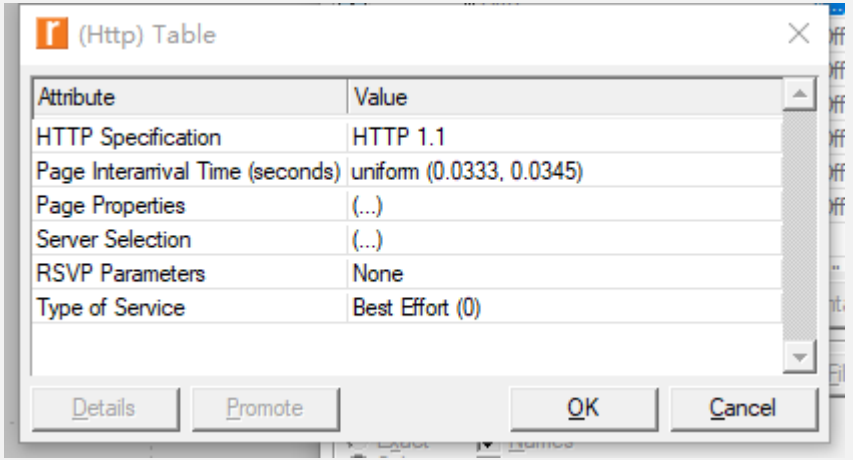


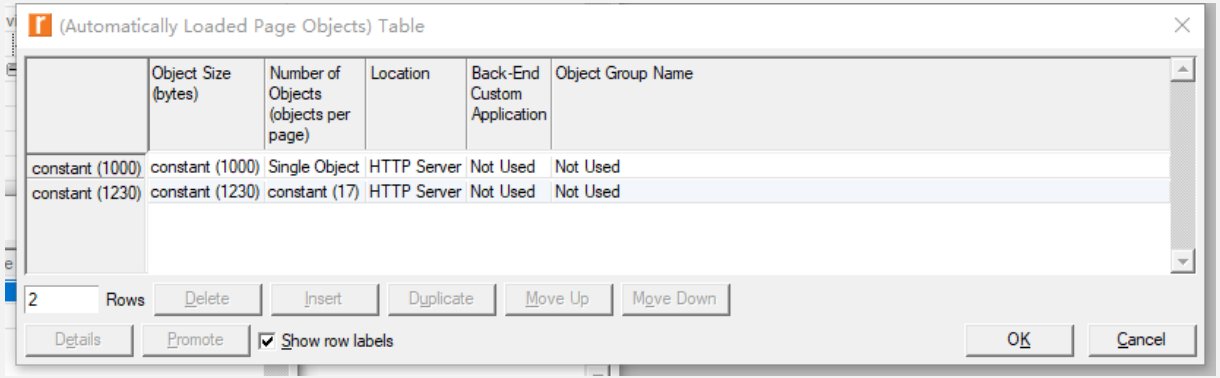
Topology with a fixed node.

Scenario 1: Mobile node VS Computer (fixed) node

Settings for Video Streaming:

- FPS: uniform (29,30),
- page Interarrival Time: “uniform (0.0333,0.0345)”
- Packet size: 1230 bytes





Scenario 1: Mobile node VS Computer (fixed) node

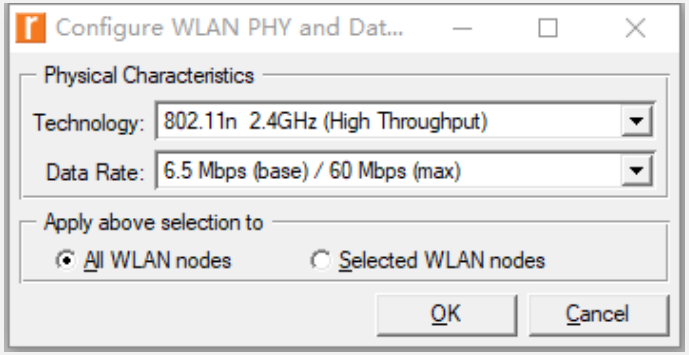
280	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
281	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
282	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
283	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
284	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
285	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
286	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
287	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
288	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
289	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230
290	2022-04-21 17:33:38.169573	2001:569:2:8::e	2001:569:7ed0:1700:1979:f760:e17b:b62	UDP	1292 443 → 58830 Len=1230

Wireshark trace of YouTube Video.

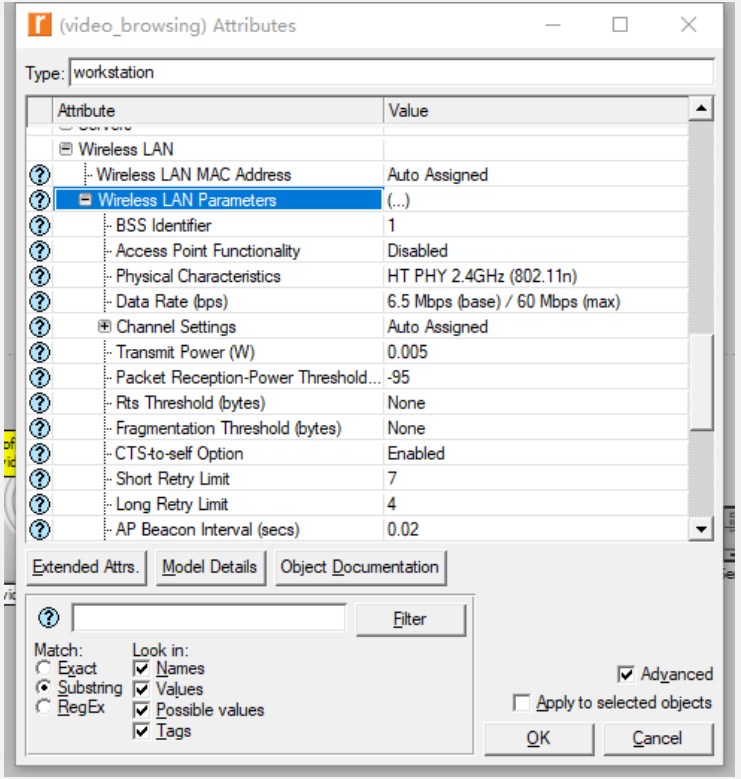
```
> Frame 1910: 1292 bytes on wire (10336 bits), 1292 bytes captured (10336 bits) on interface \Device\NPF_{04C447E9-EC33-47A2-AB33-51FAA5A60346}, id 0
> Ethernet II, Src: Actionte_fc:d0:20 (9c:1e:95:fc:d0:20), Dst: IntelCor_00:ff:d7 (b0:35:9f:00:ff:d7)
> Internet Protocol Version 6, Src: 2001:569:2:8::e, Dst: 2001:569:7ed0:1700:1979:f760:e17b:b62
> User Datagram Protocol, Src Port: 443, Dst Port: 58830
v Data (1230 bytes)
      Data: 5da892e808ab34695dec2365b9464d121ed14b0f3b2eb8d4a0433a9e7a3147492ab4bdfd…
      [Length: 1230]
```

Details of a YouTube packet.

Scenario 1: Mobile node VS Computer (fixed) node

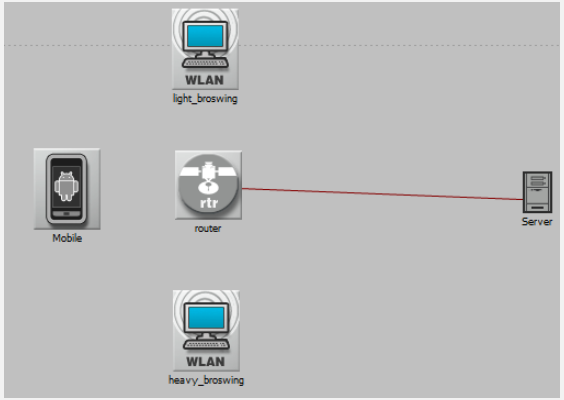


WLAN Configuration.

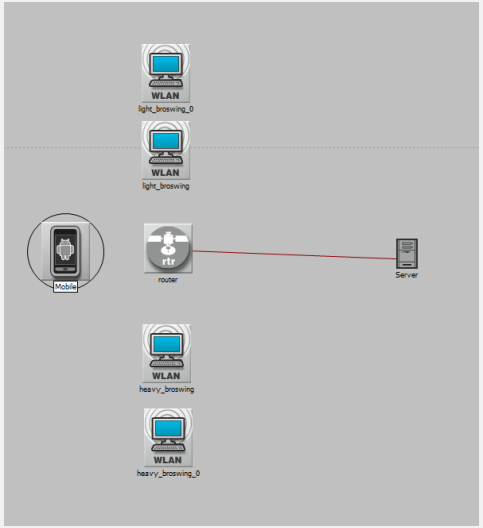


WLAN Configuration.

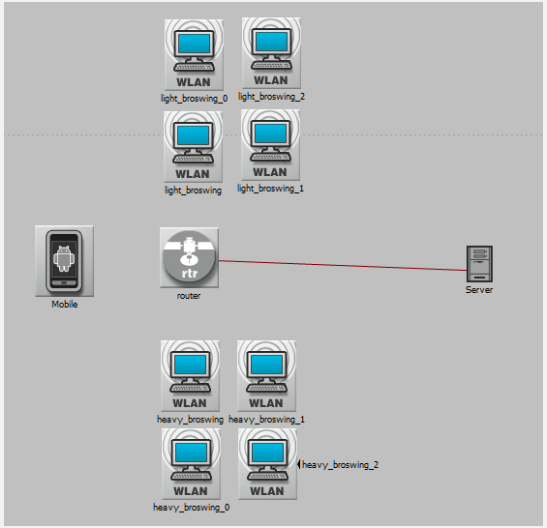
Scenario 2: Video streaming of Mobile with other users



One node of light browsing and one node of heavy browsing

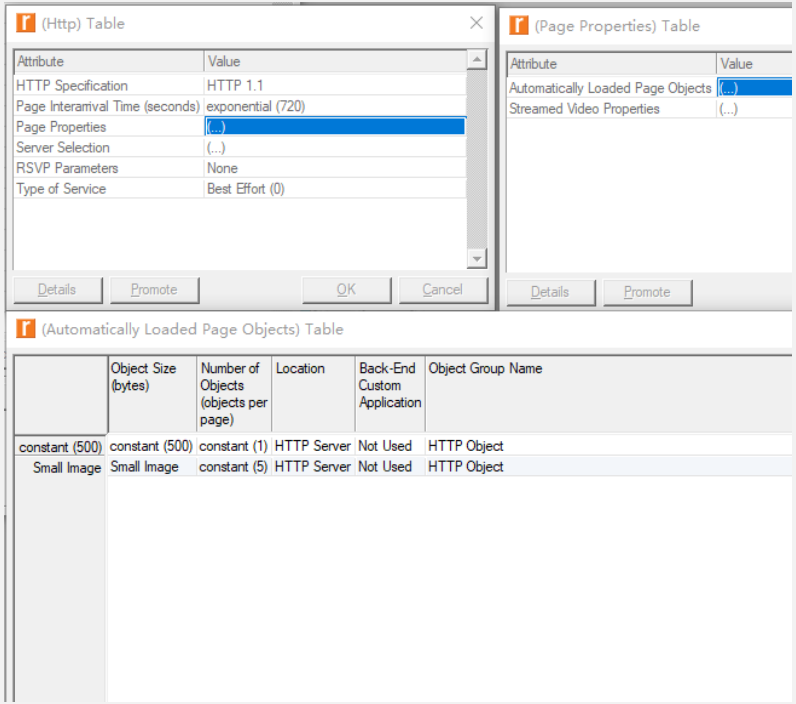


Two nodes of light browsing and two nodes of heavy browsing

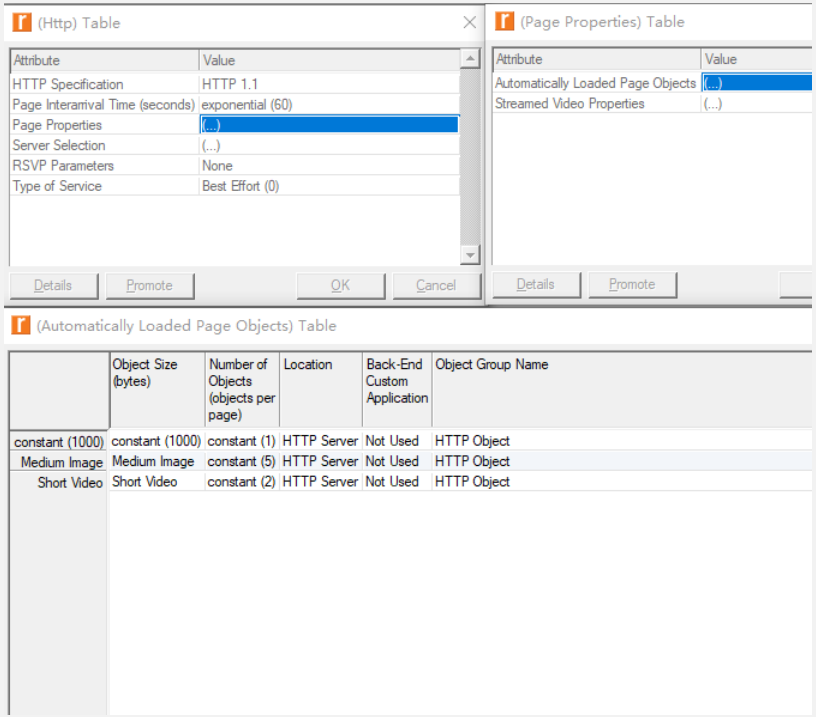


Four nodes of light browsing and four nodes of heavy browsing

Scenario 2: Video streaming of Mobile with other users



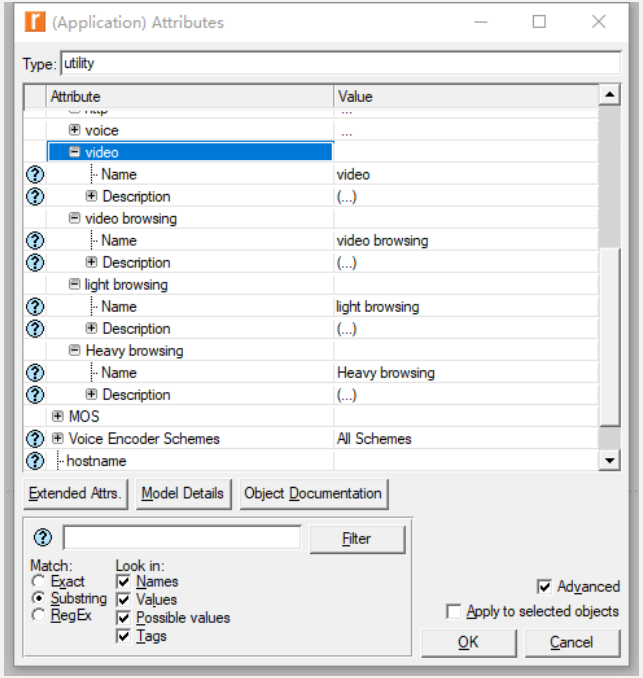
parameters of light browsing



parameters of heavy browsing

Scenario 2: Video streaming of Mobile with other users

- The Light Browsing application has a small object size to simulate user searching for interesting video or browsing comments.
- The heavy Browsing application has a larger size to simulate viewing the pictures in community.

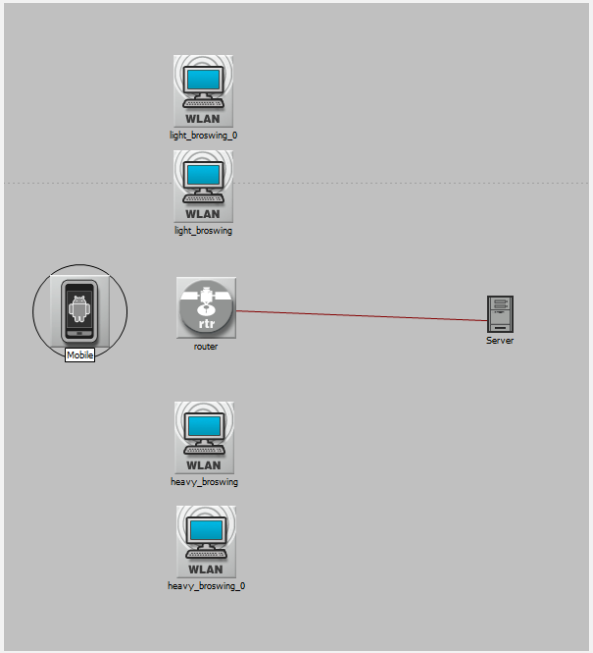


Application configuration: light browsing and heavy browsing

Scenario 3: Effect of data rate and Wi-Fi protocol

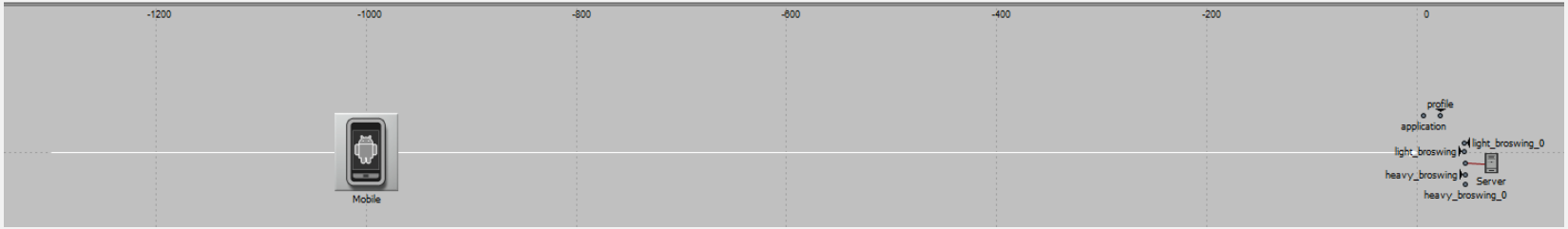
802.11g (Mbps)	802.11n (Mbps)
12	13
18	19.5
24	26
36	39
48	52
54	58.5

Table 1: Data rates



Topology for scenario 3.

Scenario 4: Effect of distance and movement on data rate and Wi-Fi protocol

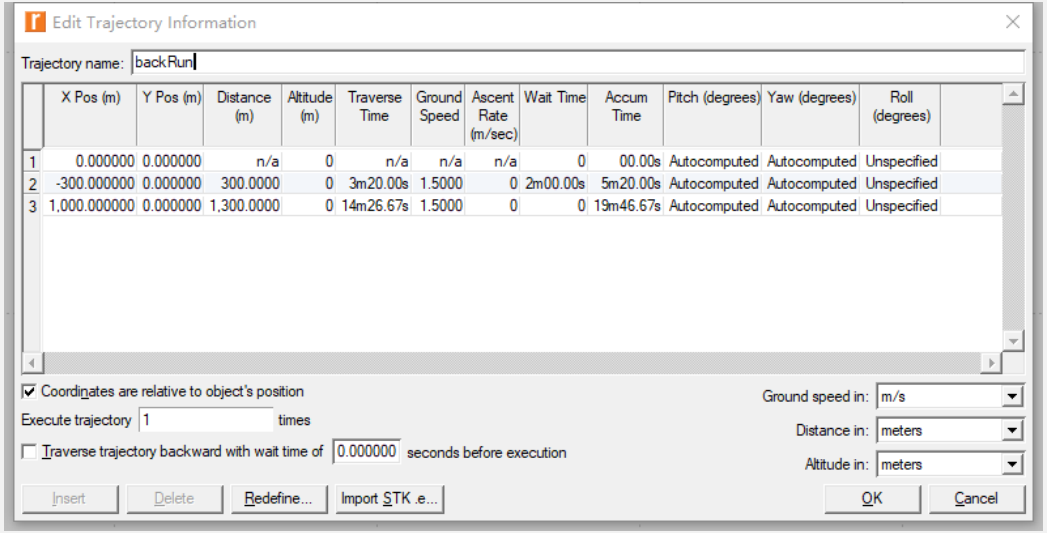


Topology for scenario 4.

Focus on these three aspects:

- The influence of the distance between the mobile node and the router.
- The different ranges of different protocols and data rates.
- The reactions of nodes after backing into the effective distance for different protocols and data rates.

Scenario 4--Trajectory Setting



The mobile node is placed to the left of the router at a distance of 1000 meters from the router.

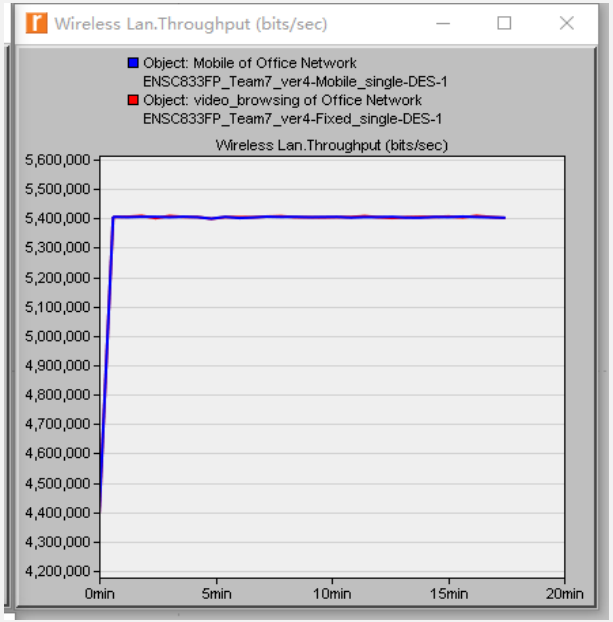
First, it moves 300 meters to the left and stays in place for two minutes, and this step aims to find the maximum effective distance of the current WLAN protocol.

Next, the mobile walks to the right until the end of the simulation. The speed is set to 1.5m/s all the time. In this step, the mobile will connect to the router again at one moment. Then the mobile will keep walking to close the router. After that, we can find what happens when the mobile reconnects the router and the effect of the distance between the node and router.

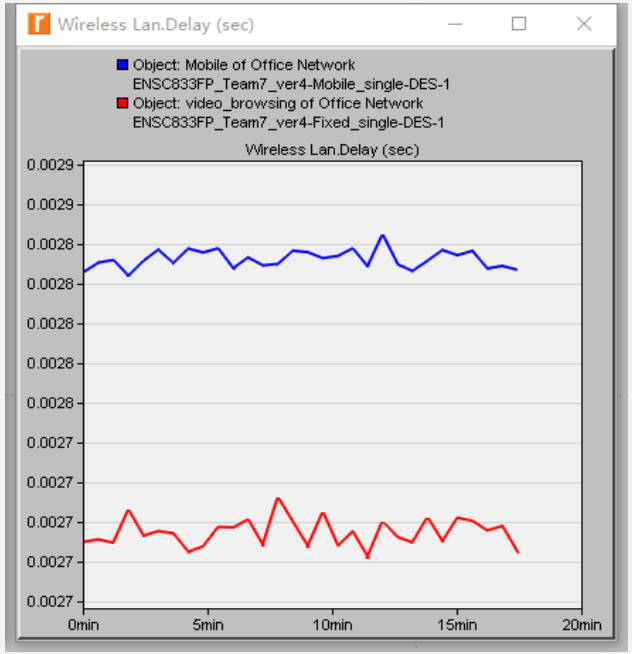
Part 4

Result & discussion

Scenario 1: Mobile node VS Computer (fixed) node

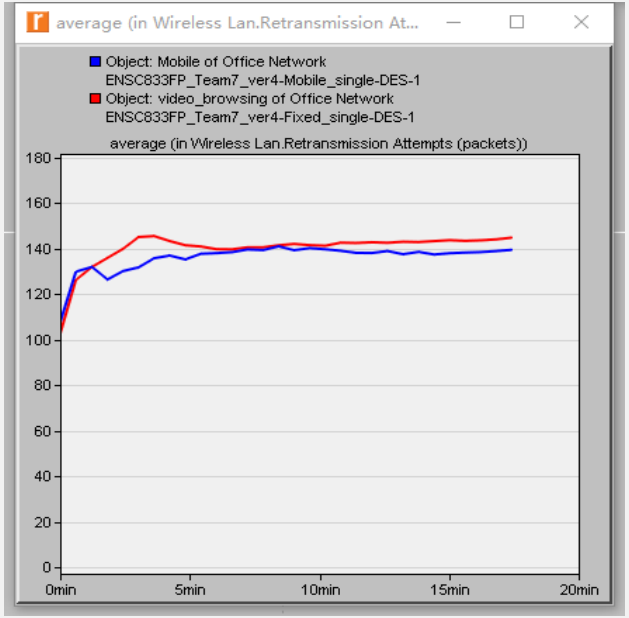


Throughput of mobile and fixed users



Delay of mobile and fixed users

Scenario 1: Mobile node VS Computer (fixed) node

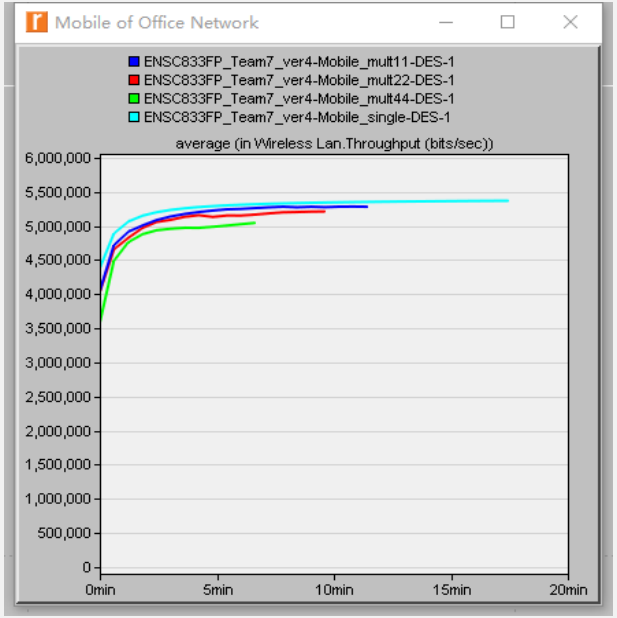


Retransmission(avg) of mobile and fixed users

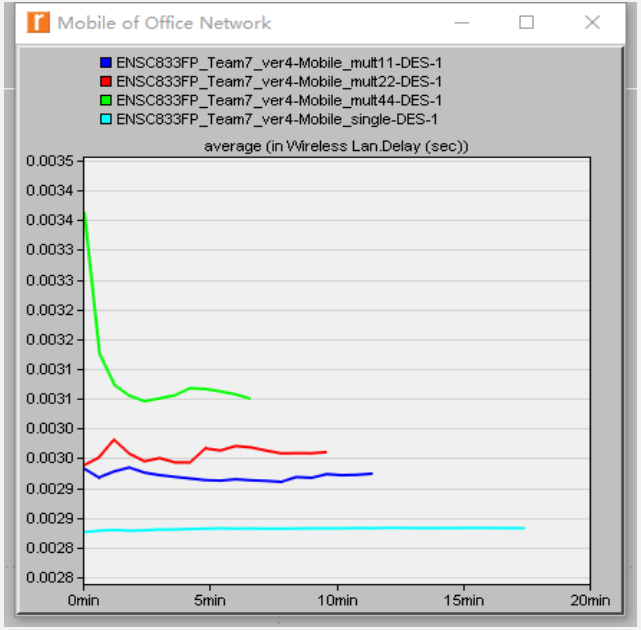
The mobile's baseline data in this project:

- 5.4Mbps throughput, 100-160 retransmission attempts, and 0.0028 seconds delay.
- Mobile's throughput performance is the same as the fixed node's.
- Mobile's average retransmission attempts are fewer than the fixed node's.
- Mobile's delay performance is worse than the fixed node's.

Scenario 2: Video streaming of Mobile with other users

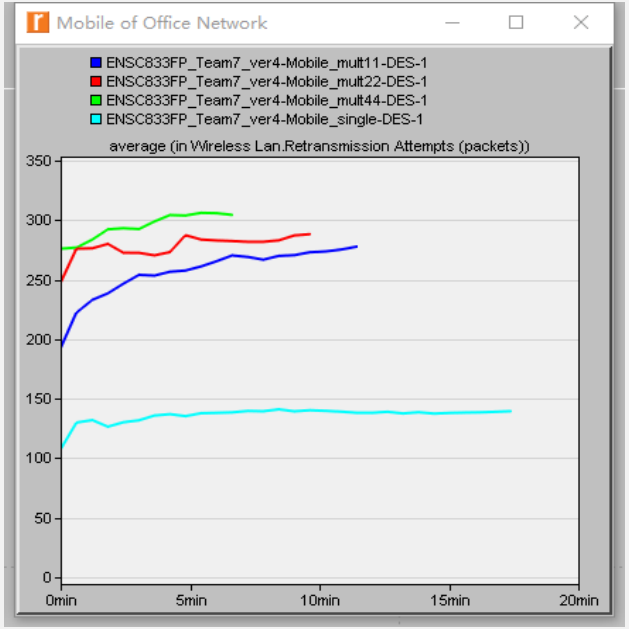


Throughput average of scenario 2



Delay Average of scenario 2

Scenario 2: Video streaming of Mobile with other users



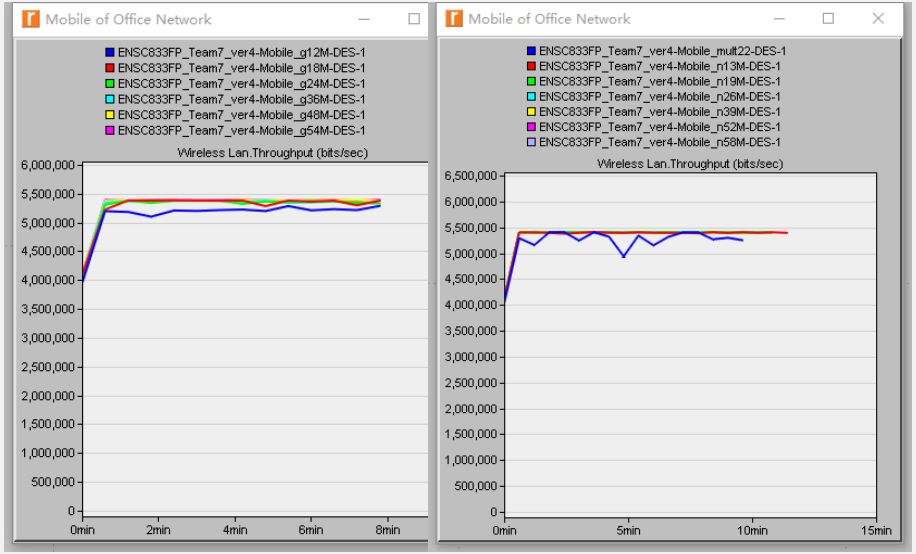
Retransmission average of scenario 2

The more nodes are joined, the smaller the throughput is.

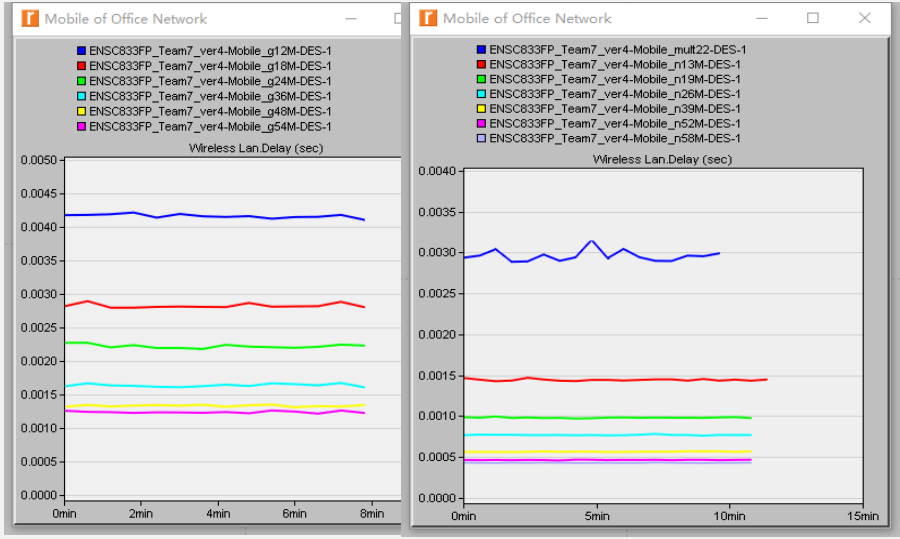
the average retransmission attempts and delays of mobile are increasing with the increase of users.

the mobile’s overall performance becomes worse with the increasing of nodes (especially the "heavy browsing" client)

Scenario 3: Effect of data rate and Wi-Fi protocol

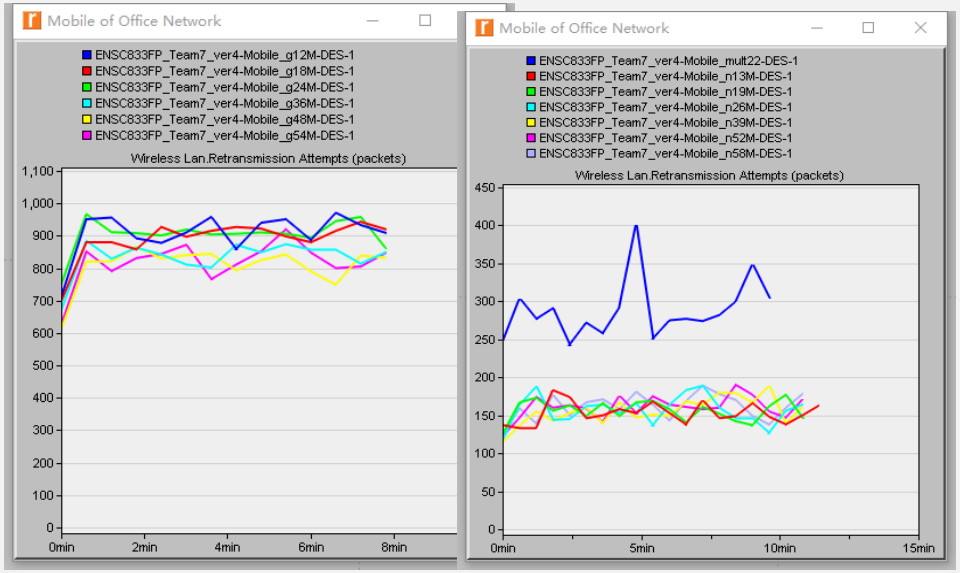


Throughput of 802.11g and 802.11n



Delay of 802.11g and 802.11n

Scenario 3: Effect of data rate and Wi-Fi protocol

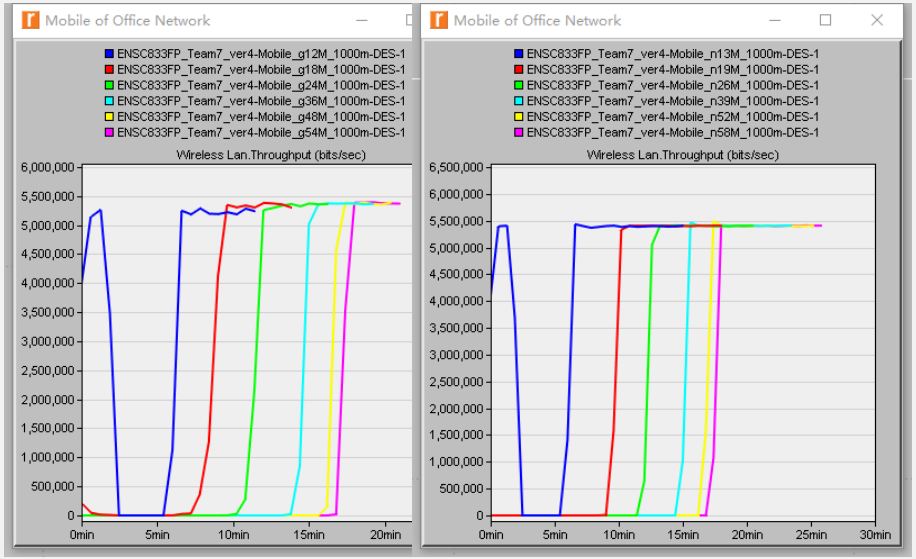


Retransmission of 802.11g and 802.11n

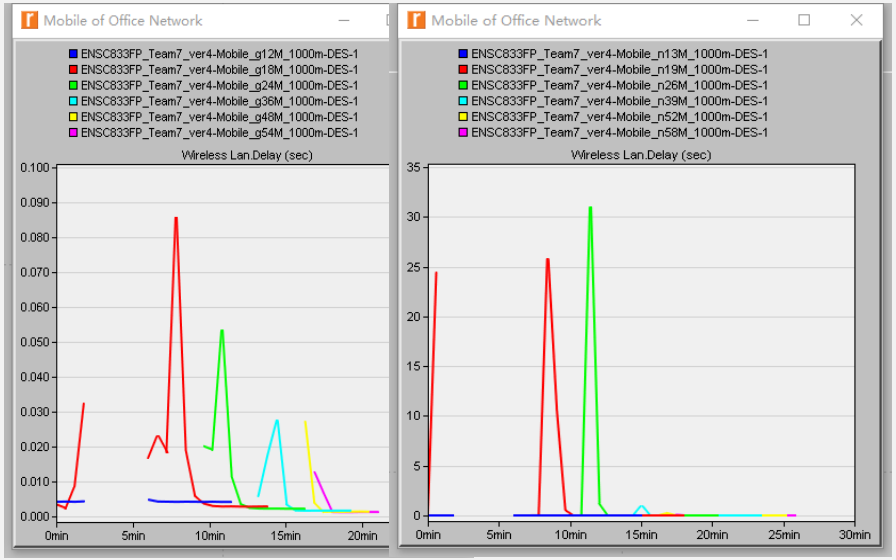
In this scenario, 802.11n performs much better than 802.11g on mobile devices.

In the same WLAN protocol, the overall performance of mobile becomes better as the increase of data rate.

Scenario 4: Effect of distance and movement on data rate and Wi-Fi protocol

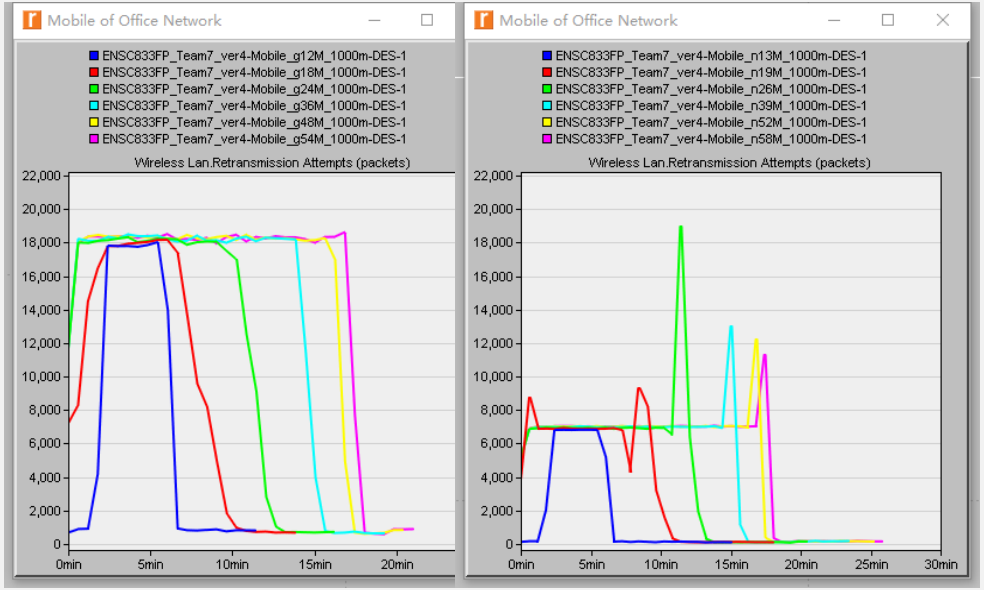


Throughput of 802.11g and 802.11n



Delay of 802.11g and 802.11n

Scenario 4: Effect of distance and movement on data rate and Wi-Fi protocol



Retransmission of 802.11g and 802.11n

In this scenario, when the mobile is out of the range, they do not have throughput and delay and keep sending retransmission attempts.

When the mobile arrives at the range, the bufferbloat(congestion) may occur. During the short time, the throughput increases to 5.4Mbps, and the retransmission and the delay increase seriously.

After that, the throughput kept around 5.4Mbps, and the retransmission and the delay decreased.

When the phone is near the router, the mobiles with different data rates have the same performance as in scenario 3, and the distance does not affect the performance.

Part 5

Conclusion & Improvement

Conclusion

This project simulates a mobile watching a 1080P/30FPS YouTube video in different scenarios through Riverbed Modeler.

1. The first scenario shows the overall performance of mobile: about 5.4Mbps, around 100-160 retransmission attempts, and about 0.0028-second delay.
2. The mobile performance will be influenced due to the other users' requests that need to be handled. As a result, the mobile will send more retransmission, leading to congestion, delay, and lower throughput.
3. The mobile has a better overall performance with a higher data rate. Furthermore, mobile with 802.11n has better performance than mobile with802.11g.
4. The router's effective range becomes smaller as its data rate becomes higher. When the mobile is out of the router's effective range, it will keep sending the retransmission attempts and has no throughput or delay.

Future Work

- Due to the academic version of the Riverbed Modeler, this project suffers from two significant limitations: First, the academic riverbed modeler has a cap of 50000000 events. Second, it cannot customize the router's valid range.
- This project only selects 1080p 30fps for simulation in terms of YouTube, but there is more resolution [720p 2k, 4k] and frame options (24fps, 60fps). Furthermore, the comparison between different resolutions and frame number combinations is one for future work.
- Besides, the project set the attributes "uniform(0.0333,0.0345)" page interarrival time and "constant(1230) with constant(17) number" objects based on the data from YouTube Help.
- Chapter 2 lecture describes how streaming stored video works. In the future, the project can define other kinds of video browsing, such as "step-by-step data transfer" (Right now, it defines "continuous speed" video browsing).
- In terms of scenarios, there is a large potential to build more complex and detailed topologies for new scenarios. For example, scenario4 found that distance and movement do not affect mobile performance. Therefore, the project can focus on scenario4 and build new topologies for improving it in the future.

Reference

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Reference

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Thank you!