Performance Analysis of Video Streaming over LTE using Riverbed

ENSC 427 – Communication Networks

Spring 2016

Group #2 Project URL:

http://www.sfu.ca/~rkieu/ENSC427_Project.html

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Roadmap

- Introduction
- Project Overview
- Project Design
- Simulation Results and Analysis
- Summary
- References
- Questions

Introduction

- A lot of internet browsing and video streaming is done over Long Term Evolution (LTE)
- Users prefer watching videos on their cell phones while at work and home, or while travelling
- We analyze the performance of YouTube streaming over LTE using Riverbed

Introduction - LTE Technology

- One of the most commonly used and fastest growing wireless telecommunication technologies
- Used by network operators around the globe for high-speed communication for smart phones or data terminals
- Fast downloading rate: 5-12 Megabits/second(Mbps)

Project Overview

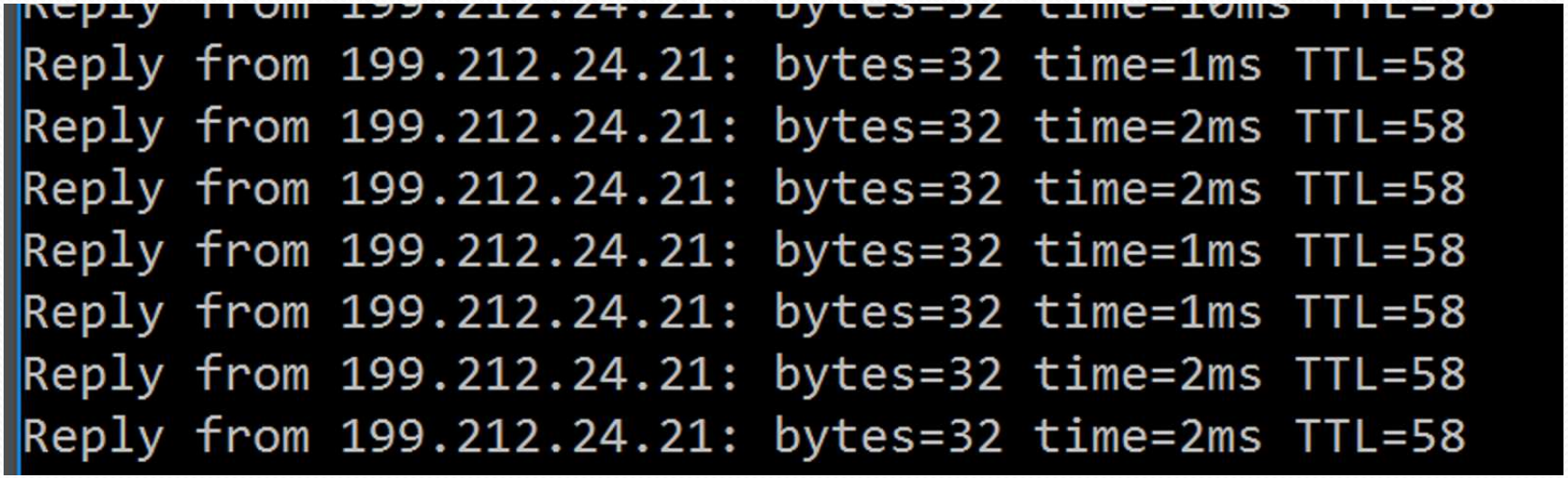
- Scenario Zero – Validation Scenario
- Scenario One - Single base station with one mobile node and two fixed nodes
- Scenario Two – Two base stations with single mobile node
- Scenario Three – Three base stations with one then two mobile nodes
- Aim - Analyze Throughput and Delay for all scenarios

Project Design - Wireshark

No.	Time	Source	Destination	Protocol	Length	Info
25	11.375375	199.212.24.16	207.23.168.151	TCP	1450	[TCP segment of a reassembled PDU]
26	11.375663	199.212.24.16	207.23.168.151	HTTP	1076	HTTP/1.1 200 OK (text/html)
27	11.375727	207.23.168.151	199.212.24.16	TCP	54	51664 → 80 [ACK] Seq=288 Ack=2419 Win=65536 Len=0
28	23.203122	74.125.28.95	207.23.168.151	TCP	60	80 → 65134 [FIN, ACK] Seq=1 Ack=2 Win=344 Len=0
29	23.203245	207.23.168.151	74.125.28.95	TCP	54	65134 → 80 [ACK] Seq=2 Ack=2 Win=256 Len=0
30	32.332730	207.23.168.151	74.125.28.95	TCP	54	65134 → 80 [FIN, ACK] Seq=2 Ack=2 Win=256 Len=0
31	32.345979	74.125.28.95	207.23.168.151	TCP	60	80 → 65134 [ACK] Seq=2 Ack=3 Win=344 Len=0
32	45.135637	207.23.168.151	54.243.128.120	TCP	55	[TCP Keep-Alive] 51511 → 80 [ACK] Seq=553 Ack=6523 Win=62894 Len=1
33	45.203336	54.243.128.120	207.23.168.151	TCP	60	[TCP Keep-Alive ACK] 80 → 51511 [ACK] Seq=6523 Ack=554 Win=27097 Len=0
34	53.409429	207.23.168.151	23.235.47.192	TCP	55	[TCP Keep-Alive] 65136 → 80 [ACK] Seq=1 Ack=1 Win=256 Len=1
35	53.434616	23.235.47.192	207.23.168.151	TCP	66	[TCP Keep-Alive ACK] 80 → 65136 [ACK] Seq=1 Ack=2 Win=60 Len=0 SLE=1 SRE=2
36	55.689192	207.23.168.151	142.231.1.182	TCP	55	[TCP Keep-Alive] 65205 → 80 [ACK] Seq=1 Ack=1 Win=255 Len=1
37	55.697261	142.231.1.182	207.23.168.151	TCP	66	[TCP Keep-Alive ACK] 80 → 65205 [ACK] Seq=1 Ack=2 Win=961 Len=0 SLE=1 SRE=2
38	56.375730	207.23.168.151	199.212.24.16	TCP	55	[TCP Keep-Alive] 51664 → 80 [ACK] Seq=287 Ack=2419 Win=65536 Len=1
39	56.389421	199.212.24.16	207.23.168.151	TCP	66	[TCP Keep-Alive ACK] 80 → 51664 [ACK] Seq=2419 Ack=288 Win=30336 Len=0 SLE=287 SRE=288
40	65.156487	54.243.128.120	207.23.168.151	TCP	60	80 → 51511 [FIN, ACK] Seq=6523 Ack=554 Win=27097 Len=0
41	65.156532	207.23.168.151	54.243.128.120	TCP	54	51511 → 80 [ACK] Seq=554 Ack=6524 Win=62894 Len=0
42	71.813809	199.212.24.16	207.23.168.151	TCP	60	80 → 51664 [FIN, ACK] Seq=2419 Ack=288 Win=30336 Len=0
43	71.813811	199.212.24.16	207.23.168.151	TCP	60	[TCP Out-Of-Order] 80 → 51664 [FIN, ACK] Seq=2419 Ack=288 Win=30336 Len=0
44	71.813894	207.23.168.151	199.212.24.16	TCP	54	51664 → 80 [ACK] Seq=288 Ack=2420 Win=65536 Len=0
45	71.814106	199.212.24.16	207.23.168.151	TCP	60	[TCP Out-Of-Order] 80 → 51664 [FIN, ACK] Seq=2419 Ack=288 Win=30336 Len=0
46	71.814143	207.23.168.151	199.212.24.16	TCP	54	[TCP Dup ACK 44#1] 51664 → 80 [ACK] Seq=288 Ack=2420 Win=65536 Len=0
47	72.336787	207.23.168.151	54.243.128.120	TCP	54	51511 → 80 [FIN, ACK] Seq=554 Ack=6524 Win=62894 Len=0
48	72.637155	207.23.168.151	54.243.128.120	TCP	54	[TCP Retransmission] 51511 → 80 [FIN, ACK] Seq=554 Ack=6524 Win=62894 Len=0
49	72.642488	54.243.128.120	207.23.168.151	TCP	60	80 → 51511 [RST] Seq=6524 Win=0 Len=0
50	72.835951	54.243.128.120	207.23.168.151	TCP	60	80 → 51511 [RST] Seq=6524 Win=0 Len=0
51	81.385450	207.23.168.151	199.212.24.16	TCP	54	51664 → 80 [FIN, ACK] Seq=288 Ack=2420 Win=65536 Len=0
52	81.387298	199.212.24.16	207.23.168.151	TCP	60	80 → 51664 [RST] Seq=2420 Win=0 Len=0
53	92.339712	207.23.168.151	142.231.1.182	TCP	54	65205 → 80 [FIN, ACK] Seq=2 Ack=1 Win=255 Len=0
54	92.339913	207.23.168.151	23.235.47.192	TCP	54	65136 → 80 [FIN, ACK] Seq=2 Ack=1 Win=256 Len=0
55	92.342591	142.231.1.182	207.23.168.151	TCP	60	80 → 65205 [FIN, ACK] Seq=1 Ack=3 Win=961 Len=0
56	92.342683	207.23.168.151	142.231.1.182	TCP	54	65205 → 80 [ACK] Seq=3 Ack=2 Win=255 Len=0

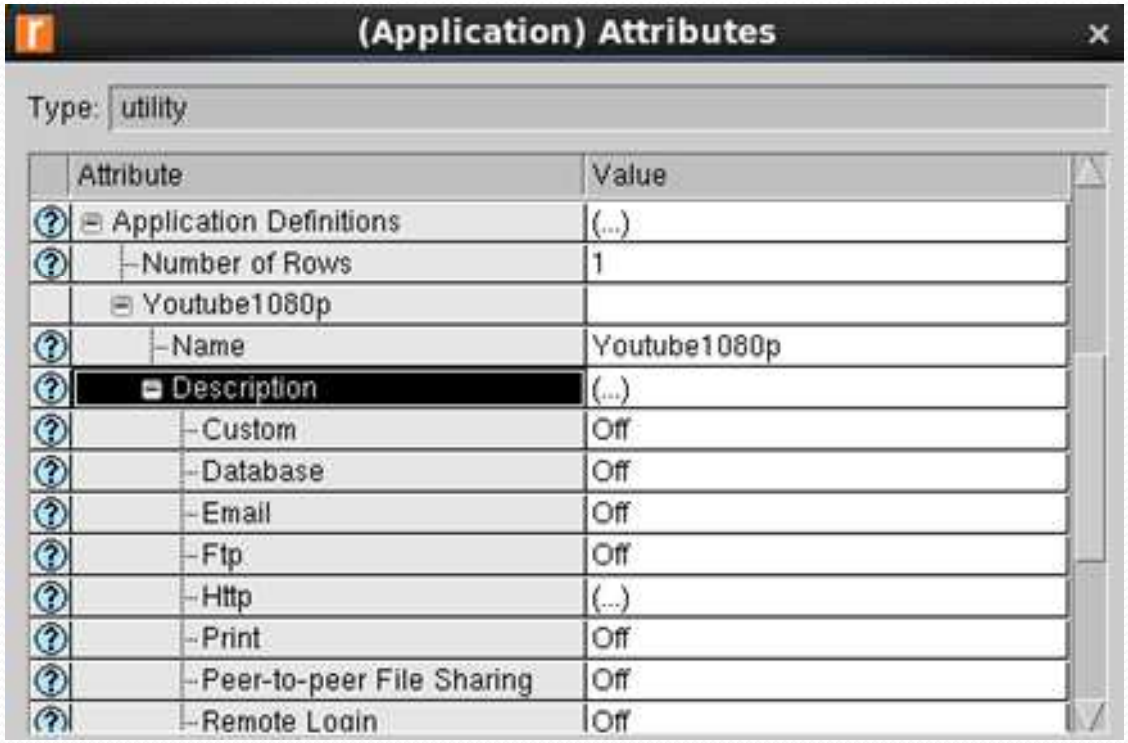
- Wireshark information of playing the video.

Project Design - Wireshark



- Pinged 'www.youtube.com'
- Found that the IP address for YouTube is 199.212.24.21
- Time to live (TTL) for YouTube is 58 seconds

Project Design - Application



YouTube Application

Project Design - Application

(Http) Table

Attribute	Value
HTTP Specification	HTTP 1.1
Page Interarrival T...	uniform (0.03333333333, .066666666666)
Page Properties	(...)
Server Selection	(...)
RSVP Parameters	None
Type of Service	Best Effort (0)

Hyper Text Transfer Protocol (HTTP) Settings

(Streamed Video Properties) Table

Attribute	Value
Video Existence Probability	All Pages Include a Video
Play Start Time Offset (seconds)	constant (5)
Video Length (seconds)	exponential (300)
Video Type	On Demand
Frame Inter-arrival Time (seconds)	exponential (0.1)
Frame Size (bytes)	poisson (20000)
Location	HTTP Server
Back-End Custom Application	Not Used
Object Group Name	HTTP Video Object

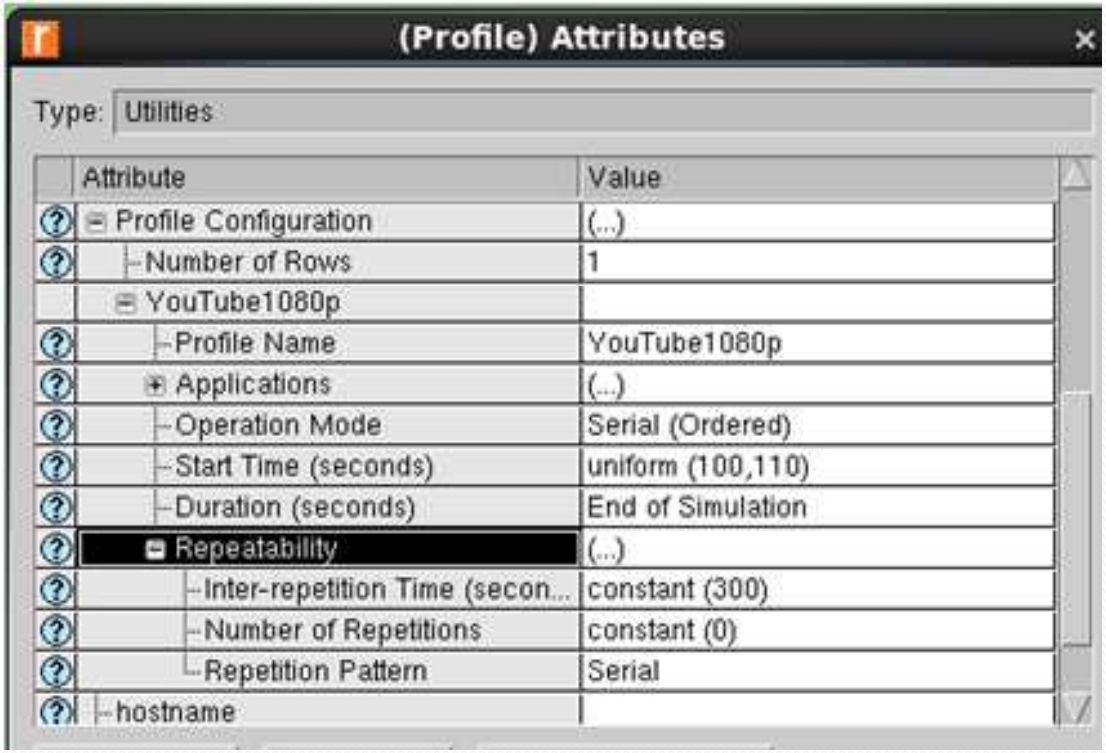
Video Properties

(Automatically Loaded Page Objects) Table

	Object Size (bytes)	Number of Objects (objects per page)	Location	Back-End Custom Application	Object Group Name
constant (1092227)	constant (109227)	Single Object	HTTP Server	Not Used	Not Used

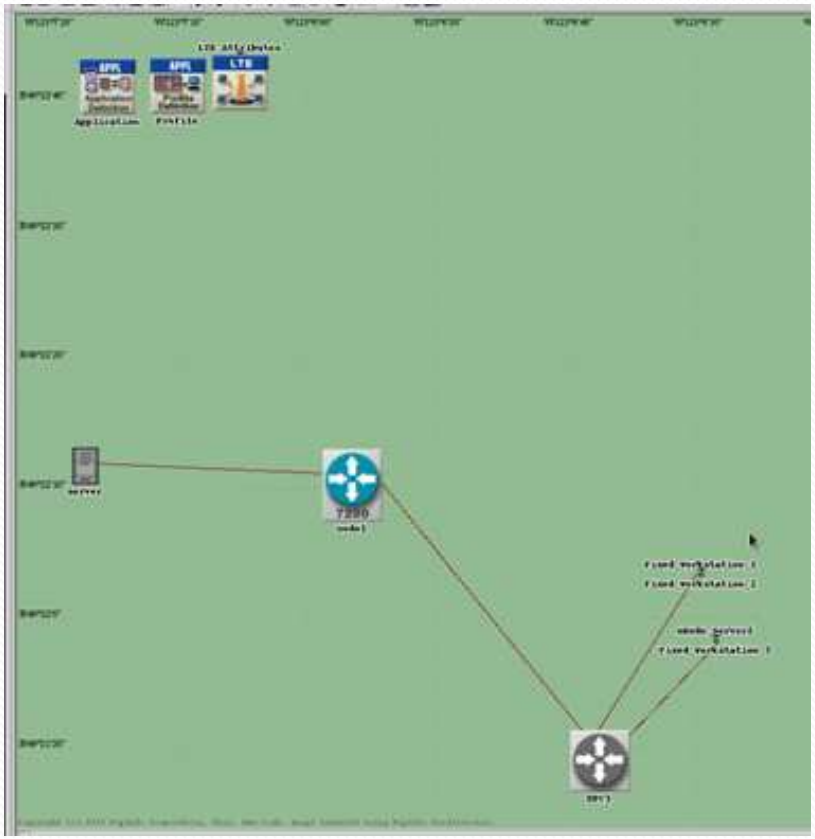
Loaded Page Objects

Project Design - Profile



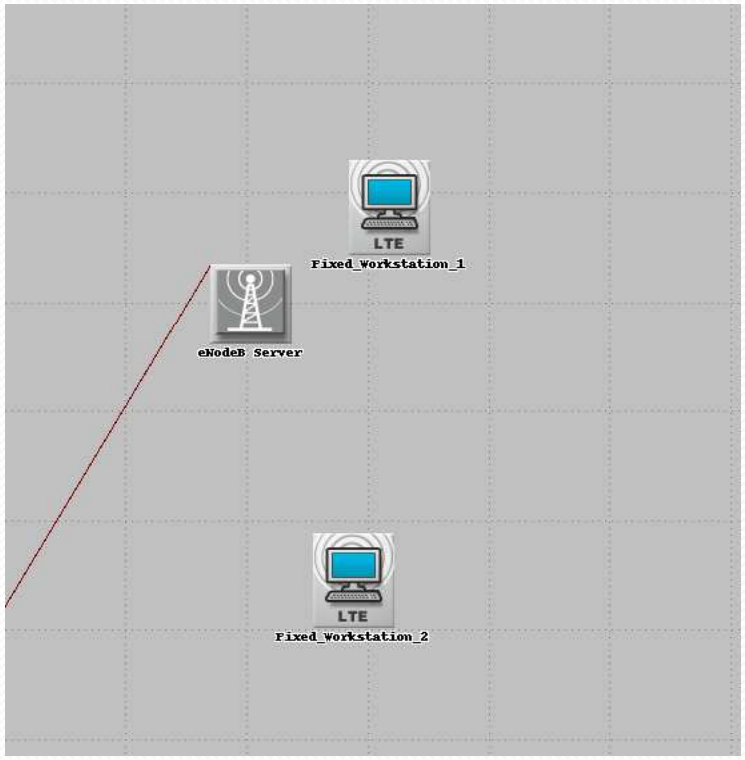
YouTube Profile

Project Design – Scenario Zero

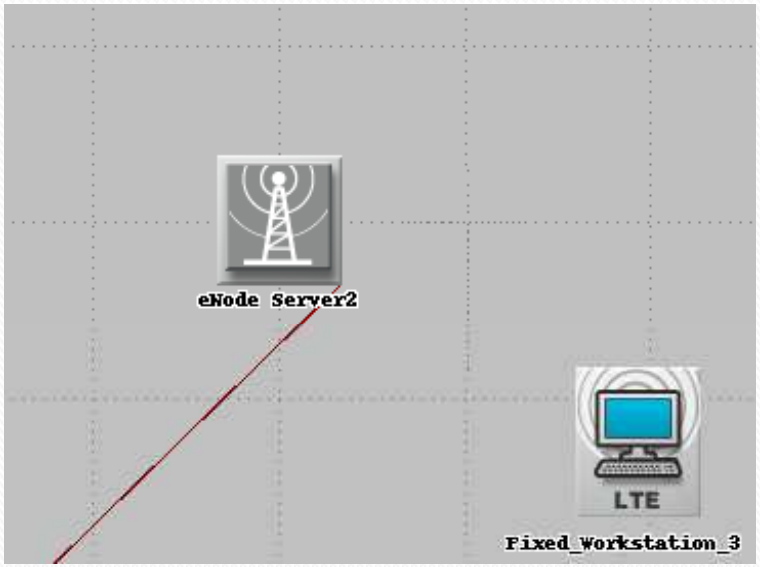


Scenario Zero – Validation Topology

Project Design – Scenario Zero

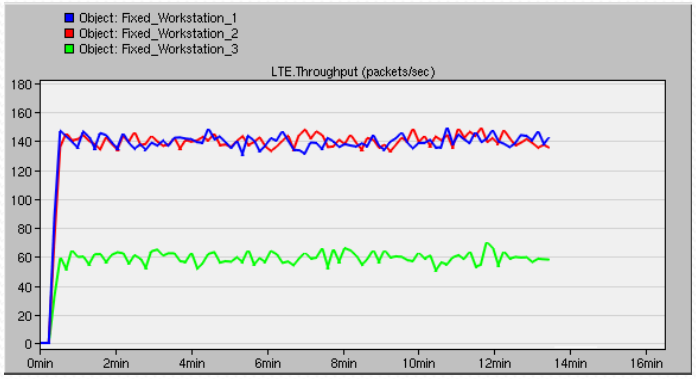


Topology for Base Station 1

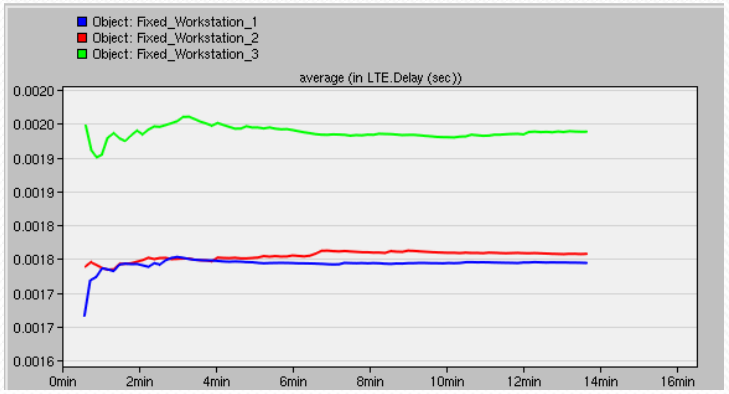


Topology for Base Station 2

Simulation Results and Analysis – Scenario Zero



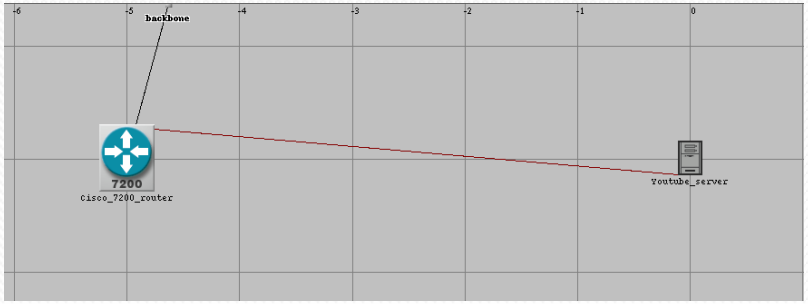
Throughput of Fixed Workstations



Delay of Fixed Workstations

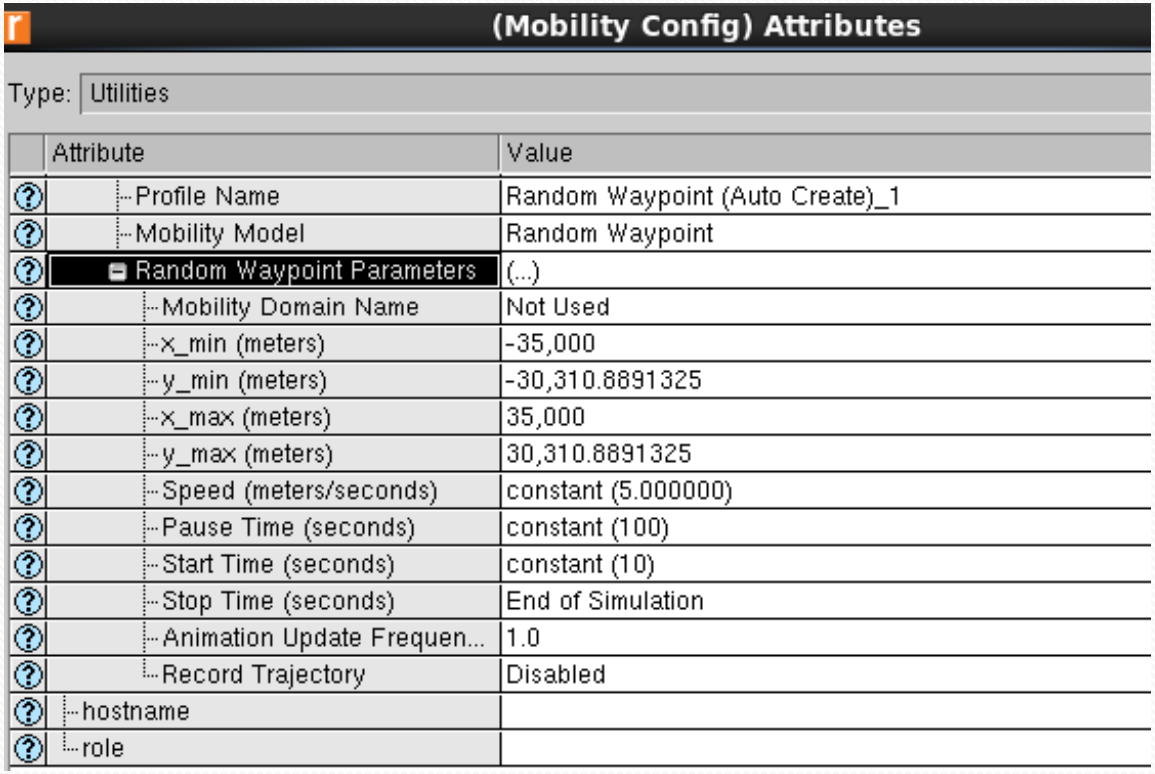
Project Design – Topology for Scenario One, Two, and Three

Parent Subnet



Client Subnet

Project Design – Mobility



(Mobility Config) Attributes

Type: Utilities

Attribute	Value
Profile Name	Random Waypoint (Auto Create)_1
Mobility Model	Random Waypoint
Random Waypoint Parameters	(...)
Mobility Domain Name	Not Used
x_min (meters)	-35,000
y_min (meters)	-30,310.8891325
x_max (meters)	35,000
y_max (meters)	30,310.8891325
Speed (meters/seconds)	constant (5.000000)
Pause Time (seconds)	constant (100)
Start Time (seconds)	constant (10)
Stop Time (seconds)	End of Simulation
Animation Update Frequen...	1.0
Record Trajectory	Disabled
hostname	
role	

Mobility

Project Design – Server

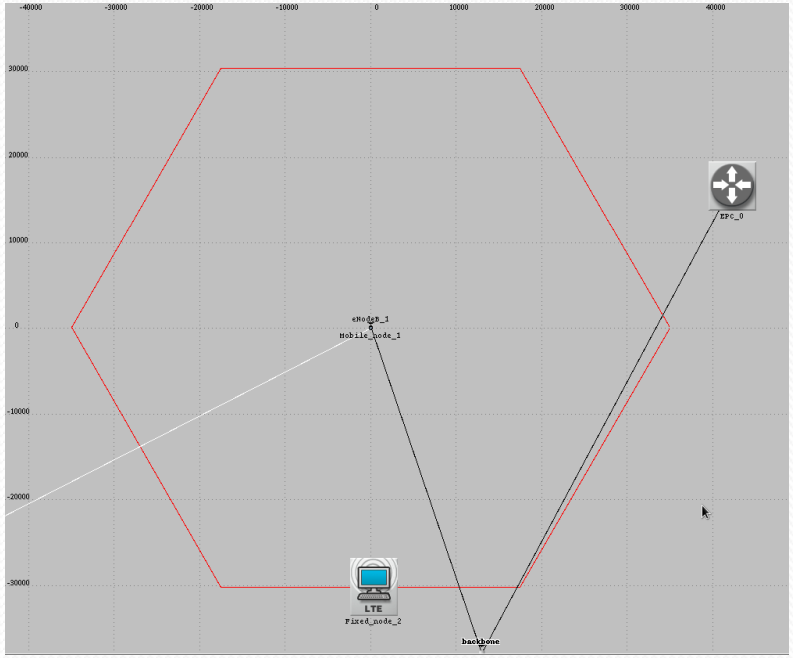
(Youtube_server) Attributes

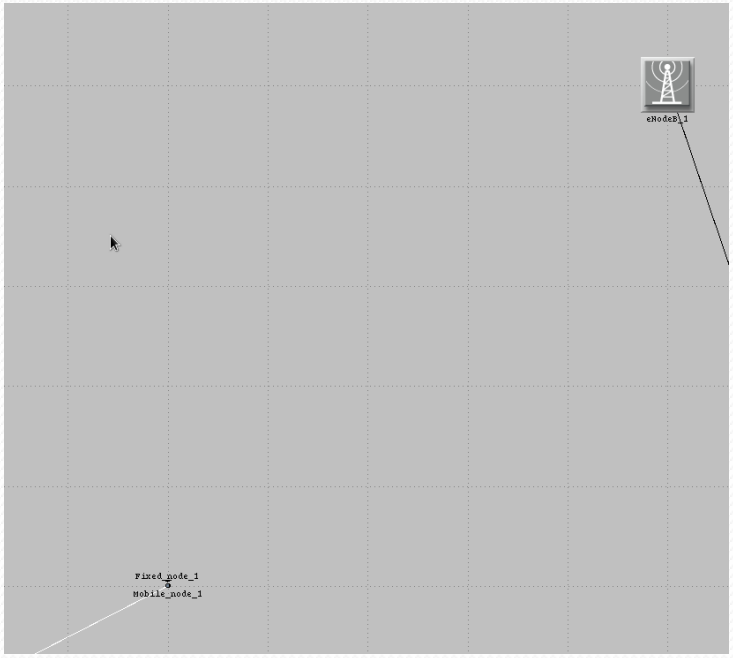
Type: server

Attribute	Value
Applications	
Application: Destination Prefere...	(...)
Number of Rows	1
All Applications	
Application	All Applications
Symbolic Name	HTTP Server
Actual Name	(...)
Number of Rows	0
Application: Supported Profiles	(...)
Number of Rows	1
Youtube_Profile	
Profile Name	Youtube_Profile
Traffic Type	All Discrete
Application Delay Tracking	(...)
Start Time (seconds)	Start of Simulation
End Time (seconds)	End of Simulation
Sample Every N Applicat...	All
Maximum Samples	Tracking Disabled
Application: Supported Services	None
Application: Transaction Model ...	(...)

YouTube Server

Project Design – Scenario One





Client Subnet

Project Design – Scenario One

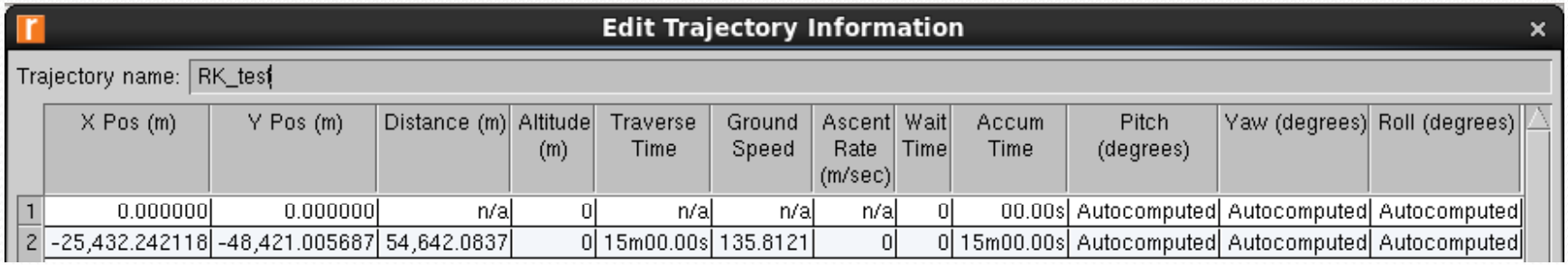
(eNodeB_1) Attributes

Type: enodeb

Attribute	Value
Address	Auto Assigned
LTE	
Admission Control Parameters	Default
PHY	
Antenna Gain (dBi)	15 dBi
Battery Capacity	Unlimited
MIMO Transmission Technique	Spatial Multiplexing 2 Codewords 2 Layers
Maximum Transmission Power...	0.5
Number of Receive Antennas	2
Number of Transmit Antennas	2
Operating Power	10
PHY Profile	LTE 10 MHz FDD
Pathloss Parameters	(...)
Pathloss Model	Free Space
Model Arguments	Not Applicable
Shadow Fading	Disabled
Receiver Sensitivity (dBm)	-200dBm
Buffer Status Report Parameters	Default

Base Station Attributes

Project Design – Scenario One



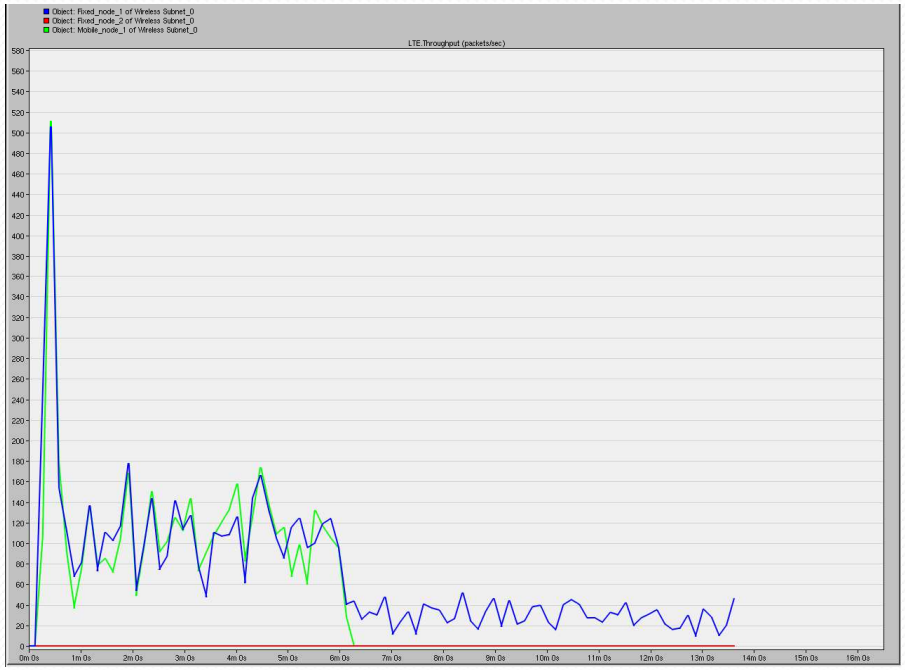
Edit Trajectory Information

Trajectory name: RK_test

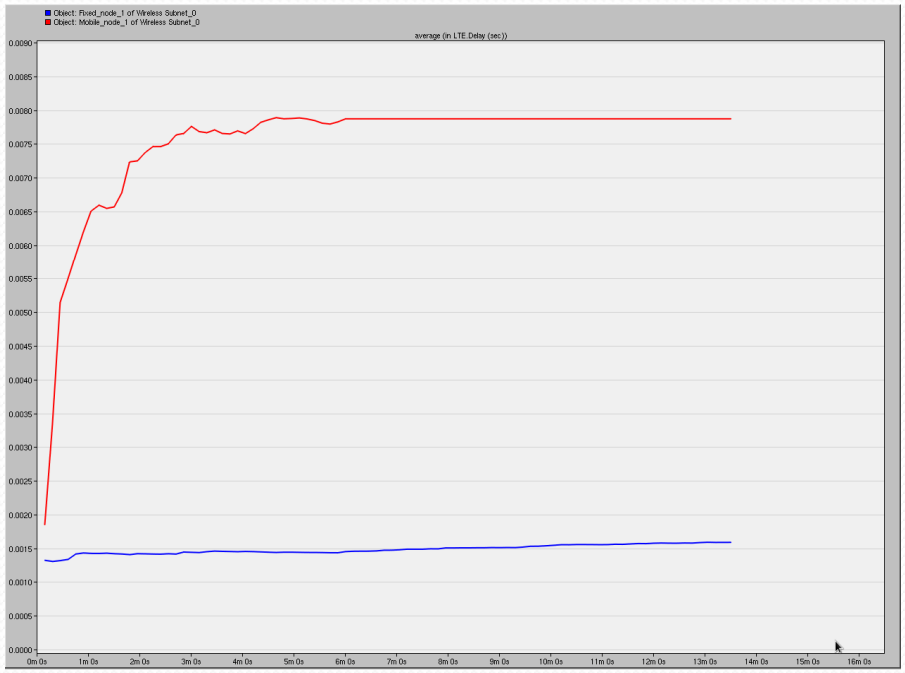
	X Pos (m)	Y Pos (m)	Distance (m)	Altitude (m)	Traverse Time	Ground Speed	Ascent Rate (m/sec)	Wait Time	Accum Time	Pitch (degrees)	Yaw (degrees)	Roll (degrees)
1	0.000000	0.000000	n/a	0	n/a	n/a	n/a	0	00.00s	Autocomputed	Autocomputed	Autocomputed
2	-25,432.242118	-48,421.005687	54,642.0837	0	15m00.00s	135.8121	0	0	15m00.00s	Autocomputed	Autocomputed	Autocomputed

Mobile Node Trajectory

Simulation Results and Analysis – Scenario One

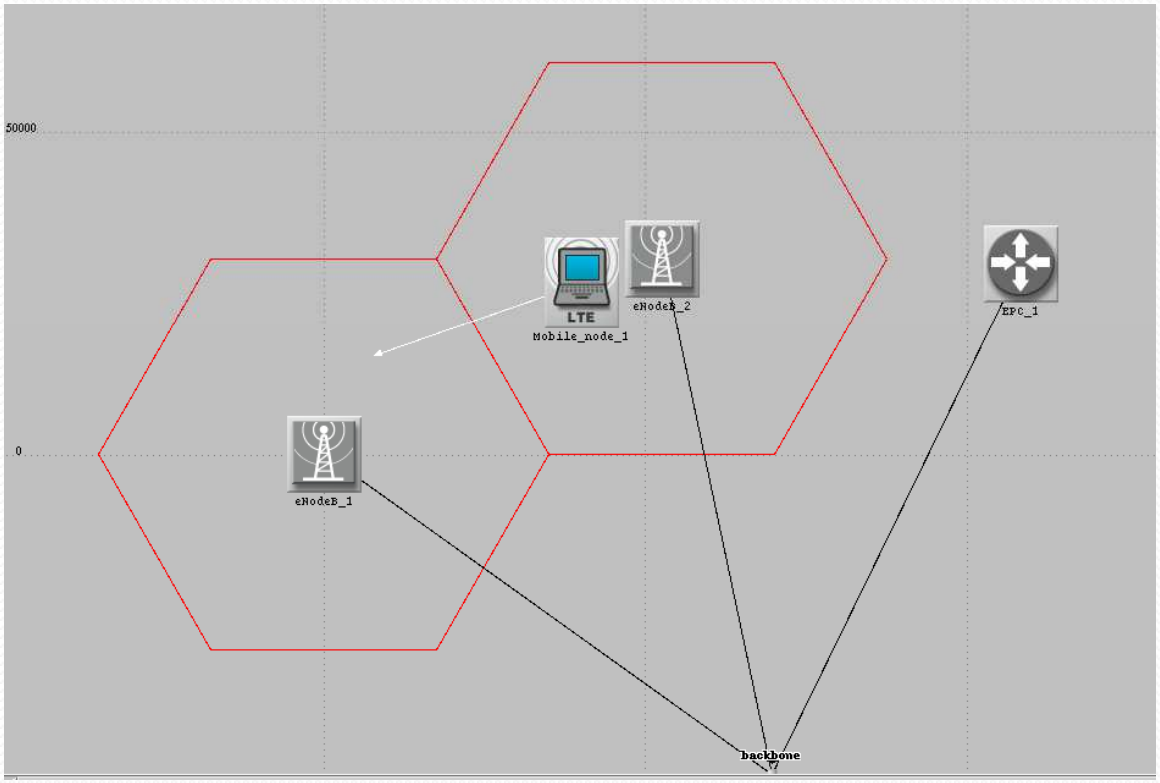


Throughput of Fixed Nodes (Blue and Red) and Mobile Node (Green)



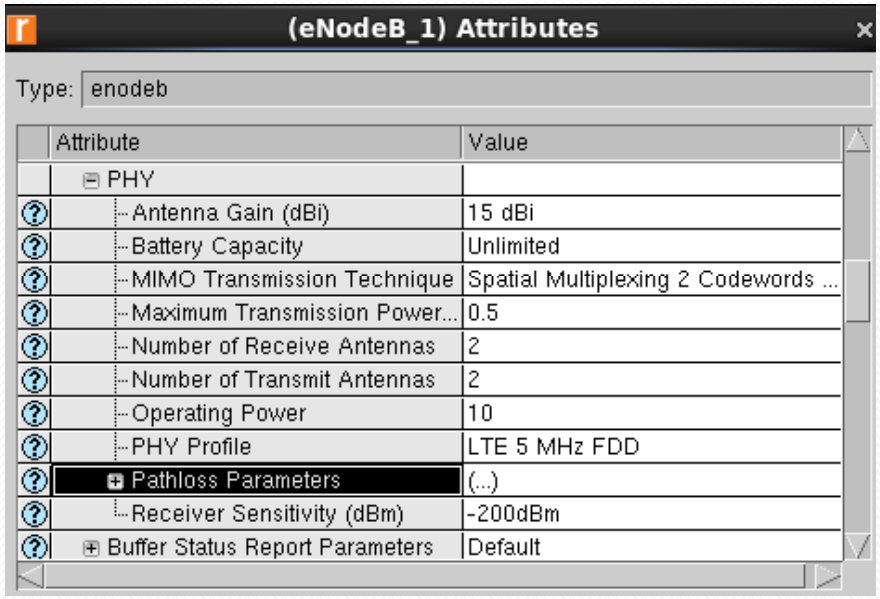
Delay of Fixed Nodes (Blue and Green) and Mobile Node (Red)

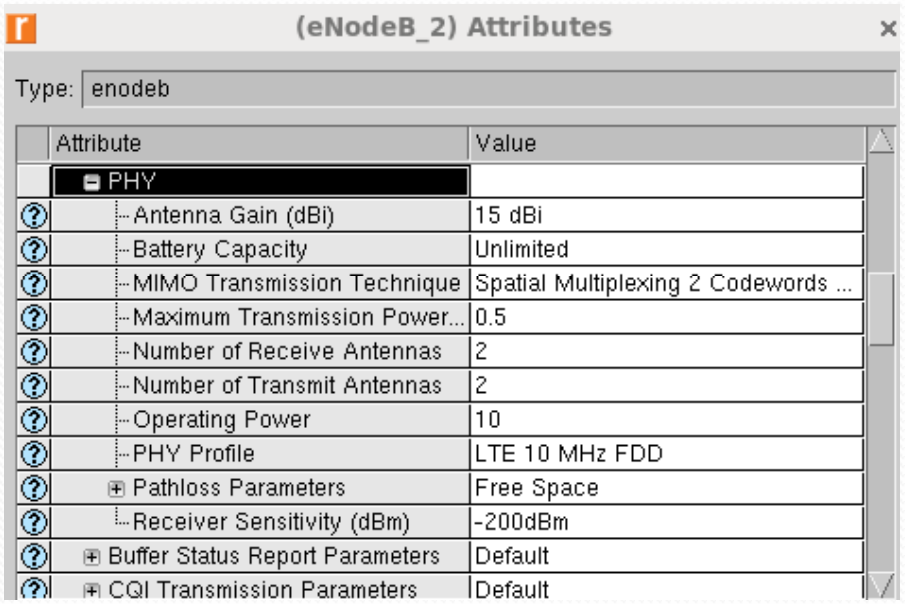
Project Design – Scenario Two



Client Subnet with Two Base Stations and a Mobile Node

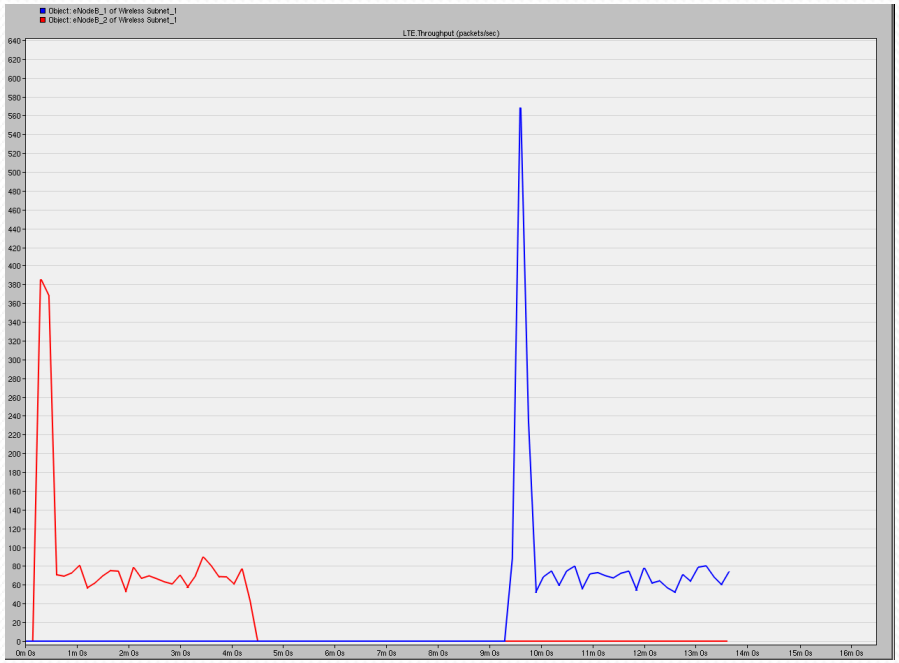
Project Design – Scenario Two



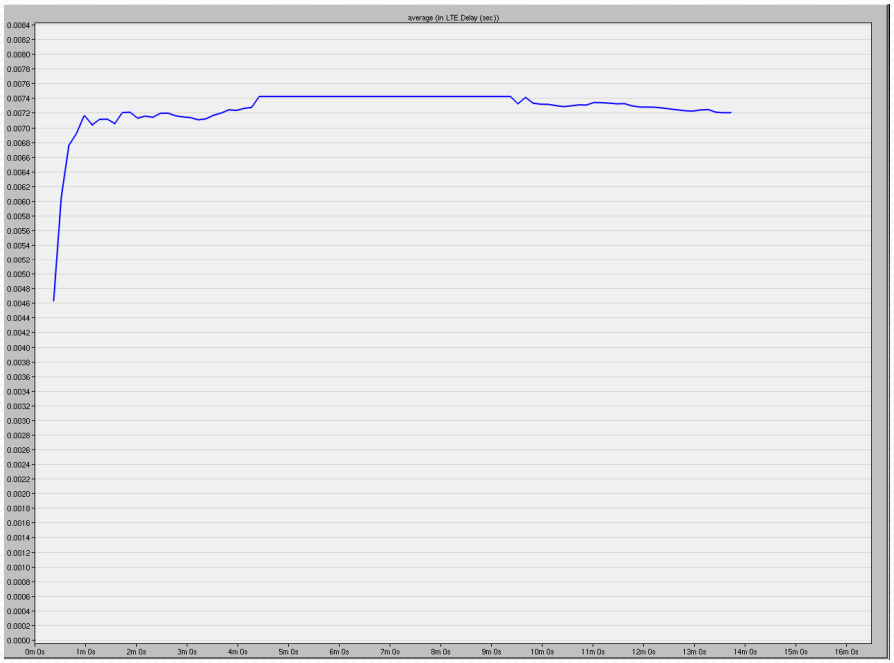


Base Stations Attributes

Simulation Results and Analysis – Scenario Two

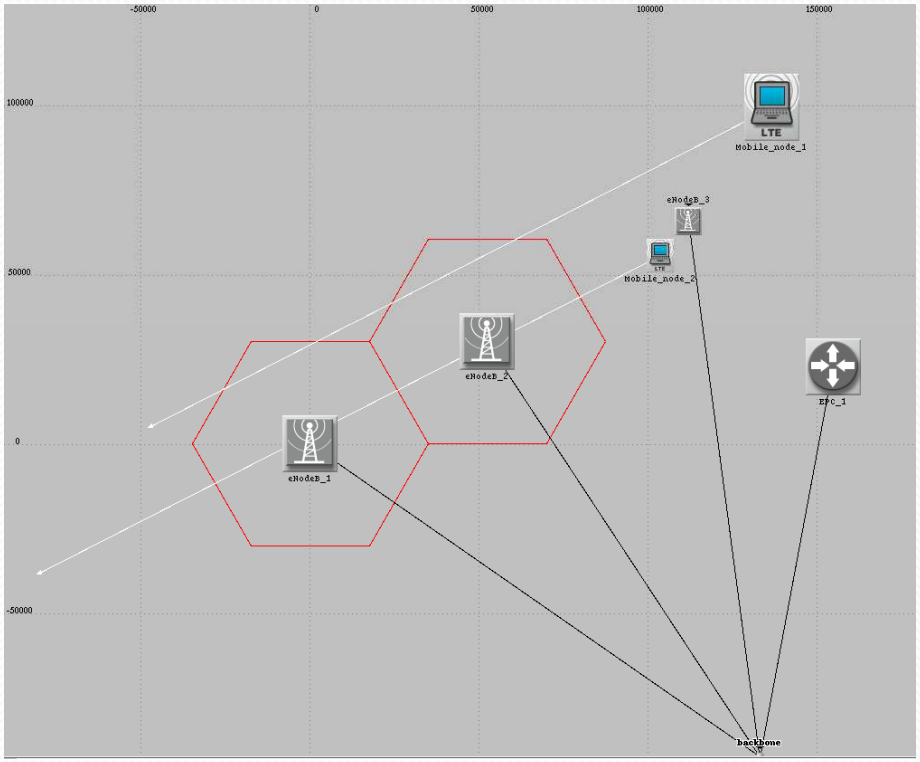


Throughput of Mobile Node going from 10MHz to 5MHz Base Stations



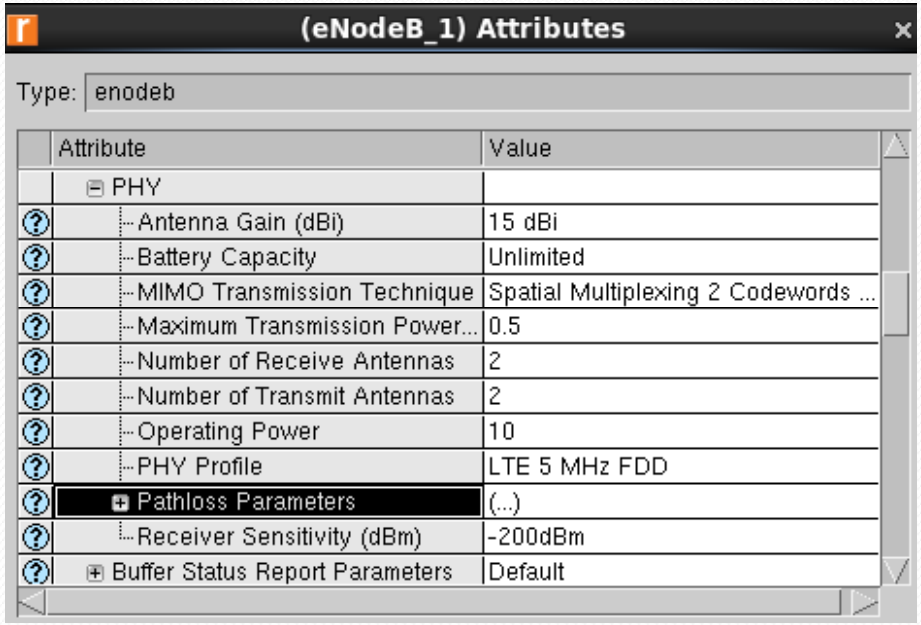
Delay of Mobile Node going from 10MHz to 5MHz Base Stations

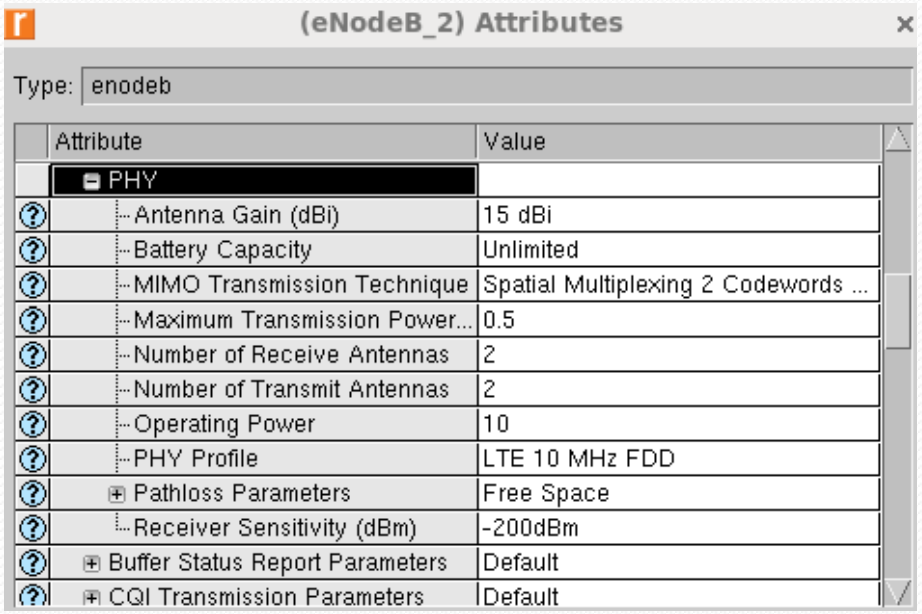
Project Design – Scenario Three



Client Subnet with Three Base Stations and Two Mobile Nodes

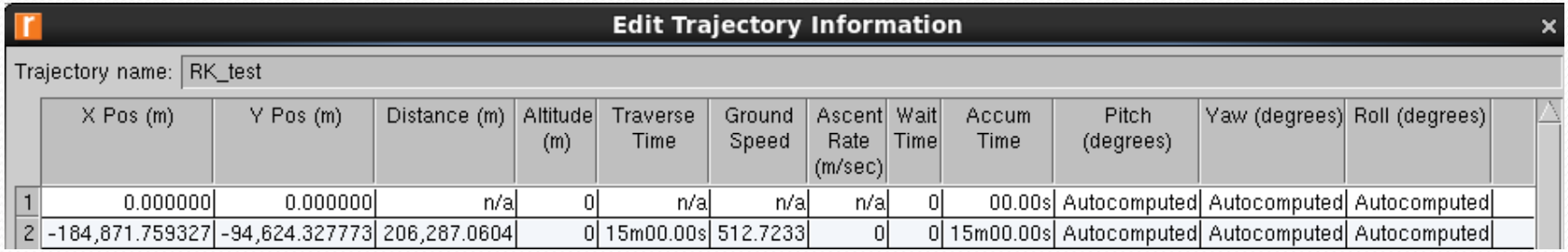
Project Design – Scenario Three





Base Stations Attributes

Project Design – Scenario Three



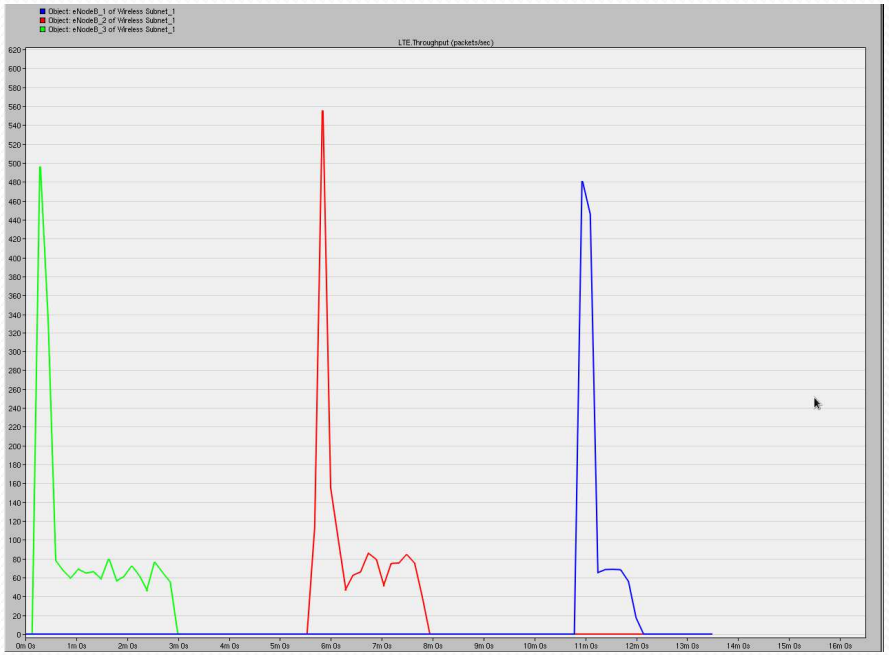
Edit Trajectory Information

Trajectory name: RK_test

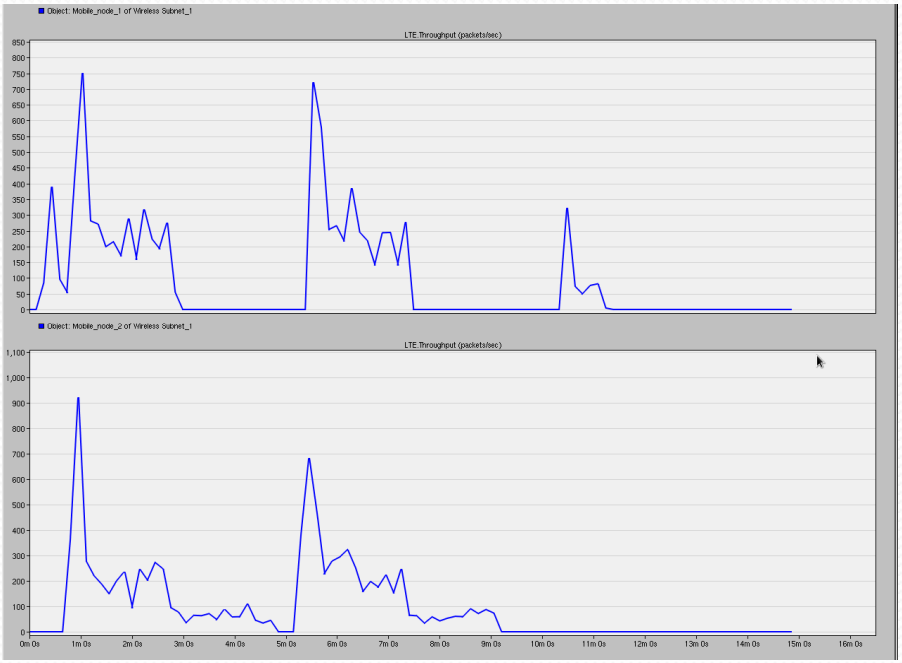
	X Pos (m)	Y Pos (m)	Distance (m)	Altitude (m)	Traverse Time	Ground Speed	Ascent Rate (m/sec)	Wait Time	Accum Time	Pitch (degrees)	Yaw (degrees)	Roll (degrees)
1	0.000000	0.000000	n/a	0	n/a	n/a	n/a	0	00.00s	Autocomputed	Autocomputed	Autocomputed
2	-184,871.759327	-94,624.327773	206,287.0604	0	15m00.00s	512.7233	0	0	15m00.00s	Autocomputed	Autocomputed	Autocomputed

Mobile Node Trajectories

Simulation Results and Analysis – Scenario Three



Throughput of Single Mobile Node Traversing Three Base Stations



Throughput of Two Mobile Nodes Traversing Three Base Stations

Simulation Results and Analysis – Scenario Three

Delay of Single Mobile Node Traversing Three Base Stations

Delay of Two Mobile Nodes Traversing Three Base Stations

Summary

- Better to start with the basic topology and build on top of it
- Mostly consistent with our expectation of results
- How using mobile nodes with different base stations gave us a better understanding of how the signal handover works and how results vary with distance from the base stations

References

[1] "LTE (telecommunication)". (2016, March). [Online]. Accessed on: https://en.wikipedia.org/wiki/LTE_(telecommunication).

[2] J. D. Biersdorfer. "Q& A: The Difference Between 4G and 4G LTE" . (2012,March) . [Online]. Accessed on: http://mobile.nytimes.com/blogs/gadgetwise/2012/03/26/qa-the-need-for-speed/ .

[3] M. Rouse. "Evolved Packet Core (EPC)." (2011, January). [Online]. Accessed on: http://searchtelecom.techtarget.com/definition/Evolved-Packet-Core-EPC.

[4] J. Ozer. "Encoding for YouTube: How to Get the Best Results." (2012, July). [Online]. Accessed on: http://www.streamingmedia.com/Articles/Editorial/Featured-Articles/Encoding-for- YouTube-How-to-Get-the-Best-Results-83876.aspx

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[6] G. A. Abed, and M. Ismail, and K. Jumari. "A Realistic Model and Simulation Parameters of LTE- Advanced Networks."[Online]. Fac. Eng. & Built Env., National University of Malaysia,Selangor, Rep. ISSN:2278-1021. August 2012. Accessed on: http://www.ijarcce.com/upload/august/16-A%20Realistic%20Model%20and%20-Ghassan.pdf.

[7] "LTE Tutorial". (2016). [Online]. Accessed on: http://www.tutorialspoint.com/lte/lte_quick_guide.htm.

Questions