ENSC 833
Network Protocol and Performance
Final Project Presentation
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Investigation on Handover in WiMAX and Performance Comparison of VoIP over WiMAX and LTE

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Roadmap

- Introduction
- Implementation Details
- Simulation Scenarios and Performance Analysis
- Conclusion
- References

Introduction

- WiMAX (Worldwide Interoperability for Microwave Access), a tele-communication technology that provides wireless data over long distances.

- To achieve seamless handover, both mobile station (MS) and base station (BS) scan the neighboring BSs for selecting the best BS for a potential handover.

- The signal strength is a dominant factor for handover decision, which is based on the computation of signal-to-noise ratio (SNR) received at the MS from various BSs.

Introduction

- LTE (Long-Term Evolution) is a standard for wireless communication of high-speed data for mobile terminals, developed by the 3GPP (3rd Generation Partnership Project).

- LTE is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements.

- LTE ensures greater data speeds, better performance and more efficient use of spectrum.

Introduction

Similarities

- IP technologies
- Advanced MIMO (Multiple Input and Multiple Output) supported
- Based on OFDM (Orthogonal Frequency Division Multiplexing)

Differences

- LTE can handle speeds up to 450 km/h, while WiMAX 120 km/h
- LTE uses different channels bandwidth from 1.4MHz to 100MHz, while WiMAX uses channels bandwidth up to 40MHz

Goal

- Implement WiMAX and LTE network on Riverbed Modeler 18.5.
- Analyze the performance of handover and data transmission of WiMAX and LTE.
- Improve the handover algorithm of WiMAX to achieve a better system performance.
- Compare the performance of VoIP over WiMAX and LTE in the presence of traffic sent, received and throughput.

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Implementation Details

- MS nodes have a constant downlink traffic flow of 64 kbps to a server through the uplink of the target BS.
- Voice over IP (VoIP) application is selected.
- Comparison of VoIP over WiMAX and LTE via traffic sent, received and throughput is based on the same type of constant traffic, exactly the same trajectory and same speed of the mobile station (10m/s).

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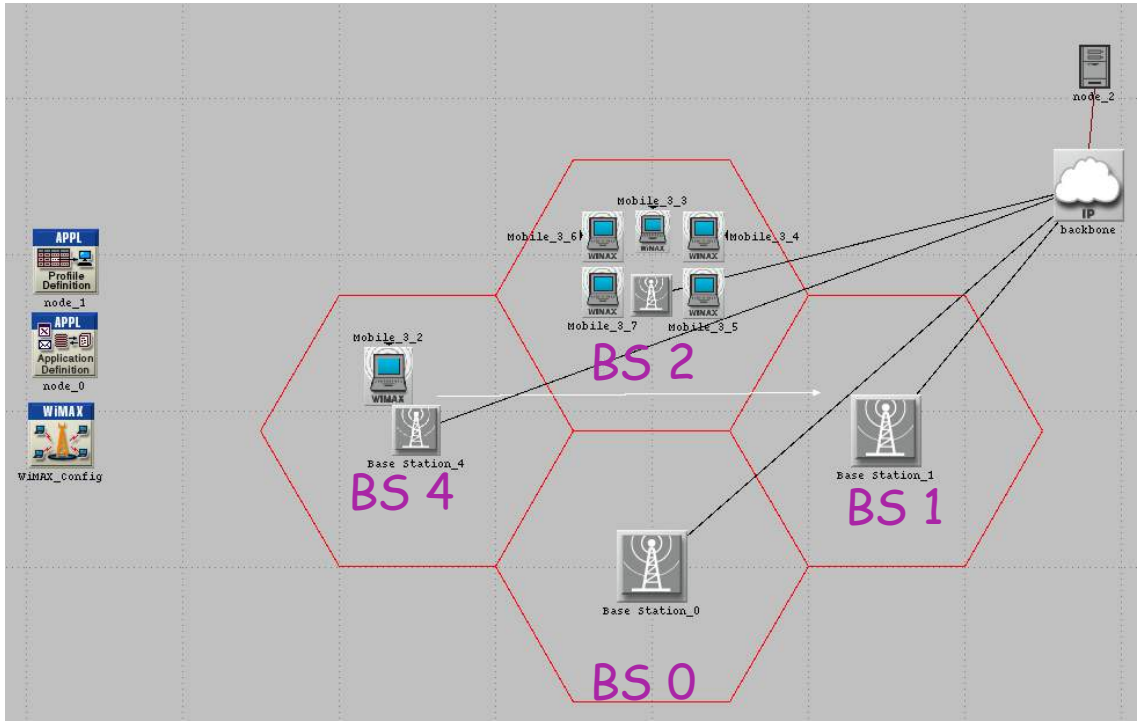
Handover Algorithm

- Handover decision is determined both by the MS and BSs.
- When the MS is moving across the region of the BS, it should be served by that BS.
- However, if the BS is serving many mobile stations in the meantime, the handover would be based on the computation of the SNR and the estimation of free capacity of the BSs.

Handover Algorithm



When the MS on the left moves from left to right, it should be served by BS 2 in the process. However, as BS 2 is serving many MSs in the meantime, and BS 0 is free with the maximum capacity, the target MS should get connected to BS 0 for better resource utilization.

Handover Algorithm (MS-Initiated)

- $SNR_{maxDT} - SNR_{DS} \geq H_1$

  where SNR_{maxDT} denotes the maximum downlink SNR of the target BS,

  SNR_{DS} denotes the downlink SNR of the serving BS.

- The minimum difference between the SNR of the serving BS and a neighboring BS is H_1, when triggering a handover to replace the serving BS with a neighboring BS.

WiMAX Scenario 1

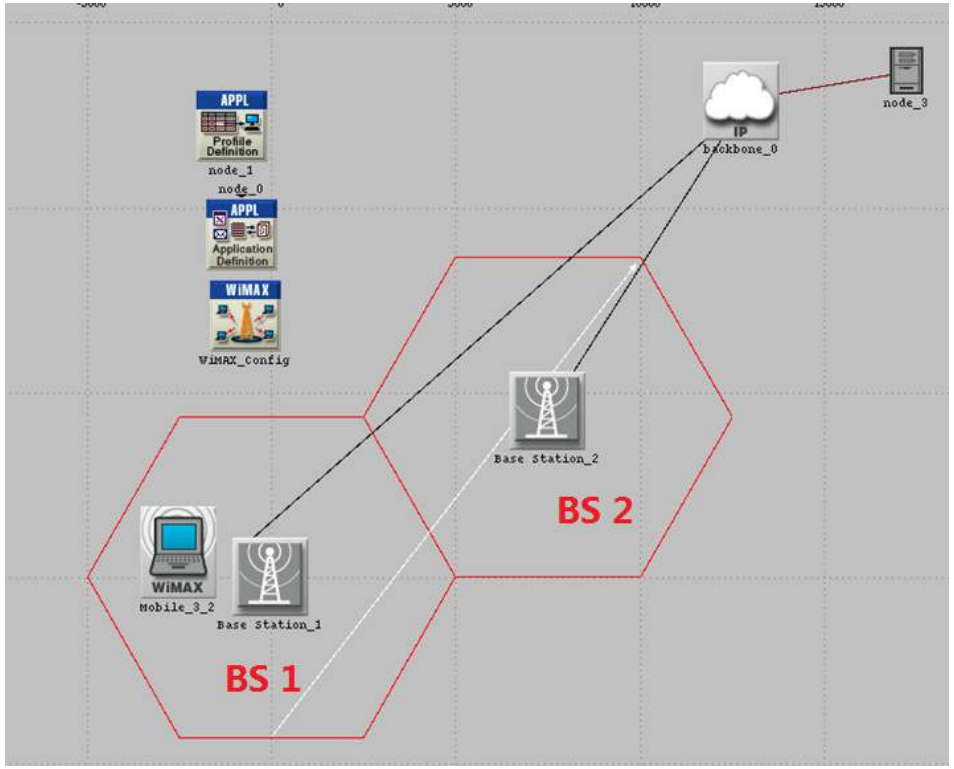


Fig 1. Scenario 1 for WiMAX network

The MS moves from the covered region of BS 1 to BS 2.

WiMAX Scenario 1

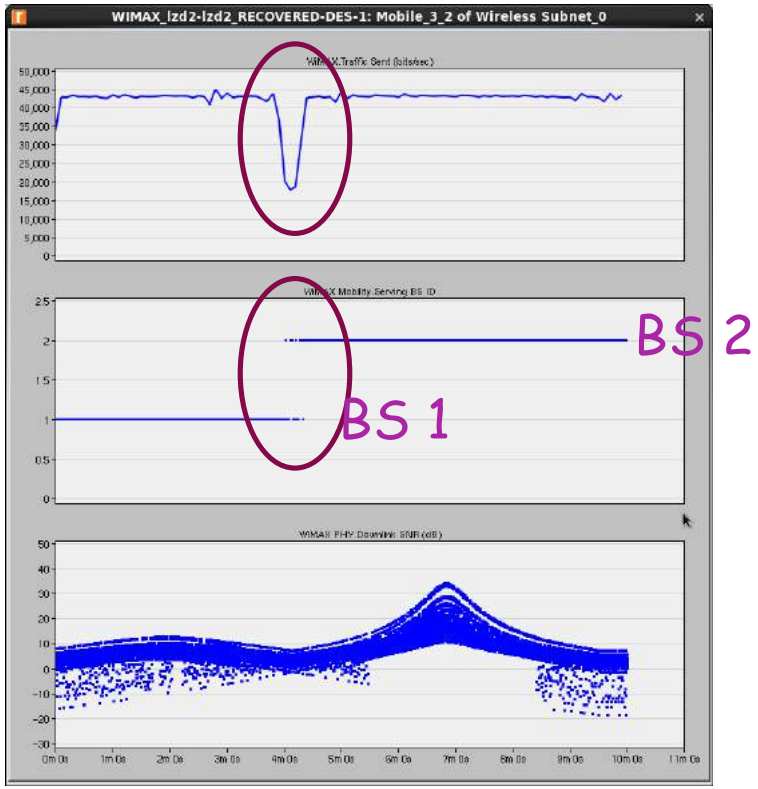


Fig 2. served BS ID, traffic sent, and downlink SNR

- The value of Handover Threshold Hysteresis in this case is 0.4, the default value.

WiMAX Scenario 1

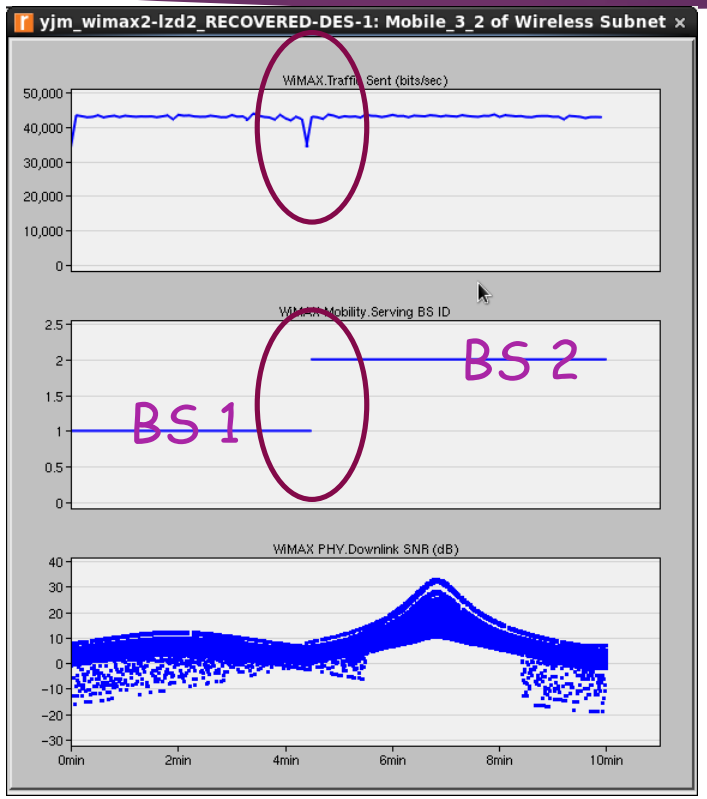


Fig 3. served BS ID, traffic sent, and downlink SNR

- The value of Handover Threshold Hysteresis in this case is 6.
- It could be observed from the figure that with larger H_1, the traffic loss could be ameliorated, the handover process would be stable.

WiMAX Scenario 2

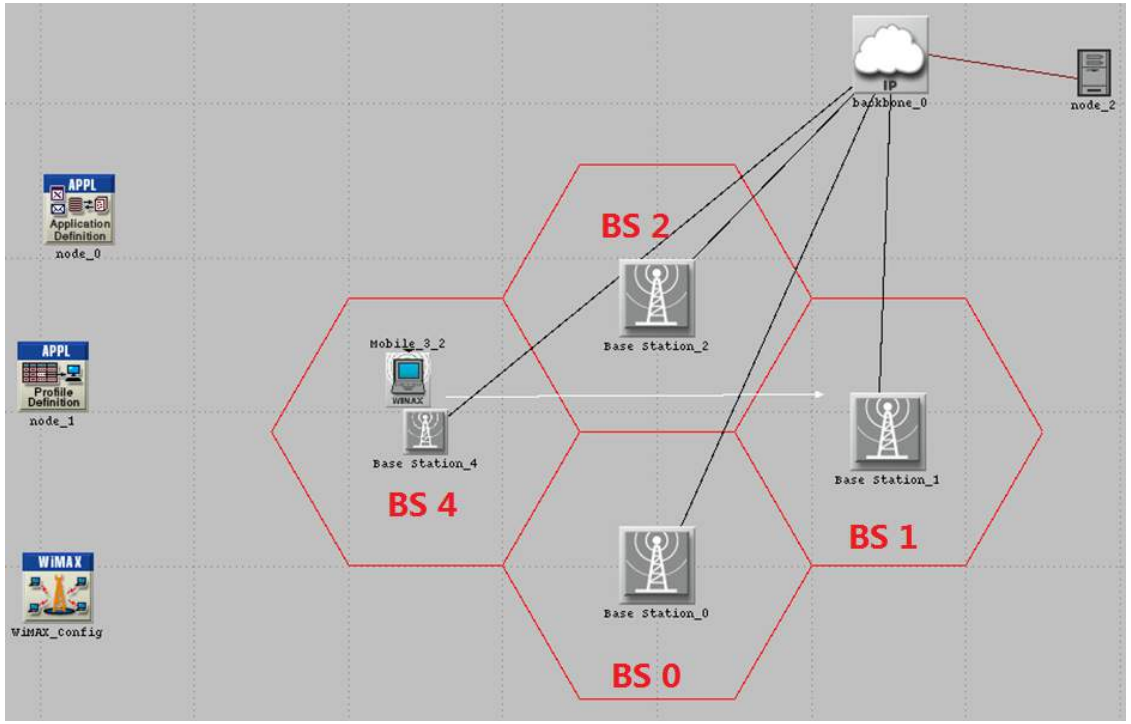
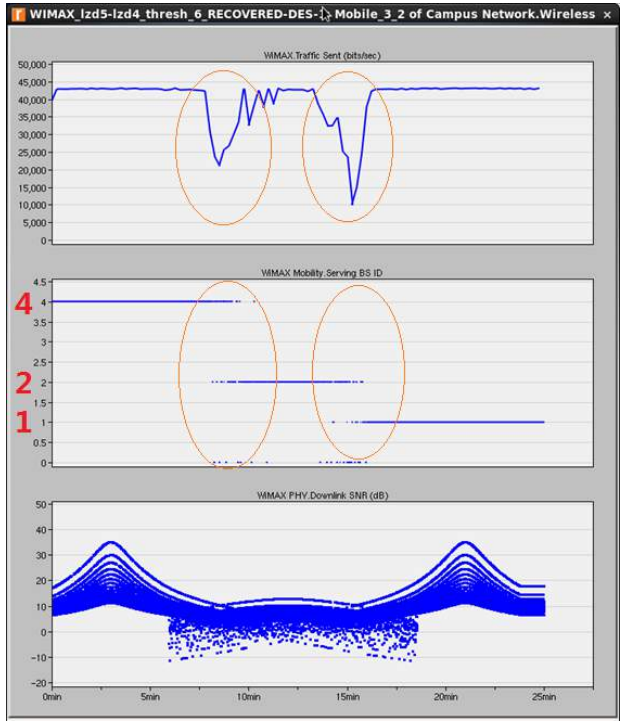
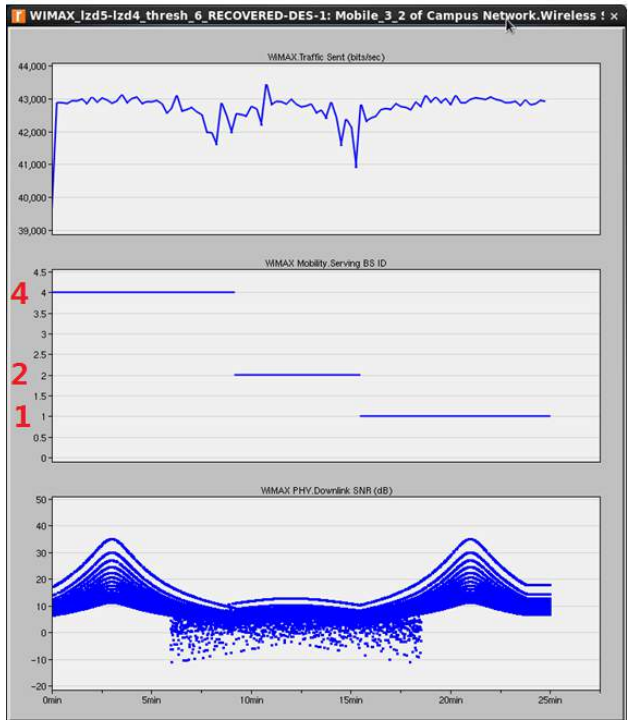


Fig 4. Scenario 2 for WiMAX network

The MS moves from BS 4 to BS 1. The neighboring BSs are BS 2 and BS 0.

WiMAX Scenario 2



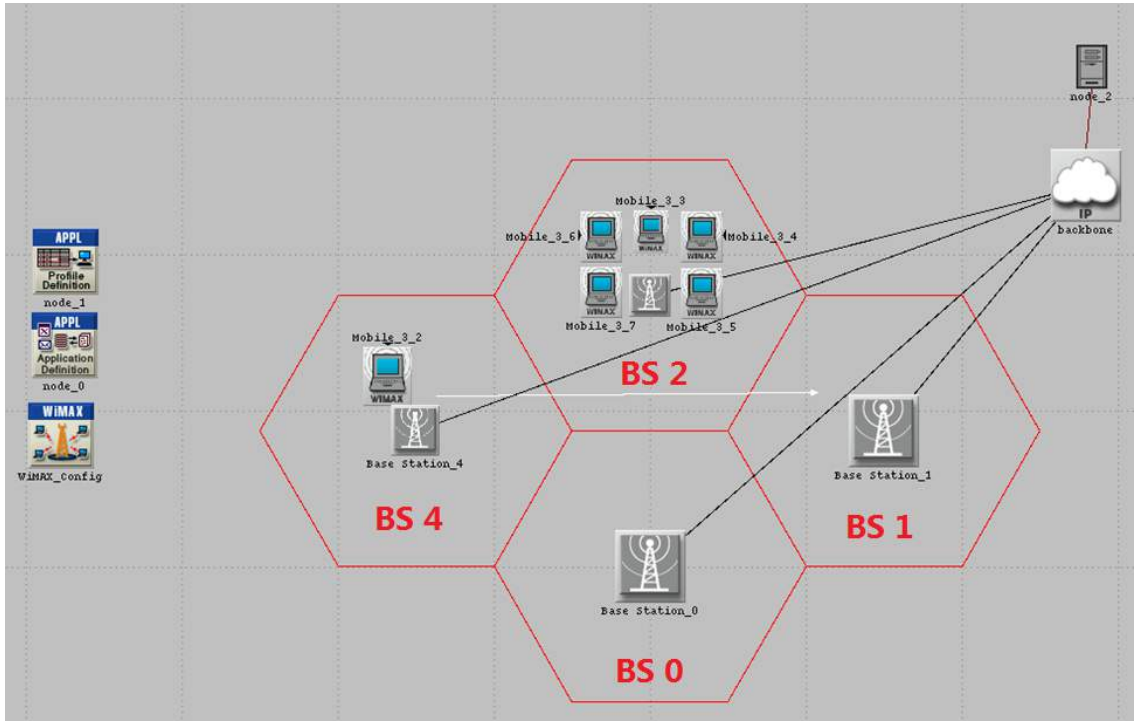


Handover Parameters	(...)
MS Handover Retranmission Timer (milliseconds)	30
Maximum Handover Request Retransmissions	6
Handover Threshold Hysteresis (dB)	6.0
Multitarget Handover Threshold Hysteresis (dB)	0.0
Maximum Handover Attempts per BS	3

- The default value of Handover Threshold Hysteresis is 0.4.
- It could be observed that with higher threshold, the handover process would be more stable with less attempts.

Fig 5. traffic sent, served BS ID, and downlink SNR with threshold = 0.4 and 6

WiMAX Scenario 3



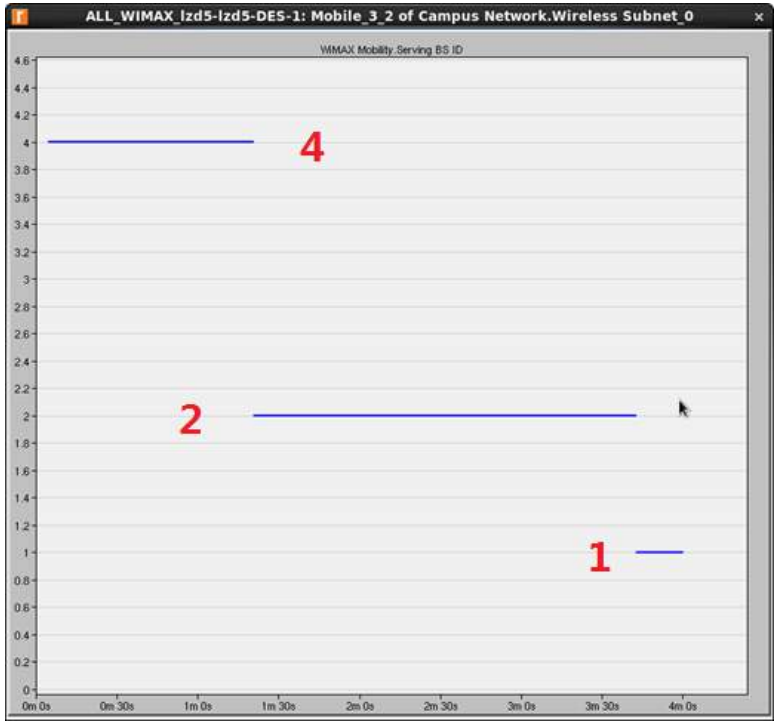
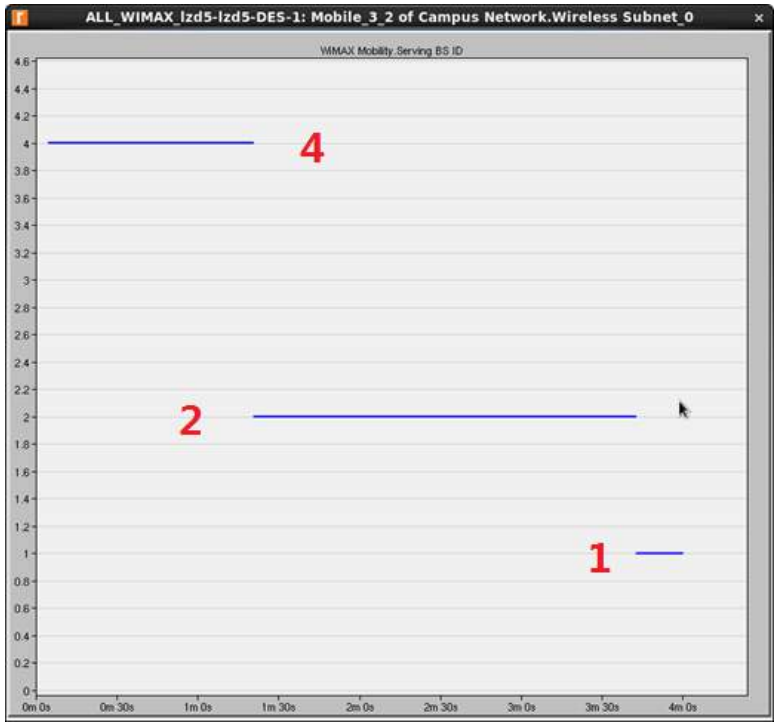


Fig 6. Scenario 3 for WiMAX network and served BS ID of the mobile station

WiMAX Scenario 3



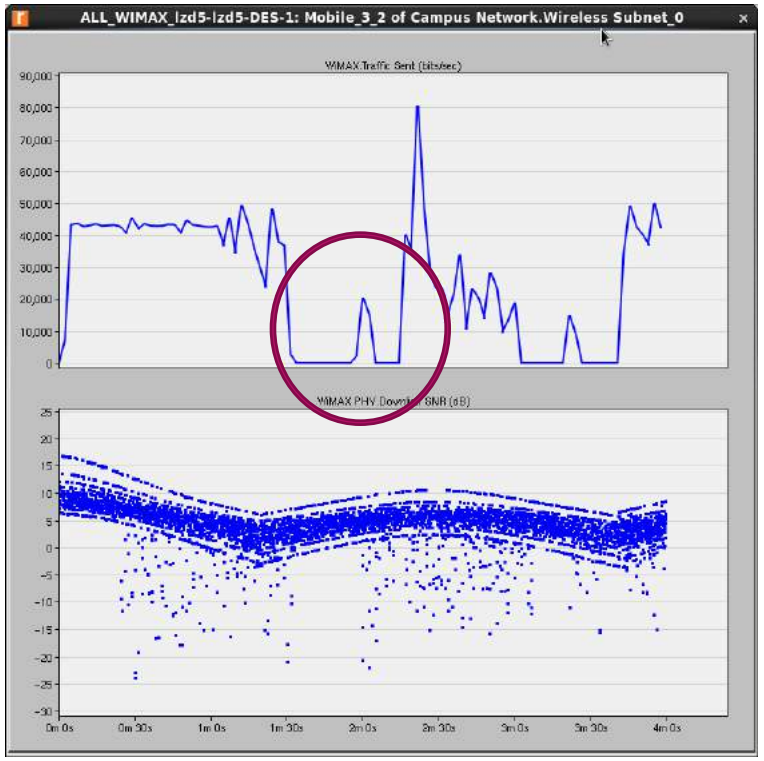
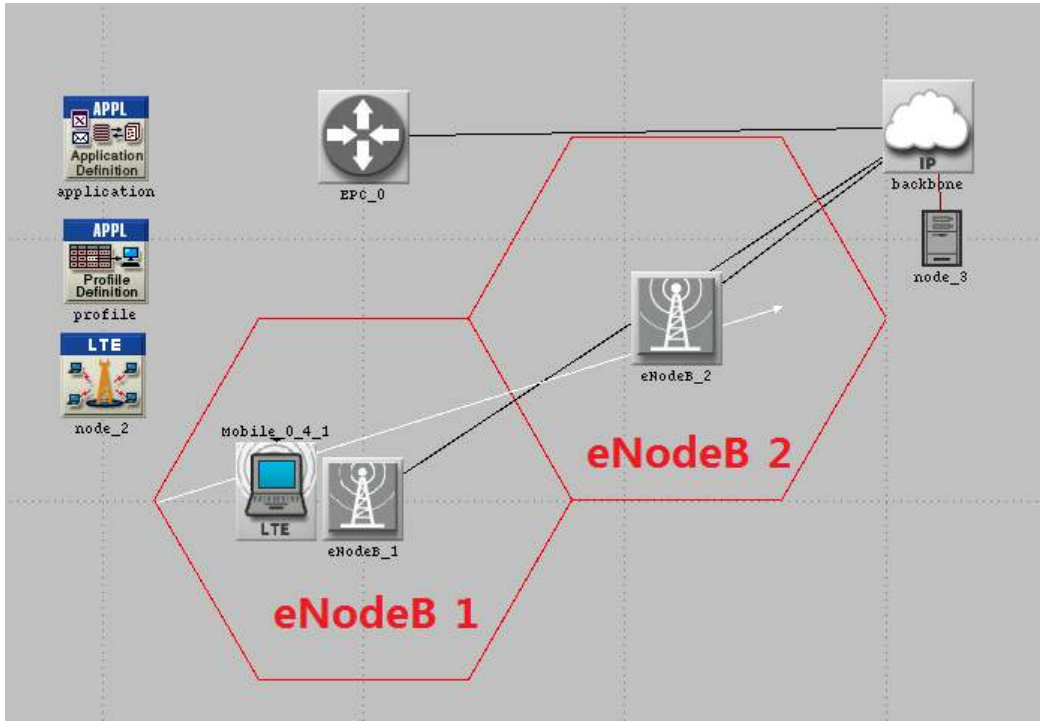


Fig 7. served BS ID, traffic sent, and downlink SNR

LTE Scenario 1



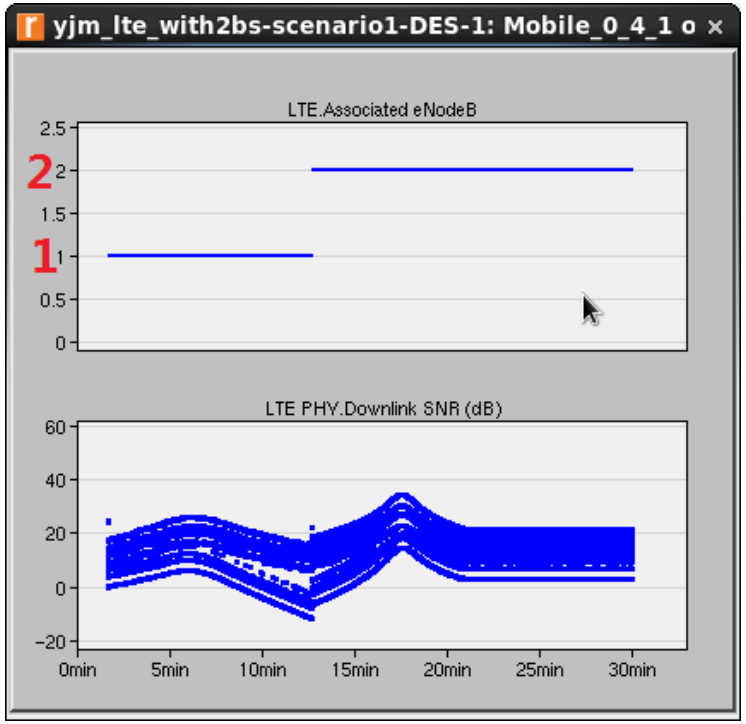
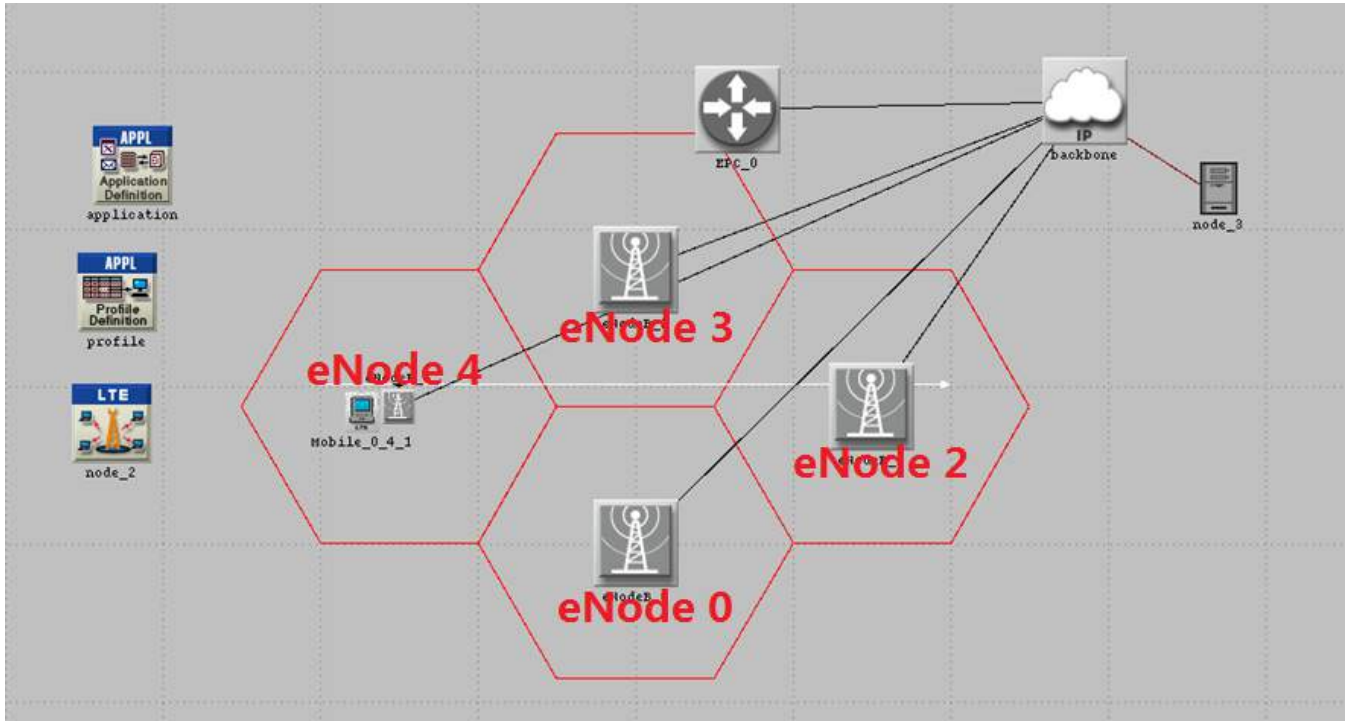


Fig 8. scenario 1 for LTE network and associated eNodeB ID of the mobile station

LTE Scenario 2



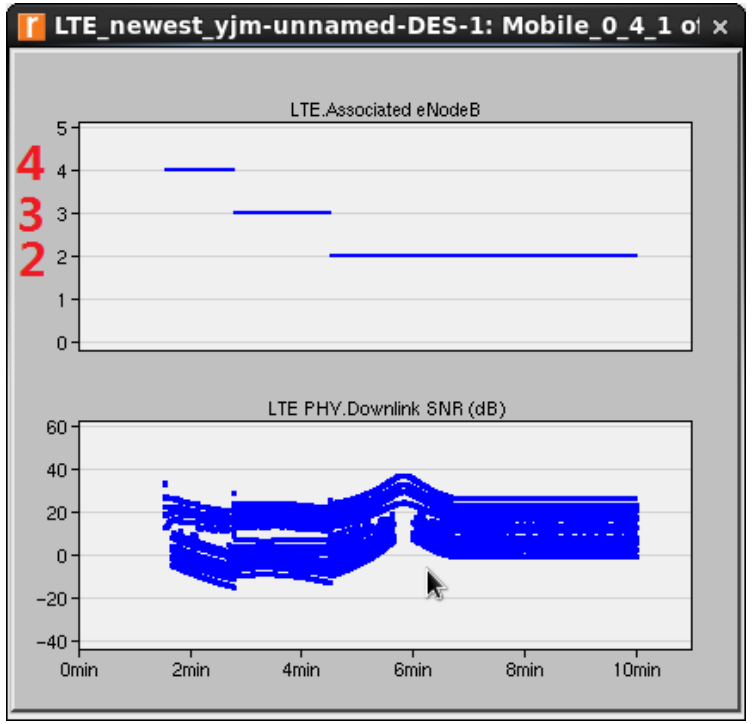
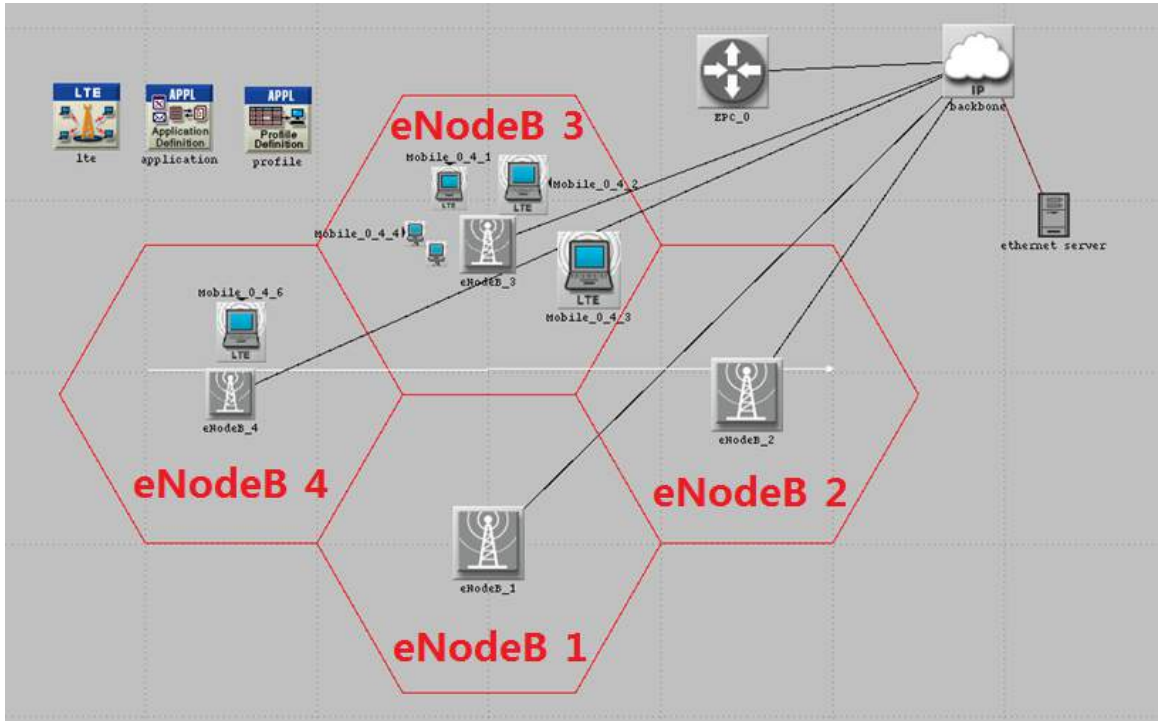


Fig 10. scenario 2 for LTE network and associated eNodeB ID of the mobile station

LTE Scenario 3



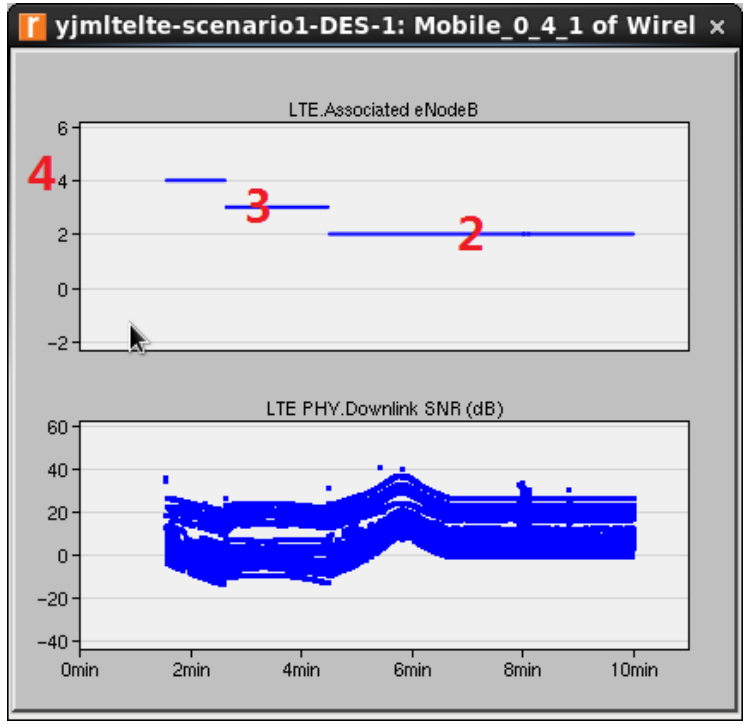


Fig 12. scenario 3 for LTE network and associated eNodeB ID of the mobile station

Comparison of WiMAX and LTE over Data Rate

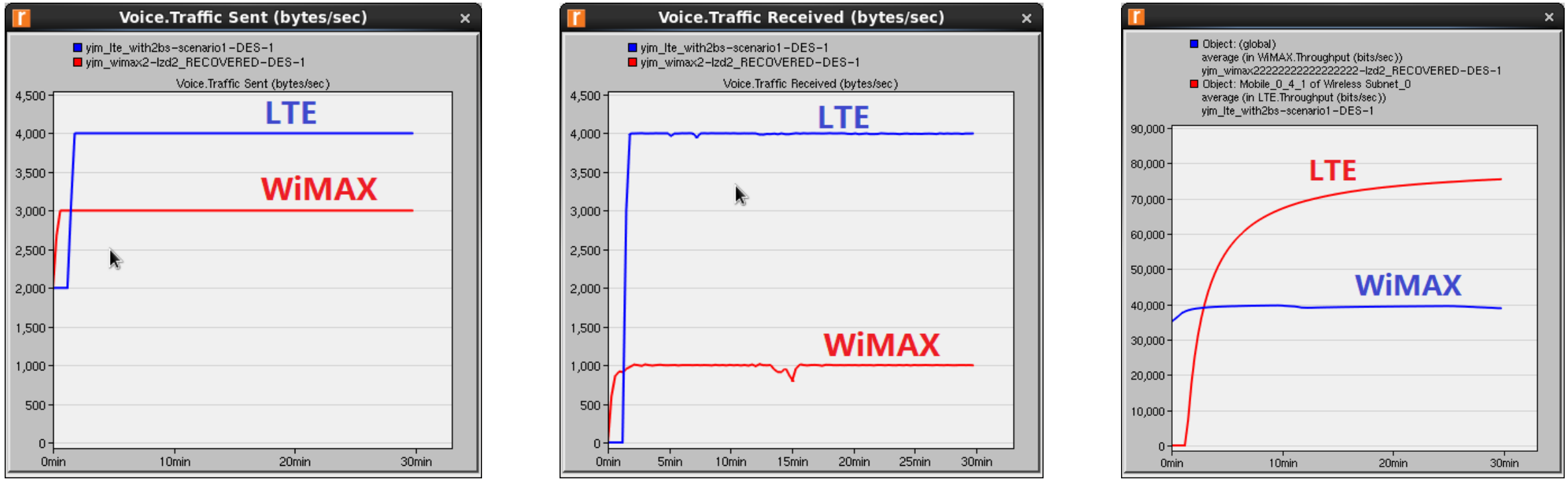
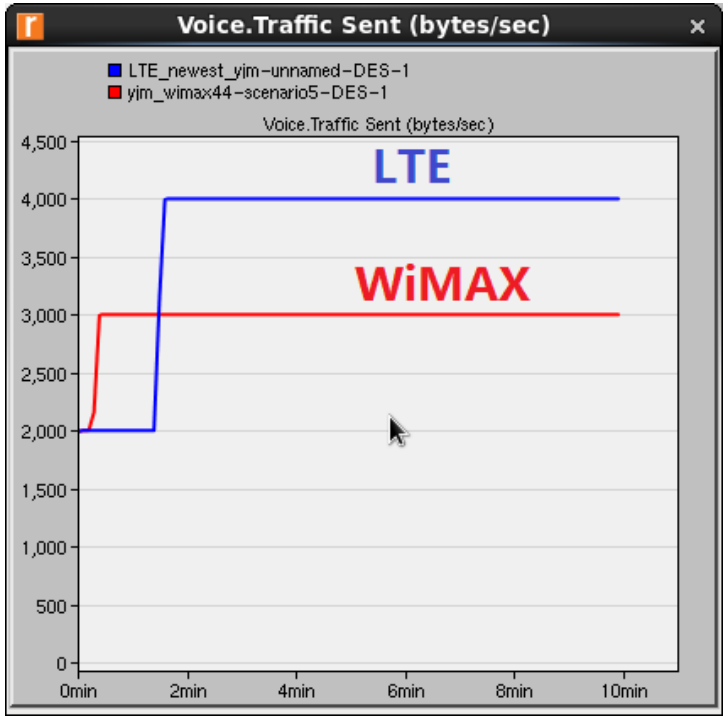
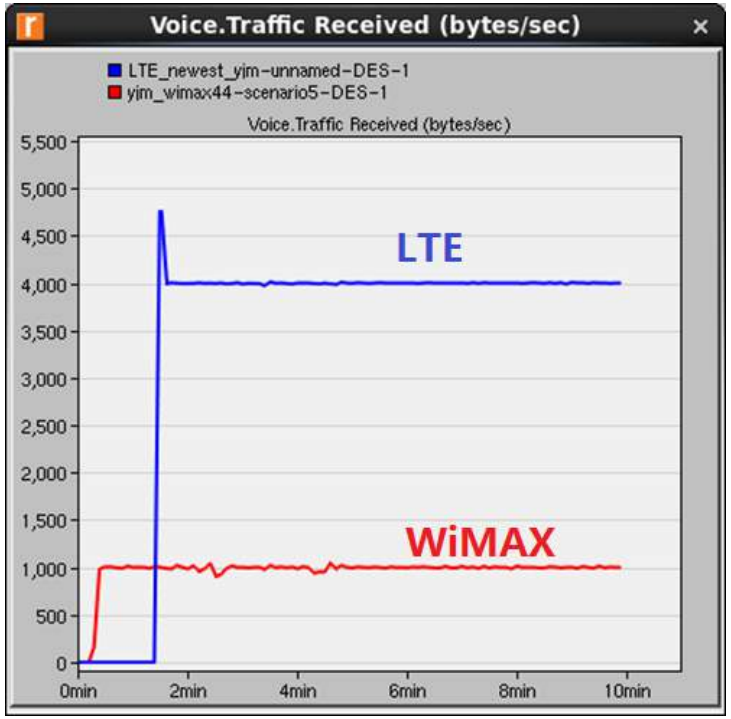


Fig 14. Comparison on Scenario 1 (with 2 BS and 1 MS)

Comparison of WiMAX and LTE over Data Rate





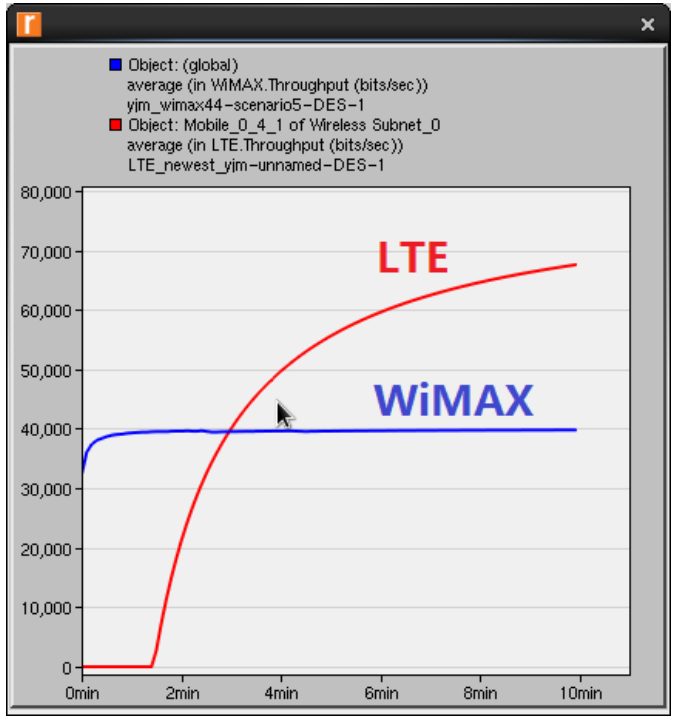


Fig 15. Comparison on Scenario 2 (with 4 BS and 1 MS)

Comparison of WiMAX and LTE over Data Rate

		Scenario 1	Scenario 2
Voice traffic sent (bytes/sec)	WiMAX	3000	3000
	LTE	4000	4000
Voice traffic received (bytes/sec)	WiMAX	1000	1000
	LTE	4000	4000
Throughput (bits/sec)	WiMAX	40000	40000
	LTE	75000	68000

Table 1. Results of WiMAX and LTE for Scenario 1 and Scenario 2

The results indicate that LTE outperforms WiMAX in the presence of voice traffic sent, received and throughput.

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Conclusion

- We successfully implement WiMAX and LTE network on Riverbed Modeler 18.5.
- Handover threshold hysteresis would affect the performance of handover. Large threshold value would reduce the handover attempts while it reduces the connection quality.
- LTE performs better in terms of traffic sent, received (that is, data rate), and throughput than WiMAX. LTE may performs better on mobility.

Future Works

- Implement the dual-trigger handover algorithm on OPNET 18.5.

- $C_{EF} \geq H_2 \times C_{max}$,

  where C_{EF} is the estimated free capacity of the serving BS,

  C_{max} is the estimated maximum capacity of the serving BS.

- The free capacity of the candidate BS should be no less than H_2, for example, 40%.

Future Works

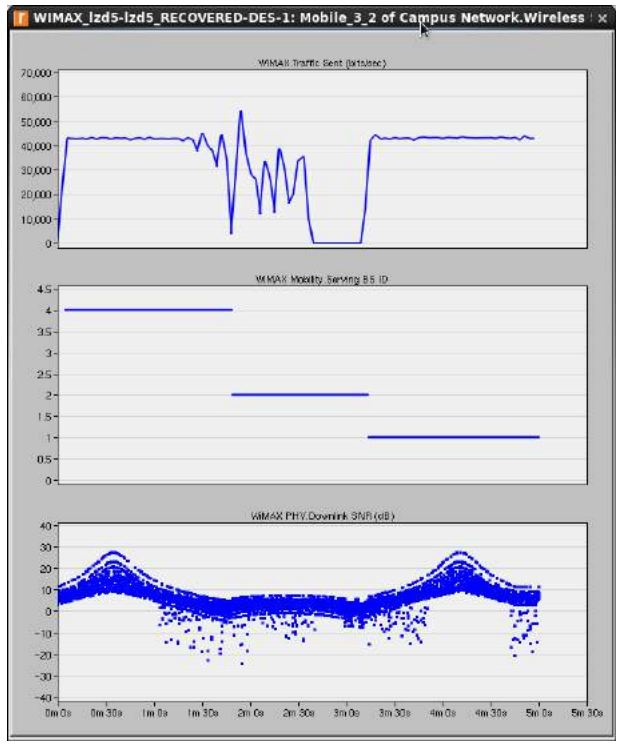
- Compare the difference of mobility between WiMAX and LTE.

- In general, mobility management includes location update and paging. The UE reports its new location to the network through the location update procedure. When an incoming call arrives, the network would identify the location of the UE through the paging procedure.

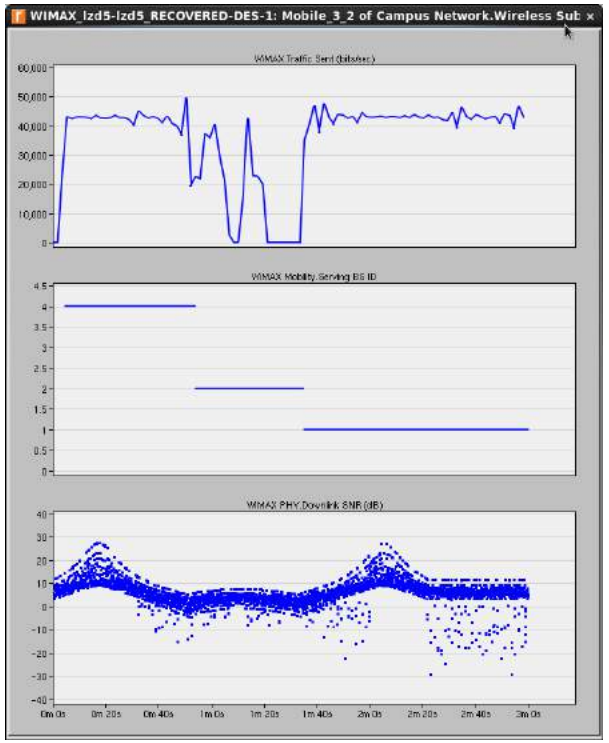
- We research mobility case in WiMAX. It could be observed that the performance of WiMAX has huge difference with different ground speed (50 km/h, 100 km/h and 200 km/h). When the speed of MS is up to 200km/h, there would be more traffic loss and the MS would not even connect to BS 1 in the end.

WiMAX Mobility

50 km/h



100 km/h



200 km/h

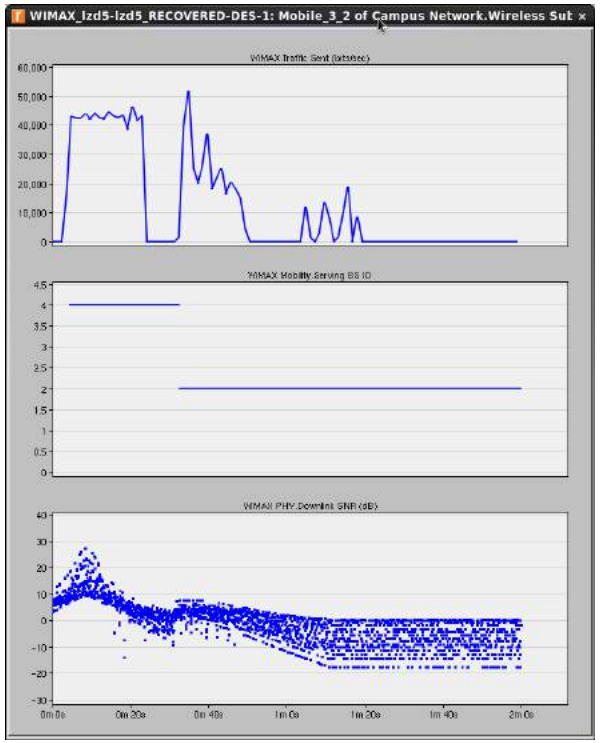


Fig 18. Comparison on Scenario 3 (with 4 BS, 1 MS, and 5 fixed station served by one of the BS), with different speed

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References

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Thank you!