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Optimization Backhaul Capacity for LTE Network Using Ethernet Based Technique

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ABSTRACT

Objective – 4th Generation Long Term Evolution (4G LTE) networks offer significantly higher data rates and require suitably higher capacity backhaul networks. As a result, it is urgent to emerge new transmission technology as attempt to enhance the backhaul capacity. This paper worked in LTE MIMO 2×2, we used two Ethernet based technique, namely Ethernet over SDH and MPLS-TP to analyse the performance of network as the primary object by measuring and comparing the throughput, latency and jitter between Ethernet over SDH and MPLS-TP.
Methodology/Technique – We used bandwidth capacity 240 Mbps as plant bandwidth link, then we used this value as reference to get the best performance for those Ethernet based techniques that we used in this paper.
Findings – The results of measurement indicate that MPLS-TP is a way for achieving improvement in performance to support LTE network respect to Ethernet over SDH.
Novelty – D From all the testing results, we see that MPLS-TP has a better performance in the current assessment to satisfy LTE backhaul requirements.
Type of Paper: Empirical

Keywords: MPLS-TP; Ethernet over SDH; LTE; Backhaul.

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1. Introduction

4th Generation Long Term Evolution networks offer significantly higher data rates and require suitably higher capacity backhaul networks. LTE aims to offer a minimum of 100/50 Mbps DL/UL (Downlink/Uplink, 1 sector, 20MHz spectrum) and up to 1 Gbps DL (3 sectors, DL/UL of 300/150 Mbps per sector) per LTE Base Station (eNB) [1]. Consequently, it is urgent to emerge new transmission technology as attempt to enhance the backhaul capacity of LTE networks.

Aleksandra et al. [2] have describe that Carrier Ethernet, one of the candidate technologies for mobile backhaul, protects the network from users that want to flood the network with their data and manages to keep the delay experienced by other users low. Andrei et al. [3] have analyzed the impact of backhaul packet delay

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(latency) on the LTE S1-U interface, which provides user plane transport between the Core Network and the Evolved NodeBs. Andrei et al. [4] have analyzed the impact of backhaul packet loss by focusing on the LTE S1-U interface, which provides user plane transport between the Core Network (CN) and the Evolved NodeBs (eNBs). Yi Shi et al. [5] introduced a novel wireless backhaul framework for small cell networks by introducing a new backhauling component, which is referred to as Type-A relay in order to capable of communicating simultaneously with two macrocells by leveraging the downlink resource of one cell as well as the uplink resource of the other, which effectively operates in full-duplex mode without incurring additional costs to acquire carrier resources. G.Vijayalakshmy et al. [6] presented the analyzing of convergence of 3G (3rd Generation), IEEE 802.16, IEEE 802.11 with an LTE backbone network for improving the network performance.

Patteti et al. [9] describe that in LTE there is 100.8 Mbps for single chain, therefore in this paper, we used LTE system with 2×2 MIMO (2T2R), then the throughput will be two times of single chain throughput. *i.e.* 201.6 Mbps. Patteti et al. [9] also describe that there is 25% of overhead used for controlling and signaling. So the effective throughput will be 151.2 Mbps. In this paper, the use of Ethernet based technique are implementing, namely Ethernet over SDH and MPLS-TP. The used of these techniques are to describe performance of the LTE network by measuring the Quality of Service (QoS) parameters that are measuring. The Quality of Service (QoS) parameters that are measured are throughput, jitter and latency. From these parameters, indicated that MPLS-TP technique are able to optimized the backhaul capacity for LTE network. The rest of this paper is organized as follows: Ethernet over SDH vs. MPLS-TP is presented in Section 2, in Section 3 LTE Network Impairment problems is describe, in Section 4 the results and analysis are discussed, and in Section 5 the conclusion of this paper is presented.

2. Methodology

2.1 Ethernet over SDH vs. MPLS-TP

In this paper, we used Ethernet over SDH (EoS) technology, which is ratified international standards (ITU-T) and offers the advantage of using the carrier's existing infrastructure and the efficient bandwidth granularity [7]. Also, we used MPLS-TP technology, which is designed to be used in an environment that operates with or without an IP-based control plane, meaning that MPLS-TP provides functionality for centrally controlled transport network (such as in Software Defined Networks (SDN)) or may be integrated with an existing IP/MPLS packet network [8]. We used ring topology in this paper which can be seen in Figure 1.

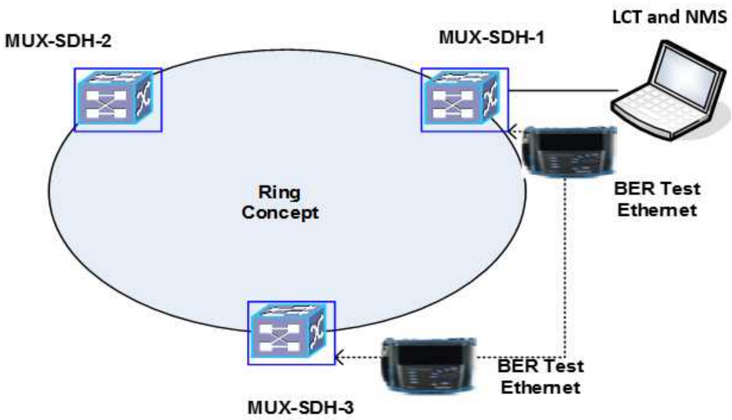

Figure 1. Topology of Ethernet over SDH (EoS)

In Figure 1, there are three Mux-SDH that connected each other, then we connected One of the three Mux-SDH with LCT and NMS as a gateway to monitor the parameters. Figure 2 is second topology using MPLS-TP.

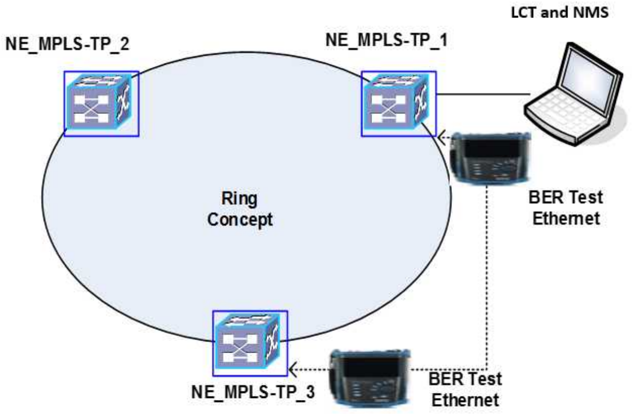

Figure 2. Topology of MPLS-TP

Figure 2 is showed that there are three network elements that support MPLS-TP technology. one of the three network elements are connecting to LCT and NMS that has been installed in laptop as a gateway to monitor the parameters. During this step, we measured the parameters namely throughput, latency and jitter.

2.2 Impairment Problems in LTE Networks

Impairments in real-life commercial networks affect traffic packets traversing them. The cause for these impairments are cumulative random events (e.g. busy hours, high profile events, panic usage, localized service disruptions, dynamic routes and paths for packets, faulty or overloaded network elements) [10]. In this paper we used RFC 2544 Standard testing to validate the Quality of Services (QoS) in LTE networks. The RFC 2544 is a standard developed by the Internet international standardization body, the Internet Engineering Task Force (IETF), which contains the necessary testing methods to measure the quality of an Ethernet network. The parameters that are testing in [11] are as follows:

Table 1. Standard for Throughput

Category	Throughput
Very Good	76% - 100 %
Good	51% - 75 %
Moderate	25% - 50 %
Bad	< 25%

Table 2. Standard for Jitter

Category	Jitter
Very Good	0 ms
Good	0 – 75 ms
Moderate	76 – 125 ms
Bad	126 – 225 ms

Table 3. Standard for Latency

Category	Latency
Very Good	$t_{\text{end to end}} < 150$ ms
Good	$150 \leq t_{\text{end to end}} \leq 300$ ms
Moderate	$300 < t_{\text{end to end}} \leq 450$ ms
Bad	$t_{\text{end to end}} > 450$ ms

3. Results and Analysis

In this section, we provide the measurements results to verify the performance of network quality for all the frame sizes measured. There are seven difference sizes of frame length that we used during measurement process, which are 64, 128, 256, 512, 1024, 1280, and 1518 fit to testing standard RFC 2544 [11].

3.1 Throughput

Figure 3. (a) presents the test results of throughput parameter values with different frame length, which could be seen that the actual link plan for throughput is 240 Mbps for all frame sizes. The test results for Ethernet over SDH technique is varied from 224.94 Mbps to 225.2 Mbps for all frame sizes. Whereas, the test results for MPLS-TP technique is 240 Mbps for all frame sizes.

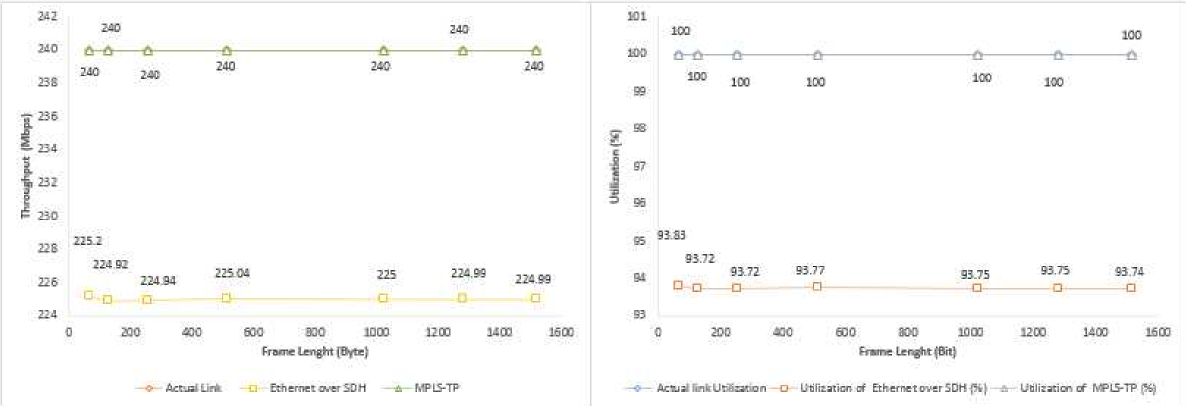

Figure 3 The Results of Throughput Testing. (a) The Value of Throughput Testing from, Actual Link Plan, Ethernet over SDH and MPLS-TP. (b) The Utilization in Percentage from Actual Link Plan, Ethernet over SDH and MPLS-TP.

Figure 3. (b) shows the throughput utilization of those techniques, where the throughput utilization for Ethernet over SDH varied from 93.72 % to 93.83 % for all frame sizes, whereas the throughput utilization for MPLS-TP is 100 % for all frame sizes.

From the testing results, there is gap between Ethernet over SDH technique and actual link plan in term of throughput values, where the value of throughput from the Ethernet over SDH technique didn't reach the defined value that is 240 Mbps. Whereas there is no gap between MPLS-TP technique and actual link plan.

The results verify that MPLS-TP has superior performance as compared to Ethernet over SDH when the throughput values of MPLS-TP meet to 240 Mbps as a defined value. However, since throughput values of MPLS-TP meet to defined value, there is a greatly affect to performance of LTE network, that is no packet loss during transmission. Conversely, when the throughput values of Ethernet over SDH below the defined value, therefore, it affected to reduce performance of LTE network lead to packet loss during transmission process.

3.2 Frame Loss

Figure 4. (a) shows the frame loss of Ethernet over SDH and MPLS-TP with different frame length. The results showed the frame loss values of Ethernet over SDH technology varied from 14.8 Mbps to 15.08 Mbps for all frame sizes, whereas, there is no frame loss in MPLS-TP technology. In figure 4. (b) shows the values of frame loss in percentage, where the percentage values of frame loss in Ethernet over SDH varied from 6.17 % to 6.28%, there is no frame loss as like in Figure 4. (a). All the results showed that MPLS-TP provide better performance then Ethernet over SDH.

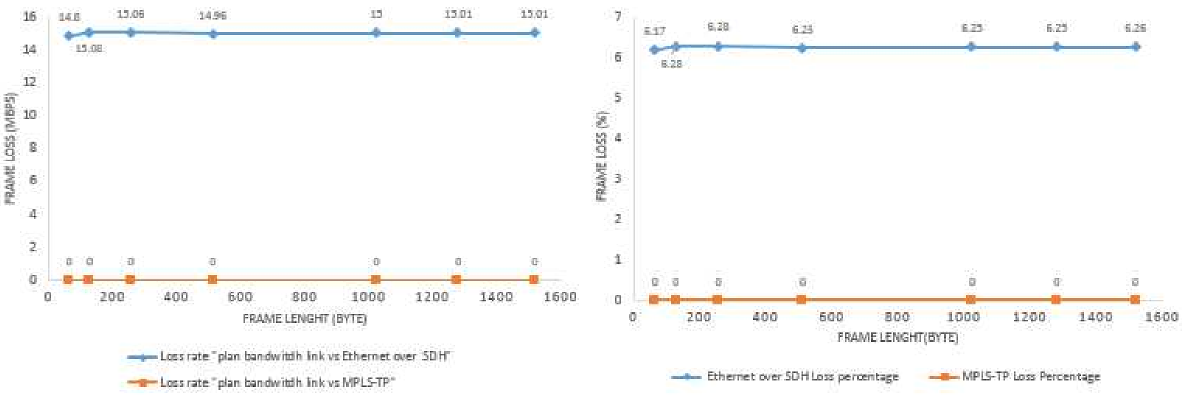

Figure 4. The Value of Frame Loss. (a) The Value of Frame Loss from Actual Link Plan, Ethernet over SDH and MPLS-TP. (b) The Frame Loss in Percentage from Actual Link Plan, Ethernet over SDH and MPLS-TP.

3.3 Latency

Figure 5. illustrates the results of measurements for latency values of Ethernet over SDH and MPLS-TP with different frame length. Both of the results is kept below the standard QoS that is 150ms [12]. However, the results verify that MPLS-TP has better performance as compared to Ethernet over SDH.

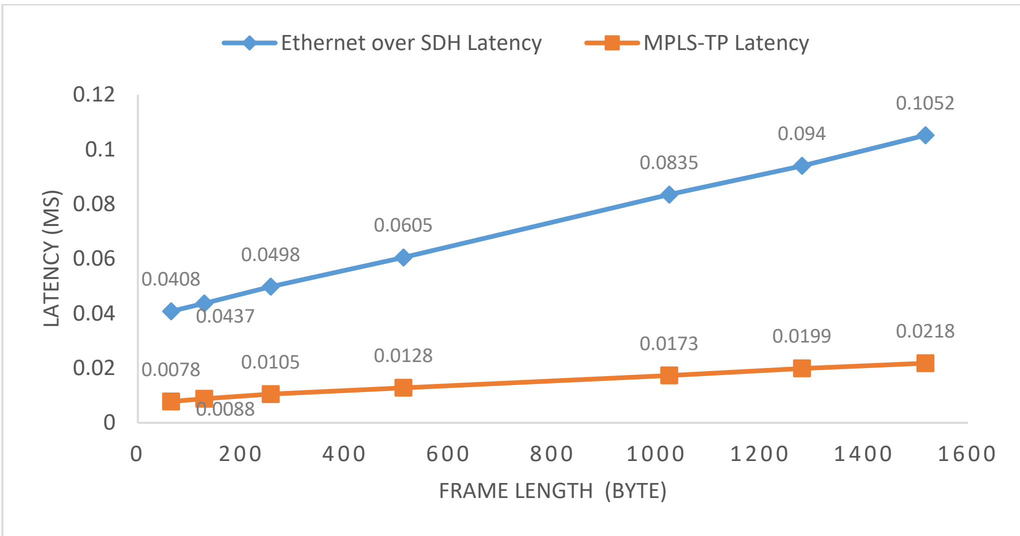

Figure 5. The Latency Values of Ethernet over SDH and MPLS-TP

3.4 Jitter

Table 1 shows the result of measurements for both Ethernet over SDH and MPLS-TP. The results showed that the jitter’s values for both Ethernet over SDH and MPLS-TP is matched with defined category that us 0-75ms [12]. The values of latency Therefore, the value of jitter for both Ethernet over SDH and MPLS-TP are available to support LTE network.

Table 4 The Value of Jitter for Ethernet over SDH and MPLS-TP

Maximum (ms)	Minimum (ms)	Current (ms)	Average (ms)	Estimate (ms)	Category (ms)

0.015	**0.015**	**0.015**	**0.015**	**0.015**	**0 - 75**

Conclusion

Analyzing the results, we see that throughput values of MPLS-TP reached 100% (240 Mbps), and throughput values of Ethernet over SDH varying around 93% (224.92 Mbps – 225.2 Mbps). Refer to [12] both of values are able to support LTE network (MIMO 2 ×2) but MPLS-TP has a better performance than Ethernet over SDH. The latency values of MPLS-TP in this paper is around 0.078ms – 0.0218ms, while the latency values of Ethernet over SDH is around 0.048ms – 0.1502ms, both of values are consistent with latency standard (<150 ms) [12]. From the latency values, we see that MPLS-TP has better performance as compared to Ethernet over SDH. Table 1 shows that the result of measurements for both techniques are same, that is 0.015ms, this results are meet to latency standard in [12]. From all the testing results, we see that MPLS-TP has a better performance in the current assessment to satisfy LTE backhaul requirements.

References

[1] G Kalimani Venkatesan, Kishor Kulkarni, Wipro Technologies, Bangalore 560100, "Wireless Backhaul for LTE – Requirements, Challenges and Options", 2008 2nd International Symposium on Advanced Networks and Telecommunication Systems , pages 1-3.

[2] Aleksandra Checko, Lars Ellegaard, Michael Berger, "Capacity planning for Carrier Ethernet LTE backhaul networks", 2012 IEEE Wireless Communications and Networking Conference: Mobile and Wireless Networks, pages 2741-2745.

[3] Andrei Rusan, Radu Vasiu, "Assessment of Packet Latency on the 4G LTE S1-U Interface: Impact on End-User Throughput", Software, Telecommunications and Computer Networks (SoftCOM), 2015 23rd International Conference on.

[4] Andrei Rusan, Radu Vasiu, "Emulation of Backhaul Packet Loss on the LTE S1-U Interface and Impact on End User Throughput", Intelligent Computer Communication and Processing (ICCP), 2015 IEEE International Conference on, pages 529-536.

[5] Yi Shi, Mingchao Li, Xin Xiong, Guanglin Han, Lei Wan, Xiaodai Dong," A Flexible Backhaul Architecture for LTE-Advanced", 2014 International Conference on Connected Vehicles and Expo (ICCVE), pages 1098 1105.

[6] G.Vijayalakshmy, G. Sivaradje, "LTE Backbone for Heterogeneous Architectures", 2014 International Conference on Circuit, Power and Computing Technologies [ICCPCT], pages 1354 – 1359.

[7] Hong Ju Kim, Seung il Myong, Hyun Ha Hong, Jong Hyun Lee, Jung Sik Kim," The Role of Ethernet over SDH in QoS Switch/Router", 2006 8th International Conference Advanced Communication Technology (Volume:2), pages 985-990.

[8] Jeong-dong Ryoo, Taesik Cheung, Daniel King, Adrian Farrel, Huub van Helvoort, "MPLS-TP Linear Protection for ITU-T and IETF", IEEE Communications Magazine, Year: 2014, Volume: 52, Issue: 12, Pages 16-21.

[9] Patteti Krishna, Tipparti Anil Kumar, Kalithkar Kishan Rao, "Throughput Evaluation of Downlink Multiuser-MIMO OFDM-LTE System", Int. J. Communications, Network and System Sciences, 2015, 8, pages 58-61

[10]"Predicting and Managing Network Impairments", IXIA Whitepaper, 2012, rev.A, available: http://www.ixiacom.com/sites/default/files/resources/whitepaper/impairment.pdf

[11] Agilent Technologies. RFC 2544 Testing of Ethernet Services in Telecom Networks. White Paper. 2004.

[12] NEC. *SDH Transmission System*. 6th edition, Japan, 1999