Comparison of TCP Variants in Long Term Evolution (LTE)

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***Abstract*— Transmission Control Protocol (TCP) is one of the protocols that work in the OSI (Open System Interconnection) modeling transport layer. TCP was designed more for wired networks. However, to meet the need for rapid development of network technology based on user needs, further development is needed for the use of TCP on wireless devices. One of the implementation of wireless-based network is mobile technology Long Term Evolution (LTE) broadband offering advantages, especially in terms of access. TCP Tahoe, TCP Reno, TCP SACK, and TCP Vegas are variants over the LTE network model with scenario. First is the view Throughput of each TCP variants when only one variant Certain working in the network. Both observe throughput All variants of TCP at the same time and have a QoS Equivalent, but with the possibility of a small congestion based on the capacity of the links made sufficient.**

Keywords*— *TCP, LTE, Throughput, Congestion, NS 2

I. Introduction

For the future technology in using internet, there are emerging from demands of telecommunication service users so thats it can get access to data quickly wherever located. This encourages the rapid development of wireless broadband technology. Society already started surfing the internet or sending email with a device that supports High Speed Packet Access (HSPA) or send files, videos, or music using a 3G phone [1]. In this, is required a technology that can provide experience and satisfaction which are better for telecommunication service user [1]. Long Term Evolution (LTE) was born as the answer. With the various advantages offered by LTE in terms of performance and capacity, architectural simplicity and ease of implementation, and the wide choice of user types equipment that can access LTE [2], LTE is estimated will become the major broadband technology in the future [1]. But the actual LTE system is also still in phase development [2]. On the other hand on the development of data networks, Transmission Control Protocol (TCP) is one protocols that work on the transport layer of the OSI modeling and much used [3]. Although initially and on generally TCP is not designed for real application purposes time and wireless network, still needed employing For TCP mechanisms further or at least consider a relatively more efficient TCP type inside new networks are formed [4], [5].

TCP is one of the protocols acting on the OSI modeling transport layer. TCP was designed more for cable networks [3]. However, to meet the need for rapid development of network technology based on user needs, further development is needed for the use of TCP on wireless devices [3], [5]. One of the implementation of wireless-based network is LTE network model that offers various advantages, especially in terms of access speed [3]. Network simulator is used to view the throughput of TCP variants are TCP Tahoe, TCP Reno, TCP SACK, and TCP Vegas over the LTE network model, with some scenarios. The four variants of TCP are the most variant of the approach congestion control on the wireless network model with the development of interrelated algorithms.

II. Literature Review

This research system builds algorithm framework of each variant of the TCP protocol which has been determined on topology LTE. This research framework is not developed on real network, but in simulations run on network simulators. The design of the test framework is done so that the TCP variant algorithm can be assessed its quality in accordance with the parameters that have been determined. Test parameters need to be set so that there is a common point of view in assessing an algorithm. Not all QoS parameters will be implemented in the test. Only parameters affect the performance of the algorithm and allow to be calculated to be used as algorithm test parameters. In performing simulations, a precise simulation scenario should be specified so that the algorithm of the tested TCP variant can be tested under various conditions [6]. In each scenario a value is calculated for each parameter. TCP quality measurements measured in the form of throughput. The measurement of the data is done by utilizing the implementation of delay retrieval. Data delay for each test is taken on a replication when the independent replication method indicates that replication is sufficient. Measures of throughput quality are measured in terms of average in a simulation.

A. *TCP Variants*

1) TCP Tahoe

Tahoe refers to the TCP congestion control algorithm which was proposed by Van Jacobson [6]. TCP is based on a principle of conservation of packets, if the connection is running at the available bandwidth capacity then a packet is not injected into the network unless a packet is taken out as well [6]. TCP implements this principle by using the acknowledgements to clock outgoing packets because an acknowledgement means that a packet was occupied off the wire by the receiver [5][6]. It also maintains a congestion window (CWD) to reflect the network capacity. However there are certain problems, which need to be resolved to ensure this equilibrium.

TCP Tahoe is the simplest of the other variants. TCP Tahoe on three congestion control algorithms, namely slow start (SS), congestion avoidance (CA) and fast retransmit. TCP-Tahoe not using rapid recovery algorithm In the phase of congestion avoidance, TCP-Tahoe duped duplicate three ACK equal to time out [6]. Tahoe suggests that anytime a TCP connection starts or re-starts after a packet loss it should go through a procedure called slow-start [10]. The reason for this procedure is that an initial burst might overwhelm the network and the connection might not running.

2) TCP Reno

TCP Reno is a variant of TCP used as a fast recovery technique which permits the transmitter to avoid difficult the pipe, and to transfer or after cwnd to (cwnd /2) in the space of a solitary RTT [10]. TCP Reno is TCP Tahoe through the adding of Fast Recovery [6]. The impression is to usage the incoming duplicate ACKs to step retransmission [6].

TCP Reno retains the basic principle of Tahoe, such as slow starts and the coarse grain retransmit timer [10]. However it adds some intelligence over it so that lost packets are detected sooner and the pipeline is not emptied every time a packet is lost. Reno needs that we accept quickly acknowledgement anytime a segment is accepted [8]. The logic behind this is that anytime we accept a duplicate acknowledgment, then his duplicate acknowledgment could have been accepted if the next segment in sequence expected, has been delayed in the network and the segments reached there out of order or else that the packet is lost [8], [10]. If we receive a number of duplicate acknowledgements then it means that adequate time have passed and even if the segment had taken a longer path, it should have gotten to the receiver by now. There is a very high probability that it was lost. So TCP Reno recommend Fast Re-Transmit. Anytime we receive 3 duplicate ACK‘s we take it as a sign that the segment was lost, so we re-transmit the segment without waiting for timeout [11].

3) TCP SACK

Selective Acknowledgment (SACK) is the receiver evidently tilts which sets, messages, or wreckages in a creek are recognized (either negatively or positively) [10]. Optimistic selective reaction is an excellent in TCP that is appreciated in satellite internet access. TCP SACK selection distinct in RFC 2018 is used by the TCP data receiver to acknowledge non-contiguous chunks of data not enclosed by the cumulative acknowledgement field [10]. However, RFC 2018 does not stipulate the use of the SACK decision once identical sections are established [10], [11].

4) TCP Vegas

TCP Vegas is a TCP congestion prevention procedure that highlights packet deferral, relatively as compared to package loss, as an only one to assistance control the rate at which to send packets [9], [11]. It was established at the University of Arizona by Lawrence Brakmo and Larry L. Peterson and proposed in 1994 [11]. Bandwidth Estimation scheme used by TCP Vegas is more efficient than other TCP variants. This scheme makes bandwidth estimation by using the difference between the expected flow rates and the real flow rates. It increases TCP-Reno by modifying its congestion avoidance mechanism. Like TCP-Reno it uses Slow Start and Fast Retransmission. TCP-Vegas use its congestion avoidance mechanism in order to avoid packet loss by decreasing its CWND as soon as it detects congestion in the network [12].

B. *TCP Mechanisms for LTE*

Transmission Control Protocol (TCP) is a protocol which is in the transport layer (in seven layers of the model Reference OSI) connection-oriented and reliable [6]. In LTE network, To solve the problem on wireless connection, applied error recovery mechanism on the link layer, so will be the same as the error recovery function at the transport layer of the TCP/IP layer model. LTE assumes that connection End-to-end TCP regulates congestion control and coping The missing package problem [13].

LTE network also implements Quality of Service (QoS) on radio and transport networks, but at the other hand does not adapt the flow control mechanism [1], causes the possibility of the packet to be lost when congestion occurs at each terminal or node. Each TCP variant has its own working mechanism [9], [11]. To solve problems when they occur congestion. In its implementation, TCP performance is not so optimally especially in wireless network conditions, where The effect of bit error rate also greatly affects the performance of TCP, But for the further development of TCP performance, In this paper will be compared among TCP variants which is tested on the simulation, so it can be seen comparison of TCP variant performance on the LTE network [11], [13].

III. Result

The main purpose of this research was to construct a test frame to test the variant algorithm according to the predefined QoS parameters. The test framework constructed consists of QoS parameters and their calculations, simulation scenarios, and algorithm testing steps using simulators and tools for trace analysis of simulated results files. In the first scenario, simulations are performed alternately on each TCP variant, starting with TCP Reno, then TCP Tahoe, TCP SACK and TCP Vegas. TCP packet size used is 700 bytes and window size is 64 kBytes.

The design of the test framework is done so that the TCP variants algorithm can be assessed its quality in accordance with the parameters that have been determined. Test parameters need to be set so that there is a common point of view in assessing an algorithm. Not all QoS parameters will be implemented in the test. Only parameters affect the performance of the algorithm and allow to be calculated to be used as algorithm test parameters. In performing simulations, a precise simulation scenario should be set so that the algorithm of the tested TCP variant can be tested under various conditions. In each scenario a value will be calculated for each parameter. The system diagram block in Fig. 1 describes the input data traffic as inputs and parameters which will then be calculated and analyzed by comparison in each scenario as output.

The measured quality of TCP variant is measured throughput. The measurement of the data is done by utilizing the implementation of delay retrieval. Delay for each test is taken on a replication when the independent replication method indicates that replication is sufficient. Measures of throughput quality are measured in terms of average in a simulation.

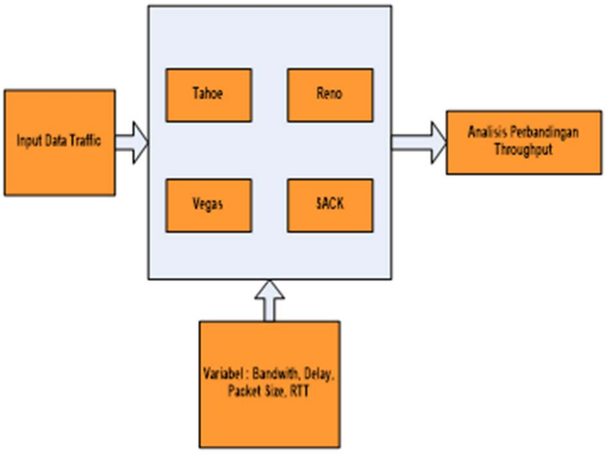

Fig. 1. System Chart

In this section simulations of each TCP variant on the network where only one node works, represents a specific TCP variant. In the simulation, the network capacity from eNB to EU was made 42 Mbps which refers to the large ever tested. To find out the average throughput can be seen in the graph throughput, because it shows a relatively constant number. It can also be done exact calculation by looking at the number of packets that have been received during the span of the simulation. Then, to compare the TCP variant in a network condition that is working specifically at a given time in simulated network conditions, between TCP Reno, TCP Tahoe, TCP Vegas and TCP SACK variables do not have a difference in results significant throughput.

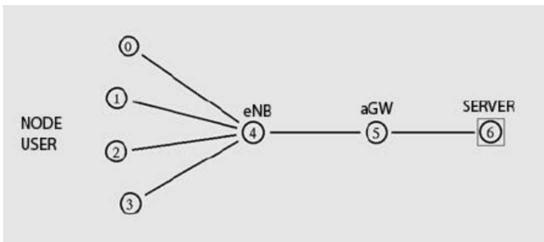

Fig. 2. Topology Simulation

Node 0, node 1, node 2 and node 3 are representations of user equipment where in the simulation topology is called the node user. Node 4 as enhanced Node-B (eNB) where it is tasked to take care of all the problems related to the radio interface function other than of course functions to deal directly with the user equipment. Node 5 as a gateway that connects eNB with the server. Node 6 as server. With the topology in Fig. 2 some simulation scenarios will then be performed.

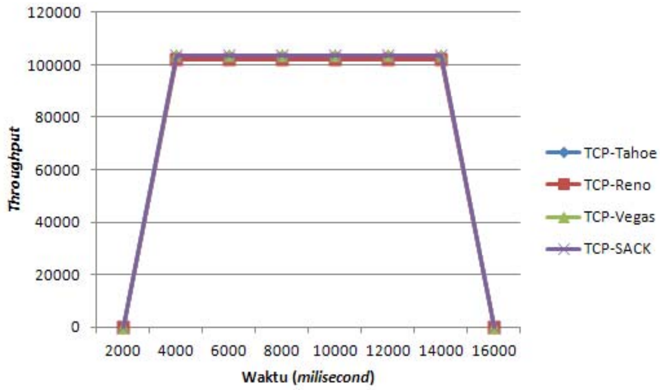

Fig. 3. Graph Throughput Scenario 1

In fig. 3 shows scenario 1 is visible although there are slight differences where nodes using TCP Vegas, TCP Tahoe and TCP SACK have relatively large throughputs, whereas TCP Reno shows smaller values. Nevertheless, the amount of data received by each node and the magnitude of the average throughput value is still relatively equal. While Fig. 4 shows scenario 2 there is almost no significant difference between TCP-SACK and TCP-Vegas. While TCP-Reno has a relatively small throughput compared with other TCP variants. Large throughput from the use of TCP-Vegas and TCP-SACK can be said to have a relatively large channel efficiency because it is also close to the allocation of link capacity it has.

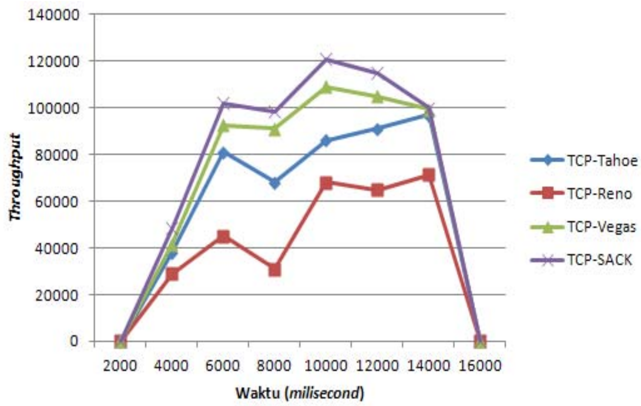

Fig. 4. Graph Throughput Scenario 2

IV. Conclusion

Some conclusions in this research :

1. Throughput on the condition of only one TCP variant working at one time, both TCP-Reno, TCP-Tahoe, TCP-Vegas, and TCP-SACK show the same magnitude and no significant difference.
2. Under equivalent QoS conditions between each of the TCP variants implemented in fairness obtained, all tested TCP variants also have a significant throughput showing no significant difference, although there is little difference in the amount of data received by each node representing the TCP variant used.
3. TCP-Vegas and TCP-SACK variants have a relatively large average throughput, where TCP-Reno is at the lowest

average throughput, and TCP-Tahoe is between the two, in the case that packets are lost due to the full capacity of the network.

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