Scientific Journal of Impact Factor(SJIF): 3.134
e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 2, Issue 5, May -2015

Performance analysis of TCP and UDP during intra LTE handover

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Abstract —*Wireless communication is playing an important role in our daily life since it offers flexibility and mobility. New multimedia services demand data-rates of up to hundreds of Mbps and thus higher frequency bands are being explored to support these new high data rate services. LTE (Long Term Evolution) has been standardized in 3GPP (3rd Generation Partnership Project) to provide higher data throughput as well as lower latency for various IP based services including web browsing, VoIP (Voice over IP), video streaming and so on. However, to support mobility, handoff is a must in many of these networks and systems. The high reduction in signal strength as a function of distance results in a small coverage area, thereby causing frequent handoffs for mobile terminals. In this paper we give an overview of the LTE intra-access handover procedure. We investigate the effect of handover on TCP and UDP throughput and delay***.**

Keywords- LTE architecture, LTE handover, Communication system control, Mobile communication.

I. INTRODUCTION

3GPP summarized the standardization work for LTE in its release 8 [1, 2] and the commercial deployment of LTE has commenced in several countries at the time of this writing. LTE is designed to provide higher throughput and lower latency than its predecessor, i.e. HSDPA (high speed downlink packet access) which is also known as 3GPP release 5 [3]. LTE also introduces the all-IP network and all services are provided by IP. Therefore the throughput and delay performance must satisfy certain criteria even in the mobility scenario. However, the throughput performance will be degraded by the interference between source and target eNBs during handover. In addition, there is a link interruption in the user plane during handover because LTE supports only hard handover. Although the loss or out-of-order delivery of packets is avoided by the X2 forwarding scheme, the interruption degrades the delay performance of UDP because no data can be sent between eNB and UE during the interruption [6]. It has also been pointed out that longer interruption times may degrade the TCP throughput performance. If the interruption time exceeds the retransmission timeout of a TCP session, the TCP throughput is reduced by the congestion avoidance algorithm of TCP. This phenomenon is called spurious timeout [7].
Congestion avoidance algorithm of TCP. This phenomenon is called spurious timeout [7]. There are many studies that evaluate TCP and UDP performance during handover. Nemeth et al. investigated TCP throughput performance during handover by using an emulator that models the effect of link interruption [8]. Pacifico et al. conducted numerical simulations to evaluate TCP performance during handover [9]. Both papers concluded that buffer management is very important. Prokkola et al. measured the one way transmission delay of VoIP traffic in a commercial HSPA enabled network [10]. They found that handover generates interruptions that reach several hundreds of milliseconds and that VoIP quality is disturbed by the interruptions. The optimization of handover parameters such as A3-offset and TTT (time to trigger) is another important issue and is extensively studied in [11, 12].

II. LTE ARCHITECTURE

Before we describe the LTE handover procedure we first outline the LTE RAN architecture. Figure 1 depicts the LTE architecture, showing also the protocol termination points at the different entities. As it can be seen in the figure the radio link specific protocols, including RLC/MAC layers are terminated in the eNodeB. This means, for example that the HARQ (Hybrid ARQ) protocol and the second layer ARQ protocol, parts of the RLC/MAC layer, are terminated in the eNodeB. In HSDPA, for instance, the HARQ protocol is also located in the eNodeB (in the MAC layer) but the second layer ARQ (i.e., the RLC layer) is terminated in the RNC [4].

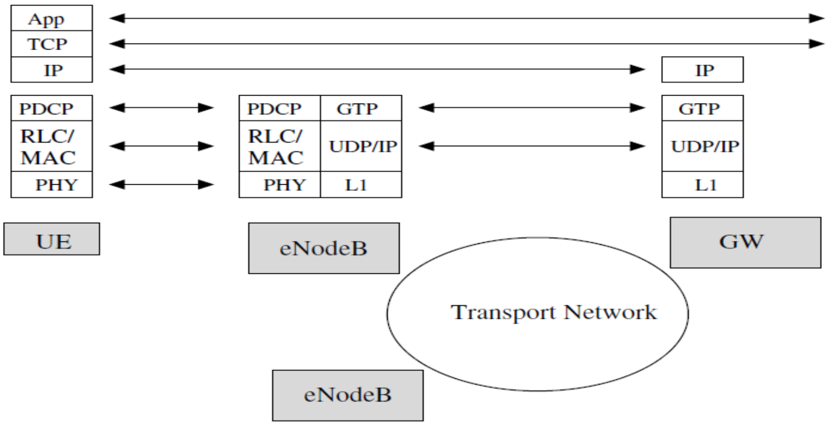


Fig. 1: LTE architecture [6]

The PDCP layer, which is responsible for header compression and ciphering, is also located in the eNodeB. Between the GW and the eNodeB a tunneling mechanism (based on the GTP protocol [5]) is used to deliver the user data packets to the right eNodeB where the UE is currently located. In case of a handover the protocol endpoints that are located in the eNodeB will need to be moved from the source eNodeB to the target eNodeB. Then, it is an option whether the full protocol status of the source eNodeB is transferred to the target eNodeB or the protocols are reinitialized after the handover. This raises the question for example, whether the HARQ and ARQ window state is discarded and reset or transferred during the handover.

III. LTE HANDOVER

In this section, we briefly introduce X2-based intra frequency handover [12] that is used in our experiment. Note that S1 - based intra-frequency handover, inter-frequency handover, inter-RAT (radio access technology) handover are out of scope of this paper. X2-based intra-frequency handover is used when a UE, that has an active communication session, moves between eNBs that have a common EPC and an IP connection using X2 interface between them. It consists of three phases, preparation phase, execution phase, and completion phase.Data forwarding via X2 is started as soon as the source eNodeB receives the Handover (HO) Request ACK from the target eNodeB. The target eNodeB starts to send the forwarded data to the UE just after it receives the HO Confirm.

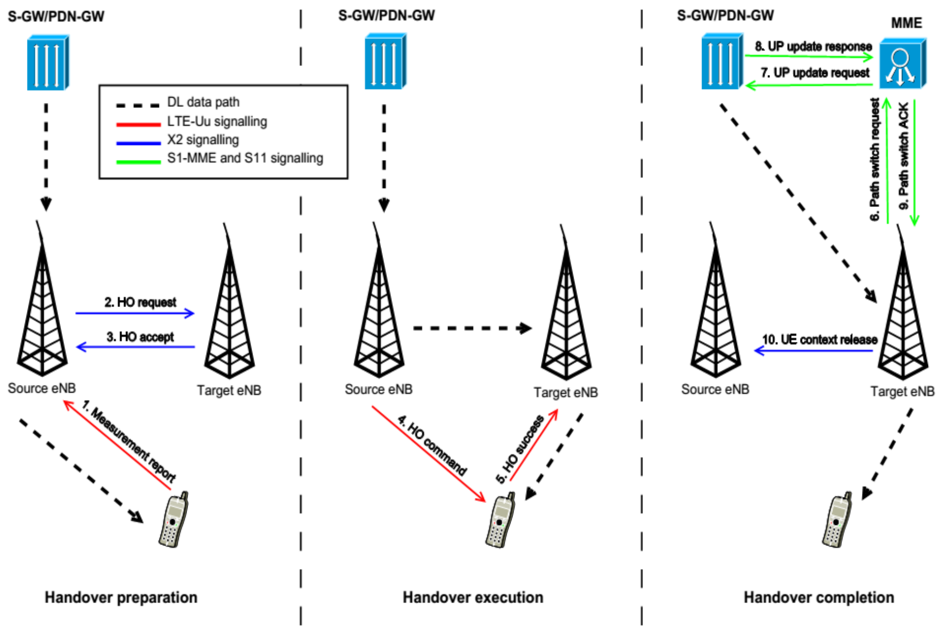


Fig. 2: Intra-frequency X2-based handover [13].

IV. PERFORMANCE EVALUATION

4.1. Simulation Model

Ns-2 simulation is used in simulation study. In this simulation create a LTE and measure end to end delay and throughput.

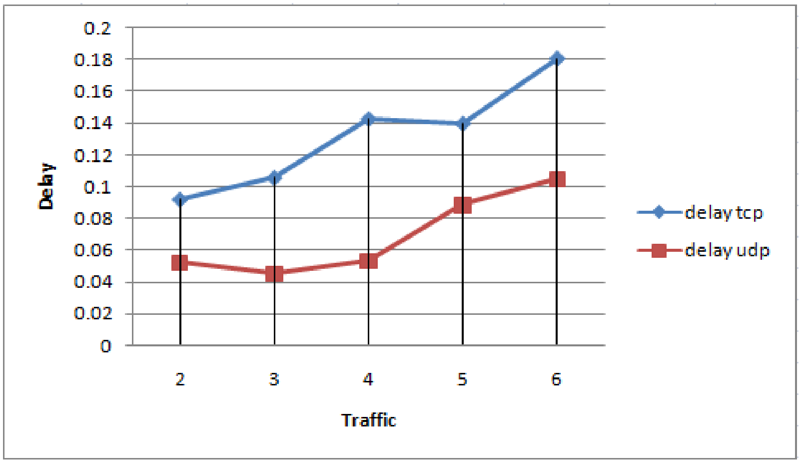
Table 1. Simulation parameters

Parameters	Values
Network Dimension	500m x 500m
Network Interface	Wireless phy/OFDM
Propagation Model	Two ray ground
MAC	MAC/802_16
Interface Queue Type	Queye / Drop Tail /Priqueue
Antenna Model	Omni Directional
Link Layer	LL
Simulation time	250 s
Traffic type	Application /FTP

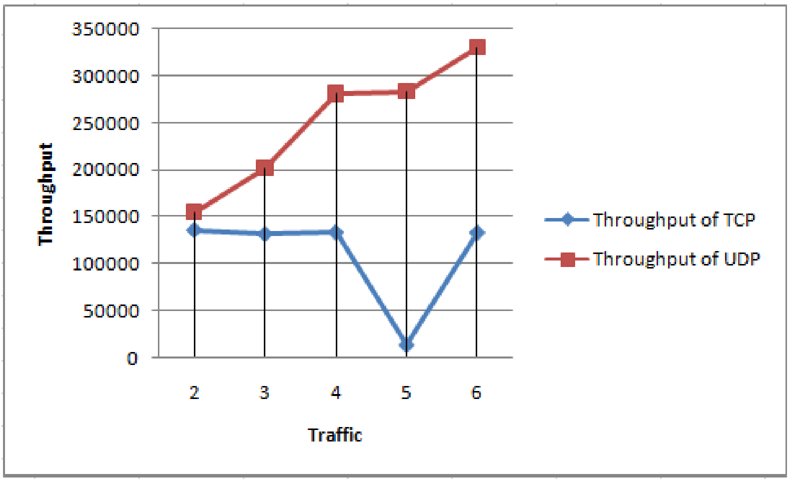
4.2. Evaluation Result

A simple LTE architecture consists of one server for serving FTP, HTTP, and provides a source connection for the TCP link over the topology. In LTE system, the main job of a GW router is to control the flow rate of the streaming data from server to user equipment (UE) called evolved NodeB (eNodeB), where these nodes responsible for buffering the data packets for UE over the network. Each eNodeB, connected to the corresponding a GW through wired simplex link. During the data forwarding, when a new packet is transmitted by server, it passes through the core network router. And right after it arrives at the Source eNodeB, it is forwarded through the core network router again to the Target eNodeB. Therefore, every packet that must be forwarded visits the core network router twice in a very short time.

This "twice queuing" problem causes congestion inside of the core network router which leads severe performance degradation of TCP. Twice queuing gives rise to overloading of core network router buffer. Consequently, processing delay of the core network router increases dramatically which brings out spurious timeout at the TCP sender side. Also, some packet may be lost by buffer overflow. In this section, the implemented LTE handover mechanism is tested under different traffic situations. We compare these results with varying traffic .The simulation results for effect of number of traffic on the TCP throughput and UDP delay are depicted in figure.The red line shows UDP and blue line shows TCP performance for different traffic. First in the starting phase of network TCP and UDP throughput is increases and delay is increases. But when there is a handover in the network then TCP throughput decreases and delay increases suddenly while UDP throughput and delay is not decreases. Here TCP throughput and delay is affected by handover because TCP is reliable while UDP is unreliable and no need of any acknowledgement for data transmission.



(a)



(b)

Fig..3: (a) Delay versus Traffic for TCP and UDP. (b) Throughput versus Traffic for TCP and UDP.

V. CONCLUSION

This work presents the design and implementation of a handover for LTE system model. The handover performance under different traffic is studied by simulating increased numbers of traffic. The results illustrate the impact of high traffic on performance UDP delay and TCP throughput. The results show the comparative analysis of delay and throughput of TCP and UDP for the whole LTE network and also when there is handover.

VI. FUTURE SCOPES

Our future research will concentrate on analyze the result for UDP and TCP for inter handover and try to compare the result with intra handover.

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