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Reducing Traffic Congestion for Machine to Machine Type Communication over 4G-LTE Network by Decreasing Total Bytes Transmitted

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Abstract – **In the near future, with the development of Machine to Machine (M2M) communication service providers may see a spike in traffic degrading the quality of service (QoS). With the addition of several M2M devices, it is expected to create conditions for overload in the Radio Access Network (RAN) and Core Network in 3GPP LTE networks. There are many studies that examine various characteristics of M2M communication devices including protecting the physical devices, authentication methods, congestion controls, privacy protection and many others. However, congestion will be a persistent problem with the increased devices and is the focus of this paper. There is research on the methods to control congestion, though this paper is considering increasing availability through reducing total bytes transmitted and thus avoiding or reducing overload and congestion in LTE network. In this paper, we have proposed and tested various optimizing mechanisms for reducing the signalling traffic and bandwidth utilization, thus decreasing the overload in the LTE architecture.**

Keywords – RAN, congestion, RoHC, QoS, DoS, 4G LTE.

I. INTRODUCTION

With the rapid evolution of M2M devices, service operators and researchers estimate the mobile traffic will see a tremendous growth in coming years. Estimates predict up to 50 billion M2M interconnected devices by 2020 [2]. Therefore, transmitting data from numerous heterogeneous devices will create traffic and degrade quality of service (QoS) soon [1]. With the increased dependency on the Internet for people to communicate and get timely access to information, the demand and necessity for seamless communication technology has been evolving at a rapid rate [3]. The crucial role M2M will play has increased concerns about network congestion among the service provider and end users and made security of the network even more critical [4]. The main objective of this paper is to find an effective method to reduce congestion in the RAN side and core network side of the LTE architecture.

II. METHODOLOGY

Though few tests have already been performed to determine congestion in the LTE network with the increase in UE devices, our purpose is to get a baseline of the problem. In this paper, the congestion problems identified above have been verified using the Omnet++ simulation tool.

The methodology adopted for this research is analysing the congestion areas and studying each part where the congestion occurs, thereby coming up with a solution which can be efficiently worked out to reduce congestion in both RAN and core network parts of the LTE network architecture. In Omnet++, an LTE network used by many devices was set up as shown in Figure 1. The LTE network consisted of 10 to 50 devices to communicate over the LTE. The LTE network also consisted of an eNB, PGW, and a receiving server. The tool simulated how devices initiate a connection request to Evolved Node B (eNB) allocating an IP address from PGW and transmitting data. The objective of the simulation was to show the more traffic, the more congestion. Hence, we used 10 UE devices to generate traffic through a limited bandwidth. The load was at peak within 7 seconds, subsequently 20 devices showed a peak traffic at 3 seconds, 30 devices showed a peak traffic at 2 seconds and 50 devices showed a peak traffic within half a second.

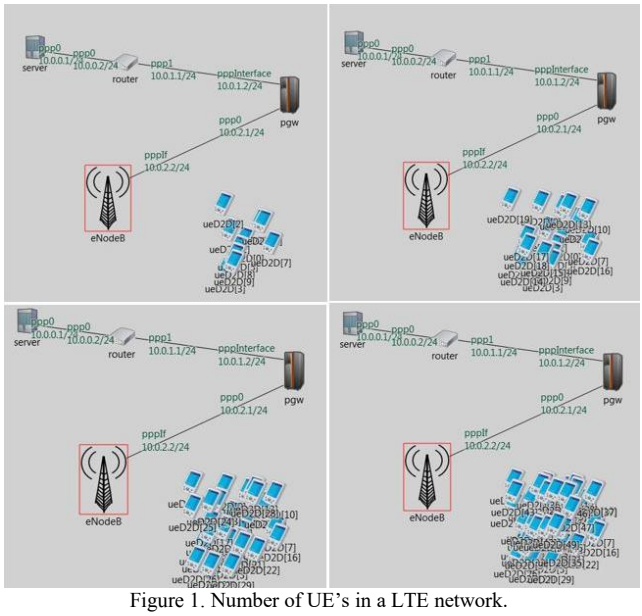

Figure 1. Number of UE's in a LTE network.

Optimization techniques to reduce congestion can be determined such that they minimize bytes that are transmitted and are not required.

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III. EXPERIMENTAL RESULTS

A. Robust Header compression (RoHC)

There are many small sizes of data carried by huge IP packets since the header part consumes more resources than the real data during a voice transmission. A similar concept can be applied to M2M packets. M2M data are mostly bursty and frequent packets that transmit over the network. M2M often transmits small chunks of data which can be less in size compared to its IP header. Therefore, RoHC can be applied to decrease the header size to save significant resources by compressing both the dynamic and static fields in IP header. RoHC was implemented to a Linux-based virtual machine. In the test we have used a data size similar to a M2M IPv4 packet. In the test, we created five IPv4 packets with 26,21,22,23, and 21 bytes of packets. When the stream of IP packets are combined it gives 113 bytes of IPv4 packets. The RoHC program was executed for these stream of IP packets using the RoHC program, we could achieve a robust header compression of packets from 113 bytes to 33 bytes with 71% savings in total size. The experiment proves that when tiny streams of IP packets are transmitted from M2M devices through LTE, robust header compression could be an effective method to reduce the packet size thereby decreasing the bandwidth.

B. Method to Eliminate User Information

A method is needed to eliminate the user information within the normal limits defined by the user of the M2M devices. This can substantially reduce load in the network and will decrease the RA request from M2M devices to attach to eNB thereby reducing signalling traffics. This method can be achieved by coding placed into the Java card of the SIM using C or assembly language to keep a small code size with high performance. In this test using a C program, we were trying to build a table that has the threshold values of basic health monitoring in the case of an e-health device. The C program checks for the health rates defined in the table. It could be then programmed in such a way that when a M2M device send values frequently to the SIM for transmitting to the 4G network, the program checks to see if the values are within in normal limit already defined in the table. If the value of health is getting within the normal range the packet will not be transmitted, and if the value gets above or below the normal limit it would be transmitted through devices using LTE. The M2M device would invoke a radio channel only when there is an information to transfer i.e. when the value is above or below the threshold limit. With this regard, the RAN side congestion would decrease considerably by avoiding frequent RRC request to the eNB. The unsolicited values are eliminated which can save bandwidth and network resources. If there is no need to transmit due to redundant values, the SIM will drop the request to attach to network.

C. Lightweight Compression

A light weight compression method can be applied to M2M packets originating from the devices. As described in the work done by authors in [5], we can use a similar concept by applying lightweight compression method in Java SIM card. As mentioned in the paper, light weight compression is a combined version of dictionary compression and folding compression, which can be applied to M2M devices that uses the 4G SIM to transmit data. This can substantially reduce the bandwidth and provide a faster execution. Space saving can be achieved by defining compression as follows.

$$Sxcompr = \frac{AppSize_{original} - AppSize_{Xcompr}}{AppSize_{original}}$$

Here, $AppSize_{original}$ is the size of the original application and $AppSize_{Xcompr}$ is the size after the compression [5]. With light weight compression, they could achieve 12% space saving. For application running on Java cards the amount of space saving could significantly help the resource utilization by keeping application size minimum.

IV. CONCLUSION

This paper explores the goal of availability from the standpoint of reducing total bytes transmitted. Our experiment in this paper experimentally verified the more the number of UE devices increases, the more it gets congested. This paper discusses potential solutions to reduce congestion both at the RAN side and core network of the LTE network architecture. Since M2M devices transmit data with a size much lower than its IP header, a lot of space is currently being used by its IP header. The experimental results showed using the RoHC technique could be an effective solution to reduce IP header overhead, thus reduce bandwidth usage and help to prevent network congestion providing higher availability and QoS. Another solution proposed in this paper is to reduce signalling overhead at the RAN side by eliminating redundant information sent by M2M devices using a C program in the SIM card. This could help the SIM to identify required information to be sent and eliminate unsolicited data which could reduce frequent RRC requests eventually saving resources and reducing signalling overhead. The last proposed solution in this paper is from the work of [5] by using a light weight compression method on Java cards. This paper promotes to use the optimization techniques discussed to reduce congestion in the LTE network.

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