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Study of Overload Control Problem for Intelligent LTE M2M Communication System

Yao-Chung Chang

Department of Computer Science and Information Engineering, National Taitung University, 684, Sec.1, Chung Hua Rd., Taitung, Taiwan, R.O.C.
ycc@nttu.edu.tw

Abstract

According to the definition of 3GPP TS 22.68, Machine to Machine (M2M) and Machine Type Communication (MTC) are a new type of data communication which contains of direction communication between machines and devices without human interactions. The MTC network architecture not only enhances the group mobility, rapidly secure authentication of Long Term Evolution (LTE) communication architecture, also the new type of M2M communication provides functions for flexibility of deployment, network congestion control and accounting ability. The objective of this work is to study and examine the overload control problem for MTC network for intelligent LTE M2M communication system. How to promote the performance of network access in the LTE M2M communication network is the key innovation of this study. The NS3 simulator is used to simulate the LTE core network architecture. Finally, issues of performances of Random Access Channel (RAC) procedure are illustrated in this work.

1. Introduction

Long Term Evolution (LTE) is recommended from the third Generation Partnership Project (The 3rd Generation Partnership Project, 3GPP) [1]. LTE is derivative from GSM/UMTS mobile wireless communication technologies with the core network architecture called Evolved Packet Core Network (EPC). LTE uses Orthogonal Frequency Division Multiple Access (OFDMA) that provides greater throughput of wireless transmission and stronger multipath resistance capability. With the Multi-Input Multi-Output (MIMO) antenna technology, LTE significantly enhances the performance of the wireless transmission. The LTE system architecture is constructed by the Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and EPC core network which contains E-UTRAN NodeB (eNodeB), Serving Gateway(S-GW), Packet Data Network Gateway(PDN-GW), Mobility Management Entity(MME), Policy and Charging Rules Function(PCRF), Home Subscriber Server(HSS) shown in Fig.1.

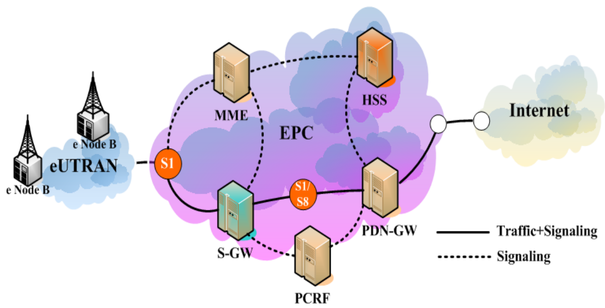

Fig.1. Network Architecture of LTE Evolved Packet Core (EPC)

According to the definition of 3GPP TS 22.368 [2], Machine to Machine (M2M) and Machine Type Communication (MTC) are the new type of data communication which contains of direction communication between machines and devices without human interactions. The unprecedented way that Machine-to-Machine (M2M) communication connects communication-enabled devices enables the Internet of Things (IoT) [3][4]. In contrast, Machine-Type-Communication (MTC) applications are automated applications for communicating between machines or devices without human intervention. Such applications are widely used in everyday life. Figure 2 shows the scenario for high mobility traffic communication including three kinds of communication: Inside Vehicle Communication, MTC for Vehicle to Vehicle and MTC between Vehicle and Traffic Control Center. Inside Vehicle Communication provides the necessary information for driver to control the vehicle. MTC for Vehicle to Vehicle extends the auto communication area from one car to a group of vehicles. Finally, the traffic control center monitors the traffic information and communicates to MTC servers that using the mobile relay station and base stations of the LTE Core Network. Thus, vehicles can communicate with traffic control center to acquire necessary traffic information. How to promote the performance of network access in the LTE M2M communication network is the key innovation of this study. The NS3 simulator [5] is used to simulate the LTE core network architecture. Finally, issues of performances of Random Access Channel (RAC) procedure [6][7] are illustrated in this work.

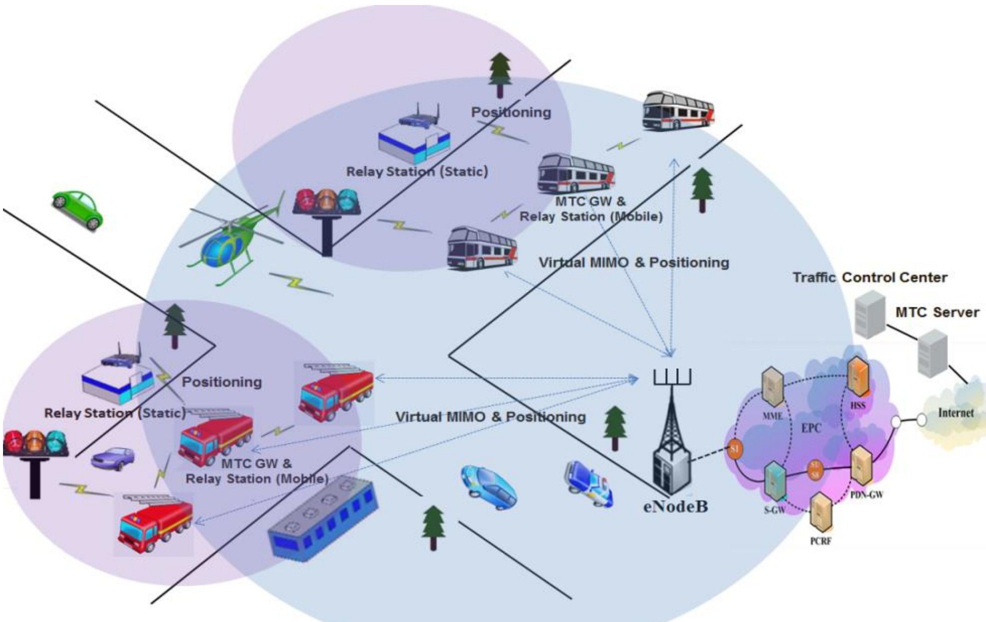

Fig.2. Scenario for Intelligent LTE M2M Communication System

2. Related Works

Machine type communication (MTC) is becoming an important part of the LTE network. Diverse MTC applications are going to be realized in LTE network due to the advantages of better coverage and lower deployment cost. However, the rapid growth in the number of MTC devices causes the radio access network (RAN) to overload when a large number of MTC devices try to access the radio resources in a very short period. The overloading problem has been aggressively addressed by 3GPP as an essential working item. As MTC continues to burgeon rapidly, a comprehensive study on overload control approach to manage the data and signaling traffic from massive MTC devices is required too. There are two kinds of overload control approach: Push based methods and Pull based methods. Push based methods include Randomized Access Dispersion, Differentiated Service Provision [1] and Dedicated Resource Allocation [8]. Pull based methods include Paging Method and Contention-Free RACH Procedure [9]. Furthermore, the RACH procedure can be divided into two modes: Contention and Non-contention Random Access Channel shown in Fig. 3. The RACH procedure provides time synchronous information for the uplink between UE and eNodeB and mobility access information for LTE network. Hence, this study focuses the study and analysis the Random Access Overload Control problem for Intelligent LTE M2M Communication System [10][11][12][13].

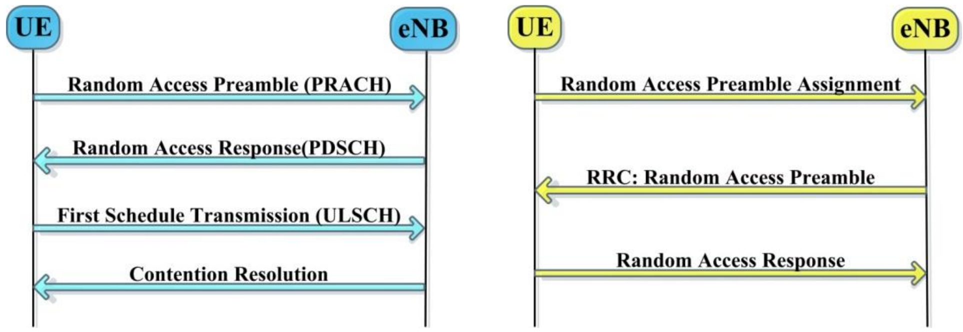

Fig.3. Contention and Non-contention Random Access Channel

3. Simulation Results

This study analyzes the MTC throughput for the LTE EPC network in different environments using LENA simulator [14], including LTE-EPC Environment, eNodeB + UE in pairs for a network connection; and MTC Environment, a connection with a large number of UEs for an eNodeB.

- LTE-EPC Environment: This simulation examines the overload control problem for LTE EPC network. Figure 4 shows the simulation architecture that the UE connects to EPC and P-GW using eNodeB. Figure 5 illustrates how the numbers of pair E-UTRAN (eNodeB+UE) affect the performance and throughput of EPC network.

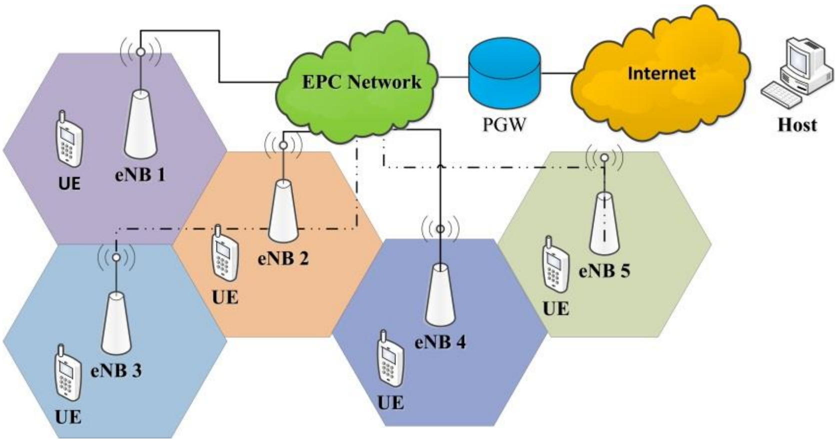

Fig.4. Simulation Architecture of EPC Network

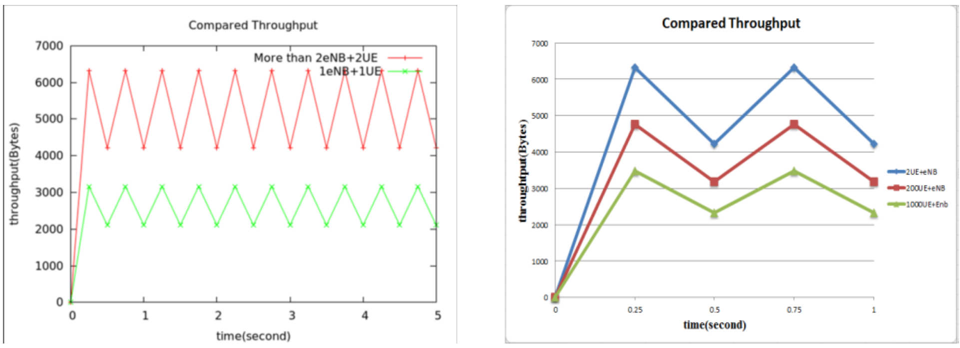

Fig.5. Performance Analysis for EPC Network

- MTC Environment: This simulation examines the performance of eNodeB with a large number of mobile devices. The maximum number of RRC connection entity is 320 mobile devices. The start number of mobile devices is set to 5. Because of a large number of connections, the transmission throughput of MTC causes to decline (shown in Fig. 6).

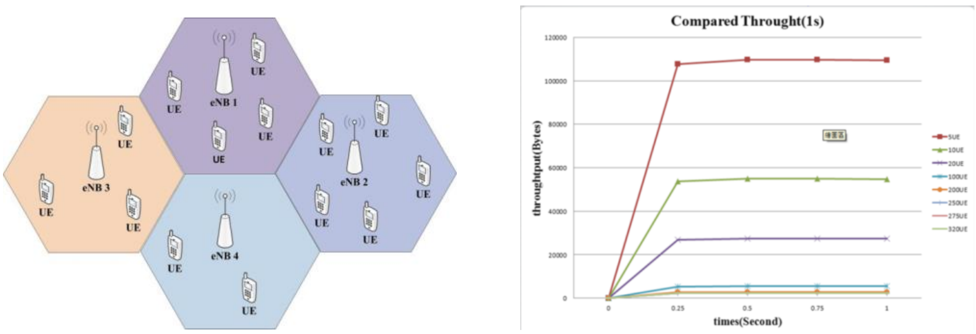

Fig.6. Performance Analysis for MTC Throughput

4. Conclusion

The objective of this study is to develop the key technologies and applications for Intelligent LTE M2M Communication System. Furthermore, the goal of this work is to study and examine the Overload Control Problems of Radio Access Network for MTC network. An Efficient Data Transmission Scheme (EDTS) for MTC Network will be proposed to simulate and evaluate the performance in the future. Finally, a Prioritized Group based Random Access Method (PGRAM) for MTC Network will be developed and examined in this study.

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