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REDUCTION OF NETWORK CONGESTION IN M2M COMMUNICATION

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Abstract- The automated data transmission between the devices is achieved by Machine-to-Machine (M2M) communication. The devices which take participate in M2M communication comes under Internet of Things (IoT). M2M communication is applicable in many fields. The devices which take part in M2M communication are known as Machine-Type-Communication (MTC). They communicate with each other over LTE-Advanced cellular networks. The number of M2M devices has been increasing than that of the H2H devices which gives rise to QoS degradation of H2H devices. Thus to overcome this problem dynamic RACH preamble allocation scheme is proposed. It allocates preamble according to the network condition.

I. INTRODUCTION

Machine-to-Machine (M2M) communication is an emerging technology that enables multiple devices interconnected together of same type, since they are more powerful than a single device. M2M supports many applications and services. Due to human needs M2M devices has been increasing. So the individual M2M devices tends to infinite. So many devices has the probability to access the base station simultaneously[1]. It may cause signaling overloads and Quality of Service (QoS) degradation of H2H devices. Thus to avoid this problem many schemes has been proposed solutions for contention resolution. The proposed theory is not effective for congestion control since there are only limited RACH resources to be supported for simultaneous access. A solution must be undertaken for this network congestion.

Mobile users in today cellular networks use high data rate services. Though mobile users are sharing files in close proximity, they follow cellular transmission procedures (i.e. sender mobile to base station). This is resource consuming. So to avoid this complexity, in close proximity Device-to-Device (D2D) communication has been proposed [2]. Here mobiles can communicate directly between themselves using the same cellular resources. Here eNB intervention is required. An eNB can identify if any mobile pair is eligible for D2D communication. After it identifies, eNB intimates directly to communicate between the mobile devices. D2D communication promise three gains reuse gain, proximity of UEs and use of a single link in D2D mode.

In this paper, we propose a modified method of random access with dynamic RACH preamble allocation scheme. In

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section II and III, two conventional 3GPP solutions for RACH contention resolution has been reviewed. In section IV, proposed dynamic RACH preamble allocation scheme has been discussed in detail. Section V provides the conclusion.

II. System Model

An LTE based M2M devices (sensors) connected to a series of eNB or an eNB using cellular communication methods. The sensors can collect data as per their functionality and send to the central application services through the eNB. The application server can be a remote device infrared directly to the eNB or to another M2M device[3]. If two M2M device intends to communicate with each other, they need to transmit via the eNB.

Two types of communication are possible 1. Cellular M2M communication to communication through eNB.

2. Direct M2M communication to direct D2D communication between M2M devices bypassing the eNBs.

In cellular M2M communication case, M2M devices initiate communication with server through eNB. The wireless channel between the M2M devices and the eNB is assumed to be frequency selective and time varying. Here they use TDD(Time Division Duplex).

Based on the received signal to interference and noise ratio received at eNB, eNB assigns adaptive modulation and coding rates to each of the devices. All communication are performed at the license band and by the active participation of the eNB. Therefore interference and collision can be avoided.

III. Related Work

A M2M device performs an ACB algorithm to initialize a RACH procedure. Before that , an eNB broadcasts System Information Block Type 2 (SIB2) to M2M devices (UEs). It includes ACB parameters such as access class barring factor and access class barring time. The ac-Barring Factor are in range of [0,1). It indicates the transmission probability of a device. The ac-Barring Time indicates access barring time in seconds. A M2M device draws a random number N1, 0<=N1<=1. If N1 is lower than the ac-Barring Factor, M2M device performs the RACH procedure[4],[5]. Or else it is barred for ac-Barring Time and the M2M device repeats the same process.

The RA procedure in 3GPP LTE consists of four steps. First step is for UE to transmit a RA preamble message (Msg1). The message includes one of 64 preambles. In second step RA Response Message (Msg2) is transmitted. The message includes a temporary UE identifier. If the second message has the same RACH preamble that is transmitted in RA preamble message, the UE transmits a RRC Connection Request message (Msg3) in the third step[3]. The message consists a new identifier that replaces the temporary identifier used in the previous step.

RACH preamble is divided into two groups(H2H and M2M). The total number of RACH available preambles is 64. The M2M and H2H devices both share the same resources. As the usage of M2M is increasing than that of the H2H devices this

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causes network congestion due to equal preamble division. In RACH resource separation scheme, preambles are allocated orthogonally for both M2M and H2H devices. If the number of RACH preambles of H2H devices is x, then the number of RACH preambles of M2M devices is 64-x. This is inefficient since it cannot adjust according to the traffic condition. For an effective performance, other mechanisms should be combined to avoid traffic condition.

IV. PROPOSED THEORY

The difference between strict RACH resource separation and dynamic RACH resource separation scheme is that it dynamically shifts the M2M RACH resources according to the network condition. M2M devices monitors the SIB2 from a base station. M2M devices calculates the available RACH preamble range with the ac-Barring Factor.

When the ac-Barring Factor in SIB2 is p50 and the ac-Barring Time is s512, M2M devices can use only 50% of total RACH preambles. If the range of available RACH preamble range is 0 to 31, for dynamic RACH preamble allocation scheme, M2M devices draw a random number N1, 0<=N1<=63. If N1 is bigger than 31, then they should retry after 512 seconds. Otherwise, RACH procedure is initiated[6].

This scheme adjusts the number of M2M devices according to network conditions and hence there is no QoS degradation.

Under normal condition base station does not broadcast SIB information. Device 1 is a member of H2H devices and Device 2 is a member of M2M devices. In normal condition, both share 64 preambles. Device 1 draws a random number to generate a RACH preamble for a Random Access Preamble 1 (RAP 1) message and sends its message to the Base Station. The RACH preamble for a Random Access Preamble 1 (RAP 1) is 36. And Device 2 draws a random number to generate a RACH preamble for a Random Access Preamble 2 (RAP 2) message and sends its message to the Base Station. The RACH preamble for a Random Access Preamble 2 (RAP 2) is 63.

Under network congestion, base station broadcasts SIB information. Device 1 is a member of H2H devices and Device 2 is a member of M2M devices. Here, only H2H devices can use 64 RACH preambles. But M2M devices should adjust the range of RACH preambles according to the ac-Barring Factor[7]. Device 1 draws a random number to generate a RACH preamble for a Random Access Preamble 1 (RAP 1) message and sends its message to the Base Station. The RACH preamble for a Random Access Preamble 1 (RAP 1) is 36. Before initiating a RACH procedure, device 2 should calculate available RACH preamble range with the ac-Barring Factor .When the ac-Barring Factor in SIB2 is p30, it means M2M devices can use only 30 percent of total RACH preambles. The calculated range of available RACH preamble is from 0 to 12. If device 2 draw 63 as a random number N1, it should retry after 64 seconds. If device 2 draws 11 as random number N1, it generates a RACH

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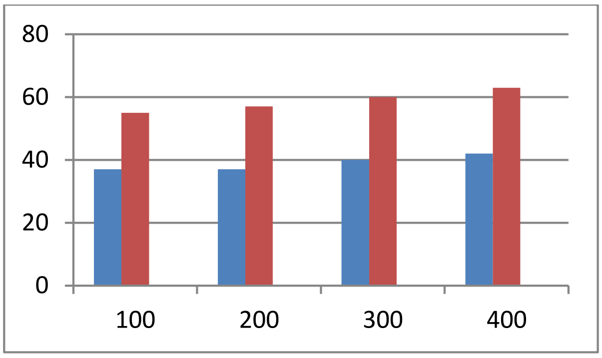
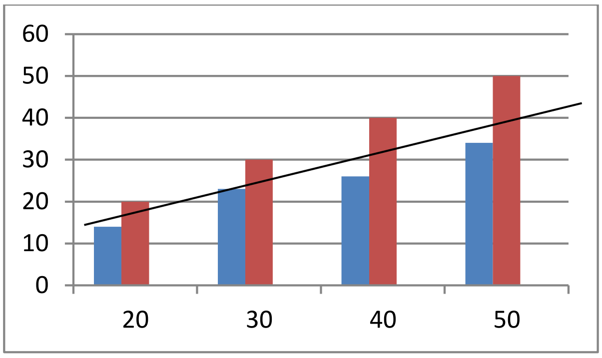
preamble for a RA preamble 2(RAP 2) message and sends its message to the base station.

V. PERFORMANCE EVALUATION

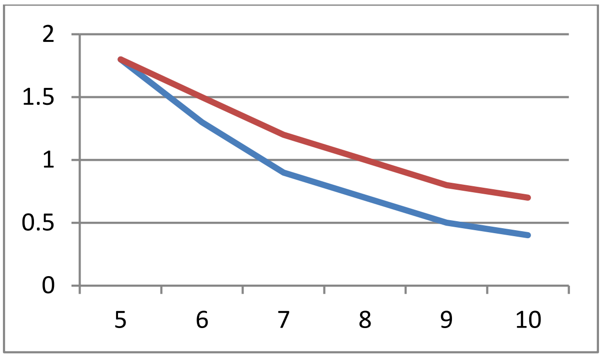
Consider a single cell that consists of both transmitter and receiver pair belongs to the same eNB. Were the receiver belongs to a different cell. This connection will be treated as a cellular pair. Here multiple users are registered to the eNB. In this some constant number of active connections are scheduled for a particular frame of 60 RBs[5]. The active connections are divided into two sets : cellular pairs and D2D pairs. 30% of total users are D2D users. Once the cellular users are scheduled to the number of RBs in the first phase, the D2D pairs will be scheduled for the same RBs ensuring minimum interference.

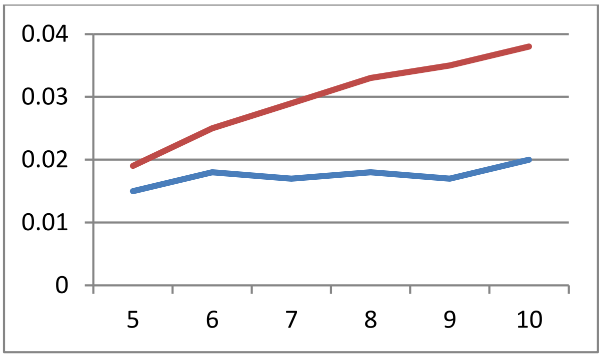
The effective capacity of the network with varying number of active connections is shown. We observe that the effective capacity of the network with D2D classification and scheduling is subsequently higher than that without D2D classification. With increase in number of active connections, effective throughput of the network also increases[4]. As large number of D2D pairs always contend for the RBs, our results show significant improvement in throughput in case of D2D communications.





To verify the model, we have also emulated our scheme in a lab setup. Appropriate signaling techniques and power control techniques are implemented in the android phones as well as at the wireless access point and the two phase scheduling is also implemented at the access point end. The UEs are placed at different distances and based on the Receiveed Signal Strength Indication value. Data is collected from the emulated test-bed environment and analyzed for bandwidth utilization, latency and overall power consumption. From the results it is clear that using D2D along with cellular communication improves the overall performance and optimizes resource utilization of the system.





VI. CONCLUDING REMARKS

In this paper, an algorithm to avoid network congestion in LTE has been introduced. The range of available preambles can be adjusted according to the traffic condition in this algorithm. It ensures the guarantee of QoS of H2H devices. Thus, this algorithm ensures optimal performance under network congestion condition.

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