NEW TECHNOLOGY FOR MACHINE TO MACHINE COMMUNICATION IN SOFTNET TOWARDS 5G

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Abstract

Machine to Machine communication or M2M, refers to a model of communication where devices communicate directly with each other using the available wired or wireless channels. M2M is a new concept proposed under 3GPP(3rd Generation Partnership Project); several research are working on providing solutions for M2M communication for the 5G networks. Challenges associated with M2M communication are the lack of standards, security, poor infrastructure, interoperability and diverse architecture. In this paper, we propose a new mechanism called TM2M5G (The Machine to Machine for 5G) based on SOFTNET platform which results in support of 5G heterogeneous network. In this paper, we propose the architecture for M2M communication based on SOFTNET and provide new features support like security algorithms for data transmission among devices and scheduling algorithm for seamless transmission of data packets over the network. Finallysimulation results ofthis algorithm based on a system level simulator, considering two different approaches for analyzing the parameters such as delay, throughput and bandwidth are presented.

Keywords

5G,heterogeneous network,Machine-to-Machine Communication, and Softnet.

1.INTRODUCTION

Fifth Generation (5G) cellular network will enable people to globally use Machine to Machine Communication (M2M) technology for a better user experience. The M2M communication will access devices without the need of cellular infrastructure such as Access Points (AP's) or the evolved Base Stations (eNB's). The M2M communication could use the technologies of Bluetooth, WI-Fi, Wi-Fi direct, NFC(Near Field Communication) and Proximity services as needed. Compared to the number of connected devices in the current generation 5G would support 10-100 times more number of connected devices with longer battery life along with greatly reduced latency. In future 5G cellular networks will involve key technologies such as spatial modulation, millimeter wave and Visible Light Communication [1].

The major issue with 5G cellular network is the need for super fast downloads to small data requirements of Internet of Things (Iot) devices and various wide ranges of variations of data rates. In essence 5G is not just a mobile communication technology, it is ubiquitous access to high and low data rate services. M2M communication in 5G can also incorporate the millimeter wave technology to sustain large communication ranges which can be accomplished with high gain directional antennas with reduced propagation losses [2].

Since M2M communication involves an increased number of user devices compared to available cellular users, resource allocation for this type of services play a major role in handling the large number of devices. To have a resource allocation scheme for busty data traffic like M2M communication, several cross layer design and stochastic optimization techniques, considering channel state information (CSI) and the queue state information (QSI) should be measured. Although cross layer performance evaluation and resource optimization in available cellular network is well researched subject, the effect of these issues on M2M communication is of great interest [3]

Heterogeneous network is a network which provides service through a wireless Local Area Network (LAN) that connects and communicates with different operating system. Figure 1 diagrammatically represents a cluster of network like 2G,

3G, 4G, Wi-Fi and Wi-Max forming a heterogeneous network. For example deploying Wi-Fi access point in an environment improves the coverage of a cellular network like inside a building or providing last mile connectivity for areas where cellular services reach is limited. This creates opportunities for M2M Communication, by connecting devices in locations that are traditionally difficult to reach by cellular network. M2M access points can be deployed for carrying large and small data services among users.

Due to the explosive growth of user devices to access the high and low data rate multimedia traffic has resulted in the dramatic increase in the energy consumption due to wireless devices in recent times. . The large energy consumption has resulted in high operational expenditures and large amount of green house gas emission. As a result many recent studies have focused on energy -efficient design for the current and the future communication technologies like LTE(Long Term Evolution), LTE-Advanced and 5G communication, and 3GPP also integrated green communication research as an important part of LTE standard documentation. Authors [2] propose an efficient near-optimal algorithm to perform QoS-aware energy-efficient resource allocation which guarantee Quality of Service (QoS) particFularly at high Signal to Noise Ratio (SNR) and low network load.

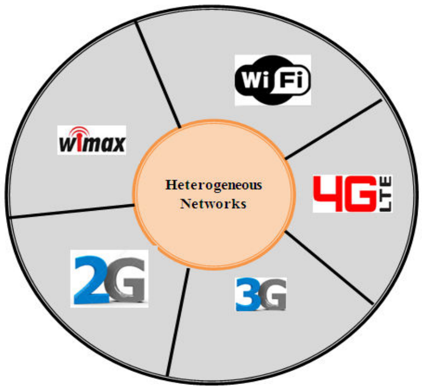

Figure 1: Heterogeneous Network

In [3], authors propose a novel approach for hybrid random access and data transmission protocol for M2M communication to reduce the excessive signaling overhead. In this hybrid process the M2M UE's (User Equipment) would transmit the data on Physical Random Access Channel (PRACH) before a connection is established with the base station to remove the inefficiency. In the conventional method M2M UE's would transmit the data only after the connection is established with the Base Station. The protocol operation is explained in six steps such as(i) PRACH scheduling, (ii) Access barring, (iii) Preamble transmission, (iv) Data channel scheduling, (v) Uplink data transmission and (vi) Acknowledgement. A joint adaptive resource allocation with access barring scheme has been proposed to maximize the M2M throughput and to resolve the congestion control problem in the random access procedure.

Latency is the time delay between the cause and the effect of some physical change in a network.The 3GPP LTE standards aim in achieving high packet data rates and low latency for M2M communication. Jason Brown and Jamil Y Khan [4] propose one way algorithm for reducing latency in the prediction of resource allocation, the challenge is to identify the nearest node for transmitting the packet through it and reaching the destination node without any loss. Two way algorithms along with both forward and reverse direction were proposed but are significantly more difficult to model via theoretical analysis.

M2M communication is mainly focused on proximity based services; the issues related to proximity based services are: (i) Device Discovery and (ii) Resource Allocation. To realize the proximity based service in the system, it is necessary to design a Device Discovery Scheme by which UE can discover another UE in its proximity. Authors [5] propose a discovery scheme based on random access procedure in LTE- Advanced network. The proposed scheme starts with discovering the UE and then allocating RB (Resource Block) for communication. Algorithms proposed here were designed to reduce the underutilization of resource blocks.

The discovery occurs in a centralized manner, where as the resource block allocation is through random access procedure. In the random access procedure, each UE transmits a preamble via a physical random access channel to BS. Upon receiving the preambles, the BS allocates the RB's both in uplink and downlink request. This entire algorithm takes place using the four following steps such as (i) Preamble Transmission, (ii) Random Access Response (RAR), (iii) Connection Setup Request Message and (iv) Connection Setup Response Message. Previous algorithms maintained a fixed number of RB for a particular network which was not utilized completely by the users. Entire process is split into three phases such as PRACH access phase, Receiver- user equipment reporting phase and transmitter UE phase.

Researchers Jean-Pierre Charles, Anders Furusk¨aret.al.proposed a simple operator specific way that chose aimed at meeting future traffic and data rate demands. The operators have opportunity to select between a variety of network evolution approaches. This method includes both conventional dimensioning parameters like targeted user experience, average traffic demand, user density, cell sizes, and three dimensional spatial user parameters like traffic distribution, site specific propagation and deployment strategies. This method has limited complexity for addressing the need for practical model [7].

Although the literature survey focuses on various issues related to M2M communication, there have been no efforts made to implement M2M communication model on a simulation platform like SOFTNET to understand the various nuances and the solutions to those issues. This paper contributes to the framework for M2M communication as follows:

(i) A novel technology for Implementing M2M communication on SOFTNET platform by modeling the architecture using both M2M model and SDN (Software Defined Network) model.
(ii) M2M UE's are provided with security feature along the uplink direction on user side. The security algorithm proposed is HMAC-SHA(Hash based Message Authentication Code) 384 cryptographic algorithm.
(iii)For the large number of M2M devices communicating on the network the scheduling of these data packets are using MidFuzzyRR (Radio Resource) scheduling algorithm.
(iv)Efficient transmission and routing of data packets among the network node elements by Tree Based Intelligent Routing Algorithm.

(v) Handover mechanism based on Fuzzy logic system is designed for handling mobility of devices between the base stations.

The remainder of this paper is organized as follows. Section II briefly describes the related work on SDN and issues related to M2M communication, whereas Section III defined the problem definition and followed by the proposed work in Section IV. Finally, the simulation results, conclusion, and future work are described in Section V.

2.RELATED WORK

Software Defined Network (SDN) and Open Flow represent the *programmable networks* which could be the commonly deployed networks of the future. SDN is an emerging network architecture, which performs the subdivision of control plane and data plane which allows greater performance in terms of routing and forwarding. Authors G. Araniti et.al.,[6] presented the performance analysis of Software Defined Networking (SDN) and Open Flow in a wireless networks. The aim of their research was to evaluate potential advantages introduced by SDN architecture based on Quality of Service (QoS) metrics such as packet loss, throughput, end-to-end delay and packet delivery ratio.

Various applications can be deployed based on the concept of M2M communication, one such application is mobile relay technique supported for communication in LTE-Advanced networks for high speed rail networks. However, due to increased train speed mobile relays suffer from frequent handover from the serving BSs. This process incurs network loads and degrades network performance. To overcome this problem a handover scheme is devised compatible with LTE-A layer 2/3 protocols. The scheme contains enhanced measurement procedure and a group in-network handover procedure. They use a special Control Mobile Relay (cMR) node and several general mobile relays in train for packet transmission [8].

Currently, due to emerging online streaming videos and websites the cellular users tend to watch videos online than offline mode. This results in latency and reduced quality of service in mobile networks. Ching-Feng Lai et.al studied a buffer-aware HTTP live streaming approach, which evaluates the weights of media segments to decide the transmitting priorities based on the current playing time and adjust the appropriatetransmission path through the decision making network controller according to the utilization and stability of the routers and switches in SDN [9].

Mobile social networking and IoT,have brought challenges in flexibility, efficiency, and scalability to the current LTE network. Inspired by thinking of the fundamental mechanisms in LTE as reasons causing those problems, SoftNet, a software defined decentralized mobile network architecture toward 5G, is proposed in this article following principles proposed for designing an efficient and scalable network. The analysis of the working mechanisms of SoftNet, including its dynamically defined architecture, decentralized mobility management, distributed data forwarding, and multi-RATs (Radio Access Technology) coordination, show that SoftNet has improved system capacity and performance. Simulations are conducted to demonstrate that signaling cost in SoftNet, as an important performance metric, can be decreased significantly compared with LTE networks [10].

Research such as Massimo Condoluci et.al introduced a novel Tird Generation Partnership Project (3GPP) complaint architecture which absorbs the Machine Type Communication (MTC) System traffic via homeevolved NodeBs. This allowsto significantly reduce congestion, core networks and overload on radio access. These quantify the performance of a network which handles ultra-dense MTC over LTE-A networks [11].

The Fifth generation mobile communication will be the next major phase of mobile technology, which is anticipated by several researches throughout the world. Bjo¨rnSkubicet.al [12] proposed an optical approach to pave the way for 5G and the Network Security. Their focus is not limited to higher peak data rates, but on higher number of simultaneously connected device (M2M, D2D and MTC) higher spectral efficiency, lowers battery consumption and lower latency. Author suggested a key defining factor for 5G transport and outlines a concept for programmable transport based on WDM (Wavelength Division Multiplexing) and exploits the emerging optical devices which are enabled by integrated photonics. This optical transport continues to hold its place in metro and core segments. The integrated photonics have low-cost, low footprint and reduced power consumption. An Increasedlevels of flexibility that was done by low cost optimal components which provide more degree of freedom in transport layer which facilitates higher optimization from antenna to core.

In the present cellular network 50% of the traffic generated is through video, and this evidence suggests that demand for videos will increase at a much faster pace. The challenge for the network operators is to offer higher data rates to keep up with the demand for high quality video. Researchers such as, AntoniosArgyriou et.al [13] investigated a video communication in Heterogeneous Cellular Networks (HCN) when Time Domain Resource Partitioning (TDRP) is employed. The main aim of this process is maximizing the experience of video quality for end users. This is done with help of jointly optimizing of the TDRP for HCN, video quality is transmitted that is specifically selected by user and rate allocated for each user. This includes system-level parameters like fractioning of users that receive video and it supports DASH-based video streaming.

5G technology has no limitations to have new technologies to incorporate within, Author Min Chen et.al [14] has thought about emotion aware mobile cloud computing for 5G. He has proposed a frame work called EMC (Emotion-Aware Cloud Computing) that offers emotional aware services for better user experience. The Quality of Experience (QoE) is achieved by modifying the Mobile Cloud Computing (MCC). MCC architecture is modified to achieve the required QoE in emotion aware applications. The proposed framework would be helpful in providing personalized, human centric, intelligent emotion-aware services in 5G.

Authors [15], presented an infrastructure which allows mobile users to securely share and search for real-time video data. This proposed infrastructure involves combination of 5G technologyand cloud platform for achieving their goals. The goal of this framework allows real time video sharing between mobile users and friends and also to their family members using cloud service. Here other user has no permission to get informationabout the videoi.e.users from outside cannot get permission for accessing the files and they even cannot get any information about the video files. Here searching is provided additionally and securely with users own video data.

Users in the 5G network will likely be able to use 3GPP standards, IEEE 802.11 and other technologies simultaneously so as to maximize the user quality of experience .Researchers such as Olga Galinina, Alexander Pyattaev et.al [16] have analyzed the uplink performance gain of multi radio access technology solutions versus the legacy approach. The authors predict that an unprecedented paradigm shift in user experience and network design of Cellular to Wi-Fi offloading will be required for integrating technologies.

Pablo Ameigeiraset.al[17] proposed an SDN based architecture for the 5G packet core. Authors focus on designing *access cloud* with the goal of providing low latency and scalable Ethernet-like support to terminal and MTC (Machine Type Communication) devices including mobility management. The authors also proposes architectural enhancement on issues like network scalability and mobility, edge network elements (Access Points) and finally SDN enhancements for broadcast and network management issues.

3.PROBLEM DEFINITION

The evolution of mobile technologies has resulted into new network services such mobile social networking, mobile device–to-device communication, M2M communication, inter vehicular communication and so on. These new services create diverse requirements for mobile networks, like accessing the cloud servers with latency less then10ms,high speed data transmission of 5Gbps and several other factors. Such requirements cannot be satisfied by the LTE networks and here there is a need for the further development and redesigning of the centralized core network. Many organizations have proposed better and new approaches for designing the core network like Open RAN, OpenRadio, MobileFlow , and Soft cell .

SofNet is a Software defined Network which is a decentralized network architecture for 5G mobile networks. Today's cellular network involves large number of network protocols and network elements to perform mobility management, centralized routing mechanisms which involves nodes such as Mobility Management Entity(MME), Packet Data Gateway(PGW), Serving Gateway (SGW) the evolved gateway. All the functionalities of the above mentioned LTE network can be implemented on a SoftNet platform by employing SDN and NFV (Network Virtual Functionality) technologies.

SoftNet has excellent scalability and flexibility to accommodate different communication scenarios .Secondly, signaling overhead in the core network is reduced dramatically due to decentralized mobility management. Finally, both system capacity and performance are improved by supporting decentralized mobility management, distributed data forwarding and multi RATs (Radio Access Technologies) coordination. Several factors influence the drawback of SoftNet which are low decentralized mobility, lower coverage and QoS to maintain the minimum delay between nodes. In this work we propose to maintain a minimum quality of service by calculating the delay between nodes and allocating the required bandwidth to maintain the QoS of the system.

The simulation considers large number of nodes deployed in the defined environment, where each node is represented by (vi) . Initially the transmission power of each node is equal and it changes dynamically while transmitting the packets. The model with nodes and connecting links are defined by the graph G(V,E). Where V represents the finite number of nodes and E represents the finite number of links in the environment. The total number of nodes V ={v1, v2… vn} and E={(i, j) |vi, vj∈ V}, (i,j) ∈ E that denotes both vi and vjare within the coverage area of each other.

Each node in the environment has to be allocated with a minimum transmitting bandwidth (bi, j), where the distance between each nodes is represented by (li, j) having a transmitting delay of (di, j). Hence the data transmission delays between the nodes viand vjis denoted as (di, j) delay which also include queuing delay and propagation delay between nodes. Euclidean distance between nodesis denoted as (li, j) and also bandwidth link between nodesis represented as (bi, j).

The values (di, j), (li, j) and (bi, j) are all real positive numbers. In a transmission scenario we consider source as (s ∈ V) and destinations as (D ⊆ V – {s}),let d =|D| be the number of destination nodes in a network. M represents a destination group and {s} U D is the multicast group. A multicast tree is described as T(s, D) ⊆ M, this tree has root from single source to all the destinations in D. Here delay in the data transmitted path in tree (T) from source (s) to destination

($v_t \in D$) is denoted as delay($pT(s,v_t)$). Let ($pT(s,v_t)$) is unique path from s to ($vt \in D$). The delay for the destination node is represented by

$$Delay\ (pT(s,vt)) = \Sigma(i,j) \in pT(s,vt)\ di,j$$

Minimum bandwidth of a path from source s to destination ($vt \in D$) is denoted as bandwidth ($pT(s,vt)$).

$$Bandwidth\ (pT(s,vt)) = \min\{bi,j,\ (i,j) \in pT(s,vt)\}$$

Let Δdbe the delay constraint and $B_d$be the bandwidth constraint of the destination node ($vt \in D$). Then, the delay bandwidth constraint minimum Steiner tree problem is to find minimum cost multicast tree T* (s, D) is,

$$Delay\ (pT^*(s,vt)) \leq \Delta d,\ \forall\ vt \in D$$

$$Bandwidth\ (pT^*(s,vt)) \geq Bd,\ \forall\ vt \in D$$

Once T* (s, D) is identified, during data packets transmission in tree T* will adjust the transmission power level.

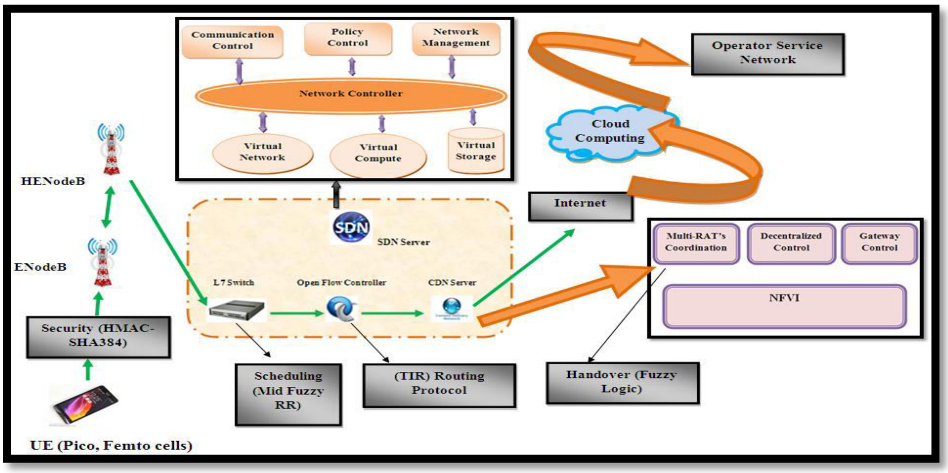

Figure 2: Architecture for TM2M5G Mechanism

4.PROPOSED WORK

4.1 OVERVIEW

In this work we propose a novel mechanism called TM2M5G instead of enhancing the existing SoftNet Architecture. This mechanism will overcome the problems and challenges existed in SoftNet Architecture. The TM2M5G is capable of accessing different wireless technologies such as 2G,3G, LTE,Wi-Fi and Wi-Max. The proposed mechanism introduces the concept of SofNet for Machine to Machine Communication with additional improvements to the existing SoftNet Architecture which provides better performance in terms of signaling cost, throughput and bandwidth requirement of our network architecture.

Additional architectural enhancement in our proposed mechanism includes L7 switch for scheduling the data packets inside the network, Open flow controller for routing the packets, we also provide a security feature for the user equipments in uplink direction. We employ SDN (Software Defined Network) technology as a base to construct the SoftNetarchitecture which enhances the scalability and flexibility to accommodate the communication services. Owing to availability of various heterogeneous wireless networks, mobile users can experience a better service for effective communication using several preferences. We also provide handover mechanism for the users to have mobility from one network to another for which fuzzy logic is used for handling multivariable problem where a joint correlation analysis for several input is required.

Figure 2 describes our proposed mechanism, which consists of SDN (Software Defined Network) core network, CDN (Content Delivery Network) server, Open Flow controller and L7 switch. The architecture diagrammatically explains the concepts of each device. Here L7 networking switch is used for scheduling the large amount of incoming requests from user and to distribute the packets based on requirements. Open flow controller switch is used for routing process. Other components such as CDN server and SDN core network are most essential components used for effective handover mechanism. The SDN core network has a main role that controls the entire network which also composes of policy control, communication control and network management.

Tree based Intelligence Routing (TIR) protocolis usedfor selecting the best path in the network. The CDN server acts as decentralized control to maintain multiple radio access technologies for coordination.The The Key to CDN server is to deliver contents at higher user avalibality and better performance for the end user.Mobile terminals do not the support of the core network to access to Internet it uses the CDN server.Fuzzy logic based Handover mechanism is used to coordinate between multiple radio access technologies.

4.2 ROUTING

Our Proposed mechanism uses TIR protocol. This routing generally works for selecting the best path in a network for transmitting data to reach the destination nodes at a specific time without delay. In thismechanism routing is done based on open flow controller for determining the best routing path. The rules for finding best path are placed in open flow controller. Forwarding the packets to destination and dynamically changing the traffic parth is the responsblity of Open flow controller,Quality of Service of the traffic path and scheduling has to be taken care. For routing process, the initial tree is constructed called Steiner tree [18]. This tree is constructed based on total number of hops needed to transmit the packet to all destinations which must be as small as possible. After the complete construction of tree, we need to find the neighbors i.e. next hop nodes. If neighbor nodes are present then, greedy multicast forwarding is used. If the current node has more than one next hop, then the packet is split. The purpose of packet splitting is for reaching the destination node in several directions. The set of next hop is identified by,

$$f(w) = \frac{\lambda|W|}{|N|} + \frac{(1-\lambda)\sum_{d\in D} \min_{m\in w} l(m,d)}{\sum_{d\in D} l(s,d)}$$

Here, s is the forwarding node.

N is the set of all neighboring nodes.
W is the set of all subset of N.
D is the set of all destination nodes.
d is the destination d_1,d_2 or d_n.
l(x,y) is the function measure distance between nodes.

The equation contains two parts, first part providesnumber of neighbors that packets are transmitted and second part specifies the remaining distance to destinations. The best route for delivery is based on delivery probability [19], which is defined as that delivering packet at the good level of energy consumption and time interval. The delivery probability is estimated efficiently based on Kalman filter for the selection of the route. Here we include two attributes they are changing in degree and future co-location.Kalman filter is used as a prediction filter for nodes identification that are in mobility , highest mobility nodes has to be identified as they have highest probability to reach maximum destination nodes.

Let HS be represented as host source and DS as destination node.. The change of connectivity of a host HS is

$$\boldsymbol{U_{cdc}(t)} = \frac{|\boldsymbol{n(t-T)} \cup \boldsymbol{n(t)}| - |\boldsymbol{n(t-T)} \cap \boldsymbol{n(t)}|}{|\boldsymbol{n(t-T)} \cup \boldsymbol{n(t)}|}$$

Where,
n(t) is host neighbor set at time t.

The above formula yields the number of hosts which became neighbor in time interval [t-T,t].

$$U_{col\ (h,i)}(t) = \begin{cases} 1 \ \ if\ host\ HS\ is\ co\_located\ with\ host\ i \\ 0\ otherwise \end{cases}$$

The above formula denotes the calculation of co-location HS with host I .Figure 3 describes the pseudo code for routing processand Figure 4 describes the flowchart of the routing process.

Pseudo code: Tree based routing Intelligent.

=====================================

Step 1: Construct T
Step 2: FindN_{hop}
Step 3: FindD_{Prob}
Step 4: CalculateD_{con}
Step 5: CalcualteC_{Loc}
Step 6: Select P_{best}
Step 7: Transmit M

Figure 3: Pseudo Code for Tree Based Intelligent Routing.

Figure 3 describes the TIR routing process which initially constructs the Steiner tree (T) and it checks for next hop (Nhop) for the transmission. Here by using Kalman filter we determine the delivery probability (DProb) followed by its degree of connectivity (DCon) and the Co-location (CLoc) of the route. Then finally we determine best path (Pbest) for packet (M) transmission.

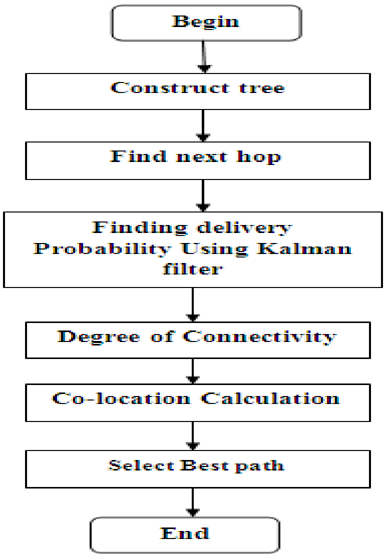

Figure 4: Flow Chart for routing Process

4.3 HANDOVER

In cellular communication and telecommunication process, the user devices are in mobility always, for these devices the support from the network must always be served. Handover is defined as a process of transferring the call or data session from one cell site to another without any session discussion. In this work we handle two types of handover they are,

- Horizontal Handover
- Vertical Handover

Horizontal handover refers to a type where the UE's (User Equipment) moves in the same cell i.e. between the Base Station or GSM to GSM handover. Vertical handover refers to a network node (UE) that changes the type of connectivity from one network to another network, i.e., UMTS and WLAN.

Trigger in vertical handover decision is based on several events such as

- Request from new service.
- Mobile Node in proximity to wireless network.
- Low Coverage in wireless network.
- When any requirement of resource blocks.
- Insufficient resources in some network.

We perform handover mechanism based on Fuzzy logic which is initiated by mobile nodes. When mobile nodes move around a network like LTE, WLAN or Wi-Max the node discovers a new wireless link or may have low coverage of the wireless network. At this situation, the fuzzy based logic is useful for selecting a network for the mobile node.Fuzzy algorithms are implemented in mobile nodes; handover decision engine provides rules for decision making. The result of the fuzzy logic system changes is time dependent.

Figure 5,representsthe architecture of Fuzzy Logic based Controller,Where in the input and output parameters are considered to determine the handover decison. Fuzzy logic is used for dealing with the uncertainty cases when input arises from roughly estimated values. It provides an interference process that interprets and executes commands.

The Fuzzy Controller consists of three blocks. First block being Fuzzifier, second Interference engine, and the last Defuzzifier. In Fuzzifier, the input values are transformed to linguistic values based on membership function. It's a linguistic system for defined rules, these rules are described in the form of IF-THEN conditions and it also use Boolean operations such as AND, OR and NOT.

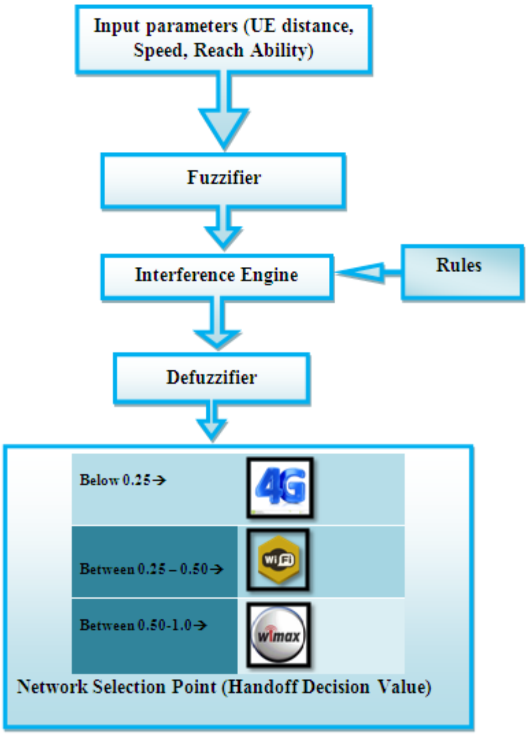

Figure: 5 Fuzzy Logic based Handover Decision

Here the interference engine which relates the inputs and outputs using "IF…..THEN" rules. In the end, Defuzzifier generates crisp values from the output values which, concludes the handover decision.

In our TM2M5G mechanism, we use three different parameters which are the distance of mobile nodes (MN), Speed of the mobile node and reachability of mobile node. We consider threedifferent typesof networks they are LTE, Wi-Max and Wi-Max networks . Initially, the process starts at the first blockfuzzifier where the input parameter gets transformed to fuzzy sets of values. Next in the interference engine, the fuzzy sets are fed by IF….THEN rules which are applied for getting fuzzy decision sets.

The output fuzzy decision sets are finalized to the single fuzzy set, and it is passed to Defuzzifier. In Defuzzifier, the final decision for the handover is taken.

Let us look at three input parameters and their effect:

- Reachability (RA)
- Distance (D)
- Speed (S)

Table 1 represents the above parameter values and their corresponding handover decision values. The output parameters are represents as "low" and "high" and they are denoted as „L" and „H". Fuzzy Rules are specified as follows:

```
Begin If (RA=D=S=H)
{
Select Wi-Max
}
Else if (D=S=L || S=RA=L || D=RA=L)
{
Select Wi-Fi
}
Else if (D=S=H || S=RA=H || D=RA=H)
{
Select Wi-max
}
Else
    LTE
        End
```

The handover decision value ranges between 0 to 1. Here the handover is considered when the decision is higher. When the decision value is lower, the mobile node stays in the network. The output of interference engine is defined by state levels , These state levels are given into Defuzzifier which converts them to crisp values.

The handover decision takes place as follows:

i. Mobile nodes move to LTE network if the value of the state is less than 0.25.
ii. Mobile nodes moves to Wi-Fi if the value of the state is between 0.25-0.50
iii. If the output value is between 0.50-1.0 then the mobile nodes takes handover decision and moves to Wi-Max.

Based on above three points the handover decision is made. These values are considered for selection of handover in our proposed mechanism.

Table 1: Handover Decision Based On Fuzzy Rule

			THEN
REACH ABILITY	**SPEED**	**DISTANC**	**HAND-OFF DECISIO VALUES**
L	**L**	**L**	**Very L**
H	**L**	**L**	**L**
L	**H**	**L**	**L**
H	**H**	**L**	**H**
L	**L**	**H**	**L**
H	**L**	**H**	**H**
L	**H**	**H**	**H**
H	**H**	**H**	**Very H**

4.4 LOAD BALANCING

Load balancing is defined as the ability to balance traffic across wireless nodes using routing protocols. When there are more number of incoming users accessing the same network, the load on the network increases rapidly .To reduce the load on the network and balance the load we have implemented the L7 (Layer 7) switch. The queues of pending requests in Layer7 switch is used for predicting the load on servers. L7 switch being a multilayer switch consists of in-built load balancing programs and accepts incoming packets from various users.

The users request increases the traffic load in the network, which has be balanced between the network and is the main goal of load balancing .A new load balancing algorithm is developed to solve the traffic issues at different cell of Machine to Machine Cluster.The numbers of incoming tasks are to be scheduled, which is done by a novel Mid-Fuzzy Round Robin Scheduling algorithm in our proposed mechanism.

In this Mid-Fuzzy Round Robin scheduling, the fuzzy rules are noted based on handover mechanism which gives the output as handover decision value ranges i.e. network ranges. The number of requests occurs and we calculate the values of requests. Then we calculate the average of requests values for choosing the middle value. The middle value is compared to other values and then request for higher prioritized nearer value to the middle value is obtained.

```
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Pseudo code: Mid-Fuzzy Round Robin Scheduling
============================================
Input: RQ, PQ, Ui¯{U1, U2, U3… Un}, Bi □{B1, B2, B3… Bn}
Output: Scheduled data
Begin
Step 1: Tq= Binni=1
Step 2: Ui¯ ¯RQ
Step 3: MV = Uinni=1
Step 4: while (MV nearer to Ui)
        Ui□¯PQ
        If (Bi <= Tq)
        Process Ui
        Remove Uifrom RQ
        Else
        Ui□□last RQ
        End if
        End while
  End
============================================
```

Figure: 6 Mid-Fuzzy Round Robin Scheduling Algorithm

Figure 6 describes Mid-Fuzzy Round Robin algorithm where RQ is the Ready queue, PQ is the process queue, U1, U2, U3… Unis the number of user requests and B1, B2, B3… Bnis the burst time according to the user requests. Tqis the time quantum which is calculated by average of the burst time. MV is defined as middle value, which is calculated by the average value of user requests. The values of user requests are calculated based on fuzzy rules of handover mechanism. Initially the Uiare allowed to ready queue and we calculate middle values for user requests. After middle value calculation, the value is compared to all other user request values. The Uiis selected with higher priority when its value is nearer to middle value and it is moved to process queue. When the Tqexpires for Ui, while it is processing then it is moved to last of the ready queue.

4.5 SECURITY

Security is defined as the set of policies which is adopted to protect and monitor unauthorized access, modification or misuse of data during transmission in the network. Currently in heterogeneous network, as the number of device users has increased threat perception and security needs also increased. In our proposed mechanism, HMAC-SHA384 security algorithm is proposed for providing security. This includes the combination of a keyed-hash message authentication code (HMAC) and SHA384 cryptosystem.

Initially the message M is hashed, and they are padded with its length (l) which is also 1024 bits long. Then they are parsed into 1024-bit message blocks M1, M2 … MN. Calculate the hash values based on [20],

H (0) = H (i-1) + CM (i) (H (i-1))

Here C denotes the SHA compression function which gives a secret key "K" and + denotes word-wise modulation 264addition. H (N) is hash of M. After computing the hash function and expanding, finally, 384-bit hash is obtained. After this perform the padding operations for the values. Finally the operation of HMAC is described as,

$$HMAC\ (M) = h((\ K \bigoplus opad)||h((K \oplus\ ipad)||M))$$

==

Pseudo code: HMAC-SHA 384 Algorithm

Input:

Message M, bits b=1024, C1=00110110, C2=01011100
Step 1: Message M
Step 2: Compute K using SHA384
Step 3: Compute Hash () for K
Step 4: if length (K) < b
Pad 0 to K
K¯K+
Step 5: [K+ ipad with [C1] by b/8 times]¯□S
Step 6: (Append M & S)□¯Z
Step 7: Hash (Z) □¯Z1
Step 8: [K+ opad with [C2] by b/8
times]¯¯S0
Step 9: Attach (Z1 & S0) ¯□Z2
Step 10: Hash (Z2) ¯¯HMAC

Figure 7: HMAC-SHA384 Algorithm

Finally Message Authentication Code is generated for the message. Figure 7 represents the pseudo code for HMAC-SHA384. Figure 8 describes flow chart of HMAC-SHA384.Here message m is encrypted with key K using SHA384 compression function. Then hash value is calculated for K based on SHA-384. If length of the key (K) is less than b values then it is padded with 0 then assigned to K+. Then K+ is ipad with constant value C1 for repeatedly by 128 times and it is said to be S. we need to append the original message M and S value to form deformed value as Z. Again we compute Hash function for Z to get Z1 and followed by pad with constant value C2 repeatedly by 128 times and it is said to be S0. Attach Z1 and S0 to get Z2. Finally by computing hash function for Z2 we get HMAC.

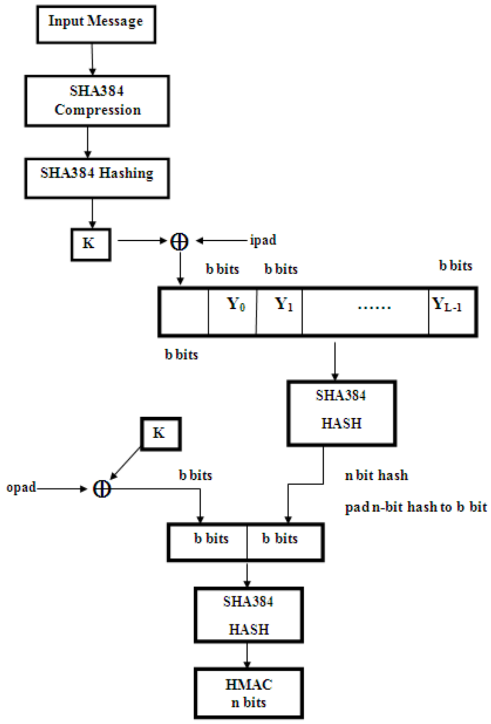

Figure 8: Flow chart of HMAC-SHA384 Algorithm

4.6 PERFORMANCE EVALUATION

This section evaluates the proposed mechanism by considering various performance parameters. The parameters considered are number of hops, coverage and handover. In our proposed system, we added additional features to SoftNetarchitecture which enhances the communication in 5G network and provides security on user side.

- **Number of Hops:**

Hop is defined as the packet transferring from source to the destination. The number of hop changes for each transmission which is based on path selected. Normally, single hop is said to be the direct transmission between source and destination. In our mechanism, Multi-hop transmission is supported.

- **Coverage:**

The coverage is defined as the geographical area of the radio station where it can communicate with the higher performance efficiency. Also this area is specified as service area. The simulation consists of 15 eNB’s spread over the region with distance between each station of 500m.

- **Handover:**

SoftNet has an s1 handover and it is performed between source eNB and target eNB through s1 interface. Inter-access server handover takes place that results in more signaling cost at single hop itself.

Table 2 compares the existing system called SoftNet [10] and our TM2M5G mechanism. The problems inSoftNetare compared with our mechanism.The parameters considered for simulation are signaling cost, bandwidth, delay, handover and throughput. Effects on these are discussed.

Characteristics	SoftNet	TM2M5G
Security	No Security is provided	Security based on HMAC SHA 384
Delay	Router increases the delay	Open flow controller reduces the delay
Signaling Cost	Reduced because of single hop transmission	Decreased by 30%
Hops	Single	Multiple
Scheduling	No process is enhanced	Uses Mid Fuzzy RR for overcoming packet loss
Signaling Overload	Reduced due to low decentralized mobility	Reduced compared to SoftNet

Table 2: Comparison of Softnet Framework and Our Tm2m5g Mechanism

4.6.1 SIMULATION SETUP

We implement our proposed work using OMNET++ simulation framework, the simulator is supported by GUI (Graphical User Interface). This simulation tool helps us to support all the newly proposed protocols, mechanism and algorithms.

Simulation parameters of the proposed work are as described in Table 3.

PARAMETERS	VALUES
Simulation Area	2000*2000 m^2
Duplex mode	True
Mobility Speed	10-100 Mbps
Connected Address	Wireless Core Network
Bit Rate	2-60Mbps
Carrier Frequency	2.4GHz
Transmission Rate	100 Mbps
Queue Type	Drop Tail queue
Management SSID	HOME

Table 3: Simulation Parameters

Table 3 describes values of parameters that has been taken for simulation. For conducting our simulation, we consider oneeNode, one server and 40 Mobile Nodes. In our proposed mechanism our mobile nodes are in mobility i.e. moving one cell to another cell. Our area of simulation is about 2000m *2000m. The transmission rate is 100 mbps for information processing. Due to mobility of nodes, the mobility speed is taken as 10 mbps - 100 mbps. Here drop tail queue is used for queuing type which is a simple queue management algorithm. The number of bits processed per unit time is 2-60 mbps. Center frequency is set as 2.4 GHz which is termed as carrier frequency.

4.6.2PERFORMANCE METRIC:

We consider some metrics which are to be conducted for experiments on OMNeT++ simulation framework which existing system and proposed system. The parameters are,

- **Signaling Cost:**

It is defined as the summation of packet delivery cost and cost of location update. The location update cost is calculated by

$$C_{LU} = \frac{E[M]CUH + CUh}{E[M]Tf}$$

and packet delivery cost is obtained by

$$C_{PD} = \eta\lambda_a + \left(l_{h-lf} + l\right)\delta_D$$

So,

$$C_{tot} = C_{LU} + C_{PD}$$

- **Delay :**

It is defined as the amount of time taken for multicasting the data from source node to multiple destination nodes. This is calculated by

$$\text{Delay} = \frac{\sum(\text{Arrival time} - \text{Send time})}{\sum(\text{Number of connections})}$$

- **Throughput:**

There are two throughput such as Uplink and Downlink throughput. Here the Uplink throughput is calculated by the average of successfully transmitted data from Mobile node to the eNB. While the Downlink throughput is calculated by the amount of data transmitted from eNB to the Mobile node.

- **Bandwidth:**

It is defined as total amount of information that can be transferred to the network on every second. This represents the transmission capacity of the network. The bandwidth is calculated as

$$\text{Time of sending a file} = \frac{\text{Size of file to be sent (bits)}}{\text{Bit Rate}}$$

4.6.3 COMAPRITIVE ANAYSIS :

Our TM2M5G mechanism is compared with previous framework with different scenarios such as

1) TM2M5G Mechanism with Handover and
2) TM2M5G Mechanism without Handover.

By concatenating variance of parameters like signaling cost, overall handovers, uplink throughput, downlink throughput, and QoS parameters such as delay and bandwidthare presented.

4.6.3.1TM2M5G Mechanism with Handover:

In our proposed TM2M5G mechanism, let us consider three main parameters for fuzzy logic system for handover decision as already mentioned in the fuzzy logic section. The three main input parameters for our fuzzy logic are (i) Reachability (RA) ,(ii)Distance (d),(iii) Speed. Where 'd' is the distance between the mobile nodes, 's' is speed of each mobile nodes and 'RA'is reachability of mobile nodes. For handover we consider three different networks used of the mechanism they are LTE, Wi-Fi and Wi-Max.

This provides good results when compared with existing solutions. Figure 9 represents the performance results of signaling cost in proposed mechanism on a time interval (seconds). In the previous framework [10], signaling cost is a critical issue which gives lower performance while our TM2M5G mechanism gives higher improvement in it.

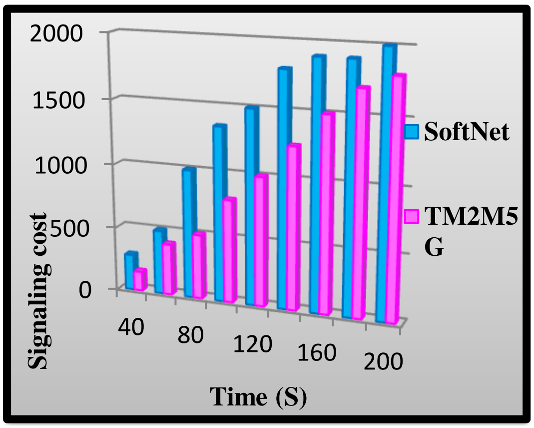

Figure: 9 Performance of Signaling Cost

Our proposed method TM2M5G is flexible and scalable system that dynamically enable/disable related virtual network functions and employs new mechanism to improve the system capacity. By employing the decentralized management in the system a decreased signaling cost compared to Softnet is achieved in TM2M5G.

Figure 10 describes the uplink throughput comparison between our system (TM2M5G) with that of the existing system [21]. Higher uplink throughput is good. This uplink throughput is compared with load as increased number of mobile UEs in the network.

Both uplink throughput and downlink throughput have been achieved better then LTE network. The typical throughput is what user experience when they are near the base stations. The typical throughput is hard to measure and depends on the protocols and transmission used , slower schemes of transmission are used at longer distance from access point due to redundancy.

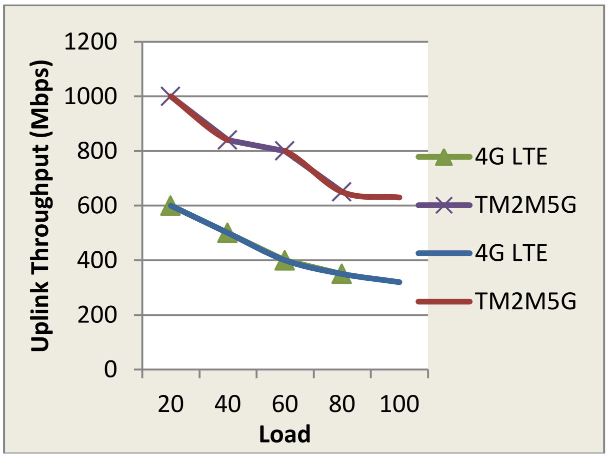

Figure: 10 Performance of Uplink Throughput

Figure 11 represents the Downlink performance which compared with the existing system [21]. It shows the plots between downlink throughput and load for both existing and proposed system. Our TM2M5G mechanism shows the improvement in downlink throughput also

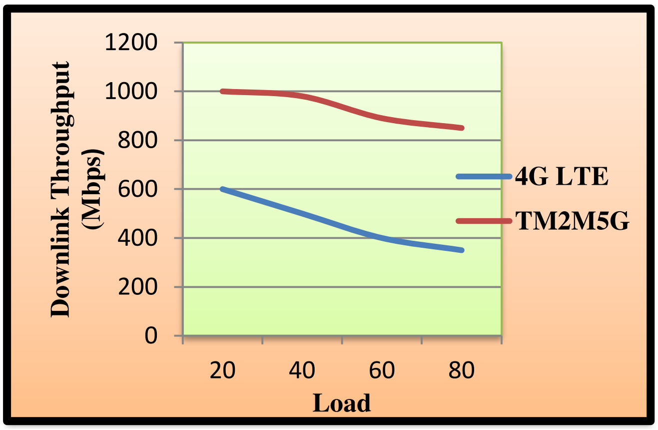

Figure: 11 Performance of Downlink Throughput

Figure 12 shows the ranges of network bandwidth during handover from one network to another network. When a mobile node moves in their network area, that results in variation of bandwidth. Here the handover takes place from LTE to Wi-Fi, bandwidth varies initially and it is maintained at the constant level. While in handover from Wi-Fi to Wi-Max, there is a slight change on bandwidth with respect to time.

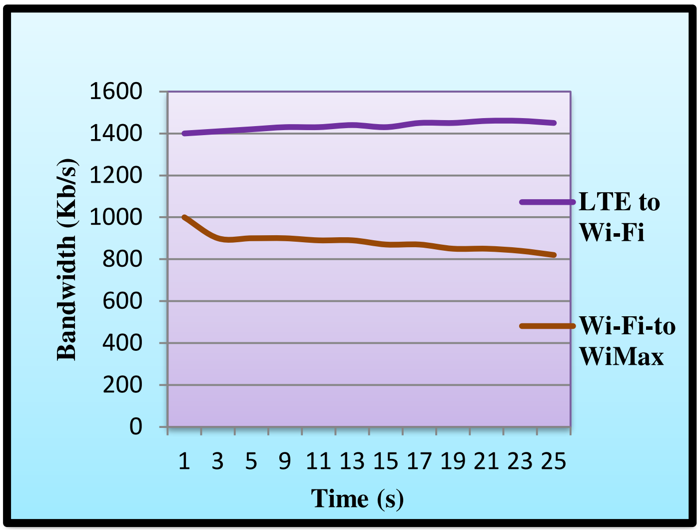

Figure: 12 Performance of Bandwidth with respect to Time during Handover

Figure 13, shows the last packet transmission during handover of user. Delay is maintained at constant range i.e. no increase in delay with respect to time, during handover. In our TM2M5G mechanism, the handovers such as LTE to Wi-Fi and Wi-Fi to Wi-Max delay varies but stays constantly.

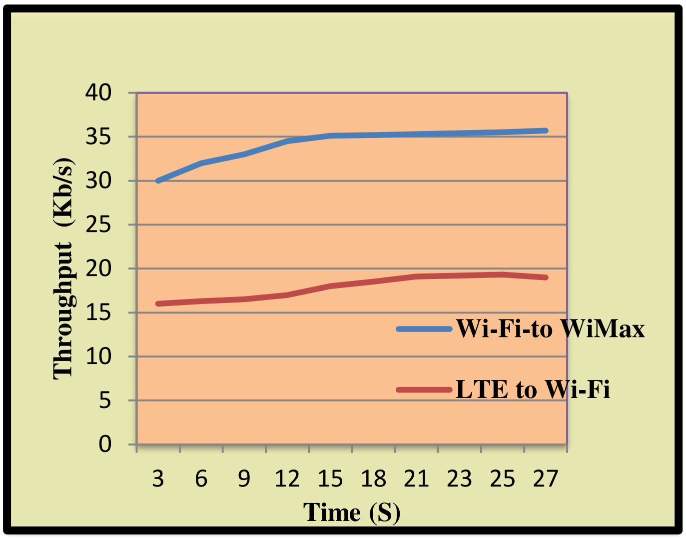

Figure: 13 Performance of Delay with respect to Time during Handover

4.6.4 TM2M5G Mechanism without handover:

In this scenario, our TM2M5G mechanism provides better results. Figure 14 is a plot of delay for the different networks such as LTE, Wi-Fi, Wi-Max with respect to time. Our TM2M5G Mechanism provides good results in terms of delay on without handover scenarios.

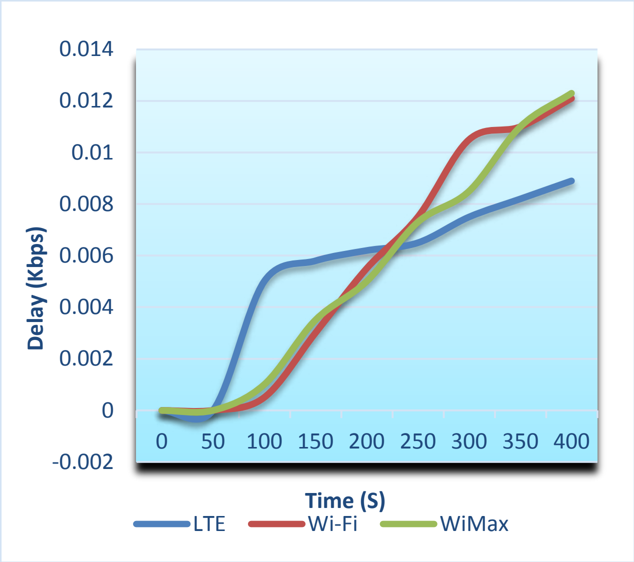

Figure 14: Performance of Delay in LTE, Wi-Fi and WiMax

Figure 15 is a plot of throughput which shows the maximum throughput is achieved by the user in different networks. Wi-Fi saturation of 30Mbps is achieved due to the practical limitations of Wi-Fi where the maximum data rate achievable is 54Mbps.

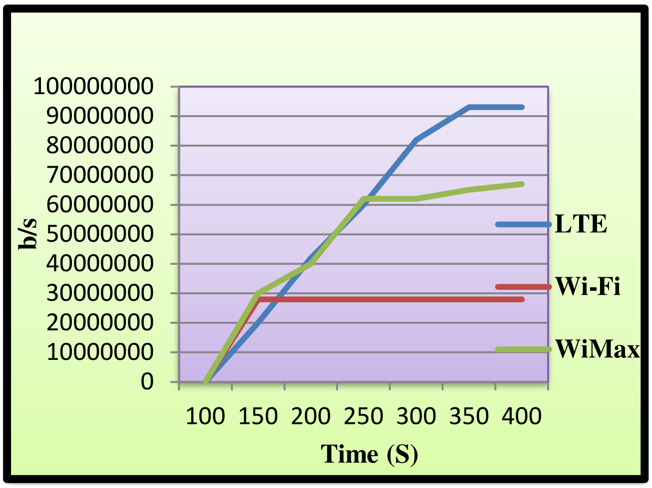

Figure 15: Performance of Throughput inLTE, Wi-Fi, WiMax

5. CONCLUSION

Our TM2M5G mechanism consists of three types of network they are LTE, Wi-Fi, and WiMax. This involves Machine-to-Machine communication and it is collectively said to be heterogeneous network. This mechanism mainly focuses on security process on the user side called HMAC-SHA384 and load balancing algorithm called Mid-Fuzzy RR forcontrolling the access requests. We use fuzzy rule for handover mechanism when a mobile node moves it from one place to another place. The loads are reduced with use of L7 switches. We consider parameters like delay, signal overhead, throughput and bandwidth. Based on these parameters, our simulation result shows better performance compared to existing Softnet. An important challenge of heterogeneous network was providing reliable network communication and connection for large number of devices and machines. Here we analyzed overall handover process which takes place in network and proposedsolutions to reduce handover in network. Our TM2M5G Mechanism proves the improvement in QoS parameters and machine-to-machine communication is more efficient than previous system. The entire throughput is increased in the network which shows the improvement of network performance.

For the further enhancement, we have planned to test with multimedia transmission and evaluate the performance. Further the system will be secured from external threats.

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