A Modified Hybrid Structure for Next Generation Super High Speed Communication Using TDLTE and Wi-Max

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Abstract In the era of high speed communication, high speed data downloading and fast internet uses increase day to day. This leads to several applications, such as IP telephony, mobile internet access, gaming services, HD mobile television, 3D TV, video Conferencing and cloud computing. In the 4G technology, communication system provides ultra-broadband mobile Internet access, cellphones and for other movable devices, USB wireless modems for laptop. A modified 4G systems based on TD-LTE with Wi-max technology is carried out to improve the 4G network status that uses LTE with WiMax. The current work proposed a comparative survey of LTE technology with Wi-Max and TD-LTE with Wi-Max in 4G. Two 4th generation candidate systems are technically implemented, namely the

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standard Wi-MAX and the LTE (Long Term Evolution) standard of first broadcast with TD-LTE technology. In order to simulate the proposed structure, Network Simulator (NS-2) can be used.

Keywords TDLTE · Wi-Max · LTE · Wireless USB and 4G

1 Introduction

A wireless sensor network (WSN) is a network which entails many small and self-contained electromechanical devices that are used in several applications, such as monitoring environmental conditions. These sensors can extend beyond a wide geographical area. These nodes can moreover communicate among each other via hops in an ad hoc manner. The sensors have restricted power as they are operated based on batteries. Energy is considered the primary concern among WSN. The WSN are considered the foundation of the entire internet of things (IoT) energy smart solutions. It consists of independent dispersed sensors that can monitor environmental/physical conditions, including pressure, temperature, humidity, sound and motion. This sensor is cooperatively pass and interconnected the collected data through the networks to the principal location and base station. It enables the integration of communications solutions and several technologies.

Several design aspects are critical for the WSN implementation including proper placement of devices, mobility, infrastructure, network topology, size and density of a network, connectivity, service life, node addressability and data collection. Typically, the WSNs can be flat or hierarchical architecture at which the nodes' roles vary. In flat architecture, all nodes are even. The hierarchical architecture involves cluster heads that control the sensor nodes in their clusters. In both architectural, the data collected through each sensor is transmitted to a base station (BS), which is the only processing center by the network. Afterward, the base identifies the surrounding characteristics.

Wireless communications and digital electronics are improved due to evolution of economical, compact, short-distance, small and multifunctional sensor nodes in micro-electro-mechanical systems (MEMS). These small-scaled sensor nodes that used in the detection, processing of data and communication among the components, take benefit of the sensor networks which is depend upon on the cumulative effort of a huge number of nodes. Sensor networks have a significant enhancement over traditional sensors, which are performed in two different ways:

- Sensors can be placed away from the location where actual phenomenon is under process, thus the data is fetched by sensory perception. In this approach, the implementation of large sensors is also required to distinguish targets from ambient noise.
- Many sensors which have the ability of detection can be positioned. The deployment of sensors and communications topologies for them is cautiously

designed. Time series of the detected phenomenon are transmitted by sensors to the central nodes, where the calculations are made and then the data is updated.
- A sensor array is defined to be made up of an extensive number of sensor nodes.

Using the 802.11 standards, the wireless local area network (WLAN) allows wireless communication between any two electronic devices via high speed Internet connection within a concise range. The speed of the network may go up to 54 Mbps within a range of about 30 to 300 meters. Primarily, there are five core WLAN provisions, namely IEEE (802.11a, 802.11b, 802.11e, 802.11g and 802.11n). Previously, IEEE802.11a/b/g has been a popular used specification of WLAN, however, now 802.11 standard which works at the 2.4 and 5 GHz bands is highly utilized. WiMAX is designed by Alvarion and Intel in 2002 for long-range communication and rectified by the IEEE Engineers under the name of IEEE-802.16. Figure 1 illustrated the mesh network using Wi-Fi or/and WiMAX.

Figure 1 illustrated the mesh topology of a network with Wi-Fi and/or WiMAX. WiMAX can run on all layers of a municipal mesh network (hot zone/metropolitan area). The current Wi-Fi mesh network architecture is essentially consists of three layers. There is access to a mesh transport routing, mesh node and nodes of traffic to mesh gateways and to a link network linking a meshed gateway to another content gateways or to an Internet point.

Typically, WiFi is a short-range wireless local area network (LAN) implementation in area, such as in a college campus, university, office whereas WiMAX spread over a larger area of a size that of a metropolitan by connecting houses, buildings and even cities. WiMAX is distinct from WiFi in many ways, namely the covered area and data throughput. Although, both WiFi and WiMAX offer a wireless linking to every problem using different technical work methodology. Unlike WiMAX, WiFi cannot operate at a greater distance as it is operated in unauthorized frequency. Due to the less power, the same effects arrive at the
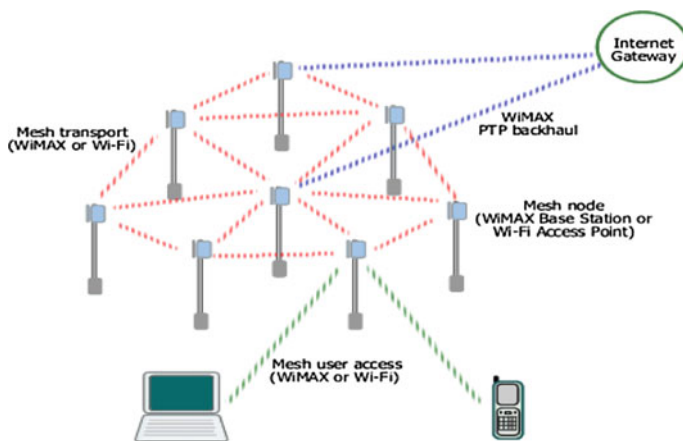

Fig. 1 Wi-Fi and/or WiMAX mesh network

distance. In addition, both the WiFi and WiMAX used different adopted algorithm, the WiFi MAC layer utilizes contention access algorithm, while WiMAX utilizes a planning procedure. In contention mode procedure, users should participate against the data rate at the access point. However, in the planning mode procedure, it tolerates users to compete only once at the AP. As an output, WiMAX has a higher throughput, spectral efficiency and latency as compared to WiFi.

2 Literature Survey

Lin [1] measured and compared the throughput and latency of Time Division-Long Term Evolution (TD-LTE), WiMAX and the third generation (3G) systems by performing some technical tests. Quantitative measurements and comparisons provided guidance to the operators for deployment of their future networks. Analysis of the results indicated that TD-LTE is the enhanced among all of them, followed by WiMAX and WCDMA and TD-SCDMA. Lin [2] considered voice as the major telecommunication service, where the VoIP performance played a major role in implementing the global interoperability and providing all IP network service for microwave access (WiMAX) technology. The results depicted that the field measurements performed outstandingly when the two communication devices were in stationary position and showed satisfactory QoS when both the communication devices were in motion at a speed of 50 km/h.

The thorough study of the analyzed results suggested that the VoIP service by the M-Taiwan program WiMAX-based infrastructure performed well with the standard G.107 requests in the worst and in the most severe scenario, where the CPE VoIP are connected wirelessly to the same WiMAX BS with the two mobile CPEs at speeds maximum upto 50 km/h while both pass out handovers at the same time [3]. Sung [4] provided a software for VoIP operation measurement named NCTU VoIP Testing Tool (NCTU-VT). This research defined the NCTU-VT software development, which is a free tool that offers a solution for evaluating performance of VoIP. Correspondingly, NCTU-VT is associated with two commercial tools, Smart VoIPQoS and IxChariot on the basis of a case study on VoIP enactment in a Wi-Fi environment. Cano-Garcia [5] presented a test configuration to identify the real UMTS networks' end-to-end performance. Using this test bench, a set of measurements was executed for the analysis of end-to-end behavior of Internet access based on UMTS. This research concentrated on the characterization and analysis of packet delay. Periodically, the packets are sent and their end-to-end delays are monitored. Thus, through this various features of the operation and configuration of the UMTS network are deduced. Using these comparatively simple measures, a parsimonious model of end-to-end UMTS behavior is developed that could be used for network simulation or emulation experiments.

Prokkola [6] designed a tool to calculate the quality of service (QoS) unidirectional performance statistics for passive observing of the anticipated applications and also provides information on the QoS delivered by the network. The tool

designed is essentially compatible with any type of network construction providing supported IP. In this research work, the use of QoSMeT has been demonstrated to identify the outlined and particular behavior of 3G delay. The QoSMeT is developed for end-to-end evaluation, but for administrators, operators and researchers it is required to extract the subnets effects and even network components. Consequently, the development of the tool capable of processing several measurement points is being worked. Further in future, QoSMeT might be also utilized to offer direct input to QoS applications.

3 Technical Concepts

3.1 Worldwide Interoperability for Microwave Access (WiMAX)

WiMAX technology is described as global microwave access interoperability by the WiMAX environment. It is known for yielding wireless broadband connection to mobile/fixed terminals in an extended topographical area. It is operated on authorized and unauthorized frequencies using LOS and non-LOS technologies. It also ensures to deliver last mile wireless high-speed access to Internet able to giving high-intensity applications.

3.1.1 Architecture of WiMAX Network

The MS, BS, HA Server, AAA Server, ASN Gateway devices are operated on Wi-MAX technology are IP-based nodes. These nodes are directly connected to the main network of computer. The BS is in charge for carrying out the air interfacing and managing the radio resources. The received data from the mobile stations is sent via the interface of air. The ASN gateway has managed the mobility and QOS policy between various base stations. It is also used to link several base stations to the backend basic services network. The IT is open source software that achieves the process of authentication. In addition, High Availability (HA) is also open source software that performs the mobile IP. Its job is to execute the roaming between the ASN gateways.

3.1.2 Standards for WiMAX

IEEE 802.16 is the standard for WiMAX. It is standardized by the IEEE, which is a series of broadband wireless technologies. The IEEE 802.16 group was generated in 1998 for the evolution of wireless broadband services.

3.1.3 WiMAX Protocols

The primary topologies, which are utilized in WiMAX are point to point for the backhaul and point to the point multi point station for the station of subscriber. For the implementation of both the topologies, several inputs and output antennas are used. The defined structure of the protocol of the IEEE 802.16 wireless broadband standard is illustrated in Fig. 2.

Figure 2 illustrated four layers of the protocol, namely the MAC, convergence, transmission and physics, which correspond to the lowest layers of the OSI model, i.e. the data binding layers and physical layer. WiMax implement many applications and user interfaces, such as Ethernet, ATM, TDM, IP and VLAN. The IEEE 802.16 standard is much adaptable protocol that allows time division multiplex (TDM) or frequency division duplex (FDD) deployments that allow both
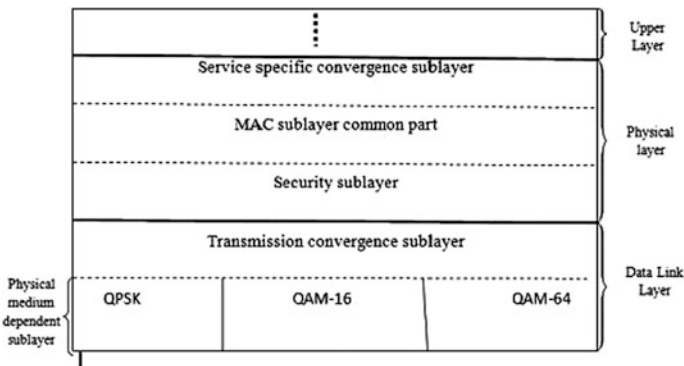

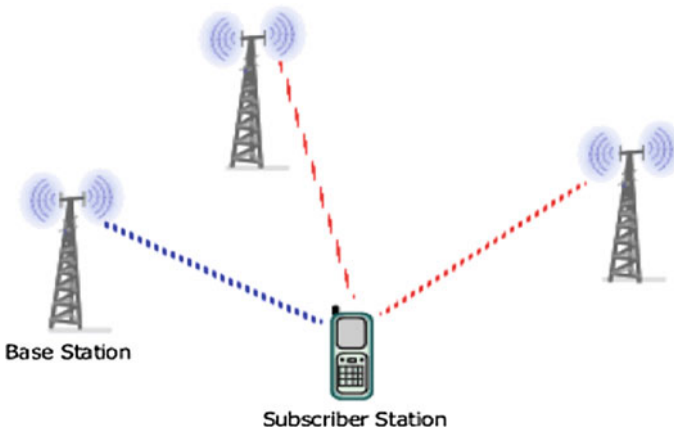**Fig. 2** IEEE 802.16 protocol structure of broadband wireless MAN

Fig. 3 Soft handoff

half-duplex and full terminals. The IEEE 802.16 supports primarily 3 physical layers, the essential physical mode is FFT OFDM (Orthogonal Frequency Division Multiplexing) of 256 points, the other different modes are 2048 OFDMA (Orthogonal Frequency Division Multiplexing Access) and Single Carrier (SC). The relative European standard - the ETSI Hiperman standard explain a single PHY mode that is approximately equal as the 256 OFDM modes in the 802.16d standard. The MAC has been devised for a point-to-multipoint wireless access to the environment. It accommodates protocols, such as the Ethernet, ATM, and IP (Internet Protocol). The frame structure of MAC comprises the downlink and uplink profiles of the terminals according to the link conditions, which is a compromise between capacity and lustiness in real time.

3.2 Handover in Mobile WiMAX

For balancing the load, a process of view transfer is required to distribute the network load with the transfer process. An important attribute of mobile WiMAX technology in the field of mobility is the transfer. The transfer is the process of altering the serving BS to obtain an elevated throughput in the network by the MS. In addition, transfers are considered the necessary component for the efficient utilization of system resources and increased quality of service. In 802.16e, the transfer process is triggered for two reasons.

3.2.1 Handover Types in Mobile WiMAX

This work has lately categorized the transfer types from different points of view in wireless networks and WiMAX. Types of transfer are categorizes on the basis of technology, structure, initiation and delivery mechanisms. Technologically, it will be specified whether the transfer algorithm is executed between two same or different technologies. Structurally, it will be specified whether the transfer is triggered between different BS or among different channels in a BS. The initiation aspect tells about the responsible driving force for directing the transfer i.e. MS or BS. Furthermore, the execution aspect reveals about the diverse type of transfer according to the defined standard transfer types.

- **Technological aspect**: Handovers can take place between different technologies. This implies the transfer may happen between mobile WiMAX and other wireless technologies, or vice versa. It is classified into different classes, vertical handovers and horizontal handovers. Horizontal handovers refers to the transfer in a single technology whereas the vertical handovers means the transfer process involves different technologies, such as mobile WiMAX and wireless LAN.
- **Structural aspect**: Transmission can persist between different BS, but it can also occur in the different channels of a particular BS, which is named as the

intra-cell transfer, whereas in handover, transfer of one BS to another BS takes place by the MS.

- **Initiation aspect**: One is the case of MS Handover in which MS transfers the MS connection to an appropriate target BS (TBS) because of deterioration of the radio signal. Additional is the BS initiated Handover in which BS initiates the handover due to presence of imbalance situation in the system. This handover is transmission triggered due to non-balanced traffic distribution.
- **Performance Mechanisms Aspect**: WiMAX mobile implemented three types of transfer processes for execution. Hard transfer (HHO) is a mandatory process where as the fast switching of the BS and the transfer of macro diversity is optional.

  1. Hard Handover (HHO): "Brake-Before-Make" mode is utilized in this procedure, in which the MS disconnects from the service BS before establishing connection with the next BS (TBS). It didn't have any connection during two phases; Synchronization and reintegration of TBS and network.
  2. Fast Base Station Switching Transfer (FBSS): In the MDHO and FBSS, the MS is associated to one or more than one base stations during transfer execution. This process is cumbersome as during the transfer execution, phases 3 and 4 are repeated for several BSs. In this mechanism, a list of active BSs is maintained by the MS that have established a connection to it. The MS receives and transmits each frame of any of the BS to all the active base stations. Thus, during this process no interruption takes place. A point to be noted in FBSS is that all the Base Stations in the group does receive the frames addressed to the MS but only on among the lot transmits the data back via air interface. On the contrary, rest of the BSs leave behind the packet.
  3. Macro Diversity Transfer (MDHO): In this type of transfer, a list of competent BSs is registered for the MDHO over its coverage area by MS. This group of competent BSs is identified as diversity. A BS still occurs in the diversity game which is expressed as a BS anchor. The MDHO procedure is started by the MS when it wants to transmit or receive from several BS at the same time. By MDHO transfer, the MS interconnects with all BSs allowing the diversity combination to be used to achieve optimal signal quality in both downlink and uplink.

3.3   Wireless Networks Bandwidth Optimization

The slower rate of 2nd generation wireless networks (9.6 Kbps on GSM, 14.4 Kbps with PCS and 19.2 Kbps with CDPD) is considered the main obstacles for the companies and users to adopt wireless Internet applications. The defined standards of 3G networks are expected to provide national coverage with its increased speed and capacity.

3.4 Handoff Mechanism in Mobile WiMAX

For building an efficient mobile network, a smooth transfer mechanism must be defined to maintain an uninterrupted user communication session, while the user is in motion. The transfer mechanism manages the switching of the subscriber station (SS) from one BS to another when the transmission process via one BS becomes weaker than the nearby present BS. All the different techniques developed can be classified into 2 types of handoff, namely the soft/hard handoff.

In handoff, a subscriber station preserves multiple connections with very short delay. Soft handoff is utilized in cellular voice networks, including the Global System for Mobile Communications (GSM) or code division multiple access (CDMA). In this process, first a strong connection is established with a new BS and then the previously established connection is broken.

This procedure is appropriate for processing the voice and various latency-sensitive services like Internet multiplayer and videoconferencing. When used to provide data traffic (net browsing and email), soft forwarding will cause lower spectral efficiency as this form of traffic is congested and does not necessitate continuous switching of one BS to another. A Subscriber Station preserves a linking to a single BS at a given instance. Mobile WiMAX technology was perceived from the beginning as a broadband technology able to offering triple play services which are voice, data and video. Nevertheless, a WiMAX cell network is anticipated to be leaded by delay-tolerant data traffic. Voice is packetized (which is called VoIP) in Mobile WiMAX and then processed as other IP packets categories except that it has priority. Hard handoff (HHO) is thus used in WiMAX Mobile. The hard handover is illustrated in Fig. 4.

In the case of a hard transfer, a linking with a BS is completed beforehand a Subscriber Station passes to another BS. This is referred as a breakout approach before doing. Smooth transfer is much efficient in terms of bandwidth than smooth

Fig. 4 Hard handoff

transfer, but it has a longer delay. An optimized grid-optimized transfer mechanism has been developed for mobile WiMAX to maintain a transfer delay of less than 50 ms.

3.5   Long Term Evolution (LTE)

LTE is a broadband technology for mobile described by the 3G Partnership Project (3GPP). It is the GSM/UMTS standard of 3GPP development. The main aim of LTE is to provide and deliver high-speed data rates, continuous and smooth mobility between heterogeneous networks for cellphone users. The requirements as well as the number of mobile users for high-speed data rates are rapidly increasing. LTE-Advanced, meets all IMT-Advanced requirements and sometimes exceeds requirements. In October 2010, ITU-R decided that the submitted LTE-Advanced proposal meets all the requirements and needs of the first version of IMT-Advanced, which referred to it as the fourth generation (4G) system. The LTE-Advanced is already in testing phase by different countries and even started commercially operating it in 2014. In addition to the salient features including lower latencies, increased data rates, and better spectral efficiency are critical aspects to be considered in the LTE, which is the central based new type of architecture of the entire IP network, known as the Evolved Packet Core (EPC). LTE should extensively use the user-installed femtocells to attain its high-speed and spectral targets for a larger number of users. The users' confidentiality and sensitivity and data in transit in these digital cellular networks are dominant to both business and private users.

LTE uses OFDMA radio access technology. It offers orthogonality between many users for both the downlink and uplink channels so that there is no interference in the same cell but Interference between cells. Power control and coordination between cellular interference are also an essential property of LTE. Figure 5 depicted the evolution of the GSM radio access network to LTE network.

3.5.1   LTE Network Architecture

LTE has an architecture built on IP with slight difference from WiMAX architecture in the respect of security technique. LTE is incapable of meeting the security requirements of the company and it authenticates only on the basis of the identity (IMSI) and entry of the SIM card. An improved security technique was proposed including authentication of identity and key along with corporate certificates. With the use of orthogonal frequency division multiple access (OFDMA) technology, for the highest category terminals, LTE can provide 150 Mbit/s download speeds for multi-input multi-output (MIMO). The incompatibility of 3G standards with present available specifications and the constant request for higher data rates have shifted the attention of industry to the 4G WNS and basically the speed supported is in
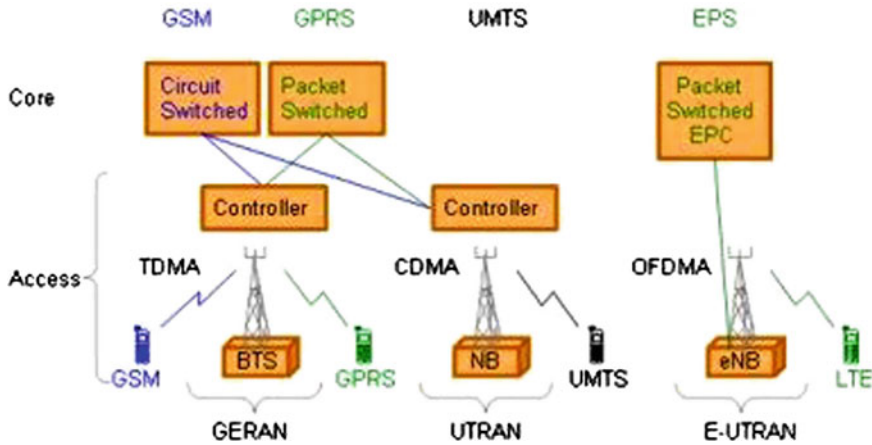
Fig. 5 Radio access network solution from GSM to LTE

surplus of 100 Mbps. It is responsible for the integration of the entire wireless network. The use of high bandwidth offers a perfect mode for data transport. Orthogonal frequency division multiple access (OFDMA) and Orthogonal frequency division multiplexing (OFDM) adequately allots network resources to wide number of users and offer them with superior audio and video. Also, 4G have superior low latency data transmission and security. It is a packet-switched network in which digital network elements are implemented. It supports service portability and global mobility.

3.5.2 Standards for LTE

LTE Advanced is a standard mobile communication that was officially recognized as a 4G system candidate to the ITU-T. LTE Advanced is accepted as a standard by the 3rd Generation Partnership Project (3GPP) as a primary enhancement to the LTE standard.

3.5.3 Features of LTE

LTE supports various features which deed the instant radio situations in a constructive way. A power control mechanism is used in the uplink, to control interference and to provide high average signal quality.

3.5.4 LTE Protocols

The LTE protocols, including radio link control (RLC), Packet Data Convergence Protocol (PDCP) protocols, physical layer (PHY) protocols, and medium access control (MAC) are included. Figure 6 demonstrated a brief idea of the protocol stacks graphically. The control plane stack consists of radio resource control (RRC) protocols. The primary works in each layer are computed up below.

1. **NAS (Non-Access Stratum)**: It establishes a connection between the user interface and the main network and governs sessions between them. Validation and registration of processes is also performed. Also, it has the capability of enabling/disabling Bearer context and position recording management.
2. **RRC (Radio Resource Control)**: All the information related to the broadcasting system of the NAS and Access Layer (AS) is provided by RRC. It is capable of establishing, releasing and maintaining the RRC connection. It also look after security functions, which primarily include the mobility functions, key management, QoS management functions, and Direct transfer of NAS messages between NAS and UE.
3. **PDCP (Packet Data Convergence Protocol)**: The essential job of PDC is compression of header; sequential retransmission and transmission of PDCP Session Data Units (SDUs) for acknowledgment mode radio carriers at the time of transfer. It also caters for duplicate detection, encrypting data and integrity protection.

Fig. 6 LTE protocols stack
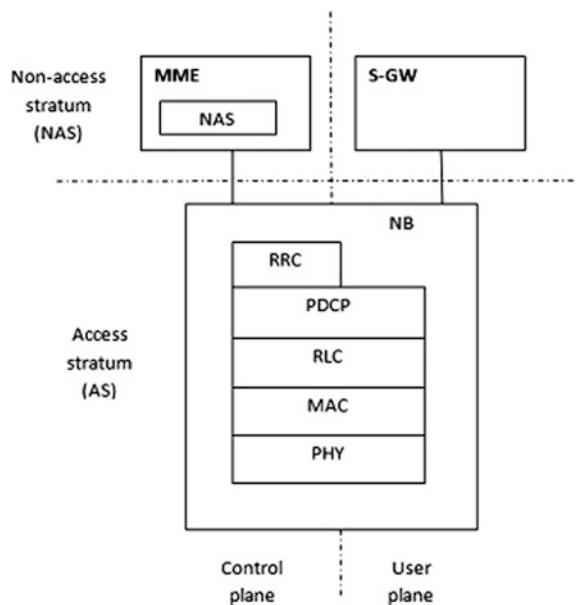
4. **RLC (Radio Link Control)**: Error amendment by automatic repetition demand (ARQ) and segmentation in consistent with the proportions of the re-selection and transport block if retransmission is required is provided by RLC. The amalgamation of SDU for the alike Radio bearer, retrieval, protocol error identification and delivery in sequence is also executed by this.
5. **MAC (Media Access Control)**: It executes de-multiplexing and multiplexing of RLC packets (PDUs). It also does information planning, developing report of HARQ hybrid error correction, hierarchy local chains and padding.

4 Proposed Methodology

4.1 3G (Third Generation)

The 3G refers to wireless mobile telecommunications technology generation. It is based on the fixed set of standards defined for mobile services and mobile telecommunication usage services, which are in accordance with the International Telecommunication Union's (IMT-2000) International Telecommunications 2000 specifications. The 3G has various applications in day to day life such as wireless voice and video calling, Internet access to mobile as well as fixed wireless equipment and mobile Television. It offers a data transfer rate of 200 kBit/s or above. The enhanced versions of 3G, generally indicated to as 3.5G and 3.75G, also offer multi-Mbit/s mobile broadband access to mobile modems in laptops and smartphones. Thus, the 3G technology is applicable to wireless voice and video calls, mobile as well fixed wireless access to the internet, and mobile TV technologies.

4.2 4G (Fourth Generation)

The fourth generation of wireless mobile telecommunications technology, mainly indicated to as 4G is the enhanced replacement of 3G technology. A particular set of standards have been defined by ITU in IMT Advanced for 4G technology. Some extra potential and current applications includes modified access to high-definition mobile TV, gaming services, mobile web, IP telephony, videoconferencing and 3D television. A 4G candidate system called the Long Term Evolution (LTE) has been commercially implemented in Oslo, Norway, and Stockholm, Sweden since 2009. A long debate took place to decide whether LTE should be considered as 4G or not.
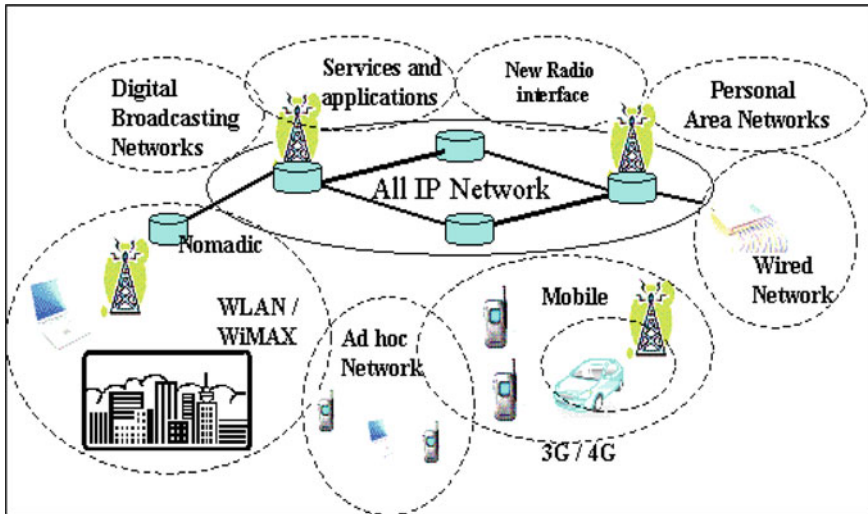
Fig. 7 Shows the proposed structure

4.3 TD-LTE

In FDD, a carrier frequency is used both for the uplink of data and the downlink of data. On the other hand, a single carrier frequency in utilized in TD-LTE for both the actions: downlink and uplink. In TD-LTE, the radio frame is divided into sub-frames, which are then allocated to the uplink or downlink depending on the immediate requirements of the users. This approach of random allocation of sub-frames is best suited to the editable data profile of today's users, who for the most part download more than they download, but rarely transmit data like photos and videos.

The spectrum defined for mobile communications is valuable and the concept of usage of single frequency in TD-LTE rather than a spectrum pair is advantageous for any of the operator where the available spectrum is limited or where an operator has access to only one unpaired frequency as shown in Fig. 7.

The proposed method or system is the combination of Wi-Max and LTE system. For the improvement of bandwidth, data rate and frequency use this architecture. The complete system of 4G communication system is dividing into the three parts. The transmitter end algorithm is reported as follows.

Algorithm: Transmitter end

Input

      Number of mobile nodes: Mobile sensor node = N_n

      Sender node = S_n representing a sub part of N_n

      Receiver Node = D_n representing a sub part of N_n

      Time of Simulation = t0/t0=100seconds

      Routing protocol for wireless communication = AODV;

      MAC Standard= 802.16

      Mobile nodes radio range = RR, where the radio range for WiMAX =1000
         meters same as consider for LTE

RREQ_Pks_Broadcast (S_n, D_n, RR)

{

If ((RR<=1000m) && (Next_Neighbour >0))

{

Compute route

{

    routing_table-> insert (routing_table -> routing_table _nexthop); // send RREQ
to Next_hop

    routing_table 1->insert (routing_table1 -> routing_table); // send RREQ to des-
tination

If (D_n = = Available)

{

Send ACK with routing_table1;

Data_packet_send (s_no, next_neighbour, type)

}

Else

{

Destination (D_n) is not Exist;

  }

      }

Else

{

D_n un-reachable;

}

      }

End

This algorithm shows the direct wired network. It is implemented for the data rate improvisation with the help of OFDM. In wired network the direct link is available communication of wired and wireless on the basis of 3G and 4G. The total bandwidth feasible for frequency in wired network in Frequency division multiplexing (FDM) methodology maximum of 48 kHz. The OFDM multipath interface utilized by WiMAX and LTE, where a signals from a Sender travels to a detector

through two or more than two paths and, under the correct condition frequency of 3 GHz is used as compare to wired network.

If (Frequency < = 48 Khz && data rate <= 10mbps)
{
Wired and Wireless network communication is possible on the basis of 3G Technology.
}
 The condition of proposed LTE, WiMAX with 4G communication is work on more frequency and data rate.
If (Frequency < = 3 GHz && data rate <= 50mbps) // the value is decided on the basis of 4G capacity.
{
Wireless and wired network communication is feasible based on 3G Technology.
}
}

Now channel estimation calculation and channel equalization on the basis of frequency, subsequently calculate the required frequency for communication. The communication of frequency range and data rate limit not less than lower limit (consider theory of different research), but consider more as according to different theory mention on internet or research papers.

5   Simulation and Result

In this chapter the result of proposed method is discussed. The proposed method is simulated on network simulator software which is known as NS-2. NS-2 is well known tool in the sphere of network simulators, which is described as follows.

5.1   Simulation Environment

Simulation is the process in which salient features of processes and different kinds of systems are replicated to learn about the characteristics and performance of the system. Some of the network simulators which can be used for simulating the routing protocols are OPNET, Glomo-Sim and NS-2 etc. For this work, network simulator software version 2.34 (NS2.34) is used. It is an open source platform which is easy to use and is also available for free.

5.1.1 Network Simulator

Network Simulator (NS) shown in Fig. 8 is a simulation tool, which is an object oriented and discrete event simulator, advanced primarily for networking research. It is liable for handing substantial bolster over both wireless and wired networks for simulation of routing, TCP, and multicast protocols. The coding of NS-2 simulator is executed in C++ and Object Tool Command Language (OTCL). The scripting language OTCL is utilized by the users for signifying the network and determining other feature like traffic or routing protocols and agents. Figure 8 shows a view of network simulator.

5.1.2 Tool Command Language (TCL)

The TCL is a scripting language that utilized to frame the simulation scenario, node and system traffic configuration. Typically, any TCL script contains traffic scenario, network topology, and event scheduling. TCL scripts are compatible with many platforms and easy to use.

5.1.3 Trace File Analysis

The NS-2 simulation produces trace files as a results form, which contains the network complete data flow information. The traces in NS-2 empowers recording of information connected with packet events, such as packet drop, packet send or arrival happening in a link or queue. Example of wireless trace format for 'AODV' Ad-hoc network routing protocols: r 1.501360188 _2_ RTR — 0 AODV 48 [0 ffffffff 0 800] —— [0:255 −1:255 30 0] [0 × 2 1 1 [1 0] [0 4]].
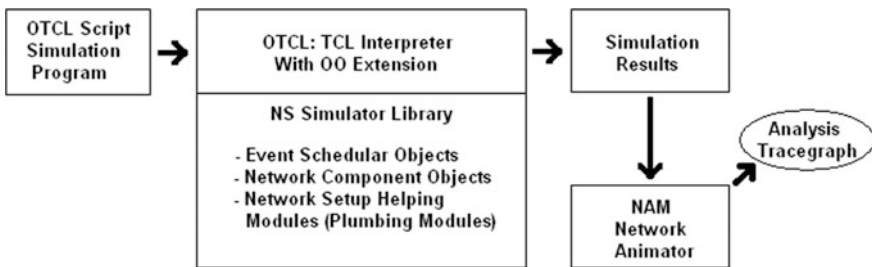

Fig. 8 Simplified users view of network simulator

5.1.4 Network Animator

It is used for the network topology visualization, where the NAM is an animator tool of NS-2 to draw a network topology picture showing the simulation time increase. The visual packets movement view around the network can be examined. Figure 9 shows the view of NAM, where the display of the running window is illustrated in Fig. 10.

The NAM file of 3G included routers, clients, end servers and nodes. Data is transferred from client to end servers through routers. It shows the delivery of packets from one to other. There is congestion of data between them. Figure 11 illustrated the packet delivery ratio (PDR) graph of the 3G.

Figure 11 shows the PDR of the 3G system. It reports the successfully received packets at the endpoint in relation to the total sent number of packets. The PDR is calculated per AWK file. AWK contains all information about all nodes and their performance. The packet delivery report (PDR) calculation is done on the basis of the received and transmitted packets as recorded to the trace file. Normally, PDR is the collected packets ratio at the destination point and the packets transmitted by the input source. Packet Delivery Ratio is determined via AWK script, which produces the final result by processing the trace file. Figure 12 illustrates the packet delivery ratio proposed method.

Figure 12 shows the packet delivery report of the proposed system. The quantity of packets that delivered to a destination point with respect to the total transmitted number of packets is mentioned. The packet delivery report (PDR) calculation is on the basis of the generated and received packets amount mentioned in the trace file. PDR is normally explained as the ratio of the packets total number collected at the destination point and the total number of packets that are generated by the input source. Packet Delivery Ratio is determined using the AWK script that do the processing of the trace file as well as produces the result. The time consumed to
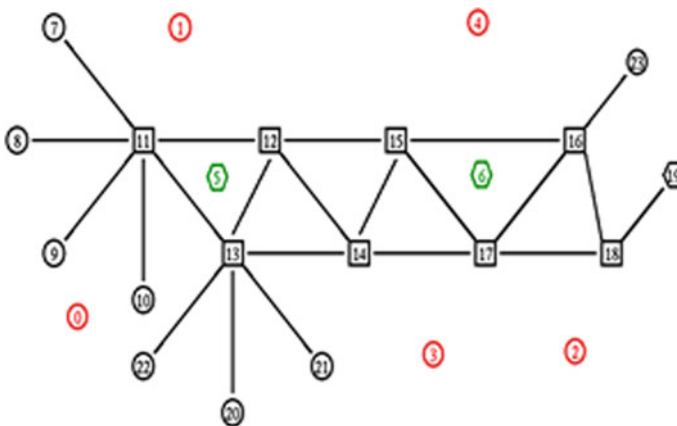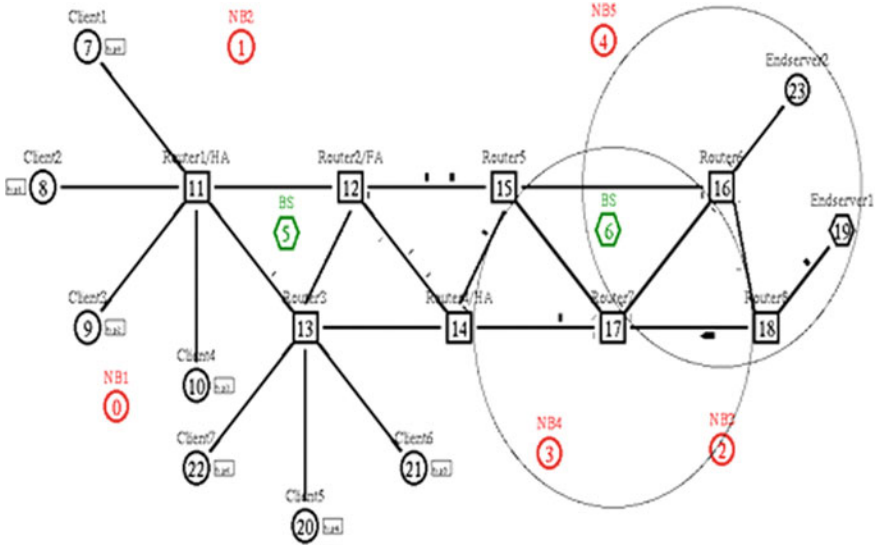

Fig. 9 NAM window of proposed work
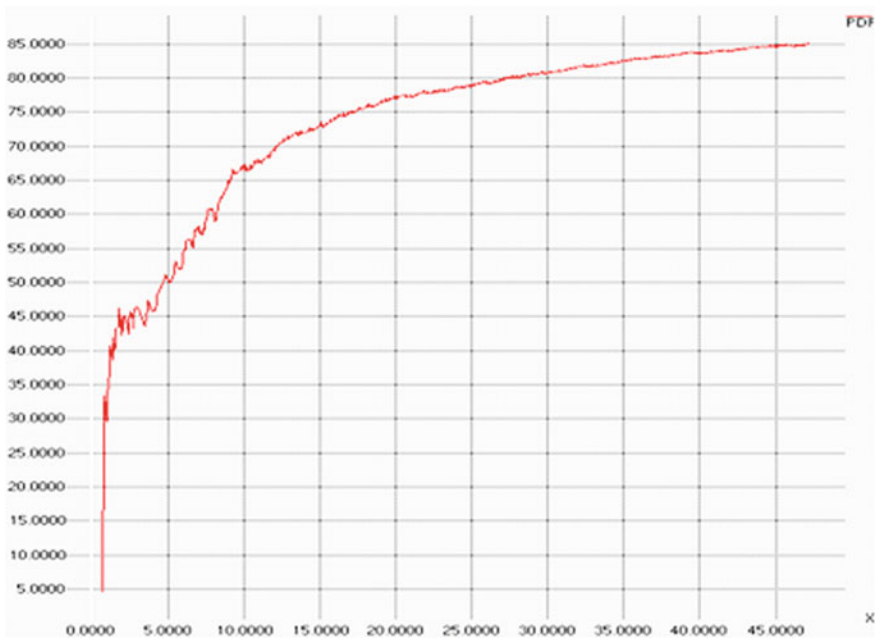
Fig. 10 Running window of NAM

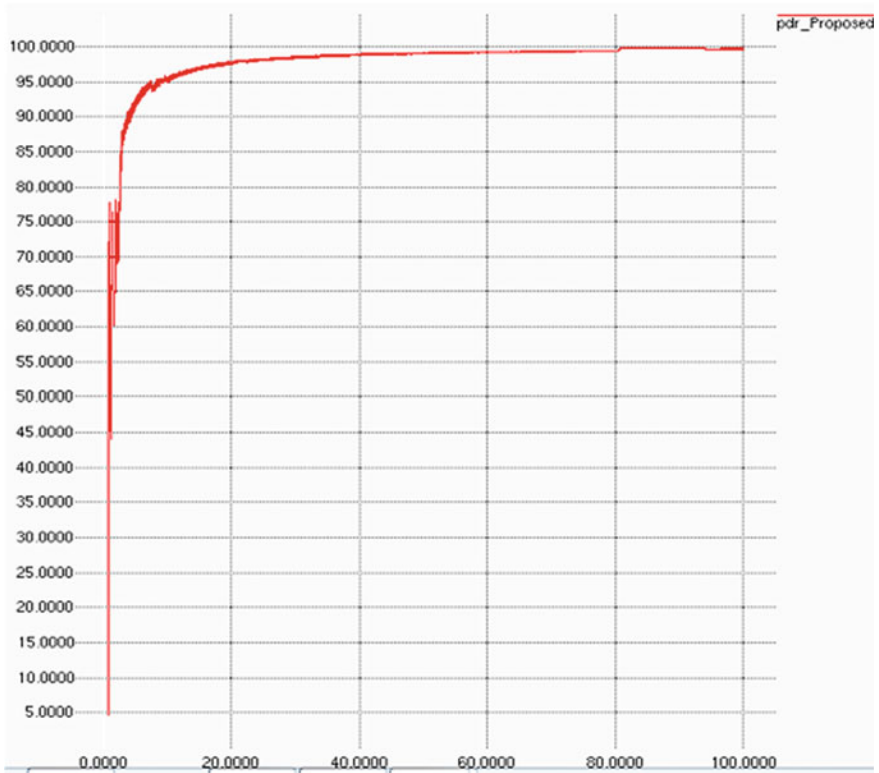**Fig. 11** Packet delivery ratio (PDR) graph of 3G

Fig. 12 Packet delivery ratio proposed method

route the packet per unit time is signified by the X axis, whereas Y axis indicates the total number of packets which have been transmitted and collected by the system. Figure 13 demonstrates the comparison of PDR proposed 4G system and old 3G system.

In Fig. 13, the X axis shows the time taken to complete packet delivery per unit time and the Y axis shows the total number of the packets transmit and collected in the system. The Fig. 13 reports the compression of packet delivery ratio of previous method and proposed method, where the red line shows the previous method and green line shows the proposed method. The proposed method shows better packet delivery ratio as compared to the other methods. Better PDR means that performance of system is good.

$$\text{(Packet delivery ratio) PDR} = \frac{\text{Total number of delivery at the receiver end}}{\text{Total number of delivery at the transmitter end}}$$
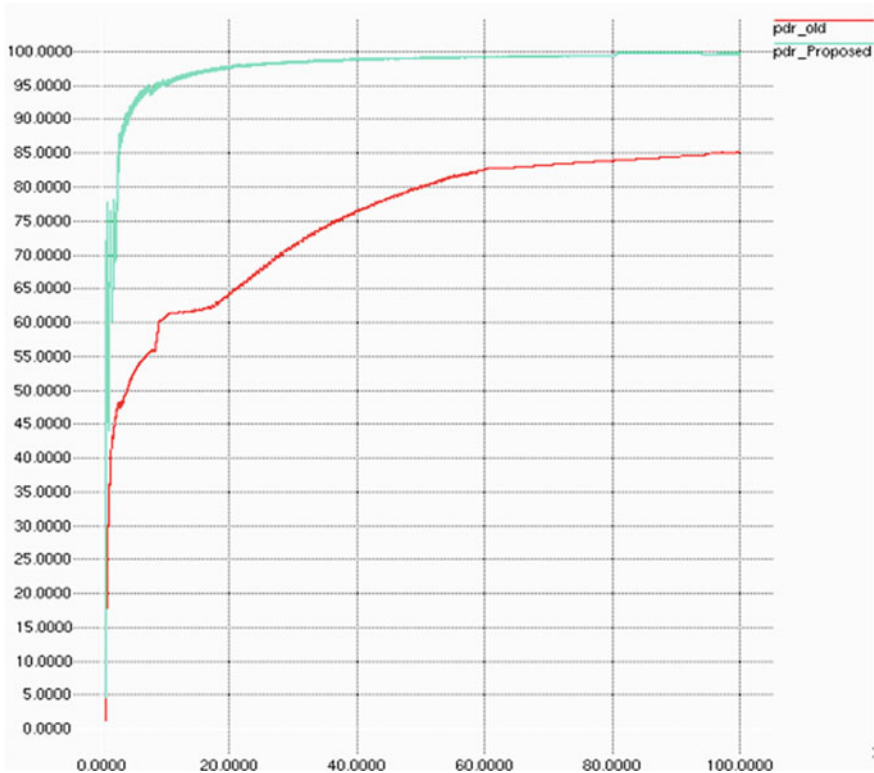
$$(1)$$

Fig. 13 Comparison of PDR proposed 4G system and old 3G system

Figure 14 demonstrates the comparison of delay in packet delivered at the receiver end in both methods, namely the proposed fourth generation system and pervious system. The time and delay in per packet delivery is signified by the X-axis and Y-axis; respectively. These results clearly show that proposed method achieves low delay compared to previous system in packet transmitted at the receiver end. Figure 15 included the comparison of throughput proposed 4G system and old 3G system.

The throughput illustrated in Fig. 15 is demarcated as the packets total number that is received successfully in a unit time. Throughput is represented in bps. It is computed using AWK script in which the trace file is processed and thus the result is produced.

$$\text{Throughput} = \frac{\text{received\_data}}{\text{Data Transmission Period}} \qquad (2)$$
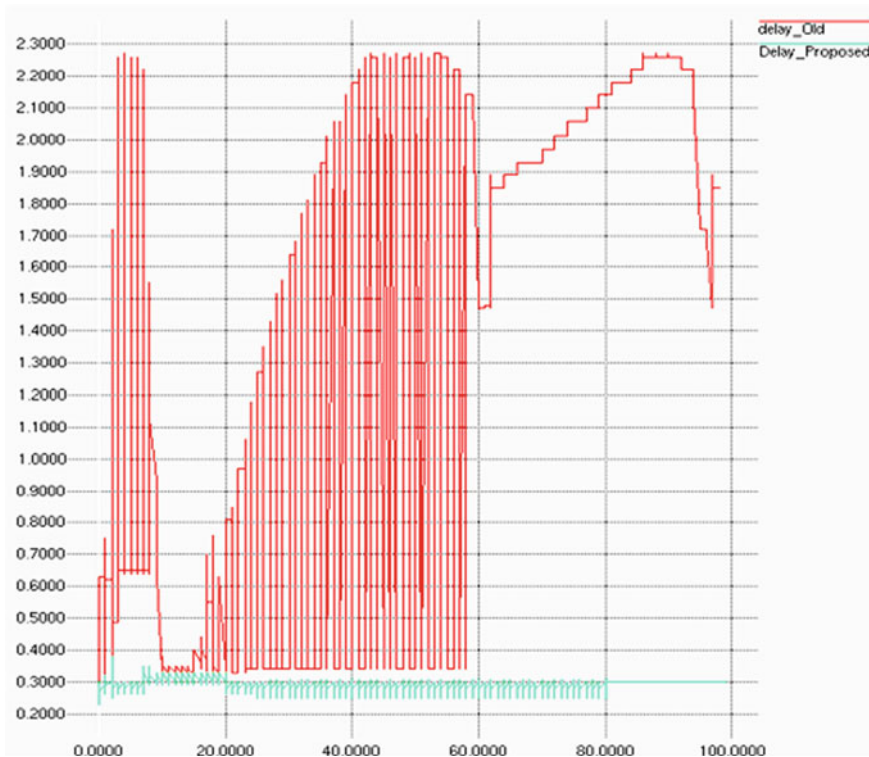
Fig. 14 Delay comparison of delay in previous method and proposed method

where, the Transmission Time = File Size/Bandwidth (s), and the Throughput = File Size/Transmission Time (bps). The result outcome of the proposed TD-LTE is calculated in NS2 as follows in Table 1.

Table 1 reports the results of the proposed 4G TD-LTE system. The basic result parameters calculated for the proposed method, they are the PDR of 99.67%, routing overhead is 2745, normalized routing load is 0.39, throughput of the network (KBps) is 3.50 and the average end to end delay is 0.29 ms. There are basic parameters calculated in the proposed method and further compared the parameters with previous system. The outcome is calculated with the network tool. Table 2 reports the output of previous method.

Table 2 illustrates the previous method result showing the value of parameters, namely the total sent packets is 810, total received packets is 688, total dropped packets is 123, average hop count is 3 hops, packet delivery ratio is 84.94%, routing overhead is 1433, normalized routing load is 2.08, throughput of the network (KBps) is 0.34 and average end to end delay is 2.76 ms. Combining the results in Tables 1 and 2 in Table 3 to report the assessment of the proposed TD-LTE with the previous work results establishes the efficiency of the proposed method.
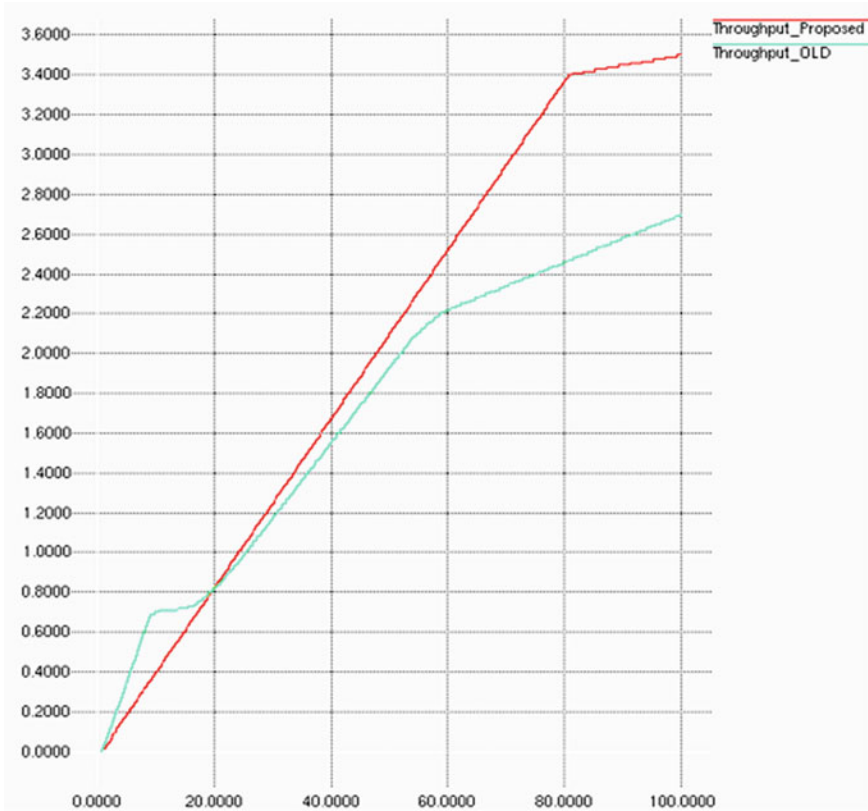
Fig. 15 Comparison of throughput proposed 4G system and old 3G system

Table 1 The proposed TD-LTE results

Parameters	Proposed TD-LTE
Total packets sent	7021
Total packets received	6998
Total packets drop	24
Average hop count	1 hops
Packet delivery ratio	99.67%
Routing overhead	2745
Normalized routing load	0.39
Throughput of the network (KBps)	3.50
Average end to end delay	0.29 ms

The preceding results depict the effectiveness of the proposed wireless communication system. Several studies have been carried out on the ireless sensor networks and Wimax [7–13]. For the improvement of the data communication and

Table 2 The previous work output results

Parameters	Old work
Total packets sent	810
Total packets received	688
Total packets drop	123
Average hop count	3 hops
Packet delivery ratio	84.94%
Routing overhead	1433
Normalized routing load	2.08
Throughput of the network (KBps)	0.34
Average end to end delay	2.76 ms

Table 3 Comparison of proposed TD-LTE with previous work

Parameters	Old work	Proposed TD-LTE
Total packets sent	810	7021
Total packets received	688	6998
Total packets drop	123	24
Average hop count	3 hops	1 hop
Packet delivery ratio (%)	84.94	99.67
Routing overhead	1433	2745
Normalized routing load	2.08	0.39
Throughput of the network (KBps)	0.34	3.50
Average end to end delay (ms)	2.76	0.29

due to the massive data speed and the increased data requirements, a high speed communication connection is required which is possible with the merging of the Wi Max and TD LTE properties.

6 Conclusion

The proposed work presented a TD-LTE system design for next generation wireless communication system. The main motive of this work is the analysis of Wi-Max system with TD-LTE concept for long range high speed data communication. Both the 3G and 4G LTE technologies were compared on the basic of different parameters, namely the total number of packets sent, routing overhead, received and dropped, normalized routing load, average hop count, packet delivery ratio, throughput of the network, and average end to end delay. In addition, different technical aspects for the designing of next generation communication system were discussed.

References

1. Lin, Y.-B., Lin, P.-J., Sung, Y. C., Chen, Y.-K., Chen, W.-E., Lin, B.-S. P., et al. (2013). Performance measurements of TD-LTE, WiMAX and 3G systems. *IEEE Wireless Communications*, *20*, 153.
2. 3GPP TS 25.308. (2011). 3rd generation partnership project; technical specification group radio access network; high speed downlink packet access (HSDPA); overall description; stage 2 (Release 10), June 2011.
3. Lin, Y.-B., et al. (2010). Mobile-Taiwan experience in voice over IP-worldwide interoperability for microwave access trial. *IET Proceedings Communication, 4*(9), 1130–1141.
4. Sung, Y.-C., et al. (2010). NCTU-VT: A freeware for wireless VoIP performance measurement. *Wireless Communications and Mobile Computing*, *12,* 318.
5. Cano-Garcia, J. M., Gonzalez-Parada, E., & Casilari, E. (2006). Experimental analysis and characterization of packet delay in UMTS networks. *Next Generation Tele traffic and Wired/Wireless Advanced Networking (NEW2AN)*.
6. Prokkola, J., et al. (2007). Measuring WCDMA and HSDPA delay characteristics with QoSMeT. In *IEEE International Conference Communication (ICC)*.
7. Fuentes, Lidia, Gamez, Nadia, & Sanchez, Pablo. (2009). Managing variability of ambient intelligence middleware. *International Journal of Ambient Computing and Intelligence (IJACI), 1*(1), 64–74.
8. Johansson, D., & Wiberg, M. (2012). Conceptually advancing "application mobility" towards design: applying a concept-driven approach to the design of mobile IT for home care service groups. *International Journal of Ambient Computing and Intelligence (IJACI)*, *4*(3), 20–32.
9. Roy, S., Karjee, J., Rawat, U. S., & Dey, N. (2016). Symmetric Key encryption technique: A cellular automata based approach in wireless sensor networks. *Procedia Computer Science*, *78*, 408–414.
10. Kumar, S., & Nagarajan, N. (2013). Integrated network topological control and key management for securing wireless sensor networks. *International Journal of Ambient Computing and Intelligence (IJACI)*, *5*(4), 12–24.
11. Borawake-Satao, Rachana, & Prasad, Rajesh Shardanand. (2017). Mobile sink with mobile agents: Effective mobility scheme for wireless sensor network. *International Journal of Rough Sets and Data Analysis (IJRSDA), 4*(2), 24–35.
12. Binh, H. T. T., Hanh, N. T., & Dey, N. (2017). Improved Cuckoo search and chaotic flower pollination optimization algorithm for maximizing area coverage in wireless sensor networks. *Neural Computing and Applications*, pp. 1–13.
13. Chakraborty, Chinmay, Gupta, Bharat, & Ghosh, Soumya K. (2015). Identification of chronic wound status under tele-wound network through smartphone. *International Journal of Rough Sets and Data Analysis (IJRSDA), 2*(2), 58–77.