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IoMT: A Reliable Cross Layer Protocol for Internet of Multimedia Things

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***Abstract*—The futuristic trend is towards the merging of cyber world with physical world leading to the development of Internet of Things (IoT) framework. Current research is focused on the scalar data based IoT applications thus leaving the gap between services and benefits of IoT objects and multimedia objects. Multimedia IoT applications require new protocols to be developed to cope up with heterogeneity among the various communicating objects. In this paper, we have presented a cross-layer protocol for multimedia IoT (IoMT). In proposed methodology, we have considered the cross communication of Physical, Data Link and Routing layers for multimedia applications. Response time should be less, and communication among the devices must be energy efficient in multimedia applications. IoMT has considered both the issues and the comparative simulations in MATLAB have shown that it outperforms over the traditional protocols and presents the optimized solution for multimedia IoT.**

Keywords*—*Internet of Things, Cross Layer Protocol, Multimedia, Network Layer

I. Introduction

The traditional desktops are converting to physical objects in the emerging era to exploit the benefits of Internet of things (IoT). The physical objects surrounding us are joined in one form and providing a network to facilitate communication among different devices [1][2]. Thus the new challenges are emerging, which gave rise to the multiple technologies such as Radio Frequency Identification (RFID) and sensor network in which database and communication protocols that are embeded so as to meet needs of the various users.The need is to store and process enormous data and then display it in an efficient and understandable form. This perspective and challenge can be fulfilled by the IoT [3] which, can also be regarded as the extension of the Internet and all sorts of physical objects can communicate with its assistance.

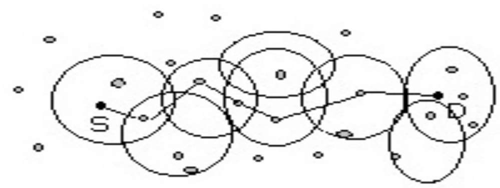

Fig. 1: Multi-hop Packet delivery of a MANET [9]

There exists various subsystems of IoT. When these subsystems operate on existing infrastructure, they can exchange the information and control the systems. It is a three layered model with Sensing layer at the bottom, which sense and sends data to its upper layer naming as network layer. It is designed to transmit data to short range heterogeneous devices such as Bluetooth, Zigbee etc and long range transmission for GPRS, 3G etc. The Third and uppermost later is application layer which decode the message, transmitted from lower layer and thus helps in controlling corresponding devices.

Wireless Sensor Networks (WSNs) are considered as a subpart of IoT, which acts as data acquisition tool and is used in various industrial aspects related to IoT [4].

Various protocols are being designed to support WSN in multimedia IoT for its heterogeneity as well as for power consumption needs [5][6][7]. Thus, WSN uses CoRE instead of HTTP (Hypertext Transfer Protocol in Internet) and OMA-DM Lightweight instead of OMA-DM etc. to support IoT by the WSN limited hardware. In recent past, many cross layer protocols have been proposed for Ad-Hoc Networks (AHNs), Wireless Mesh Networks(WMNs) and wireless sensor networks(WSN)[8].

Although these networks are quite interrelated to each other, still there exists some fundamental differences between them which are on the basis of Data centric, Global Identification, Soundness and Quality of Service metrics (QoS), Scalability, Fault-tolerant,Traffic patterns and operating software [9].

Based on the above mentioned differences, it can be noticed that WSN is more suitable to the wide network with heterogeneous devices. But this heterogeneity poses many challenges in front of IoT: 1) Physical objects or the things can have different requirements in terms of quality of service metrics (QoS) as time, scalability, fault tolerance etc. Fault tolerance and reliability in the low battery powered devices can be

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steered only by the green computing techniques. 2) From the hardware perspective, the objects can have different memory, battery power, processing capability etc.

As a consequence, these two problems pose a challenge in designing a network to cope up with different hardware and software needs. Moreover, the idea of multimedia communication over IoT is hot topic in energy conserved communications [10-12].There are two types of energy conserved IoT communications a) Quality of Experience model (QoE) (degree of operations under the available battery conditions) and b) application play-out (i.e. user does not know when the multimedia data can stop operation due to battery of nodes). But assumptions are made in the literature work that a relationship between the QoE and application payout is known which can be useful for the superficial model of IoT not for the practical IoT.

This requirement motivated us to propose the idea of cross layer communication protocol for energy conserved IoT where different layers collaborate with each other to exploit the maximum benefits for the multimedia application layer of IoT. Multimedia applications require that network architecture of applications should be designed in such a way that applications could get maximum advantage of energy conserved IoT. IoMT is beneficial in many areas e.g. Smart home, Leisure scenarios,etc. [28]. Use of CCTV cameras is essential in every aspect and data captured by the cameras also requires online video streaming for security and surveillance purposes and for the same it is mandatory to gather the data from all the different parts (heterogeneous data) of the city (Smart City Projects) which again raises the need of IoMT.

In this paper, we therefore proposed a layered architecture covering first 3 layers namely Physical layer, Data Link Layer and Network layer which supports high heterogeneity as well as choose optimal routing path to exchange multimedia data. Rest of the paper is organized as follows: Section II presents the related work. The mathematical framework of proposed approach has been described in section III. Overview of phases used in protocol is given in Section IV. Section V presents the result analysis and section VI elaborates the practical scenario with future challenges. Finally, the paper is concluded in section VII.

II. Related Work

Initially, IoT was considered as objects which can be uniquely identified and can be connected to RFID (Radio Frequency Identification.With the growing era IOT relates with other areas and many other applications are developed such as sensors, actuators, GPS devices and mobile devices [14]. Thus, the new and commonly accepted definition is a dynamic global network infrastructure with self configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'Things' have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network [15].

Specifically, the foundation of IOT is served by integration of RFID tags, actuators, sensors etc and defines the communication between physical objects through internet and reach common goals [14]. The various areas of Industry got affected by emergence of IoT and has many projects associated with it such as agriculture, food processing etc industry, security surveillance, environment monitoring etc.[16]. Such as in the food Industry, RFID and WSN is integrated to develop an automated system so as to track, monitor and trace food quality with food supply chain so as to improve quality of food. As technology is developing at rapid pace, so various low power integrated circuits are available which are economical as well as efficient and thus used in remote sensing device [17]. Thus sensor networks are used at large scale having intelligent nodes which lead to gathering, processing, analyzing the valuable information of environment. For analyzing, the sensed data from sensor nodes is sent to distribute or centralized system where WSN monitoring network includes:

1) WSN Hardware: Includes transceiver units, processing units, sensor interfaces, power supply and multiple A/D convertors [18].
2) WSN communication stack: Includes suitable topology, routing path. In WSN, nodes need to communicate to each other in single or multi-hop to a base station. The sink node must be strong enough to communicate with the outer world even with gateway in the form of Internet.
3) WSN Middle-ware: It is a scheme to provide interface between cyber world and physical world so as to enable communication between heterogeneous resources. Thus the isolated resources can be used by independent processes [19].
4) Secure Data aggregation: A secure data aggression method is necessary for enhancing lifetime of network and thus a reliable network is obtained ensuring reliable data is collected from nodes. A healing topology is defined which recover data after its failure even. Security is the important task as the data must not be hacked by intruders.

Moreover the multimedia data have unique features as compared to scalar data and impose the quality of service requirements on green communications IoT [20]. The green routing protocol is based on the selection of parent based on network metrics. But routing protocol can be more beneficial by the inclusion of cross layer communication as proposed in this paper. IoT is based on the unverified user applications , therefore security is basic requirement of the multimedia applications. In the proposed scheme, we have included the security bit in the frame to recognize the authenticated data. An efficient protocol CoUDP is proposed in [21] for real time communication in IoT for multimedia applications in IoT. Four layers have been proposed for the multimedia IoT in [22]. These are physical devices layer, network layer, combination layer and context layer. But we have presented the cross layer architecture based on Physical, Data Link, Network and Application layers.

A new caching policy for popularity-aware video caching in topology-aware Content centric network has been proposed recently [24]. They have used scalable video coding (SVC) for fast-start video delivery and cached each video layer by

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following the designed caching policies.A BCMN/A protocol [25] is proposed to improve the reliability and delay parameters. However, our cross layer protocol also ensures scalability along with these features (QoS metrics). To enhance the QoS metrics, an efficient data gathering scheme is designed in [26]. But this considers only network layer and can be extended to MAC and Physical layer. By cross communication, the parameters on other layers can be enhanced for efficient working of IoT network. For a reliable network with accurate power consumption and high heterogeneity support; a cross layer model is designed in [8].First three layers such as physical layer, data link layer and network layer are optimized, but there exist some drawbacks in the model in terms of QoS metrics, so a new model is proposed in this paper. Mathematical framework is designed to show inter relation among different layers functionalists in multimedia IOT. Many Cross layer protocols have been proposed in recent past [27] for WSN and they have optimized the various parameters of the layers. But these protocols require to be enhanced by the optimization model for multimedia IoT as proposed (IoMT) in this paper.

III. Proposed Approach for Multimedia IoT

A new approach for internet of things is presented here with cross layer optimization. With discussion of design of the new framework, new approach is derived mathematically.

A. Cross layer Model

We used the design approach of [8], to merge the different functions into one model and provide the optimization solution for IoT. It is based on the multiple objectives of the applications for different situations. Various parameters of three layer model of IoT are considered as channel and modulation of physical layer, error control and security in link layer and routing in network layer to get the objective function for the multimedia applications of IoT.

B. Multi-objective optimization

Heterogeneity of various objects in multimedia IoT requires that services ranging from the error free communication to reliable and secure with minimum energy consumption; should be provided by some model. Therefore, multi-objective function should be considered as the solution of optimization problem.The parameters of different layers should be normalized and optimized with deviations from predefined threshold values.

$$\min\{PER_{e2e,}time_{e2e,}Energy_{e2e}\} \quad (1)$$

$$\min\{\frac{PER_{e2e}}{PER_{opt}}-1+\frac{time_{e2e}}{time_{opt}}-1+\frac{Energy_{e2e}}{Energy_{opt}}-1\} \quad (2)$$

$PER_{e2e,}time_{e2e,}Energy_{e2e}$, defines the end to end packet to error ratio, time and energy consumption. In equation (2), the objective function is defined by the optimal parameters and it is multiplied by their weights, to get the optimized function. By assigning different weights to the each term, the various values can be controlled to increase the throughput.

C. Functionalists and parameters of different layers

In this section different layers are discussed with their tunable parameters for the cross layer model.

1) Physical Layer : At physical layer,different types of hardware interact with each other and thus each have their own transmission power and storage capacity thus can select different maximum transmission power, can select different modulation schemes.

1) Frequency Allocation : IEEE 802.15.4 standard has defined frequency spectrum allocation. For Indoor propagation of IOT applications, ITU channels are used. The loss at physical layer in terms of noise can be defined as

$$\mathrm{L} = 10\mathrm{n}\log_{10}(\mathrm{d}) + \mathrm{C} \quad (3)$$

where L is the path loss in decibels, n is the path loss exponent, d is the distance between the transmitter and the receiver, usually measured in meters, and C is a constant which accounts for system losses.
2) Transmission power and modulation :The Bit Error Rate (BER) is directly proportional to transmission power and the modulation. BER at the link m can be defined by Signal to noise Ratio as:

$$BER^{j}_{link}(d)=\varphi(SNR^{j}_{link}(d),mod^{j}) \quad (4)$$

where φ is well known for standard modulations and return Bit Error Rate (BER) for corresponding Signal to Noise Ratio (SNR) and modulations.

2) Data Link Layer: By cross layer communication we analyze the effect of error rate and link control. Effects of cross communication with other layers and restrictions imposed by the things are discussed.

Error Control Rate and Packet Error Rate: Different schemes can be used to error control and packet error rate are:

1) Forward Error Correction codes can also be used to fix various erroneous bits, and thus reducing packet error rate.
2) Another scheme is to use ARQ (Automatic Repeat Request), thus whole packet is re transmitted if there exists erroneous bit.
3) For higher security combination of two can be used naming Hybrid ARQ scheme, a light coded packet is sent, If erroneous, then it is corrected by appropriate FEC code or more robust FEC code is used. If error is found in the corrected data, it is retransmitted.
   In the proposed work Bose–Chaudhuri–Hocquenghem (BCH) code is more preferable over Convolutional codes for error correction as they are more energy efficient. For energy restricted things, BCH codes are used more efficiently [4]. If the transmission of packet fails first time then more robust code is used to successfully transmit the packet.
4) To control error, a protection bit is also attached to the data which ensure end to end delivery of the data.

Medium Access Control:Since many of the physical objects in IoT have limited energy level, thus MAC is transformed in

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order to coordinate with Sleep MAC protocol (SMAC) and it is co-related with CSMA/CD. The SMAC defines the idea of Listen and Sleep. Thus, energy can saved during awake/ sleep cycle. Decreasing the duty cycle leads to decrease the objects connected and thus the links too. In CSMA/CD, a node reserves the channel if it finds medium to be idle for Inter Frame Space (IFS).If the node fails to reserve the medium, it switches to sleep mode to save energy and waits for the next listening cycle. Thus hybrid ARQ technique when combined with SMAC will save energy and reduce the interference among things too. The longer duration of sleep may lower the idle energy consumption but also increases longer end to end delay [9].

3) Network Layer: Network layer on routing algorithms to ensure node to node delivery. When working with WSN, there are many challenges such as providing energy efficient routing protocols, increasing network life time, techniques to aggregate data etc. So it is required to choose best routing algorithm for the system as routing algorithms influence the performance of network a lot. WSN protocol must be light weighted and designed in such a way that they support limited battery. The protocols are required to be dynamic according to the applications. Some changes are required to ensure the features such as reach ability, power availability, etc. Along with this, protocol must be fault tolerant so that dynamic environment will be adapted by it easily. The effect of propagation increases with increasing distance between nodes and so as the multi path fading. There exist various routing protocols which used to define the optimal path between two nodes naming LEACH, SEP, genetic HCR and ERP. A protocol named Chain Based Cluster Cooperative Protocol (CBCCP) is proposed in [10] which perform very well in terms of energy and time. It can be merged with the proposed framework for the IoT, as it provides the multiple objectives which are suitable for the various multimedia applications (Environment Monitoring, Border Surveillance etc.) of IoT.

D. Mathematical Model

The optimization algorithm for the things known in domain will execute offline and locally to find various communication parameters which are modulation type mod_j, size of the packet $pack\_len$, maximum number of retransmissions $pack^j_{\max\_link}$, additional bits for the security and error schemes with time duration to sense the channel $addl\_i$, power at the link po_{link_j}. These parameters can be defined as following:

Parameters which are given or offline are:

$$\begin{aligned} PER_o, PER_{th}, time_o, time_{th},\\ Energy_o, Energy_{th}, PER_{inter}, time \end{aligned} \tag{5}$$

Parameters Required to Compute:

$$addl\_j, pack^j_{\max\_link}, po_{link\_j}, mod_j \tag{6}$$

Minimize: Defined in equation (1).

$$\begin{aligned} PER_{e2e} = 1 - (1 - PER_{inter})*\\ (1 - PER_{hops}) \leq PER_{th} \end{aligned} \tag{7}$$

$$pack\_len = N_{data} + addl\_j + N_{head\_data} \tag{8}$$

$$Energy_{e2e} = \sum_{j=1}^{N_{hop}} Energy^j \leq Energy_{th} \tag{9}$$

Where:

$$\begin{aligned} Energy^j = Energy_{RN} + Energy_{CCO} +\\ Energy_{NN} + Energy_{chs} \end{aligned} \tag{10}$$

$$time_{e2e} = \textstyle\sum_{j=1}^{N_{hop}} (time^j_{queue} + time^j) \leq time_{th} \tag{11}$$

, where $time^j$ =

$$(time^j_{h\_shake} + time_{data} + time_{addl\_i}) * n1_{links} + time_{ack} \tag{12}$$

$$T\_put_{e2e} = \frac{N^{t\_data}}{time_{e2e}} \geq T\_put_{th} \tag{13}$$

The mathematical notations in the proposed architecture are as follows:

1) $PER_{th}$is the end to end packet error rate which is confined by threshold$PER_{th}$and it depends upon the multi-hop transmission(PER_{hops}) and internet (PER_{inter}). Packet error rate depends upon the links with ARQ error control and can be computed as:

$$PER_{hops} = 1 - \prod_{j=1}^{N_{hops}} (1 - PER^j_{link\_nodes}) \tag{14}$$

2) Signal to noise ratio depends upon the packet error dropout rate and bit error rate and modulation type. All these parameters compute the uncoded packet error rate over all the links. $Packet^j_{dropout}$can be computed as in equation (15) and depends upon the maximum number of packets at the transmitter and receiver ($\max^{j_pack}$)and total local traffic in the network($Local^j_{traffic}$).

$$Packet^j_{dropout} = (\max^{j\_pack}, Local^j_{traffic}) \tag{15}$$

Bit error rate is defined in equation (4). From these parameters the uncoded packet error rate is computed as:

$$\begin{aligned} PER^j_{uncoded} = (1 - Packet^j_{dropout})*\\ \left[1 - \left(1 - BER^j_{link}\right)^{N_{data}}\right] \end{aligned} \tag{16}$$

3) $pack\_len$ depends upon the size of the packet that is N_{data}, header size N_{head_data} and additional bits $addl\_j$(security bits, parity bits, redundant data).
4) Energy is computed by the energy consumed over all the hops $Energy^j$and it should be less than threshold$Energy_{th}$. $Energy^j$depends upon all the multi-hop communications i.e. energy processing in

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communications of relay nodes$Energy_{RN}$,cluster coordinators $Energy_{CCO}$, normal nodes $Energy_{NN}$and cluster head nodes $Energy_{chs}$.

5) $time_{e2e}$is the end to end time duration which includes the internet time $time_{inter}$and queuing delay $time^{j}_{queue}$. Delay at each link $time^{j}$is determined by handshake time $time^{j}_{h\_shake}$, data transmission time $time_{data}$, acknowledgment time$time_{ack}$and additional data transmission time $time_{addl\_i}$. The handshake time, transmission data time and additional data transmission time is computed in local cluster$n1$and its links $n1_{links}$.

End to end throughput $T_put_{e2e}$is inversely proportional to the end to end time and it is restricted by the throughput thresholdT_put_{th}. The table 1 shows the parameters used in cross layer framework optimal solution.

a) Optimization Problem : The proposed framework in [8] suggests that optimization problem consists of finding the shortest route among the nodes. The nodes have different communication capabilities and communication range. The cost on the bidirectional link is determined to find out the path. This problem has been generalized for the search of shortest route. The new optimized solution proposed in this paper has formulated the paths not only at the local level of clusters but also at the inter-cluster level. The routing paths are determined by distance of nodes to the Cluster Heads (CHs) at the local level and at the inter-cluster level the communication is felicitated by with cluster coordinators (CCOs) which are fixed and elected by the transmission algorithm. Complexity of the path is reduced because of static routing algorithm.

IV. Cross layer Phases

The cross layer architecture proposed in this paper is based on the data link and physical layer of [8] and network layer of ME-CBCCP[23]. It is divided into Service discovery & Network association phase, Transmission initiation phase, route selection and data transmission phase. First phase is same as discussed in [8]. In the first phase, the access points (AP) broadcasts their ID and message parameters in their domain and things is the AP get themselves registered with the help of network association packet (NAS). It is done with the help of multi-hop communication. The AP virtually divides the regions. The things which are in the closer virtual region can transmit NAS to the AP. AP gathers all the information about the objects. In the second phase, if the nodes have data to transmit they collect information of predefined path with the help of RNs, CHs and CCOs. Route Information of the packet is sent to the MAC layer. In the next phase, The AP constructs the optimal architecture based on the route defined by transmission algorithm. Due to already defined path based on routing algorithm the time taken in taking decision of route is reduced than [8]. In the last phase, after receiving the signal from the node for the transmission of packet, it acknowledges the node on the same path as defined by node in the request packet. If the node is not acknowledged in the fixed time interval, packet again sends the request to the AP and previous request packed is discarded.

V. Result Analysis and discussion

This section demonstrates the comparison of the proposed methodology with traditional layers in MATLAB. We compared the minimization of delay and energy consumption. The size of the packet is 4000 bits. The same path is followed in all the transmissions so route selection time is reduced but at each transmission the energy of nodes is checked against the threshold level which is 0.1 joule. The links among the things are at intra and inter level. At the intra level the things communicate with the help of relay nodes (RNs) and transmit data to the local CH. At Inter cluster level the objects communicate with the help of CCOs. The nodes deployed in the network frame are homogeneous and have same capabilities. The power rate is kept same (but can be changed according to requirements based on the signal strength) and link rate of objects varies in 10-100 milliwatts. The multitier framework proposed in our previous work [23] has been extended in this paper for the multimedia internet of things. The multi tier framework has shown the improvement over the traditional routing protocols. In the present scenario, we have implemented our routing algorithm on the physical and MAC layer for IoT of [8]. Figure 2, shows the end to end delay versus the internet of things while figure 3 shows the energy expenditure versus internet of things. The maximum between the source node and the destination node is 200 meter. The nodes in nearest clusters to the BS have less distance than the nodes of farthest clusters. We have compared our results with the traditional schemes and the cross layer solution presented in the [8]. We have gained 10-15% advantage in terms of energy and time over cross layer proposed in [8]. As the number of things increases in the network, the proposed solutions further divides the virtual regions and more than one base station (BS) can be used to receive the data. In [23] cross layer framework, we have proposed that number of BSs on the application layer can be more than one with unlimited power supply. With more BSs and virtual division of area, the gain in both the parameters of delay and energy is optimal.

The energy expenditure and end to end delay (distance between source and destination) have been shown in figure 4 and figure 5. We have considered the novel cross layer framework for multimedia applications. So distance is considered up to 200 meter. We have used ten virtual regions (clusters) in this distance and we have assumed one thing in each region. As the distance between source node (node in the farthest cluster) and destination (BS) increases the intermediate nodes (RNs and CCOs) are increased. Due to which the end to end time increases. It involves extra handshakes, wait in queue and extra processing at each level. Total end to end energy is increased because of longer distance and multi-hop communication. But still, new proposed cross layer solution shows the validation over other methods. Energy consumption is kept close to uniform energy consumption in all the nodes, since each CH and CCO has load of only one cluster. It proves the advantage of our new scheme over the others.

It is the multi objective solution as it has improved the energy, delay, reliability and scalability. But it has one limitation, when the distance increases, the number of hops also

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TABLE I: Parameters of Cross Layer Model

Physical layer	Power at the link and modulation po_{link_j},mod_j
Data Link Layer	FEC coding scheme, Maximum number of transmissions $pack^{j}_{\max\_link}$
Network Layer	Routing path and size of the packet $pack\_len$

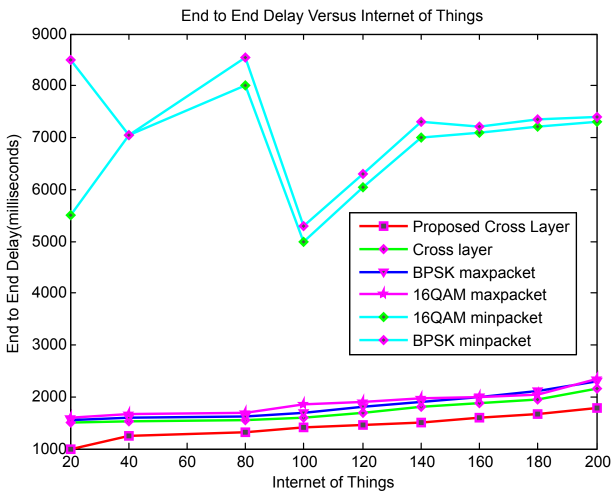

Fig. 2: IoMT versus End to End Delay

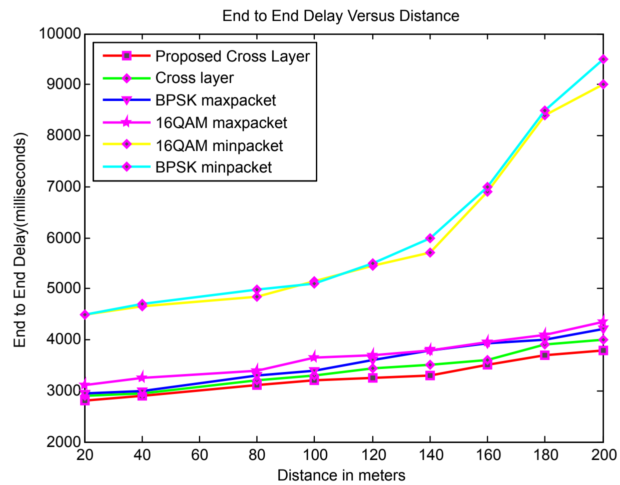

Fig. 4: Distance versus Delay in IoMT

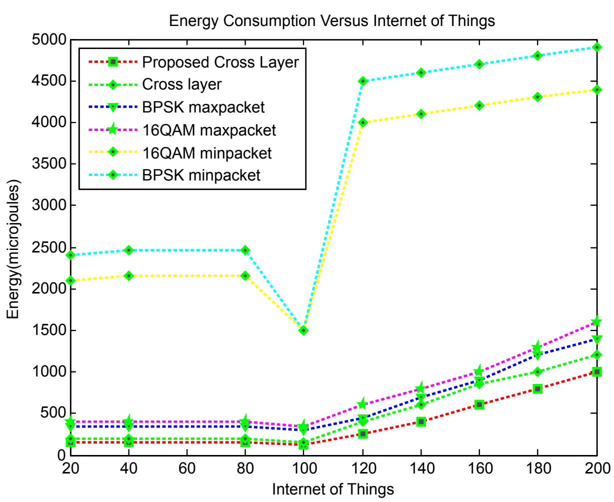

Fig. 3: IoMT versus Energy Consumption

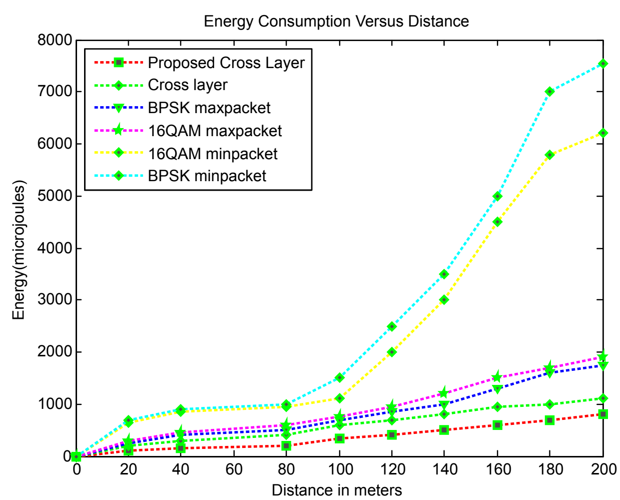

Fig. 5: Distance versus Energy Consumption in IoMT

increase which increase the end to end delay and overall end to end energy consumption. If mobility of sink is taken into account in the transmission algorithm, then this limitation can be overcome. But that will increase the overall complexity of the algorithm. Moreover, the cross layer solution presented in this paper has validated over the other schemes because of homogenous consumption of energy in all virtual regions.

VI. Application Scenario and Future Challenges

We all are aware of the problems of roads, inadequate infrastructure and inefficient accidents mismanagement of transportation which cause several misfortunes.These problems require some long term solutions to eradicate them totally or to avoid them with the help of new techniques and methodologies. We consider a scenario as shown in figure 6. In this figure we have shown the cars moving on the roads. We assume

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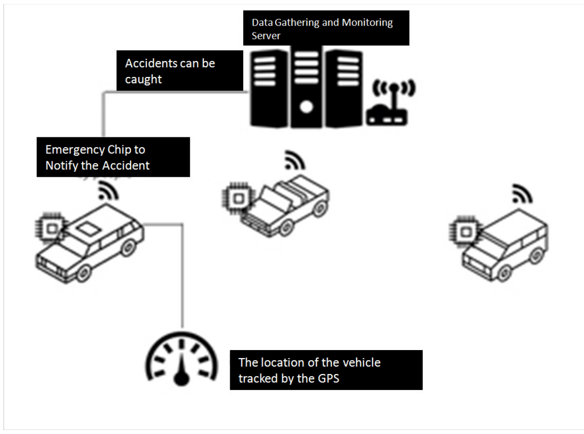

Fig. 6: Secure Transportation Scenario

that they are equipped with GPS and some video capturing cameras. When they move on roads their movements are transferred by the videos and locations are recorded via GPS. In smart city projects, these scenarios will be implemented for secure transportation. If some accident is going to be happened, some signals can be raised to warn beforehand about the accidents by capturing their driving activities. Locations can are required to be traced in case of some mishappening so that proper actions should be taken on time. Research on VANETs is already providing many directions for safety and other assistance to the drivers.Our protocol is suitable for road to infrastructure (R2I) communication. Now a days, video transferring technology has also been added to the sensors. Sensors can transmit and receive the videos. In this multimedia communication, IoMT protocol can be beneficial in terms of QoS metrics[28].

Undoubtedly a lot of research on solutions of various problems is active for feasible and efficient structure of multimedia IoT still there are some future challenges required to be resolved in near future. Some are outlined as below:

1) Deployment: As there will be many devices connected together, it is necessary to consider the deployment of the nodes i.e. whether is should be incremental or predetermined.
2) Security: When things will be distributed on the large scale, then security is major challenge as it provides random entry points to the malware.New layers of IoMT like middleware, M2M communication, video transmission etc. create more complexities and new risks.
3) Management of heterogeneity: Data gathered at the server is the result of many diverse sources and all sources use different techniques. For example, if data is being captured of different vehicles like bus , cars, trucks etc. They may have different types of devices and multimedia data transmitted by them may differ in size, format etc. and it becomes a new challenge to the server, that how to process the different types of data together.
4) Size of the packet: Multimedia data is heavy than the textual data. It requires a lot of time to gather and process the data. Data time transmission is also high. What should be the packet size of the data is again an issue because if it will be too small, then number of transmissions will be high and if it is too large then network traffic problem can arise.
5) Technology disruption and Fragmented M2M: Smart systems are not properly aligned with the IoT infrastructure and they create problem for the network service providers. Technology of ,multimedia communication is shifting the phase across the value chains which will give rise to the new revenue, loss and profits. Without realizing the accurate idea about these, it is not possible to implement it in the efficient way.
6) To settle the Device capabilities: Many opportunities fr M2M communication are present and they have been introduced in the market regularly. But it is the big question in front of us, how to deploy them and which data should be gathered as size of the data is already large in case of multimedia. Hence processes of analysis, storage, collection etc. pose a major challenge in the way of IoMT.
7) Common Standards: To facilitate the communication among the heterogeneous devices , it is required that they should function at some common standards which are not available yet. Well documented application program interfaces are required to start by the network service providers so that users can have the benefits of open standards.

Above mentioned challenges have accelerated the research in the field of IoMT. Timely delivery of data is crucial issue to get the benefits of IoT for smart and safe transportation. Our proposed architecture is beneficial for the above mentioned challenges, as shown in the figures from 3 to 6. In multimedia communication, jitter is not tolerable, which requires the real time communication and timely delivery of data and in IoT, sensors play major role in data transmission therefore reduction in energy consumption as well as delay supports the feasible solution to the above challenges.

VII. Conclusion

The IoT is growing technology for all the applications whether they are scalar or multimedia applications. The traditional and classical protocols are not suitable for the IoT framework because of heterogeneity of hardware capabilities of the objects involved in the multimedia communication. SNR and PER should be at low level in these multimedia applications. It is possible with the cross layer communication as presented in this paper. Recently, many researches are focused on converting the IoT in reality. The proposed scheme can be implemented practically.

In the previous work we presented the architecture for the IoT and in this paper we have presented the cross layer communication of the layered stack. Cross communication and optimal solution presented in this paper, has improved the energy and delay parameters. We have exploited the advantages of cross communication of layers. In future we will focus on the BS situated in the centre and will try to overcome the limitation which is that overall end to end energy consumption is increased with distance. End to end delay at each level is also increased with mote number of RNs and CCOs which is not suitable for multimedia communication so in future we will try to reduce the number of levels, CCOs and RNs for multimedia IoT applications.

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