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SMART Communication: An Emerging Era of Communication

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Abstract:- The amalgamation of IoT enabled communicating devices with Mobile Adhoc Network technology leads to generation of newer domain for communication and finally leads to extension of IoT applications. Information can be collected from sensors used in IoT applications and from data generated by Gateway Hub which can further be concatenated and aggregated at MANET Hub. The role of MANET becomes all the more important because it acts as foundation of IoT architecture. Due to the specific properties of MANETs, it's nodes can connect with different devices without the requirement of any infrastructure whatsoever. MANET nodes overtake the IoT transmission mechanism and collect information from IoT based sensors or any radio communication nodes. MANET cores can be applied and implemented as advancements in IoT applications. Due to the self – designing nature of MANET hubs, these can be sent for newer unseen applications and areas. In this paper, we try to correlate the concepts involved in several computing paradigms like Cloud, Fog, Edge with IoT and MANETs. Such a correlation can be considered as an improvement over existing communication system in the domain of IoT.

Keywords:- *MANET, IoT, Cloud Computing, Fog Computing, Edge Computing.*

I. INTRODUCTION

MANETs belong to a category of systems that have been self – driven and automatically connected in a frameworked architecture. Due to this, they play vital role in IoT domain. In MANETs, each device can travel in any direction by establishing a connection with neighboring device in it's close proximity in order to share the information. Each node in MANET can act as a structure or a switch which can be firmly recognized by Wireless Sensor Networks (WSN). The integration of MANET and IoT provides latest domain for configuration management in complex situations and testing issues in it's system management perspectives. The most prominent factor in MANET – IoT framework is the changing situation across nodes. As, the systems integrated with IoT are dependant on remote sensing for determining MANET convention centers. Power optimization of sensor has been the most crucial point of concern in making a multi – hop remote system available. The utilization of remote access protocols is not achieved in a legitimate manner due to constrained sensors, communication speed, and human interaction with nodes. It gives rise to a combined solution for diverting towards MANET – IoT devices which can provide nodes communication efficiently and effectively [1]. MANETs must exhibit following qualities –

- **Dynamic Topologies –** Generally, Network topologies are multi hops which can be changed quickly with respect to time and can be unidirectional or bidirectional depending upon the specific situations.
- **Data Transmission –** Almost all the wireless communications have to compromise with quality, effectiveness, steadiness and limit when compared with wired system for communication. The throughput provided by remote correspondence is also not equivalent to radio's transmission rate subsequent to managing imperatives like numerous entrances, commotions, obstruction conditions etc.
- **Self – Promising Behavior –** Each node can work as a switch or host which indicates it's self promising behavior.
- **Vitality Constrained Operation –** All hubs have different capacities in terms of battery power and other perspectives for their vitality. Portables are available with lesser memory, force and weight.
- **Restricted Security –** Wireless systems are highly prone to security dangers. A composite firewall is missing due to its circulated nature of activity for security, steering and host set up.
- **Less Human Intervention –** It requires less human intervention to make subsequent changes to system as they are powerfully independent in nature.

IoT is a global system for communication which can provide interface to any kind of device in order to communicate everywhere across the Internet. IoT application areas include urban areas, personal computerization, transportation, natural observation, special venture computing, associated home appliances etc [2]. Towards the latest advents of computing, MANET will contribute very significantly in Internet of Things (IoT). MANET comprises of self – structured remote systems that are automatically associated in a decentralized framework. Each device in MANET can travel anywhere regardless of direction. They can configure a network with their neighbor's active devices in close proximity in order to communicate information to another device.

II. LITERATURE SURVEY

IoT implementation and applications are very vast and cover almost all technological domains like Healthcare, Home Automation, Robotization, Persona Digital Assistants, Power Transmission and Medium etc. The Fig [1] shows categorization of IoT into several dimensions.

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Fig. 1: IoT Implementation and Application Areas

Now a days in urban areas, there exist the demand for development of a new domain like IoT in which professionals are continuously developing newest models and deploying applications for enhancing the living standards. Bluetooth Low Energy (BLE) or IEEE 802.15.4 enabled sensor devices can easily detect many parameters and collect information by hardware deployment. Further, IoT includes another valuable device RFID chip which can use for differentiation purpose with the help of RFID tags [3]. In sensors we utilize MANET enabled nodes and Internet as communication medium in place of power constrained sensor nodes. By the use of RFID, we can enhance the devices either for information transfer to MANET node or to access point of Wireless LAN and information is being transmitted through sensor nodes. Applications developed and deployed in urban areas recognize the importance of role played by IoT devices in giving specialized assistance to society like traffic monitoring etc. In the domain of IoT, results are depending on their overall deployment and subject to interoperability constraints among several communication protocols and standards. Extensive development of sensors invokes the requirement of expansion for increasing the remote access capability of such devices. Wireless Sensor Network (WSN) involves sensors, which are efficient in accessing and retrieving the information to and from a node which may be a sensor. Finally, the collected or transferred information from different sensors has to be transmitted to main hub which is called as Sink [24]. Remote Sensors are the major components in global IoT architecture by which we can collect and transmit data to and from several systems. IoT domain must be consistent in order to achieve effective and efficient utilization which must be dependent on WSN versatility [25]. Various statutory bodies have been formed in order to develop new conventions and architectures for communication in the domain of IoT like IETF (Internet Engineering Task Force). IETF plays a very significant role in categorizing and characterizing specialized and specific functionalities in the domain of IoT. IETF developed CoAP (Constrained Application Protocol) which is a specific Internet protocol used in Internet devices [26] over IPv6 Low Power Wireless Personal Area Networks (6LoWPAN) which enables a system to suit IPv6 information transmission on IEEE 802.15.4 [27] and IPv6 Routing Protocol for Low Power and Lossy Networks (RPL) [28] which is IPv6 routing protocol for systems. Further, IETF has created another environment CoRE (Constrained RESTful Environment) Link Format [29] for collaboration in IoT and newer serializations. Latest improvements in MANETs have shown incredible inclination towards IoT domain.

III. MANET INTEGRATION WITH IoT DEVICES

Linked devices like dedicated home robotization model, dedicated air conditioners, power savvy centre points, smart indoor regulator, shade changing smart lights, smart cell phones, dedicated watches and intelligent tablets are play significant role in our daily routine and help us to access these devices remotely. These dedicated devices are associated with each other forming an IoT environment and a system is configured. It faces huge challenges in setting up correspondence within the network. Security is the most important aspect while dealing with cloud model of web computing. The enhanced capabilities in cloud computing put the entire communication system under diffused structure which suffer from security challenges. Heterogeneous devices taking part in communication make the perspectives and objectives wider.

MANET can be a part of broader Web or can work independently. They adopt a powerful self – structured topology with one or several distinctive hubs in it's close proximity. The standard operation performed by MANET is to prepare every device to maintain the data traffic in a persistent manner. MANETs consist of a distributed, self – shaping, self – retrieving system. MANETs around 2000 – 2015 commonly import radio frequencies between 30 MHz – 5 GHz which can be utilized in street networks, extending sensors, home, health, calamity salvage, air/land/naval force protections, weapons and robots etc. At present, IoT has driven the excited advancement of differently related application administrations. It has it's implementations in various fields e.g. dedicated home [15], human

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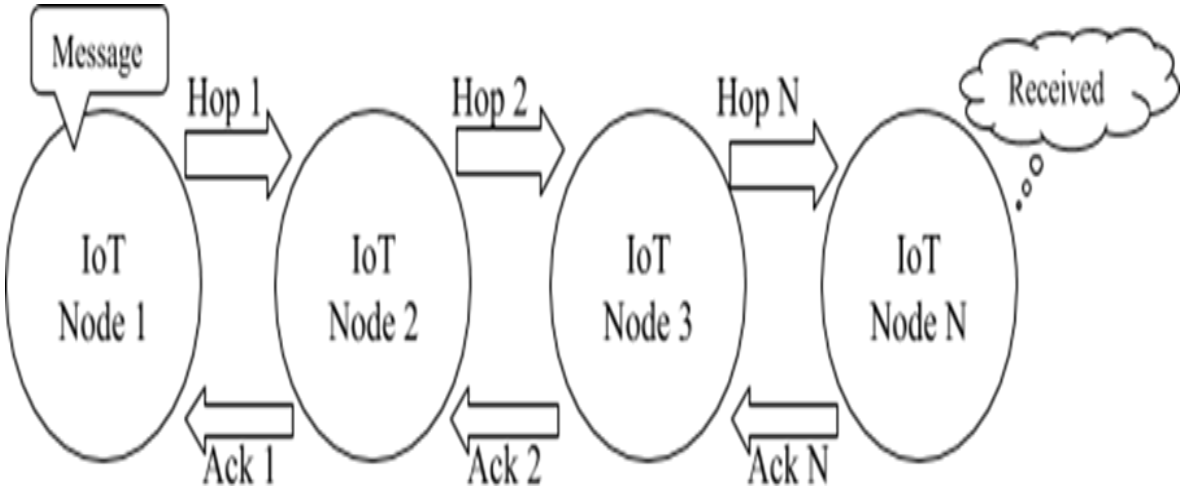
identification, building structural security, individual identification proof etc [16] [17] [18].

A. MANET's Role in collaborating IoT Environment

One of the most challenging issue about deployment of multi-hop Ad-hoc nodes is that they can affect the existing transmission network. The existing network can be partially or completely affected by an unwanted situation. Multi-hop Ad-hoc transmission is the only alternative in order to meet the specific condition like absence of exchanging devices in a disaster condition. These are equipped with enhanced devices e.g. MANETs, VANETs, DTNs, WSNs in order to deal with such circumstances. The deployment of IoT can be done in order to motivate the analysis in various dimensions [9] like universal detecting and inevitable processing depending on communication infrastructure given by a remotely accessed system (MANETs). The Fig. [2] shows the process of information passing among nodes in disposition of MANET and IoT. The overall distributed information after sending or receiving is being provided by these nodes due to the availability of decentralized structure. IoT can provide a large number of alternatives e.g. WiFI, Cellular, Bluetooth and ZigBee. ZigBee is based on IEEE 802.15.4 protocol which provides favorable conditions in complex architectural frameworks with constrained power supply and high adaptability. Applications based on IoT require constant concern about information cloud enhancements over Internet. 6LoWPAN is a management layer that allows transmission of IPv6 packets through connection layer as specified by IEEE 802.15.4 [10].

Fig. 2: Process of Information Passing among Nodes



Favorable circumstances for incorporating MANET and IoT are –

- Separation from core system organization
- Self – structuring and Self – Enhancing Hubs do not require human interaction
- Every Hub can work either as a Router or as a Switch

Unfavorable circumstances for incorporating MANET and IoT are –

- Restricted assets due to constraints like commotion, impedance conditions etc.
- Approval authorities are absent
- Progressively inclined due to lack of physical security

B. Collaborating Cloud – MANET with IoT

Cloud – MANET system focuses on deployment of dedicated devices which are based on the concept of distributed computing and MANET. Such an architecture communicates with cloud service providers through MANET client's smart devices in the IoT enabled environment where entire processing has to take place. These devices can move from one palce to another within the specified scope of MANET. Several MANETs can be connected with one cloud and take benefit of services provided by the Cloud. In order to obtain this environment, cloud environment must be incorporated with versatile applications [4].

The cloud computing deployment proves to be very helpful and offers a huge list of advantages for its clients like high capacity, high accessibility etc. Cloud environment not only provides ability for information collection but complex processing can also be done by using the concept of virtual machines (VMs). In the most adaptable IaaS (Infrastructure As A Service) cloud computing model, clients can run virtual machines inside cloud itself and due to it several applications can be performed. Foundation As A Service (an extension to IaaS) gives VMs capability to fulfill client needs to maximum extent.

➢ *Advantages*

- **No Upcoming Venture –** Cloud Computing works on Pay as You – Go evaluation model. Client does not have to accommodate resources but can pick up from Cloud Service Provider. It minimizes investment on infrastructure and only requirement is to pay as per utilization.
- **Reduced Deployment Cost –** Cloud resources can be quickly dispersed or received on immediate request basis. Hence, an organization no longer requires to make arrangements regarding specific resources. It provides huge financial funds as resources can be discharged in order to save money only on working costs and administration is either no or minimized.
- **Highly Versatile –** Infrastructure provider gathers huge amount of resources from Cloud Servers and make

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them effectively available. A Cloud Service Provider without much efforts can extend its support for huge resources.

Cloud has limitless capabilities in terms of capacity. Huge IoT applications has set the platform for distributed computing models, using adaptability, execution lead to raise the Cloud abilities and development of mechanical imperatives of IoT frameworks [5].

- Cloud Essential Features for IoT –
- On – Demand Self – Management
- Wider Access to Network
- Resource Pooling
- Location Preference and Proximity
- Rapid Versatility
- Constrained Services
- Collaborating with IoT –

Several challenges may be encountered in developing application in collaboration of Cloud and IoT which includes constrained distributed computing, typical programming styles and rules. The composition, communication and management of such applications is very difficult. In the continuous development, another innovation has been generated which involves the deployment of dedicated devices with cloud through Internet. The devices enabled with IoT deal with tremendous amount of data and require support of enormous processing, effective and efficient capacity of heterogeneous frameworks, programming styles which manages control among variety of applications. Large amount of difficulties have emerged with this new innovation as it must be adaptable with coming 5G technological domain. Thus, the collaboration of IoT and cloud is done in such a manner that they can support for all versatile applications, communication mediums provide by IoT infrastructure on a large scale. Such applications are helpful in deployment of IoT devices which are distributed geographically at different locations. Under such situations, cloud provides an environment for quick, adaptable and productive advancement for end user applications [4] [6] [7].

➢ *Incorporating Smart Devices* –

Earlier there was Personal Computer, then Cell Phone came and now there are huge amount of smart devices that individuals use very frequently like Tablets, Smart TVs, eBooks, Google Glass, Smasung Watch etc. The processing of devices in terms of computation that can be associated with Internet has been expanding each and every day. Organizations are selecting some smart devices to extent their quality product. Cloud Computing has become incredibly powerful by influencing cross stage applications e.g. applications can run at multiple stages and at several platforms.

➢ *Application Advancement in Cloud Computing*

Cloud Computing has been equipped with cross platform based approach that provides an special ability of execution to a code that it can be run over multiple stages. In a cloud based application, the entire information has been kept over servers at a remote location with the facilitation of normal system inside cloud environment itself which supports insignificant programming technique as demanded by client. It provides electronic environment with Internet as now Internet becomes the necessity for client. Thus, in this manner, a cloud based application remains to be consistently compact in size. In case if one of the server goes down, the cloud service provider can proceed without any hindrance. In case if there is any change in hardware then upgraded server will be incorporated from pool of available resources which makes the product adaptable with new environment.

The chained experiments and innovations in the domain of hardware and IT industries lead to face significant changes especially concerning with adaptability with new standards. As a result of which, certain organizations do not prefer to provide security to their product in such constrained framework however they want to remain stuck with their traditional transmission medium which are totally platform dependent. The smart device – to – device communication in MANET – Cloud environment provides us an innovative platform which finds an associative relationship with dedicated devices without any incorporate framework [8]. Thus, the proposed algorithm can prove to be helpful in Machine – to – Machine communication where devices remain in close proximity with each other. The client's smart devices utilize cloud management in order to search these devices and helpful in collecting huge amount of information and processing of recordings, pictures, contents and sounds etc.

C. Fog Intermediation

The architecture based on Fog computing provides secured communication medium for IoT enabled devices. This framework counts for adaptability and security of IoT organizations in collaboration with cloud computing and fog computing. Currently deployed technologies assume that Fog is responsible for establishing secure communication among devices and also that each Fog node must be trusted and secured against outside attacks [11]. The Fog enabled devices can be used for deployment without Internet and provide services with extraordinary capabilities as compared with conventional cloud platform where the entire environment is managed by Cloud Service Provider. Fog nodes can be activated as physical or virtual frameworks over heterogeneous computing environment, moving from power constrained Personal Computer to Enhanced Server Machines. This communication model is incorporated with dedicated route depending on transmission medium like power ARM CPUs and as compared to smaller than traditional server machines for extraordinary capacity and information analytics [12] [13]. The Fig. [3] shows the collaboration of Cloud, Fog and Edge Computing paradigms with IoT end devices.

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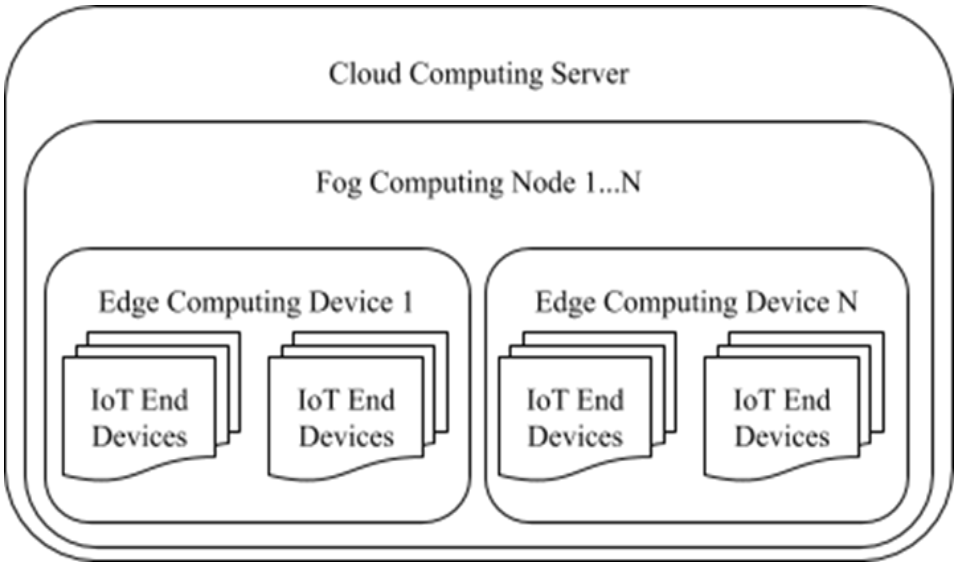

Fig. 3: Collaboration of Cloud, Fog with Edge and IOT end devices

All devices like Fog based nodes and Cloud based services must conform with each other about specific constraints like cryptographic keys in order for establishment of a secured communication medium. It is assumed that cloud service providers play the role of service providers and maintain trustful environment in order to establish a versatile conformed communication medium and that typical heterogeneous cloud services can utilize such constrained frameworks in order to empower cross – validation among their different devices and management. Fog enabled nodes do not suffer from limitations like constrained equipments and can verify benefits of cloud paradigm by utilizing TLS or DTLS protocols [14].

D. Edge Enhancement

The domain of edge computing offers organized processing of applications and management to clients by distributed edge devices. It can also deals with advanced issues like cancellation and offloading availability to computational assignments towards edge devices in close proximity of informational resource. While dealing, IoT devices can have some separate functionalities with promoting services [19]. The Fig. [4] represents the incorporation of Edge Computing devices for the enablement of IoT.

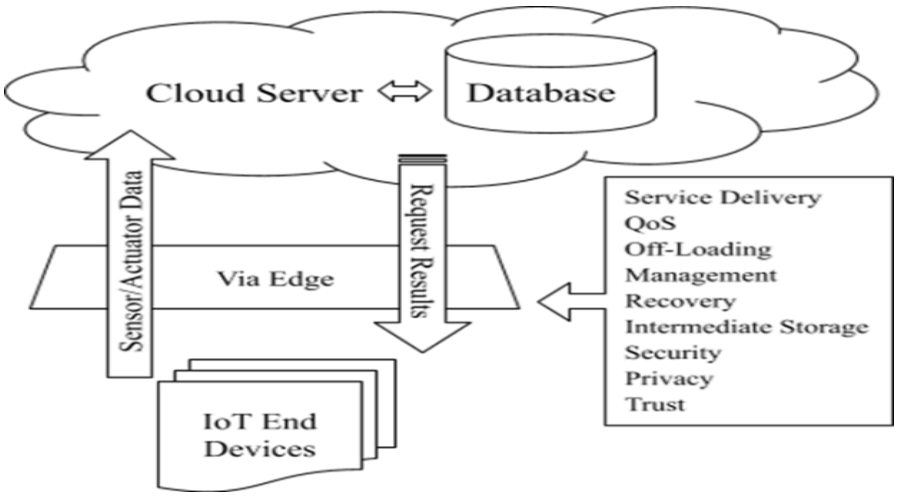

Fig. 4: Incorporation of Edge Computing Devices for Enablement of IoT

The devices enabled with the concept of Edge Computing are utilized like e.g. Smart Vehicles, Smart Cameras [22] [23]. They are considered as information developer and deals with information handling and transmission issues. Although, it is very difficult to trust on device's capacity while dealing with tremendous amount of data in order to fulfill the subsequent requirements. As a result, it is very clear that by deploying the concept of Edge computing we can utilize these devices. These edge devices are located in close proximity with end user devices and help in providing efficient and effective system management. Contrary to this, the edge devices have an impressive ability of computation and the edge devices provide quicker response to the end users as compared to cloud. Thus, in this manner, we can utilize these devices in dealing with computational overheads, the response time of devices can be improved. Further, these edge devices also provides the storing facility which can reduced the access time in real time situations [20] [21].

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IV. CONCLUSION

The point of concern here is how MANETs work in collaboration of IoT architectural framework and such devices may be helpful to individuals under some constrained situations. The temporary nature can be used by various applications where these systems has more end users. Power optimized MANET devices can be tried and executed in collaboration with IoT. Consequently, MANET, WSN and LTE are incorporated in order to examine the capacity of expanding the heterogeneous environment by selecting a device that deals with IEEE 802.11 and LTE. Further, in future we can also include expansion of MANET devices with LTE innovation in order to allow communication over web and to provide friendly environment. In lieu of such circumstances, the establishment of communication system between smart and dedicated devices in a heterogeneous environment of 5G system can also be attempted.

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