Chapter 33
A Short Study on IoT-Based Cellular Network

M. V. Sai and G. Rama Naidu

Abstract Nowadays, the requirements of the world getting change rapidly in the field of communication. With the evaluation of the internet, almost everything is supported by the network. Huge amounts of information are transferred every time, which enhance the necessity of an efficient and secure network system. As the networks are also required to address the real-time issues, it is needed that the network must be highly efficient in terms of response time and adaptability. Critical information is sensed and analyzed and transmitted through the network which has complex structure and scalability. Apart from that in today's world, data theft is one of the major issues. As the conventional network fails to fulfil these requirements, a new but potential technique is evolving. This new technology is a combination of the cellular network data transmission technique and internet of things (IoT) technology. The combination of these techniques makes this technology adaptable, scalable, highly responsive and extremely secure. This presented paper highlights the basic structure of a cellular network and the IoT-based cellular network along with its major breakthrough and potential.

33.1 Introduction

The presented paper mainly deals with the concept of the internet of things with the multilayer method of transporting data from end-to-end communication through a cellular network securely. The complete implementation of this type of network provides an extremely secured network pathway to communicate. Nowadays, as the uses of the Internet of things intensify, it brought with it a heightened awareness of the security issues that are associated with linked devices. There are numerous ways but although, all of these systems/devices are utilizing cellular connectivity to interconnect. Rather than the cellular connectivity-based solutions, some more options can be utilized such as Ethernet or wireless Wi-Fi-based using which the

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S. Yadav et al. (eds.), *Proceedings of Second International Conference in Mechanical and Energy Technology*, Smart Innovation, Systems and Technologies 290,
https://doi.org/10.1007/978-981-19-0108-9_33

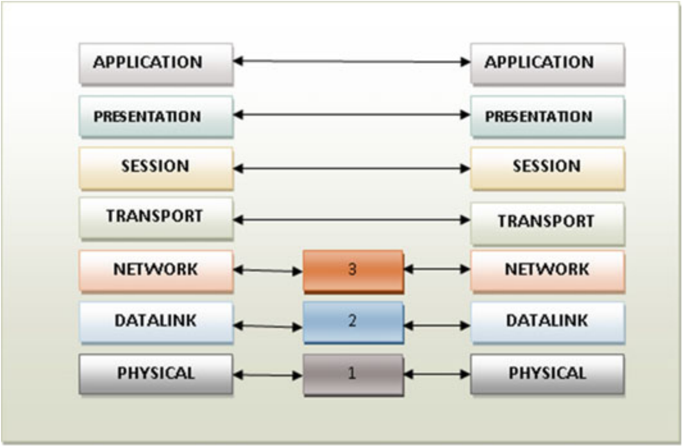

Fig. 33.1 Layers in ISO layers

data is transported from the edge devices to the host. All of these alternate solutions also offer remote monitoring and tracking of devices. However, the security threat risk is very high. Various security breach incidents have happened in which Wi-Fi over the public internet was used as a means of gaining access to the data stream and altering the operation of internet of things devices. Therefore, it is necessary to secure communication between two or more linked devices. This study proposed that the multilayer method of transportation in the Internet of things (IoT) communication is one of the best potential candidates that protect and ensure security to the data which is exchanged between connected devices.

Cellular networking has a high capacity in voice and data communication with increased multimedia and coherent roaming facilities for supporting cellular devices. It is well known and presented in Fig. 33.1 that from source to destination it has seven layers process occurs application, presentation, session, transport, network, data link, and physical layers on both the sides of source and destination. This process is done for transporting the data from source to destination securely. The complete process of communication required some basic characteristics. These essential necessities are highlighted below.

33.2 Methodology Discussion

33.2.1 Infrastructure

The whole communication network areas are bifurcated into several small cells. To connect all base stations available in the region, these small cells necessitate a complicated infrastructure. Switches for call forwarding, location registers, and other infrastructure are also highly required. These all the requirements make the single-cell structure too complex.

33.2.2 Handover Process

As these communicating base stations are dynamic and there is a high probability that one base station can move from one cell to another while communicating, hence it is necessary for the mobile station that the process of the handover must be efficient and uninterrupted when the base station is switching from one cell to another.

33.2.3 Proliferation of Antenna

Nowadays, the number of antennas is greatly increased (transmitting as well as receiving antennas) on a cell tower and cell phone in modern cellular networks, which has boosted the performance of the network significantly. However, this arrangement required large space for the establishment, which has its own limitations. Therefore, a way must be required to optimally fulfil this challenge. In this scenario, the use of MIMO (multiple-input, multiple-output) seems to be a potential solution. The customers who can receive simultaneous signals from many transmitters have seen a huge improvement due to the MIMO technique. However, there are two side effects of MIMO that reduce the performance for some users. First, MIMO has reverse distance effects, in other and simple words MIMO mostly favors individuals who are nearest to the cell tower, which means that others who are further distant from the cell tower have fewer quality connections accessible. Second, MIMO works best with non-adjacent cellular channels which means at the time of high call rate MIM will enhance the signal strength for one channel at the cost of the strength of the other channel, which affects the customers who are on the weaker channel; they may be facing lowering quality issues.

33.2.4 Shape of the Cellular Footprint

The strength of the signal around the cell tower is not identical. If it is measured at any cell site and plot signal strength, it can be easily observed that the footprint of a cell tower resembles that of an amoeba, with the signal traveling a very short distance in certain directions and traveling much farther in others. Also, this footprint is not static in nature, it is highly influenced by the temperature, humidity and user density present in the region of the cell footprint. Due to this, it is critical to distribute the broadcasting of the wireless services as the delivery footprint is continuously moving, often radically. That is why, it is hard to predict the absolute nature of the point-to-point connection between the mobility data center and the destination host, which provide the most efficient and reliable services. This connection might be an IPsec VPN tunnel, MPLS, frame relay, or any number of other landlines secure point-to-point connectivity methods provided by the carrier's outbound side. Generally, the IPsec VPN route seems to be the most common, with Cisco firewall VPN equipment, which is used at both the carrier and host data sites. The other possibility to establish a close secure connection between radio modules of the IoT device through the tower and the carrier's mobility data center transmitting through the GGSN/PDN-GW is to combine two functional elements delivered by the custom APN and IP sec VPN tunnel. It is also designed in such a way that the data connection is routed out of the mobile data center via a special off-the-internet secure pipe to the enterprise customer's host, which is terminated at the IP sec VPN router. Even the different IoT devices cannot talk of communicating to each other directly as the common misconception has spread out. This misconception is might be due to the other recognition of IoT which is "Machine to Machine". This also follows the same technique that the communication through the defined protocols using all the layers presents in the design or system. Direct machine-to-machine communication through any carrier or router is prohibited. In reality, the communication between the IoT devices is only routed through the application layer within the backend host that manages IoT solutions. If the situation demands the transformation of data between two IoT devices, this can be accomplished via the application layer on the backend host server, rather than a direct data packet transfer between the two devices. Although it is technically possible to establish an APN to route device-to-device traffic via the carrier's data center, this method violates the security measures outlined above. If it is permissible to exchange the data directly from one IoT device to other via the carrier's data center, then, no record or footprint would be left in the customer's router or backend host system. In other words, the devices may be communicated back and forth without the enterprise customer being aware of or realizing it, then one cannot able to investigate the communication for malicious behavior, which increase the security risk to a great extent. However, through the appropriate protocols followed, the device can communicate with each other efficiently with no risk. Therefore, it can be said that the devices are now the user of the data they collected. As communication between the devices is an inherent part of IoT, the device can be able to exchange information automatically without any presence of the monitoring body or system.

Figure 33.2 represents a general multi-hop interconnected intelligent IoT system. This designed system can transfer the data with its peer devices, acquired information and transmit them via the multi-hop method, utilizing neighboring networks. The proposed structure of the network will ensure that information exchange within and between clusters is trustworthy [1]. For this purpose, various networks have been designed to transform data security and reliability. Some of the major breakthroughs are highlighted here for reference and a better understanding of the real scenario.

In the case of IoT equipped uplink cellular network, where a cellular user can able to gather the information of mobile data for a cluster of IoT devices, the user can send the sensory data directly or via cellular communication to the base station. This process is accomplished by machine-to-machine communication. This idea was

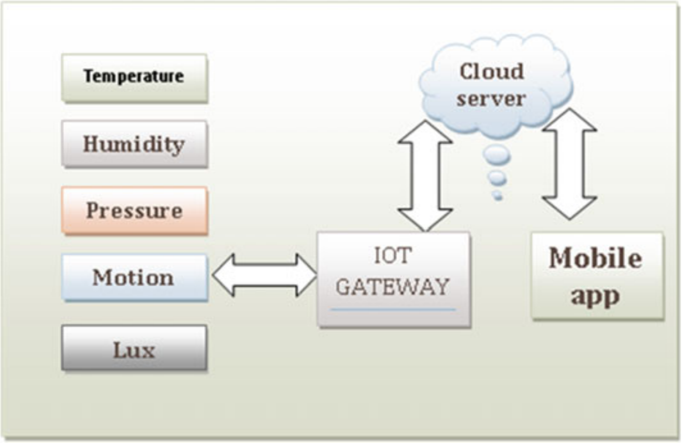

Fig. 33.2 A multi-hop interconnected intelligent IoT system

proposed by Zhang et al. in the year 2019, according to their study, this proposed IoT scheme can accommodate a greater number of IoT devices than the allowed spectrum alone. The presented scheme for communication in a cluster-based network equipped with an IoT facility makes the use of an unlicensed spectrum for machine-to-machine communication in clusters. As data traffic develops, more internet of things devices is connected to the base station, resulting in reduced interference [2]. In the same year, Khan et al. presented another model IoT network keeping goal to make it cost-efficient and spectrum effective utilization. This designed model is also low power IoT which is unrestrained and unhindered interference in nature. This model addressed the effective spectrum utilization problem with the help of cognitive radio networks, which is also observed as a low-cost solution. The observation of this study demonstrated that the IoT network is better and efficient as compared to the conventional networking strategies. The designed model also supports the complex data with the improved character of throughput and delay while comparing with the traditional models for varieties of traffic [3]. As the IoT technology is getting improved, it is observed that this technology has tremendous features that can be used to solve real-life issues such as environmental contamination but this necessitate a real-time monitoring system to be made. The entire system consists of the hardware module equipped with efficient sensors that sense the environmental parameters such as temperature, humidity, etc. These acquired data is transmitted through the wireless router under the instruction set of wireless fidelity protocol. A remote server is also deployed and this receives data via the internet from the sensor node and saves these data in the database. To make the system more reliable and efficient, finite state machines and asynchronous communication protocols are implemented in the system. After analyzing the data it is concluded that at a certain height the concentration is more near the ground and after that, it reduces with the increase in attitude. This entire model was developed to address the real-time pollution issue by Xu et al. in the year 2016 [4].

The IoT encompasses a wide range of technologies and applications, as well as commercial potential and concerns. It enables data to be smoothly transported from physical devices to the internet. The proliferation of intelligent devices will establish an information-rich network that will enable supply chains to accumulate and interrelate in new ways. According to the research, the internet of things has a lot of room for expansion and will be a big revenue generator [5]. This technology has the capability of finding effective solutions and adoptability to connect with the new and various types of networks in order to form a new network structure and going beyond the technological barriers which are due to the inherent confines of the constrained devices usually used in this perspective. This technology also enables the development of scalable network architectures which is capable of collecting and processing data from restricted devices in order to provide valuable services and applications to end-users [6].

33.3 Conclusion

This study mainly focused on the end-to-end data communication using IoT. It is observed that this network has the capability to provide an extremely secure network. This network is also capable of effective interconnects using cellular connectivity. As the new world requirements are the out of the way network structures in order to make the communication efficient and secure along with the quick response to address the real-time issues, the IoT-based network is a much better performance as compared to the conventional. Its adaptability makes this technique unique as complex algorithms and structures can be easily implemented built using this, in other words, this technology has a high order of flexibility and scalability. These all characteristics make IoT-based networks a future potential network to address our unsolved and upcoming issues in terms of data collection, communication, etc. Along with these, due to its ability to build an information-rich network, it has high commercialization value too. However, there is a mile to go and need intense study and research in this field in order to cope with the limitations and challenges but it can be easily predicted that IoT-based communication network is our future.

References

1. Bello, O., Zeadally, S.: Intelligent device-to-device communication in the internet of things. IEEE Syst. J. **10**(3), 1172–1182 (2014)
2. Zhang, H., Di, B., Bian, K., Song, L.: IoT-U: cellular Internet-of-Things networks over unlicensed spectrum. IEEE Trans. Wireless Commun. **18**(5), 2477–2492 (2019)
3. Khan, F., Rehman, A.U., Jan, M.A., Rahman, I.U.: Efficient resource allocation for real time traffic in cognitive radio internet of things. In: 2019 International Conference on Internet of

Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), pp. 1143–1147 (2019)
4. Xu, B., Zheng, J., Wang, Q.: Analysis and design of real-time micro-environment parameter monitoring system based on Internet of Things. In: 2016 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), pp. 368–371 (2016)
5. Singh, S., Singh, N.: Internet of Things (IoT): security challenges, business opportunities & reference architecture for E-commerce. In: 2015 International Conference on Green Computing and Internet of Things (ICGCIoT), pp. 1577–1581 (2015)
6. Davoli, L., Belli, L., Cilfone, A., Ferrari, G.: From micro to macro IoT: challenges and solutions in the integration of IEEE 802.15. 4/802.11 and sub-GHz technologies. IEEE Internet Things J. **5**(2), 784–793 (2017)