

# Internet of Things in Telecommunications

Matthew N. O. Sadiku<sup>1</sup>, Paul A. Adekunle<sup>2</sup>, Janet O. Sadiku<sup>3</sup>

<sup>1</sup>Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX, USA

<sup>2</sup>International Institute of Professional Security, Lagos, Nigeria

<sup>3</sup>Juliana King University, Houston, TX, USA

## ABSTRACT

The Internet of things is a concept that refers to a network of everyday physical objects or devices that are connected to the Internet and can communicate with each other and with end-users. Today, IoT technology has entered practically all industries, and it is hard not to note its impact on the telecommunications sector. The implementation of IoT-based initiatives is a must for telecom businesses striving to embrace the digital age, getting a strong competitive advantage, and making the most of the possibilities that modern technology offers. The Internet of things strategies for telecommunications have been completely changing the technological landscape. It is revolutionizing the telecommunications industry, having a huge impact on all business processes. This paper examines the roles of IoT in the telecommunications industry.

**KEYWORDS:** *Internet of things, IoT, telecommunication industry*

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## INTRODUCTION

Technology is changing fast, and the Internet of things (IoT) is a big part of it. IoT is a network of everyday physical objects or devices. These objects can be anything, from your smartphone, smartwatch, or smart home devices like thermostats and lights, to larger things like smart cars and industrial machines. IoT is used in smart homes, offices, self-driving cars, and even security systems. IoT has become a commonplace practice and are being permanently improved and expanded. IoT solutions are actively implemented in various sectors around the world, especially in the telecom industry in recent years.

Retail, agriculture, healthcare, manufacturing, and utilities are just a few of the industries that are using IoT solutions. The number of devices connected to the Internet of things worldwide is forecast to triple by 2030.

The telecom infrastructure stands at the forefront of technological evolution, and is noted for its complexity, as typically shown in Figure 1. Everything from work to play is shaped by modern

telecom's unified voice, video, and information architecture.

Telecommunications play a key role in creating an interconnected world through the Internet of things. They provide the essential infrastructure and services needed to connect IoT devices to each other, to the Internet, and to other systems. The effects of IoT adoption will mean that telecoms have an increasing role to play in areas like healthcare, manufacturing, city infrastructure, factories, and integrated home environments. Industry giants like Vodafone, AT&T or Verizon, are playing a crucial role in shaping the future of IoT and staying ahead of the game. They already offer narrowband IoT networks that can ensure low-cost, stable signal coverage for connected devices.

## OVERVIEW ON INTERNET OF THINGS

The Internet began with some military computers in the Pentagon called Arpanet in 1969. It expanded throughout the 1980s as a set of four parallel military networks, each at a different security level. The core technology which gives the Internet its particular

characteristics is called Transmission Control Protocol/Internet Protocol (TCP/IP), which is essentially a set of rules for communication [2].

Internet of Things (IoT) is a worldwide network that connects devices to the Internet and to each other using wireless technology. IoT is expanding rapidly and it has been estimated that 50 billion devices will be connected to the Internet by 2020. These include smart phones, tablets, desktop computers, autonomous vehicles, refrigerators, toasters, thermostats, cameras, alarm systems, home appliances, insulin pumps, industrial machines, intelligent wheelchairs, wireless sensors, mobile robots, etc. Figure 2 illustrates the Internet of things [3].

There are four main technologies that enable IoT [4]: (1) Radio-frequency identification (RFID) and near-field communication, (2) Optical tags and quick response codes: This is used for low cost tagging, (3) Bluetooth low energy (BLE), (4) Wireless sensor network: They are usually connected as wireless sensor networks to monitor physical properties in specific environments. Communications technologies in Internet of things are portrayed in Figure 3 [5].

IoT technology enables people and objects to interact with each other. It is employed in many areas such as smart transportation, smart cities, smart energy, emergency services, healthcare, data security, industrial control, logistics, retails, structural health, traffic congestion, manufacturing, and waste management. The Internet of things is extensively developed world-wide with a focus on civilian applications such as electric power distribution, intelligent transportation, healthcare, industrial control, precision agriculture, environmental monitoring, etc.

## INTERNET OF THINGS IN TELECOMMUNICATIONS INDUSTRY

The key role of IoT is that it improves everything around us, making objects smart, connected, and able to interact with each other. Internet of things technologies transform the role of mobile network providers in ensuring the connection between users and devices. Telecom companies use the Internet of things (IoT) to deliver a collection of products and services that bring additional value to their existing networks. Figure 4 shows major IoT use cases in telecom [6]. Telecom companies can take advantage of IoT in the following key ways [7,8]:

➤ *IoT Connectivity*: A first and foremost IoT implementation option for telecom providers is to offer connectivity services to those users who have IoT devices. It is offering connectivity

services to users who already own IoT devices. The IoT is bringing a new era of interconnectivity to our world. The basic principle behind IoT is connectivity between web-enabled smart devices and the cloud and between the devices themselves. An IoT connectivity platform is responsible for managing devices and improving the quality of connecting the customer's infrastructure to the telecom network. The Internet of things in telecom provides seamless and secure communications, and the challenge is for industry leaders to tune their physical assets to offer IoT-enabled connectivity platforms. Providing the connectivity required for IoT networks will define future telecom operations.

➤ *Data Analytics*: IoT initiatives provide telecommunications businesses with an enormous amount of data, enabling telcos to create information pools or apply this data for analytics. Today, telcos have unique opportunities to use analytics combined with data from IoT devices. By implementing Internet of things initiatives, the telecommunication business can obtain huge amounts of vital data. Analytics, combined with data generated by IoT devices and supplemented with algorithms based on artificial intelligence and machine learning, also facilitates tracking user behavior, allowing telecom providers to carry out diagnostics and develop forecasting models.

➤ *Data Storage and Management*: Since IoT creates lots of data, telecommunications companies help manage it. They store, process, and analyze the data so that businesses can make smart decisions based on the information. Telecom companies can also store and process data gathered from clients' IoT devices. A customer runs a business application to access any needed information on the centralized platform. In this scenario, the provider is responsible for all backend processes including data storage, filtering, classification, and cleansing.

➤ *Asset Monitoring*: Monitoring assets remotely is another popular use case of IoT in the telecom sector. By using an IoT platform, telecom companies can connect their diverse physical assets to the cloud and remotely manage their operations, investigate malfunctions, run firmware upgrades, and keep track of inventory. For many industries, the location of physical assets such as vehicles, orders, or even patients is critical to track in real time via mobile apps. Using extended communications networks and cloud computing, telcos can monitor asset

movements by collecting signals from embedded sensors and transmitting them to industry-tailored applications.

- *PaaS and SaaS Solutions:* Platform as a service (PaaS) and software as a service (SaaS) solutions are among the most profitable ways for telecom companies to generate revenue. The PaaS model enables clients to independently develop their own solutions by accessing cloud-based IoT platforms. SaaS applications offered by telecom operators can be tailored for practically any industry and bring exceptional benefits.
- *Location Services:* Mobile networks and IoT sensors help realize advanced and improved location capabilities, which is a necessary feature of smart cities. These IoT sensors can be integrated into public transport infrastructure to provide users with optimized routes, find the nearest stops, and pick transport in real-time.
- *Autonomous Vehicles:* Autonomous driving is being actively explored by numerous carmakers all over the world. Connected vehicles, autonomous driving, and the automotive infrastructure as a whole are some of the key areas for the Internet of things and 5G mobile technologies. For cars to be completely autonomous, their environment must be equipped with sensors to send signals that can be interpreted in real-time to make driving secure and reliable. The introduction of IoT devices with LTE-V solutions allows cars to interact, notify each other about a lane change, detour, or emergency braking, prevent accidents, and communicate with the surrounding road environment.
- *Equipment Monitoring:* Telecom capabilities provide support for communication between people around the world and let businesses access global markets. Telcos use a huge amount of equipment to ensure high-quality and consistent service, and its failure is one of the most common reasons for telecommunication breakdowns. The equipment must always stay in working condition and operate flawlessly around the clock, and any failures must be corrected instantly. IoT technologies help meet this challenge. Their sensors are able to collect and analyze data from cell towers, and also allow identifying the problems, responding to them, and carrying out surveillance in real-time.
- *Hazard Detection:* Equipment failure is not the only reason that prevents the uninterrupted provision of telecom services. Among other

critical threats are global catastrophes that telcos must also immediately respond to since the lack of control over such hazards can cause great damage to equipment. The capabilities of the Internet of things allow communication providers to effectively manage facilities, monitor incidents, and detect disasters in time so that operators can perform an emergency shutdown of equipment to prevent its total breakdown.

- *Security:* One more critical point in terms of security at remote sites is the exposure of expensive and critical equipment to the possibility of theft. This means that telcos must implement extremely reliable and robust protection systems. IoT-based smart cameras become the best solution in terms of physical security.
- *Healthcare Industry:* The healthcare industry is one of the leading and most promising for telecommunications. This industry is one that is actively adopting IoT solutions and devices. The telecom companies are building ties with healthcare institutions for ensuring high-quality, fast, and cost-efficient connections. The Internet of things not only facilitates the process of monitoring the condition of patients but also allows the introduction of extra remote healthcare services. Other applicable options include remote medical diagnostics, automated incident control systems, and streamlined healthcare delivery. The implementation of IoT solutions in the medical industry is costly due to the increased privacy and complexity of the systems, but it is definitely something that will pay off in the near future. The most significant applications of IoT within remote healthcare are in remote asset management platforms, remote healthcare diagnostics devices and solutions, and smart incident management systems. Due to data sensitivity and the sophistication of technology, deploying IoT technologies in the medical sector requires substantial investment.
- *Smart Cities:* The main objective of smart cities is to optimize how a city functions and promote economic growth while also improving the quality of life for citizens by using smart technologies. This could include smart surveillance cameras, waste management, and predictive and proactive healthcare. It is difficult to overestimate the role of telecommunications in smart home and smart city technologies. The core of their implementation consists of 5G and the narrowband IoT. The idea of smart cities has developed around the world, with technology in use from New York to Copenhagen. Cities are



using data from smart devices to assist with power consumption and distribution, traffic management, and environmental efforts. If in smart home technology we are talking about managing security, lighting, electronics, and others, then in the development of smart cities, the role of telco and IoT comes down to creating an efficient, inclusive, and interconnected ecosystem. In all these cities, telecom partners have helped implement the necessary 5G and narrowband IoT networks. The success of these initiatives means that more cities will be looking to modernize with IoT integration. Figure 5 shows a typical smart city [9].

- *Smart Homes:* Smart home systems have been around for a while, but they have been modified and enhanced a lot. Today, citizens are using sophisticated devices based on latest technology for their daily usage at homes. We know that this ecosystem is heavily dependent on high-speed Internet. Telcos are playing an important role in their development. The IoT version of a smart home relies on interconnectivity on a network level. This gives telecom providers a unique opportunity in smart home networks. Rather than relying on separate smart devices with different communication standards, the devices operate on a smart network. This is managed by the telecom provider in the cloud and the user accesses it all with an app on their smartphone. IoT and telecommunications play an important role in tasks and processes involved in smart homes, such as management of lighting, temperature, appliances, security, and others. Deutsche Telecom, AT&T, and Comcast all have their own versions of smart home network services. Figure 6 depicts a typical smart home [6].

## BENEFITS

The benefits and opportunities of the Internet of things allow telecommunication enterprises and start-ups to expand their existing services and products, as well as introduce new ones that go far beyond their basic offerings. IoT technologies are responsible for automation, innovation, and transformation. The IoT affects both internal and external processes, improving customer satisfaction, enhancing the quality of service, creating new sources of income, increasing return on investment, and completely transforming traditional approaches in telecom. Other benefits include [7]:

- *Operational Efficiency:* IoT-based technology makes it possible to modify the process of collecting data in real-time to optimize performance, decrease resource requirements, and

avoid errors caused by the human factor. IoT solutions can affect various critical processes. For example, they can improve customer experience and level of satisfaction.

- *Higher Speed:* Where connectivity and speed are mission critical for a remotely-operated device and the network drops, becomes slower or lags, the results would be loss of time, money and equipment. With IoT technologies, telecommunication service providers can also leverage the advantages of advanced bandwidth and increased speed of data exchange. The interaction of IoT and telecom companies leads to accelerated speed and advanced bandwidth. IoT protocols and 5G interconnection are able to broadcast information from thousands of devices to numerous users without slowing down communication speed or reducing bandwidth. The introduction of IoT innovations is always accompanied by an increase in the energy efficiency of telcos and the ability to serve millions of connected devices.
- *Customer Satisfaction:* By applying the Internet of things and using it to collect and analyze large amounts of data generated by telecom operators, businesses can identify current tendencies and determine customer behavior, which will let them implement better solutions in terms of marketing, sales, and production, helping to attract new customers and retain existing ones. Hence, the use of IoT in the telecom industry can optimize the user experience and allow telcos to dominate the industry in terms of customer satisfaction.
- *Monitoring:* Telecommunications companies need to maintain constant control over their cell towers, and it is expensive and time-consuming to monitor the state and functioning of each tower manually. Smart monitoring in real-time can predict machine errors and reduce downtime from malfunctions. Leading businesses in the telecom industry are using IoT to trace products, monitor customer satisfaction levels, keep track of employee and user engagement, and more. For example, the Internet of things in telecom can help prevent the spread of infections by following the location of an infected patient and their contacts.
- *Enhanced Security:* Safety must be given priority. Ideas like smart cities are exactly what is fueling the growing demand for Internet of things security. The implementation of IoT solutions in smart cities will definitely provide enhanced security. One of the leading tendencies in increasing security, enhancing privacy, and

providing IoT data protection is blockchain technology, which is embedded into IoT networks to provide improved confidentiality and safety.

- *Enhanced Safety:* Every enterprise that has remote facilities or sites knows that the risks related to these objects are extremely high. There are a lot of weather factors and conditions (like fire) that cannot be controlled but have a serious impact. The Internet of things in telecommunications can monitor the safe operation of equipment, giving the company the ability to take timely preventive measures and avoid serious damage.
- *Service Creation:* New digital services need to be created as IoT applications develop. These services need to be broad in scope and will require a lot of forward planning. There is huge revenue potential in establishing these services, though, as IoT platforms become more popular.
- *Service Provision:* Telecom companies are ideally suited to becoming IoT platform providers. Their ability to act as service providers goes beyond networks. They have the capacity to process large amounts of data and to develop the existing digital infrastructure that is required.
- *Network Development:* The most natural role for telecom providers is network development. This involves the creation and maintenance of network infrastructure for 5G networks that can handle IoT data. This is actually not dissimilar to what many telecom providers are currently doing.
- *Roaming Capabilities:* The telecoms that support and use IoT devices have roaming capabilities where devices can still connect to a cellular network in geographic areas where the primary telecom does not have any infrastructure. AT&T, Orange, Vodafone, and Verizon all claim they have roaming capabilities for their IoT devices because of the SIM cards' capabilities in the devices.
- *Increased Revenue:* Due to the implementation of IoT services, telecom operators can introduce innovative value-added services for their clients. Growing customer satisfaction lets telecommunication companies increase their profits.
- *Business Opportunities:* Another benefit of IoT is that it creates more job opportunities in the telecom sector as a result of the deployment of new technology and the creation of new alternatives. The convergence of telecommunications and the Internet of things is opening up new business opportunities.

Companies can leverage advances in telecommunications to create new products, services, and solutions that can increase efficiency, streamline processes and create new revenue streams.

- *Energy Savings:* AT&T was able to reduce the energy consumption by 9 million kWh per year thanks to energy management using the Internet of things, saving almost one million dollars.

Figure 7 shows some of these benefits [10].

## CHALLENGES

The Internet of things represents enormous potential for telecommunications companies, but also poses a number of challenges that need to be addressed. In spite all its promise, IoT for telcos is not that easy to adopt. The undeniable advantages and endless opportunities go hand in hand with inevitable challenges telcos face when trying to implement IoT solutions. Facing the competition on their own is not a viable option for any telecom operator. Other challenges include [7]:

- *Availability:* IoT is usually utilized to facilitate information anywhere at any time. For IoT environments to become fully functional, round-the-clock availability will be vital. The real-life applications of IoT in environments like smart factories and healthcare environments cannot afford unplanned downtime. The Internet of things is typically used for the constant and uninterrupted transmission of information, capturing user needs. Thus, accessibility is a vital challenge for the Internet of things, and guarantees of high availability of all applied telecom devices are necessary. To ensure accessibility, the best way out is to use these fallback mechanisms.
- *Reliability:* One of the critical points of the Internet of things in telecom is to ensure a reliable and uninterrupted user experience. And this will happen not only by providing reliable information but also by getting used to the changing circumstances of the environment. Absolute reliability must be provided and assured.
- *Security:* Ensuring absolute security and complete confidentiality is one of the key priorities for IoT in telecommunications. With so much interconnectivity, security has become a primary concern for users and businesses. That means that reliable networks with built-in redundancy failsafe will need to be developed within smart devices to eliminate the issue of network disruption. The problem here is that the memory devices in the IoT are only capable of storing a

limited amount of data, which means that some of the information is stored on other resources remotely. Such a type of storage of important data is definitely vulnerable in terms of privacy and reliability. The secrecy and security points are not solved within the technology of the Internet of things.

- **Privacy:** IoT devices store only a small amount of data locally, while the rest is saved on the cloud. Users worry about their personal data getting into the wrong hands, so telecom companies must protect their customers' privacy. Telecom companies should implement strong encryption techniques to secure the communication between IoT devices and the cloud.
- **Interoperability:** IoT technology envisages connecting various devices. This means that interoperability is a must, regardless of device type. The Internet of things in telecom must provide services equally to all connected devices.
- **Scalability:** It is important to consider the scalability of connected devices in such a way as to ensure fast processing of all data. The telecom sector is an incredibly fast-paced environment where the underlying infrastructure has to continuously scale alongside the continuous growth of the number of connected devices. As organizations add more connected devices, IoT scaling gets buried under an avalanche of new forms of data from devices such as sensors, gateways, routers, and cameras.
- **Compatibility:** Various devices should be connected and should be able to communicate with each other. Compatibility between products, cloud storage solutions, and business tools will be vital in large environments using multiple smart devices. This presents a significant challenge in a market saturated with different tech businesses pursuing their own standards. Good interoperability is a prerequisite for the implementation of the Internet of things in telecommunications. It must be maintained between various products that are permanently connected. The fact is that with the growth of the IoT, different technologies are battling to be the standard. Such competition obviously leads to integration problems. Users must update their gadgets and install all fixes to maintain constant compatibility. Diverse industries must work together to ensure maximum compatibility and avoid interoperability issues.
- **Big Data Management:** The introduction of IoT solutions is closely tied to the work with high

volumes of data. This is one of the challenges for telecom operators today that want to deliver IoT services. As the number of connected devices grows, the production of data also multiplies. Managing this data means having access to it, processing it in a timely manner, and storing an enormous amount of it. To deal with this task, they need to use agile and scalable computing platforms that would not negatively affect the productivity of apps.

Some of these challenges are depicted in Figure 8 [6].

## CONCLUSION

The Internet of things (IoT) has progressed from a term to a solution with widespread use in homes and companies in recent years. It is expected to continue to change the roles of telecommunications service providers in enabling communication between people and devices. Integration of the IoT and telecommunication industry will become a solid competitive edge that optimizes productivity, improves service quality, unlocks extra opportunities, raises customer loyalty, increases profits, and leads the telecom business to success. Telecom companies are taking advantage of IoT technology to drive efficiency and optimize resource use within their own businesses. More information about IoT in the telecommunications industry is available from the books in [11-14].

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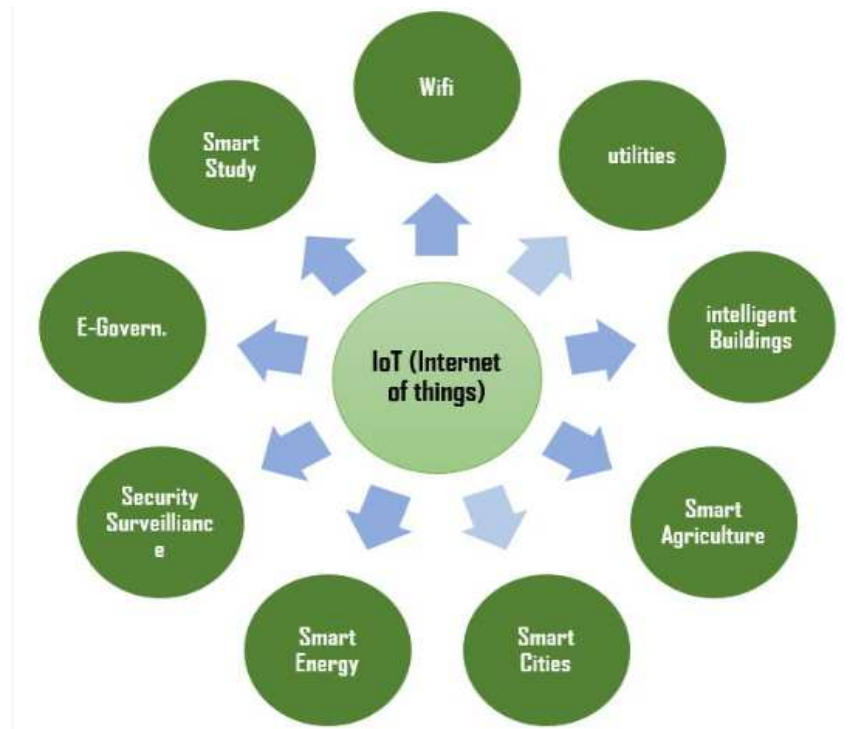
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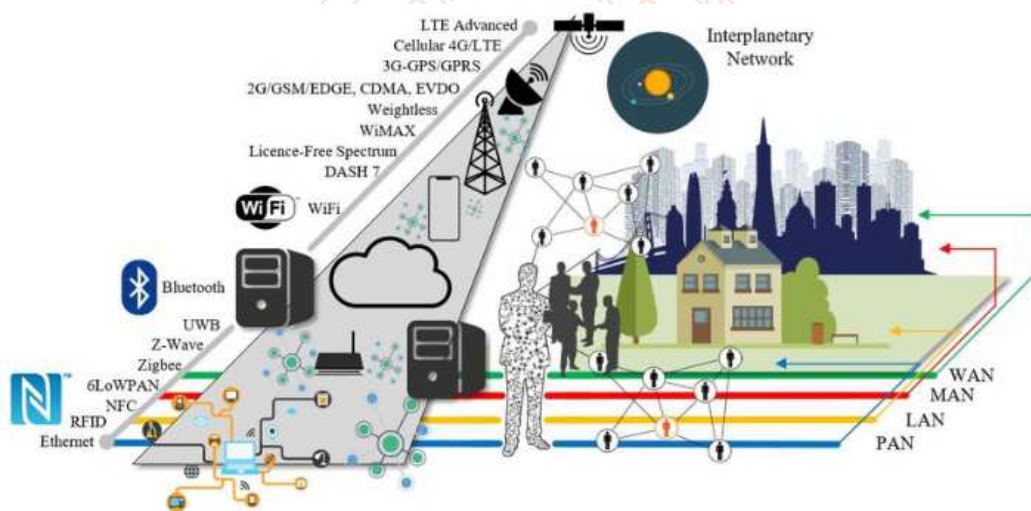
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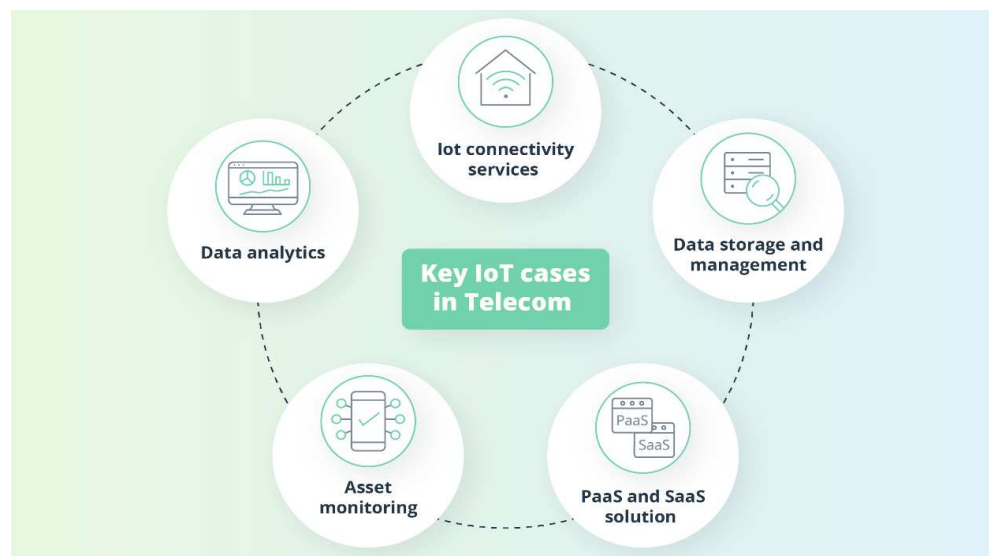
**Figure 1 Complex telecom infrastructure [1].**



**Figure 2 The Internet of things [4].**



**Figure 3 Communications technologies in Internet of things [5].**



**Figure 4 Major IoT use cases in telecom [6].**





Figure 5 A typical smart city [9].

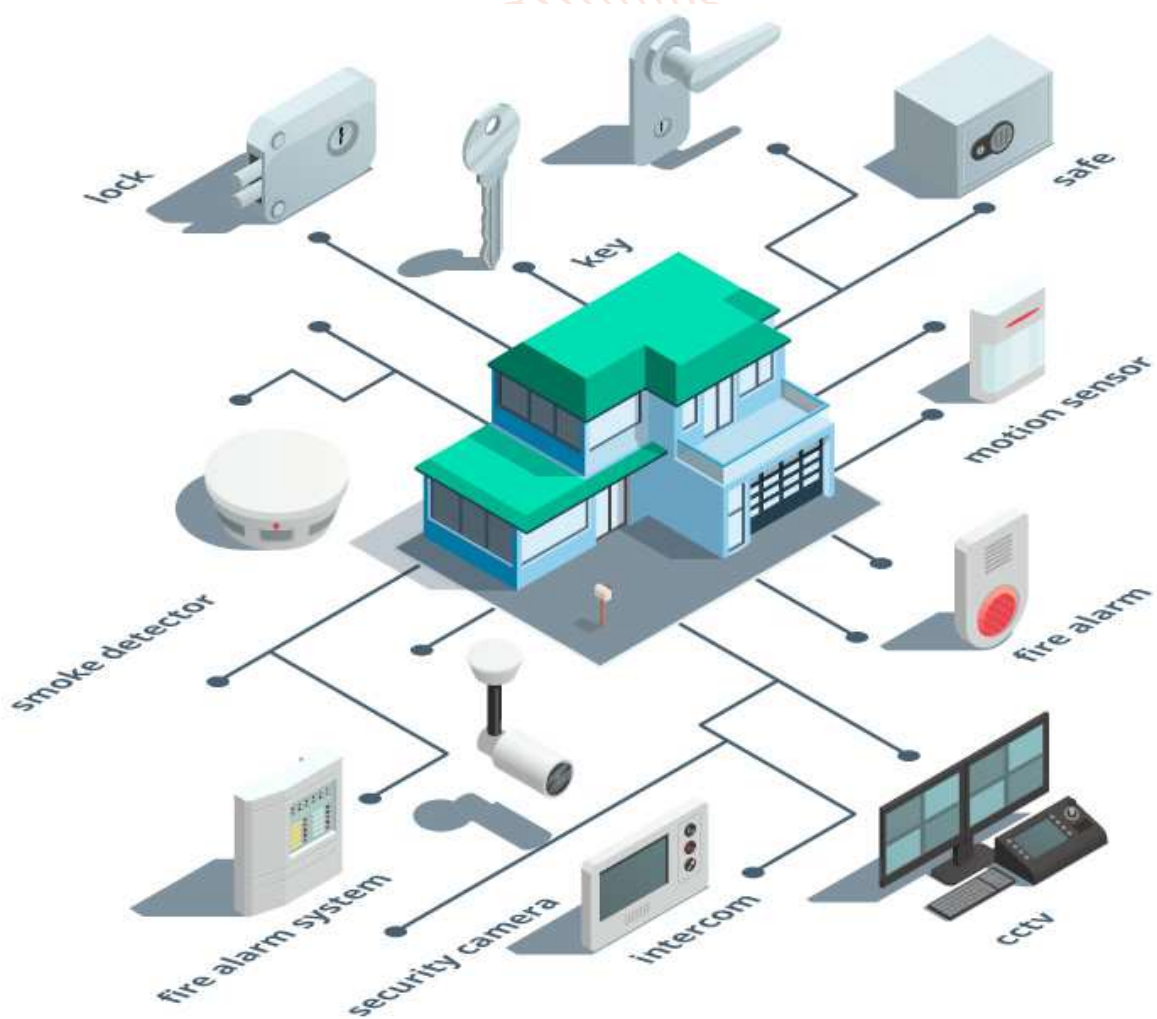
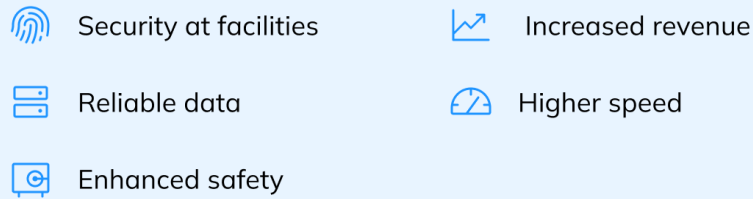
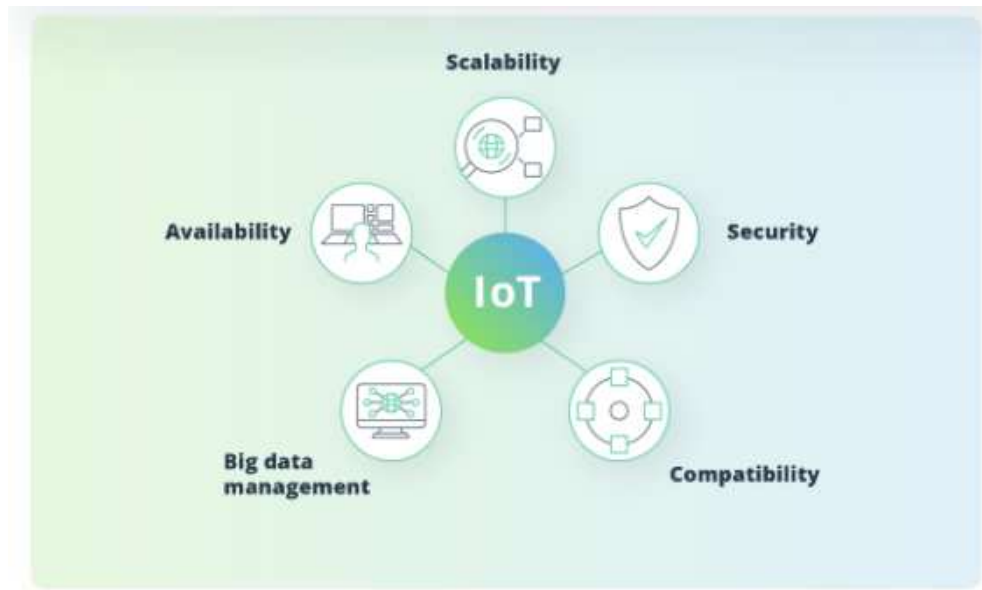


Figure 6 A typical smart home [6].

## Benefits of IoT in telecom



**Figure 7 Some benefits of IoT in telecom [10].**



**Figure 8 Some of these challenges of IoT in telecom [6].**