Impact of Internet of Things (IoT) on 5G

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Abstract

Currently, a disconnected system makes a major challenge for IoT tech-nologies. The ability of 5G to transmit data more quickly and support further links can benefit at once address the present challenge and simplify the connected device control. In contrast, using 4G/LTE networks, 5G will be able to process data quickly, which was a challenge for IoT solutions. The consequence has been long delays from sending data to receiving it. By using the 5G network, more users could contin- uously send more information without fear of overcrowding the network, leading to delays in the past. The 5G connectivity would allow everyone to realize the IoT technology's strength. Now, IoT potential is vast, but the potential connectivity will come to fruition with 5G technology. Using sensors, "Smart" apps can easily transmit data even from thousands of miles away. In this paper, we discuss the impact and importance of 5G on IoT with its applications. As IoT is more established and essen- tial due to the rapid growth of 5G, we discuss the establishment and necessity of IoT over 5G. Lastly, we focus on the aspect of IoT on updated 5G technology.

Keywords 4G/LTE ▪ 5G ▪ Internet of Things ▪ Security ▪ Artificial intelligence, Fifth Generation i.e. 5G**,** Wireless Mobile Industries, Telecom Customers**.**

Introduction

In the last few years, the Internet of Things (IoT) has changed the pervasive measure including a large collection of built-up applications covering different sensor types. A large number of activities are expected to grow in the IoT-based product lines in the coming years of planning of up to billions of devices with an average of 6–7devices per person by 2020 . With most of the above device and protocol concerns resolved over the past decade, the cyber-physical and device-to-device (D2D) inter- action convergence of sensors and sensor-based systems are now growing. A lot ofdiscussion about 5G of the fifth generation of mobile communication networks has been taking place recently. As each new generation arrives, they are accompanied by more capacity and faster connections. Projected benefits include:

- Enhanced coverage: over the 4G and LTE towers, 5G cell towers will have improved capacity, which ensures that more phones will connect simulta- neously.
- Reduced latency: 5G eliminates log time and delays in sending and receiving information significantly.
- Faster connection: it is estimated that 5G speeds are about 10 faster than 4G connections are now feasible.

It is promised that the upcoming 5G wireless network technology will be respon- sive, fast and power-efficient . While faster downloads and insufficient latency offered through 5G will attract mobile phone users, it is just not enough to explain the huge cost Bloomberg estimates at 200 billion a year.

The Internet of Things is still one industry that can see all of this differently as depicted in Fig.

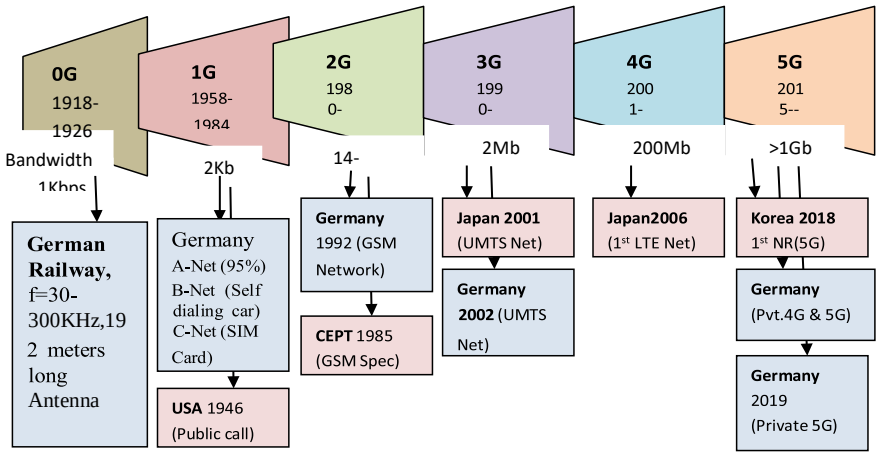


Fig. 1 Generation of private networks in Germany (from 0G to 5G in Germany)

Currently, 5G is not a term officially used for any particular specification or in any official document yet made public by telecommunication companies such as 3GPP i.e Third Generation Partnership Project. New 3GPP standard releases beyond 4G and LTE are already in a progress but it is not enough for new mobile generations.

5G Technology stands for 5th Generation technology for cellphones .This 5G technology has a Fast speed as well as powerful network for cell phones within very huge bandwidth that noone can imagine before.In today's time, users have sufficient information about the cell phone (mobile) technology. This technologies contains a various type of extraordinary features that makes 5G more powerful & most demandable network in the future. on IDC results, is expected to reach 1.2 trillion.The researchers, engineers andscientists face different challenges on IoT-based system development with 5G wire- less communications. Mostly the advancement of cloud computing and its extension version fog computing, with the proliferation of smart IoT devices can be extended further. As IoT technologies, i.e. machine to machine communication, intelligent data analyses are expected to impact on the 5G. This research challenge helps us to design a new system with the presence the smart IoT devices and its applications.

The 5G network will mainly contribute to the creation of the Internet of Things as an integral part of the world by laying the foundation to unlock its full potential. Recent mobile technology has no equal accommodation for 20.4 billion connecteddevices and is setting up the exchange of data without small lags . IoT's increas- ingly emerging technologies revealed an impressive step in five key areas in the technology interruption:

- Sensing—Endpoints of IoT,
- Communication—IoT communication,
- Secure—Secure IoT,
- Comprehension—IoT information and analytics,
- Acting—Intelligence Artificial IoT (AI).

5G promises a massive, friendly IoT ecosystem, with huge improvements over the 4G's current capacity. It is capable of covering up to 100 times more connected devices per unit area compared to the 4G LTE. IoT's idea is to have heterogeneousconnected devices that collect the information in real-time over a limited period oftime. After all, the continuous transmission of data contributes to exhaustion in thebattery life of both the network and the phones. The new cellular network will see a 90% reduction in the network energy routine for up to 10 years of battery life forlow-power IoT phones. Businesses and consumers of apps are enthusiastic about the prospects that will grow in 2019 and 2020.

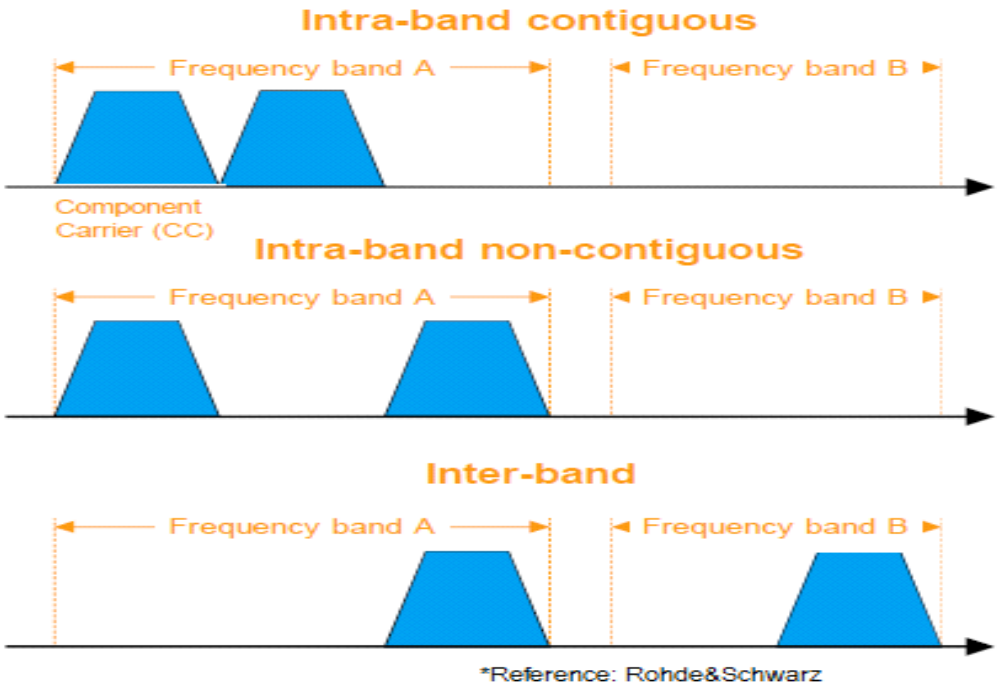
The rest of the paper is organized as follows: Sect. 2 presents the IoT challenges, which most likely offers the system requirements. In Sect. 3, we discuss 5G chal- lenges. Section 4 presents 5G characteristics along with their applications. Section 5 describes the impact of 5G on IoT. Finally, in Sect. 6 we conclude the

advantage of 5G over the use cases of IoT.

WORKING OF 5G TECHNOLOGY

5G technology uses various methods.Following are the key points for working of 5G technologies

1.Carrier Aggregation:Carrier aggregation is a technique used in Long Term volution i.e LTE and helps to improve the system productivity and efficiency. In carrier aggregation, there are two or more carrier signals are aggregated to support wider bandwidth which allows even up to 100 MHz,too.



Carrier Aggregation(CA) uses three techniques for aggregation

Intra-band contiguous: In this technique,there are two carriers which are transmitted at neighboring channels .

Intra-band non contiguous: In this technique,there are two carriers that are transmitted with channel spacing.

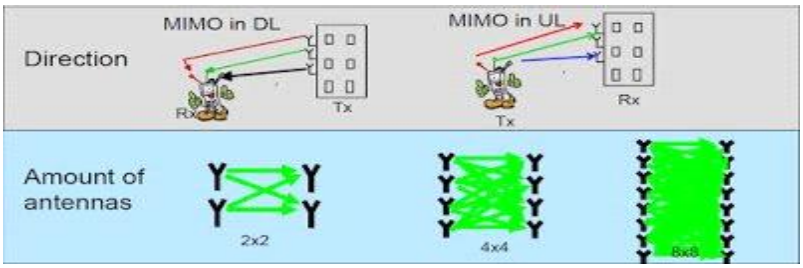
Inter-band: In this technique,different Long Term Evolution i.e LTE bands are used for sending and receiving of data very fastly as well as simultaneously.

2. Small Cell Concept

In this technique, in order to increase network efficiency, there is a dividation of a cells amongst the tiny i.e. micro as well as Pico cells. And the Spectrum ability to reuse i.e reusability allows the network to add more users in a small geographical area and is also allows us to handle network more efficiently as well as securely.

3. MIMO (Multiple Input,Multiple Output) Concept

MIMO is a transmission technology with the usage of multiple antennas for transmission and receiving data. High speed and Parallel transfering of data is possible using this technology thus it offers very suitable & efficient data rate.If there is more the number of devices for receiving like routers,antennas thet transmission and reception can be done ina huge amount and that will improves speed.

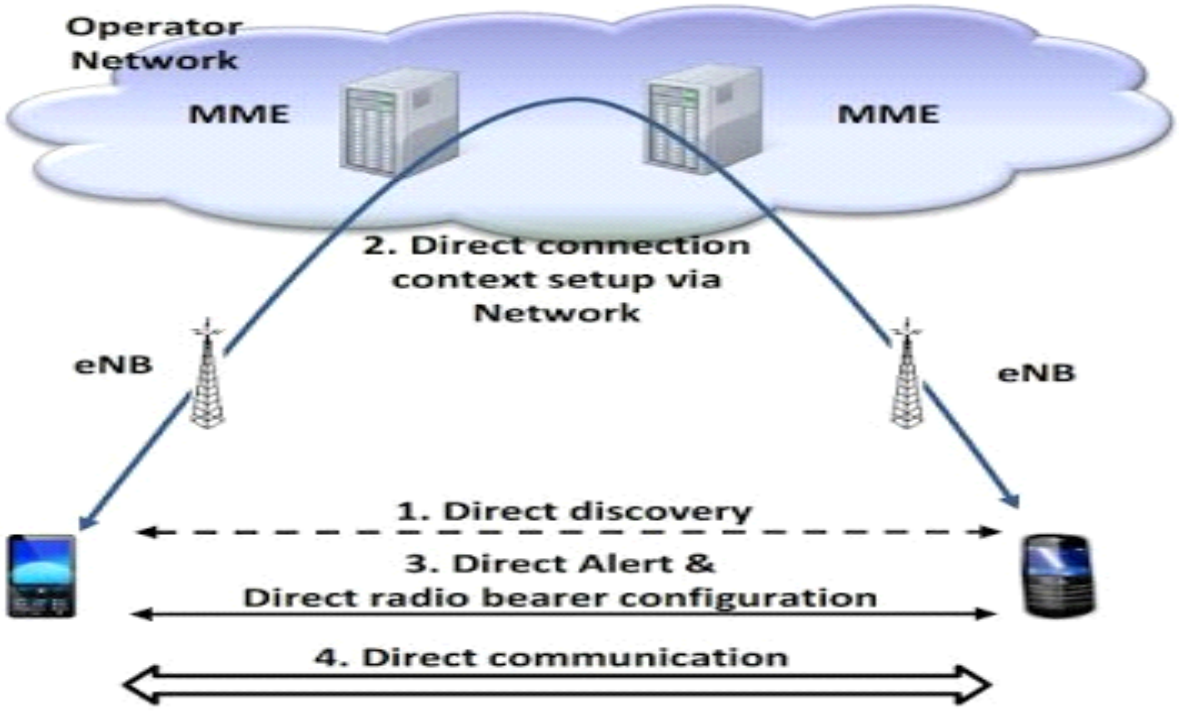


4. Wi-Fi off loading

Wi-fi ,one of our basic need that also get improved due to 5G network. Fifth genration technology i.e 5G allows the user to connect using the cellular network wi-fi network and can be assigns to other users. The 5G will be suitable for those parts or some areas where cellular network quality is poor and also user still have the option to connect to the network without any kind of receiving data by cellphones. The 5G technology will make wi-fi more accurate as well as efficient and speed up it's working or execution.

5. Device to device communication(D2D)

This type of communication is also called as D2D communication.It is method or technique where the network authorized that the two communication devices are able to communicate with each other without any interruption.



6. Cloud-A Radio Network Access

C-RAN i.e Cloud-Radio Network Acces is a network technology which is used for the reliable as well as effective communication with centralized information processing carried out remotely within cloud system.

IoT Challanges

IoT offers everything systems with the requirement of software and a large number of items must be accessible at low cost. Therefore, IoT's problems and the core criteria are as follows:

Energy efficiency: Three important stages are harvesting, conversation and consumption of IoT ecosystem require energy. Novel energy-efficient solutions need to be explored .Harvesting technologies and small batteries contribute. towards saving energy. But the problem occurs when the application takes place in a remote area where reaching is effort-consuming task and recharging or replacing batteries is another impossible task. When direct communication between IoT devices is established energy consumption may be reduced. Localconnectivity is achieved by using short-range standardization wireless tech- nologies and wireless gateways are adopted for providing remote connectivity to the Internet. The modern LTE-A cellular network is another contributor to energy-efficient networking solutions.

1. Scalability: Enormous statistics of smart devices are responsible to be part of the upcoming IoT world leading to the drawback of current network infrastructure. There are many drawbacks to be addressed in 5G based IoT systems though some recent works are carried out by 3GPP for supporting MTC in LTE-A. We expect percentage-based IoT architecture to include eliminating surplus in link access by maintaining efficient allocation of resource radio and efficient handling of small-size data communication on the assumption of

high device performance.

2. Resilience: The dynamic essence of the wireless IoT ecosystem ensures system operation under severe conditions including deficiencies in connectivity to the network infrastructure. Unlike the capillary network broadcasting successes, due to crowded incidents, network node failure situations, not so good wire- less networking conditions, and many catastrophic circumstances, an unforeseen lack of infrastructure base is likely to occur. In addition to the lack of network infrastructure access, the inherent dynamic nature of wireless IoT environments often needs device stability assurances under harsh conditions.
3. Interoperability: Highly heterogeneous artifacts populate the IoT, each having specific functions that are accessible through its own language and network one of the main criteria, is to handle this inherent diversity, which provides efficient solutions for the seamless integration of devices, technologies and services .From the communication point of view, IoT versatility will take the range of radio technologies involved in the support of low-power devices. In 5G network, all evolving trends are supported by the connectivity of IoT applications. For those next-generation cellular networks needs an effective mechanism to handle hetero-geneous data capabilities, manages different radio technologies and integrated mobility management, etc.
4. Team communications: In IoT universal environments, data provided by a single object may not be reliable or useful enough to support specific applications and therequired quality of the data. At the same time, autonomous IoT systems can have advantages in activating simultaneous actions on multiple actions such as street light lamps in a smart city. The relevance of IoT group communication involves standardizing a resource-constrained device application protocol based on IPv6 . Multicast and unicast-oriented solutions can provide team communications. The former situation is the most difficult because the network has to facilitate the simultaneous transmission of packets to a number of recipients. This enables network traffic to be reduced and the efficient use of resources to be improved .

5. Cloud-based IoT network environment: Supporting a dynamic execution system for complex IoT applications is another major challenge. On-demand processing and storage tools are deployed globally with supported by data centers. IoT device virtualization, dynamic processing sensor events, image transcoding, face reorganization, storing huge amount of data and analyzing the big data make more challenges in IoT platforms. Vehicular networks, Fog computing was introduced for IoT, address these issues through cloud services. These cloud computing solutions face delays in communication with remote data centers due to traffic congestion.
6. Multimedia IoT support: Multimedia smart devices also need to be fully incor- porated to support multimedia services in order to implement a robust IoT plat- form. Different use cases involve telemedicine-based ambient assisted living and patient care, integrated smart home monitoring systems, advanced interactive smart city monitoring involving real-time processing of sensor data. In addition, the so-called “Multimedia Things Internet”incorporates functionality and network specifications that vary from those of the traditional resource-limited IoT environment. Multimedia things foresee higher computational capabilities to manage multimedia flows and, above all, communication is focused on band- width, jitter, and loss rate to ensure acceptable multimedia content delivery. Low- power radio systems are not well suited to serve these traffic types, although cellular networks offer better performance for multimedia flows. Nevertheless, taking into account the additional traffic created by multimedia products, 5G must include new, efficient strategies to satisfy both system and human requirements,
e.g. by utilizing edge data caching and delivery of proximity information.

5G Challanges

In 5G development, the early challenges include:

- Using different frequency bands: In 5G networks a combination of low, mediumand high channels. All the mobile operators are expected to be implementing 5G services through a smaller spectrum band.
- 4G to 5G Gradual transition: In industry, services must be 4G to 5G, due to the critical continuous requirements of on-demand delivery of hardware, software and services.
- Preparing the core network: Implementing the 5G setups, requires substantial improvements in cloud computing networks, in the area of virtualization and MIMO.
- Data interoperability: It is very crucial to achieve interoperability between user elements (UE) and commercially developed 5G networks to validate key technology.
- 5G business models Establishment: In industries, 5G business models must be low-cost and high-performance implementations as depicted in Fig. 2. Developing a network infrastructure and application ecosystem to help a sustainable business model for 5G services

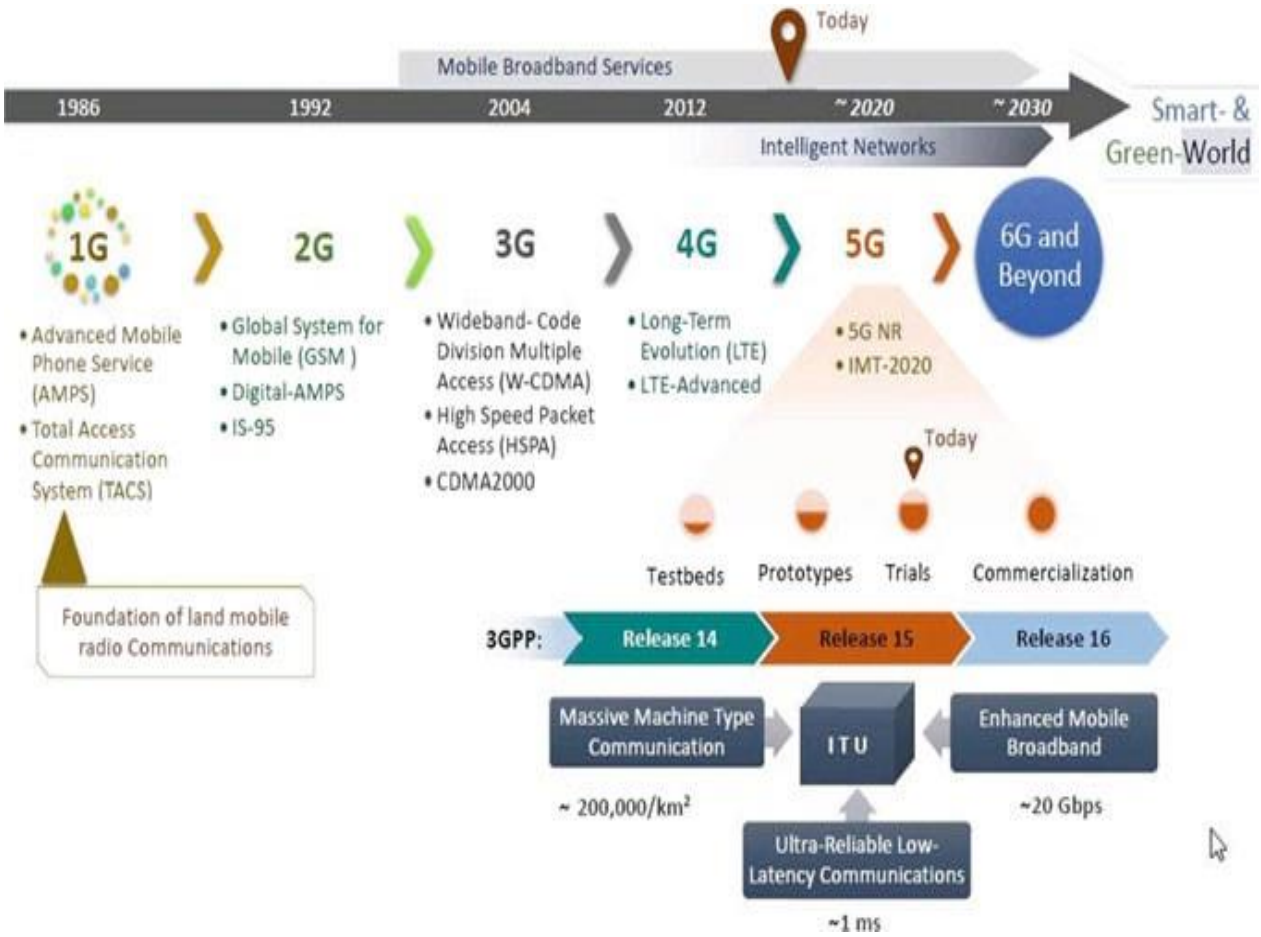


Fig. 2 Evolution of mobile technology

1. 5G Characterstics & Their Application

There are some characteristics of 5G along with their values/applications are summarized in Table1.

1.1 5G on IoT: A Single Network for Millions of Applications

With commercial 5G deployments beginning across the world, there will be increasing interest surrounding the benefits that 5G can provide to the growing Internet of Things (IoT) movement. A major roadblock to realizing the potential and promise of the IoT is that multiple, specialized networks are being utilized for different IoT use cases, from applications that utilize low-data transfer rates to high-end mission-critical applications that require instantaneous data transfers. 5G, however, offers a solution that allows for a single network to support myriad IoT use cases and build economies of scale.

Table 1 Characteristics and their application

Characteristics	Application
Network characteristics	Cloud computing, software engineering, virtualization,slicing
Maximum data rate	20 Gb/s
Maximum experienced data rate	0.1 Gb/s
Efficiency rate	3 times of 4G
Network efficiency	10–100 times of 4G
Traffic capacity	10 Mb m^2/s
Density of the connectivity	10^6 devices/km^2
Latency	1 ms
Mobility	500 km/h
Technology	Cloud/fog/edge computing, massive MIMO, flexible framestructure, network slicing
Usage scenario	eMBB, URLLC and mMTC

1.2 The Importance of 5G on the IoT

In short, IoT growth is exploding, and using multiple specialized networks to handle various IoT applications is costly and difficult to scale. By 2020–2030 in a period of just ten years, IoT devices will expand by 40–140 billion and the IoT upgrade from 4G to 5G is strong: today's 4G networks, for instance, can accommodate up to 6000 NB-IoT devices on one cell. With 5G, on the other hand, a single cell can handle up to one million devices. IoT applications that require minimal data transfer rates can result in massive volumes of data transmitting over networks, and this requires a great deal of connection management for each network. On 5G, however, this is not the case: the single network approach of 5G is already optimized to handle massive data transfers across a broad range IoT application .

1.3 Application of 5G Over IoT

5G and IoT together would also help to put each product on the shelves to the Internet. Consumer products do not need to be continuously connected to the Internet as hard- ware devices, but they can send and receive data about themselves as connected smart products based on event-based experiences with clients and other entities through scanning, RFID readers, NFC tags and more . The current wireless infrastructure is not up to the task of dealing with so many network devices, but 5G will make it possible. Smart Packaging and Digital Labels can transform the way retailers manage inventory and logistics and provide a hotbed of imagination to use them as a way to interact with consumers in a creative manner. 4G does not manage data load from the ever-increasing number of online sensors and connected devices, limiting what IoT can actually do. The 5G is the ideal enabler for the Internet of Things with its high data speed, low latency, increased mobility, low energy consumption, cost efficiency and the ability to handle much larger devices. 5G can play a major role not only in transforming the way we communicate but also in changing industry and society. There are a number of companies in which 5G as well as IoT can cause interruption together, that are:

1.Self-driving cars: Sensors generate large quantities of data on self-driving cars, temperature measurement, traffic conditions, weather, GPS location, etc. The collection and assimilation of each quantity of data require a great deal of energy. These cars also heavily relay on real-time information transmission in order to provide optimum services. Nevertheless, with high-speed communication and low latency, this intelligent care will be able to collect all kinds of data on an ongoing basis, including time-critical data on which algorithms will work inde- pendently to keep track of the working condition of the car and improve future designs..

2. Healthcare: As all types of medical devices are powered by IoT, changes in their services will also be seen in the medical field. Notwithstanding proper healthcare infrastructure, the IoT link will greatly benefit rural areas and other similar remote locations. With such low latency, it becomes an option to provide world-class health care services such as remote surgery .

3. **Logistics**: 5G networking will improve end-to-end logistics operations with advanced IoT monitoring sensors. High speeds and low latency will not only allow data to be obtained in real-time, but also enable energy efficiency to generate more diverse information at all points within a supply chain for a very long time. A buyer would have access to detailed information such as where the fish she had just bought was caught, the temperature at which it was treated during processing, and when delivered to the seller.

4. **Smart cities**: 5G will allow broader applications from water and waste manage- ment to smart city projects, traffic control to enhanced facilities for health care. Smart cities will benefit from the benefits of the new generation network as more and more devices reach urban infrastructure. Not only will 5G be able to

handle the massive data load, it will also make it a reality to incorporate multiple smart systems that continuously interact with each other, bringing a truly connected city's dream closer.

5.Retail: As they attempt to shape customer engagement and experience through mobile phones, retail IoT will see a positive impact from 5G's arrival. Improved connectivity and a larger number of network-connected devices would allow new and innovative ways of engaging consumers to engage faster with shoppers through better digital signage. With increased reality and virtual reality, it will become more popular. Retailers will be able to enhance the shopping experience by implementing omnichannel sales activities more efficiently.

The Impact of 5G on IoT

Today, disconnected networks are a major challenge for IoT technologies. The capacity of 5G to transmit data more rapidly and allow more connections will help at once address this issue as well as simplify the management of connected devices. In contrast, 5G will be able to process data quickly using 4G/LTE networks, which has been a challenge for IoT solutions. The result was a long delay from the time the data was sent to the time it was received. The 5G connectivity would allow everyone to understand the IoT technology's strength. As of now, IoT's potential is enormous, but the real networking must come to fruition with 5G technology. Using sensors, "Smart" apps can easily transmit data even from thousands of miles away. The impli- cations on an individual and municipal scale are endless. The 'smart' city has become a reality that will reap the rewards for both local businesses and residents .5G will make it possible for companies investing in IoT technology or creating IoT-based platforms to have many of the desired specifications. Better connectivity, lower latency and faster connection mean more people can transmit more data at the same time. As a result, IoT solutions will grow companies constantly without thinking about disconnected networks that have plagued IoT developments so far. 5G facilitates the development of IoT applications to help all.

Establishing a 5G—IoT Ecosystem

IoT will have more chances to expand capabilities; services as well as reliability as more development resources like 5G enter the market. According to Statista, "The Internet of Things Devices installed base is expected to grow to nearly 31 billion worldwide by 2020" , Factors needed to build a 5G-IoT ecosystem are as follows:

1. Automatic power supply: Batteries and wires may be a viable IoT power solution now, but it will be nearly impossible to keep up as IoT's sheer volume expands globally. A failed or drained battery can cost a company's revenue and increase protection and liability concerns in an IoT sensor, M2M or factory automation. Having wireless power without pads and over the range is important.
2. Innovators, integrators and implementers: The implementation of 5G is clearly expensive. Companies need a short and long term growth strategy along with people to help them fully realize the benefits, safe and secure .
3. A electronic recycling program: Normally we will keep our home appliances and work equipment for dozens of years. With IoT enabled by 5G and a continuous and automatic IoT sensor wireless power supply, existing "non-smart" devices will soon become obsolete and need recycling or upcycling. Industries and soci- eties

that prepare differently for this will become an opportunity to present a potential threat to the environment.

Future of IoT

By 2025, it is estimated that more than 21 billion IoT devices are in the market. Cybercriminals will continue their role with IoT devices through DoS and DDoS attacks.
More cities will seem smarter .
Artificial intelligence with networking will become a bigger challenge in the upcoming scenario.
Routers will continue to become more secure and smarter. Instead of 4G, 5G networks will continue to fuel IoT growth.
Vehicular networks, i.e. Cars, trains, buses will get even smarter .
5G's arrival will help in smart home automation and also act to open the doorwith privacy and security concerns.

- IoT-based DDoS attacks will create a major problem in the networks .
- Security and privacy concerns will drive legislation and regulatory activity.

Aspects of IoT on Updated 5G Technologies

There are some of the different aspects of IoT to be enhanced by 5G technology, which are as follows:

Data:- The most obvious impact 5G technology implementation will have on the IoT is its ability to share far larger data volumes at faster speeds than 4G. Using more advanced communication techniques, such as MIMO, to improve 5G networks ensures that more information can be sent and retrieved in a relatively short time frame. Numerous transmitters and receivers distributed over large areas work much better than the distribution of single antennas. Hence, coverage is usually more difficult to reach remote rural areas or large buildings inside that can certainly be enhanced.

Size:- In the previous years, the IoT's sheer size has improved significantly as those devices are linked and additional applications are being created. 5G networks' abilityto transmit more data at faster speeds would empower more connected devices to connect and talk to each other to the network. High latency has been a continuous problem for companies with multiple connected devices, but after adapting the 5G network, companies have been able to add many more devices to their network without causing congestion and further latency problems.

Power Consumption:- Another issue that concerns organizations and individuals planning to implement multiple connected devices to a system. For example, recent developments in the narrowband IoT enable narrow bandwidth that is optimized for low-data rates IoT applications. This would empower the network with much lower power consumption and reduce the strain on data transmission as well. For many industrial and business operations, scalability is key and 5G technologies will hopefully make such conceivable results viable.

Conclusion

Over the past few years, there has been an increase in mobile broadband technology, 2G networks were designed for voice communication, 3G networks added voice and data and 4G offered a boost to Internet-based broadband experiences. 5G is about fusing networking computing capabilities with imagine a world in which connected devices do not have to take the computing load because the network they communi- cate over is capable of processing enough. 5G will also help to realize IoT's potential well beyond what is possible with today's technologies. Human and object interac- tions will increase to all-new levels. 5G will provide countless benefits on the road to realizing the potential of the IoT. The advantage of using a single 5G networks will prove more efficient, more cost-effective and will provide economies of scale across a wide variety of IoT use cases. 5G is believed to be more speed up to 10 Gbps, lower latency and higher extensive coverage and increase the data traffic protection.

Reference

1)https://www.seminarsonly.com/Labels/5g-Mobile-Technology-Abstract.php.

2)https://www.rfpage.com/how-5g-technology-works.

3)https://www.tutorialspoint.com/5g/5g_architecture.

4)www.Grammarly.com/Research_Writing.

5)www.gsmaintelligence.com/research/?file=141208-5.

6)www.ajer.org/papers/v2(10)/ZP210344353.pdf.

7)ijcsmc.com/docs/papers/March2014/V3I3201499a91.pdf.

8)www.engpaper.com/5g-2016.htm.