A. Introduction to 5G and AIoT

Chapter #1: Overview of 5G and AIoT

ET0743
5G and AIoT Applications

Week #1

Learning Objectives

At the end of instruction, the learner should be able to:

- Understand an overview of 5G.
- Understand an overview of AIoT.
- Describe the importance of 5G and AIoT in current and future applications.

What is 5G?

"***5G is an end-to-end ecosystem to enable a fully mobile and connected society. It empowers value creation towards customers and partners, through existing and emerging use cases, delivered with consistent experience, and enabled by sustainable business models***," – NGMN (Next Generation Mobile Networks Alliance)

"***5G enables technologies such as AI, Digital Twin, augmented and extended reality to seamlessly work together, key for businesses at the forefront of digital transformation and providing consumers with a better-quality experience***," – IMDA's press-release about 'IMDA announces new 5G projects, including augmented reality experience in Marina Bay' on CNA (03 Aug 2022)

Here are some definitions / statements given by some people on what is 5G, and what 5G can do.

The Next Generation Mobile Networks Alliance is a mobile telecommunications association of mobile operators, vendors, manufacturers and research institutes.

The Infocomm Media Development Authority (IMDA) is a statutory board under the Singapore Ministry of Communications and Information (MCI). IMDA manages the frequency allocation and assignment for commercial and government spectrum usage per IMDA regulations.

5G Explained in 7 Minutes: https://youtu.be/mo1lNRKnayA

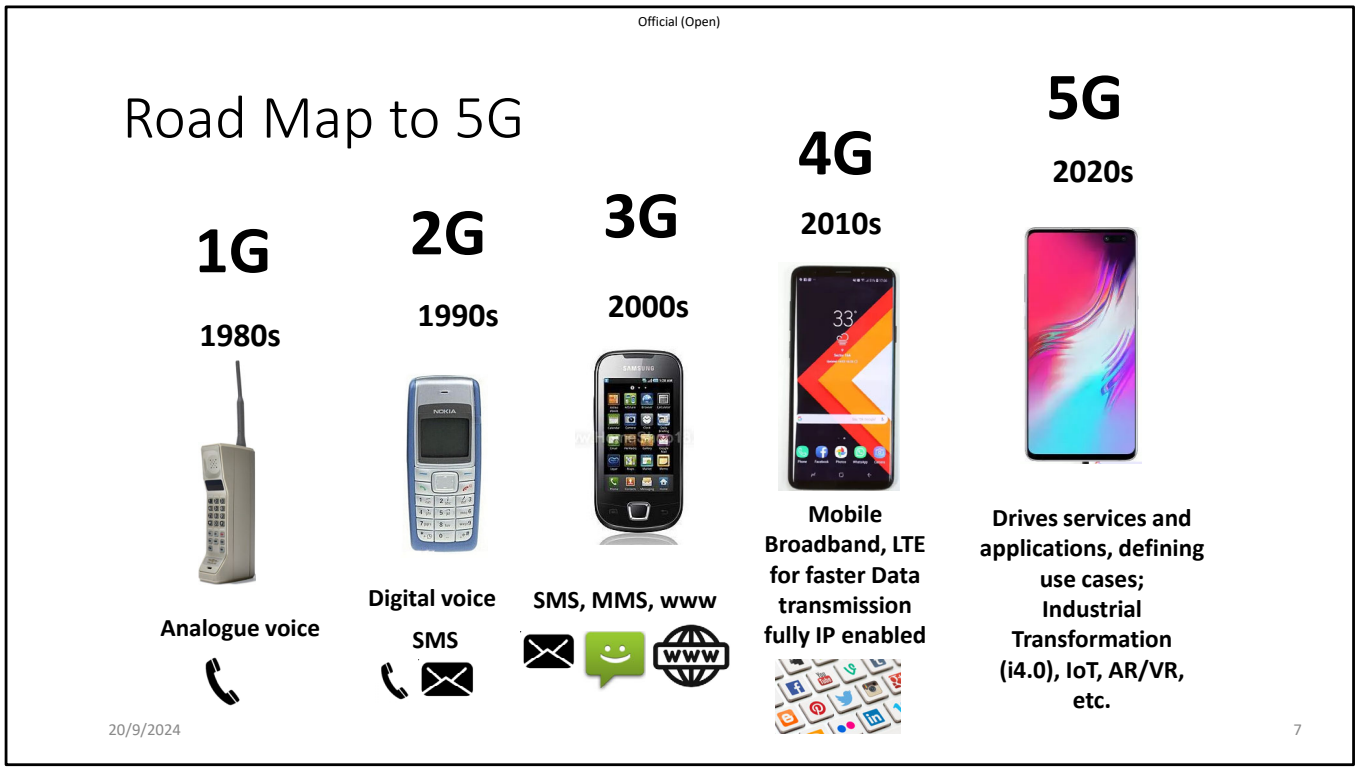
A YouTube-link to a video-clip on 5G using a simple business case to explain.

Voices of early 5G consumers: https://youtu.be/-cmNpFxqDng

South Korea is an early adopter of 5G. Here is a YouTube-link to a video-clip on what the South Koreans expect out of 5G.

5G for consumers: https://youtu.be/xJKWH0KD4Wg

Here is a YouTube-link to a video-clip on what 5G can do.



With the commercialisation of mobile phones in the 1980s, analogue voice calls became possible for consumers. Digital voice and text communications via SMS first appeared in the 1990s. In the 1990s, Nokia was the first hand phone-maker to enable SMS texting. These were regarded as 2G networks.

The inception of 3G technology in the 2000s dates back to 2001, when NTT DoCoMo introduced the first 3G network in Japan. "3G" stands for third generation mobile telecommunications technology, which was superior to 2G (second generation) systems in terms of data transfer rates, bandwidth, and features.

The mobile business saw tremendous changes with the advent of 3G technology, which made new services like multimedia messaging, video calling, and mobile internet browsing possible. However, because of its expensive nature and constrained coverage, 3G technology did not catch on quickly.
The introduction of smartphones and mobile applications in the middle of the 2000s caused a spike in the demand for 3G services. Consequently, global carriers made significant investments in growing their 3G networks and enhancing their coverage.

The late 2000s saw the introduction of improved mobile computing capabilities to consumers through the iPhone and other smartphones, which led to the pinnacle of popularity for 3G technology. But as the decade came to an end, 3G networks'

shortcomings were exposed as they were unable to keep up with the growing demand for services and apps that required a lot of data.

A new era in mobile telecommunications began with the introduction of 4G technology in the early 2010s, but 3G networks remained popular and maintained by carriers globally for many years to come.

With the advent of 4G technology, the mobile industry saw a dramatic change as new services like cloud computing, online gaming, and streaming high-definition video were made possible on mobile devices. The enhanced capacity and velocity of 4G networks enabled carriers to provide customers with more reasonably priced mobile broadband options.

The first 4G-capable smartphones and tablets, such the Samsung Galaxy S and the Apple iPad, were released in the early 2010s, further increasing the appeal of 4G technology. The increased demand for 4G services as a result of these devices prompted carriers to make investments in growing their 4G networks.

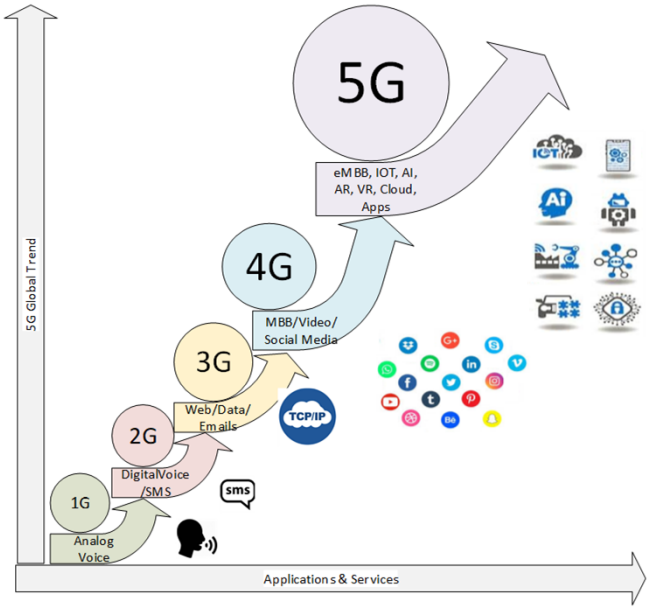
The need for 4G services grew as 4G technology became the norm for fast mobile data transport by the middle of the 2010s. But as mobile data consumption rose, carriers found it more difficult to keep their 4G networks reliable and capacity-rich.

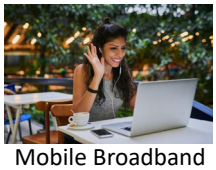
In response to these escalating obstacles, 5G technology was developed in 2015 with the goal of being implemented by 2020. The United States, China, and South Korea hosted the first commercial launches.

The arrival of 5G technology promises to revolutionise numerous facets of our existence, including novel uses like self-driving cars, online medical procedures, and virtual reality. The wider acceptance of cutting-edge technology like artificial intelligence (AI) and the Internet of Things (IoT) is also anticipated to be aided by the faster and larger 5G networks.

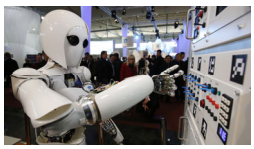
With the potential to completely transform how we interact and communicate with one another, the implementation of 5G technology is anticipated to continue for many years to come.

5G Global Trends Driven by Services & Applications




Mobile Broadband


Internet-of-Things (IoT)


Artificial Intelligence (AI)


Applications


Augmented-/Virtual-Reality (AR/VR)


Distributed Cloud

The figures in this page is another perspective of the roadmap before.

We are able to expand the network's functionality and capacity with every generation. Beginning with 1G, the first version to include analogue voice. Digital voice and SMS text messaging were integrated into 2G. Smartphones were first introduced as phones with 3G mobile broadband. Users could read e-mails, browse the web and view streaming. Although 4G was a 3G mobile broadband speed enhancement, social media traffic rose as well, necessitating even more capacity.

5G is introducing improved mobile broadband. Additionally, users' devices will be able to establish a 5G network connection. Applications like Artificial Intelligence (A.I.), Augmented Reality / Virtual Reality (AR/VR), and Internet of Things (IoT) will be made available.

Overall, it can be seen that the increasing 5G global trends are really driven by applications (apps) and services.

Benefits of 5G for Rural America: https://www.youtube.com/watch?v=g8C4puvlomk

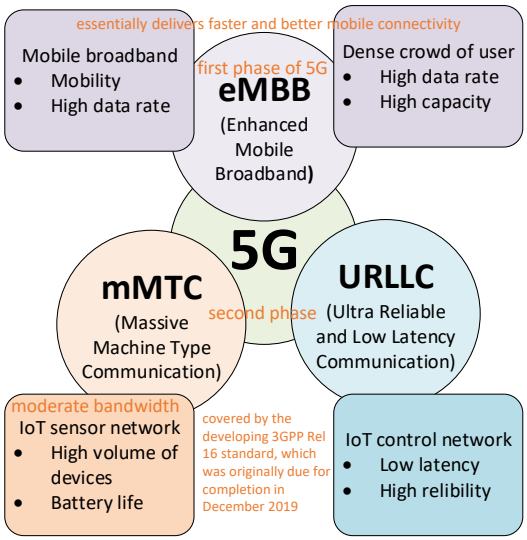
City dwellers tend to want faster data-rates (e.g. video streaming), and lower latency (e.g. online gaming) for their cellular services. So here is a YouTube-link to a video-clip on what 5G can do for consumers living in the rural areas.

What is 5G wireless technology?

5G Key Areas

- Fifth Generation of mobile networking determined by part of ***3***rd ***G***eneration ***P***artnership ***P***roject (**3GPP**) Release 15 onwards.
- That needs to meet the requirements of the ***I***nternational ***M***obile ***T***elecommunications-2020 (**IMT-2020**; "5G") under ***I***nternational ***T***elecommunication ***U***nion ***R***adio communication Sector (**ITU-R**).
- Addresses three key areas and put into four different usage scenarios:
  - enhanced mobile broadband (**eMBB**),
  - massive machine type communication (**mMTC**) and
  - ultra-reliable and low latency communication (**URLLC**)

Three key areas, or "three broad use cases of IMT-2020/5G".



The 3rd Generation Partnership Project (3GPP) is an umbrella term for a number of standards organisations that creates and maintains the technical standards for global mobile communication technologies, including GSM, GPRS, EDGE, UMTS, HSPA, LTE, and future 5G technologies. In other words, 3GPP develop protocols and specifications for the mobile telecommunications.

On the other hand, International Telecommunication Union Radio communication Sector's (ITU-R's) role is to manage/regulate the international radio-frequency spectrum and satellite orbit resources, and to develop recommendations for radio communication systems with the objective of ensuring the effective use of the spectrum. In other words, ITU-R sets the guidelines and requirements by which 3GPP must work.

In October 2015, World Radio Communication Conferences (WRC) in Geneva Switzerland, ITU-R officially authorised a resolution to move forward with research into 5G and gave 5G the official legal designation of "IMT-2020".

ITU-R categorised three key areas, or "three broad use cases of IMT-2020/5G"; i.e. Enhanced Mobile Broadband (eMBB), Massive Machine Type

Communications (mMTC) and Ultra Reliable and Low Latency Communication (URLLC).

For example, field workers utilising AR apps and smart glasses, or mobile professionals with laptops or tablets equipped with 5G connectivity, eMBB simply provides faster and better mobile communication.
eMBB is the initial/first phase of 5G, and is now included in the June 2018 3GPP Rel-15 standard along with NSA (non-standalone, based on LTE-Advanced Pro) and SA (standalone) elements.

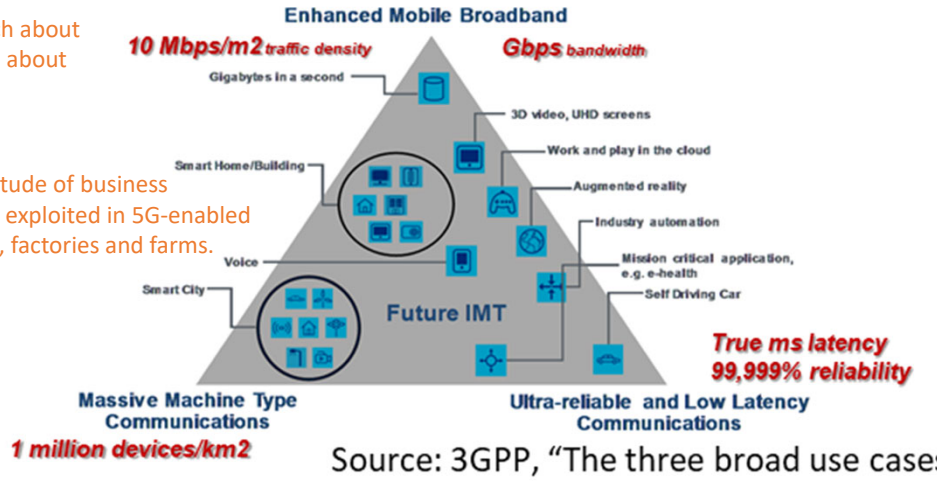
The second phase will cover the types of connections needed by IoT device-heavy environments like smart cities (whereby they require moderate bandwidth and high density; i.e. mMTC) and self-driving cars (whereby they require reliability and low-latency; i.e. URLLC). These will be covered by the developing 3GPP Rel-16 standard, which was originally scheduled to be completed in December 2019, but has been postponed by three months.

Usage scenarios of IMT-2020 and beyond

How 5G can fulfil multiple use cases in both consumer and enterprise space

5G will be as much about businesses as it is about consumers.

There's also a multitude of business opportunities to be exploited in 5G-enabled smart offices, cities, factories and farms.



Source: 3GPP, "The three broad use cases of IMT 2020 or 5G", 2018

The figure here is a mapping of some use cases/services to the categorised three key areas.

Based on their classification, these services require high density (e.g. IoT devices, Smart Cities), low latency/high threshold (e.g. AR/VR, Self-driving cars), and high bandwidth (e.g. FWA, 4K content delivery, 3D video).

These scenarios demonstrate that 5G will impact enterprises just as much as consumers. Indeed, there's self-driving cars, smart houses, augmented reality, Ultra-HD and 3D entertainment, and more. But 5G-enabled smart cities, industries, farms, and offices also present a plethora of economic prospects.

Official (Open)

5G Technology Summary

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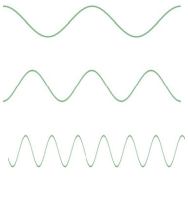
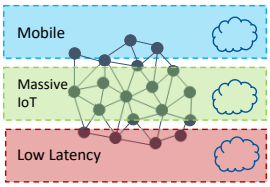
- It is 5th generation of the cellular network technology.



- Lower-bands to support wider coverage
- Mid-bands offer a balance of benefits between coverage and capacity
- Higher-bands is less crowded and provides the ultra-high bandwidth

- Higher speed
- Lower latency
- Higher capacity and increased in data bandwidth
- All as when compared to earlier generations

- Multi-access Edge Computing that brings high computational services from centralised cloud closer to end users (the edge)
- Easing the need of having high performance device at end user for computational intensive use cases such as AR/VR



- Network slicing to enable various differentiated services across different industries with assured Quality of Service

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<u>Additional information</u>: for clarity

5G runs in a broad range of frequencies, encompassing high-frequency millimetre waves (24 to 100 gigahertz, or higher) as well as low- and mid-bands (below six gigahertz). Although millimetre waves have a shorter range and demand more infrastructure, they allow for extremely fast speeds.

20 Gbps is the theoretical maximum speed of 5G, which is substantially faster than 1 Gbps for 4G. This speed enables fast downloads, smooth streaming, and ultra-HD video.

Lower latency is one of 5G's key promises, minimising the time between data input and arrival. Applications such as real-time gaming, healthcare, and self-driving automobiles require low latency.

In comparison to 4G, 5G promises to provide 1,000 times higher mobile data traffic per area. It has the capacity to manage a large number of linked devices at once.

Edge computing is made possible by 5G, which processes data closer to the source (sensors or devices). This improves real-time applications and lowers latency.

Network slicing is supported by 5G, enabling the creation of virtual networks for certain

use cases. Depending on the use, each slice may have distinct properties (such as latency or speed).

In conclusion, 5G is a revolutionary technology that will change a variety of industries, from improved mobile broadband to the Internet of Things and mission-critical control. It is not only about speed.

How 5G could change your life. | Ray Bonini | TEDxColumbus: https://youtu.be/tSRRMH8SLzU

Here is a YouTube-link to a video-clip of a talk about 5G at a TEDx event.

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What benefits does 5G technology bring?

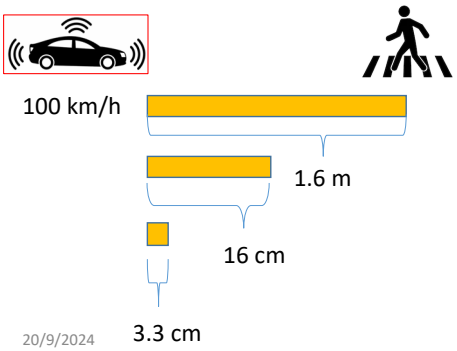
- The benefit of 5G is ***speed***.
  - 100 times faster than standard 4G
  - and 30 times faster than advanced 4G standards like LTE-A.
- Often referred to as "the network of networks".

Network type	Max download speeds	Time to download a full HD movie
3G	384Kbps	Over a day
4G	100Mbps	Over 7 minutes
4G+	300Mbps	2.5 minutes
5G	1-10Gbps (theoretical)	4-40 seconds

5G is often called 'the network of networks', as it is due to unite many existing standards and cross different technologies and industries.

What benefits does 5G technology bring?

- The another benefit of 5G is low latency.
- 50 times faster than standard 4G, and 5 times faster than advanced 4G standards like LTE-Adv, LTE-Adv-Pro.



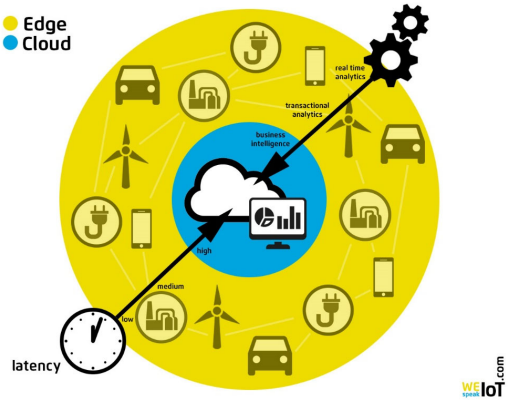
Network type	Latency	Distance travelled even after turnning on the brakes
4G	50 ms	1.6 m
4G+	5 – 10 ms	16 cm
5G	1 ms	3.3 cm

This is the time it takes for your device and the network to start communicating. Tens of milliseconds is the delay with 4G, which satisfied day-to-day demands and was deemed rapid when 4G was initially introduced. But in 2019, with the advent of data-critical technology like driverless automobiles, it can no longer satisfy our needs. When braking, an extra 10 milliseconds will add 16 centimetres to the distance travelled by a car going at 100 km/h when utilising 4G+. It might be the difference between a collision and a near miss, even though it's not a great distance. That latency drops to a mere millisecond with 5G, and braking will only result in an additional 3.3 centimetres of travel time.

Edge Computing

- The word, "**Edge**", refers to the part of the infrastructure that is near to the sources of data. -> at the Device/sensor layer
- Edge Computing simply means performing actions on data such as data analysis, decision making at the Edge. -> e.g. Edge devices/gateway
- Advantages
  - Reduce communication bandwidth between sensors and servers
  - Faster assess of data since the data is stored "near" to the source
  - Fast data analysis, computing and actions. e.g. autonomous vehicles; critical decisions cannot be done at the cloud (i.e. cloud computing)
- Disadvantages
  - Creates duplication of system functionality
  - Replicates fragments of information across distributed networks => increase redundancy

- For time critical and responsive application such autonomous car and industrial automation controllers that needs fast analysis, quick decision making and short data access storage time.



Source : www.wespeakiot.com

A distributed computing paradigm called "edge computing" moves data storage and processing closer to the data sources. Reducing the physical distance between users and servers is the aim of this paradigm, which also aims to reduce bandwidth. In this slide, are some essential details regarding edge computing.

Network Slicing

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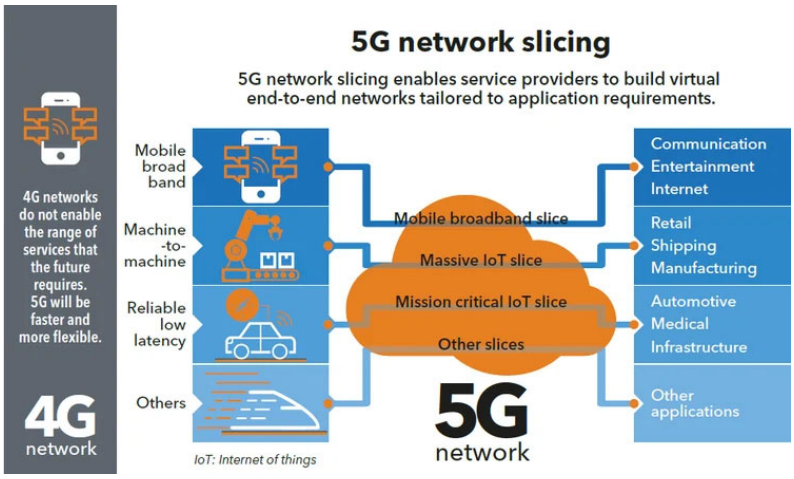


- 5G network slicing is the use of network virtualisation to divide single network connections into multiple distinct virtual connections that provide different amounts of resources to different types of traffic. – SDxCentral article
  - a type of virtual networking architecture
- Providers have to move into a system that's more flexible and adaptable – make the network more software-centric (i.e. away from rigid, hardware-defined systems)
  - to create a single, highly flexible virtualised, software-defined network instead of building multiple purpose-built networks

5G network slicing is a revolutionary method in the telecommunications industry that makes it possible to build virtualised, specially designed networks for particular use cases. Through the use of software-defined networking (SDN) and network functions virtualisation (NFV) technologies, network slicing enables operators to divide/partition a single physical network infrastructure into several virtual networks, each with distinct features and performance requirements. This division/segmentation makes it easier to allocate resources effectively, guaranteeing the best possible support for a variety of applications, including massive machine type communication (mMTC), enhanced mobile broadband (eMBB), and ultra-reliable low-latency communication (URLLC). Businesses can use 5G network slicing to dynamically configure network slices on-demand, responding to changing needs for security, latency, bandwidth, and reliability. This opens up new avenues for innovation in a variety of sectors, including manufacturing and healthcare.

Limitations of 4G Networks

Limited Capacity

Can become congested when many users try to connect at once

Slower data rates can be experienced when they are many users

Limited Connection density

The total number of devices fulfilling a specific quality of service per unit area is limited

Connection to network can be lost or very slow in a crowded area (e.g stadium)

Latency

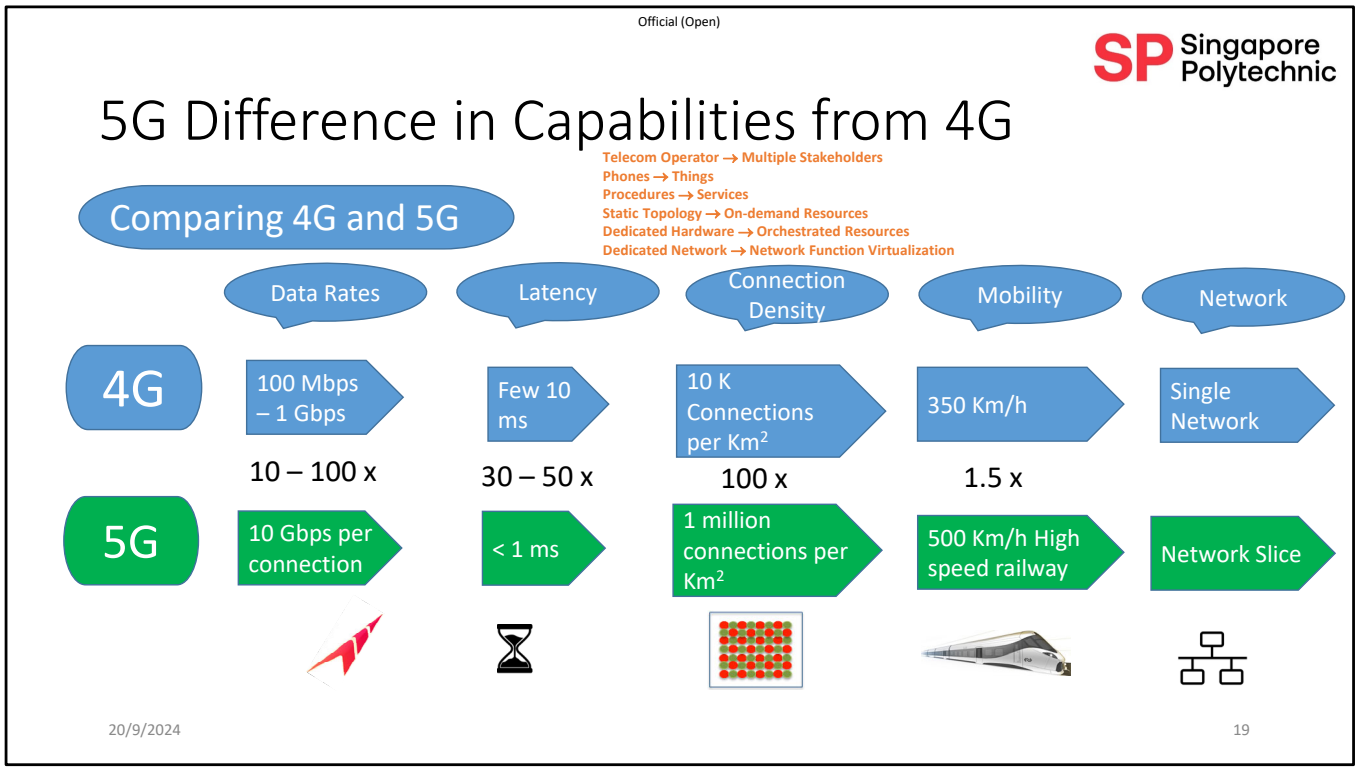
Not reliable when rapid responses are required such as gaming.

While 4G networks can attain high download and bandwidth speeds, there are still certain limits that 5G aims to address.

4G networks have a limited capacity, and when numerous users attempt to connect at once, the network may get crowded. Data rates may experience a slowdown.

Additionally, the connection density is restricted. The total number of devices that can provide a certain level of service is constrained for a per unit area. Consider the scenario where a large number of people are watching a football game or concert at a stadium. As a result, the connection may be very slow or even lost.

Even though 4G technology has significantly increased mobile data broadband rates, latency is still unreliable. It still falls short in situations requiring quick reactions.



<u>In the transition to 5G networks, we can see the following changes</u>:

The roles of traditional telecom operators have evolved, and they are now frequently a part of a larger ecosystem with many different stakeholders.

The word "things" frequently refers to the enormous variety of networked devices that go beyond conventional computers and smartphones. These can include industrial equipment, automobiles, appliances, sensors, and more. This explains why conventional phones are now included in this larger group.

Delivering just connected services is giving way to delivering more specialised and value-added services. This shift from procedures to services is indicative of a wider movement in providing end users with experiences that are more customised, adaptable, and enhanced.

.The dynamic and adaptable characteristic of next-generation networks is reflected in the shift from static topology to on-demand resources. The move to on-demand resources signifies a paradigm change towards dynamic, adaptable, and effective network operations. By adopting this strategy, operators may

maximise resource utilisation and minimise costs while better meeting the changing needs of users and applications..

The shift from dedicated hardware to coordinated resources allows operators to create more nimble/agile/flexible, efficient, and scalable infrastructure that can handle a variety of services and applications.

NFV (Network Functions Virtualisation) is an essential component of 5G technology. It enables operators to move away from using dedicated hardware for each network function, to a more flexible and cost-effective software-based infrastructure.

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Features of 5G

Key features of 5G are given below:

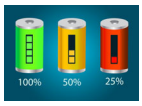
For Users:

- Has low battery consumption and better battery Life for devices
- Around 1 Gbps data rate is easily possible
- Very Low Network Latency

Network latency, sometimes called lag, is the term used to describe delays in communication over a network.

For System:

- More than 100 times more device handling capacity
- 5G has better coverage area and high data rate at the edge of the cell
- Availability of multiple data transfer rates
- 100 times higher data speed over the air
- Multiple Services can run in parallel
- Custom made Network Slices
- Better energy efficiency and spectral efficiency
- Massive MIMO – 10x more antennas than 4G demonstrated



Ultimately, it's about being enabled to provide a service-oriented, cloud-based and software-configurable technology.

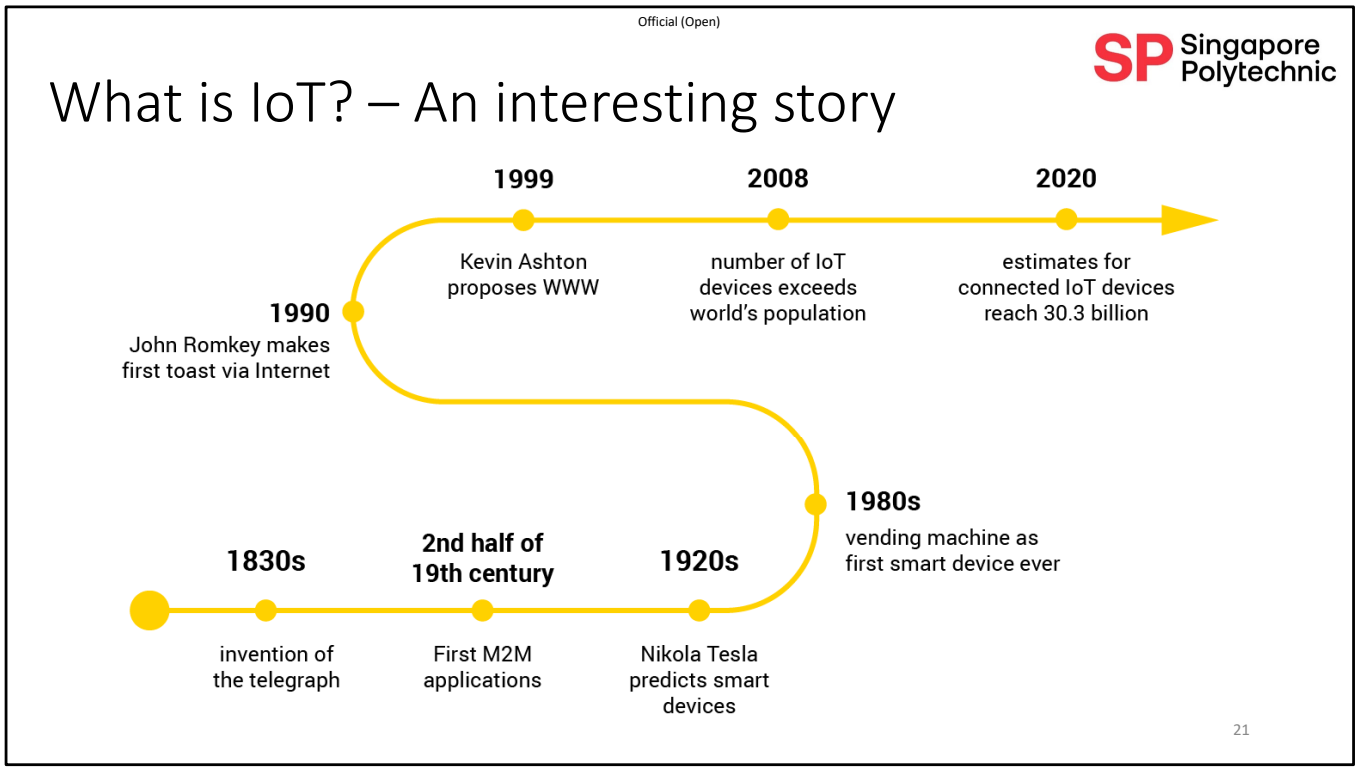
5G provides consumers with a number of important characteristics, such as minimal network latency, high data throughput, and low battery usage. 5G devices can communicate more effectively thanks to technological breakthroughs, which lowers power consumption and increases battery life. Moreover, 5G networks offer much faster data rates than those of prior generations, allowing users to watch and download media at lightning-fast speeds. Moreover, 5G's lower network latency guarantees almost instantaneous reaction, improving the user experience for apps like video conferencing, online gaming, and Internet of Things interactions. With these capabilities together, 5G is a connection game-changer that gives users better performance, longer device battery life, and smoother real-time experiences.

N.B.: Network latency, sometimes called lag, is the term used to describe delays in communication over a network.

Systems can benefit from a plethora of capabilities brought forth by 5G, most notably increased device handling capacity, faster data speeds at the edge of the cell, and support for various transfer rates. 5G networks provide smooth connectivity in densely populated places by handling a large number of connected devices simultaneously. Additionally, they ensure constant performance for users throughout the network by extending coverage to previously underserved locations while maintaining high data speeds at the cell edges. Furthermore, 5G makes it possible to offer parallel services and

customised network slices, which enables operators to effectively customise services to meet the demands of certain users and applications. In addition, 5G systems place a high priority on energy efficiency, maximising power and resource allocation to reduce operational expenses and the negative effects on the environment. Using cutting-edge technology like MIMO (Multiple-Input Multiple-Output) to maximise data throughput and network capacity, 5G dramatically improves spectral efficiency. 5G is positioned as a revolutionary technology with this extensive feature set, providing improved performance, scalability, and flexibility for both system operators and service providers.

Ultimately, it’s about being enabled to provide a service-oriented, cloud-based and software-configurable technology.



1982 – Students invent a connected Coke machine.
Students at Carnegie Mellon University were able to verify whether drinks were cold and accessible by connecting the department vending machine to the main computer through the local network. Though not everyone enjoyed Coke, they were all in awe of this invention. This vending machine is regarded as an early example of an Internet of Things device because of its linked nature and the type of service it offered.

1990-1993 – World's first IoT device invented
John Romkey invented the first Internet of things (IoT) gadget in 1990 - an Internet-controlled toaster. By 1991, he had added a crane system that also inserted the bread, automating the entire process. Then, in 1993, the University of Cambridge installed the Trojan Room Coffee Pot, the first webcam prototype in history, to keep track of how much coffee was left in the brewing machine.

1999 – "The Internet of Thing" is coined
The founder of Auto-ID, Kevin Ashton, dubbed his talk at Procter & Gamble "The Internet of Things." Ashton's novel connection between RFID (radio-frequency identification) and the Internet captivated the audience. Although Ashton's concept of RFID-based device connectivity is not the same as the IP-based (Internet Protocol) IoT of today, his innovation was crucial to the development of

both the IoT and technology in general.

What is IoT?

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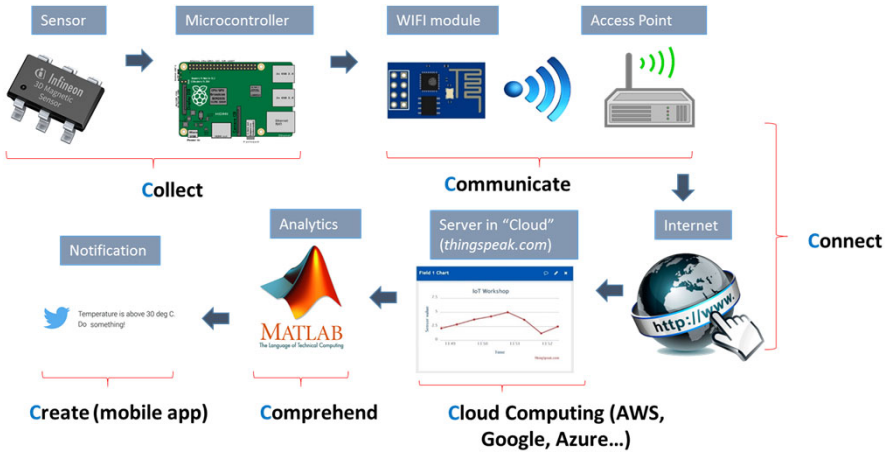
- The internet of things (IoT) is the network of physical devices, vehicles, buildings and other items - embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data



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The 6 C's methodology for IoT:

Internet of Things is the interconnection, via the internet, of computing devices embedded in everyday objects enabling them to send and receive data. We follow the 6 C's of IoT in order to conceive the IoT system. The 6 C's are:

Collect - collection of data (through the use of sensor and microcontroller), such as temperature, humidity, brightness, GPS position, accelerometer & gyro readings etc.

Communicate - wireless (or wired) communication technologies (to allow the collected data to reach the internet) such as Bluetooth, WIFI, GPRS, ZigBee, Lora, Sigfox etc.

Connect - network connection, usually through the telco's WAN infrastructure, with the use of switches and routers etc.

Cloud - computing resources such as storage and server applications residing in AWS (Amazon Web Services), (Microsoft's)Azure, Google Cloud etc.

Comprehend - data analytics to make sense of the data. For instance, MATLAB can be used in Thingspeak server, while (Microsoft's) Power BI is another popular tool which allow you to code the analytics to be performed on the data.

Create - value creation through mobile apps such as Twitter (notification of an alert / event), various messaging apps, or custom-made Android or IOS apps.

See: https://www.youtube.com/watch?v=20YAacRtTa8

Enabling Massive IoT

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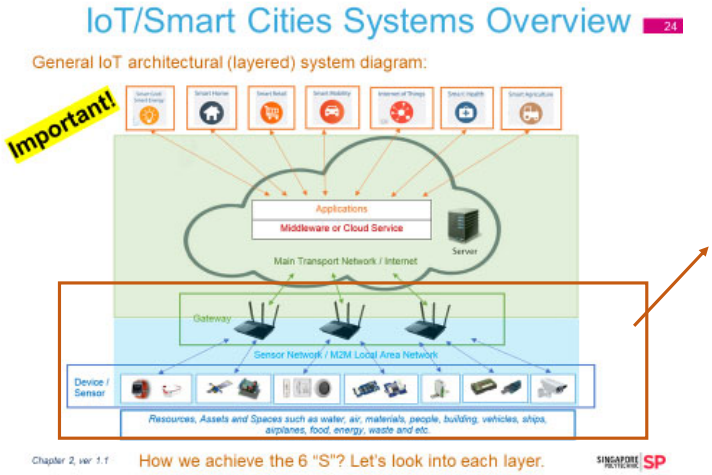
- **Cellular standards** like 5G provide a network backbone for IoT services, supporting both high data rates and long-range communications.



Sensor Network or M2M Local Area Network – This specify the wired such as USB, Ethernet, Serial, or wireless technology such as WiFi, LoRa, Bluetooth, DSRC, used to connect between various devices or sensors to its respective localise Gateway for local centralise control before communicating out to the Main Transport Network or internet.

Just as important as faster speeds are to smartphones and video, very low-speed, low-cost devices are to IoT applications such as remote monitoring sensors. An increasing trend with IoT devices is to make them as low-cost and low-power as possible. Often, these devices are battery powered and may be located in places where replacing batteries or performing other service can be inconvenient.

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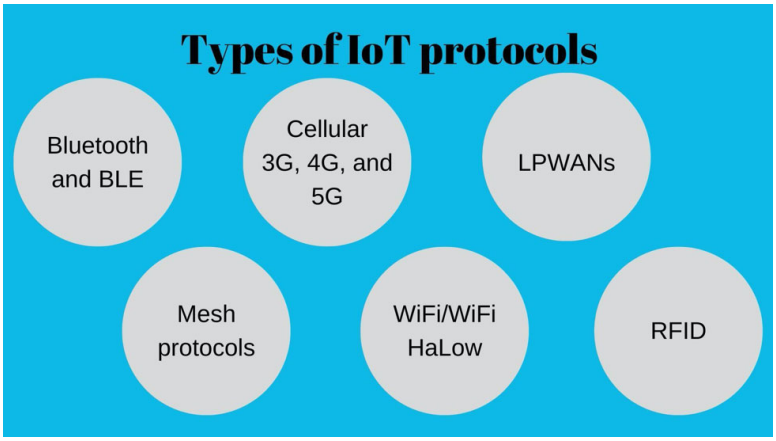
Enabling Massive IoT

- Evolving IoT networks are being designed to accommodate these devices through several new technologies shown in



Source: https://www.allerin.com/blog/six-types-of-iot-network-protocols

The Internet of Things (IoT) is undoubtedly a popular topic. Many items, such as remote weather stations, connected garage door openers, and refrigerators that can remind you to pick up milk and eggs on your way home from work, are being enhanced with intelligence and connectivity by developers.

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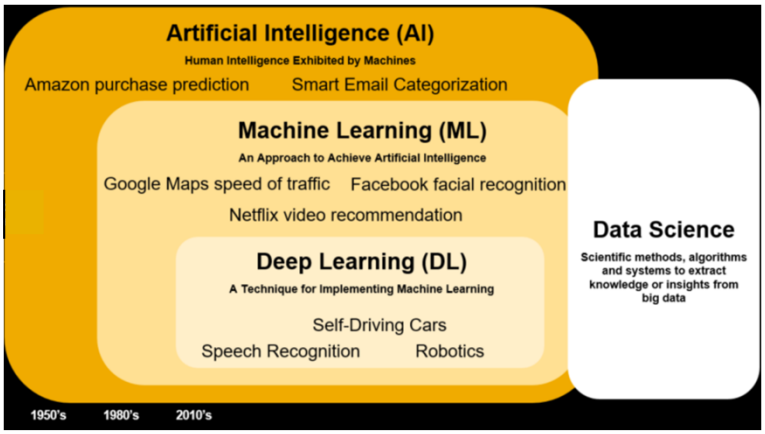
What are AI and Machine Learning?

- Artificial Intelligence
  - The science and engineering of making intelligent machines, especially intelligent computer programs
- Machine Learning
  - An application of AI that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.



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While the ideas of machine learning (ML) and artificial intelligence (AI) are closely connected, their uses and applications are different. AI is a general term for the larger field of developing machines or systems that can replicate human intelligence and carry out tasks on their own. It includes machine learning among many other methods and strategies. Conversely, machine learning is a branch of artificial intelligence that focuses on teaching algorithms to become data-driven predictors or decision makers without explicit programming. As ML algorithms are exposed to more data, they get more proficient over time, allowing them to recognise patterns, anticipate outcomes, and automate processes. Essentially, machine learning (ML) is a specific technique or method used to enable machines to learn from data, whereas artificial intelligence (AI) is the overarching goal of developing intelligent machines.

What is AIoT?

- Today AI has evolved from algorithm approach into self-learning and big data management; processing, connectivity, sensing and actuating along with security are the key enablers of AI.
- The Internet of Things (IoT) is a popular technology trend, which in recent years has been joined with another popular trend, Artificial Intelligence (AI) to form a brand new keyword “AIoT”.
- Artificial Intelligence of Things (AIoT) is the Internet of Things, with embedded Artificial Intelligence. Without AI, the data pool created by IoT devices would fail to reach its full potential and, without the IoT, AI systems won’t have required data sets.
- The IoT benefits from AI’s advanced data analytics capabilities, while AI applications receive real time information from extensive networks. By merging capabilities of AI & IoT helps to bring our best of the two, it helps to turn IoT connected devices from passive sensors into data learning machines.
- E.g. Self-driving cars and AI will help to augment our transportation. In future, there will be many applications of AI on end devices; which are also known as Edge devices.

Source: element14 e-book, “The era of AIoT: Context, Capabilities and Future of AIoT”, 2020.

Artificial Intelligence has significant economic prospects and has already gained widespread adoption.

Today's AI has progressed from algorithmic approaches to self-learning and massive data management; its main enablers are processing, networking, sensing, and actuation in addition to security. The term "AIoT" is a new combination of the prominent technology trends of artificial intelligence (AI) and the internet of things (IoT), which have been combined in recent years. The Internet of Things with embedded artificial intelligence is known as Artificial Intelligence of Things, or AIoT. Without AI, the IoT-generated data pool would not be able to realise its full potential, and AI systems would not have access to the necessary data sets if the IoT didn't exist. AI's sophisticated data analytics skills enhance the Internet of Things, and AI applications get real-time data from vast networks. By combining the greatest features of AI and IoT, we can transform IoT-connected devices from passive sensors into data-learning machines.

Today's Artificial Intelligence (AI) is substantially more sophisticated than it was even a few years ago, and it is still developing quickly. Weak AI is what it is known as now. Neural networks are able to recognise images in computer vision, however they are not a perfect match for any human visual system. It has been noted that they have occasionally outperformed the human brain, though. Businesses of all kinds, even startups with only one employee, have already started utilising data and analytics to gain

a competitive advantage. AI makes it possible to generate insights, optimise processes, and make centric decisions more quickly.

We will drive self-driving automobiles in the near future, and advances in robotics, AI, and cybernetics will help us enhance our bodies by giving them more strength, endurance, and lifespan. These advancements will also benefit the disabled. In the near future, there will be numerous applications of artificial intelligence (AI) on end devices, often referred to as edge devices, even though these things demand sophisticated hardware and software.

Official (Open)

Several elements make up an autonomous driving system.

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Elements of autonomous driving system

Actuation
Steering, braking, and acceleration

Cloud
Learning and updating high-definition maps, including traffic data, as well as algorithms for object detection, classification, and decision making

Perception and object analysis
Object and obstacle detection, classification, and tracking

Drive control
Converting algorithm outputs into drive signal for actuators

Decision making
Planning vehicle path, trajectory, and maneuvers

Localization and mapping
Data fusion for environment mapping and vehicle localization

Analytics
Platform for monitoring autonomous system's operation, detecting faults, and generating recommendations

Middleware or operating system
Middleware and real-time operating system to run algorithms

Computer hardware
High-performance, low-power-consumption system on a chip (SOC) with high reliability

Sensors
Multiple sensors, including lidar, sonar, radar, and cameras

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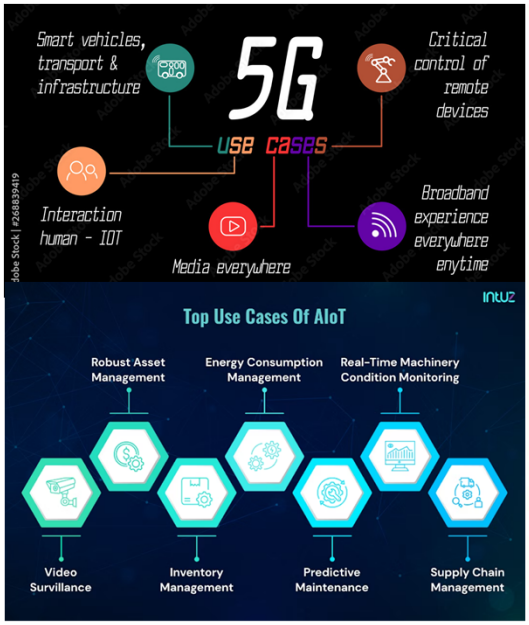
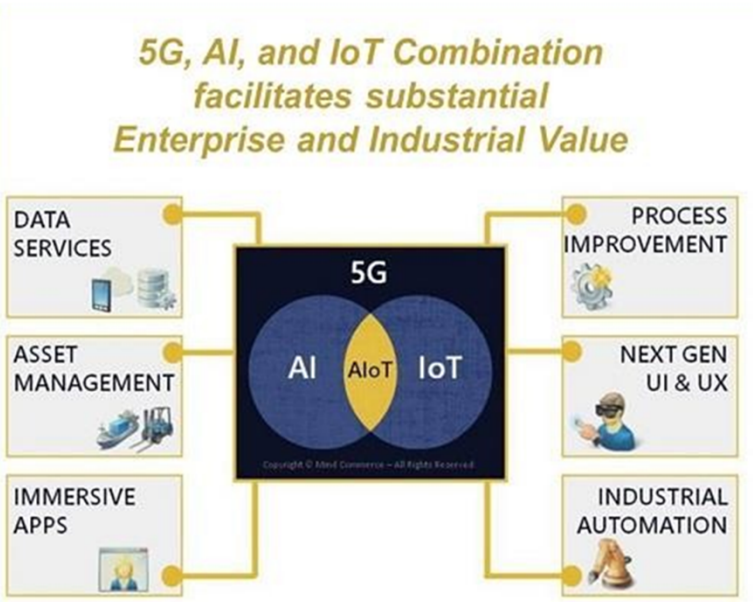
This slide shows the elements that make up an autonomous driving system.

Boxed in red, are the elements that will require AI/ML.

1.1 The Importance of 5G and AIoT in current and Future Applications





A revolutionary era in technology is being ushered in by the convergence of 5G and AIoT (Artificial Intelligence of Things), which opens up a plethora of potential in several fields. In terms of data services, real-time data processing and analysis are made possible by the combination of 5G's high-speed, low-latency connectivity and AIoT's sophisticated data analytics capabilities, which enable businesses to make choices more quickly and intelligently. 5G and AIoT significantly improve asset management by enabling seamless communication between sensors and devices and continuous asset monitoring, which reduces costs and improves efficiency. In the 5G age, immersive applications like virtual reality (VR) and augmented reality (AR) flourish, providing unmatched experiences with fast data speeds and seamless communication. AIoT-driven automation and optimisation of processes results in process improvements, simplifying operations and raising productivity across industries. The improved responsiveness and connectivity of 5G enable next-generation user interfaces (UI) and user experiences (UX), providing more natural and engaging interactions. 5G-enabled AIoT takes industrial automation to new heights by allowing real-time control and monitoring of supply chains, logistics networks, and manufacturing processes. This increases competitiveness, efficiency, and agility. The convergence of 5G and AIoT has the potential to transform present and future applications by promoting innovation, efficiency, and interconnectivity throughout various industries and domains.


Any
Question