18ECO127T
5G Technology – An Overview

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MODULE 5:
5G and Internet of Things (IoT)

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

Integration of 5G and IoT Networks

Low Power Wide Area Networks (LPWAN) in 5G

5G-enabled Smart Cities and Industrial Automation

Future Trends and Applications of 5G: 5G Beyond 2020: 6G and Beyond;

5G Use Case: Autonomous Vehicles

5G Use Case: Augmented Reality/ Virtual Reality.

5G Use Case: Smart Cities

5G Use Case: Health Care

MODULE 5:
5G and Internet of Things (IoT)

M5 S1

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

Integration of 5G and IoT Networks

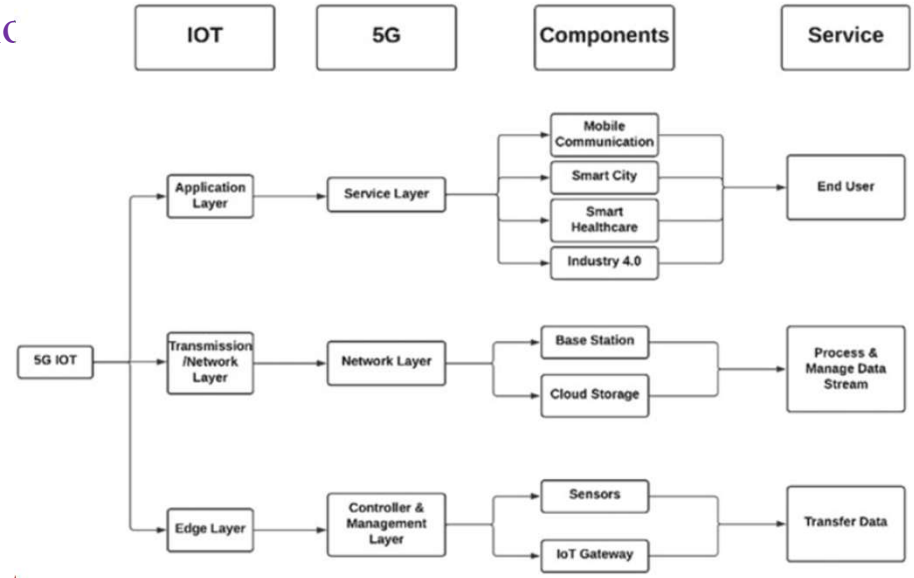
Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- The Fifth Generation Communication System (5G) has revolutionized data (voice, text, and hybrid) transmission and communication.
- Advanced communication protocol and sophisticated technology open up the opportunity to integrate 5G with other state-of-the-art technologies.
- Similarly, the Internet of Things combines sensors, actuators, and other devices that network together to collect contextual and environmental data for application-specific purposes.
- Nowadays, the applications of IoT need a fast data transfer to ensure smooth service.
- 5G has the potential to achieve this function for IoT.
- However, the energy-efficient architecture and easy-to-manage 5G-enabled IoT are still developing.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- The Internet of Objects (IoT) is based on the concept of intercommunication amongst heterogeneous things that use a variety of communication standards, stations, sensors, nodes, data centers, and artificial intelligence (AI) capable devices.
- As a result, the next generation 5G network will be connected to billions of devices, resulting in a super IoT infrastructure.
- 5G integrated IoT is an idea to develop the communication and transmission process of data in the IoT environment.
- Implementation of 5G in IoT architecture will change tour lifestyle bringing a vast amount of IoT devices in one place within a second.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applicatic



- **A General 5G IoT-layered architecture.**

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- 5G Architecture,

1. The network layer,
2. controller layer,
3. management, and
4. service layer

- are the four levels of the 5G architecture paradigm.
- The 5G protocol stack has two sublayers:
  Radio Link Control (RLC) and
  Pocket Data Convergence Protocol (PDCP).
- Instead of base stations (BS), 5G's network architecture uses adaptive, virtual, and flexible radio access network (RAN) points and a sophisticated dispersed design.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **A generic architecture for 5G ecosystem must have the following function:**
- **Radio Access Network (RAN):** 5G uses RAN to connect many technologies providing FDD frequency.
- **Data Network:** It provides operator services third-party services for internet access.
- **Access and Mobility Management:** This function ensures integrity protection, authorizes access, manages mobility, links among devices, connect ability, etc.
- **Network Slice Selection:** This function decides instances for user equipment and information for the assistance function.
- **Server Authentication Function**: It does the work of authentication for trusted and untrusted 3GPP access.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **A generic architecture for 5G ecosystem must have the following function:**

- **Control Policy:** This function initiates policy frameworks to control network behavior.
- **Network Exposure:** It exposes the network application and manages external and internal communication securing information.
- There are many more functions of 5G architecture varying from application to application.
- However, the basic scenario of every function tends to achieve more speed, low latency, proper management, and security

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **An Insight into IoT**
- IoT or the Internet of Things is a networked digital system of various electronic devices like sensors, activators, receivers, nodes that compute data, etc.
- By eliminating human involvement, IoT devices have transformed the data collecting and processing system.
- From top to bottom, IoT devices enhance the development of concepts like smart home, smart vehicle, smart agriculture, smart health care, communication, cybersecurity and many more systems.
- They have been used to conduct, monitor, and produce reactions based on the information gathered.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **An Insight into IoT**
- People have been thinking of connecting devices to the Internet for a long time.
- The Internet of Things, on the other hand, enhances and extends network technology based on existing internet technology, allowing computing and smart objects to connect and communicate with one another.
- The IoT can be broadly defined as any object that communicates, produces, and interchanges data with other objects via the Internet to perform orientation tracing, tracking, intelligent recognition, and management.
- This process is conducted by various sensors or peripherals such as GPS, thermal sensors, RFID, etc.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Characteristics of IoT**
- There are many functional and non-functional IoT needs for creating the infrastructure.
- We will discuss some of the most valuable characteristics of IoT here.

1. Availability
2. Mobility
3. Scalability
4. Security and Privacy
5. Performance

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Characteristics of IoT: 1. Availability**
- To provide customers with facilities wherever and whenever they need them, IoT availability must be implemented at the hardware and software levels.
- The capacity of IoT systems to give functionality to anybody in any location is referred to as software availability.
- The nature of computers that are always compatible with IoT features and protocols is referred to as hardware availability.
- To allow IoT capabilities, protocols like IPv6, 6LoWPAN, RPL, CoAP, and others need to be implemented inside the restricted devices of the single board resource.
- One technique for achieving high IoT service availability is to ensure the availability of critical hardware and facilities.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Characteristics of IoT: 2. Mobility**
- Although most utilities are designed to be delivered via Smartphone devices, IoT implementation is hampered by accessibility.
- A key IoT premise is to keep customers connected to their preferred resources when moving.
- When mobile devices are relocated from one gateway to another, service interruptions may occur.
- Caching and tunneling for service continuity allow apps to access IoT data even if the internet is down for a short time.
- The vast number of smart devices available in IoT systems is usually included in any solid framework for mobility control..

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Characteristics of IoT: 3. Scalability**
- Scalability in the Internet of Things refers to the ability to accept new client equipment, software, and capabilities without compromising the efficiency of existing systems.
- It is not straightforward to add new processes and manage extra devices, especially when there are several hardware platforms and communication protocols to contend with.
- IoT applications must be built from the ground up to enable extendable services and operations...

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Characteristics of IoT: 4. Security and Privacy**
- On diverse networks, such as the Internet of Things, ensuring user security and privacy is strict.
- The fundamental functioning of the Internet of Things is built on data transmission between billions, if not trillions, of Internet-connected items.
- One great problem in IoT security left out of the standards is the key distribution between devices.
- The growing number of intelligent objects around us with sensitive data necessitates transparent and simple access control management, such as enabling one vendor to view the data.

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Characteristics of IoT: 5. Performance**
- The performance of IoT services is difficult to evaluate since it is based on the performance of many components and the underlying technology.
- The Internet of Things, like other programs, must constantly develop and expand its offerings in order to meet user expectations.
- To give the most value at the lowest cost to customers, IoT solutions must be monitored and validated.
- IoT performance may be measured using various criteria, including processing speed, connection speed, system form factor, and cost.
- IoT also needs to manage the larger amount of information or data created in the ecosystem, ensuring the interoperability and quality of service..

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Requirements for 5G Integrated IoT Architecture**
- 5G-enabled IoT needs special attention for its heterogeneity, advancement, and application.
- However, there are some requirements that all the architecture should follow:

1. 5G IoT must ensure a low latency of 1 ms considering the sensitive internet system and medical perspective.
2. The architecture must ensure low energy consumption for low-battery life IoT devices but enough for 5G to transfer data.
3. An advanced application like Virtual Reality or Augmented Reality needs a high speed of 25 Mbps, so the architecture must follow with the future needs...

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

- **Requirements for 5G Integrated IoT Architecture**

4. Security must be top-notch, considering massive data transmission at a very highspeed.
5. The devices with mobility factors will get priority for the 5G IoT infrastructure.

- The fundamental 5G IoT architecture consists of five steps in general:
- **sensors, IoT Gateway, 5G-based station, cloud storage, and application**.
- These steps can be comprised in IoT layers to bring up a general 5G IoT architecture....

!!THANK YOU!!
!! Have a Nice Day!!

Today we learned about

Internet of Things (IoT) and 5G Integration – Introduction, Role of 5G in Enabling IoT Applications

Integration of 5G and IoT Networks

MODULE 5:
5G and Internet of Things (IoT)

M5 S2

Low Power Wide Area Networks (LPWAN) in 5G

Low Power Wide Area Networks (LPWAN) in 5G

- Low-power WAN (LPWAN) is a wireless wide-area network technology that interconnects low-bandwidth, battery-powered devices with low bit rates over long ranges.
- Created for machine-to-machine (M2M) and internet of things (IoT) networks, LPWANs operate at a lower cost with greater power efficiency than traditional mobile networks. They are also able to support a greater number of connected devices over a larger area.
- LPWANs can accommodate packet sizes from 10 to 1,000 bytes at uplink speeds up to 200 Kbps. LPWAN's long range varies from 2 km to 1,000 km, depending on the technology.
- Most LPWANs have a star topology where, similar to Wi-Fi, each endpoint connects directly to common central access points.

Low Power Wide Area Networks (LPWAN) in 5G

- **Types of LPWANs**
- LPWAN is not a single technology, but a group of various low-power, wide area network technologies that take many shapes and forms.
- LPWANs can use licensed or unlicensed frequencies and include proprietary or open standard options.

- The proprietary, unlicensed Sigfox is one of the most widely deployed LPWANs today.
- Running over a public network in the 868 MHz or 902 MHz bands, the ultra-narrowband technology only allows a single operator per country..

Low Power Wide Area Networks (LPWAN) in 5G

- Narrowband-IoT (NB-IoT) and LTE-M are both 3rd Generation Partnership Project (3GPP) standards that operate on the licensed spectrum.
- While they have similar performance to other standards, they operate on existing cellular infrastructure, allowing service providers to quickly add cellular IoT connectivity to their service portfolios.
- NB-IoT, also known as CAT-NB1, operates on existing LTE and Global System for Mobile (GSM) infrastructure. It offers uplink and downlink rates of around 200 Kbps, using only 200 kHz of available bandwidth.
- LTE-M, also known as CAT-M1, offers higher bandwidth than NB-IoT, and the highest bandwidth of any LPWAN technology.

- Some vendors, are deploying both licensed and unlicensed technologies to capture both markets

Low Power Wide Area Networks (LPWAN) in 5G

- Other LPWAN technologies include:

- GreenOFDM from GreenWaves Technologies
- DASH7 from Haystack Technologies Inc.
- Symphony Link from Link Labs Inc.
- ThingPark Wireless from Actility
- Ultra Narrow Band from various companies including Telensa, Nwave and Sigfox
- WAVIoT...

Low Power Wide Area Networks (LPWAN) in 5G

- **LPWAN applications**
- With decreased power requirements, longer ranges and lower costs than traditional mobile networks, LPWANs enable a number of M2M and IoT applications, many of which were previously constrained by budgets and power issues.

- Choosing an LPWAN depends on the specific application, namely the desired speed, data amounts and area covered. LPWANs are best suited for applications requiring infrequent uplink message delivery of smaller messages. Most LPWAN technologies also have downlink capabilities.

- LPWANs are commonly used in applications including Smart metering, smart lighting, asset monitoring and tracking, smart cities, precision agriculture, livestock monitoring, energy management, manufacturing, and industrial IoT deployments.

5G-enabled Smart Cities and Industrial Automation

- The adoption of 5G technology has the potential to change numerous industries, including:

1. Smart cities: 5G can link millions of devices, including sensors, lighting, and traffic lights, to a network, improving resource management, easing traffic congestion, and enhancing public safety.

2. Industrial automation: By connecting sensors and other equipment in real time, 5G can facilitate quicker decision-making and task automation in industrial settings.

3. Healthcare: Remote patient monitoring and telemedicine made possible by 5G can transform healthcare by enhancing access to treatments, cutting costs, and enhancing patient outcomes.

4. Smart agriculture: By tying sensors and other equipment to a network that can monitor and control crucial agricultural operations, 5G can enable precision agriculture, resulting in higher crop yields and less waste.

5G-enabled Smart Cities and Industrial Automation

- **Smart Cities**
- Smart cities are urban areas that use cutting-edge technologies and IoT gadgets to enhance their people's infrastructure, services, and quality of life.
- Intelligent grids, energy-efficient structures, and intelligent transportation systems are examples of smart city solutions.
- The advantages of smart cities include better resource management, reduced traffic congestion, enhanced energy efficiency, and improved public safety.
- In addition to improving public engagement and quality of life, smart city technologies also make cities more appealing places to live and do business.
- In general, smart cities have the power to change how we live and work in cities..

5G-enabled Smart Cities and Industrial Automation

- **Challenges in implementing smart cities**
- Although the idea of "smart cities" is intriguing, putting them into practice presents a number of difficulties:

1. High costs: Adopting smart technology like IoT devices and cutting-edge sensors can be expensive, and many communities do not have the financial resources to do so.

2. Data management: It can be difficult to manage and derive insights from the vast amounts of data generated by IoT devices in smart cities.

5G-enabled Smart Cities and Industrial Automation

- **Challenges in implementing smart cities**

3. Cybersecurity Risks: Smart cities are susceptible to cybersecurity concerns like hacking and data breaches since they include a large number of IoT devices connected to a network.

4. Privacy issues: Concerns concerning people's privacy and their personal data are raised by the use of IoT devices in public areas.

5. Lack of standardization: The application of smart technologies in cities is currently not standardized, which causes compatibility problems and makes scaling up solutions difficult.

6. Citizen Acceptance: Public participation and acceptance are crucial for the success of smart city initiatives. Making sure that citizens are informed and involved in the development and use of smart technology is crucial....

5G-enabled Smart Cities and Industrial Automation

- **Potential smart city applications with 5G technology**

A vast range of applications for smart cities could be made possible by 5G technology. They consist of:

1. Smart traffic management: Involves monitoring and controlling traffic flow in real-time with IoT devices and sensors enabled by 5G, increasing efficiency and lowering congestion.

2. Public safety: Enhancing public safety through real-time danger detection and response using facial recognition and video surveillance driven by 5G.

5G-enabled Smart Cities and Industrial Automation

- **Potential smart city applications with 5G technology**

3. Energy management: Managing energy consumption in real-time while maximizing efficiency and lowering expenses with 5G-enabled smart grid technologies.

4. Healthcare: Healthcare: Improving patient outcomes through real-time remote health monitoring and diagnosis made possible by 5G-powered telemedicine and remote patient monitoring.

5G-enabled Smart Cities and Industrial Automation

- **Conclusion: The transformative potential of 5G technology on IoT and smart cities**
- In summary, the adoption of 5G technology has the potential to address the shortcomings of the IoT and smart city networks.
- Real-time apps can be made possible by 5G networks' high speed and low latency, which can also ease network congestion and enhance user experience.
- Moreover, 5G can have a big impact on urban mobility and transportation by enabling autonomous vehicles, enhancing traffic, and consuming less energy.

5G-enabled Smart Cities and Industrial Automation

- **Conclusion: The transformative potential of 5G technology on IoT and smart cities**
- By enabling more effective surveillance and emergency response, the increased connection and network capacity can also improve public safety and security.
- Last but not least, 5G-enabled smart cities have immense economic possibilities, from increased production and efficiency to new job prospects and income streams..

5G-enabled Smart Cities and Industrial Automation

- **5G would enable Industry 4.0 Integration**

- Industry 4.0 refers to the integration of the Internet of Things (IOT) and other digital technologies in industrial manufacturing.
- This allows for seamless communication and coordination between different levels of the automation process, from individual machines to entire factories.

- Industrial automation employs control systems to manage various tasks, often with cutting-edge technologies such as IoT sensors, AI vision cameras and autonomous mobile robots.
- 5G has the potential to revolutionize industrial automation by powering the networking capabilities of its various elements....

5G-enabled Smart Cities and Industrial Automation

- **5G would enable Industry 4.0 Integration**

- Low-latency wireless communications will make it easier to monitor machines in real-time, giving industry leaders more information and better control of their facilities.
- The incredible speed of 5G technology will allow for significant advancements in fields like artificial intelligence and virtual reality.
- By wearing AI and VR headsets, factory technicians and engineers can get a detailed view of equipment to find components easily, streamline repair processes and instructions, and improve safety.
- These devices provide a virtual environment for technicians to handle potentially hazardous parts without being in danger themselves.
- 5G networks offer up to five times faster latency rates, making it ideal for supporting industry 4.0 business models....

5G-enabled Smart Cities and Industrial Automation

- **Predictive Maintenance and Device Lifecycle Management**

- Automated systems are a big investment, and unplanned repairs can make them even pricier.
- Not only does it cost money to fix the machinery but manufactures also suffer losses from not being able to use the machines during downtime.
- Manufacturers use predictive maintenance to keep their factory equipment and other assets in safe, working condition.
- Real-time machine health data is collected by wireless sensors and sent to cloud-based analytics applications across the network.
- Many industrial machines are now equipped with industrial IOT (IIoT) sensors.
- These sensors help to monitor equipment status and can send out alerts if a problem is detected or if the equipment is due for routine maintenance.

5G-enabled Smart Cities and Industrial Automation

- **Predictive Maintenance and Device Lifecycle Management**

- 5G not only provides high data speeds and reliable connectivity, but also allows for more sensors to be deployed to various assets.
- This in turn provides richer data than ever before.
- In addition, the low-latency network environment supports innovative vibration and motion sensors.....

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Low Power Wide Area Networks (LPWAN) in 5G

5G-enabled Smart Cities and Industrial Automation

MODULE 5:
5G and Internet of Things (IoT)

M5 S3

Health Care

Health Care

- **5G enabled remote healthcare**

1. Remote patient monitoring
2. Connected ambulance
3. HD virtual consultations
4. Video-enabled prescription management

Health Care

- **Augmented reality/virtual reality healthcare use cases**

1. AR/VR assistance for the blind
2. Distraction and rehabilitation therapy
3. Remote expert for collaboration in surgery
4. AR/VR training and education

Health Care

- **5G-enabled on-site use cases**

1. Real-time, high-throughput computational processing

2. Video analytics for behavioural recognition

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Health Care