DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT VISION

To impart the best technical education instilled with discipline, values and leadership qualities that will produce professional technocrats in Electronics and Communication Engineering.

DEPARTMENT MISSION

M1: To impart fundamental Electronics and Communication Engineering concepts and a broad set to technical skills.

M2: To prepare Electronics and Communication Engineering graduates who will effectively and responsibly in practicing engineering.

M3: To impart practical exposure on latest technological developments in Electronics and Communication Engineering.

Program Educational Objectives (PEO's)

On successful completion of UG in Electronics and Communication Engineering, the Graduates will:

PEO1: Acquire adequate knowledge in the field of Electronics and Communication Engineering to have a successful career.

PEO2: Pursue higher studies with the focusing on R&D activities in the related areas.

PEO3: Take up entrepreneurship by practicing lifelong learning with innovation

Program Specific Outcomes (PSO's)

PSO1: To design and implement application specific electronic systems to provide real time solutions combating societal, ecological and economical issues in the areas of communication, networking, embedded systems and VLSI.

PSO2: To demonstrate proficiency by quickly adapting to changes in technology and tools and administer professional engineering practice through lifelong Learning and contributing immensely to research and development

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E-ZINE

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ELECTRONICS & COMMUNICATION ENGINEERING



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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

With the evolution of the computer age, Electronics & Communication have crept into every sphere of human life, thus increasing its scope manifolds. Electronics is now a part of our everyday life, from your pocket FM radio to televisions, computers, mobile phones and even the high-end satellites that are helping us in every

path. At Gates, we have an excellent and well established Department of Electronics and Communication Engineering (ECE). The Department was started in 2001 with 60 seats in UG program. This intake increased to 90 in 2004, 120 in 2010 and 180 in 2011. The department also started a PG program in VLSI and Embedded System Design in 2012 with an intake of 18. The department has a team of well-qualified, experienced and committed faculty with industrial and research background. They carefully nurture the young engineers and lay down a strong foundation in both technological and analytical aspects. The department has well established Electronics laboratories with state of art facilities. The department uses audio visual teaching aids such as, models, charts and LCD projectors for effective teaching. Students of our department are encouraged to actively participate in technical events and national level paper presentations and few of them got awarded in those events. The department has IETE Association through which students are allowed to enrich their technical knowledge by organizing and attending national level workshops, seminars and working model exhibitions. The activities under the flagship of various associations have given an ample scope for both student and teaching community to get acquainted with latest developments in areas like Digital Image Processing, Embedded Systems, Mobile & Satellite Communications and much more.

MESSAGE



It‘s gives me immense pleasure to see the creative expressions of students who had contributed to “E-ZINE 2K23”. It aims at providing a platform to the students to explore their latent capabilities and talent, to express their creativity in writing articles. I acknowledge my heartful thanks to Faculty members and Edtitorial team members for their contribution and their hard efforts to bring out this magazine. At last, I am very much thankful to all the authors who had sent their article for E-ZINE 2K23. My Heartfelt Wishes to all.

Dr. Archek Praveen Kumar

HOD, Dept. of ECE

Gates Institute of Technology

Gooty

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Programme Outcomes (POs):

On successful completion of UG in Electronics and Communication Engineering, The graduate will have an ability to

PO1: Apply the knowledge of Mathematics, Science and Engineering to solve the engineering problems in analog and digital electronic systems.

PO2: Identify, formulate and analyze the problems from the various issues of communication systems.

PO3: Design Analog and digital systems to meet the desired needs within a realistic constraint.

PO4: Design a circuit, conduct experiments, analyze and interpret the results to Provide valid conclusions.

PO5: Use modern tools to simulate electronic systems and analyze the performance of various models.

PO6: Develop electronic systems and solutions to meet the societal needs, considering awareness of security, health and legal issues.

PO7: Provide innovative ideas by understanding the impact of engineering solutions for the sustainable developments.

PO8: Function with professional ethics and social responsibilities.

PO9: Work as an individual, member of a team or leader in multidisciplinary activities.

PO10: Communicate effectively with outside world and engineering fraternity.

PO11: Demonstrate the knowledge of project and finance management skills to carry out projects in multidisciplinary environment.

PO12: Engage lifelong learning and to adapt rapidly changing technologies.

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1. Emerging Trends in 5G and Beyond Communication

1. Emerging Trends in 5G and Beyond Communication

MALYAM DINESH

IV Year

Introduction

Over recent years, the quantity of communicating devices and their consumers has been enormously growing, forcing cellular companies to expand their bandwidth to acquire higher data rates for wireless media. In this regard, the advancement in mobile phone generations from 1G to 4G-LTE has brought about an improvement and numerous challenges. Nowadays, internet speed is an eminent concern for both users and service providers; hence, cellular companies are in a battle for fifth-generation (5G) internet implementation so that they can provide a super-fast and reliable connection to their users. Fifth-generation networks are supposed to revamp the cellular industry from top to bottom by 2022, as their primitive focus is to enhance the transmission speed, capacity, and reliability of wireless channels. This task can be accomplished by using low power and low latency for the tactile internet, the Internet of Things (IoT), massive multiple-input and multiple-output (MIMO), robotics, autonomous vehicles, and industry . Due to its super-fast nature, it brings a latency rate of 1 ms, allowing problems to be solved instantaneously, which is essential for real-time applications and seamless connectivity.

5G technology has enabled multiple networks to interact with each other irrespective of their distinct characteristics to establish a heterogeneous wireless network. Although this is a standard of 4G-LTE, the primary infrastructure does not support it. Fifth-generation devices consume low power, and Tx/Rx transmits signals at a data rate of 10 Gbps (gigabits-per-second). This technology provides an environment for the connection of millions of IoT devices. The combination of 5G and IoT can be used to execute the smart city concept. Smart devices are capable of exchanging data over millions of devices at a high transmission rate with low latency and low cost. Increased system capacity, high spectral efficiency (SE), and energy efficiency are other advantages that can improve user experience and satisfaction. The primary goal of 5G is to connect living beings and intelligent devices (machines, robotics) at any instant to provide complete services. The roadmap of 5G provides boundless possibilities

from economic and societal perspectives. The lower site density in the sub-6 GHz region is crucial for high-definition video streaming and massive machine-type communications (mMTC) applications with ultra-reliable low latency communication (uRLLC). Fifth-generation technologies will surely help to tackle applications that consume high data rates and require massive bandwidth and low latency.

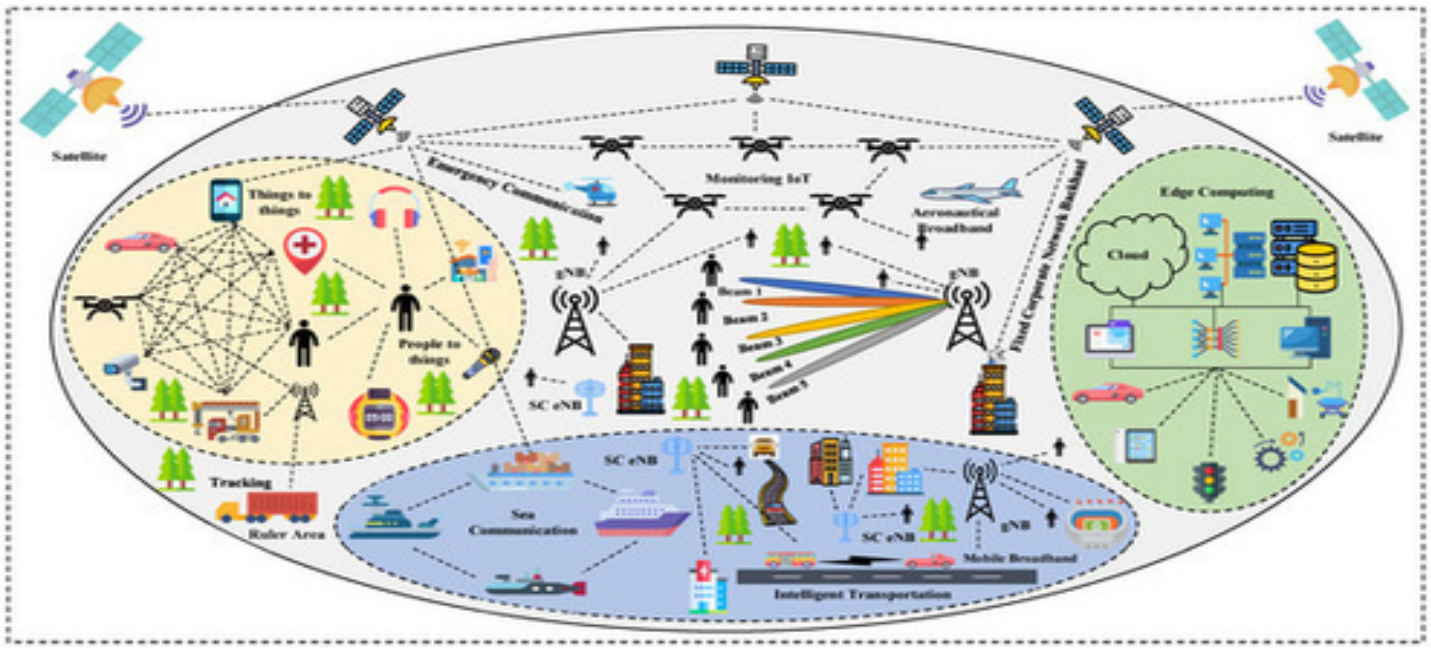


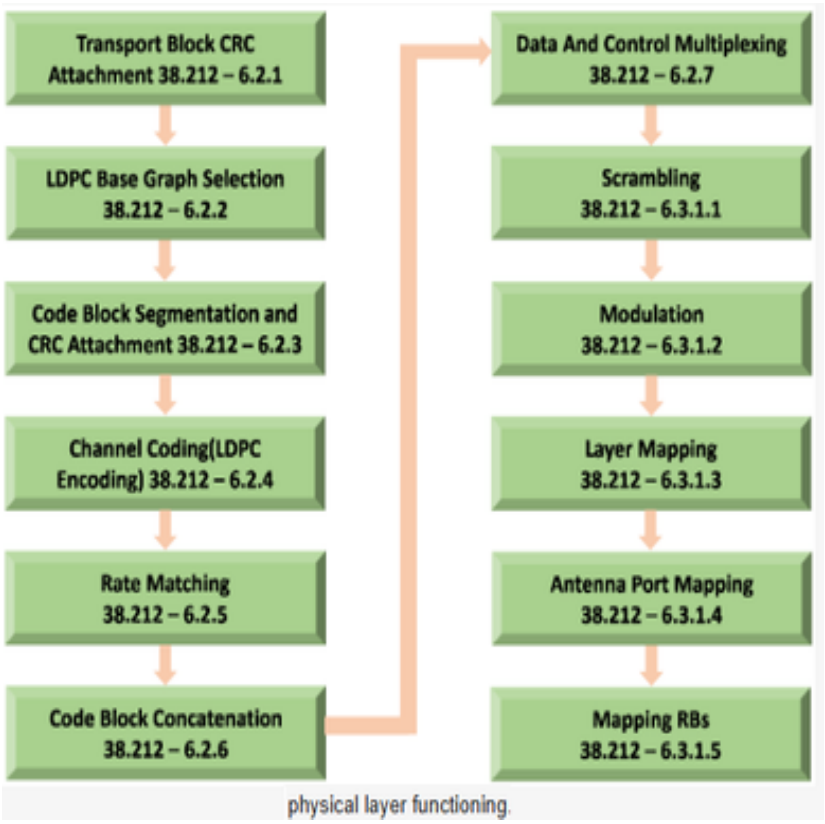
Figure 1.1: 5G Network Architecture

In Figure 1, the heterogeneous network architecture of 5G new radio (NR) is presented, in which everything is connected with 5G internet. Artificial Intelligence (AI), machine learning (ML), and deep learning (DL) techniques are envisioned to be the best techniques to make the 5G vision a reality. Considering novel use cases such as critical delay-sensitive applications, drone mobility, autonomous vehicles, mixed reality, and industrial automation. From virtual personal assistants to social media services, ML is expected to solve many challenges in numerous applications. The ML-based solutions are effective for intrusion detection and prevention, video surveillance, email spam, and predictions, while reducing online commuting. ML has become mature enough to enhance the performance of the network and its services by learning from the wireless network traffic behaviors. ML-based 5G wireless communication is possible using various modern networking standards; i.e., big data analysis, mobile edge caching, mobile edge computing, and context-aware networking. The existing heuristic radio resource management (RRM) algorithms cannot confront the fundamental demands of 5G due to their complex procedure. However, ML works incredibly well for traditional approaches to complex problems that require a great deal of human intervention. .

In addition, ML-based algorithms learn from existing or run-time data, perform automatic feature extraction, and replace the stereotypically long instructions to tackle novel problems. Substantially, an ML-based algorithm can help in the fields of education, patient sickness predictions, image recognition, self-driving cars, military surveillance, transportation, stock market, and recommendation engines. Complications in wireless networks are due to the exponential growth of heterogeneous networks, the immense numbers of end-user devices, and time-sensitive applications. For this reason, emerging use cases and services demand an automated network procedure. However, the current state-of-the-art deployment of wireless networks has taken a sporadic approach based on the fix-and-patch mentality. ML principles are often drawn from established technologies of machine vision and robotics. Such borrowed regulations address the specific situation but negligently create new research challenges. These challenges include the inept usage of network resources, weak processing, memory sufficiency, and attack vectors. Therefore, to enhance the wireless network capability, elementary units and all layers of a wireless system will integrate ML-based approaches.

Physical Layer in 5G

The physical layer, the bottom layer of 5G, is the only layer that provides a direction to the top layers. The physical layer's primary functions include encoding/decoding, error detection, modulation/demodulation, digital and analog beam-formation, RF processing, and MIMO handling. These functions are carried out through a wireless environment surrounded by an electromagnetic field, RF, signal transmission, waves, and antenna propagation. The major role of 5G is to boost the SE. Still, as soon as the bandwidth increases, the signal suffers from electromagnetic interference, pulses, and radiation, which decreases the quality of the signal. These unwanted endowments affect the signal's attributes and create unnecessary noise (i.e., additive, multiplicative, Poisson, transient, and phase noise). Additive noise is further divided into nine categories: white, additive white Gaussian, black, Gaussian, pink/flicker, Brownian, contaminated Gaussian, power-law, and Cauchy noise). Consider a simple example of a current flowing from the standard circuit to understand this concept. The circuit's elements (wire, resistor, battery) are designed to receive zero EM radiations for the current to flow without any disturbance. However, if the circuit does not follow standard regulations, unlimited reflections will be received, and the current will not flow easily. On similar lines, the circuit becomes a mono-pole antenna if the standards are not maintained in the transmission and receiving process of the wireless medium. Likewise, by enhancing SE, distortion will be generated, and the signal will suffer a significant number of reflections, interrupted noises, and reflections in its path.



physical layer functioning.

Figure 1.2: 5G Applications Overview

Applications in real-world systems



Figure 1.3: 5G System Diagram

IoT (Internet of Things)

- Enables connection of smart devices (home automation, sensors) through high-speed 5G networks.
- Supports real-time data transfer with low latency for efficient automation.

TI (Tactile Internet)

- Provides ultra-low latency communication (≈1 ms) for real-time control systems.
- Used in remote surgery, robotics, and virtual reality applications.

D2D (Device-to-Device Communication)

- Allows direct communication between devices without base station involvement.
- Improves network efficiency and reduces latency in local communication.

M2M (Machine-to-Machine Communication)

- Enables automated communication between machines without human intervention.
- Widely used in industrial automation and smart metering systems.

e-Healthcare

- Supports remote patient monitoring and telemedicine services.
- Enables real-time transmission of medical data for faster diagnosis.

FinTech

- Enables secure and fast digital transactions using 5G networks.
- Supports mobile banking, digital wallets, and real-time payment systems.

IoV (Internet of Vehicles)

- Connects vehicles to each other and infrastructure for smart transportation.
- Enhances road safety through real-time traffic and collision alerts.

Cellular

- Provides high-speed mobile communication with enhanced bandwidth.
- Supports massive user connectivity and improved network coverage.

2. IoT Based Smart Home Automation System

ANKE AKHILA

III YEAR

Introduction

An IoT (Internet of Things) based Smart Home Automation System is a modern approach to controlling and monitoring household devices using internet connectivity. It connects everyday home appliances such as lights, fans, air conditioners, security cameras, and door locks to a centralized system that can be accessed remotely through smartphones, computers, or voice assistants.

In this system, physical devices are embedded with sensors, software, and communication technologies that allow them to collect, exchange, and act on data in real time. The integration of IoT enables users to automate tasks like switching lights on/off, adjusting room temperature, or monitoring home security without manual intervention.

The concept is built on three main components:

- Smart Devices: Appliances equipped with sensors and actuators
- Connectivity: Communication via Wi-Fi, Bluetooth, or Zigbee
- Control Interface: Mobile apps, web platforms, or voice control systems

With the advancement of technologies like 5G, cloud computing, and artificial intelligence, smart home systems have become more efficient, reliable, and user-friendly. These systems not only improve convenience but also enhance energy efficiency, safety, and overall quality of life. In simple terms, IoT-based home automation transforms a traditional house into a “smart home”, where devices can communicate with each other and operate intelligently based on user preferences or environmental conditions. Among most of trending topics, home automation is one the eye catching concept where R&D is happening at a very high rate. If we are talking about home automation, we will obviously go for wireless communication like Bluetooth, Wi-Fi technology, GSM technology.



Figure 2.1: Smart Home Automation System

Among these things most effective communication is GSM, because it can be operated from very long distance and Output will be very accurate because we are going to control all the household devices by an SMS using GSM modem. This modem uses a SIM card and operates through a subscription with the mobile operator.

GSM is generally called as Modem (Global System for Mobile Communications). It is a wireless communication module, which will be used to communicate with a computer or processor over the network. The GSM modem uses a variation of TDMA (Time Division Multiple Access) which is most commonly used of the digital wireless telephony technologies like TDMA, GSM and CDMA. This GSM modem needs a SIM card to operate through a network range subscribed by the network operator. This modem can be connected to a computer via a serial, Bluetooth or USB connection. This modem is also be a standard GSM mobile phone with a suitable cable and software driver to connect to a USB port on your PC. Generally, this modem is preferred instead of a GSM mobile phone. In addition to this, we can add Wi-Fi module, to upload the data into remote cloud, to access it from anywhere in the world.

It will program the microcontroller in such a way that say whenever you send SMS to the SIM inside the GSM module, from your operational mobile to switch on the appliance, it not only switch on the appliance but also store the data in the remote server simultaneously. You can also innovate the system further to send a notification to a user at any part of the world via sms or email

Description:

- Arduino/Genuino Uno: The digital and analog input/output pins equipped in this board can be interfaced to various expansion boards and other circuits. Serial communication interface is a feature in this board, including USB which will be used to load the programs from computer.
- GSM module: The GSM module we use is SIM 800/900 MODULE. In this modem, Bluetooth is interfaced by default. Basically there are three types of GSM module are there. They are Data Loggers Data Pushers Data Pullers

- N-Channel Relay Module: The n-Channels Relay module's operating voltage is 5V DC with drive current of 20mA. This relay can be interfaced with many no. of microcontrollers such as Arduino, AVR, PIC, ARM and MSP430. Here we use Arduino, because programming is not that much typical. This relay module has ports "NC" abbreviated as "Normally connected to COM", "NO" abbreviated as "Normally open to COM" and "COM" abbreviated as Common. Along with these, there will be two types of LED's, one is to show the power status of the board and other for showing the relay status. Here "N" indicates the no relays on single board. We have 2, 4, 6, 8, 10, 12-Channel Relay Module are available in the market.
- LCD Display 16*2: Generally we use LCD to display the limited set of output statements. At present we use mostly 16*2(4 bit communication) and 16*4(8 bit communication), which means 16 letter spaces with 2 lines and 16 letter spaces with 4 lines(each line will have 16 letter spaces)
- Wi-Fi Module : ESP8266 Wi-Fi module is generally used to establish the wireless communication between the devices. But this module is not capable of 5-3V logic shifting and will require an external logic level converter.

3. Wireless Sensor Network

BOYA BHAVANI

II YEAR

It is an infrastructure-less wireless network that is deployed in a large number of wireless sensors in an ad-hoc manner that is used to monitor the system, physical, or environmental conditions. Sensor nodes are used in WSN with the onboard processor that manages and monitors the environment in a particular area. They are connected to the Base Station which acts as a processing unit in the WSN System. The base Station in a WSN System is connected through the Internet to share data. WSN can be used for processing, analysis, storage, and mining of the data.

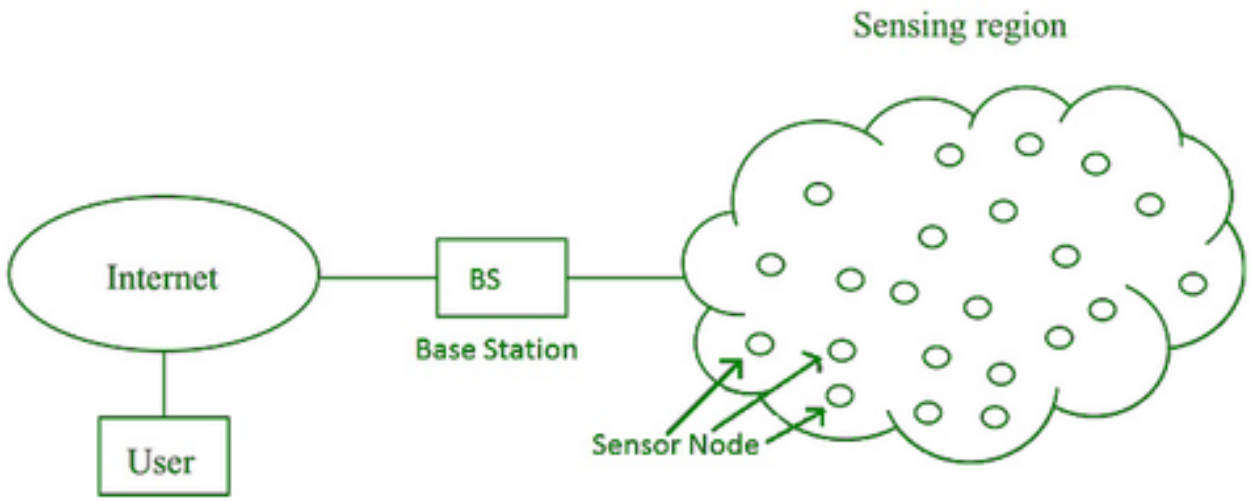


Figure 3.1: WSN Architecture

A Wireless Sensor Network (WSN) architecture is structured into three main layers:

- **Physical Layer**: This layer connects sensor nodes to the base station using technologies like radio waves, infrared, or Bluetooth. It ensures the physical communication between nodes and the base station.
- **Data Link Layer**: Responsible for establishing a reliable connection between sensor nodes and the base station. It uses protocols such as IEEE 802.15.4 to manage data transmission and ensure efficient communication within the network.
- **Application Layer**: Enables sensor nodes to communicate specific data to the base station. It uses protocols like ZigBee to define how data is formatted, transmitted, and received, supporting various applications such as environmental monitoring or industrial control.

These layers work together to facilitate the seamless operation and data flow within a Wireless Sensor Network, enabling efficient monitoring and data collection across diverse applications.

WSN Network Topologies

Wireless Sensor Networks (WSNs) can be organized into different network topologies based on their application and network type. Here are the most common types:

- **Bus Topology**: In a Bus Topology, multiple nodes are connected to a single line or bus. Data travels along this bus from one node to the next. It's a simple layout often used in smaller networks.
- **StarTopology**: Star Topology have a central node, called the master node, which connects directly to multiple other nodes. Data flows from the master node to the connected nodes. This topology is efficient for centralized control.
- **Tree Topology**: Tree Topology arrange nodes in a hierarchical structure resembling a tree. Data is transmitted from one node to another along the branches of the tree structure. It's useful for expanding coverage in hierarchical deployments.
- **Mesh Topology**: Mesh Topology feature nodes interconnected with one another, forming a mesh-like structure. Data can travel through multiple paths from one node to another until it reaches its destination. This topology offers robust coverage and redundancy.

Each topology has its advantages and is chosen based on factors such as coverage area, scalability, and reliability requirements for the specific WSN application.

Types of Wireless Sensor Networks (WSN)

Terrestrial Wireless Sensor Networks

- Used for efficient communication between base stations.
- Consist of thousands of nodes placed in an ad hoc (random) or structured (planned) manner.
- Nodes may use solar cells for energy efficiency.
- Focus on low energy use and optimal routing for efficiency.

Underground Wireless Sensor Networks

- Nodes are buried underground to monitor underground conditions.
- Require additional sink nodes above ground for data transmission.
- Face challenges like high installation and maintenance costs.
- Limited battery life and difficulty in recharging due to underground setup.

Underwater Wireless Sensor Networks

- Deployed in water environments using sensor nodes and autonomous underwater vehicles.
- Face challenges like slow data transmission, bandwidth limitations, and signal attenuation.
- Nodes have restricted and non-rechargeable power sources.

Multimedia Wireless Sensor Networks

- Used to monitor multimedia events such as video, audio, and images.
- Nodes equipped with microphones and cameras for data capture.
- Challenges include high power consumption, large bandwidth requirements, and complex data processing.
- Designed for efficient wireless data compression and transmission.

Mobile Wireless Sensor Networks (MWSNs)

- Composed of mobile sensor nodes capable of independent movement.
- Offer advantages like increased coverage area, energy efficiency, and channel capacity compared to static networks.
- Nodes can sense, compute, and communicate while moving in the environment.

Each type of Wireless Sensor Network is tailored to specific environmental conditions and applications, utilizing different technologies and strategies to achieve efficient data collection and communication.

Applications of WSN

- Internet of Things (IoT)
- Surveillance and Monitoring for security, threat detection
- Environmental temperature, humidity, and air pressure
- Noise Level of the surrounding

- Medical applications like patient monitoring
- Agriculture
- Landslide Detection

Advantages

- **Low cost:** WSNs consist of small, low-cost sensors that are easy to deploy, making them a cost-effective solution for many applications.
- **Wireless communication:** WSNs eliminate the need for wired connections, which can be costly and difficult to install. Wireless communication also enables flexible deployment and reconfiguration of the network.
- **Energy efficiency:** WSNs use low-power devices and protocols to conserve energy, enabling long-term operation without the need for frequent battery replacements.
- **Scalability:** WSNs can be scaled up or down easily by adding or removing sensors, making them suitable for a range of applications and environments.
- **Real-time monitoring:** WSNs enable real-time monitoring of physical phenomena in the environment, providing timely information for decision making and control.

Conclusion

In conclusion, Wireless Sensor Networks (WSNs) are valuable systems that enable efficient monitoring and data collection across various applications. They play a crucial role in industries like environmental monitoring, healthcare, and agriculture by providing real-time data insights. Despite challenges such as energy efficiency and security, WSNs continue to evolve with advancements in technology, promising even more effective and reliable performance in the future

4. Embedded Systems for Industrial Automation

DABBARA HARSHITHA

IV year

Introduction

Embedded systems in Industrial automation can be defined as the process of delegation of repetitive human control functions to the equipment. Industrial automation is done using control systems such as PLC's, computers, and microcontrollers to process and control machinery to help reduce the need for repetitive human intervention. Embedded systems help to automate the process by instructing the machines regarding how to

produce a product or a component. Industrial Automation is used in almost every type of manufacturing industry such as textile, food/beverage, mining, metal, manufacturing, and many others.

Embedded systems act as a programmable operating system in larger systems that perform tasks such as controlling line speeds, driving motors, adjusting temperature, and networking equipment. The main purpose of the industrial embedded systems for industrial automation is to monitor and control the processes which will enable to improve overall efficiency and maximum performance in challenging and often requiring precision environments.

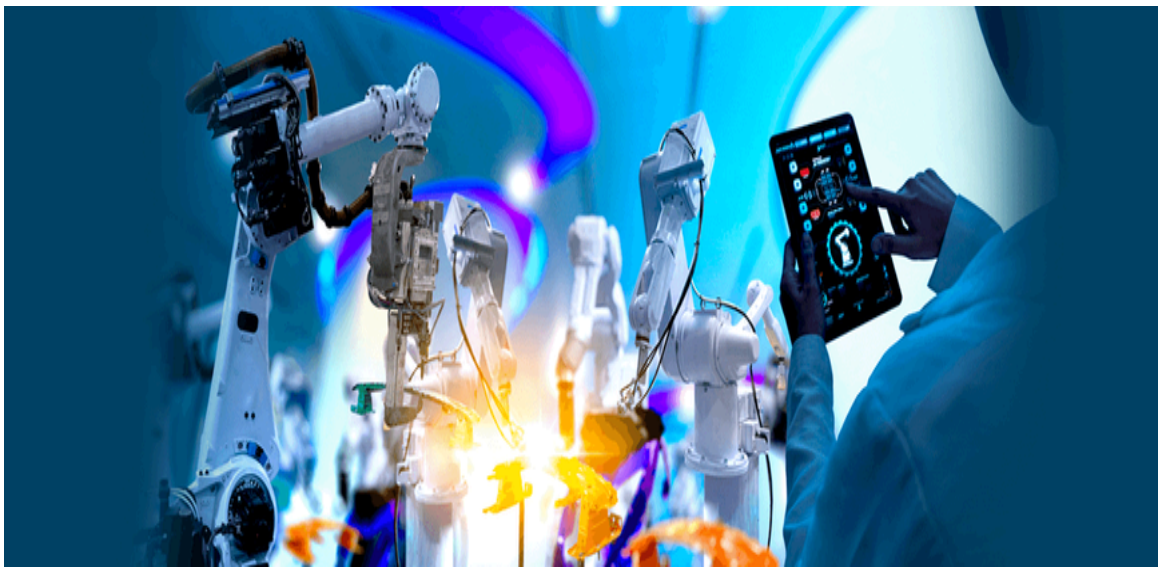


Figure 4.1: Embedded System in Industrial Automation

Industrial automation involves transferring repetitive tasks typically performed by humans to machines and equipment. This is accomplished using control systems like Programmable Logic Controllers (PLCs), computers, and microcontrollers.. These systems process and manage machinery to reduce the necessity for human intervention. Industrial embedded systems play an essential role in automating these processes by directing machines on how to produce various products or components. This kind of automation is widely implemented across numerous manufacturing sectors, including textiles, food and beverages, mining, metal manufacturing, and many others.

Embedded systems are designed to function as programmable operating systems within larger frameworks. They perform various tasks, such as controlling line speeds, driving motors, adjusting temperatures, and networking equipment. The primary purpose of these industrial embedded systems is to monitor and control processes, thereby enhancing efficiency and maximizing performance in environments that demand high precision.

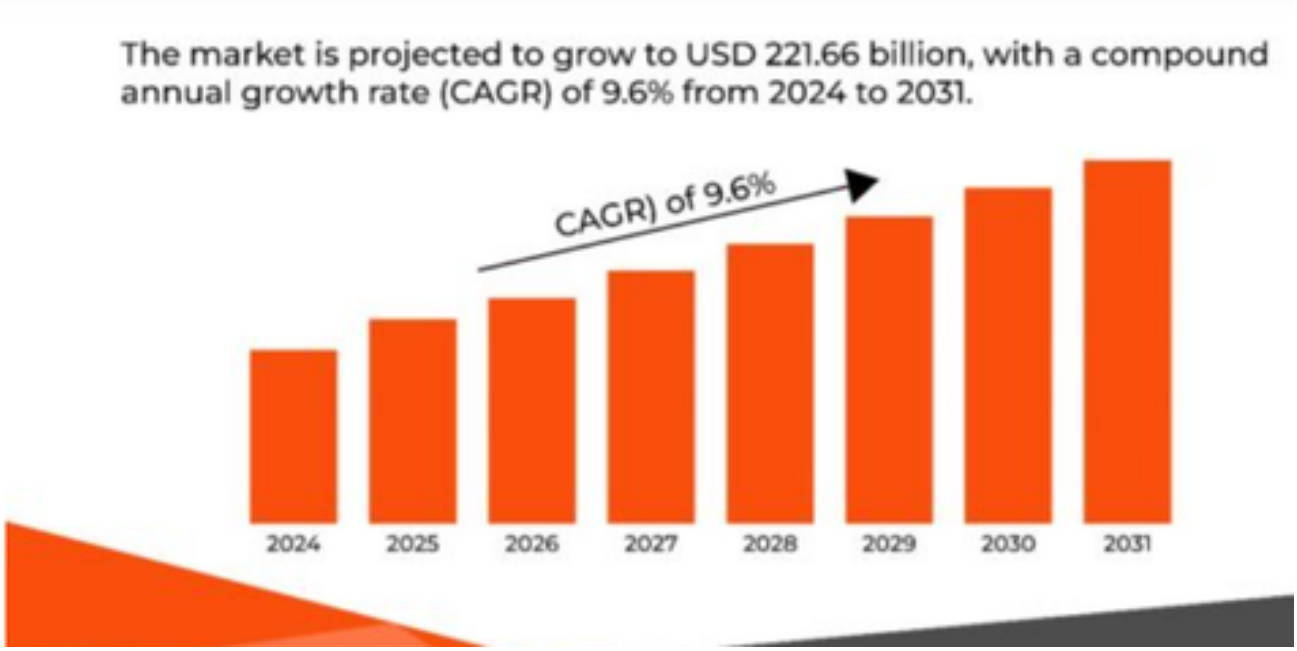


Figure 4.2: Industrial Automation Block Diagram

Before the widespread adoption of industrial embedded systems, operators manually controlled and monitored machinery. This approach presented several challenges, such as time-consuming integration with existing control and monitoring systems, network infrastructure incompatibility, and inadequate support for extensive industrial setups requiring precise control to improve efficiency.

Advantages of Industrial Automation with Embedded Systems

Better Efficiency: Automation of mundane operations increases productivity and reduces the number of human errors and smoothens the process

Cost Saver: Maintenance costs are reduced, as well as the downtime, which result in significant cost savings.

Product Quality: Consistent and precise control of processes enhances the quality of products significantly.

Real-Time Monitoring: Continuous monitoring and real-time analysis improves decision-making and operational efficiency two-fold.

Scalability: Embedded systems can easily be increased to meet the growing demands of industrial operations.

Industrial Embedded Systems in the Coming Future: **The Evolution: Advancing technology and an increasingly complex industrial process will progress further this role of industrial embedded systems. Their future will be that of increasing sophistication to achieve even higher levels of automation and efficiency.**

Real Examples of Industrial Automation

- Manufacturing Industry
- Industrial embedded systems in the manufacturing sector are applied on assembly lines for control; they are used in managing robotic arms, including monitoring temperature and pressure production parameters,

to ensure that products are made uniformly and meet quality requirements. Manufacturers can increase output, reduce waste and lower production costs by automating these tasks.

- Food and Beverage Industry
- Industrial embedded systems in the food and beverage industry help monitor and control the conditions of processing to ensure quality and safety in food. It deals with things like temperature regulation in cooking, monitoring the pH levels in beverages, and tracking the flow of ingredients. Automation in this industry ensures that the quality of products is constant, in line with regulatory standards, and at its best efficiency.
- Mining Industry
- Industrial integrated systems are employed in mining to control big equipment, measure the environment, and extract products. The system provides real-time data on equipment performance and environmental conditions, making mining safe and efficient. Automation reduces the risks of accidents and assists in the optimization of resource extraction and minimization of environmental impacts.
- Metal Manufacturing Industry
- Industrial embedded systems in metal manufacturing control the processes of casting, forging, and rolling. It keeps checking and adjusting parameters like temperature, pressure, and speed for quality production of metal products. It improves product quality and raises production efficiency while reducing energy consumption.
- The Role of IIoT and Electrical Design in Industrial Automation
- Industrial embedded system capability will be highly promoted with the integration of IIoT and advanced electrical design in industrial automation. IIoT supports the analysis of the real-time data for effective data analysis and decision-making in actual time.

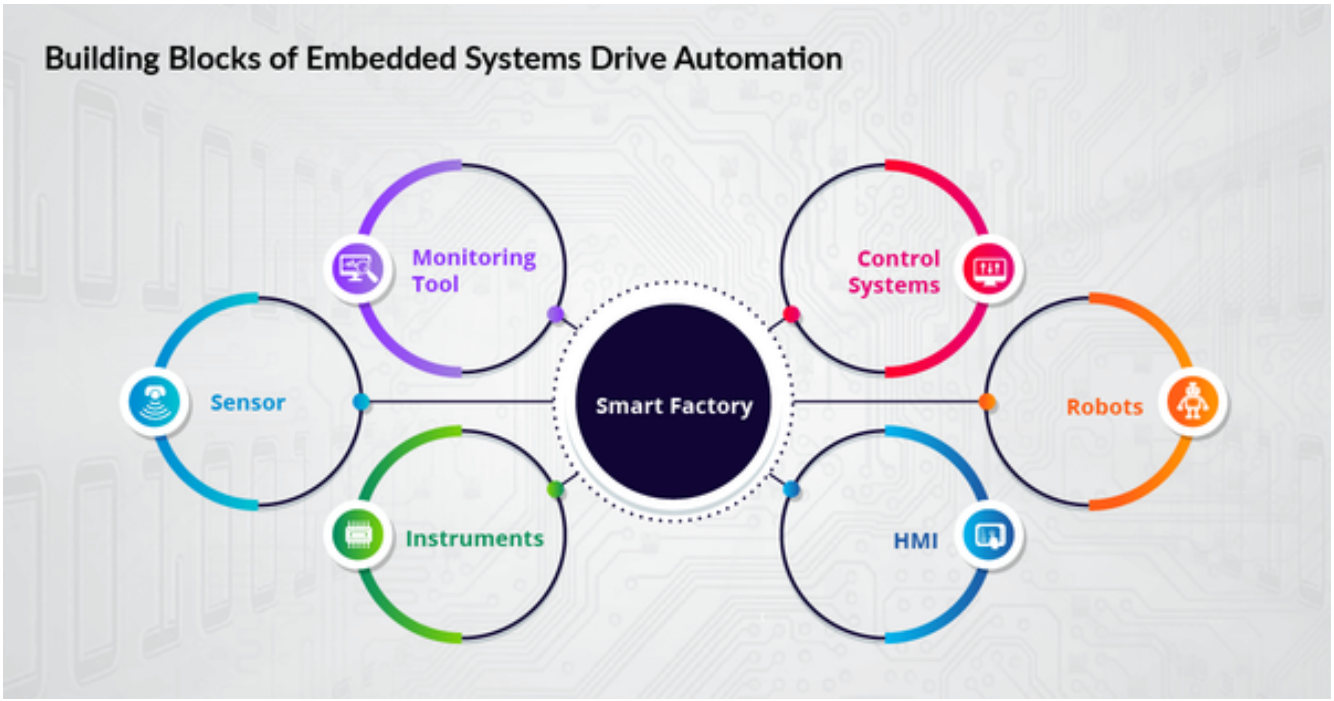


Figure 4.3: IIoT Integration

Electrical design of such systems ensures seamless integration, ensuring reliability and good performance in the existing infrastructure.

5. Low Power CMOS Technology

GORITI BHAVANA

III year

Introduction

The development of CMOS technology is reaching its final stage where the transistor structure appears to be the most complicated. After more than fifty years following Moore's Law, the technology roadmap will finally be finishing in a few years. Simply, downscaling is approaching a brick wall where our technology is unable to continue developing beyond the 3 nm node anymore. The main issues are the uniformity, reproducibility, and quality of nanomaterials in mass production when the threshold has been reached. At that stage, where we are not able to pack more transistors in a lateral direction on the chip, we try to pack them in a vertical directionIn recent years, the demand for low-power CMOS circuits has surged, driven by the ubiquitous presence of portable devices and the growing need for energy efficiency in electronic systems. Designers face the challenge of reducing power consumption without compromising performance, size, or cost. To address this, numerous techniques have been developed to balance these often conflicting requirements. This article delves into various techniques for designing low-power CMOS circuits and examines the inherent tradeoffs involved in each approach.

Understanding Power Consumption in CMOS Circuits

Power consumption in CMOS circuits can be categorized into two primary components: dynamic power and static power. Dynamic power is consumed during the switching of transistors, while static power is consumed due to leakage currents when the transistors are off. Reducing these components requires a combination of innovative design strategies and careful consideration of tradeoffs in performance and area.

Dynamic Power Reduction Techniques

- Voltage Scaling
- Lowering the supply voltage is one of the most effective ways to reduce dynamic power, as power consumption is proportional to the square of the supply voltage. While this method significantly decreases power usage, it also impacts the circuit's speed. Designers must carefully select the optimal voltage level that minimizes power while meeting performance requirements.
- Clock Gating
- Clock gating reduces power by switching off the clock signal to inactive portions of the circuit. By controlling the clock distribution, this technique minimizes unnecessary power consumption during idle times. However, the added complexity of implementing clock gating can increase design time and require additional verification efforts.
- Dynamic Frequency Scaling
- Adjusting the operating frequency of a circuit based on workload requirements can effectively reduce power consumption. This technique, known as dynamic frequency scaling, allows circuits to operate at

lower frequencies when full performance is not needed, thus saving power. The tradeoff is a potential increase in latency and a more complex control scheme.

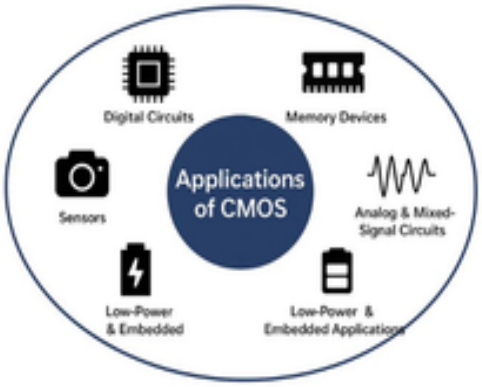
Static Power Reduction Techniques

Multi-Threshold CMOS (MTCMOS)

- MTCMOS technology utilizes transistors with different threshold voltages. High-threshold transistors reduce leakage currents in non-critical paths, while low-threshold transistors are used in performance-critical paths. This approach effectively reduces static power but introduces challenges in balancing speed and leakage across different parts of the circuit.
- Power Gating
- Power gating involves shutting off power to certain sections of a chip when they are not in use, effectively reducing leakage currents. This technique provides substantial static power savings but requires additional circuitry to manage the power states, leading to increased area and potential design complexity.
  - Use of Low-Leakage Transistors
- Implementing transistors with low-leakage characteristics can significantly reduce static power. However, these transistors may exhibit slower switching speeds, necessitating a careful design strategy to balance power savings with performance requirements.Tradeoffs in Low-Power Design

While the techniques mentioned above offer effective means to reduce power consumption, they often introduce tradeoffs in terms of performance, area, or design complexity. Designers must weigh these tradeoffs to achieve an optimal balance that meets the specific requirements of their application. For instance, aggressive voltage scaling can lead to diminished performance, while extensive use of clock gating may increase design complexity.

• Applications in real-world systems



6 Near Field Communication

MANDRI DEEKSHA

II YEAR

Introduction:

Near Field Communication (NFC) is a short-range wireless communication technology that enables data exchange between devices over a very small distance, typically within 4–10 centimeters. It operates at a frequency of 13.56 MHz and is based on radio frequency identification (RFID) technology. NFC allows two electronic devices, such as smartphones, smart cards, or payment terminals, to communicate simply by bringing them close together.

NFC is widely used for secure and contactless communication. One of its most common applications is in mobile payment systems, where users can make transactions by tapping their smartphones on payment terminals. It is also used in access control systems, public transportation cards, and electronic ticketing.

There are three main modes of NFC operation:

- **Peer-to-Peer Mode:** Enables two devices to exchange data directly.
- **Reader/Writer Mode:** Allows an NFC device to read information from tags or cards.
- **Card Emulation Mode:** Enables a device to act like a smart card for payments or access.

NFC offers several advantages, including ease of use, fast connection setup, and high security due to its short communication range. It does not require manual pairing like Bluetooth, making it convenient for quick interactions.



Figure 6.1: Diagram of NFC

The diagram illustrates the working and applications of a Near Field Communication (NFC) system centered around an NFC-enabled smartphone and controller.

At the core is the NFC controller, which manages communication between the smartphone and nearby NFC-enabled devices. The smartphone acts as the main interface, enabling wireless communication when brought close to other devices.

On the left side, NFC supports “Tap & Pair” functionality with consumer electronics such as computers, speakers, and other accessories. Instead of manual configuration, devices can be quickly connected by simply tapping them together, often in combination with technologies like Wi-Fi or Bluetooth.

On the right side, the diagram shows “Tap & Exchange”, where NFC is used to transfer data between devices or systems. This includes applications in home appliances, healthcare systems, metering devices, and data logging, enabling quick and secure data sharing.

At the bottom, “Tap & Pay” represents one of the most popular NFC applications. Smartphones can communicate with Point of Sale (PoS) terminals and NFC readers to perform secure, contactless payments.

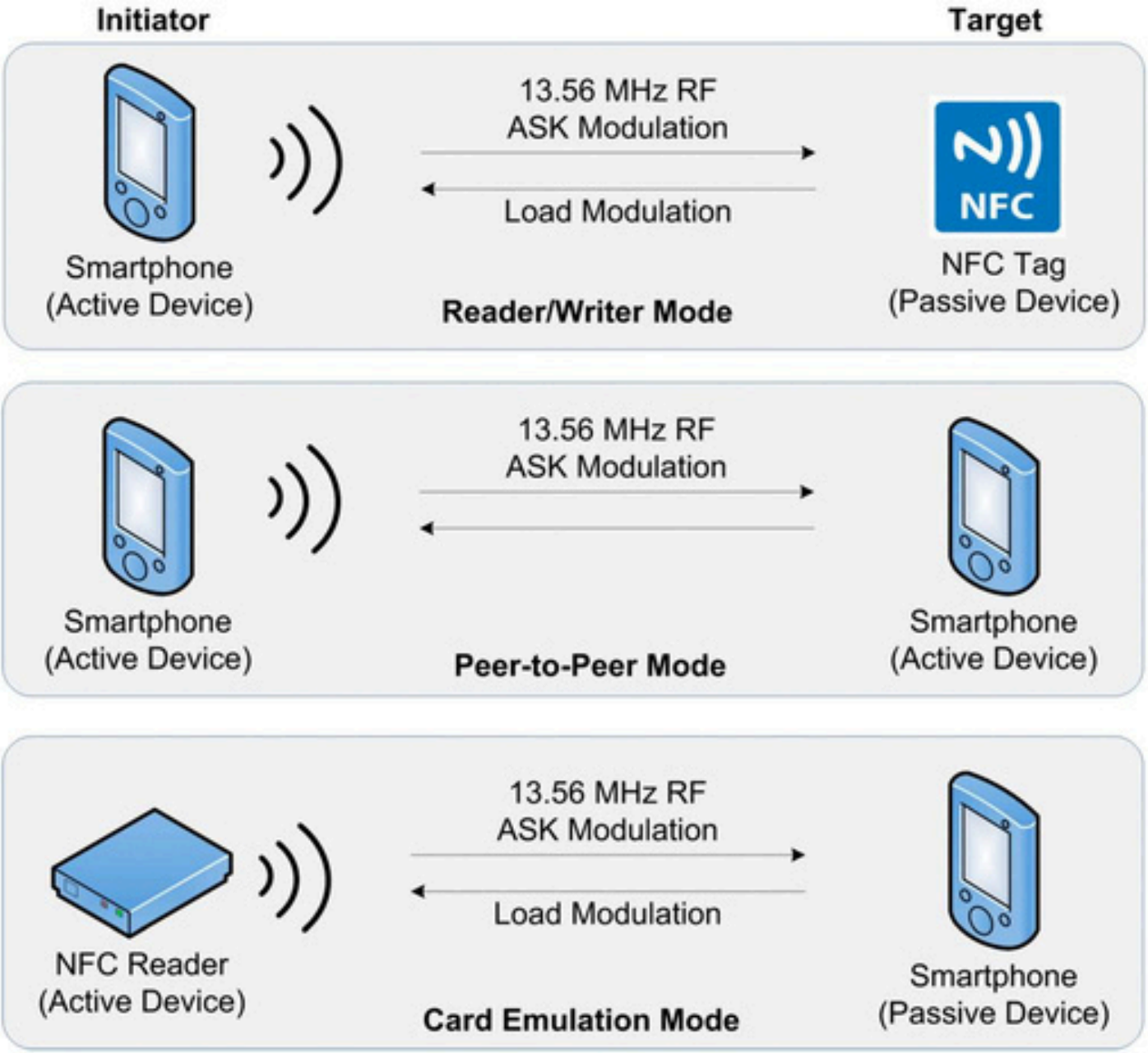


Figure 6.2: Diagram



Figure 6.3: Diagram

NFC is a very short-range wireless technology used for contactless communication. It operates within a few centimeters and is widely used in mobile payments and access control systems. NFC is highly secure due to its limited range, but it supports very low data rates compared to Li-Fi.

Applications of Near Field Communication (NFC)

Near Field Communication (NFC) is widely used in many fields due to its simplicity, security, and quick connectivity. Below are the major applications:

Contactless Payments

- NFC is extensively used in mobile payment systems. Smartphones and smart cards can be used to make payments by simply tapping on PoS terminals. This method is fast, secure, and widely used in retail stores, restaurants, and public transport.

Access Control and Security

- NFC is used in access control systems such as office entry cards, hotel key cards, and secure authentication systems. It allows users to unlock doors or systems by tapping their device or card.

Data Sharing and Device Pairing

- NFC enables quick data exchange between devices. Users can share contacts, images, or files by tapping two devices together. It is also used for **tap-to-pair** functionality in Bluetooth devices like speakers and headphones.

Public Transportation

- Many metro and bus systems use NFC-enabled smart cards or mobile apps for ticketing. Passengers can tap their cards or phones for quick entry and exit, reducing waiting time.

Healthcare Applications

- In healthcare, NFC is used for patient identification, tracking medical equipment, and accessing medical records securely. It improves efficiency and reduces errors.

Smart Posters and Advertising

- NFC tags embedded in posters or products allow users to access information, websites, or promotions by tapping their smartphones.

7. Satellite Communication and Navigation Systems

SHAIK MANSOOR

IV YEAR

Introduction:

Satellite Navigation is based on a global network of satellites that transmit radio signals from medium earth orbit. Users of Satellite Navigation are most familiar with the 31 Global Positioning System (GPS) satellites developed and operated by the United States. Three other constellations also provide similar services. Collectively, these constellations and their augmentations are called Global Navigation Satellite Systems (GNSS).

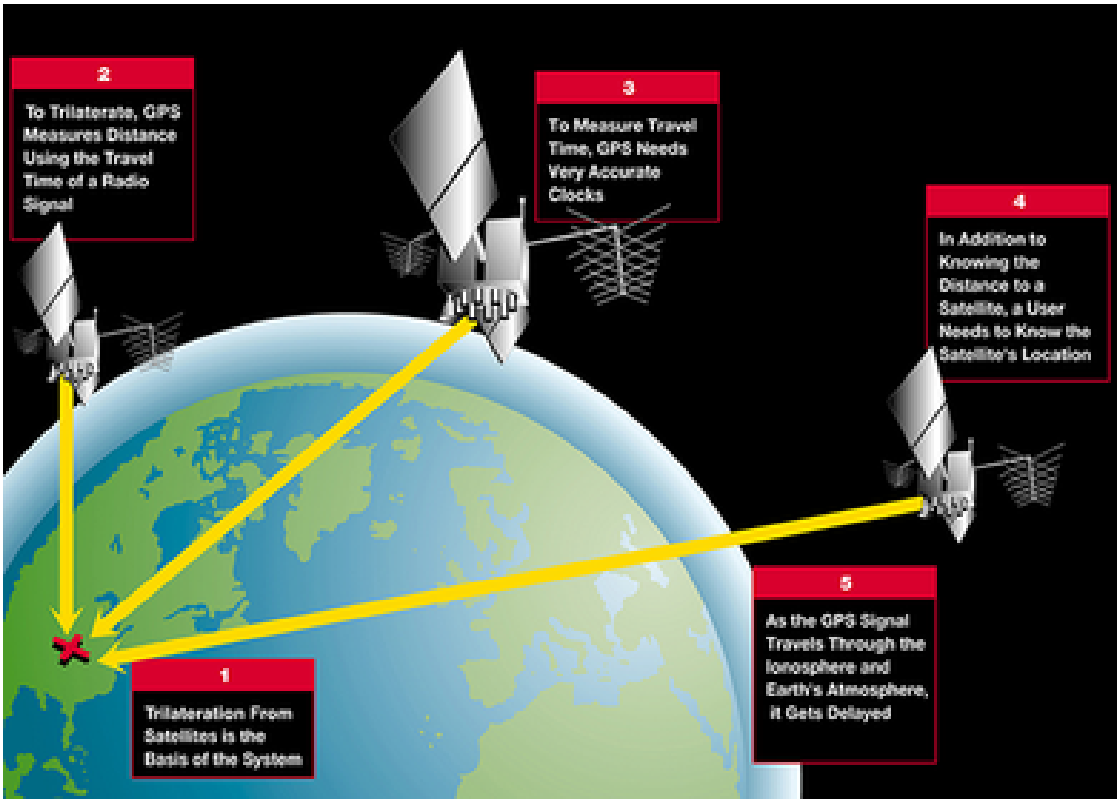


Figure 7.1: Satellite Communication System

The other constellations are GLONASS developed and operated by the Russian Federation, Galileo developed and operated by the European Union, and BeiDou, developed and operated by China. All providers have offered free use of their respective systems to the international community. All providers have developed International

Civil Aviation Organization (ICAO) Standards and Recommended Practices to support use of these constellations for aviation.

The basic GPS service provides users with approximately 7.0 meter accuracy, 95% of the time, anywhere on or near the surface of the earth. To accomplish this, each of the 31 satellites emits signals that enable receivers through a combination of signals from at least four satellites, to determine their location and time. GPS satellites carry atomic clocks that provide extremely accurate time. The time information is placed in the codes broadcast by the satellite so that a receiver can continuously determine the time the signal was broadcast. The signal contains data that a receiver uses to compute the locations of the satellites and to make other adjustments needed for accurate positioning. The receiver uses the time difference between the time of signal reception and the broadcast time to compute the distance, or range, from the receiver to the satellite. The receiver must account for propagation delays or decreases in the signal's speed caused by the ionosphere and the troposphere. With information about the ranges to three satellites and the location of the satellite when the signal was sent, the receiver can compute its own three-dimensional position. An atomic clock synchronized to GPS is required in order to compute ranges from these three signals. However, by taking a measurement from a fourth satellite, the receiver avoids the need for an atomic clock. Thus, the receiver uses four satellites to compute latitude, longitude, altitude, and time.

Applications in real-world systems

- Communication Services:
  - Global Connectivity: Provides voice, internet, and data to remote areas where terrestrial infrastructure is impossible, such as maritime or aviation communication.
  - Broadcasting: Satellite television and radio broadcasting.
  - Emergency Response: Satellite phones allow communication to continue when infrastructure is destroyed by disasters (earthquakes, floods).
- Navigation and Positioning (GNSS):
  - Transportation: Air traffic control, marine navigation, and in-car navigation systems.
  - Location-Based Services: Mobile phone tracking, logistics, and fleet management.
  - Precision Agriculture: Farmers utilize GNSS for precise mapping, guiding autonomous machinery, and applying fertilizer/pesticides efficiently.
  - Surveying and Mapping: High-precision data collection for geographical studies, mining, and civil engineering.

8. Robotics and Automation in Modern Engineering

SRISAILAM DAVID GOWD

III YEAR

Introduction: Robotics has become a key part of innovation, changing how engineers design, build, and improve solutions across industries. This is not science fiction; it is modern engineering at work. Robotics and automation have become central pillars of modern engineering, transforming how industries design, manufacture, and operate systems. Rooted in fields like Mechanical Engineering, Electrical Engineering, and

Computer Science, these technologies integrate intelligent machines with control systems to perform tasks with minimal human intervention.

Robotics refers to the design, development, and application of robots—machines capable of carrying out complex tasks automatically. Automation involves using control systems, such as computers or industrial controllers, to operate equipment with reduced human involvement. Together, they enhance productivity, precision, and efficiency in engineering systems.

Working Principle and Methodology

Robotics and automation systems typically function based on the following components:

- Sensors: Detect environmental changes (temperature, motion, pressure).
- Actuators: Convert electrical signals into physical movement.
- Controllers: Process inputs and execute commands (often using Programmable Logic Controller or embedded systems).
- Software Algorithms: Use techniques like Artificial Intelligence and Machine Learning to enable decision-making.

The methodology involves sensing → processing → decision-making → action execution, forming a continuous feedback loop.

Applications in Real-World Systems

Robotics and automation are widely used across industries:

- Manufacturing: Industrial robots perform welding, painting, and assembly tasks with high precision.
- Healthcare: Robotic surgery systems assist doctors in performing minimally invasive procedures.
- Agriculture: Automated machines help in planting, harvesting, and monitoring crops.
- Transportation: Autonomous vehicles and drones are reshaping logistics and mobility.
- Smart Homes: Integration with IoT enables automated lighting, security, and climate control.

Advantages

- Increased productivity and efficiency
- High accuracy and repeatability
- Reduced human error and labor costs
- Ability to work in hazardous environments
- Continuous operation (24/7)

Limitations

- High initial investment cost
- Technical complexity and maintenance
- Job displacement concerns
- Limited adaptability in unstructured environments
- Dependence on power and network systems

Conclusion

Robotics and automation are redefining modern engineering by enabling smarter, faster, and more reliable systems. While challenges remain, continuous innovation is pushing the boundaries of what machines can achieve, making them indispensable in shaping the future of technology and industry.

9. Wireless Sensor Networks for Smart Agriculture

PATIL ESWAR REDDY

II YEAR

Introduction:

Wireless Sensor Networks (WSN) for Smart Agriculture is an emerging technology that integrates sensing, communication, and data processing to enhance agricultural productivity and sustainability. It involves the deployment of a large number of small, low-power, cost-effective sensor nodes in agricultural fields to monitor environmental and soil conditions in real time.

Each sensor node is equipped with sensors, a microcontroller, a wireless transceiver, and a power source (battery or solar). These nodes collect data such as soil moisture, temperature, humidity, light intensity, soil pH, nutrient levels, and even crop health parameters. The collected data is transmitted wirelessly through multi-hop communication to a central gateway or base station. The base station forwards the information to a cloud platform or server where the data is stored, processed, and analyzed. Farmers or automated systems can access this information through web or mobile applications to make informed decisions. Based on the analyzed data, actions such as automatic irrigation, fertigation, or climate control can be triggered, making agriculture more efficient and precise.

WSN-based smart agriculture helps in optimizing the use of water, fertilizers, and pesticides, reduces human intervention, increases crop yield and quality, and supports sustainable farming practices. It is a key enabler of the Internet of Things (IoT) in agriculture and plays a vital role in transforming traditional farming into data-driven, intelligent farming.



Figure 9.1: WSN Smart Agriculture System

Applications in Real-World Systems

Wireless Sensor Networks are widely used in agriculture for various real-world applications:

Precision Farming: Monitors soil and crop conditions in real time to enable site-specific management of water, fertilizers, and pesticides.

Smart Irrigation: Soil moisture sensors help in automating irrigation systems, ensuring optimal water usage and reducing wastage.

Crop Monitoring: Tracks crop health, detects diseases, and monitors parameters such as temperature, humidity, and light for better yield prediction.

Greenhouse Automation: Controls temperature, humidity, CO2, and light conditions to maintain an ideal environment for crop growth.

10. Cyber Security Challenges in Communication Networks

NARPALA NASIMA

IV YEAR

Introduction:

Network security has become significant even more with the use of remote office work, education for schools, colleges, and universities, hospitals, and other critical infrastructure. We explain what some of the advanced network security threats are and how they can be circumvented, using robust technologies.

Firstly, let's understand what differentiates an IT risk, vulnerability, and threat. Threat is referred to as an incident or a process having the potential to harm the system. Vulnerability, on the other hand, refers to the weakness/gap that the hacker can exploit. Risk inculcates both threat and vulnerability by dealing with potential damage when a threat exploits vulnerability.

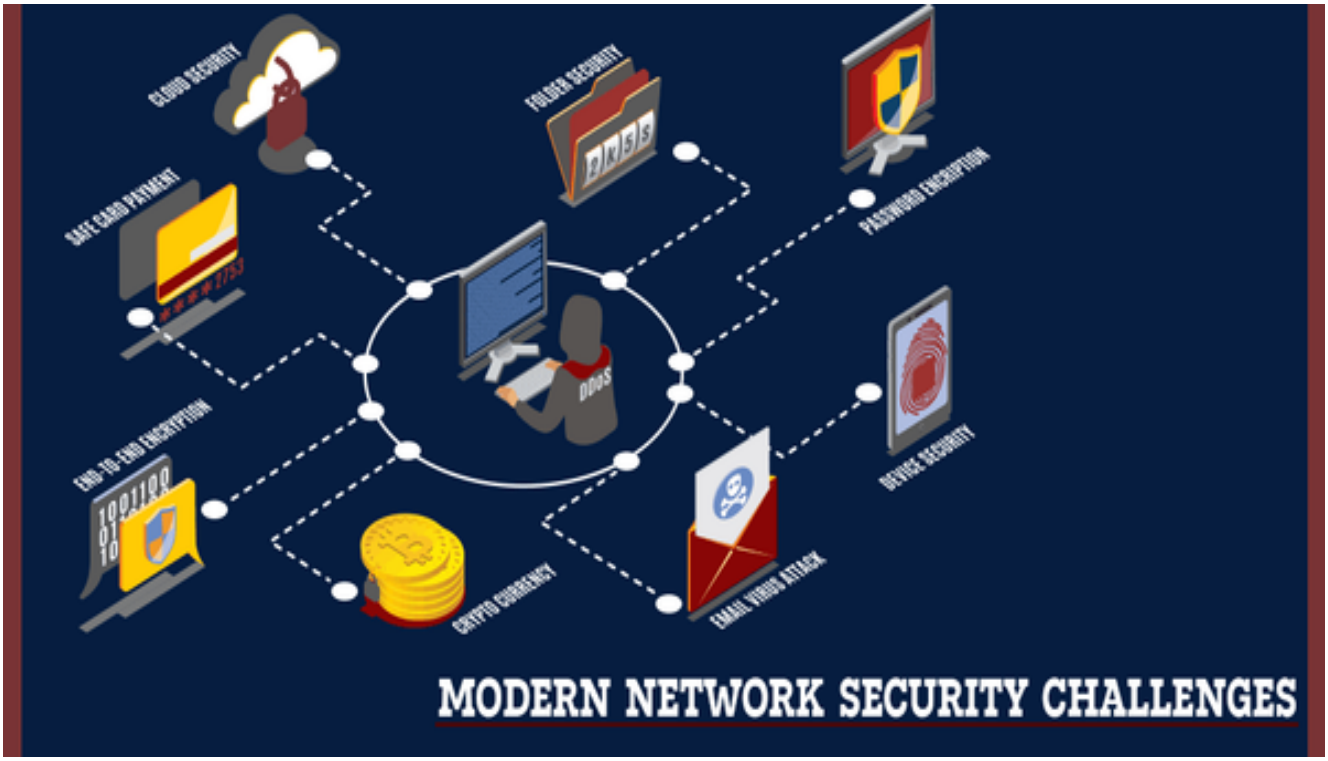


Figure 10.1: Cyber Security Threat Model

Moving on, to understand some of the common reasons for these threats to occur in the first place, we need to know what network security threats include. They include hacktivism, extortion, cyber warfare, business feuds,

and they also happen for personal reasons. There are other computer viruses as well for which you need to install firewalls to remain secure and protected.

Enabling Visibility: First way to manage network security well, is by enabling network visibility so that you know about threats, and they do not remain anonymous. Once the threat sources are known, it is easy to encounter and overcome them.

Network Access: You need to be very cautious of who is capable of having access to your organizational networks. Anonymous access to your networks only brings security threats. So, set apparent rules for allowing access.

Firewall: Advanced firewalls fully take care of unauthorized interruption in your networks by allowing network access to only authorized entities.

Free Updates Issues: You often receive updates and software installation options from unknown sources, that your admin has no idea about. Advanced network defenders make you update and install all updates through your admins, hence improving security and protection.

Major Cyber Security Challenges

Unauthorized Access

- Attackers gain access to network systems without permission.
- Weak passwords and poor authentication mechanisms are main causes.

Data Breaches and Leakage

- Sensitive information (personal, financial, industrial data) can be stolen.
- Common in cloud-based and IoT systems.

Malware and Ransomware Attacks

- Malicious software infects network devices.
- Ransomware locks systems and demands payment.

Denial of Service (DoS) Attacks

- Attackers overload the network with traffic.
- Makes services unavailable to legitimate users.

Man-in-the-Middle (MITM) Attacks

- Attacker intercepts communication between two parties.
- Data can be modified or stolen.

Phishing and Social Engineering

- Users are tricked into revealing sensitive information.
- One of the most common human-based threats.

IoT and WSN Vulnerabilities

- Devices have limited security features.
- As seen in smart agriculture systems, sensors can be easily attacked if not secured.

Lack of Encryption

- Data transmitted without encryption can be easily intercepted.
- Leads to privacy and integrity issues.

Insider Threats

- Employees or authorized users misuse access privileges.
- Difficult to detect.

Rapid Growth of Network Technologies

- New technologies (5G, IoT, cloud computing) increase attack surface.
- Security measures often lag behind
- Innovation.