INTRODUCTION TO EMERGING TECHNOLOGIES

Evolution of Technologies

- Emerging technology is a term generally used to describe a new technology, but it may also refer to the continuing development of existing technology.

- It can have slightly different meanings when used in different areas, such as media, business, science, or education.

- The term commonly refers to technologies that are currently developing, or that are expected to be available within the next five to ten years, and is usually reserved for technologies that are creating or are expected to create significant social or economic effects.

- Technological evolution is a theory of radical transformation of society through technological development

List of some currently available emerged technologies

- Artificial Intelligence

- Blockchain

- Augmented Reality and Virtual Reality

- Cloud Computing

- 5 G Networks

- DevOps

- Internet of Things (IoT)

- Intelligent Apps (I-Apps)

- Big Data

- Robotic Processor Automation (RPA)

Introduction to the Industrial Revolution (IR)

- The Industrial Revolution was a period of major industrialization and innovation that took place during the late 1700s and early 1800s.

- An Industrial Revolution at its core occurs when a society shifts from using tools to make products to use new sources of energy, suchas coal, to power machines in factories.

- The Industrial Revolution was a time when the manufacturing of goods moved from small shops and homes to large factories. This shift brought about changes in culture as people moved from rural areas to big cities in order to work.

- Generally, the following industrial revolutions fundamentally changed and transfer the world around us into modern society.
  - The steam engine,
  - The age of science and mass production, and
  - The rise of digital technology
  - Smart and autonomous systems fueled by data and machine learning.

The Most Important Inventions of the Industrial Revolution

- **Transportation**: The Steam Engine, The Railroad, The Diesel Engine, The Airplane.
- **Communication.:** The Telegraph. The Transatlantic Cable. The Phonograph. TheTelephone.
- **Industry:** The Cotton Gin. The Sewing Machine. Electric Lights.

The four types of industries are:

- **The primary industry** involves getting raw materials e.g. mining, farming, and fishing.
- **The secondary industry** involves manufacturing e.g. making cars and steel.
- **Tertiary industries** provide a service e.g. teaching and nursing.
- **The quaternary industry** involves research and development industries e.g. IT.
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Industrial Revolution (IR 1.0)

- The Industrial Revolution (IR) is described as a transition to new manufacturing processes. IR was first coined in the 1760s, during the time where this revolution began. The

transitions in the first IR included going from hand production methods to machines, the increasing use of steam powerthe development of machine tools and the rise of the factory system.

Figure 1.1 steam engine

Industrial Revolution (IR 2.0)

- The Second IR, also known as the Technological Revolution, began somewhere in the 1870s. The advancement in IR 2.0 included the development of methods for manufacturing interchangeable   parts and widespread adoption of pre-existing technological systems such as telegraph and railroadnetworks. This adoption allowed the vast movement of people and ideas,   enhancing communication. Moreover, new technological systems were introduced, such as electrical power and telephones.

Figure 1.2 Electricity transmission line

Industrial Revolution (IR 3.0)

- Then came the Third Industrial Revolution (IR 3.0). IR 3.0 introduced the transition frommechanical and analog electronic technology to digital electronics (see Figure 1.3) which began from the late 1950s.

- Due to the shift towards digitalization, IR 3.0 was given the nickname, "DigitalRevolution".

- The core factor of this revolution is the mass production and widespread use of digital logic circuits and its derived technologies such as the computer, hand phones and the Internet.

- These technological innovations have arguably transformed traditional production and business techniques enabling people to communicate with another without the need of being physically present. Certain practices that were enabled during IR 3.0 is still being practiced until this current day, for example – the proliferation of digital computers and digital record.

High Tech Electronics

Fourth Industrial Revolution (IR 4.0)

- Now, with advancements in various technologies such as robotics, Internet of Things (IoT see Figure 1.4), additive manufacturing and autonomous vehicles, the term "Fourth Industrial Revolution" or IR 4.0 was coined by Klaus Schwab, the founder and executive chairman of WorldEconomic Forum, in the year 2016.

- The technologies mentioned above are what you call – cyber-physical systems. A cyber-physical system is a mechanism that is controlled or monitored by computer-based

algorithms, tightly integrated with the Internet and its users.

- One example that is being widely practiced in industries today is the usage of Computer NumericalControl (CNC) machines. These machines are operated by giving it instructions using a computer.

- Another major breakthrough that is associated with IR 4.0 is the adoption of Artificial Intelligence(AI), where we can see it being implemented into our smartphones. AI is also one of the main elements that give life to Autonomous Vehicles and Automated Robots.

Anybody Connected device (ABCD)

ARTIFICAL INTELLIGENCE

- Artificial defines "man-made," and intelligence defines "thinking power", or "the ability to learn and solve problems" hence Artificial Intelligence means "a man-made thinking power."

- So, we can define Artificial Intelligence (AI) as the branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions.

- **Intelligence is composed of:**

- o   Reasoning

- o   Learning

- o   Problem Solving

- o   Perception

- o   Linguistic Intelligence

- **High-profile examples of AI include**

  - o   autonomous vehicles (such as drones and self-driving cars),

  - o   medical diagnosis,

  - o   creating art (such as poetry), p

  - o   roving mathematical theorems,

  - o   playing games (such as Chess or Go), s

  - o   Search engines (such as Google search), online assistants (such as Siri),

HOW AI CAME INTO EXISTENCE

- **1950:** Alan Turing published "Computer Machinery and Intelligence" which proposed a test of machine intelligence called The Imitation Game.
  - o   Alan Turing, a young British polymath who explored the mathematical possibility of artificial intelligence.
  - o   Turing suggested that humans use available information as well as reason in order to solve problems and make decisions, so why can't machines do the same thing?
  - o   This was the logical framework of his 1950 paper, Computing Machinery and Intelligence in which he discussed how to build intelligent machines and how to test their intelligence.
- **1952:** A computer scientist named Arthur Samuel developed a program to play checkers, which is the first to ever learn the game independently.

- **1955:** John McCarthy held a workshop at Dartmouth on "artificial intelligence" which is the first use of the word, and how it came into popular usage.

ADVANTAGES OF AI

- **High Accuracy with fewer errors:** AI machines or systems are prone to fewer errors and high accuracy as it takes decisions as per pre-experience or information.

- **High-Speed:** AI systems can be of very high-speed and fast-decision making, because of that AI systems can beat a chess champion in the Chess game.

- **High reliability:** AI machines are highly reliable and can perform the same action multiple times with high accuracy.

- **Useful for risky areas:** AI machines can be helpful in situations such as defusing a bomb, exploring the ocean floor, where to employ a human can be risky.

- **Digital Assistant:** AI can be very useful to provide digital assistant to users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirements.

- **Useful as a public utility:** AI can be very useful for public utilities such as a self- driving car which can make our journey safer and hassle-free, facial recognition for security purposes, Natural language processing (for search engines, for spelling checker, for assistant like Siri, for translation like google translate), etc.

DISADVANTAGES OF AI

- High Cost: The hardware and software requirement of AI is very costly as it requires lots of maintenance to meet current world requirements.

- ☐ Can't think out of the box: Even we are making smarter machines with AI, but still they cannot work out of the box, as the robot will only do that work for which they are trained, or programmed.

- ☐ No feelings and emotions: AI machines can be an outstanding performer, but still it does not have the feeling so it cannot make any kind of emotional attachment with humans, and may sometime be harmful for users if the proper care is not taken.

- ☐ Increase dependence on machines: With the increment of technology, people are getting more dependent on devices and hence they are losing their mental capabilities.

- ☐ No Original Creativity: As humans are so creative and can imagine some new ideas but still AI machines cannot beat this power of human intelligence and cannot be creative and

imaginative.

INTERNET OF THINGS (IOT)

- The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use.

- A brief review of these features is given below − AI − IoT essentially makes virtually anything "smart", meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks.

- This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer.

- Definition: IoT is the networking of smart objects, meaning a huge number of devices intelligently communicating in the presence of internet protocol that cannot be directly operated by human beings but exist as components in buildings, vehicles or the environment.

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INTERNET OF THINGS (IOT) -ADVANTAGES

- **Enhanced Data-Driven Decision Making:** Industrial IoT devices generate vast amounts of real-time data. This data enables business to make more informed and timely decisions, improving efficiency and reducing costs.

- **Predictive Maintenance:** Using sensors and data analytics, IoT devices can predict equipment failures before they occur, leading to reduced downtime, improved asset lifespan, and better resource planning. For example, Predix Asset Performance Management by General Electric (GE) is an Industrial Internet of Things (IoT) solution that utilizes sensors and data analytics to predict equipment failures in industrial settings before they happen.

- **Improved Supply Chain Management:** IOT devices enable real-time tracking of goods in the supply chain, optimizing inventory management, reducing wastage, and enhancing logistics efficiency

INTERNET OF THINGS (IOT) -DISADVANTAGES

- As the number of connected devices increases and more information is shared between devices, the potential that a hacker could steal confidential information also increases.

- If there's a bug in the system, it's likely that every connected device will become corrupted.

- Since there's no international standard of compatibility for IoT, it's difficult for devices from different manufacturers to communicate with each other.

- Enterprises may eventually have to deal with massive numbers maybe even millions of IoT devices and collecting and managing the data from all those devices will be challenging.
    - Example: For example, Amazon leverages IoT and digital twins in its supply chain management. IoT sensors in warehouses monitor inventory and smart packaging tracks product conditions during transit. Predictive maintenance is used for delivery vehicles and drones

- **Safety and Workforce Productivity:** IoT-enabled wearables and safety devices monitor employee health, detect potential hazards, and provide valuable insights to improve workplace safety and productivity.

- **Sustainable Practices:** IoT devices facilitate better resource utilization and energy efficiency, helping industries achieve their sustainability goals and reduce their environmental footprint.

- **Process Optimization:** IoT devices enable industries to monitor and optimize manufacturing processes, leading to higher product quality, reduced waste, and increased production throughput.

- **Innovation and Competitiveness:** By adopting IoT devices and leveraging data analytics, businesses can stay ahead of the competition, develop innovative products and services, and adapt to changing market demands more effectively.

IOT DEVICES

1. Temperature Sensors

They measure and monitor changes in temperature within industrial processes, machinery,

or environmental conditions. They are commonly used in manufacturing, storage facilities, and HVAC systems to maintain optimal temperature levels.

2. Pressure Sensors

Pressure sensors gauge variations in pressure levels, ensuring that industrial systems operate within safe and efficient ranges. They find applications in hydraulic, pneumatic, and various industrial processes.

3. Proximity Sensors

Proximity sensors detect the presence or absence of objects within their vicinity. They are utilized in automated manufacturing lines and robotics to enable precise positioning and prevent collisions.

4. Air Quality Monitors

Air quality monitors assess the air's pollutants and particulate matter concentration. They are commonly used in manufacturing facilities, laboratories, and industrial settings to maintain a safe and healthy atmosphere for workers.

5. Water Quality Sensors

Water quality sensors measure water's chemical, physical, and biological characteristics. Industries such as wastewater treatment plants and manufacturing facilities utilize these sensors to comply with environmental regulations and ensure water quality.

6. Noise Level Monitors

They measure and monitor industrial settings' sound levels to protect workers from excessive noise exposure. They are employed in factories, construction sites, and other noisy environments.

7. GPS Trackers

They use Global Positioning System technology to track and locate assets, vehicles, or cargo during transportation and distribution, providing real-time visibility into supply chain logistics.

8. RFID Tags

Radio Frequency Identification (RFID) tags track and identify assets and products within warehouses and manufacturing facilities, streamline inventory management, and reduce manual errors.

9. Barcode Scanners

Barcode scanners read and decode barcodes, making tracking and managing inventory easier. They are widely used in retail, manufacturing, and distribution industries for efficient asset tracking**.**

APPLICATIONS OF IOT

- **Agriculture** - For indoor planting, IoT makes monitoring and management of micro-climate conditions a reality, which in turn increases production. For outside planting, devices using IoT technology can sense soil moisture and nutrients, in conjunction with weather data, better control smart irrigation and fertilizer systems. If the sprinkler systems dispense water only when needed, for example, this prevents wasting a precious resource.

- **Consumer Use -** For private citizens, IoT devices in the form of wearables and smart homes make life easier. Wearables cover accessories such as Fitbit, smartphones, Apple watches, health monitors, to name a few. These devices improve entertainment, network connectivity, health, and fitness. Smart homes take care of things like activating environmental controls so that your house is at peak comfort when you come home. Dinner that requires either an oven or a crockpot can be started remotely, so the food is ready when you arrive. Security is made more accessible as well, with the consumer having the ability

- Healthcare - First and foremost, wearable IoT devices let hospitals monitor their patients' health at home, thereby reducing hospital stays while still providing up to the minute real-time information that could save lives. In hospitals, smart beds keep the staff informed as to the availability, thereby cutting wait time for free space. Putting IoT sensors on critical equipment means fewer breakdowns and increased reliability, which can mean the difference between life and death. Elderly care becomes significantly more comfortable with IoT. In addition to the above-mentioned real-time home monitoring, sensors can also determine if a patient has fallen or is suffering a heart attack.

- **Insurance -** Even the insurance industry can benefit from the IoT revolution. Insurance companies can offer their policyholders discounts for IoT wearables such as Fitbit. By employing fitness tracking, the insurer can offer customized policies and encourage

healthier habits, which in the long run benefits everyone, insurer, and customer alike.

- **Manufacturing** - The world of manufacturing and industrial automation is another big winner in the IoT sweepstakes. RFID and GPS technology can help a manufacturer track a product from its start on the factory floor to its placement in the destination store, the whole supply chain from start to finish. These sensors can gather information on travel time, product condition, and environmental conditions that the product was subjected to. Sensors attached to factory equipment can help identify bottlenecks in the production line, thereby reducing lost time and waste. Other sensors mounted on those same machines can also track the performance of the machine, predicting when the unit will require maintenance, thereby preventing costly breakdowns.

- **Retail -** IoT technology has a lot to offer the world of retail. Online and in-store shopping sales figures can control warehouse automation and robotics, information gleaned from IoT sensors. Much of this relies on RFIDs, which are already in heavy use worldwide. Mall locations are iffy things; business tends to fluctuate, and the advent of online shopping has driven down the demand for brick and mortar establishments. However, IoT can help analyze mall traffic so that stores located in malls can make the necessary adjustments that enhance the customer's shopping experience while reducing overhead. Speaking of customer engagement, IoT helps retailers target customers based on past purchases.