

## Unit-5

### **Emerging Technology:-**

Emerging technologies are new or developing technologies, such as AI, [blockchain](#), and [quantum computing](#), that are expected to have a significant social or economic impact.

Other emerging technologies include the [Internet of Things \(IoT\)](#), [advanced geothermal systems](#), [green energy technologies](#), and [biotechnology](#).

These technologies are often characterized by rapid growth, uncertainty, and the potential to change the status quo in various industries.

### **Examples of emerging technologies**

- **[Artificial Intelligence \(AI\)](#):** Includes machine learning, deep learning, natural language processing, and computer vision, with applications in preemptive cybersecurity and automation.
- **Blockchain:** A decentralized digital ledger technology with potential applications beyond cryptocurrency.
- **[Quantum Computing](#):** A new form of computing that uses quantum-mechanical phenomena to perform calculations.
- **Internet of Things (IoT):** A network of physical objects embedded with sensors, software, and other technologies to collect and exchange data.
- **[Advanced Geothermal Systems \(AGS\)](#):** Technologies that create artificial reservoirs deep underground to provide clean, constant energy anywhere on Earth.
- **Biotechnology:** Includes advancements like [artificial wombs](#) (exowombs) for premature infants, and the use of DNA for data storage and research acceleration.
- **Green Energy:** Focuses on sustainability, such as [Green Nitrogen Fixation](#), which uses bio-based methods to produce fertilizer with lower environmental impact.
- **[5G](#):** The fifth generation of cellular network technology, offering faster speeds and lower latency.
- **[Additive Manufacturing](#):** Also known as 3D printing, it allows for the creation of objects layer by layer.

### **Key features of emerging technologies include:**

- **Rapid Growth:** Emerging technologies typically exhibit a relatively fast growth rate compared to non-emerging technologies, in terms of the number of researchers involved, funding, publications, and products developed.
- **Prominent Impact:** They have the potential to create substantial social or economic effects and disrupt traditional industries and business models, even changing the status quo.
- **Uncertainty and Ambiguity:** Due to their early stage of development, there is a high degree of uncertainty surrounding their future potential, precise applications, cost-effectiveness, and long-term societal impacts. The knowledge of potential outcomes is often incomplete.
- **Interdisciplinary Nature:** Many emerging technologies are a result of collaboration and convergence across multiple disciplines, such as computer science, engineering, and biology.
- **Potential for Convergence:** They can converge with other technologies, leading to more advanced and integrated solutions (e.g., AI and IoT working together for smart manufacturing).

Examples of current emerging technologies that share these characteristics include Artificial Intelligence (AI), the Internet of Things (IoT), blockchain, quantum computing, and augmented/virtual reality (AR/VR).

### **Augmented Reality:-**

Augmented reality is made up of the word "augment" which means to make something great by adding something to it. So basically, augmented reality is a method by which we can alter our real world by adding some digital elements to it. This is done by superimposing a digital image on the person's current view thus it enhances the experience of reality.

### **Why Augmented Reality is Important?**

The development of AR technology is set to revolutionize industries from retail to military to education to tourism and transform the way we interact with the digital world every day.

Augmented reality has many uses in different fields like archaeology, architecture, visual arts, commerce, education, video games, and military training, etc. some applications of AR are

1. AR is being used to aid research in archaeology. AR can be used to recreate different structures and overlay them in the real environment so that researchers can study them correctly.
2. AR applications in smartphones include Global Positioning System (GPS) to locate the person's location and its phone's inbuilt compass to find device orientation.

3. Augmented reality can be used in the field of tourism to enrich visitor's experience during visits like the Eiffel tower has an AR app that can show you it looked throughout history when it was being built.

### **Key applications**

- **Commerce:**

Allows customers to visualize products, like furniture in their homes, before buying.

- **Gaming:**

Popular games like [Pokémon Go](#) use AR to place virtual characters in the real world.

- **Education:**

Can provide interactive and immersive learning experiences, such as 3D models of anatomical structures.

- **Manufacturing and healthcare:**

Used for training, as well as for technical guidance and surgical planning by overlaying digital instructions or data onto equipment or patients.

### **Limitations:**

Disadvantages of augmented reality include high costs, potential health concerns like eye strain and motion sickness, and significant privacy and security risks.

### **Virtual Reality:-**

Virtual Reality (VR) is a technology that creates a simulated environment, allowing users to feel like they are in a different place or world.

VR puts you inside a computer-generated world that feels real. It does this by using special equipment that covers your eyes and sometimes your ears called **VR Headset**.

Virtual Reality creates a believable, interactive 3D environment that you can explore and interact with, making you feel like you are really there.

VR merely is 'The Wise Guy' of the digital world. It creates a world that neither functions according to you, nor does it respond to your actions. It gives you a first-hand experience with even the after-effects of an event along with the ability to interact and interrelate with the world created. This technology holds vast potential insights into the workings of the Human Brain.

### **What is Grid Computing?**

**Grid Computing** can be defined as a network of computers working together to perform a task that would rather be difficult for a single machine. All machines on that network work under the same protocol to act as a virtual supercomputer.

The tasks that they work on may include analysing huge datasets or simulating situations that require high computing power. Computers on the network contribute resources like processing power and storage capacity to the network.

### **Why is Grid Computing Important?**

- **Scalability:** It allows organizations to scale their computational resources dynamically. As workloads increase, additional machines can be added to the grid, ensuring efficient processing.
- **Resource Utilization:** By pooling resources from multiple computers, grid computing maximizes resource utilization. Idle or underutilized machines contribute to tasks, reducing wastage.
- **Complex Problem Solving:** Grids handle large-scale problems that require significant computational power. Examples include climate modeling, drug discovery, and genome analysis.
- **Cost Savings:** Organizations can reuse existing hardware, saving costs while accessing excess computational resources. Additionally, cloud resources can be cost-effectively.

### **Use Cases of Grid Computing**

- Genomic Research
- Drug Discovery
- Cancer Research
- [Weather Forecasting](#)
- Risk Analysis
- [Computer-Aided Design \(CAD\)](#)
- Animation and Visual Effects
- Collaborative Projects

### **Advantages of Grid Computing**

- Grid Computing provide high resources utilization.
- Grid Computing allow [parallel processing](#) of task.
- Grid Computing is designed to be scalable.

### **Disadvantages of Grid Computing**

- The software of the grid is still in the evolution stage.
- Grid computing introduce Complexity.
- Limited Flexibility
- Security Risks

### **Green computing:-**

Green computing, also sometimes referred to as sustainable computing or green IT, is the practice of taking an eco-friendly and energy-efficient approach to an organization's computing technologies and processes as well as other resources such as physical hardware and equipment.

It represents a deliberate focus on sustainability and on decreasing [carbon footprints](#), reducing electronic waste (e-waste), and minimizing environmental impact.

There are many things an organization can do to make computing and the entire IT ecosystem more sustainable. Green computing practices typically involve at least some of the following:

- **Smart technology** – Tools that use AI or machine learning, for example, can help organizations analyze power usage and other metrics, which can then help leaders make informed decisions to improve those metrics.
- **Turning devices off** – Something as simple as powering down a computer when it's not in use, when multiplied by hundreds or thousands of computers across a large enterprise, can make a significant difference in power consumption.
- **Energy-efficient devices** – Today's device manufacturers are savvy about energy efficiency and there are many options for organizations that want to implement "greener" equipment, from laptops to switches to computer chips.
- **Eco-friendly e-waste disposal policies** – Green computing includes making sure that electronic equipment is properly disposed of to avoid the negative environmental impact of the many chemicals and other substances in devices such as smartphones and laptops.
- **Green data center practices** – Data centers are a major energy consumer for businesses. Fortunately, there are many ways to make data centers and processes more sustainable (which we cover in more detail later).

### Why is green computing important?

Green computing is important for several reasons involving environmental impact:

- 1) human-generated carbon emissions are negatively affecting our atmosphere and climate;
- 2) the production and disposal of electronic devices requires valuable and sometimes scarce resources and can also negatively affect the planet; and
- 3) on a global scale, organizations are taking responsibility for their actions and making efforts to mitigate environmental burden.

### Big Data Analytics:-

Uses advanced analytical methods that can extract important business insights from bulk datasets. Within these datasets lies both structured (organized) and unstructured (unorganized) data. Its applications cover different industries such as *healthcare, education, insurance, AI, retail, and manufacturing*.

**Big Data Analytics** is all about crunching massive amounts of information to uncover hidden trends, patterns, and relationships. It's like sifting through a giant mountain of data to find the gold nuggets of insight.

Here's a breakdown of what it involves:

- **Collecting Data:** Such data is coming from various sources such as social media, web traffic, sensors and customer reviews.
- **Cleaning the Data:** Imagine having to assess a pile of rocks that included some gold pieces in it. You would have to clean the dirt and the debris first. When data is being cleaned, mistakes must be fixed, duplicates must be removed and the data must be formatted properly.

- **Analyzing the Data:** It is here that the wizardry takes place. Data analysts employ powerful tools and techniques to discover patterns and trends. It is the same thing as looking for a specific pattern in all those rocks that you sorted through.

### **Benefits of Big Data Analytics-**

Big Data Analytics offers a host of real-world advantages, and let's understand with examples:

1. **Informed Decisions:** Imagine a store like Walmart. Big Data Analytics helps them make smart choices about what products to stock. This not only reduces waste but also keeps customers happy and profits high.
2. **Enhanced Customer Experiences:** Think about Amazon. Big Data Analytics is what makes those product suggestions so accurate. It's like having a personal shopper who knows your taste and helps you find what you want.
3. **Fraud Detection:** Credit card companies, like MasterCard, use Big Data Analytics to catch and stop fraudulent transactions. It's like having a guardian that watches over your money and keeps it safe.
4. **Optimized Logistics:** FedEx, for example, uses Big Data Analytics to deliver your packages faster and with less impact on the environment. It's like taking the fastest route to your destination while also being kind to the planet.

### **Usage of Big Data Analytics-**

Big Data Analytics has a significant impact in various sectors:

- **Healthcare:** It aids in precise diagnoses and disease prediction, elevating patient care.
- **Retail:** Amazon's use of Big Data Analytics offers personalized product recommendations based on your shopping history, creating a more tailored and enjoyable shopping experience.
- **Finance:** Credit card companies such as Visa rely on Big Data Analytics to swiftly identify and prevent fraudulent transactions, ensuring the safety of your financial assets.
- **Transportation:** Companies like Uber use Big Data Analytics to optimize drivers' routes and predict demand, reducing wait times and improving overall transportation experiences.
- **Agriculture:** Farmers make informed decisions, boosting crop yields while conserving resources.
- **Manufacturing:** Companies like General Electric (GE) use Big Data Analytics to predict machinery maintenance needs, reducing downtime and enhancing operational efficiency.

### **Quantum computing:-**

Quantum computing is a type of computation that uses quantum mechanics principles, like superposition and entanglement, to solve problems faster than classical computers.

It uses quantum bits, or "qubits," which can exist in multiple states at once, allowing them to process many possibilities simultaneously.

This technology is still under development but has the potential to solve complex problems in fields like medicine, materials science, and finance.

## How it works

- **Qubits:** Quantum computers use qubits, the quantum version of a classical bit. Unlike a classical bit which is either a 0 or a 1, a qubit can be in a superposition of both states simultaneously.
- **Superposition:** This allows a quantum computer to explore many different solutions to a problem at the same time. A classical computer must check each solution one by one.
- **Entanglement:** Qubits can also be linked together in a process called entanglement. When entangled, the state of one qubit is dependent on the state of the other, no matter how far apart they are.

## Potential applications

- **Drug and materials discovery:** Simulating molecules to understand their behavior and create new drugs or materials is a major potential application.
- **Optimization:** Finding the most efficient solution for complex optimization problems in fields like finance or logistics.
- **Machine learning:** Advancing artificial intelligence by improving machine learning algorithms.
- **Cryptography:** Developing new methods for secure communication.

## Brain-computer interface (BCI):-

A brain-computer interface (BCI) is a system that translates brain activity into commands for an external device, creating a direct communication link between the brain and a computer.

This technology bypasses the body's usual motor pathways (nerves and muscles) and is used to assist people with disabilities or to enhance human-computer interaction in other applications.

A typical BCI system involves acquiring brain signals, processing them to identify user intentions, and using the translated signals to control a device.

## How it works

- **Acquiring brain signals:** Sensors, often in a headset or cap, detect electrical activity from the brain, such as through an electroencephalogram (EEG). Implantable devices can also be used for more direct access.
- **Processing the signals:** A computer analyzes the recorded brain signals to extract meaningful patterns that correspond to the user's thoughts or intentions, like moving a limb or making a selection.

- **Executing commands:** The processed signals are translated into commands that control an external device. This can be a computer cursor, a robotic arm, or other applications.

### **Applications**

- **Assistive technology:** BCIs can restore function for individuals with severe physical disabilities, such as paralysis resulting from conditions like motor neuron disease or stroke.
- **Medical uses:** The technology can be used for detecting and predicting neurological conditions like epilepsy, or in rehabilitation, according to [C-DAC](#).
- **Human-machine interface:** BCIs offer new input methods for situations where traditional controls like keyboards or voice are not practical, such as in virtual reality or when hands are busy.
- **Research:** BCIs are also a valuable tool for scientific inquiry, allowing researchers to study the brain by observing and even modifying neural activity, notes the [National Institutes of Health \(NIH\)](#).