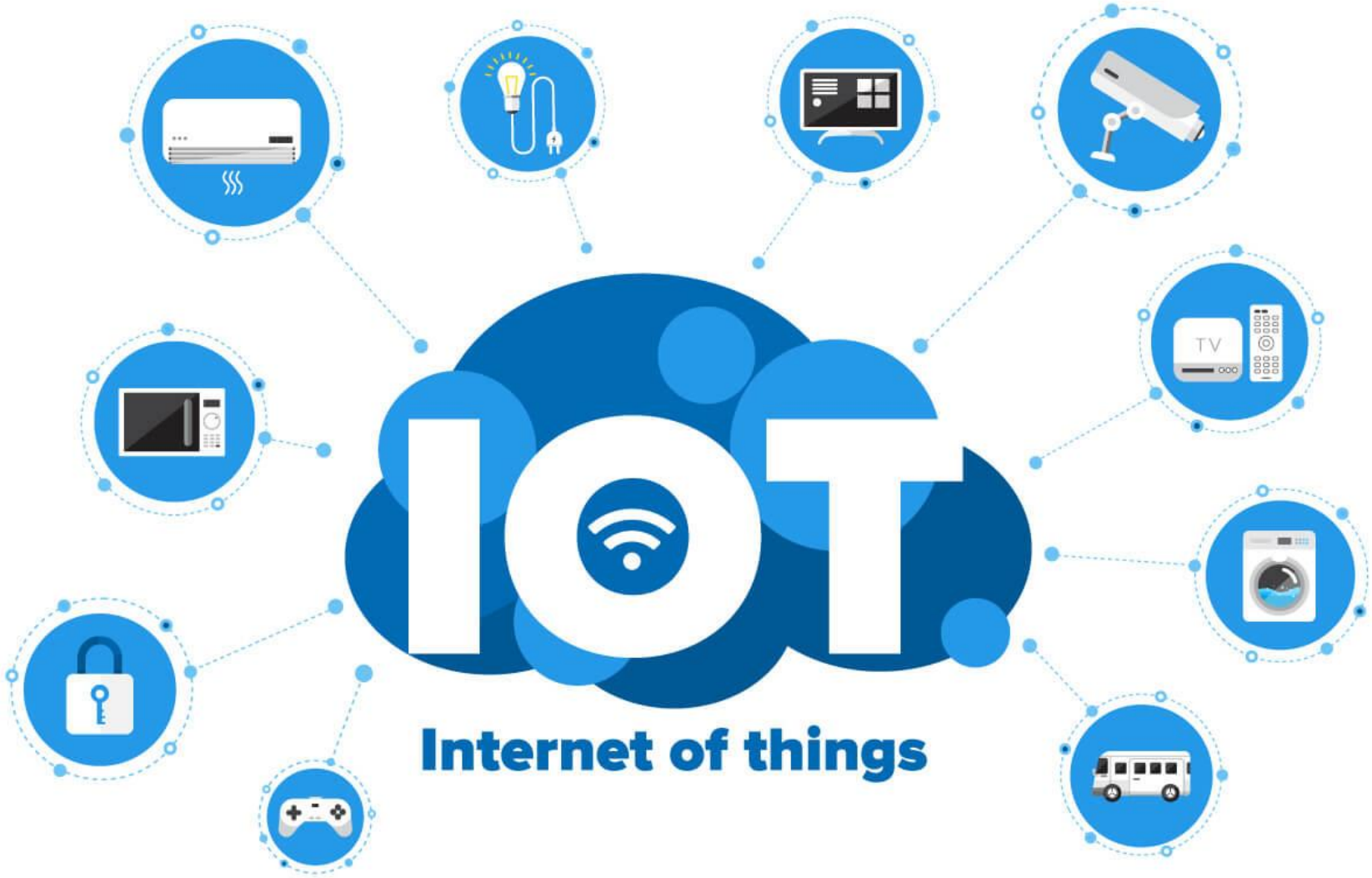

IOT
Internet of things
TV

Unit 12:Internet of Things

- Definitions and Functional Requirements - Motivation - Architecture - Web 3.0 View of IoT - Ubiquitous IoT Applications - Four Pillars of IoT - DNA of IoT -The Toolkit Approach for End-user Participation in the Internet of Things. Middleware for IoT: Overview -Communication middleware for IoT - IoT Information Security.
- Protocol Standardization for IoT - Efforts - M2M and WSN Protocols - SCADA and RFID Protocols- Issues with IoT Standardization - Unified Data Standards -Protocols -IEEE 802.15.4 - BACNet Protocol Modbus - KNX - Zigbee- Network layer - APS layer –Security.
- Web of Things versus Internet of Things - Two Pillars of the Web - Architecture standardization for WoT Platform Middleware for WoT - Unified Multitier WoT Architecture - WoT Portals and Business Intelligence. Cloud of Things:

Grid/SOA and Cloud Computing - Cloud Middleware - Cloud Standards - Cloud Providers and Systems - Mobile cloud Computing - The Cloud of Things Architecture.

- Industrial Internet of Things - Introduction to Industrial Internet of Things - Industrie 4.0 - Industrial Internet of Things (IIoT) - IIoT Architecture - Basic Technologies - Applications and Challenges - Security and Safety - Introduction to Security and Safety -Systems Security - Network Security - Generic Application Security - Application Process Security and Safety - Reliable-and-Secure-by-Design IoT Applications - Run-Time Monitoring - The ARMET Approach - Privacy and Dependability
- The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments -Resource Management in the Internet of Things: Clustering, Synchronization and Software Agents. Applications - Smart Grid -Electrical Vehicle charging

What is the Web of Things (WoT)?

- Enter the Web of Things (WoT), a novel evolution advancing beyond IoT.
- The World Wide Web Consortium or W3C has put in place a set of standards, referred to as WoT.
- It facilitates the fragmentation, interoperability, and usability of IoT.
- Basically, it is a subset of IoT that simplifies the connection of devices.
- It is created around software standards including HTTP, REST, and URIs.

What is the Web of Things (WoT)?

- The Web of Things (WoT) extends IoT by integrating devices and data into the web. WoT makes seamless device interaction possible.

- This way, it enables data sharing and interoperability. It makes IoT more accessible, scalable, and user-friendly for a wide range of applications and users.

IoT vs WoT: The Difference

- While both technologies serve the same purpose of enabling connectivity, there is a difference in the layer they work on. Some key differences between the two are mentioned below.

- The IoT connects physical devices and sensors to the Internet. On the other hand, WoT connects IoT to web architecture.

- While IoT primarily focuses on data collection and device communication, WoT ensures device interoperability and access to the web.

IoT vs WoT: The Difference

- IoT operates independently of the web. However, WoT leverages existing web standards for device communication and control.

- IoT devices have different protocols. On the other hand, WoT uses a single protocol for multiple IoT devices.

IoT	WoT
Devices can be connected with any form of internet	WoT is made to handle and use the potential of IoT
It deals with actuators, sensors, computation, communication Interfaces. Digitally Augmented objects make IoT	It deals with web servers and Protocols. WoT is made up of the applications that are made for Io Devices.
Every IoT devices have a different Protocol	A single protocol is used for multiple/various IoT devices.
Programing is difficult because of multiple protocols	Programming is easy so it doesn't have multiple protocols.
All the protocols and standard are private and it cannot be accessed publicly	WoT can be accessed freely by anyone, anytime.

Blockchain technology

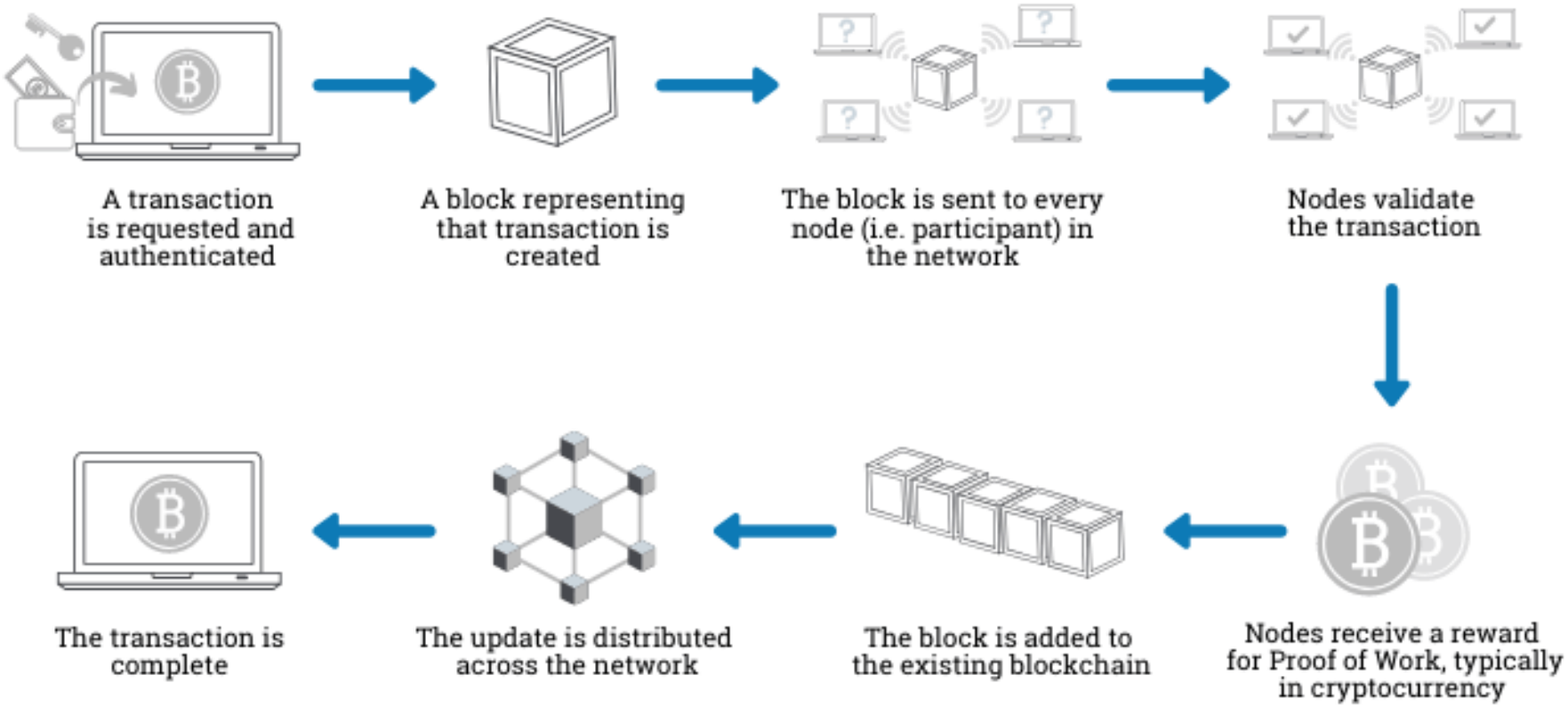
- Blockchain technology is a decentralized, digital ledger that records transactions across a network of computers.

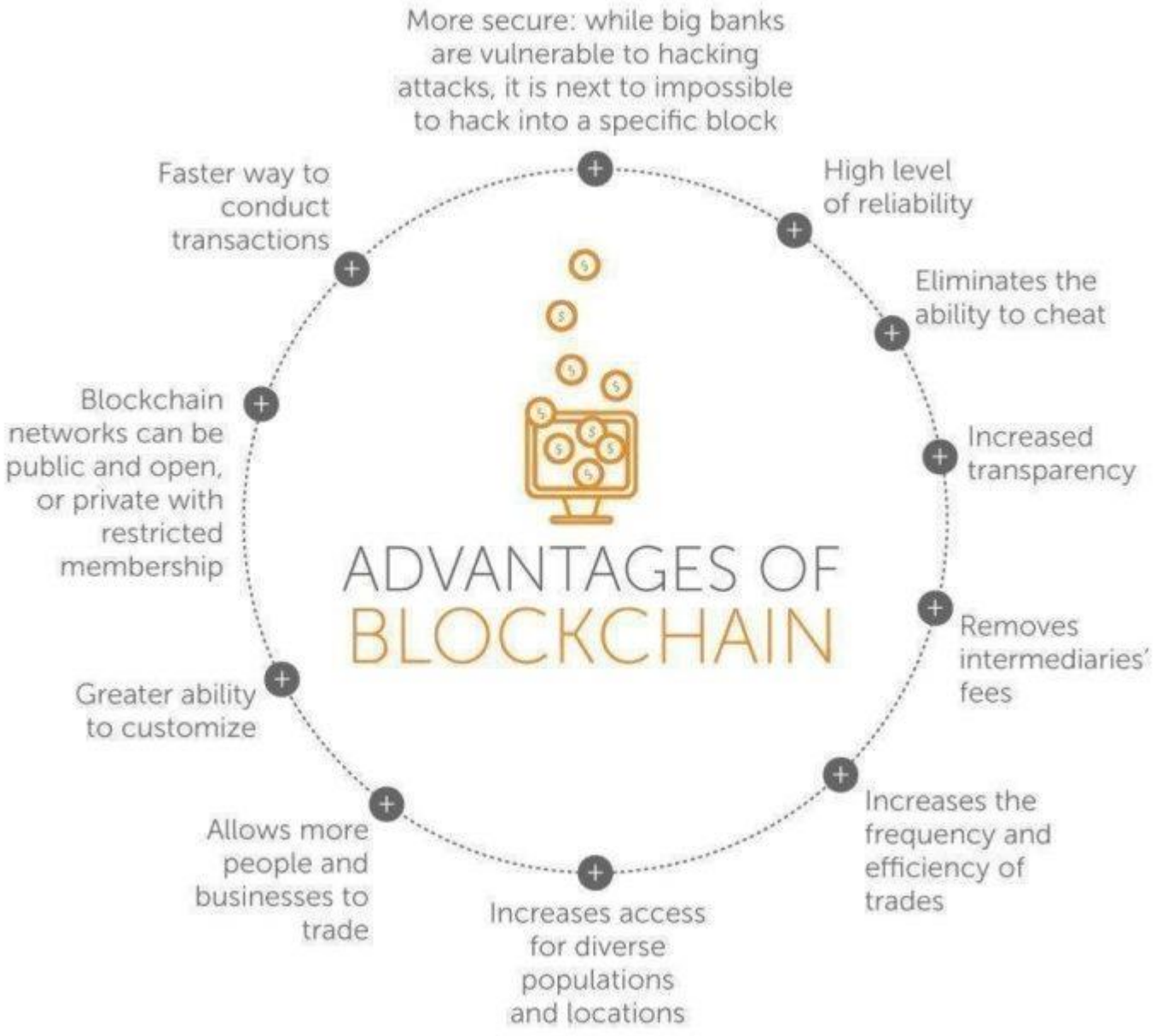
- Each block in the chain contains a number of transactions, and every time a new transaction occurs on the blockchain, a record of that transaction is added to every participant's ledger.

Blockchain technology

- The decentralized nature of technology ensures that no single entity can alter or delete previous transactions, providing a high degree of security and transparency.

How does a transaction get into the blockchain?



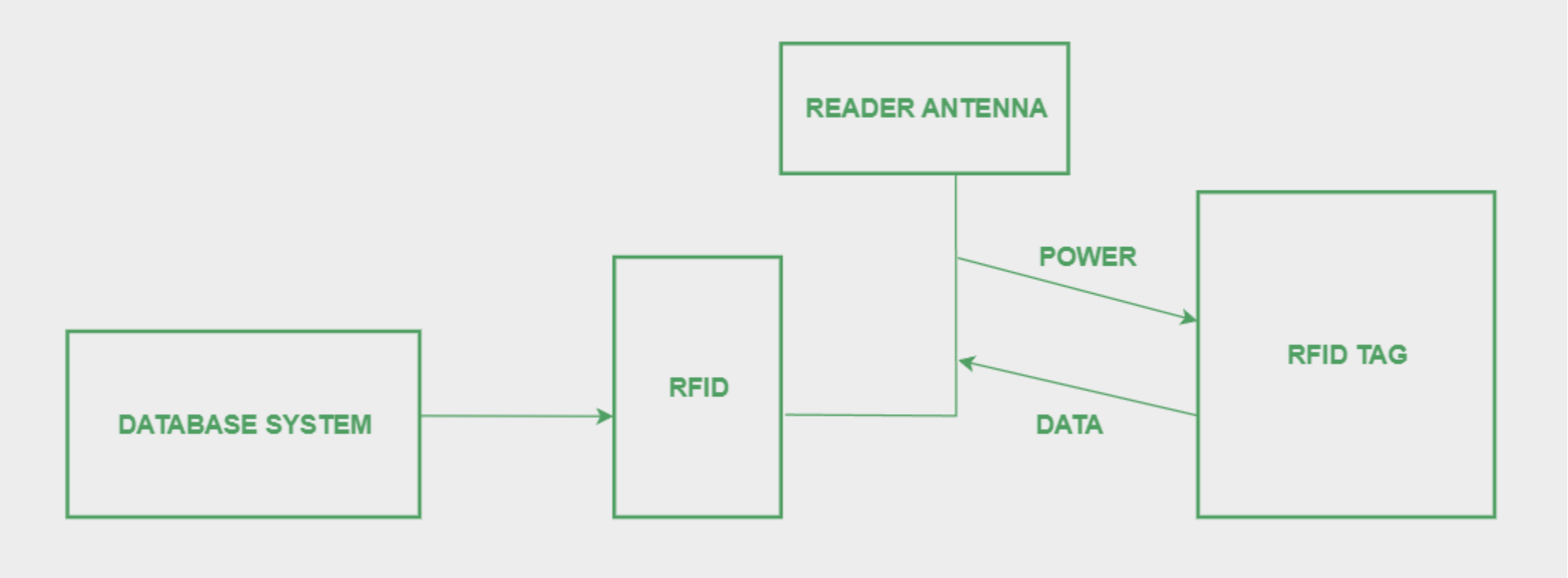


➢ Radio Frequency Identification (RFID)

- **Radio Frequency Identification (RFID) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person. It uses radio frequency to search ,identify, track and communicate with items and people. it is a method that is used to track or identify an object by radio transmission uses over the web. Data digitally encoded in an RFID tag which might be read by the reader.**

➢ Radio Frequency Identification (RFID)

- **This device work as a tag or label during which data read from tags that are stored in the database through the reader as compared to traditional barcodes and QR codes. It is often read outside the road of sight either passive or active RFID.**



Zigbee is a standards-based wireless technology developed to enable low-cost, low-power wireless machine-to-machine (M2M) and internet of things (IoT) networks.

Zigbee is a wireless technology developed as an open global market connectivity standard to address the unique needs of low-cost, low-power wireless IoT data networks. It is designed to support wireless communications, monitoring, and control of battery-operated devices and sensor networks. Zigbee operates on the IEEE 802.15.4 specification and is widely used in home automation, medical data collection, and industrial control systems.

	ZigBee	Wi-Fi	Bluetooth
Range	10-100 meters	50-100 meters	10 – 100 meters
Networking Topology	Ad-hoc, peer to peer, star, or mesh	Point to hub	Ad-hoc, very small networks
Operating Frequency	868 MHz (Europe) 900-928 MHz (NA), 2.4 GHz (worldwide)	2.4 and 5 GHz	2.4 GHz
Complexity (Device and application impact)	Low	High	High
Power Consumption (Battery option and life)	Very low (low power is a design goal)	High	Medium
Security	128 AES plus application layer security		64 and 128 bit encryption
Typical Applications	Industrial control and monitoring, sensor networks, building automation, home control and automation, toys, games	Wireless LAN connectivity, broadband Internet access	Wireless connectivity between devices such as phones, PDA, laptops, headsets

Standard	Bluetooth	UWB	Zigbee	Wi-Fi
IEEE spec..	802.15.1	802.15.3a	802.15.4	802.11a/b/g
Frequency band	2.4GHz	3.1-10.6 GHz	868/915 MHz; 2.4 GHz	2.4 GHz; 5 GHz
Max signal rate	1 Mb/s	110Mb/s	250kb/s	54Mb/s
Nominal range	10 m	10 m	10-100 m	100 m
Nominal TX power	0 - 10 dBm	-41.3 dBm/MHz	(-25) - 0 dBm	15 - 20 dBm
Number of RF channels	79	(1-15)	1/10;16	14(2.4GHz)
Channel bandwidth	1MHZ	500MHz-7.5GHz	0.3/0.6 MHz; 2 MHz	22MHz
Modulation type	GFSK	BPSK, QPSK	BPSK (+ ASK), O-QPSK	BPSK, QPSK COFDM, CCK, M-QAM
Spreading	FHSS	DS-UWB, MB-OFDM	DSSS	DSSS, CCK, OFDM
Coexistence mechanism	Adaptive freq. hopping	Adaptive freq. hopping	Dynamic freq. selection	Dynamic freq. selection transmit power control (802.11h)
Basic cell	Piconet	Piconet	Star	BSS
Extension of the basic cell	Scatternet	Peer-peer	Cluster tree-mesh	ESS
Max number of cell nodes	8	8	> 65000	2007
Data protection	16-bit CRC	32-bit CRC	16-bit CRC	32-bit CRC

Natural language processing (NLP)

Chatbots

Autocomplete

Search results

Sentiment analysis

Email classification

Predictive text

Language translation

Autocorrect

Smart assistants

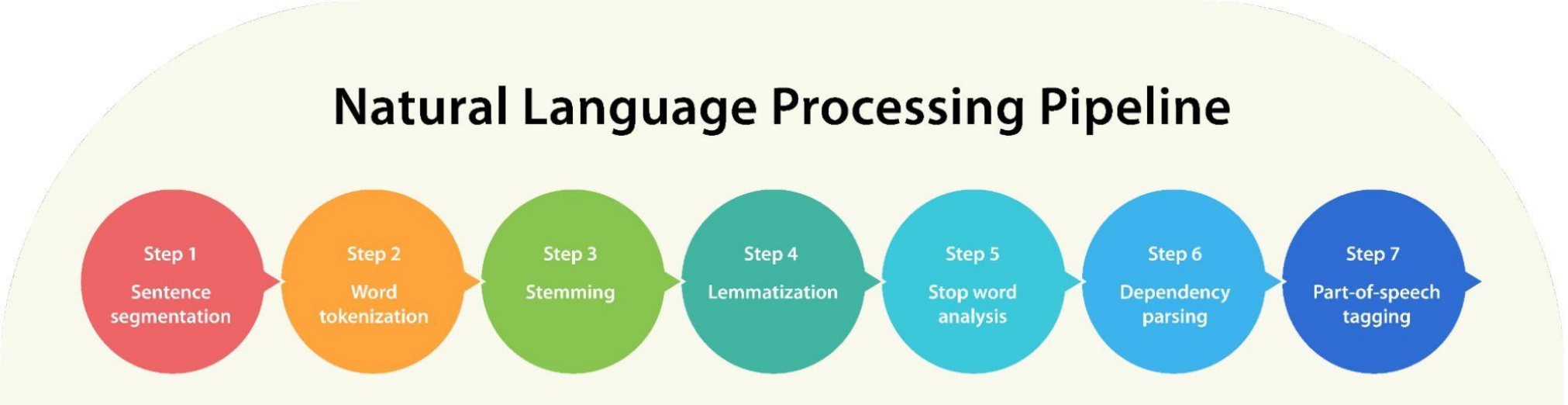
NATURAL LANGUAGE PROCESSING (NLP)

- Natural language processing (NLP) is a subfield of Artificial Intelligence (AI) that deals with the interaction between computers and humans in natural language.

- This technology works on the speech provided by the user breaks it down for proper understanding and processes it accordingly.

- It involves the use of computational techniques to process and analyze natural language data, such as text and speech, with the goal of understanding the meaning behind the language.

NATURAL LANGUAGE PROCESSING (NLP)



CLOUD COMPUTING

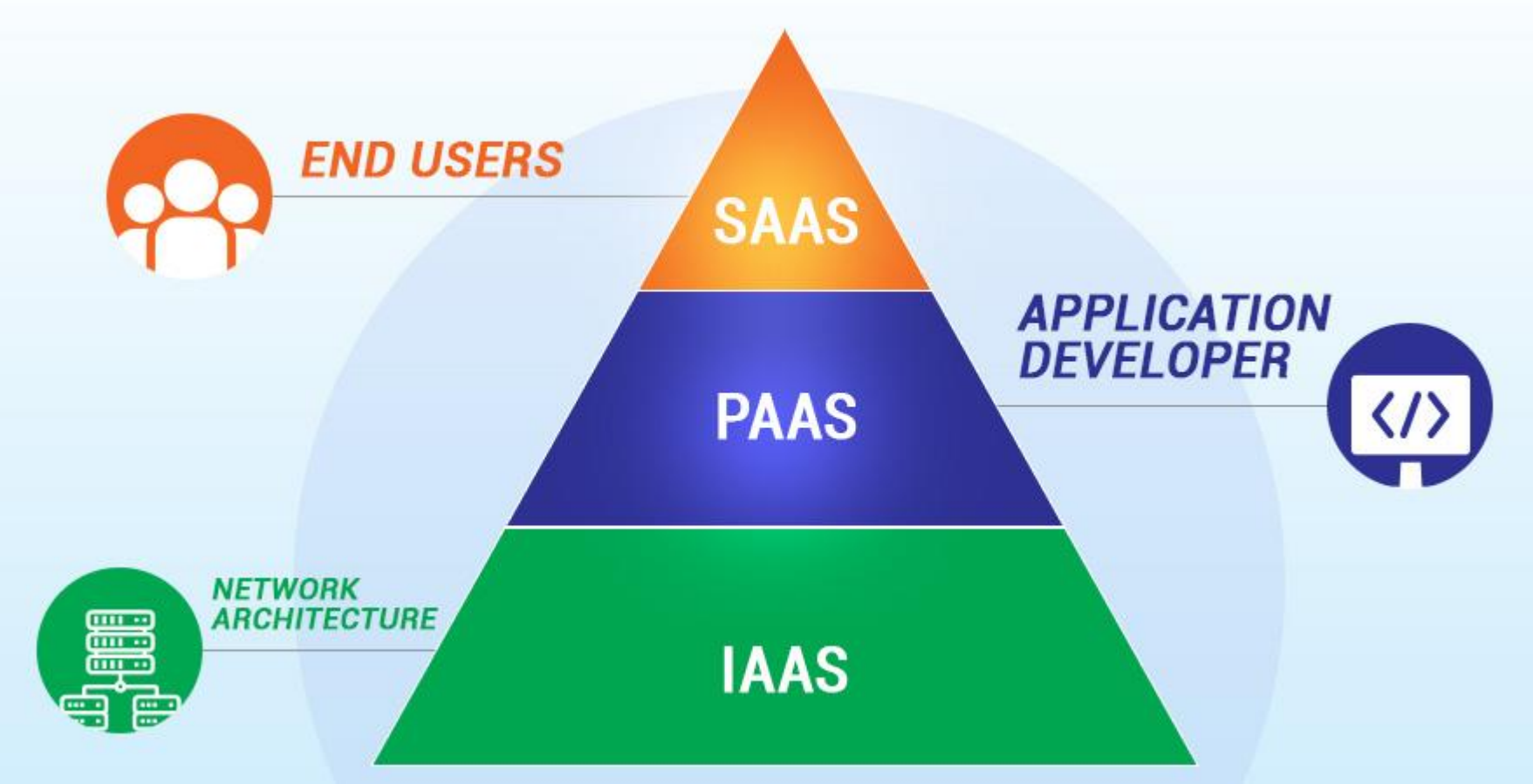
- Cloud computing means storing and accessing the data and programs on remote servers that are hosted on the internet instead of the computer's hard drive or local server.
- Cloud computing is also referred to as Internet-based computing.
- Cloud computing is the on-demand delivery of IT resources through the internet with pay-to-use charges.

Three Major Cloud Service Models

- Cloud computing services can be broken down into three models

1. Software as a Service (SaaS)
2. Platform as a Service (PaaS)
3. Infrastructure as a Service (IaaS)

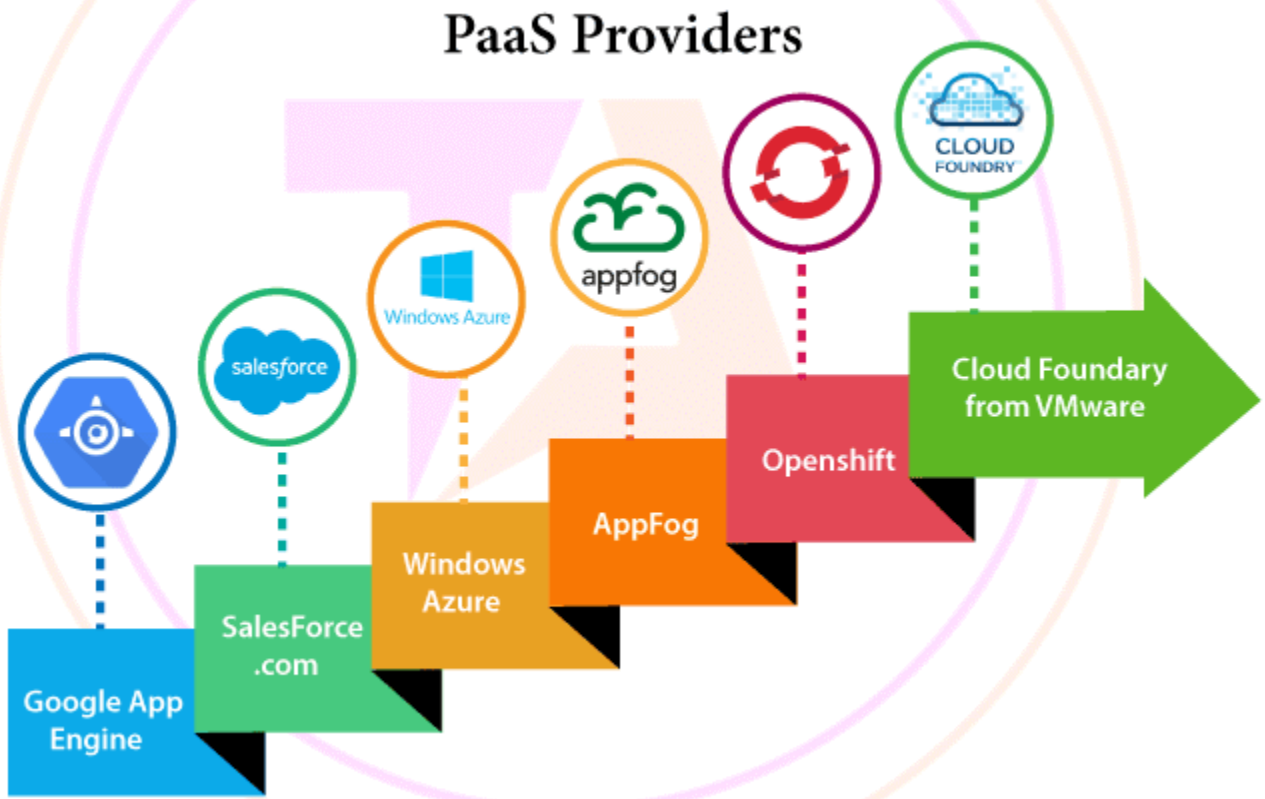
CLOUD COMPUTING



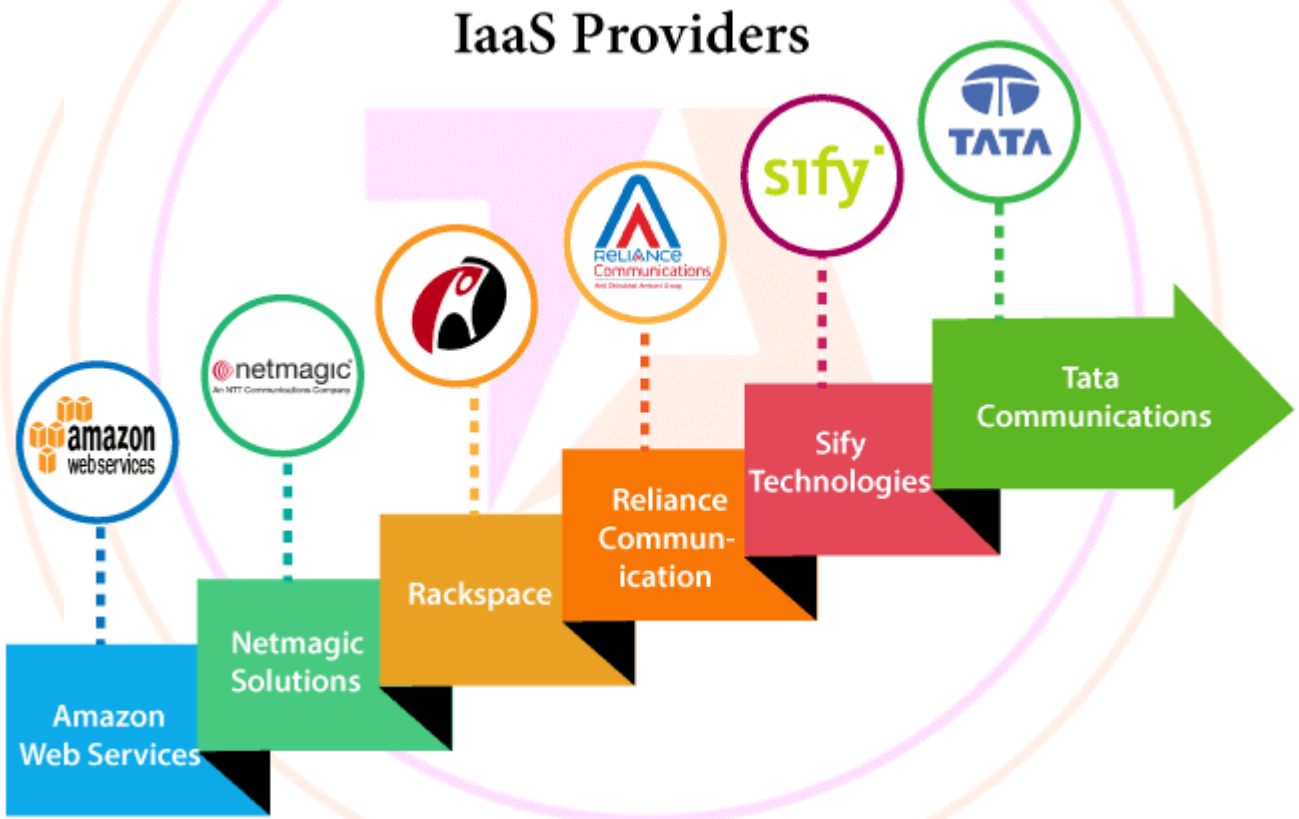
CLOUD COMPUTING

- Software services are offered under a platform.

CLOUD COMPUTING



CLOUD COMPUTING



Q. What is the main purpose of virtual reality technology?

a) To create realistic simulations of real-world environments
b) To enhance the gaming experience
c) To improve communication and collaboration in remote teams
d) To enhance the visual effects of movies and television shows

Q. In immersive technology, what does MR stand for?

a) Mixed Reality
b) Measured Reality
c) More Reality
d) Mirrored Reality

Q. What is a blockchain?

1. A blockchain is a centralized digital ledger consisting of records called blocks.
2. A blockchain is a decentralized, distributed, digital ledger consisting of records called blocks.
3. A blockchain is a digital database consisting of records called class.
4. It is a private ledger that no one can inspect.

Q. What is Machine learning?

a) The autonomous acquisition of knowledge through the use of computer programs
b) The autonomous acquisition of knowledge through the use of manual programs
c) The selective acquisition of knowledge through the use of computer programs
d) The selective acquisition of knowledge through the use of manual programs

Q. What is Cloud Computing?

a) Cloud Computing means providing services like storage, servers, database, networking, etc
b) Cloud Computing means storing data in a database
c) Cloud Computing is a tool used to create an application
d) None of the mentioned

Q. An IoT network is a collection of _____ devices.

A. Signal
B. Machine to Machine
C. Interconnected
D. Network to Network

Q. What is the main purpose of WoT (Web of Things) in the IoT?

A. Improve the usability and interoperability
B. Reduce the security
C. Complex the development
D. Increase the cost

Q. What is Mobile communication?

a) Allows to communicate from different locations without the use of physical medium

b) Allows to communicate from different locations with the use of physical medium

c) Allows to communicate from same locations without the use of physical medium

d) Allows to communicate from same locations with the use of physical medium

Q. Which of the following is not an application of IoT?

A. Wearables
B. Smart Grid
C. Arduino
D. Smart City

Q. Which of the following is a type of wireless communication ?

a) LAN
b) WAN
c) PAN
d) All of the mentioned

The three different types of wireless networks:

i) WWAN – Wireless Wide Area Networks

ii) WLAN – Wireless Local Area Network

iii) WPAN – Wireless Personal Area Network

Q. What is IoT?

a) network of physical objects embedded with sensors
b) network of virtual objects
c) network of objects in the ring structure
d) network of sensors

Q. Which of the following is false about IoT devices?

a) IoT devices use the internet for collecting and sharing data
b) IoT devices need microcontrollers
c) IoT devices use wireless technology
d) IoT devices are completely safe

Q. Which of the following is used to capture data from the physical world in IoT devices?

a) Sensors
b) Actuators
c) Microprocessors
d) Microcontrollers

Q. Which of the following is the example of a short-range wireless network?

A. VPN
B. Wi-Fi
C. Internet
D. WWW

Q. Which of the following is an example of a SaaS cloud service?

a) Google Workspace
b) Dropbox
c) Salesforce
d) All of the above

Q. _____ is an internet-based computing solution where shared resources are provided.

A. Cloud Computing
B. Networking
C. LAN
D. None of the above

Q. In block chain, _____ tree stores all the transactions in a block by producing a digital fingerprint of the entire set of transactions.

A. Merkle
B. Binary
C. AVL
D. Red black

Q. Arrange the following IOT technologies in ascending order of their wireless range:

(A) Near-field communication
(B) Wi-Fi
(C) Blue tooth low energy
(D) Cellular networks

Choose the correct answer from the options given below:

A. (A), (B), (C), (D)
B. (A), (C), (B), (D)
C. (B), (A), (C), (D)
D. (B), (C), (A), (D)

Q. Which of the following algorithm is related to Artificial Intelligence?

A. Routing algorithm
B. Greedy Algorithms
C. Hill Climbing Algorithm
D. Recursive algorithm

Q. Consider the following incomplete sentences:

3G is a _____ range wireless technology. Some activities that require _____bandwidth cannot be carried out by using 3G. Bluetooth is a _____ range wireless technology which is used to connect devices together for data transfer. Bluetooth is _____ a cost means of data transfer.

Complete the above sentences by choosing the correct words in order from the following list:

(A) Long (B) Low

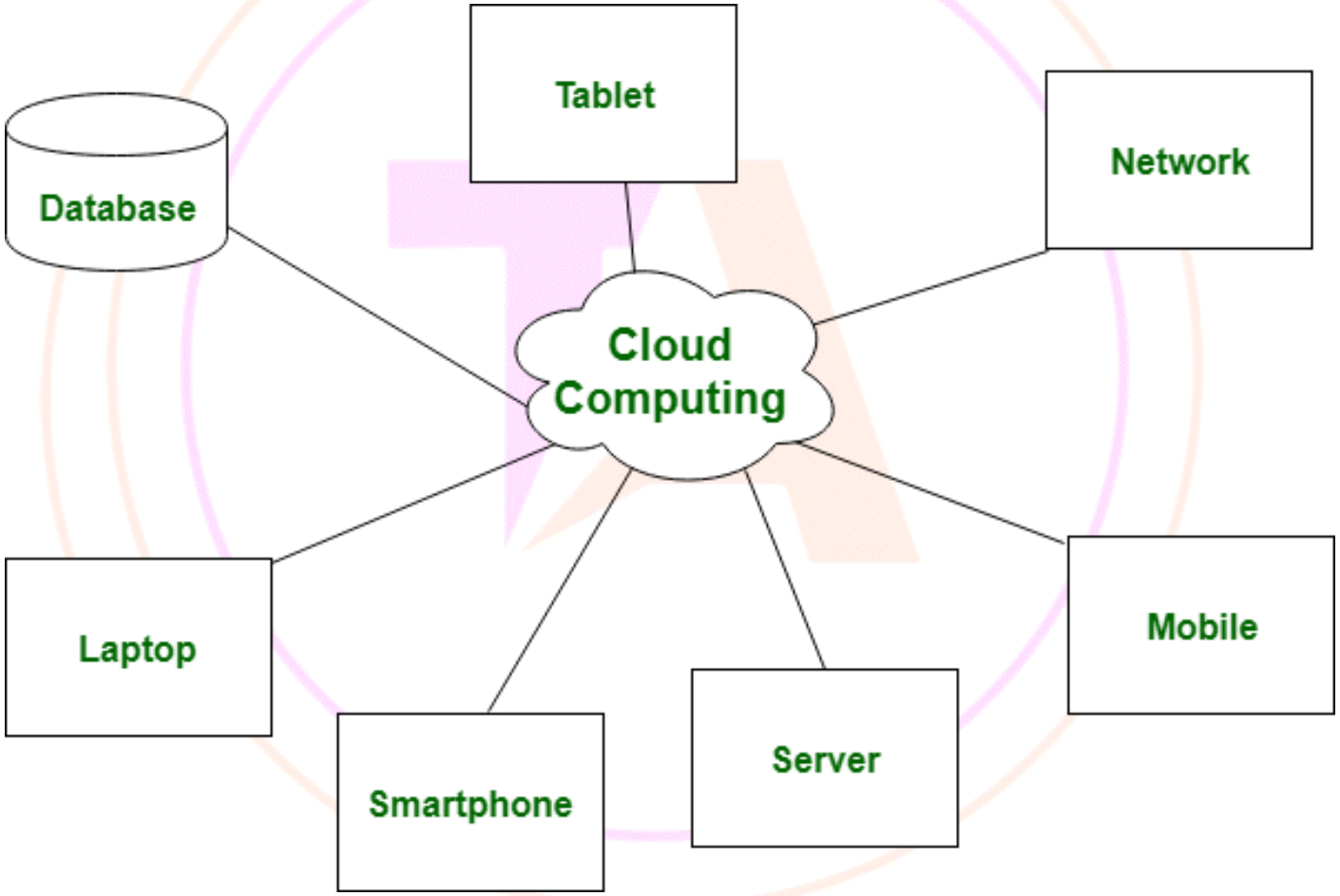
(C) Short (D) High

Choose the correct answer from the options given below:

(1) (A), (D), (C), (B) (2) (C), (D), (A), (B)

(3) (C). (B), (A), (D) (4) (A), (B), (C), (D)

CLOUD COMPUTING



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.

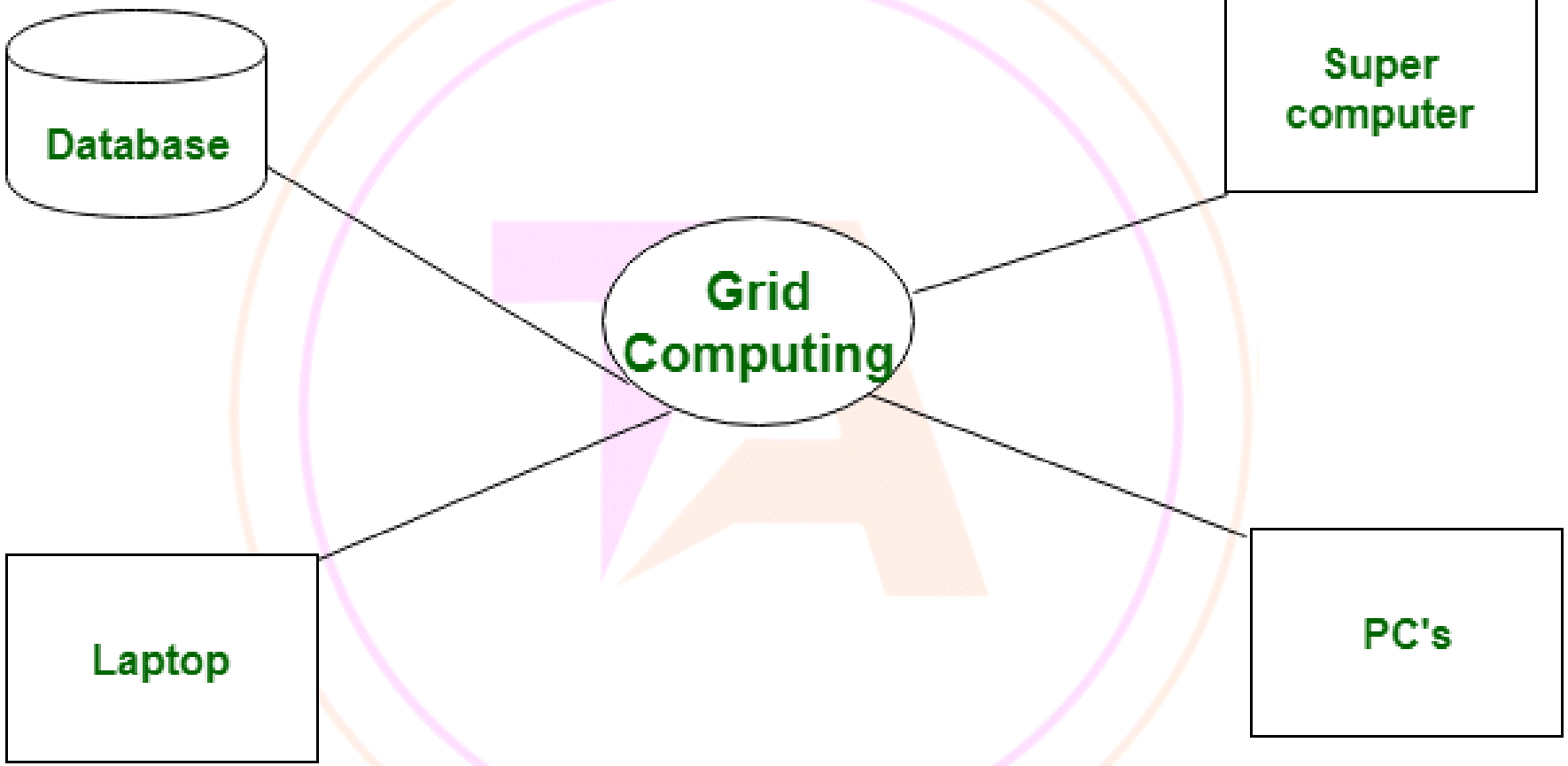
- consists of a large number of computers which are connected parallel and forms a computer cluster. This combination of connected computers uses to solve a complex problem.

Grid Computing

- The task that they work on may include analyzing 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.

Grid Computing

- A Grid computing network mainly consists of these three types of machines
- **Control Node:** A computer, usually a server or a group of servers which administrates the whole network and keeps the account of the resources in the network pool.
- **Provider:** The computer contributes its resources to the network resource pool.
- **User:** The computer that uses the resources on the network.



What is Big Data Analytics?

- **Big data analytics describes the process of uncovering trends, patterns, and correlations in large amounts of raw data to help make data-informed decisions.**

- **These processes use familiar statistical analysis techniques—like clustering and regression—and apply them to more extensive datasets with the help of newer tools.**

What is Big Data Analytics?

- On a broad scale, data analytics technologies and techniques give organizations a way to analyze data sets and gather new information.

- Business intelligence (BI) queries answer basic questions about business operations and performance.

Big data analytics tools and technology

- Big data analytics cannot be narrowed down to a single tool or technology. Instead, several types of tools work together to help you collect, process, cleanse, and analyze big data. Some of the major players in big data ecosystems are listed below.

- Hadoop is an open-source framework that efficiently stores and processes big datasets on clusters of commodity hardware.

- NoSQL databases are non-relational data management systems that do not require a fixed scheme, making them a great option for big, raw, unstructured data.

Big data analytics tools and technology

- MapReduce is an essential component to the Hadoop framework serving two functions. The first is mapping, which filters data to various nodes within the cluster.

- YARN stands for “Yet Another Resource Negotiator.” It is another component of second-generation Hadoop.

Big data analytics tools and technology

- **Spark** is an open source cluster computing framework that uses implicit data parallelism and fault tolerance to provide an interface for programming entire clusters.

- **Tableau** is an end-to-end data analytics platform that allows you to prep, analyze, collaborate, and share your big data insights. Tableau excels in self-service visual analysis, allowing people to ask new questions of governed big data and easily share those insights across the organization.

EVOLUTION OF WIRELESS TECHNOLOGIES 1G TO 5G

History of wireless technology

- Marconi, an Italian inventor, transmitted Morse code signals using radio waves wirelessly to a distance of 3.2 KMs in 1895. It was the first wireless transmission in the history of science. Since then, engineers and scientists have been working on efficiently communicating using RF waves.

- The telephone became popular during the mid of 19th century. Due to wired connection and restricted mobility, engineers started developing a device that doesn't require a wired connection and transmits voice using radio waves.

Key features (technology) of the 1G system

- Frequency 800 MHz and 900 MHz
- Bandwidth: 10 MHz (666 duplex channels with a bandwidth of 30 KHz)
- Technology: Analogue switching
- Modulation: Frequency Modulation (FM)
- Mode of service: voice only
- Access technique: Frequency Division Multiple Access (FDMA)

2G – Second generation communication system GSM

- The second generation of mobile communication systems introduced a new digital technology for wireless transmission, also known as Global System for Mobile Communication (GSM). GSM technology became the base standard for further development in wireless standards later. This standard was capable of supporting up to 14.4 to 64kbps (maximum) data rate, which is sufficient for SMS and email services.

2G – Second generation communication system GSM

- Code Division Multiple Access (CDMA) systems developed by Qualcomm were also introduced and implemented in the mid-1990s. CDMA has more features than GSM regarding spectral efficiency, number of users, and data rate.

- **Key features of the 2G system**
- The digital system (switching)
- SMS services are possible
- Roaming is possible
- Enhanced security
- Encrypted voice transmission
- First internet at a lower data rate
- **Disadvantages of the 2G system**
- Low data rate
- Limited mobility
- Less features on mobile devices
- Limited number of users and hardware capability

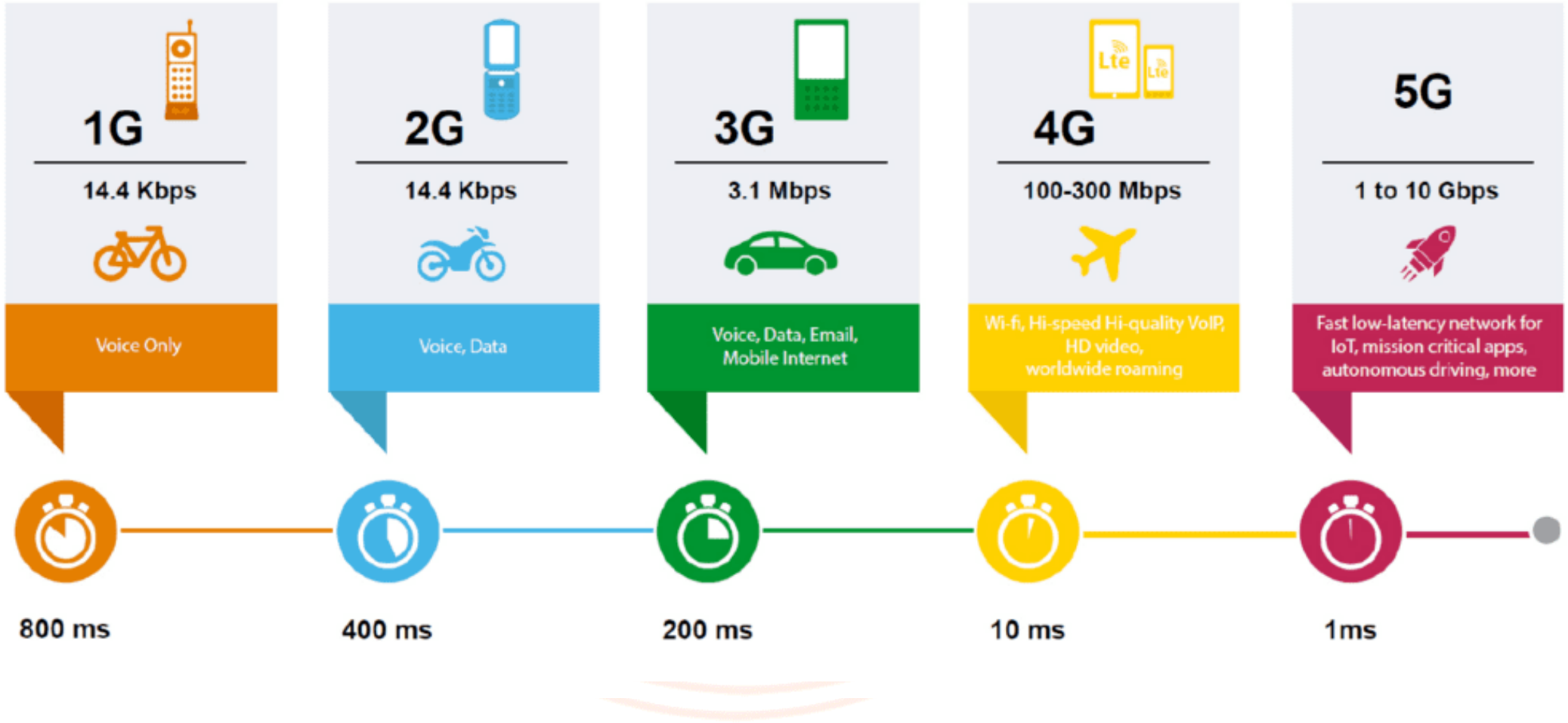
3G – Third-generation communication system

- Third-generation mobile communication started with the introduction of UMTS – Universal Mobile Terrestrial / Telecommunication Systems. UMTS has a data rate of 384kbps, and it supports video calling for the first time on mobile devices.
- After the introduction of the 3G mobile communication system, smartphones became popular across the globe. Specific applications were developed for smartphones that handle multimedia chat, email, video calling, games, social media, and healthcare.

Key features of the 3G system

- Higher data rate
- Video calling
- Enhanced security, more users, and coverage
- Mobile app support
- Multimedia message support
- Location tracking and maps
- Better web browsing
- TV streaming
- High-quality 3D games

EVOLUTION OF 1G TO 5G



1980	1990	2000	2010	2020	2030
1G (AMPS)	2G (GSM, GPRS, Edge, TDMA)	3G (UMTS/IMT-2000)	4G (LTE)	5G (New Radio)	6G
•Data Rate: 2.4 Kbps •Applications: Voice	•Data Rate: 50 Kbps •Latency: 300 ms •Applications: Voice, Text	•Data Rate: 21 Mbps •Latency: 100 ms •Applications: Voice, Multimedia	•Data Rate: 100 Mbps •Latency: 10 ms •Mobility: 350 Km/h •Applications: Voice, Mobile TV, Mobile Internet	•Data Rate: 20 Gbps •Latency: 1 ms •Mobility: 500 Km/h •Applications: Wearable devices, IoT, Smart Cities	•Data Rate: >1 Tbps •Latency: 10-100 µs •Mobility: >1000 Km/h •Applications: Tactile Internet, Space Tourism, Automated cars