

- **WRITE HISTORY OF INTERNET**
- **ADVANTAGES AND DISADVANTAGES OF ALL NETWORK TOPOLOGY**
- **WRITE THE COMPARISON BETWEEN THE NETWORK TOPOLOGY**

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A. WRITE HISTORY OF INTERNET

THE ORIGINS OF THE INTERNET

The origins of the internet are rooted in the USA of the 1950s. The Cold War was at its height and huge tensions existed between North America and the Soviet Union. Both superpowers were in possession of deadly nuclear weapons, and people lived in fear of long-range surprise attacks. The US realized it needed a communications system that could not be affected by a Soviet nuclear attack.

The official birthday of the Internet is often cited as January 1, 1983, when ARPANET and the Defense Data Network adopted TCP/IP, enabling different networks to communicate. The World Wide Web, as we know it today, emerged in 1991 with Tim Berners-Lee's work at CERN.

These machines were powerful but limited in numbers, and researchers grew increasingly frustrated: they required access to the technology, but had to travel great distances to use it.

To solve this problem, researchers started 'time-sharing'. This meant that users could simultaneously access a mainframe computer through a series of terminals, although individually they had only a fraction of the computer's actual power at their command.

The difficulty of using such systems led various scientists, engineers and organizations to research the possibility of a large-scale computer network.

ARPANET (1969):

The Advanced Research Projects Agency Network (ARPANET) was the first network to connect multiple computers, primarily at universities and research institutions, allowing them to share resources and information.

TCP/IP (1970s-1983):

Vint Cerf and Robert Kahn developed TCP/IP (Transmission Control Protocol/Internet Protocol), which provided a standard way for different networks to communicate with each other.

The Birth of the Modern Internet (1983):

The official adoption of TCP/IP by ARPANET on January 1, 1983, is considered the birth of the modern Internet.

The World Wide Web (1991):

Tim Berners-Lee's invention of the World Wide Web, with its use of HTML, HTTP, and URLs, made the Internet accessible to the public in a user-friendly way.

Commercialization:

The mid-1990s saw the Internet transition from a primarily research-focused network to a commercial one, with the rise of web browsers and online businesses.

WHO INVENTED THE INTERNET?

No one person invented the internet. When networking technology was first developed, a number of scientists and engineers brought their research together to create the ARPANET. Later, other inventors' creations paved the way for the web as we know it today.

• PAUL BARAN (1926–2011)

An engineer whose work overlapped with ARPA's research. In 1959 he joined an American think tank, the RAND Corporation, and was asked to research how the US Air Force could keep control of its fleet if a nuclear attack ever happened. In 1964 Baran proposed a communication network with no central command point. If one point was destroyed, all surviving points would still be able to communicate with each other. He called this a distributed network.

• LAWRENCE ROBERTS (1937–2018)

Chief scientist at ARPA, responsible for developing computer networks. Paul Baran's idea appealed to Roberts, and he began to work on the creation of a distributed network.

• LEONARD KLEINROCK (1934–)

An American scientist who worked towards the creation of a distributed network alongside Lawrence Roberts.

• DONALD DAVIES (1924–2000)

A British scientist who, at the same time as Roberts and Kleinrock, was developing similar technology at the National Physical Laboratory in Middlesex.

- **BOB KAHN (1938–) AND VINT CERF (1943–)**

American computer scientists who developed TCP/IP, the set of protocols that governs how data moves through a network. This helped the ARPANET evolve into the internet we use today. Vint Cerf is credited with the first written use of the word ‘internet’.

When asked to explain my role in the creation of the internet, I generally use the example of a city. I helped to build the roads—the infrastructure that gets things from point A to point B.—*Vint Cerf, 2007*

- **PAUL MOCKAPETRIS (1948–) AND JON POSTEL (1943–98)**

Inventors of DNS, the ‘phone book of the internet’.

- **TIM BERNERS-LEE (1955–)**

Creator of the World Wide Web who developed many of the principles we still use today, such as HTML, HTTP, URLs and web browsers.

“There was no “Eureka!” moment. It was not like the legendary apple falling on Newton’s head to demonstrate the concept of gravity. Inventing the World Wide Web involved my growing realization that there was a power in arranging ideas in an unconstrained, weblike way. And that awareness came to me through precisely that kind of process. The Web arose as the answer to an open challenge, through the swirling together of influences, ideas, and realizations from many sides.”

- **MARC ANDREESSEN (1971–)**

Inventor of Mosaic, the first widely-used web browser.

THE FIRST USE OF A COMPUTER NETWORK

In 1965, Lawrence Roberts made two separate computers in different places ‘talk’ to each other for the first time. This experimental link used a telephone line with an acoustically coupled modem, and transferred digital data using packets.

When the first packet-switching network was developed, Leonard Kleinrock was the first person to use it to send a message. He used a computer at UCLA to send a message to a computer at Stanford. Kleinrock tried to type ‘login’ but the system crashed after the letters ‘L’ and ‘O’ had appeared on the Stanford monitor.

A second attempt proved successful and more messages were exchanged between the two sites. The ARPANET was born.

THE LIFE AND DEATH OF THE ARPANET

President Dwight D. Eisenhower formed the Advanced Research Projects Agency (ARPA) in 1958, bringing together some of the best scientific minds in the country. Their aim was to help American military technology stay ahead of its enemies and prevent surprises, such as the launch of the satellite Sputnik 1, happening again. Among ARPA's projects was a remit to test the feasibility of a large-scale computer network.

Lawrence Roberts was responsible for developing computer networks at ARPA, working with scientist Leonard Kleinrock. Roberts was the first person to connect two computers. When the first packet-switching network was developed in 1969, Kleinrock successfully used it to send messages to another site, and the ARPA Network—or ARPANET—was born.

Once ARPANET was up and running, it quickly expanded. By 1973, 30 academic, military and research institutions had joined the network, connecting locations including Hawaii, Norway and the UK.

As ARPANET grew, a set of rules for handling data packets needed to be put in place. In 1974, computer scientists Bob Kahn and Vint Cerf invented a new method called transmission-control protocol, popularly known as TCP/IP, which essentially allowed computers to speak the same language.

After the introduction of TCP/IP, ARPANET quickly grew to become a global interconnected network of networks, or 'Internet'.

The ARPANET was decommissioned in 1990.

THE GROWTH OF THE INTERNET, 1985–95

The invention of DNS, the common use of TCP/IP and the popularity of email caused an explosion of activity on the internet. Between 1986 and 1987, the network grew from 2,000 hosts to 30,000. People were now using the internet to send messages to each other, read news and swap files. However, advanced knowledge of computing was still needed to dial in to the system and use it effectively, and there was still no agreement on the way that documents on the network were formatted.

The internet needed to be easier to use. An answer to the problem appeared in 1989 when a British computer scientist named Tim Berners-Lee submitted a proposal to his employer, CERN, the international particle-research laboratory in Geneva, Switzerland. Berners-Lee proposed a new way of structuring and linking all the

information available on CERN's computer network that made it quick and easy to access. His concept for a 'web of information' would ultimately become the World Wide Web.

The launch of the Mosaic browser in 1993 opened up the web to a new audience of non-academics, and people started to discover how easy it was to create their own HTML web pages. Consequently, the number of websites grew from 130 in 1993 to over 100,000 at the start of 1996.

By 1995 the internet and the World Wide Web were established phenomena: Netscape Navigator, which was the most popular browser at the time, had around 10 million global users.

HOW IS THE WORLD WIDE WEB DIFFERENT FROM THE INTERNET?

The terms 'World Wide Web' and 'internet' are often confused. The internet is the networking infrastructure that connects devices together, while the World Wide Web is a way of accessing information through the medium of the internet.

Tim Berners-Lee first proposed the idea of a 'web of information' in 1989. It relied on 'hyperlinks' to connect documents together. Written in Hypertext Markup Language (HTML), a hyperlink can point to any other HTML page or file that sits on top of the internet.

In 1990, Berners-Lee developed Hypertext Transfer Protocol (HTTP) and designed the Universal Resource Identifier (URI) system. HTTP is the language computers use to communicate HTML documents over the internet, and the URI, also known as a URL, provides a unique address where the pages can be easily found.

Berners-Lee also created a piece of software that could present HTML documents in an easy-to-read format. He called this 'browser' the 'WorldWideWeb'.

THE INTRODUCTION OF WEB BROWSERS

Tim Berners-Lee was the first to create a piece of software that could present HTML documents in an easy-to-read format. He called this 'browser' the 'WorldWideWeb'. However, this original application had limited use as it could only be used on advanced NeXT machines. A simplified version that could run on any computer was created by Nicola Pellow, a maths student who worked alongside Berners-Lee at CERN.

In 1993, Marc Andreessen, an American student in Illinois, launched a new browser called Mosaic. Created at the National Center for Super-computing Applications (NCSA), Mosaic was easy to download and install, worked on many different computers and provided simple point-and-click access to the World Wide Web. Mosaic was also the first browser to display images next to text, rather than in a separate window.

Mosaic's simplicity opened the web up to a new audience, and caused an explosion of activity on the internet, with the number of websites growing from 130 in 1993 to over 100,000 at the start of 1996.

In 1994 Andreessen formed Netscape Communications with entrepreneur Jim Clark. They led the company to create Netscape Navigator, a widely used internet browser that at the time was faster and more sophisticated than any of the competition. By 1995, Navigator had around 10 million global users.

B. LIST THE ADVANTAGES AND DISADVANTAGES OF ALL THE NETWORK TOPOLOGY

List of all the Topology

- a. **Bus Topology**
- b. **Ring Topology**
- c. **Star Topology**
- d. **Mesh Topology**
- e. **Tree Topology**
- f. **Hybrid Topology**

a. BUS TOPOLOGY

Advantages of Bus Topology

- It is the easiest network topology for linearly connecting peripherals or computers.
- It works very efficiently well when there is a small network.
- The length of cable required is less than a star topology.
- It is easy to connect or remove devices in this network without affecting any other device.

- Very cost-effective as compared to other network topology i.e. mesh and star
- It is easy to understand topology.
- Easy to expand by joining the two cables together.

Disadvantages of Bus Topology

- Bus topology is not good for large networks.
- Identification of problems becomes difficult if the whole network goes down.
- Troubleshooting individual device issues is very hard.
- Need terminators are required at both ends of the main cable.
- Additional devices slow the network down.
- If the main cable is damaged, the whole network fails or splits into two.
- Packet loss is high.
- This network topology is very slow as compared to other topologies.

b. RING TOPOLOGY

Advantages of Ring topology :

- In this data flows in one direction which reduces the chance of packet collisions.
- In this topology additional workstations can be added after without impacting performance of the network.
- Equal access to the resources.
- There is no need of server to control the connectivity among the nodes in the topology.
- It is cheap to install and expand.
- Minimum collision.
- Speed to transfer the data is very high in this type of topology.

- Due to the presence of token passing the performance of ring topology becomes better than bus topology under heavy traffic.
- Easy to manage.
- Ring network is extremely orderly organized where every device has access to the token and therefore the opportunity to transmit.

Disadvantages of Ring topology :

- Due to the Uni-directional Ring, a data packet (token) must have to pass through all the nodes.
- If one workstation shuts down, it affects whole network or if a node goes down entire network goes down.
- It is slower in performance as compared to the bus topology
- It is Expensive.
- Addition and removal of any node during a network is difficult and may cause issue in network activity.
- Difficult to troubleshoot the ring.
- In order for all the computer to communicate with each other, all computer must be turned on.
- Total dependence in on one cable.
- They were not Scalable.

c. STAR TOPOLOGY

Advantages of Star Topology

- It is very reliable as if one cable or device fails then all the others will still work.
- It is high performing as no data collisions can occur.
- It is less expensive because each device only needs one I/O port and wishes to be connected to the hub with one link.
- Easy fault detection because the links are often easily identified.
- No disruptions to the network when connecting or removing devices.

- Each device requires just one port i.e. to attach to the hub.
- If N devices are connected to each other in star, then the amount of cables required to attach them is N. So, it's easy to line up.

Disadvantages of Star Topology

- Requires more cable than bus topology.
- If the connecting network device (network switch) fails, the nodes attached are disabled and can't participate in network communication.
- More expensive than linear bus topology due to the value of the connecting devices (network switches).
- If the hub goes down everything goes down, none of the devices can work without the hub.
- Hub requires more resources and regular maintenance because it's the central system of Star.
- Extra hardware is required (hubs or switches) which adds to the cost.
- Performance is predicated on the one concentrator i.e. hub.

d. MESH TOPOLOGY

Advantages of Mesh Topology

- In case of failure of a single device, the entire network didn't break.
- There is no traffic problem as there is a dedicated point to point links for every device.
- Mesh Topology provides high privacy and security.
- Data transmission is more consistent because failure doesn't disrupt its processes.
- Adding new devices won't disrupt transmission of data.

Disadvantages of Mesh Topology

- Mesh Topology is costly as compared to the other network topologies i.e. star, bus, point to point topology.
- Installation of nodes are difficult in mesh topology.

- Power requirement is higher as all the nodes will need to remain active all the time and share the load.
- Each node requires a extra utility cost.
- More maintenance is required in mesh topology.

e. **TREE TOPOLOGY**

Advantages of Tree Topology

- **Efficient Data Transmission:**
Data traffic can be efficiently managed within specific branches, reducing congestion and improving bandwidth usage especially useful in networks with high data flow.
- **Segmentation:**
It allows logical division of the network into smaller, manageable units based on department, location, or function, enhancing isolation, control, and security.
- **Point-to-Point Connection:**
The root node maintains point-to-point connections with other nodes, offering dedicated bandwidth and minimizing data collisions and congestion.
- **Scalability:**
Tree topology is highly scalable, allowing expansion by adding branches and hierarchical levels to the network.
- **Flexibility:**
It can accommodate diverse sub network types and sizes by using different hubs and cables.
- **Reliability:**
Errors can be easily isolated within the network without affecting the root node, making it more reliable than many other topologies.
- **Security:**
Tree topology enhances both security and privacy by using dedicated channels or links for data transmission, making it suitable for sensitive environments.
- **Centralized Control:**
The structure supports centralized control and management, which simplifies tasks such as monitoring, troubleshooting, and overall security management.

Disadvantages of Tree Topology

- **Single Point of Failure:**
The root node acts as a single point of failure if it crashes or is damaged, it can bring down the entire network.
- **Parent-Child Dependency:**
Child nodes rely on their parent nodes for connectivity. If a parent node malfunctions, the connected child nodes also stop functioning.
- **Difficult Maintenance:**
Due to its complex structure, maintenance is not straightforward.
- **Complexity:**
The installation, configuration, and maintenance of this topology can be complex for multi-level networks.
- **Cost:**
The cost associated with setting this topology up is relatively high as we require cables, hubs, and various other network devices for its proper functioning. Hence, the overall cost increases.
- **Dependency:**
In this topology, if the root node and backbone stop working by any chance, then the overall network will be affected by it.
- **Performance degradation:**
Performance degradation, especially in downstream branches, occurs due to heavy network traffic or if the root node becomes overloaded.

f. HYBRID TOPOLOGY

Advantages of Hybrid Topology

- This type of topology combines the benefits of different types of topologies in one topology.
- Can be modified as per requirement.
- It is extremely flexible.
- It is very reliable.

- It is easily scalable as Hybrid networks are built in a fashion which enables easy integration of new hardware components.
- Error detecting and troubleshooting are easy.
- Handles a large volume of traffic.
- It is used to create large networks.
- The speed of the topology becomes fast when two topologies are put together.

Disadvantages of Hybrid Topology

- It is a type of network expensive.
- The design of a hybrid network is very complex.
- There is a change in the hardware to connect one topology with another topology.
- Usually, hybrid architectures are larger in scale so they require a lot of cables in the installation process.
- Hubs which are used to connect two distinct networks are very costly. And hubs are different from usual hubs as they need to be intelligent enough to work with different architectures.
- Installation is a difficult process.

COMPARISON BETWEEN ALL THE NETWORK TOPOLOGY

Topologies	Architecture/ Organization	Routing Methodology	Comple xity	Expansion	Reliability	Cost	Cabling Concerns	Security	Delay/Re sponse time
Star	A network topology in which peripheral nodes are connected to a central node (such as a hub, switch, or router) which rebroadcasts all transmissions received from any peripheral node to all peripheral nodes on the network, including the originating nodes may thus communicate with all others by transmitting to, and receiving from, the central node only	All information passes through the central network connection.	Very simple (used for LANs)	Add a new computer by plugging in a new cable from the computer to the connection device.	When one computer goes down, the rest of the network is unaffected. If the connection device goes down, then the network is down	More expensive of the simple topologies, it requires costly connection device. Usually cheaper than a hybrid network	Uses twisted pair cable. Requires large amounts of cable. No more than 100 meters from the computer to the connection device.	Denial of service attack	Excellent in terms of distance
Bus	Is a network topology in which there is a single line (the bus) to which all nodes are connected, and the nodes connect only to this bus. This is a bus line going through a city. The cable has a small cap installed at the end, called a terminator. The terminator prevents signals from bouncing back and causing network errors. Like a series of pipes that water travels through	One computer at a time sends information. Information goes along the cable and the computer accesses the information off the cable	The simplest one (Used for LANs)	To add a computer, you must shut down the network and disconnect the cable from the existing computers	If one computer malfunctions, the entire network goes down	A cheaper network since there is usually one continuous copper cable	Single continuous cable connects the devices. Terminator is required at each end of the cable. Uses coaxial or twisted pair cabling	Not secure cause broadcast	Delay cause broadcast
Ring	A network topology in which every node has exactly two branches connected to it. A star-wired ring topology may appear (externally) to be the same as a star topology.	Information goes in one direction around the ring and passes along the ring until it	(Used for LANs)	Cable between the computers must be	If there's a break a break in the cable or an error in the network,	One of the more expensive topologies	Requires more cabling than other topologies. Uses twisted pair	The least security as the information	Good

	Internally, the MAU (multistation access unit) of a star-wired ring contains wiring that allows information to pass from one device to another in a circle or ring. Point-to-point links in a closed loop	reaches the correct computer		broken to a new computer, so the network is down until the new device is back online	information continuous to transfer through the rest of the ring until reaching the point of the break. This makes troubleshooting easy	due to high cable costs.		intended for one machine must pass all the others	
Mesh	A network topology in which there are at least two nodes with two or more paths between them	Often uses across long distances. Information transfer can happen in different ways, depending on the other topologies	Used for WANs	Connection devices make combining different networks and different topologies easy	Troubleshooting is most difficult in this topology because of the variety of technologies	Expensive, large and usually complicated	Cabling depends on the types of networks. Can use twisted pair and coaxial cable. Also incorporates fiber optic cabling over long distances	A mesh needs secure links, routing and forwarding	Trade off with cost
Tree	The nodes are arranged as a tree. The tree topology is a generalization of the bus topology. The transmission medium is a branching cable with no closed loops. The tree layout begins at a point known as the head end (Root), where one or more cables start, and each of these may have branches. The branches in turn may have additional branches to allow quite complex layouts	A transmission from any station Propagates throughout the medium and can be received by all other stations. A host that is a branch off from the main tree is called a 'leaf'	Used for WANs	The Simplest to install and extend extra Stations in a daisy chain manner	Partitions works	Costly because it is heavily cabled	Overall length of each segment is limited by the type of cabling used. (Coax-Twisted, Pair-Fiber)	Low security as it physically star but logically bus	Possible traffic jams

