**Network Topologies: APPLICATION AND ANALYSIS**

**FRANCIS AGATHA AMEH**

**(ST/CS/ND/21/121)**

**A SEMINAR PRESENTED TO THE DEPARTMENT OF COMPUTER SCIENCE, SCHOOL OF SCIENCE AND TECHNOLOGY, FEDERAL POLYTECHNIC MUBI, ADAMAWA STATE, NIGERIA**

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**Abstract**

*A network is that two or more devices are interconnected. Computer resources, remote computers, and networking facilities are geometrically organized as network structure or network topology. The study of setup or mapping of a network's elements (links, nodes) is called network topology. Connectivity distribution of computers is now very important issue that delivers end-to-end output at low cost; thus distribution system efficiency is affected by the technology adopted by network interconnection so computer distribution is done according to communication network organized in a geometrical manner called network topology. A connection is a route of communication between two nodes. Also, the words "circuit" and "path" are used as synonyms for the connection. There are various types of topology which includes bus, ring, tree, mesh etc. This paper presents an empirical analysis of various types of basic topologies of the network based on their advantages, disadvantages and various factors which distinguish them.*

**Keywords:** Network Topologies, Wired Network.

**Introduction**

In the computer network two or more computers are connected together in order to communicate and share resources through a medium and data communication devices. The word topology in communication network relates to how the network connects the computers or workstations together. The primary types of topologies of the network are: Bus Topology, Star Topology, Ring Topology, Mesh Topology and Tree Topology (Peixoto & Bornholdt, 2012). The mathematical field of Topology examines structures whose features are unchanged due to distortion. While appearing physically different, objects can be topologically equivalent. Any two objects formed with a simple rubber band, for example, are topologically equivalent so long as the band is not split. Kirchhoff circuit analysis is a notable functional research method focused on topology (Jyothi *et al.,* 2016).

Computer Network Topology is a simple topology extension. This discipline explores the configuration and related interconnections of computer system components. It could be physical or logical to topologies. Physical topology means a network's physical architecture including equipment, location, and installation of cables. Physical Network Topology highlights the hardware linked to the network, comprising workstations, remote terminals, servers, and related wiring between resources. Logical Network Topology focuses the presentation of flow of data between nodes, not different from the Graph Theory analysis (Manco *et al.,* 2019).

**Literature review**

The earlier physical networks of computing at the end of the 20th century used these methods above to create these topologies explicitly. It’s fairly simple to envision the individual workstations being connected through Ethernet, or later through Wi-Fi, in a ring, star, tree, or bus setup, or any of the other topologies mentioned. However, figuring out the best topology involves a detailed look at the goals and objectives and other setup factors for a given network. As the cloud became a place to keep data, run networks and deliver end-user services, the concept of virtualization took over the world of modern computing (SanthaMeena & Manikandan, 2017).

In a virtualized network, those traditional physical pieces of hardware are to an extent replaced by logical partitioned resources often called “virtual machines” that parcel out CPU and memory accordingly. With that in mind, the traditional network topologies might still be used, but they’re more logical than they are a way to characterize hardware setups. In other words, the logical topologies are built “on top of” the physical topologies that connect hardware. In this type of modern network, the mesh topology, or a vibrant tree topology, would perhaps be more applicable and more popular. Where specific network destinations receive addresses and are dealt with as though they are individual nodes of the network, they're more likely to be connected to many other nodes than they would have been in the early days when that required individual physical linking (Lim, 2016).

In addition, new best practices have evolved: for physical topologies, that includes assessing the capability of systems to offer features like high bandwidth, large bisection capacities, and a greater number of alternative data paths. In the world of logical topologies, experts have begun to talk about “topology switching” as a means of dynamic customization for VLANs and other network setups. In the most modern systems, networks have become so complex that traditional topologies now apply in different ways. One of these phenomena is the use of opaque systems to foil hackers or outside cyberattacks. Some experts are now suggesting that by shielding the IP addresses and isolating different parts of the network into segments, companies can practice better cybersecurity hygiene. All of that continues to change how network topologies are used (Basant et al., 2019).

A network's logical topography can be dynamically reconfigured when there is a variety of network equipment, such as routers. Logical Topology refers to the fact that in contrast to its architecture, the way data actually moves in a network. A comparative example of physical and logical topologies is shown in Figure 1.

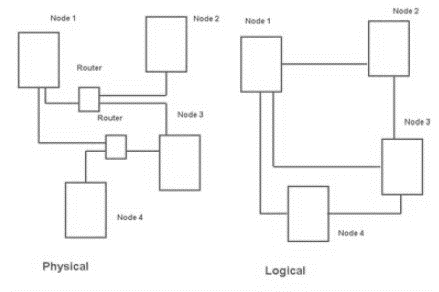


Figure 1: Logical and Physical Topology (SanthaMeena & Manikandan, 2017).

Nowadays, wireless connections are already utilized but it does mean that everyone is using this. There are still business entities that could not afford to use this type of systems and so they prefer to use the wired connections. Wired connections include the Local Area Network. This is a computer network that interconnects devices within a limited area such as a residence, school, laboratory, university campus or office building (Peixoto & Bornholdt, 2012).

## NETWORK TOPOLOGIES

**Bus Topology:**

A single cable is used in Bus Network Topology to link all devices over the net. This cable is often called backbone network. As communication takes place between nodes the computer sends the message to all nodes on the network but only the intended recipient digests the message. Problems arise when two customers want to communicate in the same bus at same time (SanthaMeena & Manikandan, 2017).

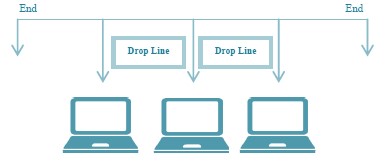


Figure 2: Bus Topology (SanthaMeena & Manikandan, 2017).

**Advantages:**

1. Simple to deploy and extend.
2. Less costly because the linking of computers requires less cable.
3. Suitable for small or temporary networks, and simple to use.
4. Repeater can also be used for extension.

Disadvantages:

1. A bus will delay due to heavy network traffic.
2. Clearance is necessary.
3. Bus cable fault prohibits all transmission.
4. Hard to administer.

**Ring Topology:**

Ring Topology has each node connected to two other nodes in the network in accordance with the connection of the first and last nodes. Messages from one node to another then pass via the set of intermediate nodes from the originator to destination. The intermediate nodes for messages intended for other nodes serve as active repeaters. Many types of Ring Network Topology have messages moving in a specific direction about ring (either clockwise or clockwise) while other variants of this type of configuration (called bi-directional rings) have messages flowing in either direction using two cables across each linked node (Cerutti et al., 2018). In some situations, in a Ring Topology Network, blocking devices are needed to avoid packet storming, the state in which packets not consumed by a network node fall into an infinite loop about the ring. Typically, ring network topology is used in networks where the volume of traffic between nodes is minimal (Kim *et al.*, 2015).

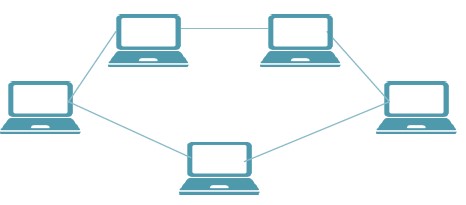


Figure 3: Ring Topology (Kim et al., 2015).

Advantages:

1. Ring offer better efficiency for a low number of workstations or for larger systems where there is equal workload for each station.
2. Ring topology can extend greater distances than other network types.
3. Easily extendable.
4. In Ring topology, unlike Bus topology, there is no signal loss, because the tokens are data packets that are regenerated on each node.

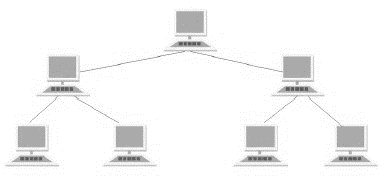
Disadvantages:

1. Relatively costly and hard to install.
2. Network failure will affect the entire network.
3. Fault is hard to find on a ring network.
4. Adding or deleting computers may interrupt the network.
5. It is much slower under normal load than an Ethernet network.

**Tree Topology:**

Tree Topology is designed either by subordinating a set of Star Network Topologies to a central node, or by connecting a set of Star Network Topologies directly through a bus, thus spreading the central node functionality among several Star Network Topology top-level nodes. In the second arrangement, the top level nodes from each Star Network are the elements that are connected via a bus (Lecturer, 2016).

No subordinate nodes to Star Network Topology are connected to the bus in simple Tree Topology. Signals in a Tree Topology can either be transmitted to all interconnected Star Networks from the central node, or be targeted to select Star Networks.



## Figure 4: Tree Topology (Kim et al., 2015).

**Advantages:**

1. Network installation and setup is simple.
2. Adding the secondary hub enables more devices to be connected to the main hub.
3. Less expensive than mesh topology.

**Disadvantages:**

1. Error in the central hub blocks the whole network.
2. In contrast to the bus topology, more cabling is needed as each node is linked to the central hub.

**Star Topology:**

Star Topology involves use of a top level central node that all other nodes are connected to. This top level node can be a computer, a simple switch, or just a common point of connection. Messages received by the top-level node can either be sent to all subordinate nodes, or if the top-level system is of appropriate fidelity, sent only to the subordinate node you like. With this configuration internode messaging delays are popular (Lim, 2016).

The computers or users are not interconnected and this allows direct inter-device communication. The active star network has an active central node, which generally has the means to escape echo-related issues.

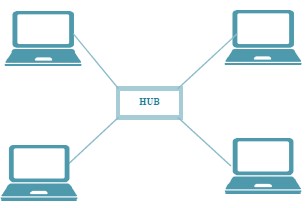


Figure 5: Star Topology (Kim et al., 2015).

**Advantages:**

1. It's more secure (if one link fails, it doesn't affect others).
2. The star network center is a good place to diagnose network faults and if one device fails the entire network is not disrupted. Hub finds fault and isolate the faulty device.
3. Replacing, upgrading or removing hosts or other devices is simple, the problem can be easily detected-it's easier to change or add a new device without affecting the rest of the network simply by running a new line from the computer to the central location and plugging it into the hub.
4. Numerous cable types are used in the same hub network.

**Disadvantages:**

1. It is costly to build as it needs more cable, because all network cables have to be pulled to one central point, consuming more wire length than most other topologies.
2. Dependence of the central node, if the central hub fails, the entire network will not be operating.
3. Many of the star networks require a device to retransmit or switch network traffic at the central point.

**Mesh Topology:**

Multiple redundant interconnections between network nodes connect devices. Every node has a connection to every other node in the network within a well-connected topology. There are high cable specifications but redundant paths are built in. Because they have alternative paths to other machines, failure in one computer does not break down the network. Mesh topologies have been used in vital host device links (usually telephone interchanges). Alternate paths enable each device to manage the load onto other network computer systems using more than one of the available link paths (Sharma *et al.,* 2013).

Consequently, a fully connected mesh network has no (n-1)/2 physical channels for linking n devices. Every computer on the network must have (n-1) input / output ports to accommodate these (Basant et al., 2019).

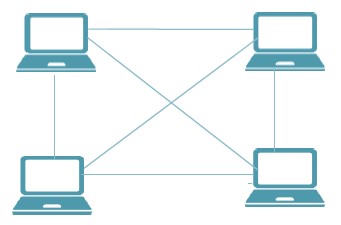


Figure 6: Mesh Topology (Basant et al., 2019).

**Advantages:**

1. Point-to-point connection enables fast isolation of faults.
2. Security is established between computers as messages move through dedicated pathways.
3. The issues with the network are easier to address.

**Disadvantages:**

1. The requisite amount of cabling is high.
2. Large number of I / O ports are required.

## Table 1: Analysis of Different Topologies

Many factors may be considered when deciding what type of topology you will be using to support your business operations. This may include the number of the people that will be participating in the operation, your office layout physical space and compatibility. Discussed lately were the common or basic types of topologies which includes bus, star, ring and mesh topology which have different advantages (Kowshiga et al., 2015).

For the network scale consideration, you should think about the number of devices that you will be employing in your network. If you just need a few devices, then a bus topology may be good. Next is to think of is the traffic management and the level of traffic that you can have in your network. If you want that servers would handle large flows of network traffic while having many devices connected, then a star topology may be a good approach to adapt. This involves the utilization of a central hub with Ethernet and unshielded twisted pair cables to link up devices on a point to point basis. If you want to have large networks having complex levels of administrative access, you may consider employing the mesh topology which involves connections on a logical network layer. This can include a full mesh that forms a high speed network backbone, or a partial mesh wherein computers are being linked to support simultaneous data exchanges. In order to boost the security of the network topology, you may consider utilizing a closed loop network or ring topology. In this part, the information would only flow in one direction around the topology. This also means that confidential information can be set up to appear only on the specified devices. If you need to gradually expand your network, you can try on combining the basic types of topology to make a hybrid one. This approach can enable you to consolidate numerous segments of a network into one system. Now the big question here will be, you’re your methods considered as practical? If yes, that’s good you may pursue it but must consider one most important thing. In business we must always see to it that our decisions are in accordance to the cost benefit principle. This means that the cost of your system must not exceed its benefit, otherwise you will be incurring losses (Andrew et al., 2015).

## Conclusion

In this paper author have carried out analytical study of various basic topologies and provide with knowledge of each topology and its features. Every topology has some benefits and drawbacks as discussed, so the solution is that user can integrate two or even more distinct topologies in order to create a resulting topology with a combination topology characteristic known as hybrid topology. It is reliable, scalable, robust and effective topology. The only downside is its architecture complexity and expensive infrastructure, because it is mixed with two or more different topologies.

These types of networks may seem traditional but it can surely be utilized for microenterprises, other business levels can also use it depending on their discretion. The modernization of technology may not be that applicable to all because many constraints may be considered such as budgets and ability to adapt technology.

**Recommendations**

1. Overall, the paper recommends that further analysis of your business situation before deciding what topology to use. But in case that your first attempt may not be that effective, there is always another chance to improve it. Before having a stable system, it is natural that we may be in a trial and error method first.
2. The paper also recommends that the selection of LAN Network topology should depend on many considerations upon the business situation but the cost benefit principle must always be applied when deciding things regarding the business.

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