In-depth Overview of the Different Network Types and Topologies

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Abstract

This paper discusses and explores the model architecture of network types. The premise assumes that the role is to create a training document to explore some network types and topology with the interns at a large company. To achieve this task, this paper investigates and provides in-depth overview of the different network types and topologies.

1 Overview of Different Network Types and Topologies

The network types and topology are the most important perspectives to discuss when it comes to computer networking. This article investigates different perspective of network types and network topologies.

The paper starts with

2 Summary of Each Network Type

This section introduces each network type.

Mendicino (1971, 2010) first introduced the concept of a growing "octopus" shaped network system in a report dating back to 1970. Since then a number of experiments have been designed to deliver the early commercialized Local Area Network or LAN technology. The original demand of this technology and service falls in the printing area. Large volume of documents are transferred for printing purpose. This led to the calling of "The Year of LAN" in the report Metcalfe (1993). Today LANs are popular amongst the local network area where people also use wireless service such as Wi-Fi to connect to their machines so that they do not have to be limited in a fixed position.

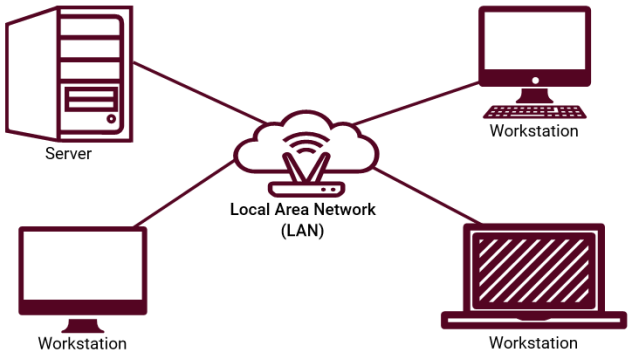


Figure 1: **Local Area Network (LAN)**. This is a local group of computers, machines, or nodes together that shared one common local network wire.

Campus Area Network or CAN, as the name suggests, is a local computer network system that connects machines, nodes, and different computers on a campus level Edwards et al. (2006). The concept of campus can refer to buildings, schools, office buildings, and so on. This is the next step up from LAN.

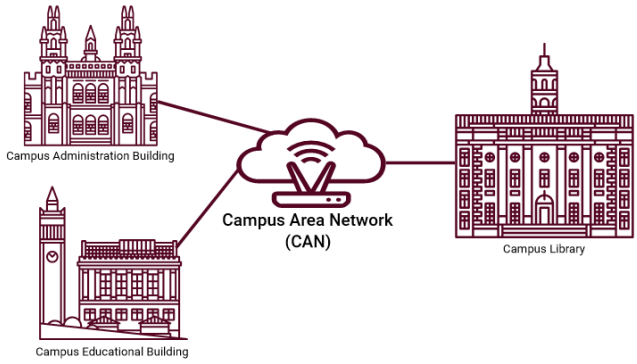


Figure 2: **Campus Area Network (CAN)**. This is a computer network that is beyond the size of LAN but the system operates on a campus level.

Based on the above discussion, it is an apparent trend to increase the coverage area for the network system. Hence, this generation of network system expands the signal to metropolitan area. A metro or a metropolitan area is a local region that is large enough to cover a densely populated urban location. It can be an agglomeration of different industrial or urban areas. On the east coast of United States, famous metropolitan areas are New York City, Boston, and Philadelphia.

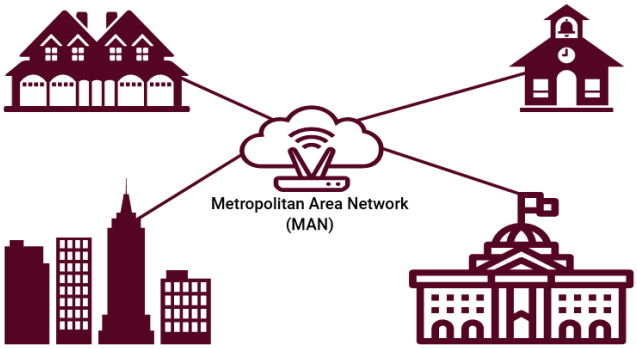


Figure 3: **Metropolitan Area Network (MAN)**. This is the network system that connects the network systems in a metropolitan area.

If Metropolitan Area Network (MAN) is not large enough, the modern technology has expanded the idea of network system to even scope at a global level and hence the concept of Wide Area Network (WAN). The WAN can provide the internet coverage for a large geographical area and sometimes to a global level. The basic definition of WAN span different regions of a country where leased lines are used. This is an interesting phenomenon for WAN, because offices and buildings that are connected using WAN need to be able to pass data and information back and forth between each other. A leased line connecting both locations would be the best candidate for this task.

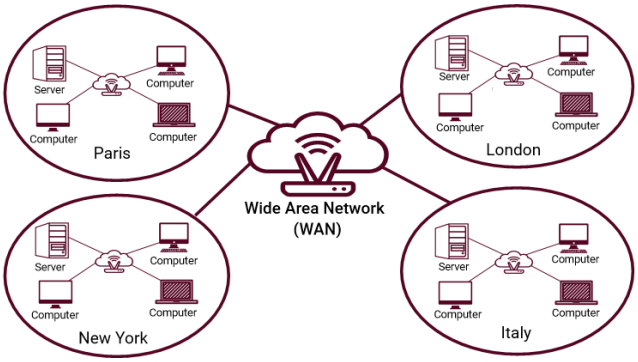
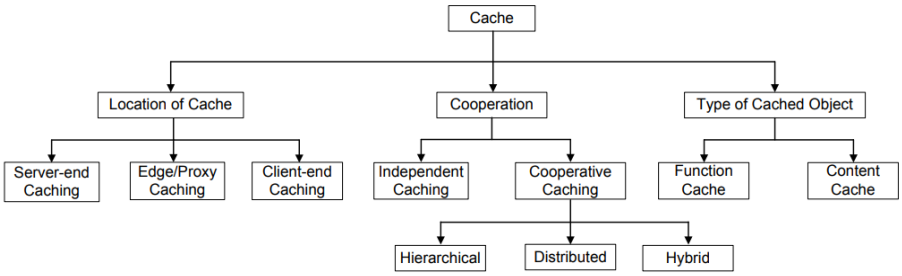


Figure 4: **Wide Area Network (WAN)**. The computer networks that operates on a country level sometimes even interconnects different nations and on a global level.

Zhang et al. (2011) proposed a hierarchy diagram (shown in Figure 5) to show the different caching techniques. Cache is a popular method to reduce network traffic response time. Based on the location and network system of each particular user, the client-side response time can differ. A single cache commonly does not possess a whole lot of information. A cluster of caches, on the other hand, can store a large volume of information on a user's local computer. Despite the good intention that cache can sometimes provide to its users, the functionality is often times abused by dark-market internet travelers and malfunction software can be passed forward using particular cache functions.

Figure 5: **Cache Diagram**.

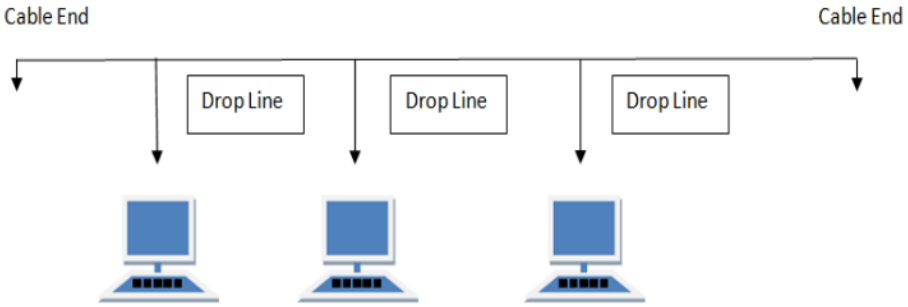


2.1 Network Topologies

Soparia and Bhatt (2014); Bisht and Singh (2015) surveyed a wide variety of different network topologies. This section introduces a wide range of network topology architectures including Bus Topology, Star Topology, Ring Topology, Mesh Topology, and Tree Topology. The section also provides a summary table of the strengths and weaknesses of these different network topologies.

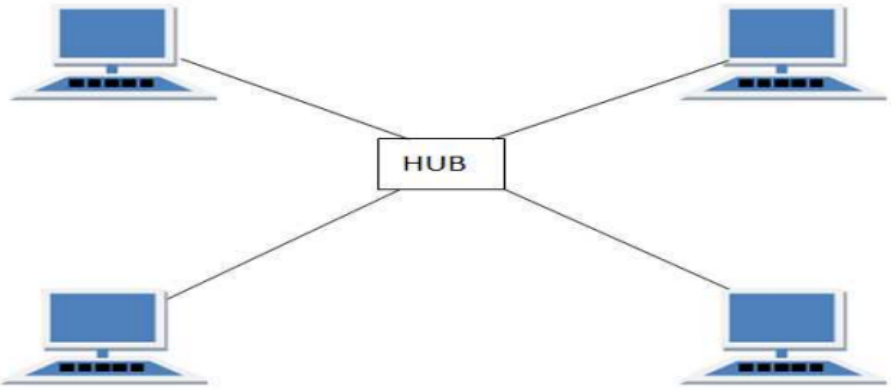
The first candidate is the Bus Topology. This type of topology is highly linear (shown in Figure 6). There is a main line serve as the central guidance. Nodes or machines can be built and extended from the central line as a branch. When a line is dropped, the machine is fed with data from the central line. This is the simplest way to connect multiple computers together.

Figure 6: **Bus Topology**.



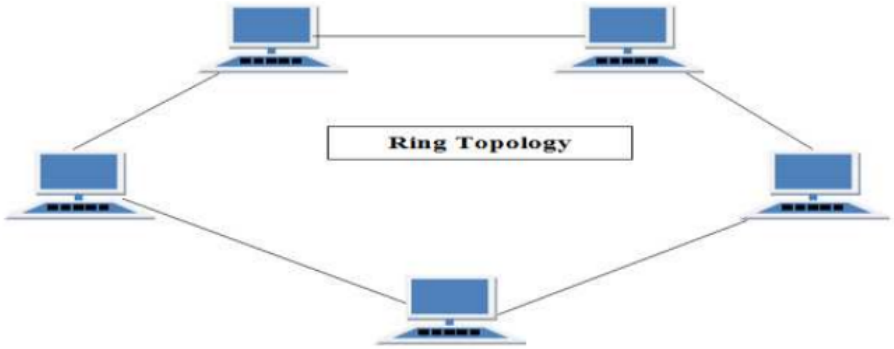
The second candidate is the Star Topology. This type of network topology is connected like the shape of a "star" which, as the name suggests (shown in Figure 7), has a central hub where the network originates. Each node and machine is extended directly from the central hub. The devices do not speak or communicate with each other directly and all communications are governed from the hub.

Figure 7: **Star Topology**.



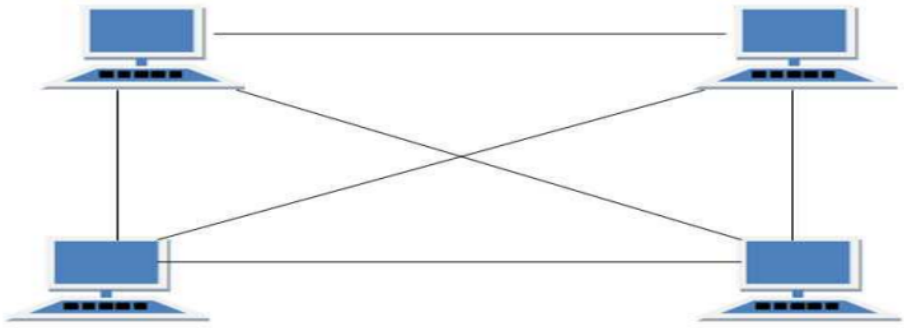
The third candidate is the Ring Topology. As opposed to the Star Topology, the Ring Topology does not have a central hub. This is shown in Figure 8. All nodes and machines are connected together as a ring. This means there is a hidden order from the first machine to the last machine. In the middle, every two machines are collected together. Another view to observe this type of topology is to consider a Bus Topology with the last machine connected to the first machine. Hence, instead of a linear architect, the Ring Topology suggests a full circle.

Figure 8: **Ring Topology**.



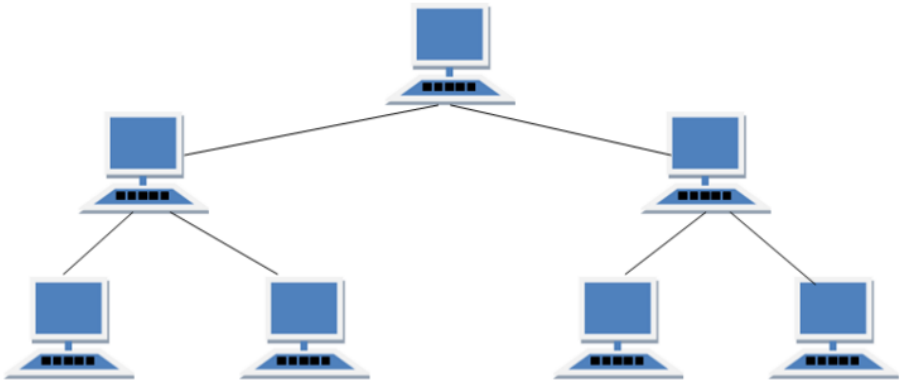
The next candidate is the Mesh Topology. This concept originated from physics. A mesh structure is a net-like structure that offers flexibility and strength together which makes it very ideal material for a variety of different tasks. In computer networks, the Mesh Topology, as the Figure 9 shown, is a type of net-like topology where each intersection is a computer. For example, if the network has four machines, each machine is then connected to each other machine (i.e. 1 machine is connected to the other 3 machines). This allows data to be transferred between two machines directly and there is no need for any intermediate party to process or approve the data.

Figure 9: **Mesh Topology**.



The last candidate is the Tree Topology. The concept of Tree Topology is rather simple to explain, because the word "tree" suggests branches, as shown in Figure 10. In the beginning of the tree, the branches grown out to be very similar to the Bus Topology. However, immediately from the second branch, the architect starts to look very differently. The tree architect suggests that nodes on the network have sub-nodes. This means that there is a mother-child relationship which makes the topology very ideal for corporate governance.

Figure 10: **Tree Topology**.



The benefits and limitations are discussed in the next section.

3 Benefits and Limitations

As a summary, the strengths and the weaknesses are provided in Table XYZ for all five contenders discussed above.

The Bus Topology is easy implement in different locations directly and the machines are connected easily. The only requirement is sufficient length of wire for the main machine and each branch is connected with minimum cost of materials. It is the most cost effective architect. The disadvantage for a Bus Topology is that the network speed might be affected. The reason is because of the linear design. If a user is downloading

heavy volume of data in one branch, the following branches will be affected because the main branch is the only branch for data transfer. It is also difficult for administrator as well because anomaly detection has to be done one by one.

The Star Topology has solid performance and sometimes better than that of the Bus Topology. It is easy to diagnose the faulty location and it is efficient to set up. This type of topology has a central hub and the design is efficient for administrator as well. The cables are efficiently installed, yet the cost is still fairly high overall due to the architect of the design.

The Ring Topology, as its name suggests, uses only two connections for each machine and the architect is highly efficient at processing and transferring data. In some occasions when there is large volume of data transferring required for the network system, it is always recommended to have the Ring Topology. The biggest pitfall for this topology is a removal of a machine. The entire system is connected as a whole and any removal of a machine would require the entire system to be shut down temporarily until it is connected. Any new member to the system also requires the system to be broken apart before the new member can be added again.

The Mesh Topology, as opposed to the Ring Topology, would be able to avoid the problem with adding or removal of a machine. The diagnosis of faulty software is easy and each of the connection carries relatively small amount of data. The cabling cost can be expensive because the design dictates each machine to be connected with every other machines. Suppose there are n machines in the network. Then each machine is connected with $n-1$ other machines. The total links would be the number of $n(n-1)/2$ which is a large number if n is sufficiently large.

The Tree Topology is specifically designed for management purpose. It is extremely easy for hierarchical management style. The error detection and blame assignment are made easy for this type of architect. However, the cable cost is heavy due to the many connections. The biggest issue is the sub-node and its machine will fail if the central hub at each branch fails. Hence, the system puts a lot of responsibility on the central hub.

Table 1: **Comparison Table for Different Network Architect**.

Parameters	BUS	STAR	RING	MESH	TREE
Installation	easy	easy	difficult	difficult	easy
Cost	inexpensive	expensive	moderate	expensive	less
Flexible	yes	yes	no	no	yes
Reliability	moderate	high	high	high	moderate
Extension	easy	easy	easy	poor	easy
Robust	no	yes	no	yes	no

4 Application: How to implement these network types

The section introduces some basic notions of implementation of computer networks. The first thing to consider is the cost. As discussed above, different architect has different cost level. The number of wire is then related to the cost level. The next important thing is the speed of the network. The data transfer and speed are highly related. One cannot be successful without the other. The easement of management is another aspect to take thoughts in. The management style is also a deterministic factor to allow the manager to decide what network topology to use.

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