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Network Topologies of Software Engineering

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ABSTRACT:

Network Topology refers to layout of a network and how different nodes in a network are connected to each other and how they communicate. Topologies are either physical (The physical layout of devices on a network) or logical (the way that the signals act on the network media, or the way that the data passes through the network from one device to the next). This Webopedia Study Guide describes five of the most common network topologies. In computer networking, topology refers to the layout of connected devices. In communication networks, a topology is a usually schematic description of the arrangement of a network, including its nodes and connecting lines. There are two ways of defining network geometry: the physical topology and the logical (or signal) topology.

Keywords:

Topology; Bush; Ring; Mesh

INTRODUCTION

Network topology is the arrangement of the various elements (links, nodes, etc.) of a computer network. Essentially, it is the topological structure of a network and may be depicted physically or logically. Physical topology is the placement of the various components of a network, including device location and cable installation, while logical topology illustrates how data flows within a network, regardless of its physical design. Distances between nodes, physical interconnections, transmission rates, or signal types may differ between two networks, yet their topologies may be identical.

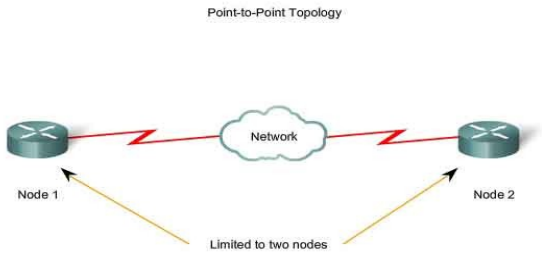
An example is a local area network (LAN): Any given node in the LAN has one or more physical links to other devices in the network; graphically mapping these links results in a geometric shape that can be used to describe the physical topology of the network. Conversely, mapping the data flow between the components determines the logical topology of the network.

I. TYPES OF TOPOLOGIES

There are two basic categories of network topologies: physical topologies and logical topologies.

- Point-to-point
- Bus
- Star
- Ring
- Mesh
- Tree
- Hybrid
- Daisy chain

II.a) Point-to-Point



Fig[1]. Point to Point Topology

The simplest topology with a permanent link between two endpoints. Switched point-to-point topologies are the basic model of conventional telephony. The value of a permanent point-to-point network is unimpeded communications between the two endpoints. The value of an on-demand point-to-point connection is proportional to the number of potential pairs of subscribers and has been expressed as Metcalfe's Law.

II.b) Bus Topology

Bus networks (not to be confused with the system bus of a computer) use a common backbone to connect all devices. A single cable, the backbone functions as a shared communication medium that devices attach or tap into with an interface connector. A device wanting to communicate with another device on the network sends a broadcast message onto the wire that all other devices see, but only the intended recipient actually accepts and processes the message.

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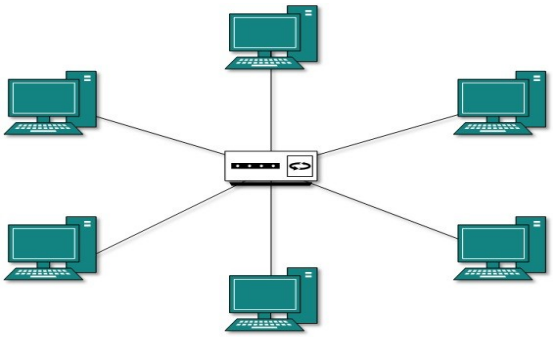
Ethernet bus topologies are relatively easy to install and don't require much cabling compared to the alternatives. 10Base-2 ("ThinNet") and 10Base-5 ("ThickNet") both were popular Ethernet cabling options many years ago for bus topologies. However, bus networks work best with a limited number of devices. If more than a few dozen computers are added to a network bus, performance problems will likely result.

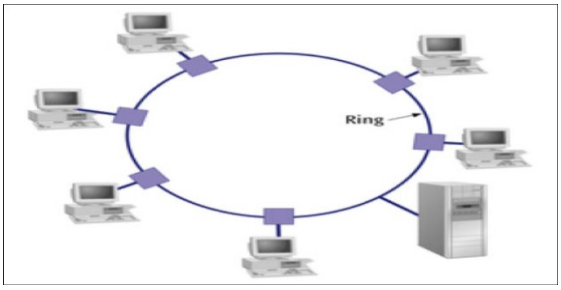
II.c) Star Topology



Fig[2]. Star Topology

In local area networks with a star topology, each network host is connected to a central hub with a point-to-point connection. In Star topology every node (computer workstation or any other peripheral) is connected to a central node called hub or switch. The switch is the server and the peripherals are the clients. The network does not necessarily have to resemble a star to be classified as a star network, but all of the nodes on the network must be connected to one central device. All traffic that traverses the network passes through the central hub. The hub acts as a signal repeater. The star topology is considered the easiest topology to design and implement. An advantage of the star topology is the simplicity of adding additional nodes. The primary disadvantage of the star topology is that the hub represents a single point of failure.

II.d) Ring Topology

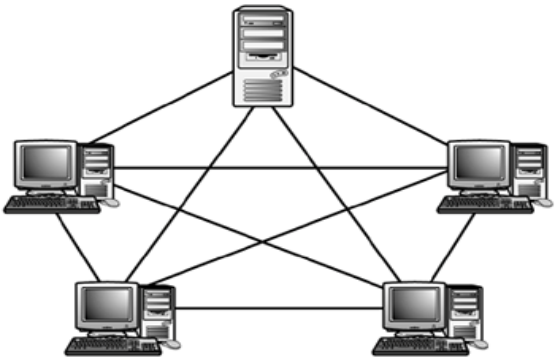


Fig[3]. Ring Topology

In a ring network, every device has exactly two neighbors for communication purposes. All messages travel through a ring in the same direction (either "clockwise" or "counterclockwise"). A failure in any cable or device breaks the loop and can take down the entire network.

To implement a ring network, one typically uses FDDI, SONET, or Token Ring technology. Ring topologies are found in some office buildings or school campuses.

II.e) Mesh Topology

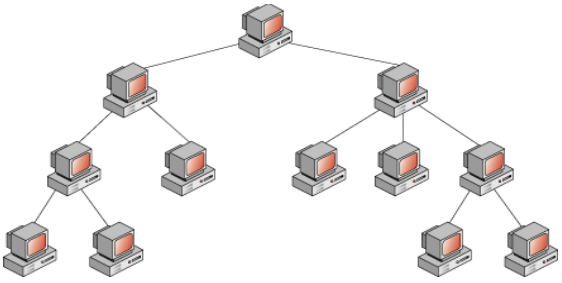


Fig[4]. Mesh Topology

Mesh topology introduces the concept of routes. Unlike each of the previous topologies, messages sent on a mesh network can take any of several possible paths from source to destination. (Recall that even in a ring, although two cable paths exist, messages can only travel in one direction.) Some WANs, most notably the Internet, employ mesh routing.

A mesh network in which every device connects to every other is called a full mesh. As shown in the illustration below, partial mesh networks also exist in which some devices connect only indirectly to others.

II.f) Tree Topology



Fig[5]. Tree Topology

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A tree topology is essentially a combination of bus topology and star topology. The nodes of bus topology are replaced with standalone star topology networks. This results in both disadvantages of bus topology and advantages of star topology.

For example, if the connection between two groups of networks is broken down due to breaking of the connection on the central linear core, then those two groups cannot communicate, much like nodes of a bus topology. However, the star topology nodes will effectively communicate with each other.

It has a root node, intermediate nodes, and ultimate nodes. This structure is arranged in a hierarchical form and any intermediate node can have any number of the child nodes.

But the tree topology is practically impossible to construct, because the node in the network is nothing, but the computing device can have maximum one or two connections, so we cannot attach more than 2 child nodes to the computing device (or parent node). There are many sub structures under tree topology, but the most convenient is B-tree topology whereby finding errors is relatively easy.

II.g) Hybrid Topology

Hybrid networks use a combination of any two or more topologies, in such a way that the resulting network does not exhibit one of the standard topologies (e.g., bus, star, ring, etc.). For example a tree network connected to a tree network is still a tree network topology. A hybrid topology is always produced when two different basic network topologies are connected. Two common examples for Hybrid network are: star ring network and star bus network

- A Star ring network consists of two or more star topologies connected using a multistation access unit (MAU) as a centralized hub.

- A Star Bus network consists of two or more star topologies connected using a bus trunk (the bus trunk serves as the network's backbone).

III. Centralization

The star topology reduces the probability of a network failure by connecting all of the peripheral nodes (computers, etc.) to a central node. When the physical star topology is applied to a logical bus network such as Ethernet, this central node (traditionally a hub) rebroadcasts all transmissions received from any peripheral node to all peripheral nodes on the network, sometimes including the originating node. All peripheral nodes may thus communicate with all others by transmitting to, and receiving from, the central node only. The failure of a transmission line linking any peripheral node to the central node will result in the isolation of that peripheral node from all others, but the remaining peripheral nodes will be unaffected. However, the disadvantage is that the failure of the central node will cause the failure of all of the peripheral nodes.

If the central node is passive, the originating node must be able to tolerate the reception of an echo of its own transmission, delayed by the two-way round trip transmission time (i.e. to and from the central node) plus any delay generated in the central node. An active star network has an active central node that usually has the means to prevent echo-related problems.

A tree topology (a.k.a. hierarchical topology) can be viewed as a collection of star networks arranged in a hierarchy. This tree has individual peripheral nodes (e.g. leaves) which are required to transmit to and receive from one other node only and are not required to act as repeaters or regenerators. Unlike the star network, the functionality of the central node may be distributed.

As in the conventional star network, individual nodes may thus still be isolated from the network by a single-point failure of a transmission path to the node. If a link connecting a leaf fails, that leaf is isolated; if a connection to a non-leaf node fails, an entire section of the network becomes isolated from the rest.

IV. Decentralization

In a mesh topology (i.e., a partially connected mesh topology), there are at least two nodes with two or more paths between them to provide redundant paths to be used in case the link providing one of the paths fails. This decentralization is often used to compensate for the single-point-failure disadvantage that is present when using a single device as a central node (e.g., in star and tree networks). A special kind of mesh, limiting the number of hops between two nodes, is a hypercube. The number of arbitrary forks in mesh networks makes them more difficult to design and implement, but their decentralized nature makes them very useful. In 2012 the IEEE published the Shortest path bridging protocol to ease

configuration tasks and allows all paths to be active which increases bandwidth and redundancy between all devices.

This is similar in some ways to a grid network, where a linear or ring topology is used to connect systems in multiple directions. A multidimensional ring has a toroidal topology, for instance.

A fully connected network, complete topology, or full mesh topology is a network topology in which there is a direct link between all pairs of nodes. In a fully connected network with n nodes, there are n(n-1)/2 direct links. Networks designed with this topology are usually very expensive to set up, but provide a high degree of reliability due to the multiple paths for data that are provided by the large number of redundant links between nodes. This topology is mostly seen in military applications.

V. CONCLUSION

Computer network topology is the way various components of a network (like nodes, links, peripherals, etc) are arranged. Network topologies define the layout, virtual shape or structure of network, not only physically but also logically. The way in which different systems and nodes are connected and communicate with each other is determined by topology of the network. Topology can be physical or logical. Physical Topology is the physical layout of nodes, workstations and cables in the network; while logical topology is the way information flows between different components.

In general, physical topology relates to a core network whereas logical topology relates to basic network.

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