Computer Network Topology for Data Communication and Networking‖

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Abstract: The goal of this paper is to provide a brief viewon Computer Network Topologies for Data Communication that may be useful to Computer Network Engineers in understanding to engineer the complex,large and interdisciplinary systems of systems and aimingto support the in designing of interconnection systems for data communications. The classification of Network topologies by how they are implemented is considered in detail through several aspects. Each kind of topology is used to achieve a particular task and capture the structure of the system at various levels of detail. In recent days for computing, distributed computer systems are playing a vital role and popular issue. It delivers high end performance at a low cost. Autonomous computers are connected by means of a communication network in a distributed computing environment which is arranged in a geometrical shape called network topology. In the present paper a detailed study and analysis on network topologies is presented. Definitions of Physical and Logical Topologies are also provided

Keywords-Data Communication (DC), Bus, Star

INTRODUCTION

Distributed computing systems have become the essential aspect of growing information technology and in computer networking. The performance of any distributed system is depends on by the technology, which we adopt in making network interconnections and how data communication takes place.

Network topologies are the technology for arrangement of various computer elements like links, nodes etc. Basically network topology is the topological structure of a computer network. In mathematics topology is concerned with the connectedness of objects which is the most basic properties of space. In simple way

network topology refers to the way in which the network of computers is connected. Each topology is suited to specific tasks and has its own advantages and disadvantages. A most simple and good example of network topology is LAN Where it LAN has one or more physical links to other devices in the network. In recent days there are basically two basic categories of network topologies Physical topologies and Logical topologies . Physical Network Topology emphasizes the hardware associated with the system including workstations, remote terminals, servers, and the associated wiring between assets. Conversely, Logical Network Topology emphasizes the representation of data flow between nodes. In this paper a brief description on these topologies are presented.

Information transmission is no longer limited to what we can place on paper. Large computer systems can hold and manipulate quantities of data in ways that just a few decades ago would have seemed impossible. Not only can these be linked together in a myriad of ways, but can also be transmitted nearly instantaneously over communications networks — sets of locations (or nodes) with concomitant hardware, software, and information that are linked together to form a system that transmits and receives information. Data Communication refers to the transmission/exchange of digital data between a source and a receiver. The physical connection between networked computing devices is established using either guided (wired) media or wireless media. The best-known computer network is the Internet. Data communication is said to be local if ommunicating devices are in the same building or a similarly restricted geographical area.

A simple data communication system has shown in Fig-1.

Simple Data Communication System

There are three types of data communications networks exist. They are Local area networks, Metropolitan area and Wide area networks. Local area network comprise multiple desktop

computers that are located near each other and linked into a network that allows the users to share files and peripheral devices such as printers, fax machines, or storage devices. A second type of network used in many businesses is the metropolitan area network. This type of network transmits data and information citywide (up to 30/40 miles) and at greater speeds than a local area network. As opposed to local area networks, metropolitan area networks are optimized for both voice and data transmissions and can, therefore, carry more forms of data than can be carried over local area networks. These include combinations of voice, data, image, and video data. Metropolitan area networks typically operate over a city-wide network of fiber optic cables. The third type of network is the wide area network. These networks comprise multiple computers that are widely dispersed and that are linked into a network. Wide area networks typically use high speed, long distance communications networks or satellites to connect the computers within the network.

TOPOLOGY

Topology refers to the way in which the network of computers is connected i.e. how the network is laid out. Network topologies are the technology for arrangement of various computer elements like links, nodes etc. Basically network topology is the topological structure of a computer network. In mathematics topology is concerned with the connectedness of objects which is the most basic properties of space. In simple way network topology refers to the way in which the network of computers is connected. Till today various types of topologies are existed. Each topology is suited to specific tasks and has its own pros and cons. The choice of topology is dependent upon type and number of equipment being used, planned applications and rate of data transfer required, response time, and cost. Topology can also be defined as the geometrically interconnection pattern by which the stations (nodes/computers) are connected using suitable transmission media (which can be point-to-point and broadcast

A most simple and good example of network topology is LAN . Where it LAN has one or more physical links to other devices in the network. In recent days there are basically two basic categories of network topologies, they are Physical topologies and Logical topologies . Physical Network Topology emphasizes the hardware associated with the system including workstations, remote terminals, servers, and the associated wiring between assets.

Conversely, Logical Network Topology emphasizes the representation of data flow between nodes. A brief view of various commonly used topologies are presented and discussed in this paper.

A. Point-to-Point

In a point-to-point link, two devices monopolize a communication medium. Because the medium is not shared, a mechanism is not needed to identify the computers. Therefore, a simple, twodevice point-to-point network has no need for *addressing*. A point to point topology is a direct connection between two devices (nodes), the value of a permanent point-to-point network is unimpeded   communications between the two endpoints. One   example of this is a PC connected to a printer. A   more common example is a mainframe terminal connected to a mainframe front-end processor

Point-to-point links can be *simplex*, **halfduplex,**

or *full-duplex*. When devices must engage in bi-directional communication on a half-duplex link, some turnaround mechanisms must be in place to switch the roles of the sending and receiving devices. In Simplex signal flows in ONE direction and only one station transmit and the other receive, In Halfduplex each station can both transmit and receive but NOT at the same time and where as in Full-duplex both stations transmit and receive simultaneously, Link capacity is shared between the two devices either by 2separate transmission path and channel capacity is divided for transmitting and receiving
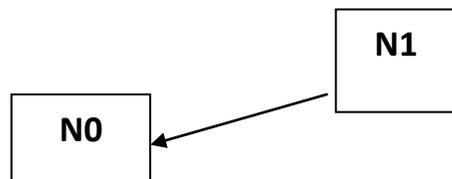
A. Multi-Point

In a Multi-Point link, three or more devices together through a single communication medium. For sharing a common channel, each device needs a way to identify itself and the device to

which it wants to send information. The method used to identify senders and receivers is called *addressing*. The common types of multi-point topologies are Bus, Ring, and Star etc.,

B. Bus

The bus topology carries the transmitted message along the cable. As the message arrives at each device (node), the nodes checks the destination address contained in the message to see if it matches   its own. If the address does not match, the node does   nothing more. A major disadvantage of this network topology is that if the node address matches that contained in the message, the node processes the message. The message is transmitted along the cable and is visible to all devices connected to that cable. issues with security as data is broadcasted across the network and single point of failure if hub or backbone goes down.
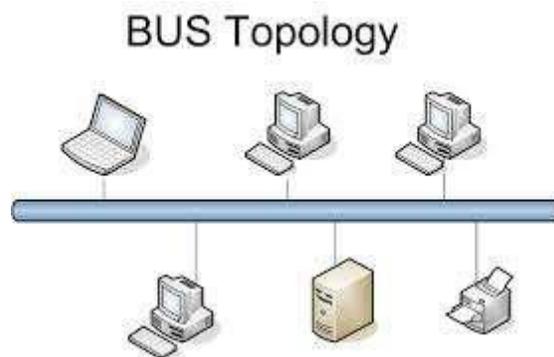

Figure III.

The main advantages of Bus topologies are Reliable in very small networks as well as easy to use and understand, Less expensive than other cabling arrangements because Bus requires least amount of cable to connect the computers (nodes) together and. It's easy to extend, two cables can be easily joined with a connector, making a longer cable for more computers to join the network. A repeater can also be used to extend a bus configuration.

By this type topology, if one node goes faulty all nodes may be affected as all nodes share the same cable for the sending and receiving of information. So the main weakness i.e. Drawbacks of bus topologies are Due to Heavy network traffic can slow a bus considerably because any computer can transmit at any time. But networks do not coordinate

when information is sent. Computer interrupting each other can use a lot of bandwidth. Bus topology have the problem of each connection between two cables weakens the electrical signal and the bus configuration can be difficult to find and can cause the whole networks to stop functioning.

C. Ring

In Ring Computers are connected on a single circle of cable and this type of Ring Topology usually seen in a Token Ring or FDDI (fiber optic) networks. In Ring each computer acts as a repeater and keeps the signal strong, no need for repeaters on a ring topology. No termination required because it's a ring. Token passing is used in Token Ring networks. The token is passed from one computer to the next, only the computer with the token can transmit. The receiving computer strips the data from the token and sends the token back to the sending computer with an acknowledgment. After verification, the token is regenerated. It is relatively easy to install, requiring minimal hardware management
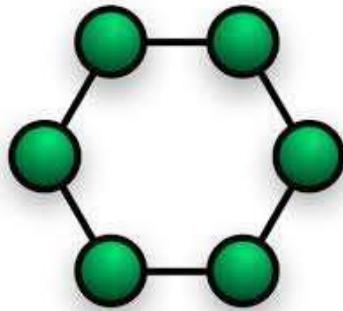
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Ring Topology is used in networks because Ring networks offer high performance for a small number of workstations or for larger networks where each station has a similar workload. Ring networks can span longer distances than other types of networks. Ring networks are easily extendable and unlike Bus topology, there is no signal loss in Ring topology because the tokens are data packets that are re-generated at each node.

Ring topology is limited to implement because it is relatively expensive and difficult to install. Failure of one computer on the network can affect the whole network. It is difficult to find fault in a ring network. Adding or removing computers can disrupt the network. It is much slower than an Ethernet network under normal load.

D. Star

Star topology is one of the most common network setups where each of the devices or nodes on a network connects to a central hub. In a Star topology, the central hub is the host computer, and at the end of each connection is a terminal as shown in Figure. Signal travels through the hub to all other computers and it is most scalable and reconfigurable of all topologies
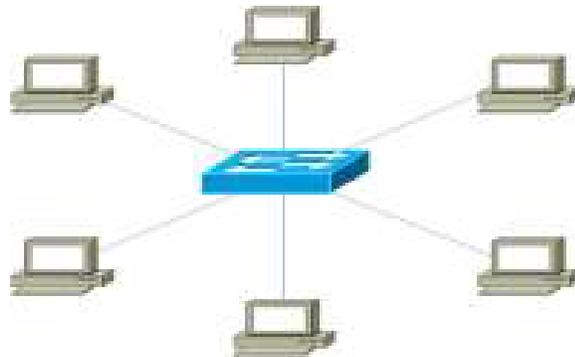
Figure V. Star Topology

The major advantages of this star topologies are It is more reliable (if one connection fails, it does not affect others) .The center of a star network is a good place to diagnose network faults and if one computer fails whole network is not disturbed. Hub detects the fault and isolates the faulty computer. It is easy to replace, install or remove hosts or other devices, the problem can be easily detected-It is easier to modify or add a new computer without disturbing the rest of the network by simply running a new line from the computer to the central location and plugging it to the hub. Use of multiple cable types in a same network with a hub and it has good Performance

The major disadvantages of this network topology are if the central hub fails, all computers connected to that hub would be disconnected. This network topology is high dependence of the system on the functioning of the central hub. Failure of the central hub renders the network inoperable. It requires more cable and If a computer goes down, the network functions normally.

E. Hierarchical/Tree:

The most common structure or topology known as Tree topology, Tree topology is a LAN topology in which only one route exists between any two nodes on the network. The pattern of connection resembles a tree in which all branches spring from one root. Each star network is a local area network (LAN) in which there is a central computer or server to which all the connected nodes directly linked. It is a logically extension of star topology i.e. Tree topology is a combination of two or more bus and the Star Topology connected together. Tree Structure suits best when the network is widely spread and vastly divided into many branches. The central computers of the star networks are connected to a main cable called the b
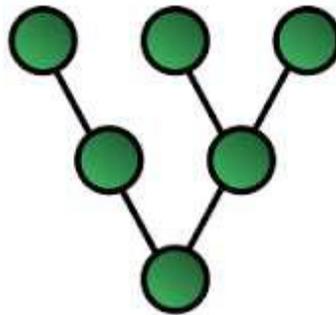

Figure VI. Tree Topology.

A major disadvantage is the length of the network depends on the type of cable that is being used and tree topology network is entirely dependent on the trunk which is the main backbone of the network. If that has to fail then the entire network would fail.

F. Mesh:

In Mesh devices are connected with many redundant interconnections between network nodes. In a well-connected topology, every node has a connection to every other node in the network. The cable requirements are high, but there are redundant paths built in.

Failure in one of the computers does not cause the network to break down, as they have alternative paths to other computers. Mesh topologies are used in

critical connection of host computers (typically telephone exchanges). Alternate paths allow each computer to balance the load to other computer systems in the network by using more than one of the connection paths available. A fully connected mesh network therefore has n (n-1) /2 physical channels to link n devices. To accommodate these, every device on the network must have (n-1) input/output ports
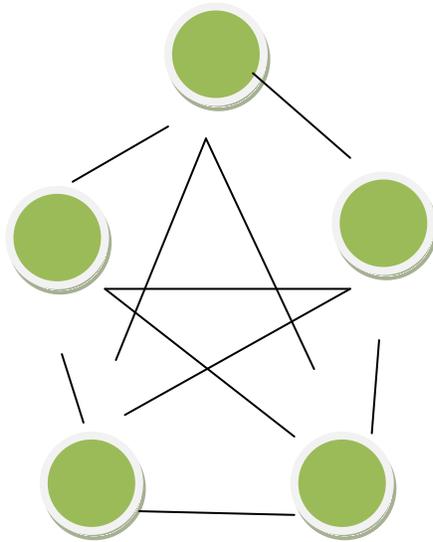

Figure VII. Mesh Topology.

In Mesh network problems are easier to diagnose and Privacy between computers is maintained as messages travel along dedicated path. Mesh is avoided to uses in some cases because it requires the amount of cabling required is high and a large number of I/O (input/output) ports are

G. Hybrid:

Hybrid topology is an integration of two or more different topologies to form a resultant topology which has many advantages (as well as disadvantages) of all the constituent basic topologies rather than having characteristics of one specific topology. This combination of topologies is done according to the requirements of the organization.
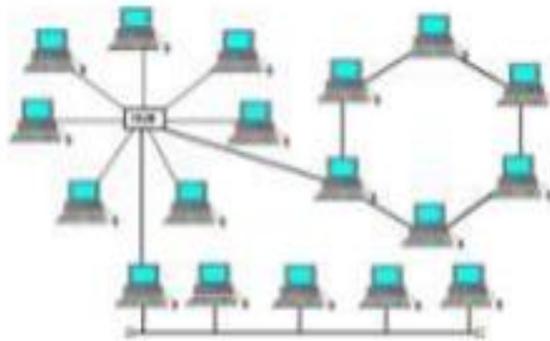
Figure VIII. Hybrid Topology

Hybrid topology is a network topology that is composed of one or more interconnections of two or more networks that are based upon different physical topologies or a type of network topology that is composed of one or more interconnections of two or more networks that are based upon the same physical topology, but where the physical topology of the network resulting from such an interconnection does not meet the definition of the original physical topology of the interconnected network

Except for star-based networks, the easiest way to add more computers into a network is by daisy-chaining, or connecting each computer in series to the next. If a message is intended for a computer partway down the line, each system bounces it along in sequence until it reaches the destination. A daisychained network can take two basic forms: linear and ring

one computer and the next. However, this was expensive in the early days of computing, since each computer (except for the ones at each end) required two receivers and two transmitters.

Topology can be formed. An advantage of the ring is that the number of transmitters and receivers can be cut in half, since a message will eventually loop all of the way around. When a node sends a message, the message is processed by each computer in the ring. If a computer is not the destination node, it will pass the message to the next node, until the message arrives at its destination. If the message is not accepted by any node on the network, it

will travel around the entire ring and return to the sender. This potentially results in a doubling of travel time for data
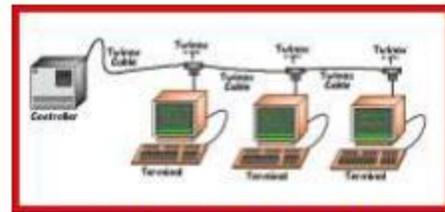

Figure IX. Daisy Chain Topology

CONCLUSION:

This brief view on Computer Network Topologies for Data Communication provides a coherent way to know about topologies and to consider their properties and priorities for network engineers in understanding to engineer the complex, large and interdisciplinary systems of systems and aiming to support in the designing of interconnection systems for data communications. In this paper, performance of different kinds of topologies is considered and studied. Description of some inherent advantages and disadvantages computer network topologies to any system under study also has been described in this paper. This paper has provided some knowledge of analysis approaches for dealing with network topology related problems. The techniques covered in this discussion can be adapted to related

Hence the authors says that there is high tendency for research in this aspect and authors conclude that there is a need of standard topology which satisfy the stake holders expectations and aiming to support for the high end data transmission of development of successful communication systems

REFERENCES

1] Banerjee, S., Jain, V., Shah, S., "Regular multihop logical topologies for lightwave networks", Communications Surveys & Tutorials, IEEE, On page(s): 2 - 18 Volume: 2, Issue: 1, First Quarter 1999

[2] Cem Ersoy, Shivendra PanWar "Topological Design of Interconnected LAN-MAN Networks", IEEE INFOCO, pp. 2260- 2269, 1992.

[3] F. Backes, ―Transparent Bridges for Interconnection of IEEE 802 LANs,‖ IEEE Network, pp. 5-9, January 1988.

[4] Li Chiou Chen "The Impact of Countermeasure Propagation on the Prevalence of Computer Viruses" IEEE Transactions on