Comparison Of Network Topologies For Optical Fiber Communication

Mr. Bhupesh Bhatia Department of Electronics and Communication, Guru Prem Sukh Memorial College of Engineering, Delhi	Ms. Ashima Bhatnagar Bhatia Department of Computer Science, Tecnia Institute of Advanced Studies, Delhi
Ms. Rashmi Ishrawat Department of Computer Science, Tecnia Institute of Advanced Studies, Delhi	

Abstract

In this paper, the various network topologies have been compared. The signal is analyzed as it passes through each node in each of the network topology. There is no appreciable signal degradation in the ring network. Also there is increase in Quality factor i.e. signal keeps on improving as it passes through the successive nodes. For the bus topology, the quality of signal goes on decreasing with increase in the number of nodes and the power penalty goes on increasing. For the star topology, it is observed that received power values of each node at a same distance from the hub are same and the performance is same. For the tree topology, it is observed that the performance is almost identical to the performance of ring topology, as signal quality is improved as it passes through the successive nodes of the hierarchy.

I. Introduction

Communication systems have revolutionized the telecommunications industry and played a major role in the advent of the Information age. Optical technologies can cost effectively meet corporate bandwidth needs today and tomorrow. Internet connections offering bandwidth on demand, to fiber on the LAN. Fiber to the home can provide true broadband connectivity for telecommuters as well as converged multimedia offerings for consumers [2]. These different communication networks can be configured in a number of topologies. These include a bus, with or without a backbone, a star network, a ring network, which can be redundant and/ or self-healing, or some combination of these. Network topology is the study of the arrangement or mapping of the elements (links, nodes, etc.) of a network, especially the physical (real) and logical (virtual) interconnections between nodes A local

area network (LAN) is one example of a network that exhibits both a physical and a logical topology. Any given node in the LAN will have one or more links to one or more other nodes in the network and the mapping of these links and nodes onto a graph results in a geometrical shape that determines the physical topology of the network [1].

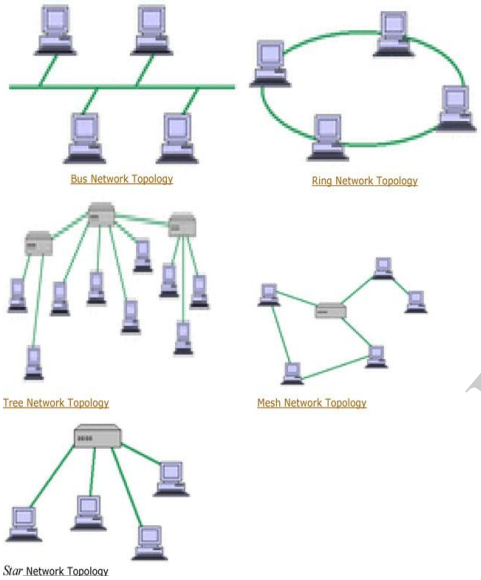

Fig. 1. Diagram of different network topologies.

Fig. 1 shows the different types of topologies. Bus is the network topology in which all of the nodes of the network are connected to a common transmission medium which has exactly two endpoints (this is the 'bus', which is also commonly referred to as the backbone, or trunk) – all data that is transmitted between nodes in the network is transmitted over this common transmission medium and is able to be received by all nodes in the network virtually simultaneously. Star is the topology in which each of the nodes of the network is connected to a central node with a point-to- point link. All data that is transmitted between nodes in the network is transmitted to this central node, which is usually some type of device that then retransmits the data to some or all of the other nodes in the network, although the central node may also be a simple common connection point without any active device to repeat the signals. In ring topology, each of the nodes of the network is connected to two other nodes in the network and with the first and last nodes being connected to each other, forming a ring. All data that is transmitted between nodes in the network travels from one node to the next node in a circular manner and the data generally flows in a single direction only. In tree topology, the central 'root' node (the top level of the hierarchy) is connected to one or more other nodes that are one level lower in the hierarchy (i.e. the second level) with a point-to-point link between each of the second level nodes and the top level central 'root' node, while each of the second level nodes that are connected to the top level central 'root' node will also have

one or more other nodes that are one level lower in the hierarchy.

Optical networks are the next revolution in technology, because they deliver the increased bandwidth demanded by the information explosion. Optical networks are spreading outward from Internet backbones to cities to corporations and even to the home. Cities are in a strategic position to create a leading-edge optical infrastructure that will drive economic growth [3]. Optical technologies can cost-effectively meet corporate bandwidth needs today and tomorrow. Internet connections offering bandwidth on demand, to fiber on the LAN. Fiber to the home can provide true broadband connectivity for telecommuters as well as converged multimedia offerings for consumers [2]. Based on optical fiber cables, digital microwave and satellite subsidiary, a transport network with fully coverage, large capacity and high rate has been basically formed. However, the development of the transport network is still slower as more and more capacity is needed for various communication technologies.

II. Bus network topology:

A bus network topology (fig. 2) is a network architecture in which a set of clients are connected via a shared communications line, called a bus. This topology is easy to implement and install. It is well-suited for temporary or small networks not requiring high speeds (quick setup), resulting in faster networks. Cost effective and easy identification of cable faults is possible. Moreover, Bus networks are the simplest way to connect multiple clients, but often have problems when two clients want to transmit at the same time on the same bus. Thus systems which use bus network architectures normally have some scheme of collision handling or collision avoidance for communication on the bus, quite often using Carrier Sense Multiple Access or the presence of a bus master which controls access to the shared bus resource. Many active architectures can also be described as a ‘‘bus’’, as they provide the same logical functions as a passive bus, for example, switched Ethernet can still be regarded as a logical bus network, if not a physical one. The limitations of Bus Network topology are limited fiber length, higher Maintenance costs, if there is a problem with the cable, the entire network breaks down. Moreover, the performance degrades as additional computers are added or on heavy traffic (shared bandwidth).

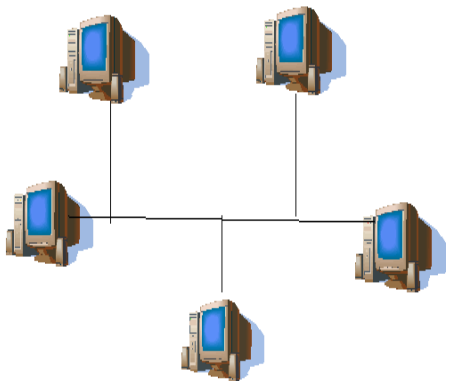

Fig. 2. Bus network layout

III. Ring network Topology

In a ring network (fig.3) each node connects to exactly two other nodes, forming a single continuous pathway for signals through each node - a ring. Data travels from node to node, with each node along the way handling every packet. Ring network Performs better than a bus topology under heavy network load and does not require a central node to manage the connectivity between the computers. But the limitations are that one malfunctioning workstation can create problems for the entire network or a node failure or cable break might isolate every node attached to the ring. Communication delay is directly proportional to number of nodes in the network. In adition, bandwidth is also shared on all links between devices. 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.

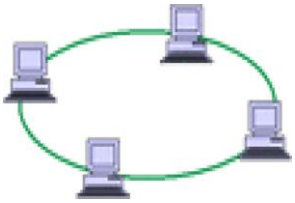

Fig. 3. Ring network layout

IV. Star network topology

Star networks are simplest form of the network topologies. This network topology consists of one central computer, which acts as a central node, to which all other nodes are connected. This central node provides a common connection point for all nodes through a hub. 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 transmission time (i.e. to and from the central node) plus any delay generated in the central node. An active star network(fig. 4) has an active central node that usually has the means to prevent echo-related problems. The star topology reduces

the chance of network failure by connecting all of the systems to a central node. When applied to a bus-based network, this central 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 transmission line linking any peripheral node to the central node will result in the isolation of that peripheral node from all others, but the rest of the systems will be unaffected.

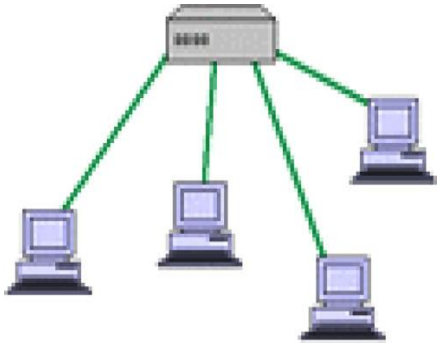

Fig. 4. Star network layout.

V. Tree network topology

A tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable (fig. 5). Tree topologies allow for the expansion of an existing network, and enable schools to configure a network to meet their needs. It is easy to add or remove nodes from each star network as there is Point-to-point wiring for individual segments. In a tree network, a cable failure in one of the star networks will isolate the node that it links to the central node of that star network, but only that node will be isolated. The limitations of the tree topology are If the backbone line breaks, the entire segment goes down and it is more difficult to configure and wire than other topologies.

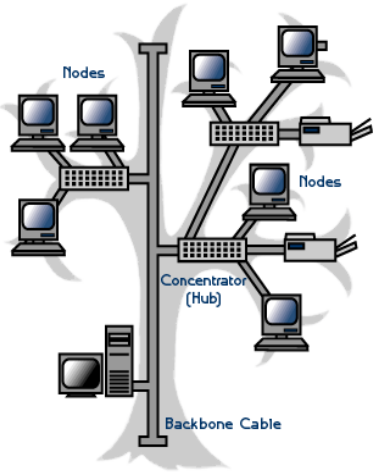

Fig. 5. Tree topology layout

VI. Conclusion

In this paper, the various network topologies comprising of various nodes have been compared. For bus network topology, the quality of signal goes on decreasing with decrease in signal input

power and the power penalty goes on increasing. It is also observed that power received goes on increasing with increase in input power. The main limitation of bus topology is its limited cable length and number of stations. If there is a problem with the cable, the entire network goes down. Maintenance costs may be higher. In Ring network topology, the quality of signal keeps on improving as it passes through the the successive nodes. In a simple ring, break in the ring can disable the entire network. Unidirectional traffic can be a disadvantage in the ring network. The star topology reduces the Chance of network failure by connecting all of the Systems to a central node. 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 rest of the systems will be unaffected. Although more cabling is required in a star network than in some other topologies. The tree topology can support more number of users by increasing the signal input power. However, it is more difficult to configure and wire than other topologies. Finally we conclude that optical fiber better accommodates today's increasingly complex network architectures than copper alternatives. Using optical fiber various topologies came into being. Each topology has its strengths and weaknesses, and some network types work better for one application while another application would use a different network type.

References:

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[3] E. Zouganeli, Migration to optical networking, in: Proceedings of International Conference on Transparent Optical Networks, vol. 1, Nottingham, June 2006, pp. 98–101.