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Performance Evaluation of Star Topology in Fiber Optic Communication

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Abstract: ***Topology refers to the layout of connected devices in a network. It describes the way in which the elements of the network are mapped. Optical network topologies such as bus, star and tree reduce complexity by using minimum number of couplers, multiplexers, demultiplexers and optical amplifiers and can reduce cost in large network. 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. The performance of star topology is investigated and identified that, it distributes optical power equally to all output ports. Maximum number of users supported by star topology is less than 64.***

Keywords: BER (Bit Error Rate), LAN (Local Area Network), Q Factor, Star Topology.

1. Introduction

Fiber-optic communication systems have revolutionized the telecommunications industry and played a major role in the advent of the Information age. 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.Network topology is the study of the arrangement or mapping of the elements 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 [1]. 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 on to a graph results in a geometrical shape that determines the physical topology of the network. 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 simultaneously.

2. Optical Network Topology

The optical networks can also be configured in a number of topologies. These include a bus, a star network, a tree network, 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 betweennodes. 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. Likewise, the mapping of the flow of data between the nodes in the network determines the logical topology of the network. It is important to note that the physical and logical topologies might be identical in any particular network but they also may be different.

3. Star Topology

Star networks are simplest form of the network topologies. Figure 1 shows the layout of star topology. This network topology consists of one central computer, which acts as a central node, to which all other node is 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 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 connectingall 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 transmission line linking any peripheral node to the central node will result in the isolation of thatPeripheral node from all others, but the rest of the systems will be unaffected. The advantage of using star are, it is easy to manage, installation and configuration is easy, easier to detect faults and remove parts. Disadvantage is central node dependency; failure of central hub disables the whole network.

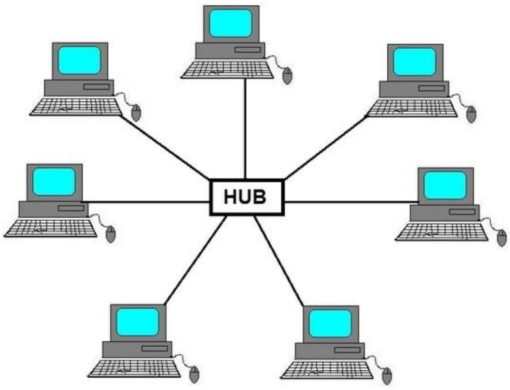

Figure 1: Star Topology

Figure 2 given below shows the block diagram of star topology, the transmitter is composed of data source, NRZ rectangular driver, CW Lorentzian laser, optical amplitude modulator and optical link section.The output from driver and laser source is passed to theoptical amplitude modulator. The optical signal from the modulator is passed through thefixed gain amplifier and then passes through single mode fiber and dispersion compensatingfiber. The combination of SMF and DCF fibers for long distance scenario has beenconsidered to mitigate the nonlinear effects. The output from the fibers is passed through a splitter and splitter splits into several parts to which several users are connected. A singleuser section is composed of optical raised cosine filter, PIN photodiode and low pass Bessel filter. At receiver measurementsare made with the help of Electrical scope and Electrical power meter.

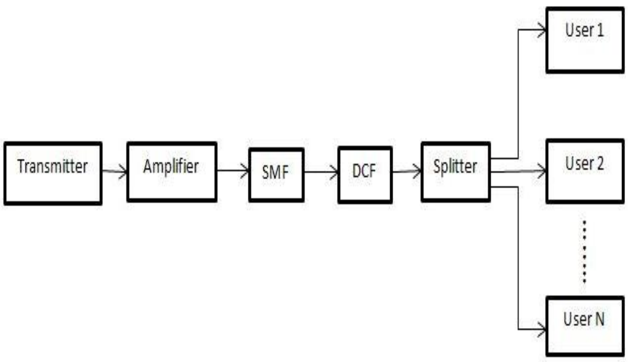

Figure 2: Block Diagram of Star Topology

4. System Design

In the simulation layout of star topology shown in Figure 3, the transmitter section consists of data source with data rate 10Gbps, laser source (CW Lorentzian), optical amplitude modulator (Sin2 MZI) and optical link section. Data source is customized by baud rate, sequence, logical signal level and the period length. In this transmitter set up NRZ modulation format is used. Laser source provides transmission at 1552.52nm laser emission frequency. Laser phase noise is taken into account by generating a lorentzianwhose power spectrum width at half maximum is specified at 10 MHz. The output from driver and laser source are passed to the optical amplitude modulator and is given to a fixed gain amplifier and to a single mode fiber (SMF) and dispersion compensating fiber (DCF) with reference frequency 193.41449 THz and then to a splitter. Splitter splits into several parts to which several users are connected. A single user section is composed of optical raised cosine filter (Raised cosine1), PIN photodiode (Ideal RX1) and low pass Bessel filter (Bessel 5 poles 1). At receiver measurements are made with the help of electrical scope and electrical power meter. Electrical scope is used to obtain eye diagram and from the eye diagram determines the values of Q factor.Electrical power meter is used to obtain the received power value.

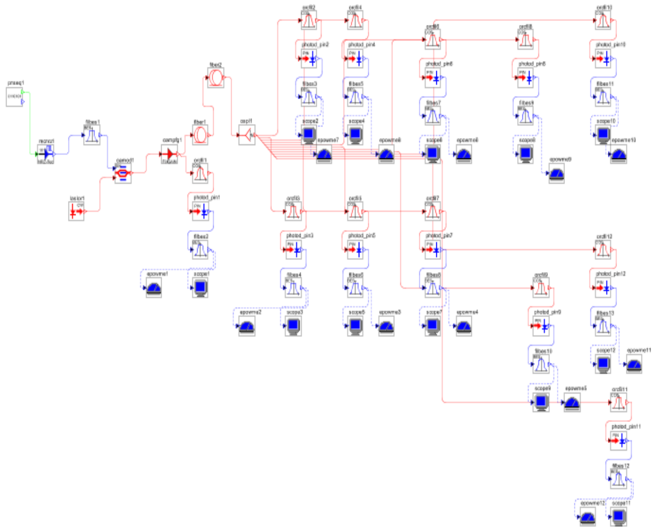

Figure 3: Simulation Diagram of Star Topology

5. Result and Discussion

Star topology is designed and simulated using the Optsim software. The results of these simulations are obtained with the help of measurement tool such as Electrical scope/BER analyzer. Eye diagram is the methodologyused to evaluate the performance of the system. The important parameters of the eyediagram are Quality factor and Bit error rate.

5.1 Performance of Star Topology

Table 1: Relationship between Q Factor and BER to different hub to transmitterdistance

Distance (Km)	*Q Factor (dB)*	*BER*
10	27.19	1e-40
20	21.06	2.99e-29
30	18.53	2.51e-17
40	14.23	2.08e-07
50	12.95	5.63e-06

Table 1 showsthe variation of Q Factor and BER by varying the transmitter to hub distance. As the transmitter to hub distance increases Q Factor decreases and BER increases.

5.2 Eye diagram of Star topology by varying the transmitter to hub distance

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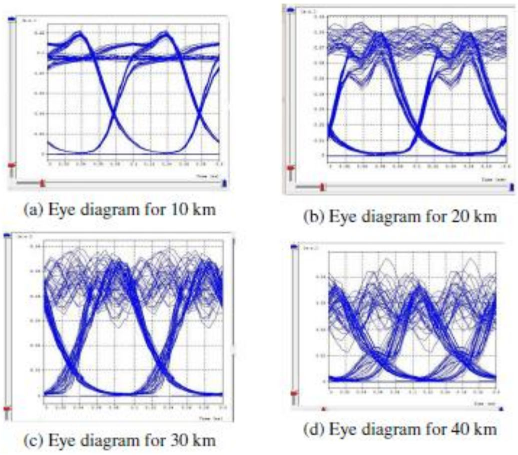

Figure 4: Eye Diagram obtained for star topology by varying internode distance

5.2 Relationship between received power at different nodes with variable input power

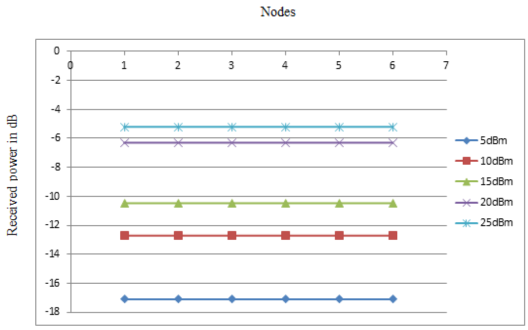

Figure 5: Relationship between received powers at different nodes with variable input power

The value of received power is observed at different nodes with variable inputpower and observed that with increase in input power the received power also increased.

5.3 Relationship between data rate and Q Factor

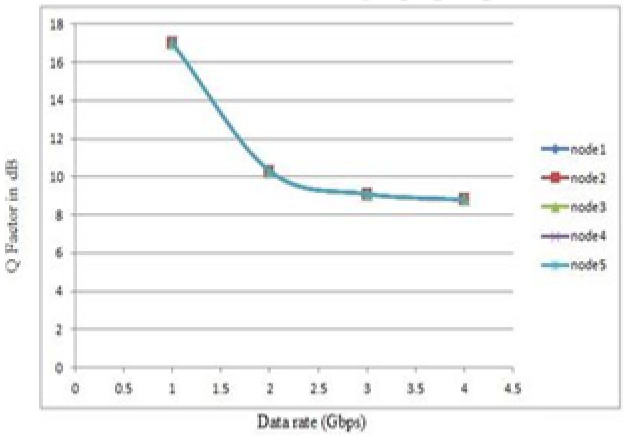

Figure 5: Relationship between data rate and Q Factor at different nodes

The value of Q Factor is observed at different nodes with variable data rate and observed that with increase in data rate the Q Factor get decreased.

6. Conclusion

Optical network topologies such as bus, star and tree reduce complexity by using minimum number of couplers, multiplexers, demultiplexers and optical amplifiers and can reduce cost in large network. Star is the topology in which each of the nodes of the network is connected toa central node with a point-to- point link. The performance of star topology is investigated and identified that, for star topology the optical power is distributed equally to all output nodes. As the internode distance increases Q Factor decreases and BER increases. Maximum number of users supported by star topology is less than 64

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