An Evaluation of Network Topologies for Enhance Networking

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ABSTRACT
A network is the interconnection of two or more devices. The study of arrangement or mapping of elements (links, nodes) of a network is known as network topology. For communication distribution of computers has become very important issue which deliver end to end performance at a low cost, hence distribution system performance is influenced by the technology adopted by network interconnection so distribution of computers is done according to communication network arranged in a geometrical manner known as network topology. This paper provides a proper study of different types of basic network topologies on the basis of their advantages, disadvantages, different factors which differentiate them, literature review on the different network topology, and the methodology of the different network topology and its efficiency in the betterment and improvement in the area of data transmission for a better future.

Keywords
Key Words: Network Topology (Bus, star, ring, mesh and tree), advantage, disadvantage and hybrid topology.

1. INTRODUCTION
In computer network two or more computers are linked together through a medium and data communication devices for the purpose of communicating data and sharing resources. Also, networking is referred as connecting computers electronically for the purpose of sharing information. Resources such as files, applications, printers and software are common information shared in a networking. The advantage of networking can be seen clearly in terms of security, efficiency, manageability and cost effectiveness as it allows collaboration between users in a wide range. Basically, network consists of hardware component such as computer, hubs, switches, routers and other devices which form the network infrastructure. These are the devices that play an important role in data transfer from one place to another using different technology such as radio waves and wires.

2. LITERATURE REVIEW
What is Topology?
The term topology in communication network refers to the way the computers or workstations are linked together in the network. Two basic categories of network topologies:

- Physical topology
- Logical topology

The physical topology and its capabilities are determined by network active devices and media like cable type(s), the level of control or fault tolerance desired, and the Capex/Opex costs related to its passive and active infrastructure.

The logical topology in contrast, is 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 without regard to the physical interconnection of the devices. A network's logical topology is not necessarily the same as its physical topology. For example, the original twisted pair Ethernet using repeated hubs was a logical bus topology with a physical star topology layout. Also, Token Ring is a logical ring topology, but is wired as physical star topology from the Media Access Unit. The logical classification of network topologies generally follows the same classifications as those in the physical classifications of network topologies but describes the path that the *data* takes between nodes being used as opposed to the actual *physical* connections between nodes. The logical topologies are generally determined by network protocols as opposed to being determined by the physical layout of cables, wires, and network devices or by the flow of the electrical or optical signals, although in many cases the paths that the signals take between nodes may closely match the logical flow of data, hence the convention of using the terms *logical topology* and *signal topology* interchangeably. Logical topologies are able to be dynamically reconfigured by special types of equipment such as routers and switches

(John, P and Timo P., 2014).
The basic types of network topologies are: Bus Topology, Star Topology, Ring Topology, Mesh Topology and Tree Topology. Although there are many types of networks available in the networking industries which is not listed above and the most common network are Local Area Network (LAN) and Wide Area Network (WAN). LAN network is made up of two or more computers connected together in a short distance usually at home, office buildings or school. WAN is a network that covers wider area than LAN and usually covers cities, countries and the whole world. Several major LAN can be connected together to form a WAN. As several devices are connected to network, it is important to ensure data collision does not happened when these devices attempt to use data channel simultaneously. A set of rules called Carrier Sense Multiple Access/Collision detection are used to detect and prevent collision in networks

(Saravanan, A. M., 2012)

2.1 PHYSICAL AND LOGICAL APPLICATION OF COMPUTER NETWORKS
The physical and logical application of computer networks in the real world is describe here, also the management tools which can be applied to manage the computer infrastructures is

also explained .

Defining an IT-network

Networks connect computers to one another, through a combination of hardware and software, sharing information and peripherals in an economical and efficient manner. The computers or other devices which are connected via the network are known as nodes. The network allows geographically distant computers to share information with one another, as well as allow multiple users to share one or more devices. A network can also be defined as a collection of independent computers, interconnected by a single technology. Two computers are described to be connected when they are able to exchange information

(Tanenbaum, 2003; Naugle, 1994).

Different types of networks exist. The smallest is the local area network (LAN), which is normally privately owned networks within a single building or campus up to a few kilometers in size. They are widely used to connect personal computers and workstations of a company which share information and resources. A metropolitan area network (MAN) covers a city, such as a cable television network. Another type of network is a wide area network (WAN), which spans a large geographical area, usually a country or continent. These are normally owned by a service provider such as a telephone company. Networks can be connected to one another through machines called gateways, which translates information in terms of hardware and software, thus creating the internet. The internet essentially connects different networks to one another, creating a global connected environment (Tanenbaum, 2003).

Due to the fact that the Potchefstroom campus implements a LAN, only the LAN network will be examined, in order to create a greater understanding of how the network is employed, what hardware is used, and how it is maintained.

2.2 Local Area Network Topologies

In terms of network layout and connectivity, the term topology describes the physical configuration of a network. There are 4 main topology types of IT networks. It must be noted that these types are purely theoretical and used as a foundation model to describe the 6yhnetworks. In reality, networks do not often fall in single types. It is the nature of networks to combine different technologies and architectures to form hybrid designs (Naugle, 1994; Serumaga-Zake, 2006).

The Star topology is also known as a wiring hub. As seen in Figure 2.1, it consists of a central hub (switch), which is connected to all the nodes. In this context the nodes represent the device, which can send and receive information, and is part of the network. The topology has no single failure point which will affect the network, except for the hub itself. This is one of the most popular topologies, and allows for efficient network management (Tanenbaum, 2003; Naugle, 1994).

As seen in Figure 2.1, the Ring topology encloses all nodes in a loop and considers them as repeaters. A repeater can both receive and transmit information. If a station receives information which is not intended for it, it re-transmits the information downstream. If a single station is down or removed from the network, it can affect the whole network (Tanenbaum, 2003; Naugle, 1994).

- The Bus topology consists of a single shared length of cable, to which all nodes are connected (Figure 2.1). This topology is also known as a linear topology. The network terminates at the endpoints and has no closed loop. If the cable is damaged at any point, all the attached nodes are removed from the network. The bus topology is normally used for Ethernet networks (Tanenbaum, 2003; Naugle, 1994).

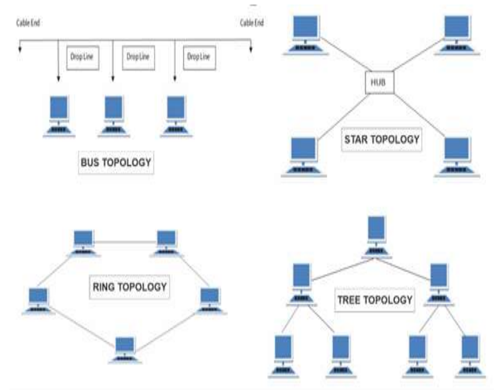


Fig. 1 Various Types of Network Topologies

Nivedit and sapan, 2015

Figure 1: structure of different network topologies (Nivedit and sapan, 2015)

The Tree topology is a generalization of the bus topology. As seen in Figure 2.1, this topology has a hierarchical undertone. It has a root point (normally a central hub/switch), from which all branches stem. There are no loops in the network, which means there is only a single data path to any endpoint on the network. If a network error occurs at a certain node in the network, all the dependent nodes down the hierarchy are disconnected from the network (Tanenbaum, 2003; Naugle, 1994).

When designing a network, it is very important to include precautionary measures to prevent a total network failure in the event that certain elements cease to work. An example of this is to ensure that a back-up central hub is in place, should the primary hub go down, when a star topology is implemented. Another example, when designing a ring topology, would be to ensure that when one station is terminated, the data flow can continue in the opposite direction (Tanenbaum, 2003; Naugle, 1994).

2.3 Cable topologies for buildings

There are various ways of wiring a building. As mentioned above, some network topologies do exist for the general network, but other topologies, specifically created to help with the wiring design inside of a building also exist. The simplest building cable topology is the linear building topology. This schema consists of a single cable, snaked through each room, where each device connects to it at the nearest point. This is a bus topology (Naugle, 1994).

The backbone topology consists of a thick cable running vertically through a building (backbone). Thinner cables connect to the backbone on each floor via repeaters and spreads throughout the floor to the nodes. A repeater is a device which receives the signal, amplifies it, and then retransmits it to the destination. A repeater is also known as a concentrator. Repeaters overcome the cable length limit and the maximum attachments limit by extending the physical topology of the network (Naugle, 1994; Tanenbaum, 2003; Serumaga-Zake, 2006).

The most popular building topology is the tree-network. This is a hierarchical network where hubs are used to redirect the transmission to the right destination down the hierarchy. The transmission may pass through a couple of switches up or down the hierarchy, but ultimately each destination has one path (Naugle, 1994).

2.4 Network hardware

A network consists of a variety of different connected hardware types. One of the most important of all the hardware types is cables. Cables are responsible for connecting different types of hardware and devices over long distances. The term "Ethernet" refers to the cables in a network. There are mainly five different types of cables used in networks. The implementation of each largely depends on the geographical scale of the network, the potential data carrying capacity needed and the number of connected features. It is common for a network to implement the use of more than one type of cable. The five most commonly used cables are depicted in Table 2.1 (Naugle, 1994; Tanenbaum, 2003; Serumaga-Zake, 2006).

The thick coaxial cable (10BASE5) also known as thick Ethernet was the original network cable, but since the latest cable releases, have become obsolete. It had a maximum data carrying capacity of 10 Mbps. More recent cables are able to cover greater distances and carry much more data. The next to follow was the thin coaxial cable. It was much cheaper and easier to install than its predecessor, but the maximum length of a segment was only 185 m and could only accommodate 30 machines. Detecting cable breaks in one of the coaxial cable systems was hard, which drove the cable industry to develop a new kind of wiring pattern (Naugle, 1994).

Table 1 The Five Most Commonly used cables

Cable type	Standard name	IEEE name	Maximum length (m)	Maximum speed (Mbps)
Multi-mode optical fiber	1000 BASE Sx	IEEE 802.3 z	550	1000
Single-mode optical fiber	1000 BASE LX	IEEE 802.3 z	10000	1000
Category Se Unified twisted pair (UTP)	100 BASE T	IEEE 802.3 u	100	100
Thick coaxial cable	10 BASE 5	IEEE 802.3	500	10
Thin coaxial cable	10 BASE 2	IEEE 802.3a	185	10

This new system consisted of every machine connecting a cable to a central hub, in which they are all electrically connected, as if they were fused together. Due to the fact that each node has its own cable, each one can easily be added or removed, which simplifies break detection vastly. The cable type for this design is unshielded twisted pair (UTP). This is the same type of cables used by telephone companies. UTP cables can be sub-divided into categories. Category 3, 4, and 5 cables can transfer data at 10, 16 and 100 Mbps, respectively

(Naugle, 1994; Tanenbaum, 2003).

A fibre optical cable is the final cable type. The cable consists of ultra-thin fibre of glass inside the cable, angled at such a degree that when a pulse of light is injected into the cable, none of the light escapes. The transmission medium has both a light detector and light source on either side of the cable. The light source accepts electrical binary pulses as input, converts it into light pulses and sends it along the fibres. The detector generates an electrical pulse when light falls on it, and converts it to an electrical pulse as output. The expensive fiber optic cable segments can stretch for kilometers and is therefore mostly used for long distances between buildings**.** There are different types of optical fibre cables, including the multi-mode optical fibre cable and the single-mode optical fibre cable. The multi-mode optical fibre has a maximum length of 550 meters, while the single-mode optical fibre has a maximum length of 10 kilometers (Naugle, 1994; Tanenbaum, 2003).

A repeater is another hardware type that is occasionally present in a network. As mentioned before, repeaters extend the physical topology of the network by extending the number of potential attachments and maximum length of cable segments. For instance, four repeaters on a 10Base5 cable will lengthen the maximum length from 500m to 2500m. In short, repeaters make it possible for a greater number of nodes to connect to a single cable. A cable segment may have a maximum of four repeaters before the signal strength weakens

(Serumaga-Zake, 2006).

There are different types of switching devices; each with its own diverting and collision management parameters, but in essence performs the same task. Switching devices can interrupt a current in a data conducting cable, and redirect the transmission to another conductor, thereby expanding the network into different branches. These devices include repeaters, hubs, switches, routers and gateways. For the purpose of this study all switching devices will be referred to as switches. Some other devices which take part in the network are:

- Ports (also known as Terminals): These are all the sources and destinations in the network.
- Hosts: Hosts are large computers serving many users, providing computing capabilities or access to a database. They are also known as servers or sources.
- Multiplexors and concentrators join the traffic of low-speed lines into a single stream, which can use a higher speed line (Serumaga-Zake, 2006).

It is not mandatory for all of the above-mentioned hardware to be present in a network. Most networks, such as the one used as the main focus of this study, implement a combination of the various hardware types (Serumaga-Zake, 2006).

3. METHODOLOGY

In this section we are going to discuss on the methodology for network topology design considering the problems of single link failure and single node-failure tolerances.

The Problem Considered

The problem of network topology design considered in this article is illustrated in Figure 1 as a *process* with *objectives, input* requirements, *methodology,* and output of *target* results. The objectives aim at a network topology with minimum cost, reliability considering both single link-failure and single node-failure tolerances and *performance* related to delay constraints at the link level, path level, and the overall network level. The input requirements of the suggested process include a number of issues related to the location of sites or nodes, traffic load between sites, reliability requirements concerned with single link and single node failures, given delay limits and cost elements. Table 1 briefly describes the various factors associated with the input issues. The target results of the suggested process include factors related to: distance between nodes, connections between nodes, traffic flow, capacity of the links, network performance and the cost of links. Table 2 describes various factors of these issues.

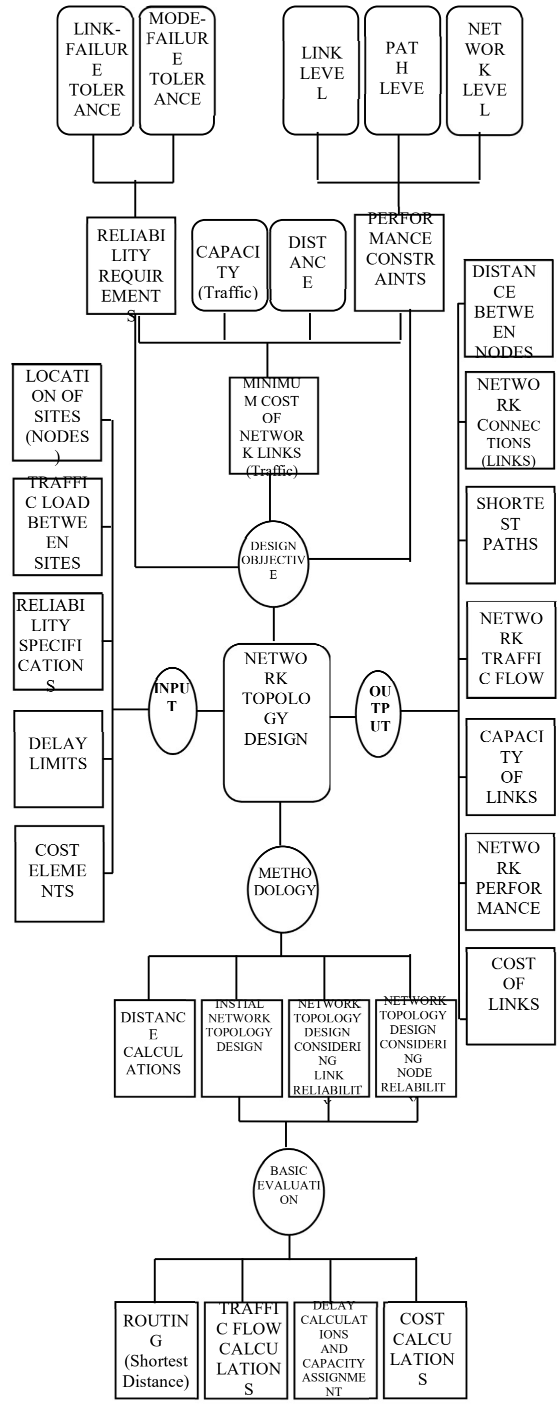
For obtaining the target output considering the objectives, and the given input parameters, a new design methodology has been developed. As shown in Figure 1, the suggested methodology is concerned with the following four main tasks:

(1) Calculations of the distances between every pair of nodes [i j], so that the lengths of all potential links are known. The equations used for this purpose use longitude (L[i]) and latitude (G[i]) of the nodes concerned2 and are given in Table ***3.***

(2) Developing an initial network topology with minimum cost, but with no reliability considerations.

(3) Upgrading the initial topology to obtain single link-failure tolerance (i.e., if a single link in the network fails, the network should remain connected and each node should be able to communicate with every other node).

(4) Improving the resulting topology further to achieve single node-failure tolerance (i.e., if a single node in the network fails, the network should remain connected without that failed node and each node should be able to communicate with every othe



Fig, 2 Class diagram of a network topology

The tasks of (2)-(4) use the shortest-path algorithm to choose the routes between each pair of nodes H[i,j], and to compute the number of hops in each route. In addition, it involves calculations concerned with the following

- Traffic flow calculations

Network traffic flow	Data flow through a link Message flow through link Average message length through a link Average number of hops per message	DF(k) F(k) M(k) AH	Data flow through link (k) (bps) Message flow through link (k) (message/s) Average message length through link (k) (bits)
Capacity of links	Capacity of a link Total capacity of all links	C(k) C	Capacity of link (k) (bits/s) $C = \sum C(k)$
Network performance	Link delay	LD(k)	Delay through link (k) (s)
	Path delay	PD(l)	Delay through the path from node i to node j (s)
	Overall average network delay	AD	Average message delay at the network level (s)
Cost	Cost of a link Total cost of link	CL(k) CL	Cost of link (k) (unit [price) $CL = \sum_{k=1}^{N} CL(k)$

Table 2: The input issues and factors concerned with the general process of network topology design

- Delay calculations
- Cost calculations.

Table **3** gives various factors concerned with these calculations together with the necessary equations. Figure **2** presents a general flowchart of the suggested methodology showing the input, the main tasks of methodology **(1)-(4),** (c) and (d),

Table 3: Basic calculations required by suggested methodologies

Calculation	Factor	Equations
Distance (between nodes I and j)	D(I,j)	$D(i,j) = arcos\{\{\sin(G(i))\}\} + \{\cos(G(i)) \cos(G(j)) * \cos(L(j))\}\} * 6371.256(km)$
Traffic flow	DF(k)	$DF(k) = \sum_{j=1}^{N}\sum_{j=1}^{N} S(i,j)M(i,j)$
	M(k)	M(k)=$\frac{DF(k)}{F(k)}$
	AH	

In the following section the procedures developed to perform the topology design requirements of **(2)-(4)** using the shortest-path algorithm3 and the equations of Table **3** are described.

Topology Design Procedures

The initial Topology

The procedure Concerned with developing the initial topology, characterized by minimum cost and no reliability constraints, has the following four main steps:

- **Step 1** is concerned with choosing the most important pair of nodes and providing a connection between them. The chosen criterion considered is related both to traffic flow and distance as described mathematically in Table 4. The importance of the pair of nodes is considered proportional to the traffic flow and to the inverse of the distance between them.
- **Step 2** is concerned with choosing the most important node to be connected next to the current state of the network topology. The choice criterion considered depends, as in **Step 1**, both on traffic flow and distance as well as on the current state of the network topology design. This is explained in Table 4.
- **Step 3** is concerned with choosing the cheapest link *to* connect the node chosen in **Step 2** to the current state of the network topology.The criterion considered here is related to obtaining minimum cost of network links, as stated in the objectives of Figure 1. Cost calculations depends on link capacity which in turns depend on routing, traffic flow and delay. Table **4** explains the problem of this step and Table ***3*** shows the equations needed to perform the required task.

Step 4 asks for the repetition of Steps 2 and 3 for all the nodes that are not yet connected to the current state of the network topology design

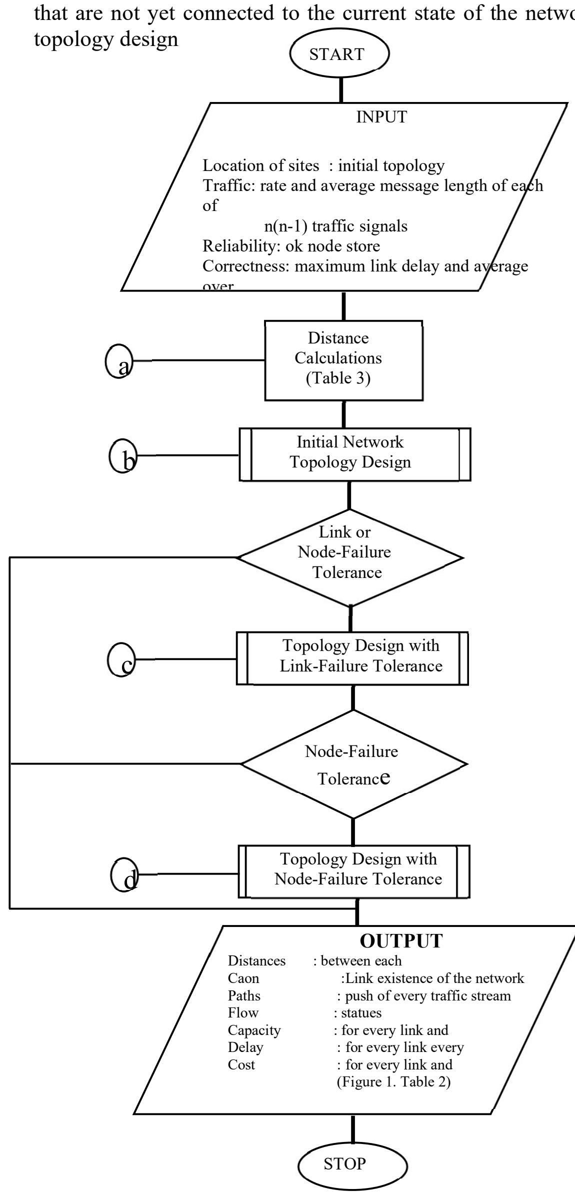


Figure 3: Network Design Methodology

Step	Problem	Factors concerned
1	Preparing the links for reliability considerations	Cost of link Cl(k) for all k
2	Checking the link failure tolerance of a link (current link according to the order of the list produced by Step 1)	Current state of network topology (CNT)
3	Choosing the cheapest link to connect G1 and G2 (to provide link-failure tolerance for the link considered)	(See factors of step 3 in Table 4)
4	Repeat Steps 2 and 3 until all links in the list are taken into account	

Criteria
Sort links in a list of descending order according to their cost (Cost is computed in the previous procedure according to the cost function of Table 3)

- Delete the link
- Check disconnectivity
- If network is disconnected from G1 & G2:

Return the link: and proceed to Step 3
ELSE return the link: and repeat Step2 for the next link

Figure **3** shows a flowchart that implements the above steps of the initial topology design procedure. One important part of the flowchart is concerned with link capacity assignment considering the delay criteria of the design objectives. Figure 4 shows the flowchart used for the capacity assignment, and this is based on references 5. Starting with a minimum link-capacity of 1200 bps, the capacity is incremented to the next available capacity if any delay limit specified by the user is not met. The link capacities considered for analog channels are 1200,2400,4800,9600 and 19,200 bps; while for digital channels they are the 64 Kbps and the T1 channel (1.544 Mbps).

Link-failure Tolerance
The above procedure designs a network topology with minimum cost, but without considering the reliability requirements stated in the objectives shown in Figure 1. In the following, a procedure that improves the initial topology of the previous procedure to tolerate single link-failure is presented. This procedure includes the following four main steps:

- *Step* **1** is Concerned with sorting the links of initial topology in a list of descending order according to their cost. This step prepares the links for reliability consideration in the order of their importance. Table 5 provides further explanation of this step. This means that the link with highest cost is selected first.

Step **2:** Let γ and δ be the nodes connected by the selected link. This step is concerned with checking the reliability of the current link (according to the order of Step 1). This is done by deleting the current link and checking whether the network is disconnected from two subnetworks G1 and G2 (such that node γ belongs to G1 and node $\boldsymbol{S}$ to G2). If the network is disconnected, the process continues to Step **3.** Otherwise, the network topology is considered to enjoy single link-failure tolerance with respect to that link and Step 2 is repeated for the link with the next lower cost. In both cases, the deleted link should be returned to its original position. The network connectivity is checked using a depth-first search procedure which has the computational complexity $O(n^2)$ for n nodes (Roberts,1984).

Step **3** is concerned with choosing a connection that connects a node α in G1 with another node β in G2, such that $\alpha \neq \gamma$, $\beta \neq \delta$, and the link connecting α and β gives minimum network cost. It is interesting to note that the newly added link is going to change the routing paths between nodes and, consequently, the capacities and delays on various existing links will be affected. This new connection would ensure single link-failure tolerance for the link considered.

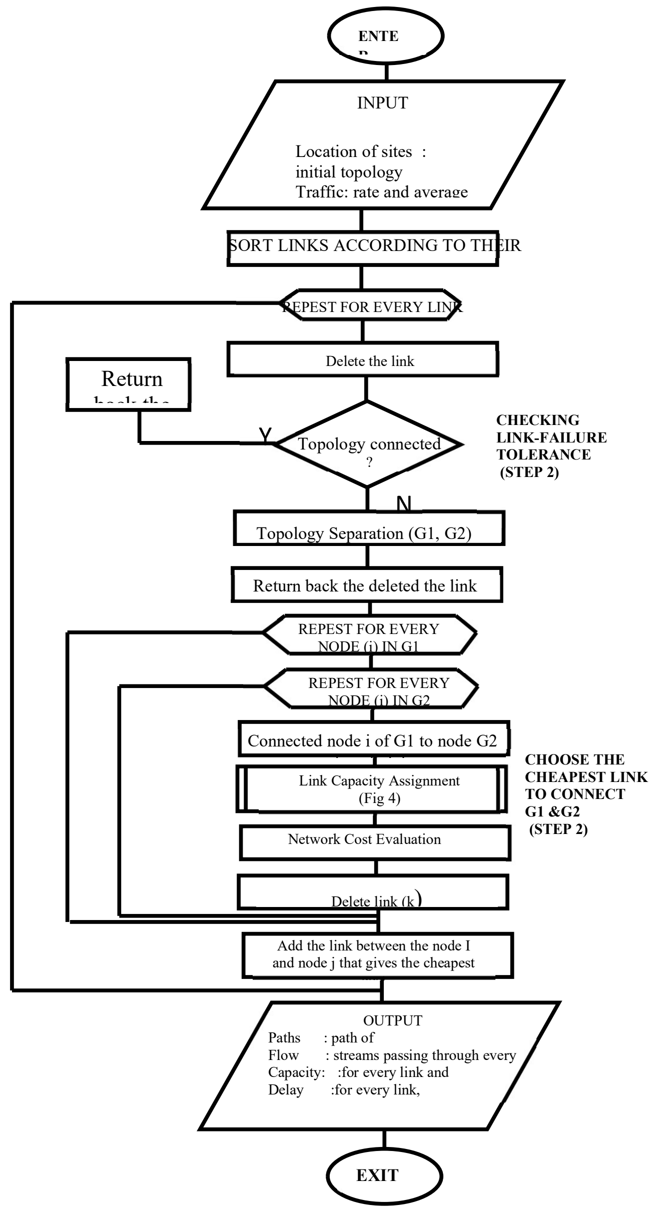


Fig 4: Initial Network Topology Design Procedure

Step 4 is concerned with considering the next link in the list provided by Step 1, and repeating Steps 2 and **3** until all links in the original list are takeninto account. Figure 5 shows a flowchart of the single link failure is shown below.

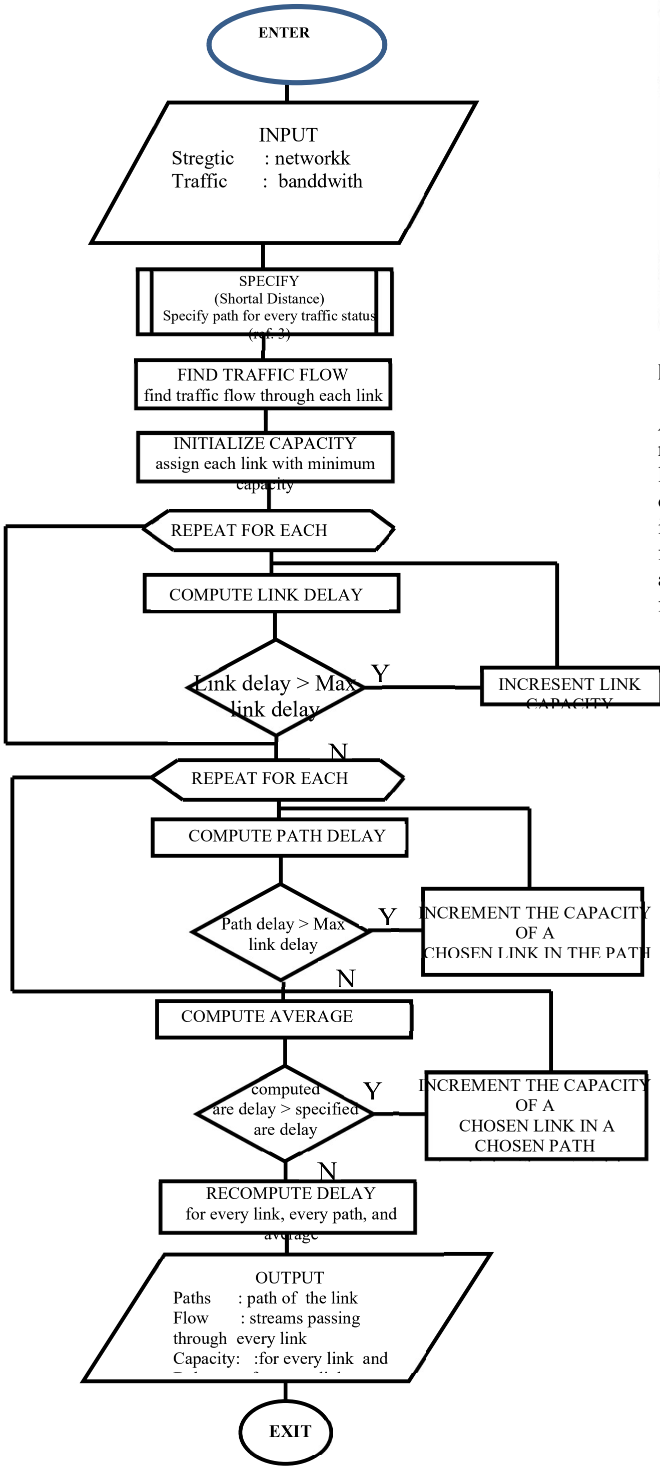


Fig 5: Procedure use for Link Capacity Assignment

Tolerance procedure, with further details of the above step.

Table 4: the basic steps of the link tolerance procedures

Step	Problem	Factors concerned	Criteria
1	Preparing the links for reliability considerations	Cost of link Cl(k) for all k	Sort links in a list of descending order according to their cost (Cost is computed in the previous procedure according to the cost functionof Table 3)
2	Checking the link failure tolerance of a link (current link according to the order of the list produced by Step 1)	Current state of network topology (CNT)	• Delete the link • Check disconnectivity • IF network is disconnected from G1 & G2: Return the link; and proceed to Step 3 ELSE return the link; and repeat Step 2 for the next link
3	Choosing the cheapest link to connect G1 and G2 (to provide link-failure tolerance for the link considered)	(See factors of Step 3 in Table 4)	(See critera of Step 3 in Table 4)
4	Repeat Steps 2 and 3 until all links in the list are taken into account		

link and Node Failures Tolerance-

As a result of the above-mentioned procedure, the designed network topology enjoys single link failure tolerance but it still lacks the single node failure tolerance as needed in the objectives shown in Figure 1. In the following, a procedure that improves the designed topology further, so that single node-failure tolerance along with single link-failure tolerance is achieved, is described (Figure **6).** The procedure has the following five main steps:

- Step 1 is concerned with sorting the nodes of the resulting topology in a list of descending order according to their traffic throughput. This step prepares the nodes for single failure tolerance consideration in the order of their importance. Table **6** provides a further explanation of this step.
- Step 2 is related to checking the node-failure tolerance of the currently selected node, γ (according to the order of Step 1). This is done by deleting the selected node, together with all the links connected to it, and checking whether the remaining nodes are partitioned into two subnetworks, G1 and G2. If the network is disconnected, the process should continue to Step ***3.*** Otherwise, the network topology is considered to enjoy single node failure tolerance with respect to that node, and Step 2 is repeated for the next node. In both cases, the deleted node should be returned together with all of its deleted links. The network connectivity is checked using a depth-first search procedure (Roberts,1984).
- Step **3** is concerned with choosing a connection that connects a node α in G1 with another node β in G2, such that $\alpha \neq \gamma,\ \beta \neq \delta,$ and the link connecting α and β gives minimum network cost. It is to be noted that the newly added link is going to change the routing paths between nodes and, consequently, the capacities and delays on various existing links will be affected. This new connection would ensure single node-failure tolerance for the node considered.
- Step 4 is Concerned with considering the next node in the list provided by Step 1, and repeating Steps 2 and ***3*** until all nodes are taken into account. Step 5 is related to deleting some redundant links that might have been introduced in the design process in Steps 1 to 4. Specifically, we sort the links of the resulting

topology (from **Step 4)** in a list of descending order according to their link cost. We start with a link with -Single link-failure tolerance (for all other highest cost, temporarily delete it, and check for the following conditions:

- Network connectivity
- Single links tolerance (for all links except the one selected)
- Single node-failure tolerance (for all nodes)
- The delay limits.

Software implementation of Methodology

For the implementation of the network topology design methodology considered above, a software package has been developed. The package has the following salient features:

- Software development in standard C language
- Portability on different hardware platforms
- Source code availability
- Software maintenance and update by the user.

The software development was done using standard ANSI C language so that the package can be compiled on any hardware platform that supports an ANSI C compiler to produce executable binary files. The choice of C language was mainly due to the fact that the language offers economy of expressions, control flow and data structures, a rich set of operators, and its use of dynamic memory allocation and pointers. The package utilizes memory efficiently by using linked lists for sparse matrices of large sizes. The limitation on the size of the network (i.e., number of nodes or links) is only determined by the resources (e.g., memory) of the computer used for topology design. The package was compiled on an IBM PC (80486) using a Turbo C compiler, and also on a SUN Spar classic workstation (running Solaris **2.3)** using a Sparc C compiler.

4. DISCUSSION OF THE RESULT

Here study of different basic topologies is done for different parameters. The installation shows easy or difficult for different topologies. Cost is defined as the requirement of cable as expensive or not. Flexible represents the modification in the network either yes or no. Reliability is based on failure defined as high, low and moderate. Extension of the topologies based on the addition of computers and at last robust resembles to the ability of the connections between nodes.

Table 5: Analysis of Different Topologies

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

For a fixed set of nodes, the resulting topology from the software package is dependent upon various factors, such as traffic load and delay limits. A change in one of these factors may result in a different topology such that overall cost of the network is minimum. A simple solution to provide single link- and node failure tolerance to a network is to join nodes in a ring; but doing this arbitrarily may not result in a topology with minimum network cost. Furthermore, we need to meet the delay criteria, which may not be possible with this simple method.

Firstly we have done analytical study of different basic topologies which provide us a brief idea about each topology and their features. Each topology has some advantages and disadvantages. Secondly the work presented in this paper has served purpose that is, it has provided a software package based on a new methodology for the design of network topology with single link-failure tolerance and single node-failure tolerance. including distances between sites (nodes), delay constraints at the link, path and network levels, practical capacity for the links, cost criteria, and link and node failure tolerances. The package implementing the methodology is of flexible modular construction, and is written in the C programming language. The package can be compiled and run-on variety of hardware platforms. This is particularly useful to students, researchers and professionals in the field. The application presented is valuable both in demonstrating the use of the package and in providing useful results for the future improvement of network topology.

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