

Review and proposal on the design of LAN for University campus with security system using cisco packet tracer

¹P Mahesh Kumar, ²Thogarchiti Ram Mohan, ³Gundreddy Sainath Reddy, ⁴Vemalaraju Nagendra Varma and ⁵Vallem Vara Prasad Reddy, ⁶Narbada Prasad Gupta.

^{1,2,3,4,5} Students, ⁶Professor, Lovely Professional University, Phagwara, Punjab.

Abstract

Computer network has become the most significant issue in our day-to-day life. Networking companies depend on the proper functioning and analysis of their networks for education, administration, communication, e-library, automation, etc. Mainly, interfacing with the network is induced by one user or all the users to share some data among them. So, this paper is about the communication among users present at remote sites, sharing the same University Area Network Scenario. So, in this work, the network is proposed to be designed using Cisco Packet Tracer, which describes how this tool can be used to develop a simulation model for the University network. Various literatures have been reviewed regarding the technology being used and its security aspect. This study provides in-depth of various concepts such as network topology, IP address configuration and sending information in the form of packets in a single common network. It also provides the details of how to use virtual Local Area Network (VLANs) to separate the traffic generated by different departments keeping in mind the information security.

Keywords: computer networks, IP addresses, ping test, Cisco Packet Tracer, VLANs, Router.

I. INTRODUCTION

The word “digital” is very significant in today’s world, with an increase in the development of technology the entire world is moving towards the digital era. The educational institutions play an important role in this digitalization. Hence, the campus should adapt to digital means of networking and become a “digital campus”. Going wireless plays an important role in this digitalization. The wireless network makes the connection easy with a reduction in the use of wires or cables. A wired connection makes it difficult to keep track of all the devices and to manage the cable connection, which is not only chaotic but also challenging to handle [1]. Campus networking via wireless connection becomes an important part of campus life and provides the main way for teachers and students to access educational resources, which gives an important platform to exchange information. As laptops and intelligent terminals are widely used, demand for access to information anytime and anywhere has become more and more urgent, but traditional cable networks cannot meet this requirement. Then wireless network construction becomes necessary and essential. The wireless network is one of the important components of a digital campus and wisdom campus. It provides an efficient way to explore the internet with a mobile terminal for teachers and students regardless of cables and places [7]. This is an important mark of the modern campus as a supplement of a cable network. With the development of network and communication technology, cable networks on a university campus bring much convenience for teaching and research work. But for mobility and flexibility, it has obvious shortcomings. A wireless network can overcome these drawbacks and has been applied to the university campus [3]. There are five types of topology in computer networks:

- Mesh Topology
- Star Topology
- Bus Topology
- Ring Topology
- Tree (Hierarchical) Topology

Mesh Topology

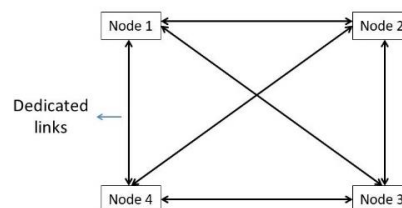


Fig 1: Mesh Topology

The figure 1 shows the Mesh topology. In this topology, each device is connected to every other device on the network through a dedicated point-to-point link. Dedicated means the link only carries data for the two connected devices only. If there are n number of devices in the network, then each device must be connected with (n-1) devices of the network. Number of links in a mesh topology of n devices would be $n*(n-1)/2$.

Advantages of Mesh topology

- No data traffic issues as there is dedicated link between two devices which means the link is only available for those two devices.
- It is reliable and robust as failure of one link doesn't affect other links and the communication between other devices on the network.
- It is secure because there is a point-to-point link thus unauthorized access is not possible.
- Fault detection is easy.

Disadvantages of Mesh topology

- The amount of wires required to connect each system is tedious.
- Since each device needs to be connected with other devices, number of I/O ports required must be huge.
- It has scalability issues because a device cannot be connected with large number of devices with a dedicated point to point link.

Star Topology

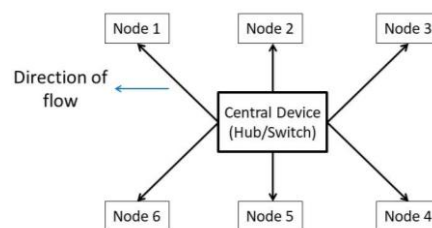


Fig 2 : Star Topology

The figure 2 shows the Star topology. In this topology each device in the network is connected to a central device called hub. Unlike Mesh topology, star topology doesn't allow direct communication between devices, a device must have to communicate through hub. If one device wants to send data to other device, it has to first send the data to hub and then the hub transmit that data to the designated device [3].

Advantages of Star topology

- Less expensive because each device only needs one I/O port and needs to be connected with hub with one link.
- Easier to install.
- Less amount of cables are required because each device needs to be connected with the hub only.
- Robust, if one link fails, other links will work just fine.
- Easy fault detection because the link can be easily identified.

Disadvantages of Star topology

- If hub goes down everything goes down, none of the devices can work without hub.
- Hub requires more resources and regular maintenance because it is the central system of star topology.

Bus Topology

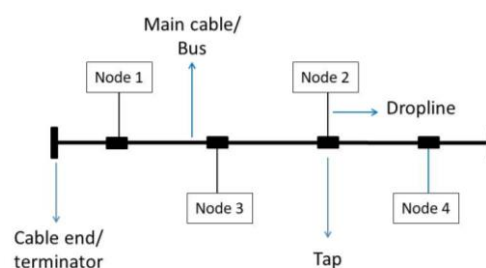


Fig 3 : Bus Topology

The figure 3 shows the Bus topology. In this topology there is a main cable and all the devices are connected to this main cable through drop lines. There is a device called tap that connects the drop line to the main cable. Since all the data is transmitted over the main cable, there is a limit of drop lines and the distance a main cable can have.

Advantages of bus topology

- Easy installation, each cable needs to be connected with backbone cable.
- Less cables required than Mesh and star topology.

Disadvantages of bus topology

- Difficulty in fault detection.
- Not scalable as there is a limit of how many nodes you can connect with backbone cable.

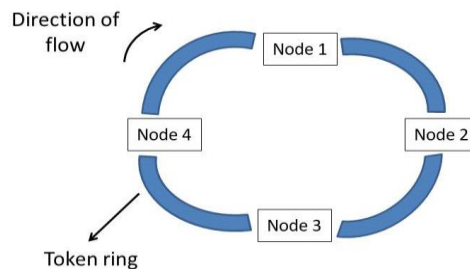
Ring Topology

Fig 4 : Ring Topology

The figure 4 shows the Ring topology. In this topology each device is connected with the two devices on either side of it. There are two dedicated point to point links a device has with the devices on the either side of it. This structure forms a ring thus it is known as ring topology. If a device wants to send data to another device then it sends the data in one direction, each device in ring topology has a repeater, if the received data is intended for other device then repeater forwards this data until the intended device receives it.

Advantages of Ring Topology

- Easy to install.
- Managing is easier as to add or remove a device from the topology only two links are required to be changed.

Disadvantages of Ring Topology

- A link failure can fail the entire network as the signal will not travel forward due to failure.
- Data traffic issues, since all the data is circulating in a ring.

Tree (Hierarchical) Topology

Tree topology is a computer network topology in which all the nodes are directly or indirectly connected to the main bus cable [7]. Tree topology is a combination of Bus and Star topology as shown in figure 5.

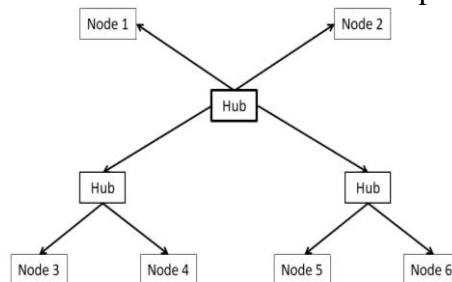


Fig 5 : Tree(Hierarchical) Topology

In this topology, the whole network is divided into segments, which can be easily managed and maintained. There is a main hub and all the other sub-hubs are connected to each other in this topology.

Following are the advantages of Tree topology:

- Large distance network coverage.
- Fault finding is easy by checking each hierarchy.
- Least or no data loss.
- A Large number of nodes can be connected directly or indirectly.
- Other hierarchical networks are not affected if one of them fails.

Following are the disadvantages of Tree topology:

- Cabling and hardware cost is high.
- Complex to implement.
- Hub cabling is also required.
- A large network using tree topology is hard to manage.

- It requires very high maintenance.
- If the main bus fails, the network will fail.

Hybrid topology

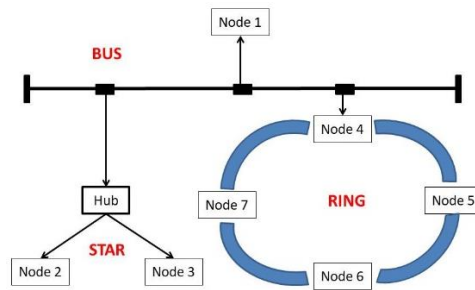


Fig 6 : Hybrid Topology

A combination of two or more topology is known as hybrid topology. For example a combination of star and mesh topology is known as hybrid topology [7].

Advantages of Hybrid topology

- The Choice can be made based on the requirement. For example, if scalability is the concern, then star topology can be used instead of bus topology.
- It is scalable as further connection is possible with other computer networks with the existing networks using different topologies.

Disadvantages of Hybrid topology

- Fault detection is difficult.
- Installation is difficult.
- Design is complex so maintenance is high thus expensive.

II. SECURITY

Security means preventing the unknown devices from forwarding packets and not allowing those devices to access the network. It is applied at various levels by using different security protocols as discussed below.

Access Control List (ACL):

It is a sequence or set of rules also called ACL entries. These rules specify the type of network traffic that can be passed or blocked through a router. ACLs are deployed at almost all points of entry in a private network and outside the network so that all the network traffic that is incoming and outgoing can be monitored. Different protocols can be used in ACLs like IPX, AppleTalk etc. A packet contains a limited number of fields such as source or destination port no., IP address, the source and destination protocols type etc. Every packet is matched with the rules of the ACL starting from the first rule and so on until it matches with the rule or the last Statement. This matching process decides how to apply the network security. The structure of a typical rule, using CISCO IOS notation might be: permit IP 10.1.2.0 0.0.0.255 host 10.2.2.1 eq. http 1362 Sharat Kaushik, Anita Tomar, Poonam. An ACL contains many rules and there can be conflicts between these rules such as redundancy, shadowing etc [9]. So, the ACLs must be managed carefully so that the conflicts can be resolved [9].

The Rule sets are generally composed of number of rules ranging from tens to five thousand [9].

TYPES OF ACLS:

Mainly two types of ACLs can be configured on the routers. These are as follows:

1. Standard ACL – This allows or denies packets based on IP address of source. Valid range of standard ACL IDs are from 1 – 99 or also can be a string [6].
 2. Extended ACL – This allows or denies packets based on protocol information and also based on IP address of source and destination. Valid range of extended ACL IDs are from 100 – 199 or also can be a string.
- Standard ACLs permit or deny packets based on source IP address. You can configure up to 99 standard ACLs. You can configure up to 1024 individual ACL entries on a device. There is no limit to the number of ACL entries an ACL can contain except for the system-wide limitation of 1024 total ACL entries.
 - Extended ACLs let you permit or deny packets based on the following information:
 - IP protocol
 - Source IP address or host name
 - Destination IP address or host name

Secure Shell (SSH) protocol

Created in 1995 by Tatu Ylönen, SSH protocol, known also as Secure Shell or Secure Socket Shell, is a network protocol that gives system administrators a secure way to access remote assets over an unsecured network. SSH provides password or public-key based authentication and encrypts connections between two network endpoints. It is a secure alternative to legacy login protocols (such as telnet, rlogin) and insecure file transfer methods (such as FTP). In addition to providing strong encryption, SSH is widely used by network administrators to manage systems and applications remotely, deliver software patches, or execute commands and move files [10].

How the SSH Protocol Works

Server (Host) Authentication

SSH protocol is built into Unix and Linux servers to enable secure connections between systems. The connection is established by an SSH client that intends to connect to an SSH server. The SSH client initiates the connection setup process and uses public key cryptography to verify the identity of the SSH server [10]. After the setup phase, the SSH protocol uses strong symmetric encryption and hashing algorithms to ensure the privacy and integrity of the data that is exchanged between the client and server.

III.LITERATURE REVIEW

Computer network has become the most significant issue in our day-to-day life. Networking companies depend on the proper functioning and analysis of their networks for education, administration, communication, e-library, automation, etc. Mainly interfacing with the network is induced by one of the other user/users to share some data with them.

This paper [1] is about communication among users present at remote sites, sharing this same network UANS. So, in this work the network is designed using Cisco Packet Tracer. The study provides into various concepts such as topology design, IP address configuration and how to send information in the form of packets in a single network and the use of virtual Local Area Network (VLANs) to separate the traffic generated by a different department. In this paper, a UANS (University Area Network Scenario) that uses networking topology implemented with concepts like VLANs in a multiple area networks using Cisco Packet Tracer. To design the network for UANS produces the substructure for all the service framework such as security of the network, wireless area network, operational efficiencies, virtual learning environments, and secure classrooms. In this paper [2] importance of information and accessing information as been discussed. With the advancement of technology, computers have entered in many areas of our lives. Computer networks and communication fields have become extremely important in our society. A campus area network is a very important part of campus life. Campus area network is a set of virtual local area network (VLAN), which covers the entire campus. In this paper described campus area network design approved by network device using Cisco packet tracer simulator software. This design also the hierarchical network design as a hierarchical design is used to group device into multiple layers.

Campus Network (CN) is a set of Virtual Local Area network (VLAN), which covers the entire university. To sophisticate the campus network service, this paper proposed Smart Campus Network Design (SCND) by integrating internet of thing device with classically network device in campus network and each smart device for different application must be registered to IOE server and controlled by legitimate user. To design the proposed campus network design, I used cisco packet tracer simulator software. To improve the campus network service, this paper proposed Smart Campus Network Design (SCND) by assimilating internet of thing device with classically network device. Each smart device registered to IOT server or home getaway and controlled by legitimate user. This paper [3] also include Hierarchical Network Design where it is used to group devices into multiple layers.

CNS Stands for the college network scenario. To Design the network outlook for the community college network scenario produces the substructure for all other exposure in the service framework such as security of the network, wireless area network, mobility as well as putting the justification to provide safety and security, operational efficiencies, virtual learning environments, and secure classrooms. This paper [4] describes the network design scenario approved by Cisco, as well as where we can apply these scenarios within the various locations of a community college network. Finally, key network foundation services such as switching, routing, multicast, and high availability are given for the full college network scenario. In this paper [5] a smart-devices are used in the network topology. A smart campus is a combination of VLANs (Virtual Local Area Networks) that provide coverage to the entire campus. In a campus network, it provides students, faculty and staff for various applications and to complete different tasks, so it needs to be designed beforehand. To enable this complex services, integration of Internet of things and Classic Network devices in the campus, this paper has been proposed. This is also termed as Smart Campus Network Design. In order to improve the service of the network, this paper proposed a conventional networking system to assimilate the Internet of Things. This network simulation can be implemented via hardware for actual working with extra constraints in place. Used cisco packet tracer simulator software to design the suggested campus network architecture.

Information technology is being used at numerous places fulfilling various purposes. Doing work at one place by professors and sharing it at another place either to faculty members and students becomes quite difficult. So this research work proposes a novel approach to communicate among various users that are present at different sites at the same time where at university premises network system is being proposed which would help departments to share information among faculty members and

students Proposed approach takes the help of sharing common network domain by DNS and applies heterogeneous BUS topology model to explore various concepts like topology design, creating dynamic host configuration protocol, sub net masking, DNS and VLAN within a single network with the help of Cisco Packet Tracer to make the network more secured and cost effective. The proposed approach helps in designing the network outlook for the university network that produces the different functionalities within a single network such as security of the network, wireless area network, mobility as well as restricting the access to limited users, operational efficiencies and a cost effective network. The template provided by this paper is applicable for any network, provided it is not too large. The network is fully featured with ISP, network administration, interconnection of various departments, VLANs for connection of Department Heads and wardens, network access for library using hubs; This paper [6] describes the network design scenario approved by Cisco, as well as where we can apply these scenarios within the various locations of a university network.

In this paper [7] College Network is a set of VLAN that covers the whole campus. Its application interface provided sustain different activities in the college and hence this network is to be designed in advance. This paper is proposed for advanced college network through integrating IOT devices with classical network device in college network and to design the proposed college network design we use Cisco packet tracer simulation software version 7.0. To improve the campus network service, this paper proposes advanced college network design (ACND) by integrating the IOT device with the classically available network device. The hierarchical design is used to group devices into multiple layers, and hence we have been effectively used the hierarchical design.

In this paper [8] VLANs are widely used to improve Ethernet scalability and support network policies. Using a lot of VLANs on campus networks has become popular for deploying many logical networks over minimal fibers/cables. In our study that VLANs are used for many objectives that they were not originally intended for, and are often ill-suited for the tasks further, the use of VLANs complicates network configuration management. Our analysis indicates that VLANs are used for many objectives that they were not originally intended for, and are often ill-suited for the tasks Further, the use of VLANs complicates network configuration management.

In this paper [9] they have configured a standard ACL (Access Control List) in a private network to provide security for the network by providing traffic flow control. It makes the router capable of performing the filtering of network packets which travels in or out of the router interfaces to increase the speed and performance of the server. It also restricts network usage by certain users or devices to enhance security.

This paper [10] shows the configuration of standard ACL and extended ACL on the router. The standard ACL create filters based on source addresses only and are used for server-based filtering, where as extended ACL provide more security by creating filters based on source addresses as well as destination addresses, protocol and port number. Routing Information Protocol (RIP) is used for routing the packets.

The below table describe the comparison between the above literatures :

Review Paper	Network Topology	Security	Wired/Wireless Network	Cost Effective (CE)
1	Star	No	Wired	No
2	Hierarchical	Yes (TELNET)	Wired	No
3	Hierarchical	Yes (TELNET)	Wired and Wireless	Less CE
4	Star	No	Wired	No
5	Star	Yes (TELNET)	Wired and Wireless	Less CE
6	Star	Yes(Switchport security and ACL)	Wired	No
7	Hierarchical	WEP/WPAPSW WPAL	Wired and Wireless	Less CE
8	Star	No	Wired	No

IV. SOFTWARE

Cisco Packet Tracer as the name suggests, is a tool built by Cisco. This tool provides a network simulation to practice simple and complex networks.

As Cisco believes, the best way to learn about networking is to do it.

The main purpose of Cisco Packet Tracer is to help students learn the principles of networking with hands-on experience as well as develop Cisco technology specific skills. Since the protocols are implemented in software only method, this tool cannot replace the hardware Routers or Switches. Interestingly, this tool does not only include Cisco products but also many more networking devices.

Using this tool is widely encouraged as it is part of the curriculum like CCNA, CCENT where Faculties use Packet Trace to demonstrate technical concepts and networking systems. Student complete assignments using this tool, working on their own or in teams.

Engineers prefer to test any protocols on Cisco Packet Tracer before implementing them. Also, Engineers who would like to deploy any change in the production network prefer to use Cisco Packet Tracer to first test the required changes and proceed to deploy if and only if everything is working as expected [2][3].

Workspace:

1. **Logical** –
Logical workspace shows the logical network topology of the network the user has built. It represents the placing, connecting and clustering virtual network devices.
2. **Physical** –
Physical workspace shows the graphical physical dimension of the logical network. It depicts the scale and placement in how network devices such as routers, switches and hosts would look in a real environment. It also provides geographical representation of networks, including multiple buildings, cities and wiring closets.

Key Features:

1. Unlimited devices
2. E-learning
3. Customize single/multi user activities
4. Interactive Environment
5. Visualizing Networks
6. Real-time mode and Simulation mode
7. Self-paced
8. Supports majority of networking protocols
9. International language support
10. Cross platform compatibility

V. CONCLUSION

Initially the discussions started with the word “digitalization” and in order to achieve that, an educational institute has been considered and proposed to design a network for a University, which is wireless. As we mentioned, mobility, and efficiency are the key aspects of wireless networks, which were our main goal, and hence, we decided to shift to a wireless network instead of a wired one, making our network clean and less chaotic.

In this paper, we proposed to design a University Network using Cisco Packet Tracer that uses a networking topology implemented using servers, routers, switches, and end devices in a multiple area network. We aimed to cover all the necessary features that are required for a network to function properly. We proposed to include a DNS server and a web server for establishing a smooth communication system between different areas of our network and specifically for the communication between students and teachers. We proposed to include an email server to facilitate intra university communication through emails within the domain. We proposed to use console passwords, ACL (Access Control List) and SSH protocol to ensure a safe and secure transfer of data.

VI. REFERENCE

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