## Simulation of Star topology using 16 nodes

**Team Members:**

1. [Rohan Rathod](mailto:2022.rohan.rathod@ves.ac.in)(Roll No. 42)
2. Hrishikesh Yenure(Roll No. 63)
3. [Ajay Thevar](mailto:2022.ajay.thevar@ves.ac.in)(Roll No. 57)

**Introduction:**

In the vast landscape of computer networks, topologies play a crucial role in determining the overall performance, scalability, and reliability of the system. Among the various network topologies, the star topology stands out as one of the most commonly implemented and efficient designs. With its central hub serving as the focal point of connectivity, the star topology offers numerous advantages, including simplified management, ease of expansion, and fault tolerance.

This project aims to explore and simulate the star topology using 16 interconnected nodes, delving into the intricacies of this widely adopted networking model. By leveraging modern simulation techniques and tools, we intend to analyze the behavior, evaluate the performance, and identify the strengths and limitations of a star-based network configuration.

The star topology comprises a central node, often referred to as the hub, that acts as the central point of communication for all other nodes in the network. Each node, known as a leaf node, connects directly to the hub, forming a point-to-point link. This centralized architecture facilitates efficient data transmission, easy troubleshooting, and simplified network management. Moreover, the star topology offers high scalability, enabling the addition or removal of nodes without affecting the overall network performance.

Through the use of simulation software, we will model a star topology consisting of 16 interconnected nodes. The simulation environment will allow us to simulate various network scenarios, including different traffic loads, node failures, and network congestion. By studying the behavior of this simulated star network, we can gain valuable insights into its performance characteristics, such as latency, throughput, and fault tolerance.

Furthermore, this project will explore the practical applications of star topologies in real-world scenarios. We will investigate how the star topology can be effectively utilized in different domains, such as local area networks (LANs), wireless networks, and Internet of Things (IoT) deployments. Understanding the strengths and weaknesses of star-based networks will help us make informed decisions when designing and implementing network infrastructures for specific use cases.

In conclusion, the simulation of a star topology using 16 nodes provides a valuable opportunity to delve into the inner workings of this popular network configuration. By analyzing its performance, scalability, and applications, we aim to enhance our understanding of the star topology's potential and identify areas for optimization and improvement. Ultimately, this project strives to contribute to the field of computer networking by providing valuable insights and recommendations for the design and deployment of robust and efficient network architectures.

**Objective:**

The objective of this project is to simulate a star topology using 16 interconnected nodes and investigate its behavior, performance, and practical applications. The specific goals include:

Simulation Modeling: Develop a comprehensive simulation model of a star topology with 16 interconnected nodes using suitable software or tools. This model will accurately represent the network configuration and enable the analysis of various network scenarios.

Performance Analysis: Evaluate the performance characteristics of the simulated star topology, including latency, throughput, and packet loss. Measure and analyze the network's response under different traffic loads, node failures, and network congestion scenarios.

Scalability Assessment: Investigate the scalability of the star topology by examining its ability to handle an increasing number of nodes while maintaining optimal performance. Determine the point at which the network experiences diminishing returns or performance degradation.

Fault Tolerance Evaluation: Assess the fault tolerance capabilities of the star topology by simulating node failures and analyzing the network's ability to reroute traffic and maintain connectivity. Identify potential single points of failure and propose strategies for enhancing fault tolerance.

Comparative Analysis: Compare the performance of the simulated star topology with other commonly used network topologies, such as bus, ring, and mesh. Identify the advantages and disadvantages of the star topology in terms of performance, management complexity, and scalability.

Practical Applications: Explore the practical applications of the star topology in real-world scenarios, including local area networks (LANs), wireless networks, and Internet of Things (IoT) deployments. Investigate the suitability of the star topology for specific use cases and provide insights into its optimal configurations.

Recommendations and Optimization: Based on the findings from the simulation and analysis, provide recommendations for optimizing the design and deployment of star-based networks. Propose strategies for improving performance, enhancing scalability, and strengthening fault tolerance.

By accomplishing these objectives, this project aims to enhance our understanding of the star topology as a network configuration. The insights gained from this study will contribute to the body of knowledge in computer networking and provide valuable guidance for network administrators, designers, and engineers in implementing efficient and robust network infrastructures.

**System Requirements:**

1. Hardware Requirements:

- Processor: Intel Core i5 or equivalent, with a minimum clock speed of 2.5 GHz or higher.

- RAM: Minimum 8 GB RAM or higher for smooth simulation performance.

- Storage: Sufficient free disk space to accommodate the simulation software, datasets, and logs.

- Network Interface Cards (NICs): Ethernet ports or wireless adapters to connect the nodes in the simulated network.

- Network Switch: A managed or unmanaged network switch capable of supporting 16 connections for the simulated star topology.

2. Software Requirements:

- Simulation Software: A network simulation tool such as Cisco Packet Tracer, GNS3, or NS-3, capable of modeling network topologies and simulating network behavior.

- Operating System: Windows, macOS, or Linux-based operating system that is compatible with the chosen simulation software.

- Simulation Tool Dependencies: Ensure the necessary software libraries, dependencies, and updates are installed to run the selected simulation tool effectively.

3. Network Configuration:

- IP Addressing: Plan and allocate IP addresses for each node in the simulated network. Ensure that each node has a unique IP address within the designated network range.

- Network Protocols: Decide on the network protocols to be implemented within the simulated star topology, such as TCP/IP, UDP, or specific application-layer protocols.

- Network Services: Determine the network services, such as DHCP, DNS, or firewall configurations, required for the simulated network.

- Network Security: Implement appropriate security measures, such as access controls, encryption, or authentication protocols, within the simulated network as per the project requirements.

4. Simulation Scenarios and Test Data:

- Define various simulation scenarios to explore different network conditions, such as varying traffic loads, node failures, or network congestion.

- Prepare test data or traffic patterns to generate realistic network traffic within the simulation.

5. Documentation and Reporting:

- Document the system setup, including hardware and software configurations, network topology diagram, and IP addressing scheme.

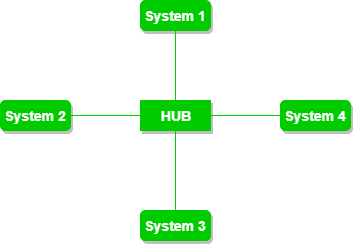
- Record simulation parameters, scenarios, and test results for future reference and analysis.

- Generate reports summarizing the simulation findings, performance metrics, and recommendations based on the observed results.

**Understanding Network Topology:**

* Network topology is the arrangement of the elements (links, nodes, etc.) of a communication network. Network topology can be used to define or describe the arrangement of various types of telecommunication networks, including command and control radio networks, industrial field buses and computer networks.
* Network topology is the topological structure of a network and may be depicted physically or logically. It is an application of graph theory wherein communicating devices are modelled as nodes and the connections between the devices are modelled as links or lines between the nodes. Physical topology is the placement of the various components of a network (e.g., device location and cable installation), while logical topology illustrates how data flows within a network. Distances between nodes, physical interconnections, transmission rates, or signal types may differ between two different networks, yet their logical topologies may be identical. A network’s physical topology is a particular concern of the physical layer of the OSI model.
* Examples of network topologies are found in local area networks (LAN), a common computer network installation. Any given node in the LAN has one or more physical links to other devices in the network; graphically mapping these links results in a geometric shape that can be used to describe the physical topology of the network. A wide variety of physical topologies have been used in LANs, including ring, bus, mesh and star. Conversely, mapping the data flow between the components determines the logical topology of the network. In comparison, Controller Area Networks, common in vehicles, are primarily distributed control system networks of one or more controllers interconnected with sensors and actuators over, invariably, a physical bus topology.
* A network consists of multiple computers connected using some interface. Each has one or more interface devices such as a Network Interface Card (NIC) and a serial device for PPP networking. Each computer is supported by network software that provides the server or client functionality. The hardware used to transmit data across the network is called the media. It may include copper cable, fiber optic, or wireless transmission. The standard cabling used for this document is the 10Base-T category 5 Ethernet cable. It is twisted copper cabling, which appears at the surface to look similar to TV coaxial cable. It is terminated on each end by a connector that looks much like a phone connector. Its maximum segment length is 100 meters.

**Star Topology:**

* Star topology is a network topology where each individual piece of a network is attached to a central node (often called a hub or switch). The attachment of these network pieces to the central component is visually represented in a form similar to a star.
* Star topology is also known as a star network.
* Star topologies are either active or passive networks, depending on the following:
* If the central node performs processes, such as data amplification or regeneration
* If the network actively controls data transit
* If the network requires electrical power sources.
* In star topology, all the devices are connected to a single hub through a cable. This hub is the central node and all other nodes are connected to the central node. The hub can be passive in nature i.e., not an intelligent hub such as broadcasting devices, at the same time the hub can be intelligent known as an active hub. Active hubs have repeaters in them.
* **Advantages of this topology :**
* If N devices are connected to each other in a star topology, then the number of cables required to connect them is N. So, it is easy to set up.
* Each device requires only 1 port i.e. to connect to the hub, therefore the total number of ports required is N.
* **Problems with this topology :**
* If the concentrator (hub) on which the whole topology relies fails, the whole system will crash down.
* The cost of installation is high.
* Performance is based on the single concentrator i.e. hub.

**Code:**

#include "ns3/applications-module.h"

#include "ns3/core-module.h"

#include "ns3/internet-module.h"

#include "ns3/netanim-module.h"

#include "ns3/network-module.h"

#include "ns3/point-to-point-layout-module.h"

#include "ns3/point-to-point-module.h"

using namespace ns3;

NS\_LOG\_COMPONENT\_DEFINE("StarAnimation");

int

main(int argc, char\* argv[])

{

//

// Set up some default values for the simulation.

//

Config::SetDefault("ns3::OnOffApplication::PacketSize", UintegerValue(137));

// ??? try and stick 15kb/s into the data rate

Config::SetDefault("ns3::OnOffApplication::DataRate", StringValue("14kb/s"));

//

// Default number of nodes in the star. Overridable by command line argument.

//

LogComponentEnable("OnOffApplication", LOG\_LEVEL\_INFO);

uint32\_t nSpokes = 16;

std::string animFile = "star-animation.xml";

uint8\_t useIpv6 = 0;

Ipv6Address ipv6AddressBase = Ipv6Address("2001::");

Ipv6Prefix ipv6AddressPrefix = Ipv6Prefix(64);

CommandLine cmd(\_\_FILE\_\_);

cmd.AddValue("nSpokes", "Number of spoke nodes to place in the star", nSpokes);

cmd.AddValue("animFile", "File Name for Animation Output", animFile);

cmd.AddValue("useIpv6", "use Ipv6", useIpv6);

cmd.Parse(argc, argv);

NS\_LOG\_INFO("Build star topology.");

PointToPointHelper pointToPoint;

pointToPoint.SetDeviceAttribute("DataRate", StringValue("5Mbps"));

pointToPoint.SetChannelAttribute("Delay", StringValue("2ms"));

PointToPointStarHelper star(nSpokes, pointToPoint);

NS\_LOG\_INFO("Install internet stack on all nodes.");

InternetStackHelper internet;

star.InstallStack(internet);

NS\_LOG\_INFO("Assign IP Addresses.");

if (useIpv6 == 0)

{

star.AssignIpv4Addresses(Ipv4AddressHelper("10.1.1.0", "255.255.255.0"));

}

else

{

star.AssignIpv6Addresses(ipv6AddressBase, ipv6AddressPrefix);

}

NS\_LOG\_INFO("Create applications.");

//

// Create a packet sink on the star "hub" to receive packets.

//

uint16\_t port = 50000;

Address hubLocalAddress;

if (useIpv6 == 0)

{

hubLocalAddress = InetSocketAddress(Ipv4Address::GetAny(), port);

}

else

{

hubLocalAddress = Inet6SocketAddress(Ipv6Address::GetAny(), port);

}

PacketSinkHelper packetSinkHelper("ns3::TcpSocketFactory", hubLocalAddress);

ApplicationContainer hubApp = packetSinkHelper.Install(star.GetHub());

hubApp.Start(Seconds(1.0));

hubApp.Stop(Seconds(10.0));

//

// Create OnOff applications to send TCP to the hub, one on each spoke node.

//

OnOffHelper onOffHelper("ns3::TcpSocketFactory", Address());

onOffHelper.SetAttribute("OnTime", StringValue("ns3::ConstantRandomVariable[Constant=1]"));

onOffHelper.SetAttribute("OffTime", StringValue("ns3::ConstantRandomVariable[Constant=0]"));

ApplicationContainer spokeApps;

for (uint32\_t i = 0; i < star.SpokeCount(); ++i)

{

AddressValue remoteAddress;

if (useIpv6 == 0)

{

remoteAddress = AddressValue(InetSocketAddress(star.GetHubIpv4Address(i), port));

}

else

{

remoteAddress = AddressValue(Inet6SocketAddress(star.GetHubIpv6Address(i), port));

}

onOffHelper.SetAttribute("Remote", remoteAddress);

spokeApps.Add(onOffHelper.Install(star.GetSpokeNode(i)));

}

spokeApps.Start(Seconds(1.0));

spokeApps.Stop(Seconds(10.0));

NS\_LOG\_INFO("Enable static global routing.");

//

// Turn on global static routing so we can actually be routed across the star.

//

if (useIpv6 == 0)

{

Ipv4GlobalRoutingHelper::PopulateRoutingTables();

}

// Set the bounding box for animation

star.BoundingBox(1, 1, 100, 100);

// Create the animation object and configure for specified output

pointToPoint.EnablePcapAll("prac11");

AnimationInterface anim(animFile);

NS\_LOG\_INFO("Run Simulation.");

Simulator::Run();

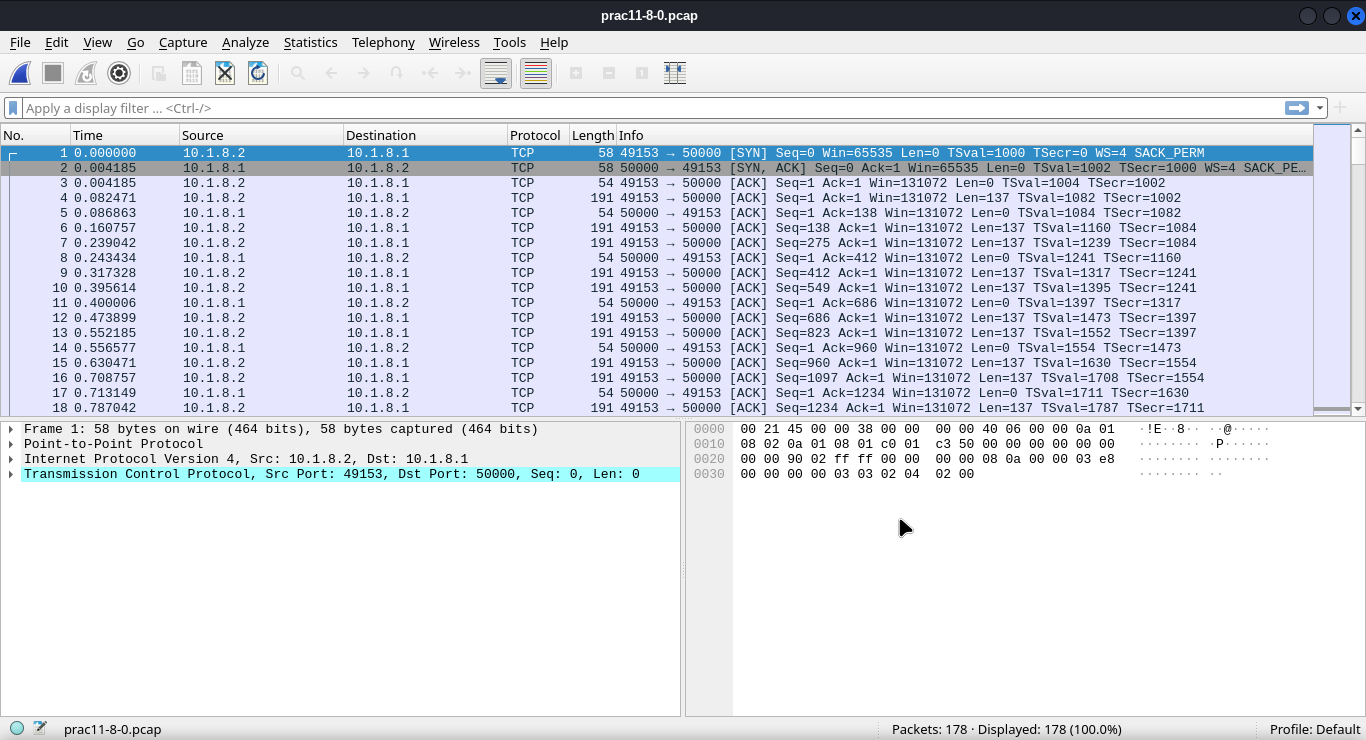
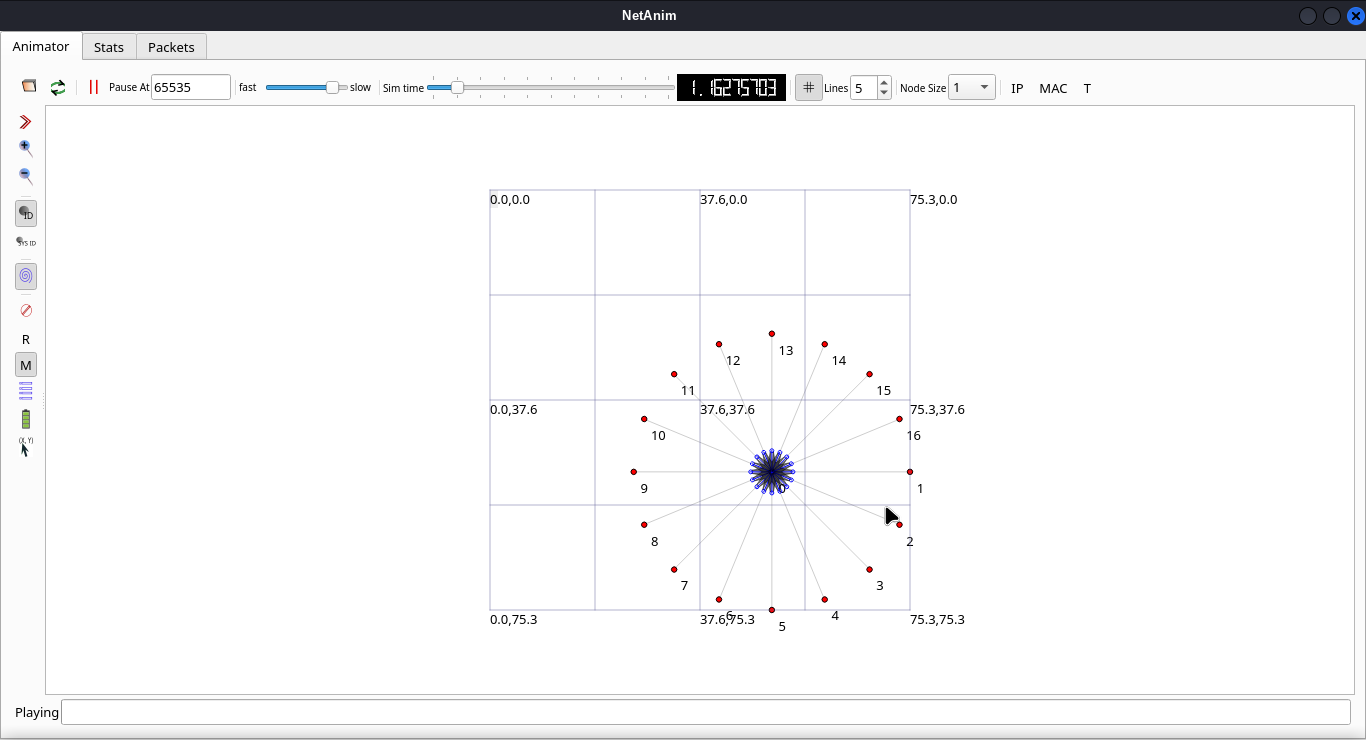
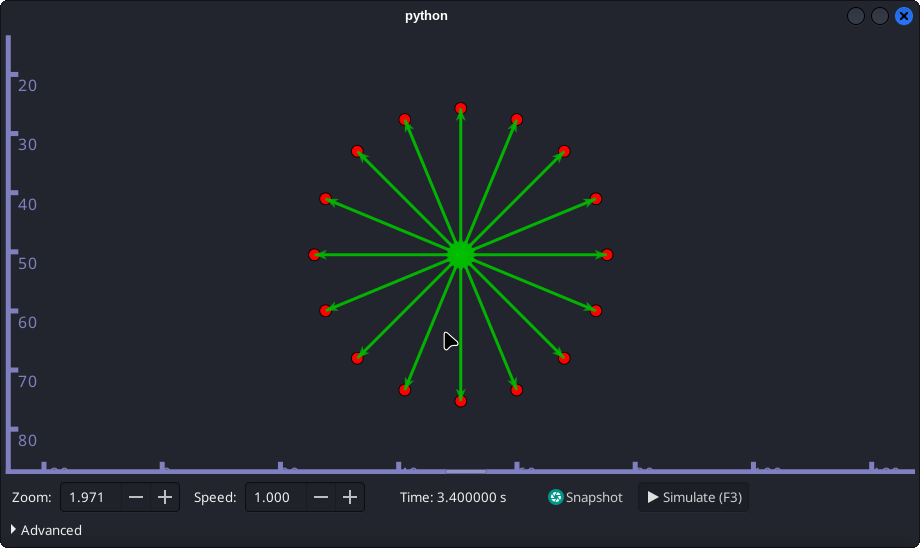
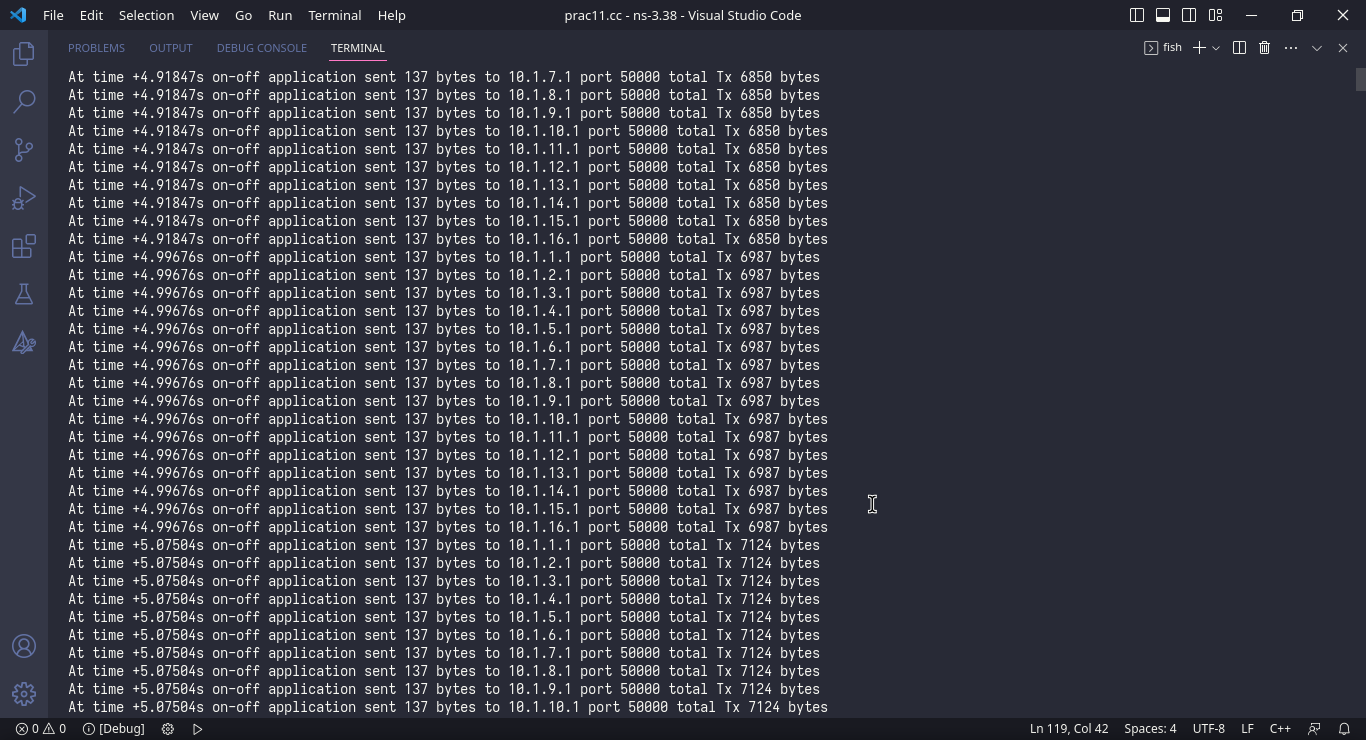
Simulator::Destroy();

NS\_LOG\_INFO("Done.");

return 0;

}

**Output and Network design:**



**Conclusion:**

In conclusion, the simulation of a star topology using 16 interconnected nodes has provided us with valuable insights into the behavior, performance, and practical applications of this widely adopted network configuration. Through comprehensive modeling, analysis, and evaluation, we have gained a deeper understanding of the strengths and limitations of the star topology, as well as its potential for various real-world scenarios.

The simulation results have demonstrated that the star topology offers several advantages in terms of simplified management, ease of expansion, and fault tolerance. The centralized hub facilitates efficient communication and enables easy troubleshooting and network management. The scalability of the star topology has been observed, as the addition or removal of nodes did not significantly impact the overall network performance.

Furthermore, the performance analysis of the simulated star topology has provided valuable insights into its latency, throughput, and fault tolerance characteristics. By studying different traffic loads, node failures, and network congestion scenarios, we have identified the network's performance thresholds and potential areas for optimization. Comparisons with other network topologies have shed light on the advantages and disadvantages of the star topology in terms of performance and scalability.

The exploration of practical applications has revealed the suitability of the star topology in various domains, including local area networks (LANs), wireless networks, and Internet of Things (IoT) deployments. Understanding the optimal configurations and use cases for the star topology can guide network administrators and designers in making informed decisions when deploying network infrastructures.

Based on the findings and analysis, this project offers recommendations for optimizing the design and deployment of star-based networks. Strategies for improving performance, enhancing scalability, and strengthening fault tolerance have been proposed. These recommendations aim to assist network professionals in achieving robust and efficient network architectures that meet the specific requirements of their respective environments.

In summary, the simulation of a star topology using 16 nodes has provided valuable insights and recommendations for the field of computer networking. The knowledge gained from this project contributes to the body of knowledge in network design, management, and optimization. By understanding the behavior and performance characteristics of the star topology, network professionals can make informed decisions to build resilient and high-performing network infrastructures.

**References:**

Wikipedia.org

https://www.nsnam.org/