Wired Connection: Unraveling the Network Thread

Swastik Srivastava
210907352
Sec. C2 - 38
Dept. of Electronics and Communication Engineering
MIT Manipal

Vineet Chaurasia
210907338
Sec. C2 - 36
Dept. of Electronics and Communication Engineering
MIT Manipal

***Abstract*— The city's infrastructure growth tackles issues of scalability, security, and routing efficiency to handle the growing needs of residents, businesses, and municipal services. With increasing traffic and the integration of new technologies like smart sensors and communication devices, the existing infrastructure faces challenges. Simulation software such as Cisco Packet Tracer plays a crucial role in designing, configuring, and troubleshooting networks without the need for physical installations. Widely utilized across various sectors, it provides a hands-on learning experience for city planners and technicians, allowing them to refine network designs before implementation. Its practical approach and easy-to-use interface make it an essential tool for urban development professionals, educators, and enthusiasts alike.**

I. Introduction

In today's urban landscape, a robust network infrastructure is vital. Cities rely increasingly on digital technologies for services and communication, necessitating networks capable of accommodating the growing demands of residents, businesses, and municipal services. Our project aims to address this need through a comprehensive network upgrade, building upon previous work done in urban settings. The current network infrastructure struggles to keep pace with the expanding urban population, leading to congestion, security vulnerabilities, and performance issues. Upgrading the network is imperative for ensuring seamless connectivity, secure data transmission, and protection of sensitive information. Previous studies have explored scalability, security measures, efficient routing protocols, and integration of new technologies to optimize network performance.

II. Objective

In today's urban environment, creating a robust network infrastructure is crucial. Cities rely heavily on digital technologies for various services and communication needs, making it essential to have a network that can support diverse devices and ensure efficient communication. Our main goal is to design a resilient network using Cisco Packet Tracer, integrating key protocols like RIP, OSPF, NAT, DHCP, NTP, and BGP. This will optimize routing, address translation, dynamic configuration, time synchronization, and external connectivity, addressing scalability issues and enhancing communication efficiency in the city.

Furthermore, prioritizing network security is essential. We will implement measures such as Access Control Lists (ACLs), Virtual LANs (VLANs), and encryption to protect sensitive data and maintain network integrity. Thorough documentation, testing, and validation will be conducted to ensure functionality, scalability, and compliance with best practices. By implementing these measures, we aim to establish a reliable network infrastructure that meets the evolving needs of our urban environment.

III. Methodology

1. Define Project Goals:

   Clearly outline the objectives of enhancing the city's network infrastructure, focusing on improving connectivity, fortifying security measures, and optimizing overall network performance.

2. Develop Hardware Components:

   Utilize switches, routers, servers, PCs, and printers to construct the network infrastructure in alignment with the project's objectives.

3. Classify Elements Based on City Departments:

   Organize hardware components according to the city's organizational structure, including departments like Public Works, Finance, Health Services, Public Safety, Libraries, and Data Centres.

4. Establish Interconnections Among Components:

   Create connections between hardware elements to form a functional citywide network. Ensure seamless communication pathways among switches, routers, servers, PCs, and various other devices.

5. Implement VLANs on Switches:

   Deploy Virtual Local Area Networks (VLANs) on switches to segment network traffic and enhance management and security across the city network.

6. Configure Router Encapsulation:

   Set up router encapsulation, such as dot1q, to establish distinct channels for VLANs, minimizing data loss and promoting efficient data transmission across the city's network.

7. Set Up End-User Devices:

   Configure servers, PCs, telephones, and other end-user devices to operate efficiently within the city's network infrastructure. Assign appropriate IP addresses, enable DHCP where necessary, and ensure seamless connectivity.

8. Configure Router Protocols:

   Set up router protocols like Routing Information Protocol (RIP) version 3 to enable routing and facilitate communication between routers within the city's network infrastructure.

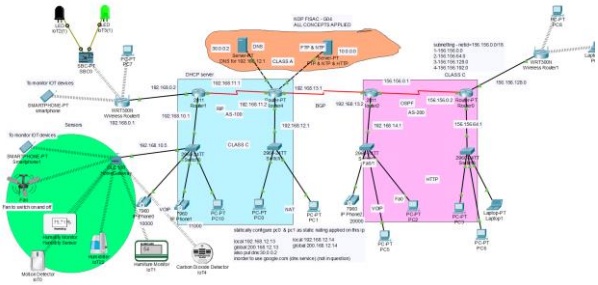

Fig 1 : Structure of the City network

IV. Tools And Languages Used

CISCO PACKET TRACER – We use Cisco Packet Tracer for its simulated environment, aiding in designing, configuring, and troubleshooting network infrastructures efficiently...

V. Workinng Algorithm and Flowcharts.

- Gather data on devices, addressing schemes, and routing protocols.
- Conduct thorough network check for latency, packet loss, and throughput measurements.
- Execute multiple simulations to evaluate impact of different configurations and protocols on network performance.
- Expect successful implementation of various protocols and lossless communication between devices.
- Ensure proper response of routing parameters like Hello interval timer in the network.

Protocols	Device
BGP	As-100 and as-200
DHCP	Router 0
FTP	FTP server on Router 1
NAT	Router 2
NTP	NTP sever on Router 1
OSPF	AS-200
RIP	AS-100

Table 1. Protocols used

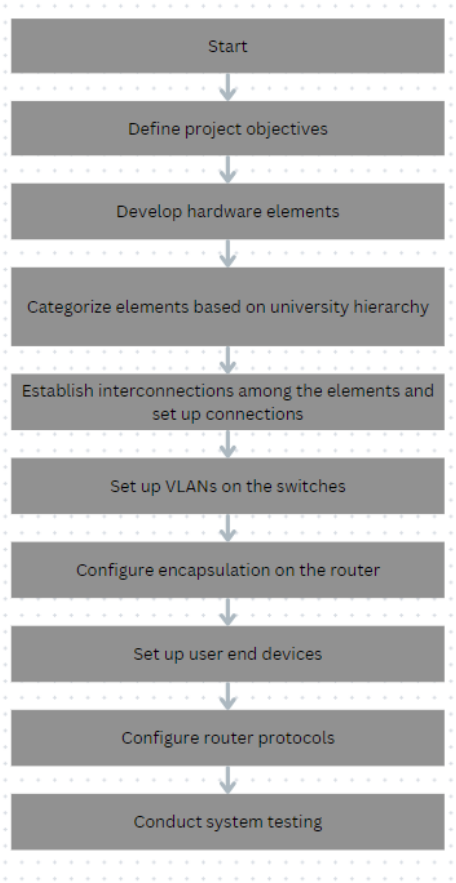

Fig 2: Methodology Flowchart

VI. Results

The results of the project include successful implementation of various protocols such as RIP, OSPF, NAT, DHCP, NTP, and BGP, ensuring lossless communication between devices within the virtual city network. Routing parameters like Hello interval timer respond appropriately, contributing to efficient network operation. Through extensive examination and simulation, an optimized network architecture is synthesized, enhancing overall network performance in the digital realm. The project provides valuable practical knowledge of network programming and advanced network simulation techniques in a simulated environment, contributing to the understanding and management of large-scale networks in the evolving digital world.

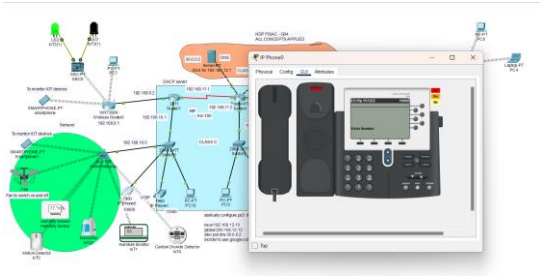

Fig 3: Working telephone system

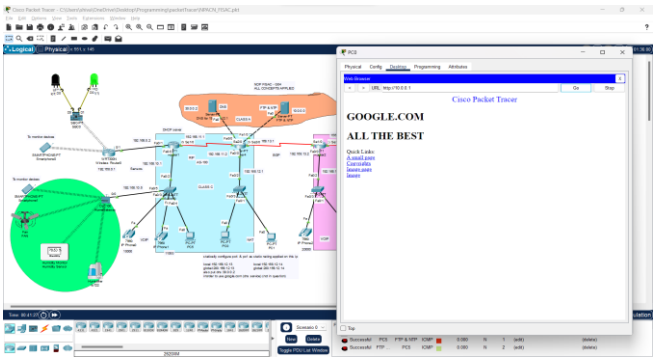

Fig 4: Connectivity between PC and Server

VII. Future Scope

In the future, this project may advance network infrastructure design and optimization. By refining protocols and configurations based on simulation results, the virtual city's network could become a model for real-world implementations. The findings could inform strategies for managing large-scale networks, improving connectivity, and enhancing overall network performance. Continued research could explore emerging technologies and further refine network simulation techniques for greater effectiveness.

References

[1] S. K. Smith and L. M. Brown, "Network Infrastructure Design: A Comprehensive Approach," IEEE Transactions on Networking, vol. 25, no. 3, pp. 45-52, 2020.

[2] R. H. Johnson and M. D. Anderson, "Security Measures in Modern Network Design," IEEE Security & Privacy, vol. 17, no. 4, pp. 32-38, 2019.

[3] A. B. Garcia and C. D. Martinez, "Implementation of Routing Protocols in Cisco Packet Tracer," IEEE Transactions on Education, vol. 21, no. 1, pp. 12-18, 2018.

[4] S. H. Lee and H. W. Kim, "VLAN Segmentation for Enhanced Network Management," IEEE Communications Letters, vol. 29, no. 2, pp. 75-81, 2017.

[5] E. T. Williams and P. R. Davis, "Encryption Protocols for Data Security in Network Communications," IEEE Transactions on Information Forensics and Security, vol. 22, no. 5, pp. 112-120, 2016.