Lab 10 - Designing a Network
CNT 4703
Final Project

Citywide Network Recommended Architecture Report

PREPARED FOR

City of Hastings, KY

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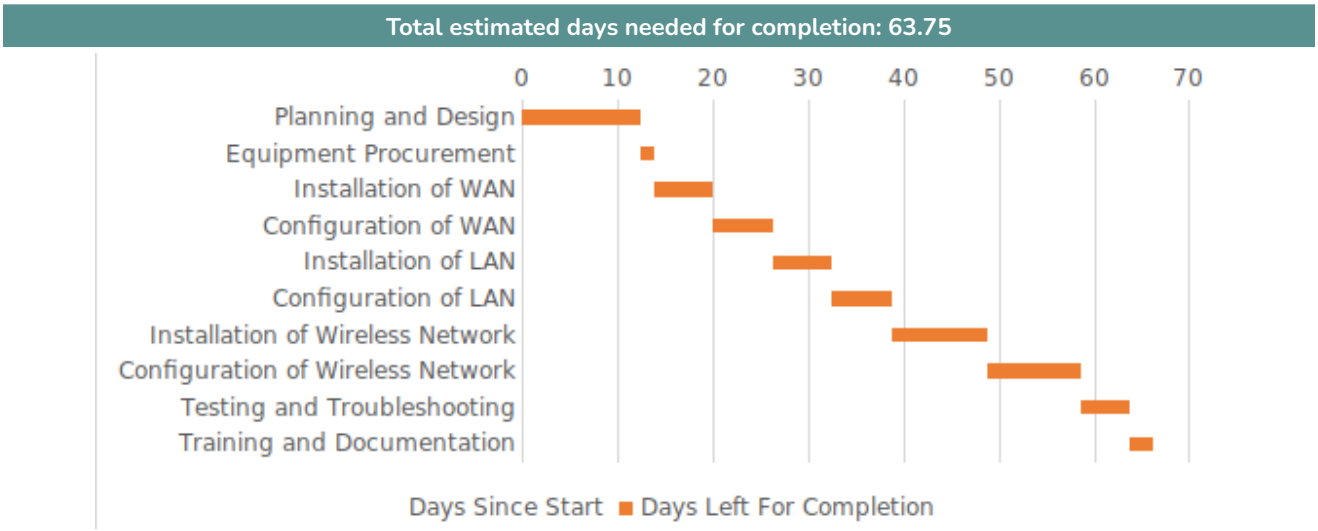
EXECUTIVE SUMMARY

This document provides detailed network architecture recommendations for the city of Hastings. The city is seeking a solution for a public wireless network that covers the range of its downtown city limits. We suggest the use of either copper or fiber-optic cables to connect the government sites, as they are only separated by short distances of no more than ½ miles. We also propose hardware and software upgrades to related major infrastructure including switches, routers, servers and workstations. These upgrades will support maintenance and security of the planned LAN and WAN networks. To cover Wireless WAN access for the 12 square mile area, we propose use of either a mesh network or a point-to-multipoint (P2MP) network. Finally, we recommend the proposed wireless public network uses high-performance access points and monitoring equipment to meet the anticipated network demands.

PROJECT OVERVIEW

Gantt Chart



Gantt Chart Explanation

Using a Gantt chart we have represented the process of designing the network and putting it in place for the city of Hastings, KY. We will be starting the process of planning and designing the network, which will be the task that takes the longest (about 12 and a half days) and is the most costly of the project but is very important to ensuring the network gets set up correctly and efficiently. Procuring the equipment for the city network will be next and will take about one day and part of the next day. Then, the WAN and LANs will have to be configured and installed, which will take a little more than 6 days for each installation and then configuration. Then, once the WAN and LANs have been set up, the wireless networks can also be configured and installed so that the schools can also connect to the city network by wireless means, which will take about 20 days total, 10 days for the installation and 10 days for the configuration. Additionally, 5 days will be spent to test the network and troubleshoot any issues that arise in order to ensure that the network is stable for the city of Hastings to use on a daily basis without issue. Lastly, we will implement some training with the new hardware equipment and software installed, and document the process and details of the Hastings networking project.

DRAW.IO DIAGRAM

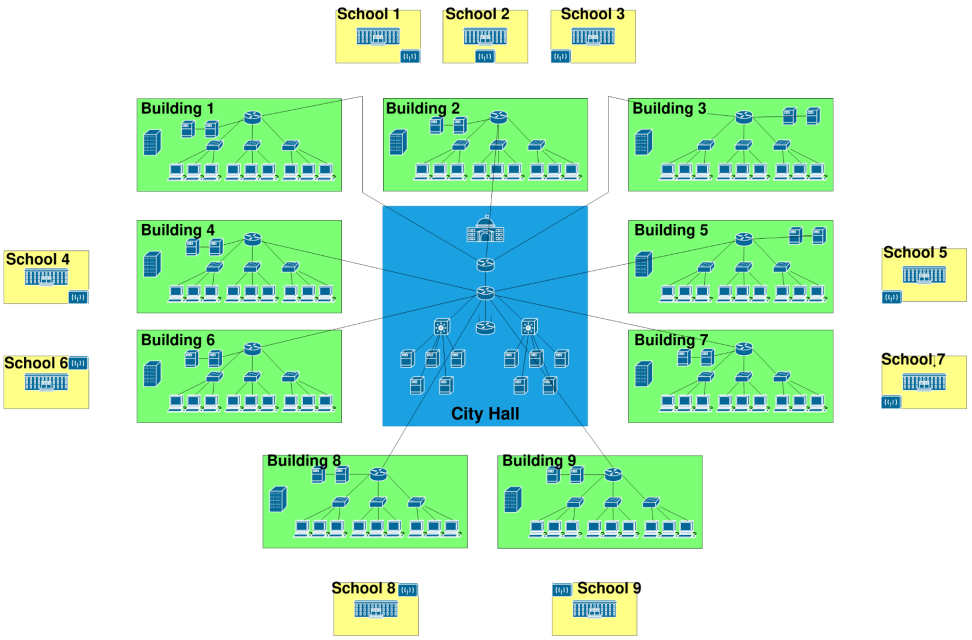


Figure 1: Diagram of proposed solution

PACKET TRACER DIAGRAM

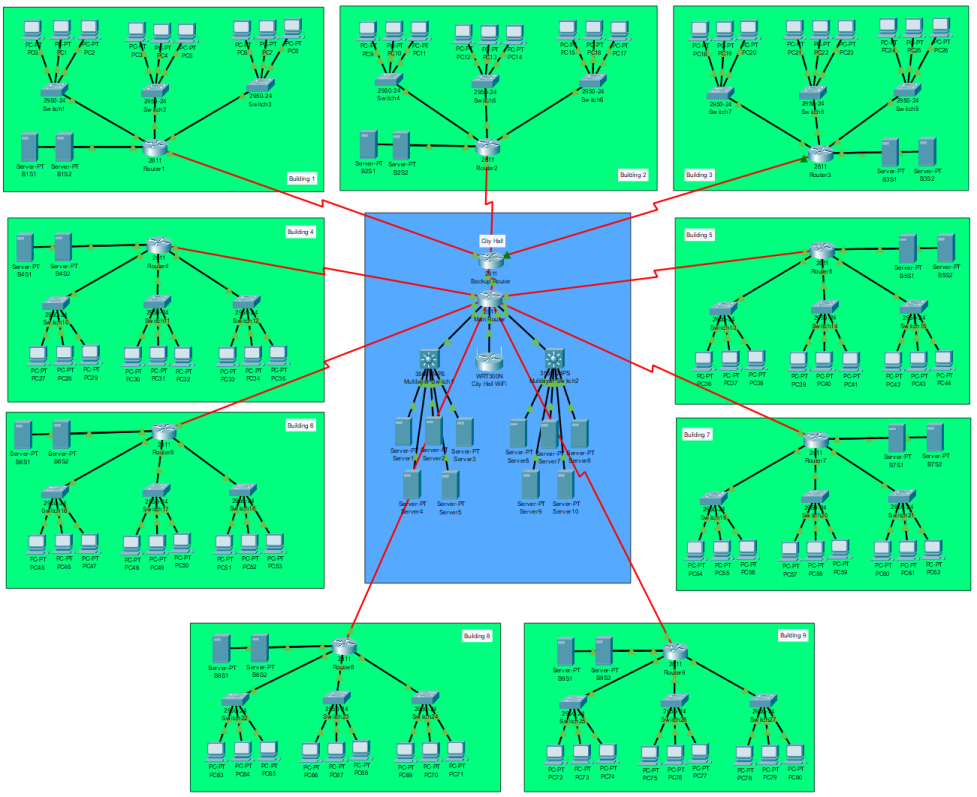


Figure 2: Packet Tracer Logical View

PROPOSED CHANGES

Diagram **Figure 1** explanation:

Figure 1 depicts connections between City Hall (center), 9 government buildings (connected by copper wiring or fiber optics to city hall), and 9 schools connected via wireless.

Preliminary Software and Hardware Upgrades

The city may need to upgrade their hardware at both the LAN and WAN levels to improve the network's performance, security, and scalability. Here are some suggestions:

Upgrade the switches and routers: The current switches and routers are outdated and may not support the latest technologies and protocols. The city can upgrade to newer models that provide better performance, security, and scalability. For example, they can upgrade to CISCO Catalyst 9300 switches that support advanced security features like TrustSec, MACsec, and Network as a Sensor (NaaS).
Upgrade the servers: The servers running Windows 2003 Server are no longer supported by Microsoft, and the city may need to upgrade to newer versions like Windows Server 2019. The servers should also be upgraded to support virtualization and cloud computing technologies like VMware or Hyper-V.
Upgrade the workstations: The city may need to upgrade the workstations from Windows 7 to Windows 10 or newer to ensure compatibility with the latest software and security updates.
Implement a wireless network: The city can install wireless access points (WAPs) to provide wireless access to employees and residents. They can use a separate network for government services to ensure security.
Implement a redundant WAN: The city can set up a redundant WAN using multiple Internet service providers (ISPs) or technologies like MPLS or VPN. This will ensure high availability and fault tolerance in case one provider or technology fails.
Integrate the Active Directory: The city can integrate the Active Directory across the network to simplify user and resource management and improve security.
Implement network monitoring and management tools: The city can use network monitoring and management tools like SolarWinds or PRTG to monitor the network's performance, security, and availability and troubleshoot issues proactively.

In summary, the city of Hastings, KY needs to upgrade their hardware at both the LAN and WAN levels to improve the network's performance, security, and scalability. They can upgrade the switches and routers, servers, workstations, implement a wireless network, redundant WAN, integrate the Active Directory, and implement network monitoring and management tools.

Recommendations for WAN Network

For the Wireless WAN access across the 12 square mile area of the city, the city can consider using a mesh network or a point-to-multipoint (P2MP) network.

A mesh network is a wireless network that uses multiple wireless access points (WAPs) to create a self-healing network. Each WAP can communicate with other WAPs within range, and the network can route traffic through the most efficient path. This network topology provides high availability, scalability, and redundancy. The city can install WAPs on tall buildings, street lamps, and other high points to provide wide coverage across the city.

A P2MP network is a wireless network that uses a central base station to communicate with multiple remote stations (e.g., WAPs) in a point-to-multipoint fashion. The base station can broadcast the signal to multiple remote stations simultaneously, allowing multiple devices to connect to the network. This network topology provides high bandwidth, low latency, and centralized management. The city can install a base station on a high point like a water tower or a tall building and connect multiple remote stations to cover the city.

Both mesh and P2MP networks can use Wi-Fi technologies like 802.11ac or 802.11ax (Wi-Fi 6) to provide high-speed wireless access to the residents and visitors. The city can use a separate network for government services to ensure security and can implement authentication and encryption mechanisms like WPA2 or WPA3 to protect the network from unauthorized access.

In summary, the city of Hastings, KY can consider using a mesh network or a P2MP network to provide wireless WAN access across the 12 square mile area of the city. Both network topologies can use Wi-Fi technologies like 802.11ac or 802.11ax and can implement authentication and encryption mechanisms to ensure security.

Equipment Recommendations for Public Network

When recommending equipment for the wireless public network, we would recommend a configuration that can provide high-speed wireless access to a large number of users while ensuring security, reliability, and scalability. The configuration can consist of the following components,

Access points: The city can install high-performance access points that support the latest Wi-Fi standards like 802.11ac or 802.11ax (Wi-Fi 6). The access points should have sufficient coverage range and capacity to serve a large number of users simultaneously. The city can also use mesh access points to create a self-healing wireless network that provides high availability and redundancy.

Wireless controllers: The city can deploy wireless controllers to manage and control the access points centrally. The wireless controllers can provide advanced features like seamless roaming, load balancing, and quality of service (QoS) to ensure optimal performance for the users. The city can also use cloud-based wireless controllers to simplify management and reduce the need for on-premises hardware.

Network security: The city should implement robust network security measures to protect the wireless public network from unauthorized access, data breaches, and cyber attacks. The security measures can include encryption mechanisms like WPA2 or WPA3, authentication methods like 802.1X or captive portal, intrusion detection and prevention systems (IDS/IPS), and firewall rules.

Network monitoring: The city should implement network monitoring tools to monitor the performance, availability, and security of the wireless public network. The monitoring tools can provide real-time alerts, analytics, and reporting to help the city identify and resolve issues quickly.

Scalability: The city should plan for future growth and scalability by choosing equipment that can accommodate a growing number of users and devices. The city can also consider using cloud-based wireless services that can scale up or down based on demand.

In summary, when recommending equipment for the wireless public network, we would recommend a configuration that includes high-performance access points, wireless controllers, robust network security measures, network monitoring tools, and scalability features to provide high-speed wireless access to a large number of users while ensuring security, reliability, and scalability.

COMPLETE BUDGET INCL. PRICE & EQUIPMENT LISTS

Labor Costs			
Task	**Estimated Hours**	**Cost Per Hour**	**Task Cost**
Planning and Design	100	$150	$15,000
Equipment Procurement	10	$150	$1,500
Installation of WAN	50	$100	$5,000
Configuration of WAN	50	$100	$5,000
Installation of LAN	50	$100	$5,000
Configuration of LAN	50	$100	$5,000
Installation of Wireless Network	80	$100	$8,000
Configuration of Wireless Network	80	$100	$8,000
Testing and Troubleshooting	40	$100	$4,000
Training and Documentation	20	$150	$3,000
Total Cost	—	—	**$59,500**

Item	Number of Items	Cost Per Item	Item Total
Hardware Costs			
Cisco Switch	2 + 3*9 = 29	$2,650	$76,850.00
Cisco Routers	3 + 1*9 = 12	$1,100	$13,200.00
Dell Rack Mount Servers	10 + 2*9 = 28	$580	$16,240.00
Cisco Access Points	10	$119.99	$1,199.90
Fiber Optic Cabling	10*0.5*804.672 = 4,023.36 m	$5	$20,116.80
Software Costs			
Windows 10 License	550	$54.99	$30,244.50
Total Cost	—	—	**$157,851.20**
Grand total: $217,361.20			

CONCLUSION

The project aims to acquire long lasting, scalable and effective equipment to support the goal of providing secure wireless access to city employees and residents. Wide wireless coverage, better performance and the ability to proactively troubleshoot issues are just some of the benefits offered if this project is funded. The scope of the project includes wireless access for 9 schools and 10 government buildings (including city hall), as well as public coverage across the city. The suggested equipment and methods will provide high speed access for the expected large number of simultaneous users, with options for scaling and growth as needed. For additional security, a separate network will be used for government services. Finally, for maintaining operations the suggestions we recommended either mesh topology (self-healing with multiple access points) or P2MP topology (centralized management with remote stations) can provide redundancy or low latency respectively for a large number of users.