Final Project Report

Course: CIS 3347

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College of Technology

Information and Logistics Technology

by

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Introduction

This final project report details the design of a secure and segmented network infrastructure for a new eight-story luxury residence hall at the University of Houston. This residence hall, specifically designed to accommodate 324 honor students, features 162 two-bedroom, one-bathroom apartments spread across floors three to eight. To cater to the diverse needs of residents, university employees, and visitors, the network design incorporates a layered approach with distinct security measures and differentiated functionalities.

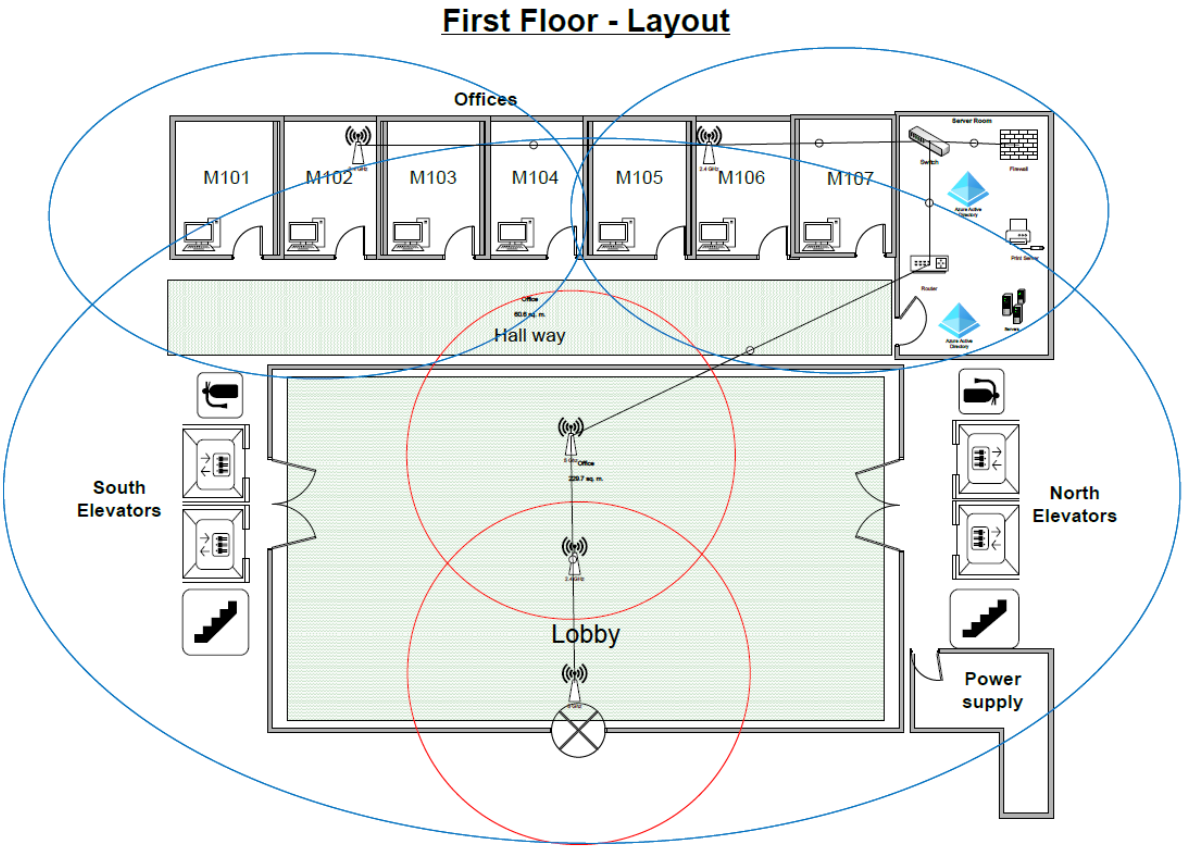
A core principle of this design is the physical separation of the university's core network from the internal network of the residence hall. This separation is further enhanced by the implementation of separate network segments with unique IP addresses, subnets, and Wi-Fi frequencies for residents, employees, and visitors. This report will delve into the specifics of this network design, outlining the network equipment, cabling types, and security protocols employed throughout the eight floors. It will also provide detailed floor plans illustrating the placement of network devices and the organization of wired and wireless connections. Finally, the report concludes with a comprehensive cost analysis for the proposed Cisco network equipment.

Recommendations

1. Floor 1 MDF (Main Distribution Facility) room details for 1 GHZ network
2. Floor 1 wired network 1 GHZ
3. Floor 1 Wi-Fi for employees and residents 5 GHZ
4. Floor 1 visitors Wi-Fi 2.4 GHZ
5. Floor 2 wired network 1 GHZ
6. Floor 2 Wi-Fi for employees and residents 5 GHZ
7. Floor 2 visitors Wi-Fi 2.4 GHZ
8. Floor 3 – 8 west wing wired network 1 GHZ
9. Floor 3 – 8 west wing Wi-Fi for employees and residents 5 GHZ
10. Floor 3 – 8 west wing visitors Wi-Fi 2.4 GHZ
11. Floor 3 – 8 East wing wired network 1 GHZ
12. Floor 3 – 8 East wing Wi-Fi for employees and residents 5 GHZ
13. Floor 3 – 8 East wing visitors Wi-Fi 2.4 GHZ
14. A high-level map for all floors

Network Architecture Design

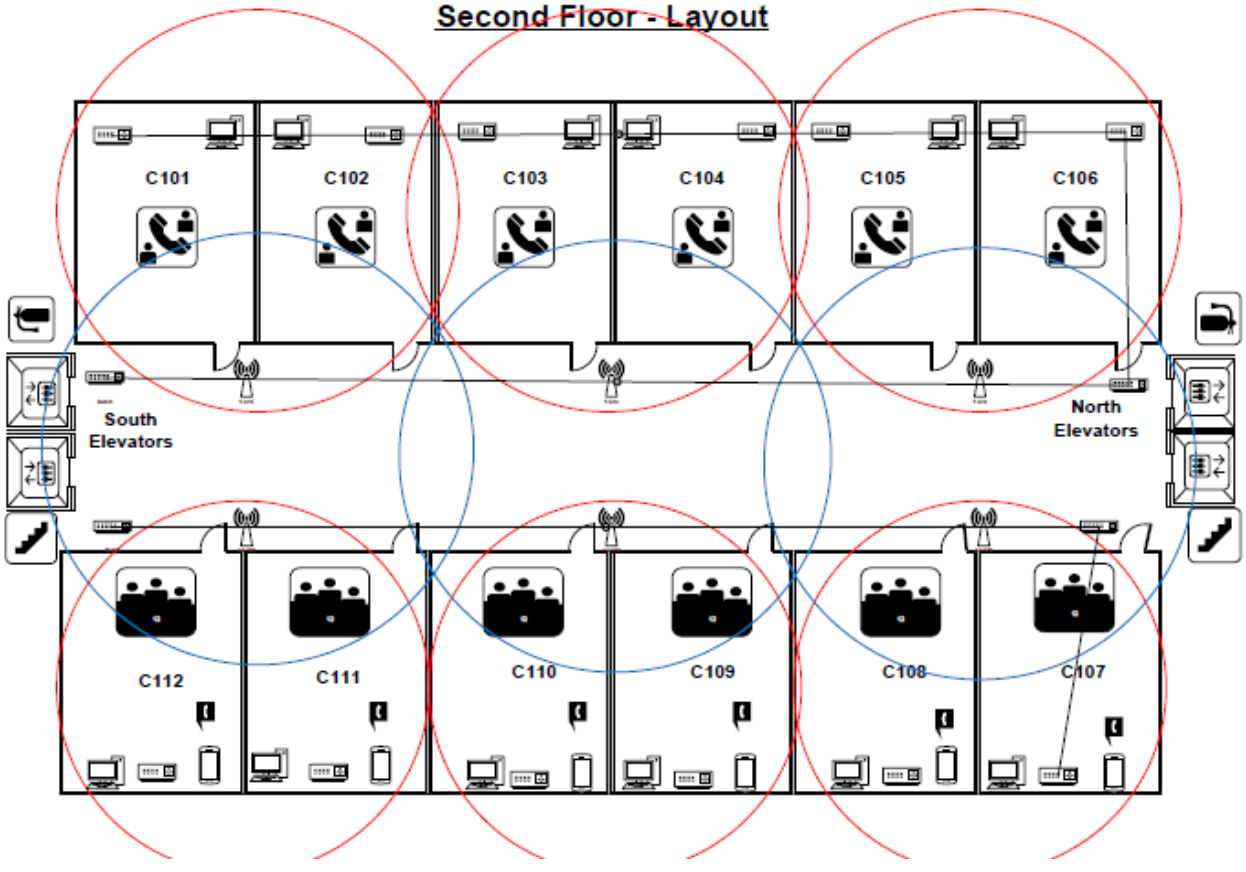
First Floor



This is the first-floor layout. Majority of it is a lobby area. A secure server room serves as the central hub for the building's network infrastructure. A robust firewall acts as the first line of defense, meticulously inspecting all traffic to safeguard the network. This firewall connects directly to a high-performance switch, the central point for data exchange within the server room. Data then travels to a network router, managing the flow of data between the internal network and the external world (likely the University's core network). Wireless connectivity in the lobby is provided by three strategically placed WAPs. Two operate on the 5 GHz frequency band for superior speed, while the third utilizes the 2.4 GHz band for broader compatibility. Within the server room, a dedicated print server manages printing tasks, while additional servers house critical applications and data for building operations.

Finally, two Active Directory servers function as a central directory service, managing user accounts and access control. High-quality Cat 6 ethernet cables connect all devices within the server room, ensuring reliable and high-speed data transmission throughout the network.

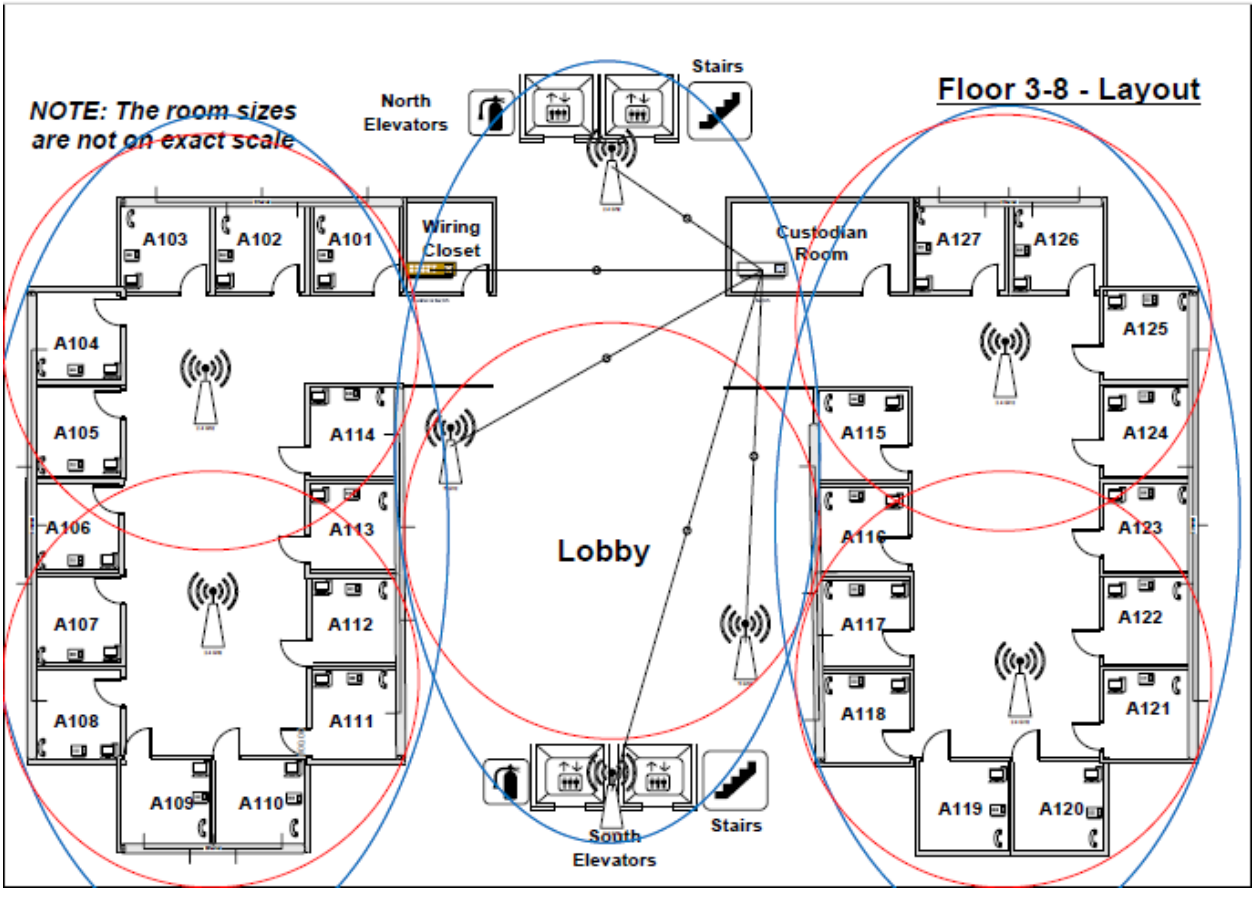
Second Floor



On the second floor, wireless network coverage is provided by a total of six WAPs (Wireless Access Points). Three of these WAPs operate on the 5 GHz frequency band, offering superior speed for bandwidth-intensive activities. The remaining three WAPs utilize the 2.4 GHz frequency band, ensuring broader device compatibility for a wider range of devices. These WAPs are strategically placed throughout the floor, as indicated by the six red circles (5 GHz) and three blue circles (2.4 GHz) on the floor plan. Each individual room on the second floor is equipped with a network drop, a Voice over IP (VoIP) phone connection, and a traditional telephone jack. These network drops connect each room to the building's network infrastructure, allowing for wired internet access and VoIP phone

functionality. All network drops, VoIP connections, and WAPs on the second floor converge on a central switch, which forms the backbone of the network on this floor. The network coverage terminates at the far end of the second floor, ensuring comprehensive coverage within the designated area.

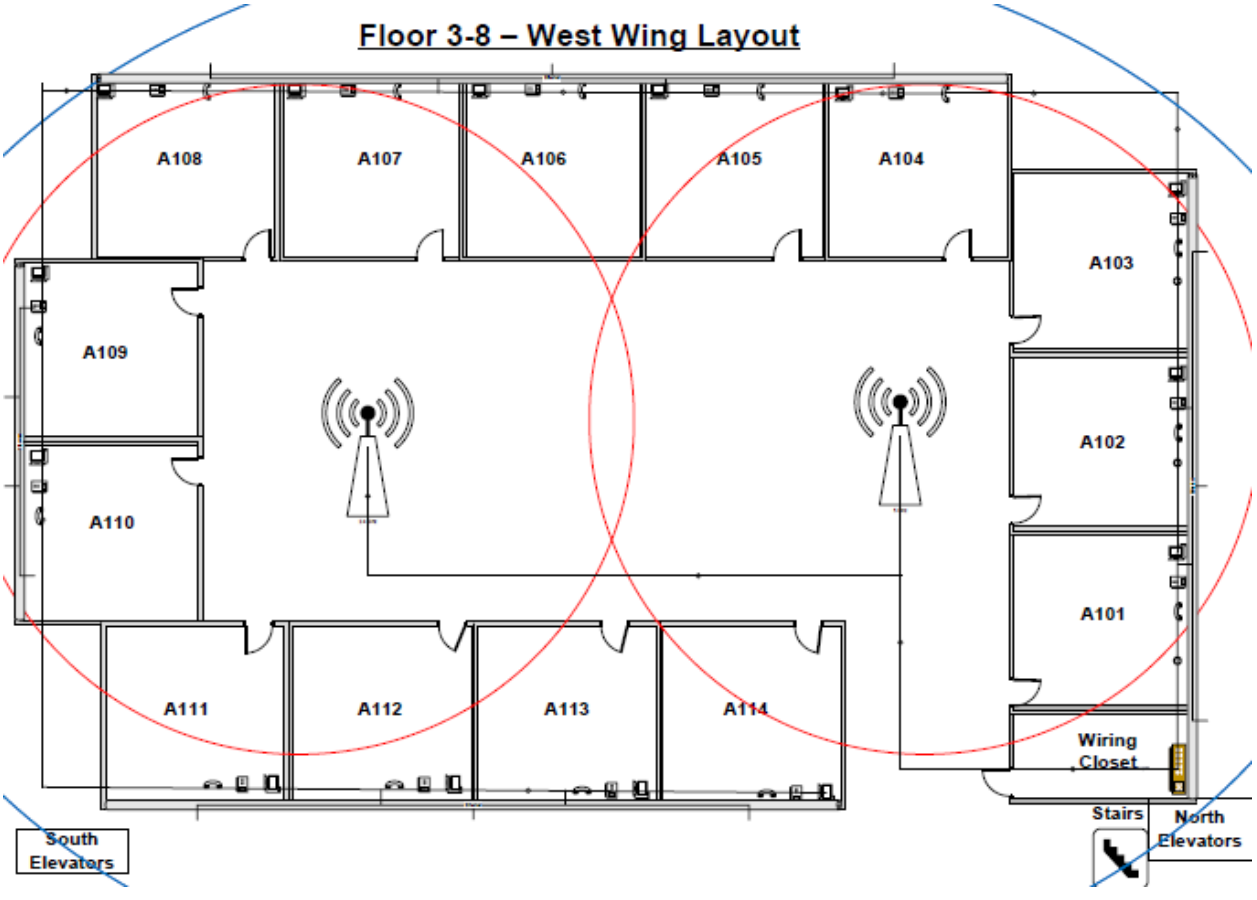
Third – Eight Floor

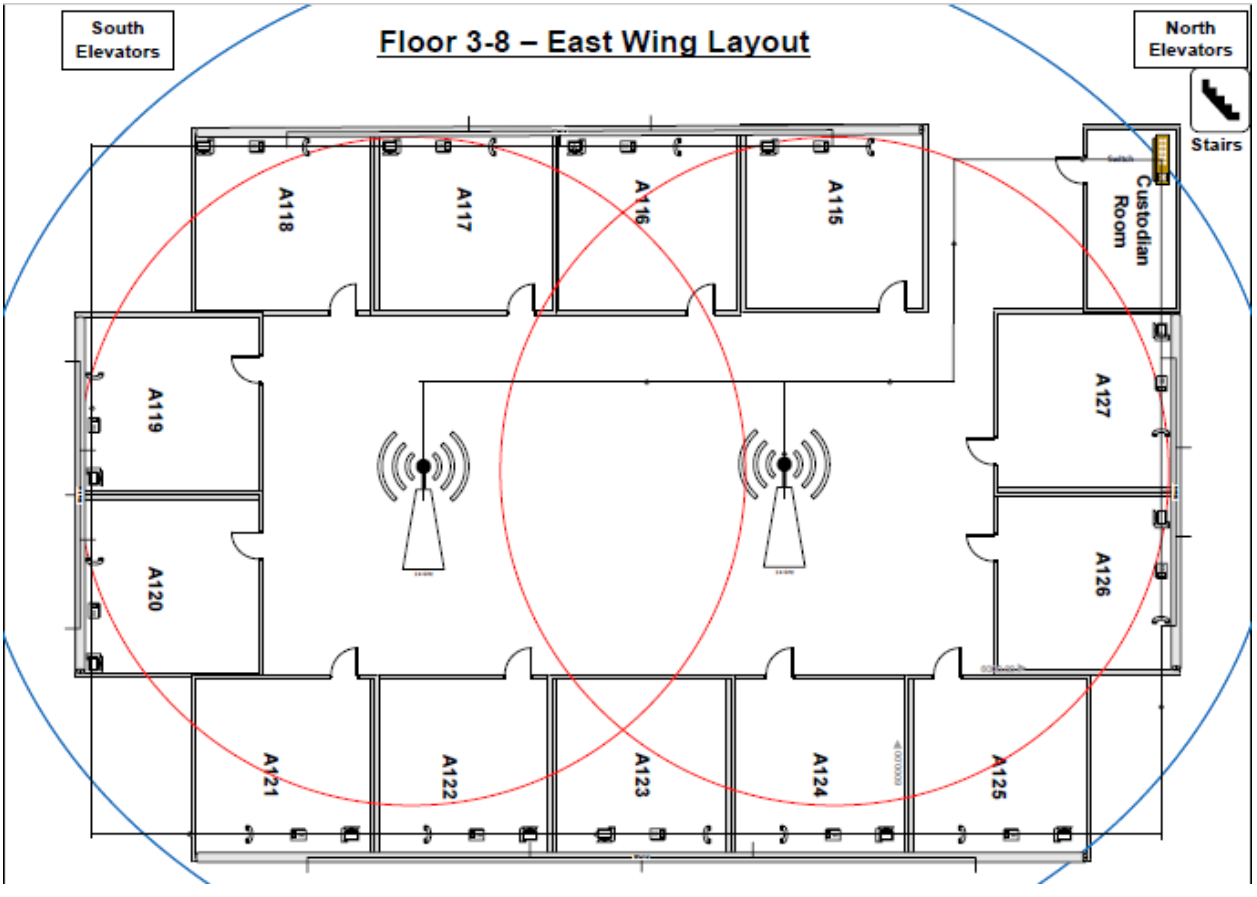


Floors 3-8, designated for residents and guests, utilize a mirrored design with separate East and West wings. Each wing benefits from wireless coverage provided by two 2.4 GHz WAPs (Wireless Access Points). A central switch located within each floor's wiring closet connects to all network drops, Voice over IP (VoIP) phone connections, and telephones in each room. This switch, in turn, connects to a backbone switch housed within the custodian room, forming the network backbone for each floor. To enhance wireless performance in these resident areas, additional WAPs are strategically placed. Each

wing features a designated zone marked by two red circles indicating 5 GHz WAPs strategically positioned around a single blue circle representing a 2.4 GHz WAP. This configuration ensures strong and reliable coverage throughout the resident area. Also, the lobby on these floors boasts a single 5 GHz WAP (red circle) surrounded by a single 2.4 GHz WAP (blue circle). This configuration extends wireless coverage towards both the North and South elevators, guaranteeing seamless connectivity throughout the public areas of floors 3-8. In total, floors 3-8 are equipped with 2 5 GHz WAPs and 2 2.4 GHz WAPs, delivering comprehensive and differentiated wireless experiences for residents and guests.

West Wing & East Wing

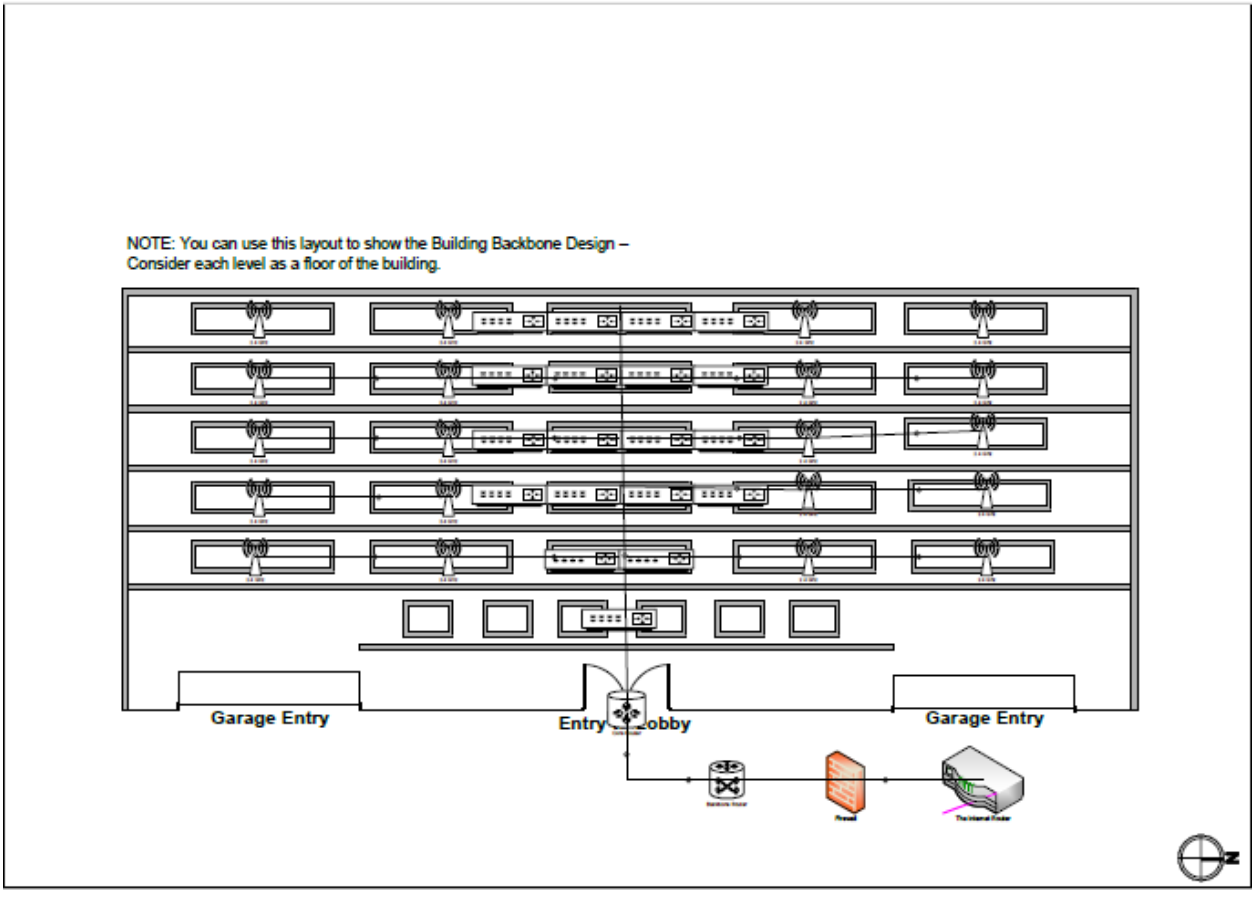




Floors 3-8, designated for residents and guests, utilize a mirrored design for the East and West wings. Each wing features a central switch located within the custodian room. This switch connects to another switch housed within the wiring closet, which acts as the backbone connection for the entire floor. Wireless Access Points (WAPs) are strategically placed throughout each wing to provide optimal network coverage. These WAPs connect directly to the switches. Each individual room within the wings benefits from a network drop, a Voice over IP (VoIP) phone connection, and a traditional telephone jack. Additionally, all rooms have pre-installed ethernet cables located along the edges, offering residents and guests the flexibility of wired internet access. The specific WAP configuration within each wing employs a combination of three circles on the floor plan to denote coverage areas. Two blue circles represent 5 GHz WAPs strategically positioned around a single red circle representing a 2.4 GHz WAP. This configuration ensures strong and reliable wireless coverage throughout the resident area, catering to both high-bandwidth activities and broader device

compatibility. In total, each wing utilizes 2 2.4 GHz WAPs and 2 5 GHz WAPs, delivering a comprehensive and differentiated wireless experience for residents and guests.

Building Backbone Diagram



The building's internet connectivity is established through a hierarchical network backbone visualized in a side-angle diagram. A single CAT6 cable serves as the primary conduit, carrying internet traffic from the internet service provider's (ISP) router directly to the building's network infrastructure. This cable connects sequentially to the firewall, backbone router, and finally, the core router. The core router then distributes the internet connection to individual floor routers strategically positioned throughout the building's center. These floor routers act as intermediaries, connecting to the respective Local Area Networks (LANs) on each floor, ensuring each floor has access to the internet and network resources.

Subnetting

Table 1: IPv4 Subnet for 172.16.0.0

Network Address	172.16.0.0
Usable Host IP Range	172.16.0.0 – 172.16.63.254
Broadcast Address	172.16.63.255
Total Number of Hosts	16,834
Number of Usable Hosts	16,832
Subnet Mask	255.255.192.0
Binary Subnet Mask	11111111.11111111.11000000.0
IP Class	B
CIRD Notation	/18
IP Type	Private

Table 2: All Possible Networks for 172.16.x.x

Network Address	**Useable Host Range**	**Broadcast Address**
172.16.0.0	172.16.0.1 – 172.16.63.254	172.16.63.255
172.16.64.0	172.16.64.1 – 172.16.127.254	172.16.127.255
172.16.128.0	172.16.128.1 – 172.16.191.254	172.16.191.255
172.16.192.0	172.16.192.1 – 172.16.255.254	172.16.255.255

Table 3: All Possible Networks for 172.168.x.x

Network Address	**Useable Host Range**	**Broadcast Address**
192.168.0.0	192.168.0.1 - 192.168.0.254	192.168.0.255

Table 4: Hardware Recommendations:

Hardware	**IP**	**Subnet**	**Type**	**Location**
Router(s)	172.16.0.2	172.16.1.x	Network	MDF
Core Switch 1	172.16.0.20	…	Network	MDF
Core Switch 2	172.16.0.31	…	Network	MDF
Switche1	172.16.0.100	…	Network	MDF
Firewall	172.16.0.2	…	Network	MDF
AP 5GHZ	172.16.0.120	…	Network	1st Floor
AP 2.4 GHZ	192.168.0.2	192.168.0.x	Network	2nd floor
Active Directory 1	172.16.0.150	…	Server	MDF
Active Directory 2	172.16.0.151	…	Server	MDF

Table 5: All Possible DHCP Range for 172.16.x.x & 192.168.0.x

Network Component	**Host Range**
Visitors Wi-Fi	192.168.0.2 - 192.168.0.254
Wired Network	172.16.64.1 - 172.16.127.254
Employees and residents	172.16.192.2 - 172.16. 255.254

Cost Estimates

Equipment	Product Name	Quantity	Cost per Item	Total Cost
Wireless Access Points	**Cisco Meraki Go Indoor Wi-Fi 6**	**42**	**$ 173.99**	**$7,307.58**
Phone	**Cisco IP Phone 8861 - VoIP phone**	**60**	**$559.99**	**$33,599.4**
Computers	**Dell OptiPlex Plus – SFF – Core i7**	**73**	**$1,514.99**	**$110,594.27**
Cat 6 Wires	**StarTech.com 1000ft Bulk Cat 6 Ethernet Cable – Solid – CMR - Blue**	**16**	**$264.99**	**$4,239.84**
Backbone Switch	**Cisco Catalyst 9200 – Network Essentials – switch – 24 ports – smart – rack mountable**	**8**	**$1,893.99**	**$15.151.92**
Core Switch	**Cisco Catalyst 9200 – Network Advantage – switch – 24 ports – smart – rack-mountable**	**1**	**$2,968.99**	**$2,968.99**
Router	**Cisco Integrated Services Router 4321 – Unified**	**1**	**$2,729.99**	**$2,729.99**

	Communications Bundle			
Ethernet Ports	**Cisco Industrial Ethernet 1000 Series – switch – 5 ports – managed**	**73**	**$681.99**	**$49,785.27**
Total Price				**$226,377.26**