



Redesigning the Campus Network

Project by

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Introduction

The purpose of this document is to redesign the campus network from the ground up. We have been given a subset of buildings to work with: ITE building, Potomac Hall, Sondheim Hall, Biology Science, Performing Arts and Humanities, Administration, and the Data Center. Furthermore, we should consider the network's overall design and answer some questions such as: What are our plans for the core, the distribution, and access layers? Will there be routers and switches in the buildings? How many are there? What kind are we looking for? Are there any special concerns about the administration building? Which switches and routers will we be using? What about the entry points? Do you require any? Etc. A budget of USD 1 million has been provided to the team to complete the project. In this document, we have proposed a network design that will be explained in the following sections.

Equipment section

Cable Identification

Copper cabling has been utilized in the communications sector for almost a century, and many networks still use it today. While network technology has advanced in recent years, with fiber-optic networks and wireless networks becoming more prevalent, copper cables continue to dominate most networks due to their affordability, speed, and reliability. According to Indigo Technology Services, a company that offers a variety of network cabling and infrastructure services to companies of all sizes and all elements of an IT system and deal with copper, fiber, and wireless networks, there are many kinds of copper network cabling, including cat 3, cat 5e, cat6 and cat6a, cat7 and cat7a. However, for our building, it will be cat 6a because it uses the

twisted pair design. It is robust, offers substantially greater capacity, and improves the maximum length to 100 meters when running at 10 Gigabits, making it suitable for higher-end applications like 10 Gigabit Ethernet. The Data Center will also use multimode fiber cabling for our 40Gbps connections. We chose multimode because we did not need the length capabilities of single mode fiber and this will give us more channels.

Switches

For switches, we will be using the Cisco Catalyst 2960-X series switches with 48 and 24 ports. Also, an external redundant power supply option is supported on the Cisco Catalyst 2960-X Series Switches. These switches come with one fixed power supply and an external redundant power supply (Cisco Redundant Power System [RPS] 2300).

Access point

The first guideline of appropriate access point placement is to figure out where Wi-Fi networks will be utilized most frequently. This may seem self-evident, but it makes a big difference in choosing the best location for access points across a network. A device's connection will be better the closer it is to an access point. As a result, placing an access point in a room with a lot of Wi-Fi traffic makes perfect sense. Similarly, you don't want to put an access point where there are not many devices to connect to. In each room/location you need to service, we must also consider the access point's specific physical positioning. To offer the best signal strength to the areas it will cover, access points must be constructed in ideal places. Access points should generally be put below a ceiling in a location that will improve signal strength in all critical areas of the space for the most outstanding results. We will be using the MERAKI MR 53 series. It is

designated for subsequent generation deployments in school, office, hospital, etc. It also has high performance, enterprise-grade security, and simple management.

Router

For the router, there will be the Catalyst 8300 Series because it has a greater WAN port density and a redundant power supply. The systems come with a range of interface options ranging from low to high module density and backward compatibility with current WAN, LAN, voice, and compute modules. In addition, there will be two routers to provide more redundancy.

Buildings

ITE Building

The ITE building will use a topology that I like to call the dual star topology. There will be two centralized devices, two routers on the first floor of the building with two switches for each floor connected to the centralized router. The only exception is that the first floor will only be using one switch. This building is primarily used for technology majors, meaning that there will be a lot of connections. There are multiple labs on floors three and four with the fourth floor being the largest number of computer labs. Each computer lab will most likely have 10-30 different

computers in the room. This means each computer lab will need its own access point or at most share an access point with one other classroom.

In order to help prevent entire floor outages due to one faulty switch, each floor will be provided with two switches. The switch will be located in the north section of the building or the south section of the building. These switches will be connected to the other switch on their floor to help have redundant paths in cases of failures. The south will be connected to router number one and the north will be connected to router number two. The north and south region will be mapped out by the dividing hallway that is present on each floor of the ITE building. The first floor switch will be alone of the first floor due to it being primarily office rooms that will not have as many computers as the other floors.

The switches for each floor will be located in the telecom rooms that are already placed in the ITE building. There is one room to the north and one to the south on the top three floors. These centralized locations will help keep cable length down. Each switch will be responsible for around 8 or 9 access points. 6a cables will be used primarily to connect all of the switches and access points together. This will allow the whole building to reach up to the 10 gigabit connection, which will be needed because the students will be video streaming and video games.

Potomac

The Potomac building will use a collapsed backbone because of its simple use case.. There will be a centralized device, a router on the ground floor of the building with individual switches for each floor connected to the centralized router. The building has a ground floor and three floors above it for a total of four floors. This building is primarily used for dormitory uses, so the building density will be lower than some of the others on campus.

The building is pretty long due to its unique shape. The two ends of the building are rather far apart from each other. The central hub for this topology will be the service room with a telecom room connected to it. The switch for each floor will be located in the center of the w-shaped floor style. This will allow for the cables to be routed north and south, reducing cable length. There will be roughly four or five access points on both sides of the switch which will be used exclusively for WIFI access. The switches will all be connected directly to the router in a star topology, however there is one modification. Each of the switches will be connected to the floor next to theirs. If one of these switches were to go down, the connection could be diverted to the next floor switch and then bypass the defective switch. This redundancy would be temporary while the switch is fixed, essentially doubling the load of a switch.

The students that live inside the dorms and apartments will all connect to the internet via WIFI. These access points were strategically placed in each of the service rooms that are conveniently located in grids that would allow connectivity to be strong. There is a maximum of two people in a dorm and there are around 10-20 people per access point in the building. 6a cables will be used primarily to connect all of the switches and access points together. This will allow the whole building to reach up to the 10 gigabit connection, which will be needed because the students will be video streaming and video games.

Sondheim Hall

For the Sondheim building, A collapsed backbone will be the best choice for the design where we'll have a centralized device, two routers on the first floor with individual switches on each floor connected to the centralized router. The building has a basement and height floors composed of:

- A sub Ground level
- 6 class lab room, seven faculty rooms, and five research rooms in the basement,
- 11 classrooms on the first floor,
- 17 staff rooms and eight classrooms on the second floor,
- 25 staff rooms on the third floor,
- 22 staff rooms and three classrooms on the fourth floor,
- 17 staff rooms and 3 study rooms on the fifth floor,
- And the sixth floor.

The size of the building is approximately 58.67m by 57.46m. Therefore, we will use the maximum cable run the length of 100m. The best location for the network equipment will be the first-level office with easy access to the basement floor for future growth. Flood protection will also be available on the first floor. Therefore, the wires will be routed from a central location in a first-floor workplace. This room must also be physically secure, with appropriate authorized access. Two routers will be located on the first floor of the building with one switch for each floor connected to the centralized routers. In total, we will have 8 switches. One of the switches will be 48 ports because of the number of computers on that floor, and the other seven will be 24

ports. The cable cat 6a will be used in this building as well because the twisted pair design used is more durable, has a larger capacity, and extends the maximum length to 100 meters while running at 10 Gigabits, making it ideal for high-end applications like 10 Gigabit Ethernet. Each switch will have around 10 access points to allow a strong connection between devices. The building will use the tree topology because it enables great scalability since the leaf nodes can add one or more nodes to the hierarchical chain. If one of the nodes in a network is destroyed or stops operating, the remaining nodes in the network are unaffected. Tree topology allows for simple maintenance and defect diagnosis.

Administration Building

The administration building is a big building and has high staff members. Keeping that in mind I want to create a ring topology between the floors so the devices can be connected to each other and will have high-speed data transmission and will flow in one direction which will help reduce the chance of packet collisions. An external redundant power supply (Cisco Redundant Power System [RPS] 2300) will be added just so there is no disruption. MERAKI MR Series 53 port will be used to connect the access point and the switches, so it can also perform the router function. This will help to connect the wide variety of fiber and Ethernet cables in order to extend switching functionality throughout the network.

There is no heavy network traffic needed on the ground floor because there will mostly be students and 1st to 10th floor will need more switches as mostly staff will be working on these floors which will increase the demand for the network. I will be using 1 on the ground floor and 3 on the other floors, total will be 31 Cisco Catalyst 2960-X series. And two routers (Catalyst 300 series) will be used to connect the devices which will connect the packet-switched networks and subnetworks in the building.

The Network equipment used in this building is Cisco Catalyst 2960-X series with 29 ports. These switches have one fixed power supply and an external redundant power supply. The reason for choosing this series is that it has stackable gigabit ethernet layer2 and layer 3 access switches. This series uses 802.1X for port-based network access control. The Cisco 2960-X will provide the PoE and the gigabit ethernet access to the people in the building. The budget can go a little higher because this building is bigger and has 11 total floors. In the diagram below the blue circles represent the access points, orange squares represent the Cisco Catalyst ports and red represents the routers..

Biological Sciences Building

The building has multiple levels and a basement. Each level has multiple rooms. All computers in one level will be connected to a switch. In turn, switches from each level will be connected to one main switch, which will be located at the lobby at the fifth level. This central switch will be then connected to two routers, which provide up-link to the internet service provider (ISP).

For cabling, the building's network will utilize the industry standard CAT6 Ethernet cable. It is our choice physical connection between devices as it provides the maximum length of 100 meters to provide the needed 10 Gigabits Ethernet P2P connection.

The Cisco Catalyst 2960-X switches will be used for our connection. The main switch will have 48 ports while access switches on different levels will have 24 ports. This implies the Biological Sciences Building will have a 24 port access switch at each level and the 48 port one at the fifth level.

To maximize WiFi coverage, the access points (APs) will be centrally placed wherever they will be installed. They will be placed on the ceiling at ideal locations to optimize signal strength throughout the different levels. Our choice AP is the MERAKI MR 53 series, which is designed for deployment in places such as schools. Besides, this AP model provides high performance, enterprise-level security, and is easy to manage. Additionally, WiFi powerline extenders will be deployed across the site on a need basis.

The router model used to connect to the ISP will be the Catalyst 8300 Series due to its high port density and redundant power supply. There will be two of these for redundancy.

In general, this will make up the design for both the buildings.

Performing Arts and Humanities Building

This building has four levels and a basement. It will utilize the same network design and technology as that of the Biological Sciences Building. Correspondingly, it will have a single 48 port Catalyst 2960-X switch for its core infrastructure and four 24 port Catalyst 29160-X switches as access nodes for the four different levels. Similarly, there will be two routers connecting this site to the ISP and will use the same model of APs.

Data Center

The Data center diagram was developed using a 3 layer topology. This topology joined our core layer to the distribution and access layer while also connecting to the server farm. The core and distribution layers use layer 3 switches allowing for routing and VLANs. The server farm is split into 6 groups, each getting a dedicated layer 2 switch stack. These switches contain a variety of server types allowing for a certain level of redundancy. Within the data center will be a lot of cabling including both 10Gbps copper cabling and fiber optic cable. Because this is the backbone of the entire network, we will be having a lot of traffic coming through here. The 4 core l3 switches have 24 ports with 40Gbps each. Meanwhile the access switches have 48 ports of 10 Gbps each. Finally the 6 l2 switch stacks have 96 single Gbps ports per stack

	A	B	C	D	E	F	Total
Peoplesoft Student Administration Servers	2	2	2	2	2	2	12
12 Peoplesoft Human Resources Servers	2	2	2	2	2	2	12
10 Mail Backend Servers	2	1	2	2	1	2	10

8 Campus Portal Web Servers	1	1	2	2	1	1	8
8 LDAP Servers	1	2	1	1	2	1	8
8 Blackboard Servers	1	2	1	1	1	2	8
8 Active Directory User Volume Servers	2	1	1	1	2	1	8
8 Active Directory Departmental Share Servers	1	1	2	2	1	1	8
6 DNS Servers	1	1	1	1	1	1	6
5 General Campus Web Servers	1	0	1	1	1	1	5
4 RADIUS Authentication Servers	1	1	1	0	1	0	4
4 DHCP Servers	1	1	0	1	0	1	4
4 NTP Servers	0	1	1	0	1	1	4
4 Video Surveillance Servers	1	0	0	1	1	1	4
4 General Login Servers	0	1	1	1	0	1	4
4 Voice-over-IP (VoIP) Servers	1	0	1	1	0	1	4
4 Mail Frontend Servers	0	1	0	1	1	1	4
2 Calendar Servers	0	1	0	0	1	0	2
Total	18	19	19	20	19	20	115

Building distribution

When determining the logistics and costs of connecting all of the buildings together, it's important to consider the cabling costs. However for this project, we are assumed to have no cabling costs. This means that either the existing cabling is sufficient for use or we use gigabit ethernet cables. We will be using WAN technology in order to connect all of the buildings in the campus. The WAN will be utilizing cell switching in order to get the low latency and high

throughput that the whole campus will need. In terms of technology, the system will use a frame relay to create the topology between buildings.

UMBC does not have that many buildings on campus and they are almost all in proximity to each other. Using a mesh topology would be within the realm of feasibility. This would provide a high amount of redundancy and would help reduce latency due to not having to route through multiple buildings. The core will consist of a Cisco NCS 5002 router that will handle the majority of the WAN connections. This will be sufficient for the buildings that were assigned to this group but it would need to be possibly upgraded. Lastly, the whole WAN system will use a Cisco 9906 edge router to connect the entire campus to the internet while keeping the campus as its own local network in itself. This single access point will serve the whole campus, at least for our specific seven buildings. It is possible that it would need to be upgraded to a higher end model if the other buildings on campus needed the power.