

# Dickens Designs

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## Dickens Designs Network Design Proposal

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# Introduction

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## 2.0 Executive Summary

Dickens Designs is a digital media signage firm with 2,500 employees. The offices are located within the United States and are spread across six states. The firm has branch offices located in Charlotte, NC; Nashville, TN; Savannah, GA; Kansas City, MO and Denver, CO with the corporate office in Huntsville, AL. The company offers digital signage and implementation services for clients nationwide. In addition to custom signage for businesses, one division of the company focuses on the management of digital highway sign advertising. Aside from the actual content management for the signs, the division also manages the ownership of the real estate on which the signs are located.

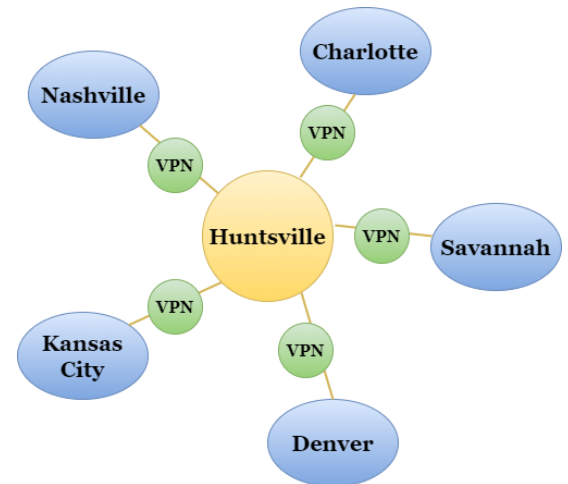
Dickens Designs wants to build a stronger and more efficient network which will link all branch offices to the corporate office in Alabama. The network design will have 3 components: a wide-area-network (WAN), a backbone network (BN), and a local-area-network (LAN). The WAN will use 1000Base-FX Gigabit Ethernet over fiber optic cables using the star topology. Then, the WAN will need to be connected to a rack-mounted switched BN that uses 100Base-TX Ethernet over CAT5 UTP straight-through cables. The BN will have switches at both layer 2 and 3. Finally, all BNs will connect to switched 100Base-TX Ethernet at each LAN location. Each LAN will connect several departments and their workstations to the BN, that will ultimately connect back to the WAN.

## Project Description

The proposed network is designed to link Dickens Designs' corporate office, located in Huntsville, AL, to the company's five branch offices, located in Charlotte, NC, Nashville, TN, Savannah, GA, Kansas City, MO and Denver, CO. For security purposes, each branch is connected through a VPN to ensure protection at the corporate office.

The corporate office of Dickens Designs has five departments that will be linked by the network. Each branch office has four departments that will be linked by the network as well.

The table below details the distance between each branch office and the corporate office. This will be used to determine the amount of cable needed.



Branch Locations	Distance to AL in miles	Distance to AL in feet
Nashville, TN	112	591,360
Savannah, GA	428	2.26 Million
Charlotte, NC	413	2.18 Million
Kansas City, MO	665	3.5 Million
Denver, CO	1,268	6.7 Million

## Network Objectives

1. **Security-** Prevent unauthorized access logically and physically.
2. **Speed-** Provide enough bandwidth to meet demand during periods of peak usage.
3. **Reliability-** Ensure that the failure of one system will not bring the entire network down.
4. **Scalability-** Sustain scalability without the need to rebuild the entire network. Changes and updates must be easy to implement.

## Design Assumptions

This network design makes the following assumptions:

- Dickens needs to have a sufficient network and server/storage infrastructure.
- Dickens has agreed to lease most if not all circuits in the network.
- Dickens doesn't share buildings with any other businesses.
- Dickens' offices have each department located on separate floors.
- Dickens wants a secure network design.
- Dickens uses Microsoft operating systems and productivity suites as well as Adobe graphic design products.

## Network Needs

- Traffic on this network will be file sharing including reports, design content, advertisements, accounting information, financial information, property profiles, and personnel profiles.
- Ability to handle graphics-heavy files, designs, web pages, and several databases.
- Needs to accommodate 2,500 employees across six locations.

## Three Layer Hierarchal Model

The Wide-Area-Network also known as WAN will be the core layer. This layer will experience most of the traffic, so faster connections will need to be used.

The Local-Area-Network also known as LAN will be the distribution layer. This layer will need to meet requirements but does not need the same speed as WAN. To keep costs down, this layer will not be as fast.

The devices in the access layer will be what employees are using. These devices will also need to meet network requirements and does not need the same speed as the WAN either.

Core Layer (WAN)- Cisco 9300 48P  
Layer 3 Switch

Distribution Layer (LAN)- Cisco 9200  
48T Layer 2 Switch

Access Layer- Devices such as dell  
products, printers, mobile devices,  
etc.

## Application Systems

Dickens Designs wants to use Microsoft operating systems and productivity suites. In order to create their designs, they also need to use Adobe graphic design products.

To the right is a software configuration idea, that has all the applications Dickens Designs will need. If one believes other products should be used, he or she can add or remove the proper applications and use whatever the company believes will be more beneficial.

Most of the applications in this specific configuration will use HTTP over TCP/IP and Windows file access. However, the Adobe Creative Suite will use FTP while Sage 50 Quantum 2021 Remote Desktop Protocol (RDP).



## General Network Information

Users Network	Transmission Speed	Security
Dickens Designs' network must accommodate 2,500 employees. Each department within the company will be using the network in some way or another. Thus, it is safe to assume that each department will produce different levels of traffic. However, it is most likely the highest amount of traffic will be generated by the accounting, finance, and sales departments. The least amount of traffic should come from human resources and customer service.	Dickens Designs' transmission speed should be as quickly as possible since there are numerous amounts of projects and clients. The network should be able to handle meaning that the network needs to handle transmission as quickly possible. Based on the company's data, data rates of 100 Mbps for each LAN and 1 Gbps for the WAN will meet network needs.	Dickens Designs' physical security will include keeping computers and servers behind locked doors with controlled access. Access will be controlled by a security surveillance system, security guards, and access cards. Dickens Designs logical security will include VPNs which will connect the branch offices to the corporate office. This will allow data to flow safely across the Internet between the corporate and branch offices. Employees will have Usernames and passwords, and they will only have access to files and servers they need to perform their job functions.

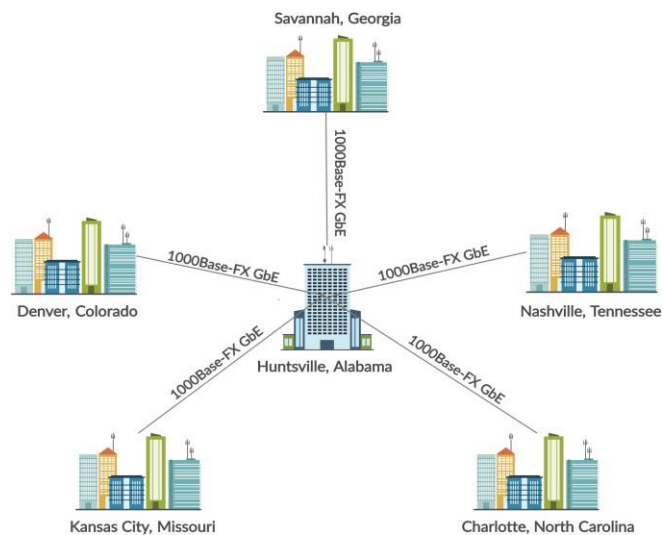
# Dickens Wide-Area-Network (WAN) Design

Dickens Designs will have one wide-area-network connecting all the branch offices to the corporate office in Huntsville, AL. The WAN will be connected to the backbone network, which will connect to all the LANs in each branch office. Thus, the branch offices will be connected to the WAN. Each employee's workstation will be connected to a department LAN. As a result, this will enable all the different departments to share files, designs, data, and other relevant information.

## Dickens WAN Design

As previously mentioned, this WAN will have a star architecture. The star topology is very popular and has increased scalability. It will be easier to manage and will ease the probabilities of network failure by connecting all the branch offices to the corporate office.

Figure 4.1 Dickens' WAN Design

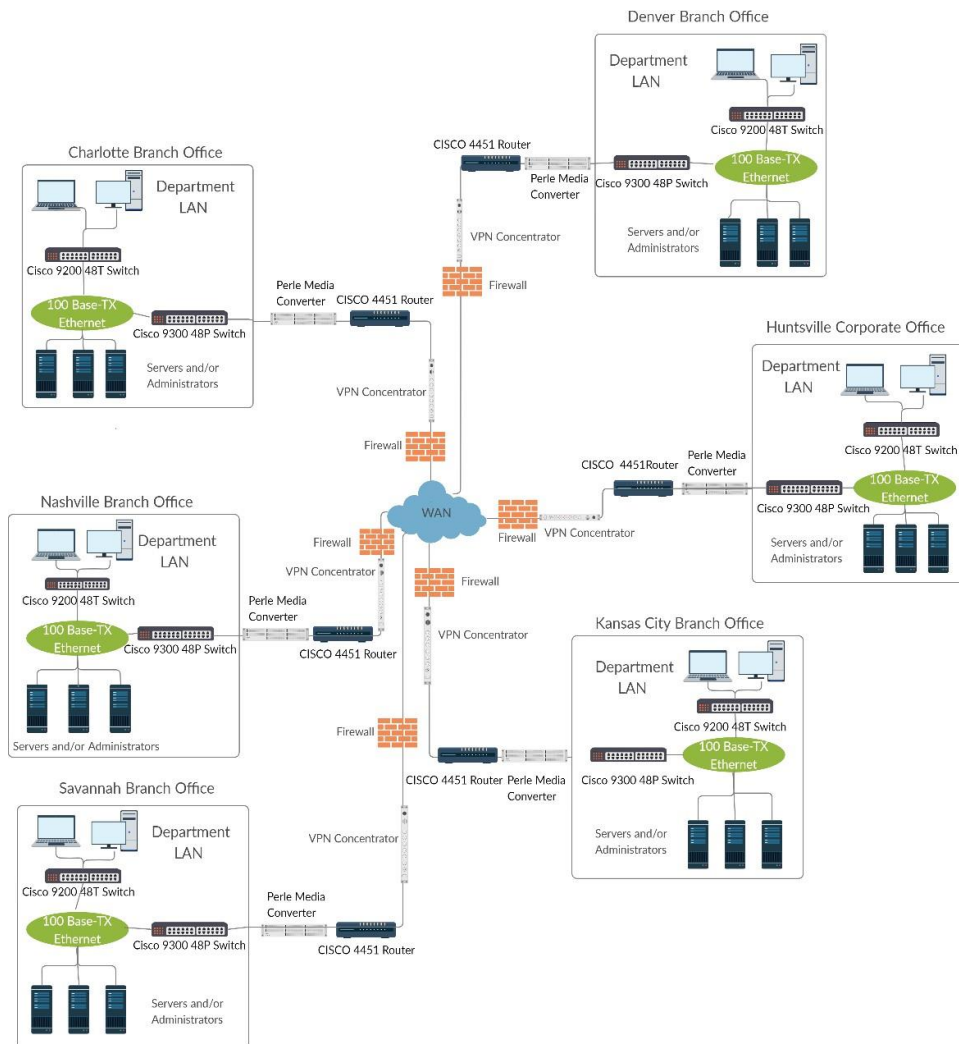


## Dickens WAN Architecture

Network Technology	For the WAN, Dickens will be better off using the 1000Base-FX Gigabit Ethernet with fiber optic cables. By using Gigabit Ethernet, the entire network will be able to use the same technology. This eliminates additional complexities, future problems, and procedures. With the implementation of the Gigabit Ethernet, this will allow Dickens to have great-depth of scalability if they want to eventually expand and have more branch offices in the future.
Cabling	The WAN will have connection from each branch office to the corporate office. The fiber optic cable will be laid to connect all branch offices to the corporate office in Huntsville, Alabama. The amount of cable needed for each location will be determined by the distances between cities. Dickens Design will need to investigate using leased lines to help keep costs down.

<b>Hardware Configuration</b>	<p>It is important to note that the WAN uses 1 GbE over fiber cables, and each LAN uses 100 Mbps with Category 5 cables. This means that we will need to use media converters to make flowing traffic compatible through the cables. I suggest using the Perle S-1110 SFP Media and Rate Converter. A media converter will be required at every location including the corporate office. Thus, 6 media converters will be needed. However, Dickens should purchase 7 media converters in case one crashes or has other problems.</p> <p>The core layer of each office will need to have a layer 3 (L3) switch. A L3 switch can come in handy for the future. This switch allows a company to create vLANS. Each location will need a CISCO 9300-48-P switch. This means that 6 L3 switches will be needed. However, Dickens should purchase 7 L3 switches in case one experiences problems.</p> <p>The distribution layer of each branch office will have a total of 5 layer 2 (L2) switches. There will be 4 L2 switches (Cisco 9200 48T Switch) for each LAN because there are 4 departments in each branch office. There will also be 1 L2 switch for the DMZ. The distribution layer of the corporate office will have a total of 6 layer 2 (L2) switches. There will be 5 L2 switches for the 5 different departments, and 1 L2 switch for the DMZ.</p>
<b>Security</b>	<p>All traffic to the Internet will be routed through the corporate office in Huntsville, Alabama to limit the points at which an outside attack can occur. The WAN will have a VPN concentrator at every cable connecting to a branch office. It will also have a firewall behind the VPN connector for extra protection and security. In total there will be 5 VPN connectors and 5 firewalls. This will increase security throughout the entire network. The network will also have demilitarized zones (DMZ) at each location that contains servers, should an intruder get past the VPN concentrator and firewall.</p>

Figure 4.2 Dickens Designs' Wide-Area-Network (WAN)

**Key Highlights:**

1. Each location has a CISCO 4451-'p- router.
2. Each location is connected to Huntsville, AL using 1GbE with 1000Base-FX cables.
3. Each location has a Perle media converter.
4. All Internet traffic is routed to the corporate office to limit entry points.
5. Each location has a L3, CISCO 9300-48-P switch.
6. Each location has a VPN concentrator and a firewall connecting to the central location (corporate office).

## Dickens Backbone Network (BN) Design

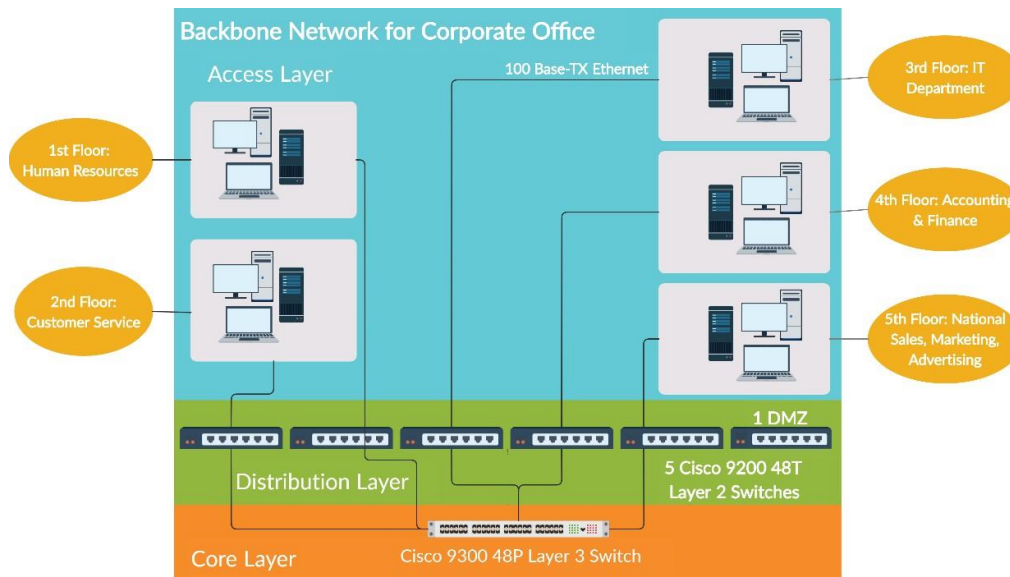
Dickens BN will consist of switched backbones that form a star topology. There will need to be a BN for the corporate office as well as a BN for each branch office. The backbone switches need to be located in a secure and centralized location at each office. My suggestion is that the switches are on the lowest bottom floor or on the floor that is in the middle of the building. Having this type of BN will allow employees to have an easier time with upgrades and maintenance. The advantage with this design is scalability, the disadvantage is buying more cables.



## Dickens BN Architecture

Network Technology	Again, the BN uses 100Base-TX Ethernet since it doesn't require much Mbps. This is why the network will require us to have the media converters for the WAN to pass traffic from the WAN to the LANs or vice versa. The backbone network is crucial in allowing traffic flow through the appropriate locations.
Cabling	The GbE connection from WAN runs through the media converter and goes straight to the Cisco 9300 48P L3 switch. When the connection reaches the L3 switch, it will then connect to the Cisco 9200 48T L2 switches and the DMZ at the branch offices. The same routine will occur at the corporate office where the L3 switches connect to the L2 switches and DMZ. Since all switches will be in the same room and on the same floor, it will not require a lot of Category 5 cabling.
Hardware Configuration	The BN will need a total of 31 L2 switches; this also includes the DMZ's since they are also considered Layer 2. There will be five L2 switches in each branch office which includes one DMZ. So far this brings the total number of switches to 25. Then, there will be six L2 switches in the corporate office which brings the total number of switches to 31. I have suggested that if Dickens has the budget for it, the company needs to purchase an extra switch in each location for a backup. Having a backup at each location would bring the total number of switches to 37. All switches will be rack-mounted in a central location of each location. Two racks will be needed at each branch location, and the corporate office will require 3.
Security	Since the WAN will only have one entry point and the WAN has a VPN and a firewall, the BNs will not require to have built in security. As a result, the BNs will not have to have security because all the security will be handled by the WAN.

Figure 5.1 Dickens Designs' Corporate Backbone Network (BN)

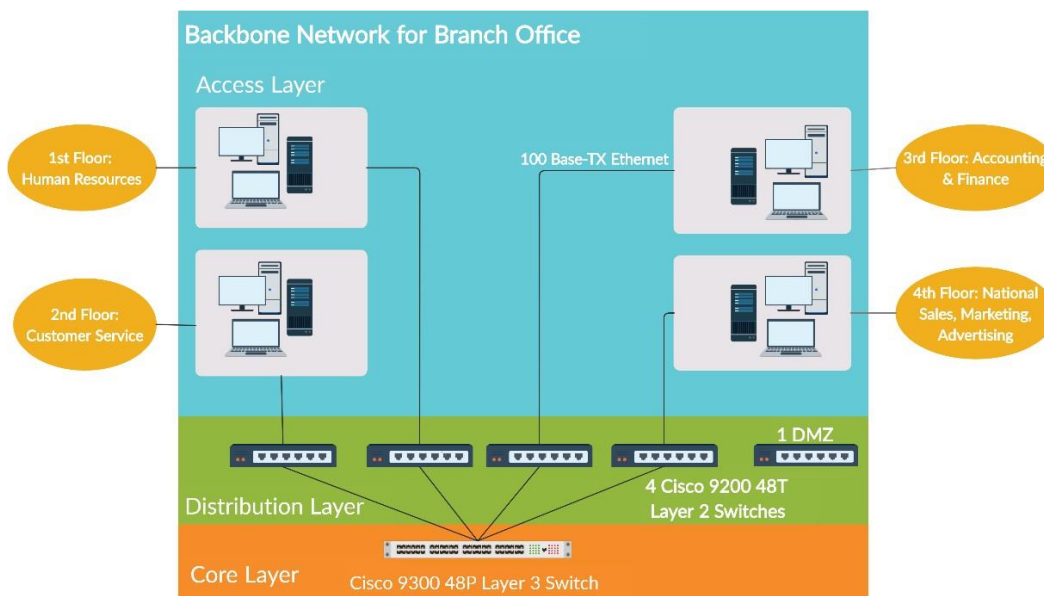


This diagram above shows the BN of the corporate office. There are 5 departments, and each department is located on a separate floor. The BN can be split up into 3 different layers; these layers are the access layer, distribution layer, and core layer.

### Key Highlights:

1. The corporate office has 5 departments; it will need 5 Cisco 9200 48T switches and 1 DMZ.
2. The office needs one Cisco 9300 48P L3 switch.
3. Each department will use 100Base-TX over Category 5 cables.
4. The DMZ adds an extra layer of security to the LAN within the network.

Figure 5.2 Dickens Designs' Branch Office Backbone Network (BN)



This diagram above shows the BN of a branch office. All 5 branch office locations will have this type of layout. Thus, this diagram can represent the four other branch offices. Each branch office will consist of 4 departments each on a separate floor.

### Key Highlights:

1. Each branch office has 4 departments; it will need 4 Cisco 9200 48T switches and 1 DMZ
2. The branch office needs one Cisco 9300 48P L3 switch.
3. Each department will use 100Base-TX over Category 5 cables.
4. The DMZ adds an extra layer of security to all the LANs within the network.

# Dickens Local-Area-Network (LAN) Design

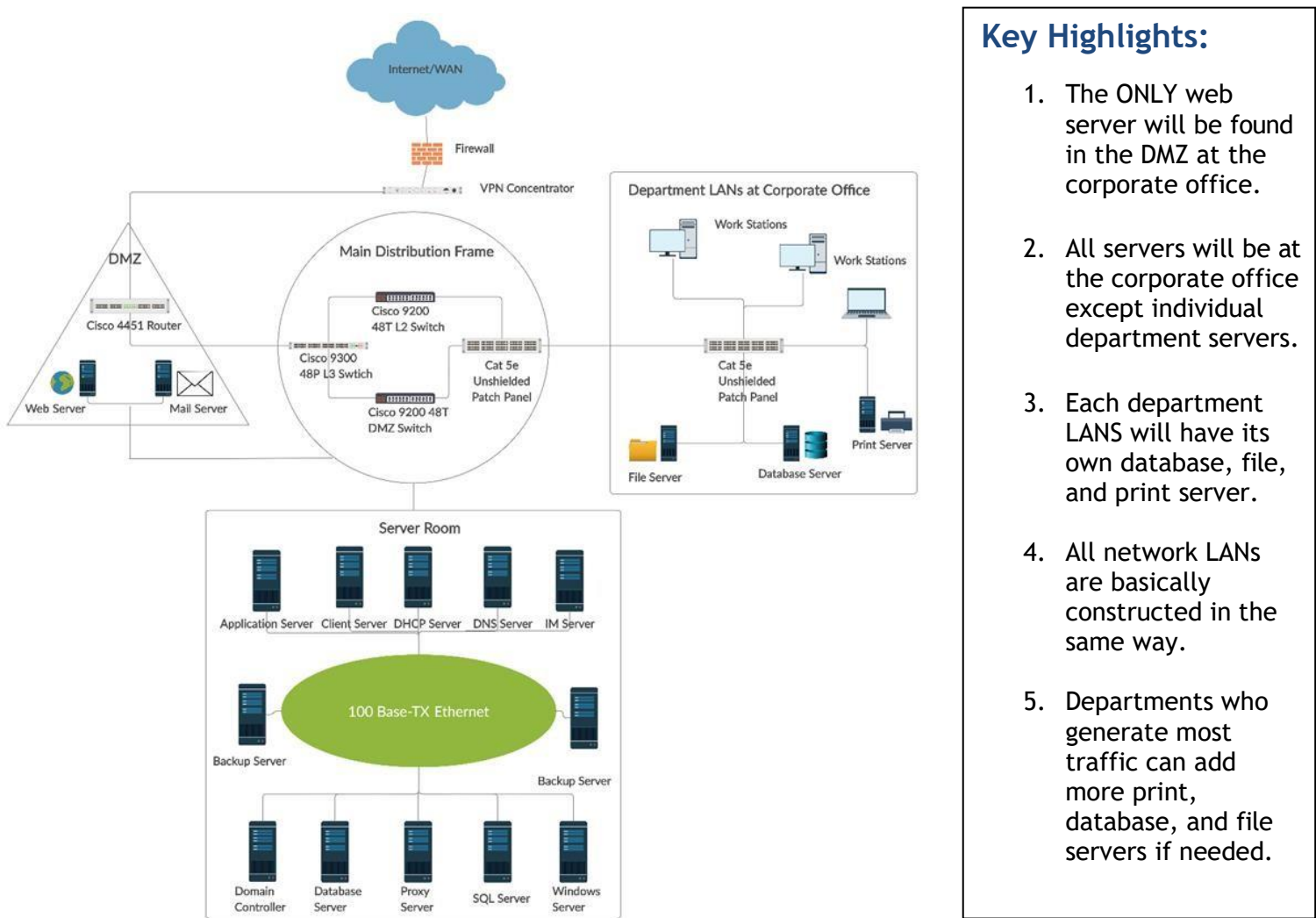
Like all WAN and BNs, the LANs will also have a star topology. Each department LAN will be a client-server network. This is the most common format of modern networks and will allow employees to share information, data, and files with each other. The LANs will use point-to-multipoint circuits to connect one device to multiple network devices. This will also help lower costs.

## Dickens LAN Architecture

Network Technology	All of the LANs will use switched 100Base-TX Ethernet. Having this type of ethernet will be more efficient and cheaper. It will allow each individual circuit to connect to a switch. This is where point-to-multipoint circuits come in. Once the circuit connects to a switch, it makes a separate point to point connection. As a result, fewer collisions should occur.
Cabling	Knowing that each department is located on a separated floor, really makes organization easier. Assuming the corporate office is 6 stories tall, at the maximum, an employee will be 70 feet vertically from the main patch panel. Assuming each branch office is 5 stories tall, at the maximum an employee will be 60 feet vertically from the main patch panel. Thus, it will require a lot of cable to run down from the workstations to the main patch panel. The corporate office will need no more than 40 rolls of 1,000 ft. Category 5 cable, while the branch offices would need 20 rolls each.
Hardware Configuration	<p>Corporate Office- Will need to have all the servers for the entire network, except for servers such as each branch's department files, databases, and printers. Depending on the number of employees working at the office, there will also need to be a certain amount of domain controllers. There will need to be a database server, DHCP server, and DNS server. The DMZ will contain a web and email server. Other types of servers that could be included but are not limited to are an application server, Windows server, Client server, SQL server, Proxy server, or IM server. There should also be at least two back up servers.</p> <p>Branch Office- Will have similar configurations to the corporate office. However, the branch offices will not need as many servers. These offices will have to require two types of servers which include a domain controller and email server. The DMZ will contain the email server. This means the servers at the corporate office will take care of the branch office's network services. All workstations within the branch office will</p>

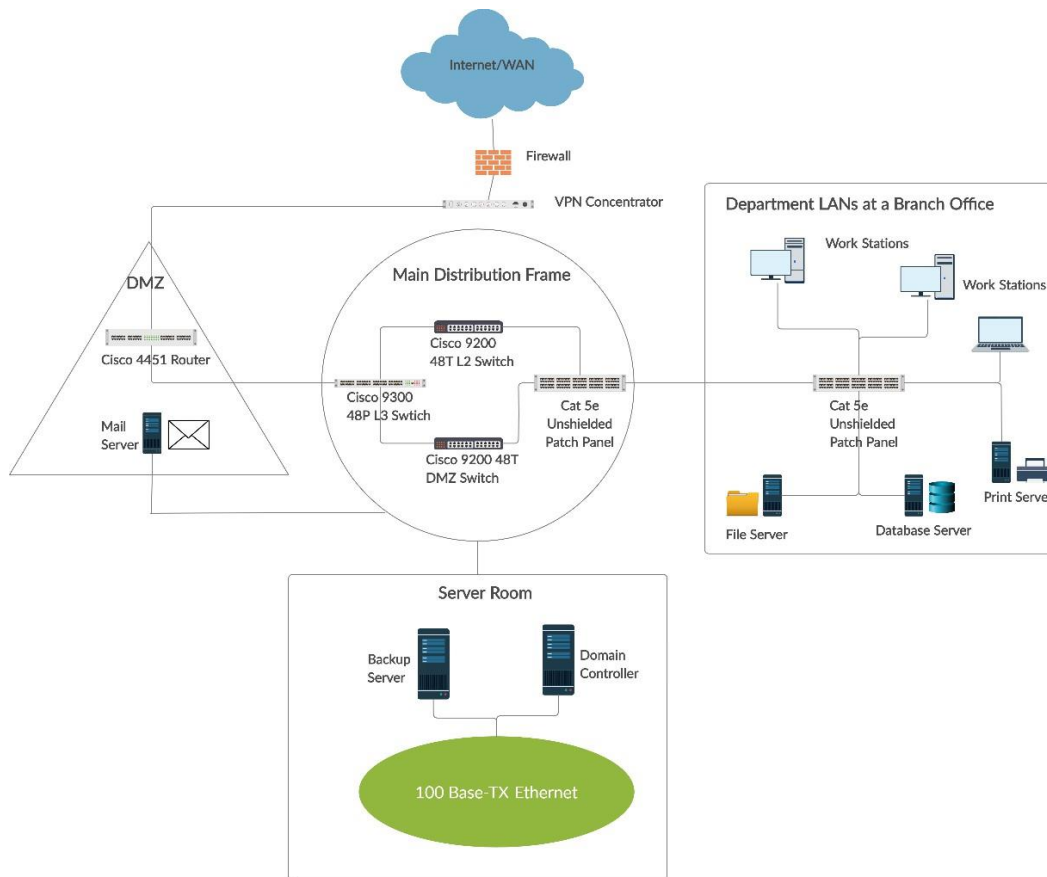
	connect to a patch panel. By using cables, this patch panel will connect to the main patch panel which is connected to a Layer 2 Switch. Then, the Layer 2 switch is connected to a Layer 3 switch. The, the Layer 3 switch connects to a router. Finally, this router will connect the LANs/workstations back to the WAN.
Security	Since the WAN will only have one entry point and the WAN has a VPN and a firewall, the LANs will not require to have built in security. As a result, the LANs will not have to have security because all the security will be handled by the WAN.

Figure 6.1 Dickens Designs’ Corporate Office Local-Area-Network (LAN)



This diagram above shows how the LAN works at the corporate office level. It shows only 1 of the 5 department LANs that are in the corporate office, but it can represent the other four departments. By looking at the LAN level only, one will realize that the same design and configurations look similar to the branch offices.

Figure 6.2 Dickens Designs' Branch Office Local-Area-Network (LAN)

**Key Highlights:**

1. For the branch offices the LANs will **ONLY** have the email server in the DMZ.
2. Each department LANs will each have their own database, file and print servers.
3. Branch offices **ONLY** have two servers (email server and domain controller).
4. Servers at the corporate office will be the source of network services.

This diagram above shows how the LAN works at each branch office. It shows only 1 of 4 department LANs, but it can represent the other 3 departments. It also represents only one branch office; the other 4 branch offices would look identical to this representation. The server room only has two servers, and each department LAN must require a print, database, and file server.

## Dickens' Total Costs

Below is a table that represents all equipment bought for the entire network. Most of the parts come from Cisco. If the costs seem too high Dickens can look at other retailers for different options. In other words, prices may vary by retailer. Also, the quantity of parts may decrease if the company decides they do not need as many servers or as much security.

### Equipment Analysis and Equipment Costs

Product	Model	Price	Quantity	Total
Cisco Firewall	Firepower 2130	\$3,450	6	\$20,700
Cisco VPN Concentrator	3060	\$883	6	\$5,298
VPN Software	Cisco AnyConnect Plus	\$1.99 per employee	5,000	\$9,950
Cisco Router	4451	\$6,798	12	\$81,576
Cisco Layer 2 Switch	9200 48T switch	\$932	35	\$32,620
Cisco Layer 3 Switch	9300 48P switch	\$1,700	8	\$13,600
Cisco Rack Mountable Server	UCS C480 M5 rack server	\$10,300	12	\$123,600
Perle Media Converter	Perle S-1110-SFP media converter	\$305	6	\$1,830
Cat 5E Patch Panel	Cat5E unshielded patch panel	\$80	12	\$960
Power Edge Rack Servers	Power Edge R440	\$2,349	47	\$110,403
Cat 5E Cable	Cat5E plenum shielded	\$275 per 1,000 feet	70	\$19,250
Fiber Optic Cable	Bulk Fiber Optic Cable Zip Cord Multimode	\$300 per 1,000 feet roll	15,232 rolls	\$4,569,600
Total Cost				\$4,989,387

Based upon the table Dickens Designs will need to spend approximately 5 million dollars on their new network and services. This is a rough estimate of the costs and can be reduced depending on what the company sees as its main issues, needs, and priorities.

## Conclusion

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After the implementation of this network design, Dickens Designs will have a stronger and more efficient network. Having a WAN, BN, and LAN will connect all branch offices for the corporate office. All three components of the network design use a star topology to allow traffic and information to flow between the offices. The WAN uses 1000Base-FX Gigabit Ethernet over fiber optic cables that is connected to the BN which uses CAT5 UTP straight-through cables. The BNs then connect to switched 100Base-TX Ethernet at each LAN location. Having the networks organized and connected in this manner ultimately connects back to the WAN.

Within the design, I did not mention much about the IP addressing and routing. The network will need to be split into 6 locations. The network will need to be assigned to a class A, B, or C subnet. I would suggest the subnet be Class A or B since those are best for bigger networks. There will also need to be a routing protocol which will explain how routers communicate with each other to distribute information. The routing protocol that is selected by Dickens should allow them to select routes between any two branches within the company. I would suggest using the Intermediate System-to-Intermediate System (IS-IS) protocol. IS-IS allows for 1 database for both IPv4 and IPv6 addresses. This comes in handy because the Dickens Designs' current management software utilizes IPv6 over the cellular network. Thus, there needs to be a way to communicate and keep track of the IP addresses that could possibly be IPv4 or IPv6. IS-IS makes sure to find the best path to and from each destination. A routing table will need to be developed so the companies can communicate with each other.

In conclusion, Dickens Designs' will have a more stable network. The only issue that still needs to be addressed and needs to have a better plan is the IP addressing for each location. The IP addresses will need to be assigned consistently throughout the network. There also needs to be a clearer plan for how many servers will need to be used at the corporate office in Huntsville, Alabama. If Dickens decides they do not need as many servers within their network, this will also reduce the price of the network. However, there needs to be a file, print, and database server for each department and location. Finally, Dickens also needs to decide whether or not they want to have Internet plan with both AT&T or Verizon. I propose that Dickens Designs makes a deal with AT&T for their Ethernet Internet Connection for the network and VPN because in my opinion, AT&T has better services, more reliability, and better pricing. I estimate that the network will cost between 5 and 6 million dollars.

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