University of Hertfordshire

School of Computer Science

BSc Computer Science Networks

Module: Network Protocols and Architectures

Assignment

Designing a Network Based on The Specification and Floor Plans given

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Level 6

Academic Year 2020 - 21

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Module Name: Network protocols and Architectures

Module code: *6COM1067*

**Chapter 1: LAN – Logical & Physical Designs**

**Section 1: 2 Diagrams:**

1: LAN Logical

Chart, scatter chart

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2: LAN Physical

Diagram

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**Section 2: Design Description:**

I have been tasked to design a network for a business based on a specific floor plan which has one floor and six rooms one of which is the comms room that will be set aside and devoted to storing data storage servers and computer networking devices for the site.

Depending on the size of the room and the business needs this room can normally store anywhere from one to several hundred servers and devices. (Admin, 2022)

In our case it will store the rack, two access and two distribution layer switches, two firewalls, two border routers, two (ISP) internet service provider routers and finally the WDM router.

Each office is then equipped with 6 desktop pc’s that all operate critical functions and are all connected to both the access layer switches, the idea for this is that in case one switch fails the other can automatically take over (Dooley, 2017) therefore redundancy will be critical in our network design.

I will also be using the 1000BaseT,1Gbps, RJ-45, CAT6 copper cable to connect all end PCs to the access layer switches, as this cable can operate at 1000Mbps or 1Gbps, and was chosen after research and learning that 1000BaseT is the most widely used networking standard for businesses. (Dooley, 2017)

Furthermore, after more research I came to learn that the average download speed that a business uses is 25Mbps and an upload speed of 3Mbps. (Morrison, 2020)

From those statistics you can understand that I may have used the 100baseT, 100Mbps, CAT6a cable but due to scalability and with the internet technology evolving fast and everyone now looking for faster speeds we should look to be a step ahead and advanced.

Gigabit Ethernet has also swiftly surpassed previous Ethernet standards including Ethernet (10BASE-T, 10 Mbps) and Fast Ethernet (100BASE-T, 100 Mbps) as the de facto network equipment standard. (wright, 2021) It is supported by nearly all contemporary equipment nowadays and provides enough performance for the majority of common applications. 1000BASE-T is utilised for endpoint client connections as well as common server interconnects. On the access layer, almost all networking equipment support it, while some backbone applications may require a faster standard.

Gigabit Ethernet cables have now even been included in many household devices manufactured in the previous decade. (wright, 2021)

The maximum length for this cable is 100meters or about 330 feet which should be enough as the business I am designing for is on one floor with all rooms situated near each other and very close to the COMMS room where all hardware devices will be stored.

Something also to note is that faster standards are now also compatible with 1000BASE-T cabling. The same Cat5e and Cat6 cables may be used for 2.5GBASE-T (2.5 Gbps) and 5GBASE-T (5 Gbps) Ethernet, Over Cat6e connections, extremely fast 10GBASE-T (10 Gbps) is possible. These standards are interoperable and self-negotiable, allowing for quick upgrades. With simply simple improvements, businesses and customers may continue to utilise their existing wires while increasing available bandwidth. (wright, 2021)

In my design I have also taken it a step further and decided to keep the network diameter low by reducing the number of switches to ensure low and predictable latency between devices.

The network diameter is known as the number of switches in the path of traffic between two endpoints.

This Network has been designed based on the cisco three-layer hierarchical model which consists of an access layer, distribution layer and core layer. Every network engineer knows how sometimes networks can be extremely complicated, and hence why cisco has designed this model for a reliable network infrastructure.

This three-layer model helps us design, implement, and maintain a scalable, reliable, and cost-effective network. Each layer has its own set of features and functions, reducing the network's complexity.

(Cisco three-layer hierarchical model, 2022)

The first layer is the access layer and will include the two switches that are connected to all the end devices with the 1000BaseT, RJ-45, 1Gbps cable as explained above, again also to maintain redundancy, which in our case are the six PCs in five rooms. The switches in this layer ensure packets are delivered to all the end devices, as well as connecting the end users to the network at the distribution layer.

Furthermore, you can also manage access control and policy, create separate collision domains, and implement port security at this layer. (Cisco three-layer hierarchical model, 2022)

The distribution layer is the second layer and functions as a point of contact between the access layer and the core layer. Its key responsibilities include providing routing, filtering, and WAN access, as well as determining how packets can access the core.

This layer assesses the most efficient method of accessing network service requests – such as how a file request is sent to a server – and, if required, transmits the request to the core layer. Routers and multilayer switches are commonly found in this layer. (Cisco three-layer hierarchical model, 2022)

In our design this layer will include two switches, that will also both be connected to both the access layer switches and both core layer switches also to maintain redundancy, using the 10Gbase-SR, 10GE, SFP+, MMF, 10Gbps, 400m fiber optic cable.

I am using the 10Gbase-SR over the LR, as SR stands for short range and thus is intended to transfer over shorter distances. I will also use the 10Gbase-LR in more core layer to connect to one of the internet service provider routers.

In today's telecommunications network, 10G fiber networks are popular, and 10G switches are commonly utilized by consumers to provide faster fiber optic speeds and is the most reliable in the sense that they loose fewer packets as well as losing less signal compared to copper cable connections which are far less reliable and nearly outdated especially with our modern-day technology improving rapidly. (Lite, 2020)

Cisco switches are the most common, according to research. And therefore, you must use a Cisco compliant optical module, such as an SFP optical module or an SFP + optical module, if you are utilizing a Cisco switch. (16 Most Common Questions Of Cisco SFP-10G-SR You Need To Know, 2017)

And as you can see from my designs, I will be using a cisco switch.

Both cisco switches from this layer will be connected to both access layer switches as well as both border routers in the core layer, this again is in case of any single point failure, we will still maintain connection as we have redundancy with the 10Gbase-SR, 10GE, SFP+, MMF, 10Gbps, 400m fiber optic cable for faster and more reliable speeds as these routers handle a lot of traffic.

I have also two added firewalls for security also connected with the 10Gbase-SR, 10GE, SFP+, MMF, 10Gbps, 400m fiber optic cable to the core and distribution layer switches.

The firewalls defend the network from harmful applications and unauthorized connections. It acts as a security guard, evaluating every traffic and data packets that try to enter your network before allowing them in based on well-established regulations.

A network without a firewall is like a building without a secure front door: anything or anybody may get access without difficulty. (Why Does My Business Need a Firewall? - TFM Networks, 2021)

The core is the third layer and is often known as the network backbone and oversees the distributing of large amounts of traffic efficiently throughout the network. The core layer provides interconnectivity between distribution layer devices and is often made up of high-speed devices such as high-end routers and switches with redundant links. (Cisco three-layer hierarchical model, 2022)

Our design will have two border routers in this layer both connected to each other to maintain redundancy and also to both switches in the distribution using the 10Gbase-SR, 10GE, SFP+, MMF, 10Gbps, 400m fiber optic cable, as well as both being connected to a WDM router using a 40Gbps DWDM connection and then each router separately being connected to one of two internet service provider routers, one using a 10Gbase-SR, 10GE, SFP+, MMF, 10Gbps, 400m fiber optic cable and the other using a 10Gbase-LR, 10GE, SFP+, SMF, 10Gbps, 25km fiber optic cable.

Our WDM router will have a 40gb DWDM connection to the border routers and to the WDM system in our (WAN) wide area network.

Based on the structure of my design and using the cisco three-layer hierarchy the network will be characterized with various benefits that will surely help the business execute and operate their work more effective and efficiently.

Some of the advantages of this design are:

Reliability - The three-tier model is the most reliable network design mostly because if one part of the network fails other parts are still up and running and will remain operational.

Availability - Because network redundancies are easier to deploy, availability improves as well. Switches at the access layer, for example, can be linked to two switches in the distribution layer. If one fails, the other is called upon. The distribution switches are also connected to numerous core switches, adding another layer of redundancy. (Popa, 2021)

Increased Scalability - The flexibility of hierarchical networks is greater than that of their counterparts. Segments and elements may be easily added to the network without causing major disruption. (Popa, 2021)

Because of the network's modularity, design components may also be copied and repeated. Consistent design from one module to the next will makes it simple for network administrators to plan and implement network expansion in the future while knowing that the topology will not change. As a result, networks may grow alongside the business with little to no downtime. (Popa, 2021)

Easier to manage - These networks are easier to administer since each network layer is intended for particular and consistent functions. If you need to update the functionality of an access layer switch, for example, you can confidently apply the same modification to all access layer switches since they all perform the same purpose. (Popa, 2021)

It's also easier to install new switches since configurations may be copied from one device to another without causing substantial changes. It's also easier and faster to troubleshoot and recover. (Popa, 2021)

Increased cost efficiency - IT networking equipment is a costly investment. However, because the company may limit the quantity of equipment to exactly what is needed based on the logical structure of the firm, hierarchical network architecture can save money.

(Popa, 2021)

The network's modular design allows it to grow without requiring large one-time investments. Rather than requiring a new set of routers and switches, adding a new department may easily be accomplished with a single access switch and a few Ethernet cables (many of which will sit underused). (Popa, 2021)

**Section 3: Network Hardware:**

**Access Layer:**

For my hardware choices in the access layer, I have decided to use the Cisco Nexus 93108TC-FX Switch as after research I came to learn that this switch supports the cables that will be using and has enough ports needed for my network.

It has 48 x 1-GbaseT ports, 6 x 40/100-Gbps QSFP28 ports.

The Cisco Nexus 93108TC-FX Switch is a 1RU switch with a bandwidth of 2.16 Tbps and a packet delay of 1.25bpps. The 93108TC-48 FX's 10GBASE-T downlink ports may be configured as 100-Mbps, 1-Gbps, or 10-Gbps ports. Up to six 40- and 100-Gbps ports, as well as a mix of 1-, 10-, 25-, 40-, 50-, and 100-Gbps connections, are supported by the uplink, allowing for various migration choices.

(Services, Switches, Switches and Sheets, 2022)

As we now know the network has 5 rooms with six PCs each amounts to 30 ports being used this also shows that with 48 ports in each switch, we will still have 18 ports free in case of future scalability and reduces the number of switches in the rack.

**Distribution Layer:**

In this layer I also decided to go with the same Cisco Nexus 93108TC-FX switches as they fulfil the requirements the network will need even in this layer.

**Core Layer:**

In this layer I have two cisco firepower 4112 firewalls that support the SFP+, has a processor/memory/storage of 400Gb, has a 10Gb ethernet data link protocol, rack-mountable, Firewall protection, High Availability, Intrusion Prevention System (IPS), URL filtering, VPN load-balancing, hot swappable 6 fans, Application Visibility and Control (AVC), firewall clustering to say the least.

For my border routers I will use the Cisco Nexus 93180YC-FX as it supports SFP+ and the DWDM connection needed for the WDM router, furthermore it can support up to 100Gbps.

The Cisco Nexus 93180YC-FX Switch is a 1RU switch that offers 3.6 Tbps of bandwidth and 1.2 bpps and has a latency of less than 1 microsecond. The 93180YC-48 FX's downlink ports may handle 1-, 10-, or 25-Gbps Ethernet or 16-, 32-Gbps Fibre Channel ports, bringing main storage, compute servers, and back-end storage resources together at the top of the rack. Up to six 40- and 100-Gbps ports, as well as a mix of 1-, 10-, 25-, 40-, 50-, and 100-Gbps connections, are supported by the uplink, allowing for various migration choices.

For 25-Gbps support, the switch is IEEE compliant and has FC-FEC and RS-FEC enabled. Wire-rate MACsec encryption is supported on all ports which is perfect for the network. (Services, Switches, Switches and Sheets, 2022)

**Chapter 2: WAN Design**

**Section 4: The Diagram**

WAN

Diagram

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**Section 5: Design Description:**

The WAN in the network has two STM-256 connection coming from my LAN border router, for redundancy I have implemented two STM-256 connections that allow 40Gbps, but only using one and the other on standby in case of a single point failure.

I also have will be using one wavelength of 40Gbps to connect the main premises to all the cities in my WAN I could also change it to 80 or 100 Gbps i.e. 8 wavelengths of 10Gbps etc...

As you can see from the diagram above this ring connection between the cities allow me to have redundancy within the network.

**Section 6: Network Hardware:**

The WDM will be the 40ch C21-C60 Dual Fiber DWDM Mux Demux, AAWG, with 1310nm and Monitor Port.

Based on AAWG (Athermal Arrayed Waveguide Grating) technology, the 40ch DWDM Mux Demux is a high density, low loss, and freestanding passive DWDM device. It maximises the capacity of the C-band range in line with the ITU-T G.694.1 100GHz grid.

The 40ch Mux Demux enables a broad range of designs, from basic point-to-point to amplified ring arrangements, when used in conjunction with the transponders and amplifiers.

This WDM has it has3.5dB Typical Insertion Loss, AAWG Technology 1% Monitor Port for Troubleshooting, 1310nm Port for Legacy Traffic Protocol Transparent for Ethernet, FC, OTN, SONET/SDH, etc.

Multiplexing of 40 Channels over a Dark Fiber Network,

Fully Compatible with All ITU-T 1G/10G/25G/40G/100G DWDM Optics Completely Passive, No Power& No Cooling Required

Support Metro, Regional and Long Haul DWDM Networks

(40CH DWDM Mux Demux, C21-C60 Wavelength Division Multiplexer - FS United Kingdom, 2022)

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