Cisco Edge Upgrade

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ABSTRACT:

With the continual and rapid advancement of technology, systems deemed prestigious today will be considered obsolete in less than a decade. These dramatic improvements in technology call for corporations to constantly upgrade their hardware and systems. This call for upgrading can be seen in Lehigh Valley Health Network’s enterprise network, a sophisticated system that allows thousands of devices to interact and communicate together, as well as connect to applications and the internet. In order to maintain usability and meet the demands of the ever expanding and developing LVHN, the I/S Infrastructure team has to upgrade and manage the components of this enterprise network. In view of improving the enterprise network, most recently the Infrastructure team is in the midst of upgrading their edge switches from Avaya Baystack 5510s to Cisco Catalyst 2960xs. Such an upgrade will allow for advancements for LVHN through aspects such as greater bandwidth, increased security, and better management of the network.

BACKGROUND:

Behind the Lehigh Valley Health Network and the healthcare it provides for the community is an enterprise network that allows the many devices of LVHN to intercommunicate and connect to the internet seamlessly. With over 30,000 devices connected to LVHN’s network at ten major sites, this sophisticated network is able to manage these devices, help maintain the speed of data communication, and limit technical difficulties of users. In order to do this, numerous networking components need to be thoughtfully integrated together. Over the years, the IS Infrastructure team has been continually upgrading the components of the network in order to increase data speed, improve efficiency, strengthen security, etc. Most recently, the Infrastructure team has begun upgrading the edge switches. These edge switches are at the end of the network and are what data patch ports connect to. Through this study, the goal is to piece together the multiple components of LVHN’s enterprise network, identify the benefits of their edge switch upgrade, and help the implementation of the Cisco Edge Upgrade.

METHODS:

RESEARCH OF NETWORK ENTERPRISE:

The first step in this study was expanding one’s understanding of the enterprise network of LVHN. Through the direction and presentations of the Infrastructure Team and independent research, an overall understanding of the network of LVHN and an enterprise network in general can be obtained. This overall structure that the network consists of is called the Dense Wave Division Multiplexing (DWDM) Ring.
The enterprise network consists of many components that connect the various sites of LVHN together and allow communication to occur. At the foundation is Layer 1, the Physical Layer of the OSI model: the physical fiber optic connections between the various ten locations, with each site possessing Ciena DWDMs (seen in the map below). Originally, these connections were limited to physical fiber optic cables that traveled from site to site, completing the ring topology (seen in the DWDM Ring diagram as the Black Connection). Such a limitation required data to be sent around the ring through multiple different sites, if necessary, since the different sites were connected logically and physically through these connections. For example, if data from a computer at the Cedar Crest Hospital site is being sent to the Data Center, it will have to pass through the Cedar Crest Professional Park site in order to reach the Data Center. Recently, the Infrastructure Team upgraded Layer 1 so that all sites are logically connected to the Data Center directly with either a one 10 Gb link or two 10 Gb links (seen in diagram as Red Connection), which according to the textbook, *Introduction to Information Systems*, bandwidth is the transmission capacity of a network in bits per second. In addition, all sites are also connected to the Data Recovery site by either a one 10 Gb link or two 10 Gb links (seen in

*Map of the physical fiber layout of the DWDM Ring connecting all main sites of LVHN.*
diagram as Orange Connection). Then between the Data Center and the Data Recovery site are eight 10 Gb links (seen in same diagram as Purple Connection).

The second component of the enterprise network is Layer 3, the Network Layer, which consists of the core closets containing the Cisco Nexus/Catalyst core switches. These core closets have two 10 Gb links to the Ciena DWDMs. At this layer is OSPF (Open Short Path First), a protocol that helps determine the shortest path between the cores when sending packets of data. It does this through the following method: each site on the DWDM Ring has an IP address (Ex. 10.4.x.x) that OSPF recognizes and remembers to locate geographically. With this information, OSPF finds the shortest path between these IP addresses, the source and the destination IP addresses, and sends the data packets through this path.

The last aspect of the enterprise network is Layer 2, the DataLink Layer, which consists of the access closets containing the Avaya switches that the data patch cables, which are connected to devices (computers, printers, etc.), are cross-connected to. With the Avaya switches, the links to the core closets and the Cisco Nexus core switches are two 1 Gb links. At Layer 2 of the OSI model, the main purpose is gathering the MAC address of each device connected to the network. Since every device has their MAC address permanently burnt in by the manufacturer, a MAC address can help one in a network identify and recognize devices, as well as determine the manufacturer of the product (first 6 digits represent the manufacturer code).

All of this encompassing background information on the DWDM Ring enterprise network is necessary to grasp before one can more thoroughly examine a component of this network. The piece of the enterprise network investigated was the edge of the network, specifically the edge switches. These edge switches were originally Avaya Baystack 5510 switches; however, the Infrastructure team has determined that an edge switch upgrade was necessary. It was determined that the edge switches would be upgraded to Cisco Catalyst 2960x switches. However, before one could investigate the advantages of the Cisco switch to the Avaya, a comprehensive understanding of what an edge switch was became necessary.
After obtaining inclusive knowledge about LVHN’s DWDM Ring, research about what a switch is and its function in a network could be done. According to Cisco.com, a network switch is a hardware device used to connect computer, printers, and servers within a building or campus. Bradley Mitchell in his article, *Switch (Network Switch)*, goes on to describe the difference between a switch and a hub. He states that a switch, unlike a hub, can inspect the data received in “packets” and determine the source and destination of the packets. Then the switch will send the data to only the specified destination through a process called packet switching, which conserves network bandwidth a switch utilizes.
Beyond the scope of just a switch is the difference between a core switch and an edge switch, the latter of which the Infrastructure team is looking into upgrading. According to Joel Snyder in his article, *Understanding the Different Layers of Routing and Switching*, a network can be broken down into two or three different layers. Snyder uses a tree to illustrate the topology of an enterprise network, stating that the branches of the tree would be the edge of the network that connects directly to end-user devices. On the other hand, the trunk of the tree would be the core of the network that connects all user access to the rest of the enterprise network. With this illustration in mind, one can see that the purpose of an edge switch (either the Avaya or new Cisco Catalyst switches) is to connect the many user-devices to the network, while the purpose of a core switch is to manage the high volume of data traffic in an efficient manner (aggregate all edge switches) and connect one to servers and the internet service provider.

**INVESTIGATION OF CISCO CATALYST 2960X:**

Once the purpose and function of an edge switch was grasped, the added benefits of the new Cisco Catalyst 2960x edge switches were investigated. Two lab test reports performed by Miercom, a private testing service, were analyzed. The first lab test report analyzed the power efficiency of the Cisco switch compared to the industry average. The second lab test report juxtaposed the Cisco switch to a competitive counterpart HP switch. After these two lab test reports were reviewed, a discussion with the Infrastructure team was held concerning the positive impacts transitioning to the Cisco Catalyst 2960x edge switches would have upon the enterprise network of LVHN.

The first lab test analyzed focused upon the power efficiency of the Cisco Catalyst C2960x switch compared to the industry average. From their testing, it was found that the C2960x is 55% more efficient in power consumption than the industry average (*Graph 1*). This power efficiency results in a 50% savings in annual operation cost compared to the industry average (*Graph 2*). In addition, the C2960x has multiple energy-saving features that are not always available in other switches, which can greatly reduce the energy usage of the switch. These features include being stackable, Hibernation Mode, Energy Efficient Ethernet, etc. Overall, the C2960x is designed in a manner that allows it to be very energy efficient, in turn, reducing operation costs.
The second lab test reviewed was a head-to-head comparison between the Cisco Catalyst C2960x switch and two HP switches (2920 and 5120). From reviewing the lab report, it appears that the C2960x performs better than the HP switches in every testing format. In terms of power efficiency, the C2960x utilizes less overall power and possesses power-saving features the HP switches did not. When comparing stacking characteristics, Cisco is able to stack more switches at once (8 compared to 4), is more reliable (Cisco remained usable after being made standalone from a stack, while HP became unstable), and allows for faster data path convergence than HP. In addition, through multiple performed tests, Cisco experienced no loss of priority traffic or latency issues (both HPs did), and was able to provide essential troubleshooting information when traffic is dropped (both HPs are incapable of providing such information). Every angle analyzed shows that the Cisco 2960x is the superior edge switch.

After reviewing these lab test reports, the Infrastructure team described the benefits upgrading the edge switches to the Cisco 2960xs would have upon LVHN. The first clear benefit that the 2960xs would provide is its ability to utilize two 10 Gb links between the access closets and core closets, compared to two 1 Gb links provided by the current Avaya switches. This means that more data can be transmitted at once, an improvement that is critical to an expanding network like LVHN’s. The mean time between failure (MTBF) was also much greater for Cisco than any of its competitors (Graph 3). In addition, with the new switches there would be no need for physical implementation of cross-connects for the new Cisco switches (Avaya structure required one to physically visit a network closet and cross-connect a data patch port to a switch every time a port became used) since all cross-connections will be made upon installing the switches, and the switches possess software that allows one to remotely enable and disable ports on the switch. Along with the ability to remotely control ports is the security the new Cisco 2960xs provide for the network. One key security feature of the new switches is the ability to remotely monitor devices that connect to the network and disable their

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**Graph 1 on left exemplifies the power efficiency of the Cisco Catalyst 2960-series, while Graph 2 on right exhibits the operation cost of the switch to the industry average.**

**Cisco Catalyst 2960-X and 2960-XR Switches:**

<table>
<thead>
<tr>
<th>Switch</th>
<th>Power Efficiency (Watts/Gbps at 100% Load)</th>
<th>Annual Cost Compared to Industry Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2960-X</td>
<td>0.66</td>
<td>$19.37</td>
</tr>
<tr>
<td>C2960-XR</td>
<td>0.65</td>
<td>$19.11</td>
</tr>
<tr>
<td>Industry Average</td>
<td>1.46</td>
<td>$38.46</td>
</tr>
</tbody>
</table>

Source: Mercom, November 2013
connection to LVHN, potentially deterring malicious behavior. The final added benefit of the new Cisco 2960xs is the troubleshooting information it provides for the operators. Unlike other switches, the 2960xs provide critical troubleshooting information when functionality goes awry, making management much easier.

**RESULTS:**

After investigating the added benefits of the new Cisco edge switches, it was seen that an inventory of all the current network closets was needed in order to supplement the Infrastructure team’s plan of upgrading the edge switches to the Cisco Catalyst 2960xs. This inventory included a recording of the current elements in each network closet, which consisted of the power supply in the closet, number of data patch ports, and available fiber/type of fiber. After the current elements were recorded, the necessary upgrades for each closet was determined, which included the number of new Cisco 2960xs needed, if a PDU (power distribution unit) was necessary, and if additional fiber was needed. Along with this inventory, the rack management within each closet was removed in order to help stage the transition to the new Cisco switches.

*Graph 3 illustrates the MTBF compared to the industry’s competing switches. Clearly, Cisco is at an advantage here with a MTBF 5 years more than the nearest competitor.*
Through the inventory of the network closets, it was found that over 400 Cisco 2960xs were needed in order to replace the current operational Avaya 5510s. The new Cisco switches will be ordered with a cost around $2,000,000 (not including remote sites, modules, SFPs, etc.). Once the new Cisco switches arrive, the Infrastructure team will be able to implement them into their network and complete their edge upgrade. This will transition the network from the Avaya switches to the new Cisco switches.

CONCLUSION:

With only a handful of the operational network closets equipped with the upgraded Cisco switches, the transition to the new Cisco switches is being implemented across LVHN and its various sites. With the current Avaya Baystack 5510 switches, the LVHN enterprise network is not fully utilizing its potential capacity. Limitations are found with the Avaya switches, as they cannot operate with the possible two 10 Gb links, but are capped at two 1 Gb links. With ever-growing facilities and increasing data transmission by information dense units such as radiology and imaging, upgrades in the network are needed. In addition, resources are consistently needed with the current structure of the Avaya switches to physically cross-connect data patch ports and switches in network closets across LVHN when a port goes into use. Such a tedious process absorbs an unnecessary amount of time and man-power from the Infrastructure team.

Through the Cisco edge switch upgrade it has been found that many improvements to the network will be implemented. First, the overall power efficiency of the edge switches will be improved once the new Avaya switches are upgraded to Cisco. Second, the network will be able to work at its potential capacity with two 10 Gb links between core closets and access closets. Along with greater transmission capacity, man-power will be conserved with no more tedious cross-connects being needed throughout the years once the Cisco Catalyst 2960xs are deployed (all cross-connections will be made upon installation), and remote monitoring will be available for security. The MTBF is also much greater with the new 2960xs, five years more than the closest competitor. And finally, troubleshooting will become more manageable with the information the Cisco switches provide when errors occur. With all of these added benefits known and the results of the network closets inventory, the I/S Infrastructure team will complete the edge switch upgrade and completely transition to the Cisco Catalyst 2960x switches by the end of the 2016 fiscal year.
REFERENCES:


