Maize High School

En-Transit Network Design

Network Expansion & Upgrade Proposal

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PRELIMINARY INFORMATION

CUSTOMER PROFILE

En-Transit is a medium to large size corporation that is currently involved in expanding via an acquisition in China. To be able to effectively work as one company when the purchase is complete, En-Transit's networks will need to be expanded to include connectivity to the new remote locations in China.

These locations do not require as large of a network as the branch offices, which have large numbers of users that require connectivity. However, it is important in these remote locations to have network equipment that will not require a network administrator at each location. The factories most likely do not have the technology staff members currently, and considering the size of their planned networks, one should not be required.

Like any organization, security is undoubtedly important for En-Transit. Steps must be taken to ensure that access to En-Transit's internal network is protected from attacks from the Internet. Additionally, the network must be scalable and adaptable enough to not require significant changes if further acquisitions occur, or if more branch offices need to be opened. Lastly, a network is useless if it cannot be relied upon. En-Transit needs a network that will be reliable, with redundancy included to protect and isolate failures if they occur.

OBJECTIVES

Based on the information we have received, we have established what we believe to be the four major objectives that your company requires a network design to meet:

1) **Expansion of LAN at Hays**

   The local area network at the Hays, KS headquarters needs to be expanded in order to account for additional employees who will be moving there after the acquisition of Bigwidget Manufacturing.

2) **Small LAN's at Chinese Locations**

   Some administrators and managers at the factories in China will require computers and a network to help them perform their tasks more efficiently.

3) **WAN Connectivity for Chinese Locations**

   To help those administrators communicate with the rest of the organization, they need to be connected to your company's private frame relay network. This will enable them to send emails, browse intranet sites, and keep them in sync the offices in the Americas.

4) **Improvements on Existing Network**

   En-Transit has requested us to recommend any additional improvements to the internal network that will benefit En-Transit. We believe there are many changes that could be made that would make En-Transit's network more reliable, scalable, and secure.

TECHNICAL ABSTRACT

WAN TOPOLOGY SUMMARY

As per your specifications, our design uses the star topology frame relay WAN that is already in place. American branch offices connected via a single T1 line. The new branch location in Shanghai, China, has two T1 lines because it provides the frame relay connection for all three Chinese locations. The other locations in China are connected to Shanghai. Kyoto has a fractional T3 line.

Additionally, all locations that have a connection to the frame relay WAN also have a backup ISDN connection that will enable them to connect to the headquarters if there is a failure, and they are unable to connect via frame relay. While ISDN has very limited bandwidth, it could be used to send important emails and files between locations, albeit slowly, and allow most employees to continue working until the primary WAN connection is repaired.

For additional information, please see the WAN topology diagram attached to the end of this report.

ADDRESSING

In our design, we have assigned 1022 usable IP addresses to each branch office, with the exceptions of the new Chinese locations. This makes it easy for those sites to handle additional employees. The locations in China have 254 usable IP addresses. Because of the limited number of computers at those locations, reserving as large of address space for them is not necessary.

For the Frame Relay WAN, 128 addresses have been allocated. This makes it possible for En-Transit to expand significantly before having to re-address. A further 128 addresses have been allocated to be used in the backup ISDN connections. The headquarters has 256 addresses allocated to be used by servers, and network equipment/links. While we feel using per-department VLAN's would be a better option, it is possible to create two networks out of the four access layer switches. In this case, we have 512 IP addresses assigned to each of the client networks. The combined 1024 addresses could be split between a number of VLAN's.

At all locations, the IP addresses will be assigned dynamically to all clients via DHCP servers running on the routers or switches that are the default gateway for the subnet. Again, we would recommend the usage of VLAN's at all locations to help segment and secure traffic. This could be especially beneficial at the headquarters, where a single VLAN could span multiple switches. Segmenting the network as much as possible can be beneficial from a security standpoint, because the number of hosts a computer could contact without being effected by access control lists on a layer three device is decreased.

For further information on addresses, refer to the addressing spreadsheet attached at the end of this report.

ROUTING

All but the smallest corporate networks need to use a dynamic routing protocol to provide routers at all locations with the information necessary for them to route traffic between branch offices and over the LAN. We have evaluated both OSPF and EIGRP while deciding on which protocol to use for your network. There are advantages and disadvantages to both; however, we have decided to go with OSFP.

Unlike EIGRP, OSPF is not a proprietary protocol, meaning that En-Transit can purchase equipment from a vendor other than Cisco if they choose to do so in the future. OSPF also has more advanced capabilities as far as segmenting a network into areas. In our design, each branch office will be its own OSPF stub area. This reduces the traffic and the number of routes that those routers have to handle. The Frame Relay WAN will be the backbone, area 0. All of the locations in China will be group into one area, instead of separating each factory into its own area. Some settings will have to be changed to allow OSPF to operate over the Frame Relay WAN, which will be a NBMA (Non-Broadcast Multi-Access)[1]. We will set up the OSPF adjacencies on each router by using the neighbor command.

CHINESE LOCATIONS

For your newly acquired Chinese sites, we have tried to limit the amount and complexity of equipment. We have done this, because we feel that it is likely that there may not be a dedicated IT staff member at each of these locations. Keeping it simple will reduce the chance of any outage, and will make it much easier to fix if there is an outage.

CANTON

Your location in Canton, China requires connectivity for approximately twenty-five users, and a dedicated connection to the Shanghai hub via a T1 line.

Cisco 2811

The Cisco 2811 used in Canton has a T1 WIC installed in it that has an integrated CSU/DSU, eliminating the need for an additional device. The 2811 can have up to four of these cards installed in it, giving En-Transit the ability to add more bandwidth, or connections to additional locations easily if the need arises. The 2811 is a relativity inexpensive router; however, it is more than sufficient for the relatively small number of users that would be relying on it.

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[1] This refers to a network that has multiple routers in one subnet, but has not concept of a broadcast like Ethernet uses. Frame Relay WAN's fall in this category, and alternatives must be configured to compensate of the lack of broadcast functionality.

Cisco Catalyst 3750

To handle the twenty-five users at Canton, we have chosen to use a Catalyst 3750 switch. Up to nine 3750 switches can be stacked, which allows them to be managed as a single switch, and provides a 32 Gbps[2] connection between them. This would make it easy for En-Transit to expand the LAN here if it becomes necessary later on. However, we have chosen a 48 port switch, which makes it unlikely that it will need to be expanded in the near future. We chose to use 100 Mbps Fast Ethernet for the connections to the clients in this instance, because we felt that the additional expense of a gigabit switch would not be justified. This switch connects the clients to the router at Canton.

KUNMING

Kunming requires very few users, and only sporadic connectivity to the WAN. Here, we have used only one device to simplify maintenance.

Cisco 2811

This is the same model of router that is used in Canton. We made a conscious choice to try to standardize equipment across multiple locations to make it cheaper for En-Transit's IT staff to maintain. This 2811 router however, has an ISDN WIC card that is made for the S/T connections that are used in China. This provides them with connectivity to Shanghai and the rest of the WAN only when necessary, thereby reducing costs. Again, the 2811 can support up to four of this type of cards, which allows you to add additional ISDN connections, or establish a leased line to another site. The 2811 router also has an Etherswitch module, which fits in the Network Module slot. This allows the router to provide up to sixteen Fast Ethernet connections to end-user computer, and limits the number of network devices that must be maintained here.

SHANGHAI

Shanghai acts as the hub for the other Chinese locations. Both of those locations must connect through Shanghai in order to access the frame relay WAN that the rest of the company is connected to. This can reduce bandwidth costs, especially if the need for such connectivity is very intermittent.

Cisco 3825

Because Shanghai acts as a hub, it has a higher-end router than either Canton or Kunming has. This router has three T1 WIC's in it. They have an integrated CSU/DSU. One of them is used for the leased line between Shanghai and Canton, while the other two are used for connectivity to the frame relay WAN. The router is also equipped with a four port ISDN network module. This is used for the ISDN connection to Kunming, as well as for the backup connection to the headquarters. The two additional ISDN ports are left open, which makes it easy to connect to any additional sites in China that may need periodic connectivity. With these modules, the router has one empty WIC/HWIC slot as well as one empty NME slot. One other piece of information to note: a strong factor

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[2] The 3750 switches use a 32 Gbps connection; the upgraded 3750E switches can use a 64 Gbps connection between the switches.

in our decision to use a 3825 router here, was the fact that the 3825 can handle a fractional T3 line, which could be needed in the future for connectivity to frame relay if Shanghai becomes a larger regional hub.

Cisco Catalyst 3750

Like Canton, Shanghai also makes use of a 48 port 3750 Catalyst switch. Again, the 3750 family of switches make it easy to connect additional switches to the network if more users need connectivity in the future. This is because of the Stackwise connections, which allow up to nine switches to act as one. Fast Ethernet is also used in this case, because we do not feel that there would be any significant advantages to using Gigabit Ethernet at this location.

EXISTING LOCATIONS

HAYS, KS

Your headquarters, in Hays, KS, is the source of your entire organization's Internet access. Because of this, it has the firewall device, as well as higher-end equipment to support the resources that are located at the headquarters.

Cisco 3825

The Cisco 3825 router at the headquarters is used to connect to the T1 line for Internet access. We also chose the 3825 in this instance because of its ability to use higher bandwidth connections, such as fractional and full T3. This is something that you may want to consider, if there are many users that need Internet access in your organization to perform their jobs. Our design incorporates a single T1 WIC in this router with integrated CSU/DSU. This router can also handle many additional interfaces if it becomes necessary, because this router can have up to four WIC's installed in it, and up to two network modules.

Cisco ASA 5510

We have chosen to use a Cisco ASA 5510 security device to separate the Internet connection from your internal network. This device will block any malicious attempts to attack hosts on the internal network, and can also perform content filtering on websites that employees attempt to view. This ensures that employees cannot easily access websites that are not appropriate for work. Additionally, this security device has the capability to act as a VPN server. This could be used to connect additional branch offices to the internal network, or, more likely, connect traveling users (sales staff, for instance) securely to the internal network so that they can send/check emails and access important documents.

Cisco 7206

The 7200 series router at the headquarters operates at the core of the network. It connects remote locations to the headquarters using frame relay. It also connects to distribution layer 6500 series switches at the headquarters, and to the internal side of the firewall. The 7206 supports up to six port adapters. Our design uses three of those slots. One of them holds the T3 card, which includes an internal DSU. The two others each have a

four port ISDN module installed in them. The ISDN modules are compatible with the U/NT1 interface used in the United States, are used in case of a failure in frame relay. The router uses the high performance NPE-G2 processing engine, which includes three Gigabit Ethernet ports. Two of these are used to connect to the distribution layer switches, and the third is used to connect to the firewall. If additional interfaces are required, there is a wide variety of port adapters that could be used in the three remaining slots. One additional port adapter can be utilized by using a port adapter jacket card, which goes in the slot that would be used by an I/O controller with lower end network processing engines.

Cisco Catalyst 6506

The two 6500 series switches in our design at the headquarters act as the distribution layer. They are configured to be the default gateway for all VLAN's. Additionally, we plan on using HSRP on them to allow all VLAN's to continue to have connectivity in case of a failure. The active default gateway can be alternated between VLAN's for load balancing purposes. These two switches are connected with a single ten gigabit connection, configured as a Layer 3 port, to reduce the need for complex Spanning Tree Configurations.

These switches have Supervisor Engine 720's in them to ensure maximum performance. While it is possible to have redundant Supervisor Engines, we chose not to include this because of the significant additional expense that it would add. Also, we felt that having two physically different switches would be more reliable than having a single switch with redundant Supervisor Engines, because it ensures that everything is redundant, especially the backplane. Redundant power supplies are used on both switches however, because these are the most likely component to fail, and relatively inexpensive in comparison to the Supervisor Engines. In our design we used the four port ten Gigabit Ethernet linecards. We are aware that an eight port ten Gigabit linecard exists. However, using the eight port card would mean oversubscribing the lines, because the connection to the backplane is only 40 Gbps (full duplex). Doing this could potentially be detrimental on distribution layer links, depending on the level of traffic that that you expect to occur on your network. If you expect traffic levels to be low, then using the eight port modules could save some money, however for maximum performance it would be best to stick with the four port modules.

Cisco Catalyst 4506

At the headquarters, the 4500 series switches make up the access layer. They are directly connected to the clients, and are connected to both of the distribution layer switches by ten gigabit uplinks. Those uplinks are configured to work as L2 VLAN trunks, meaning that the 4500 does not perform routing. I feel that it would be simpler to only have to manage two default gateways (the distribution layer 6500's). That also makes it possible to span a VLAN across multiple switches. The 4500 switches have a Supervisor Engine V installed in them. It has two ten gigabit uplinks, as well as four gigabit SFP uplinks. The Supervisor Engine V can perform Layer 3 switching, if that becomes necessary, or if you feel that it would be better to have all of the uplinks configured as Layer 3 links, as opposed to VLAN trunks. All of the 4500's have dual power supplies; however, they do not have dual Supervisor Engines. If that is a feature that you would be interested in, for additional redundancy, it would be simple to change in the design. A Catalyst 4507R would have to be used in place of the 4506 chassis's, and an additional Supervisor Engine would have to be purchased for each of them.

Additionally, the switches each have four forty-eight port gigabit linecards installed in them for the actual connections to the clients. One additional linecard can be added in each switch. The gigabit ports are oversubscribed – all of them could not simultaneously utilize all of their bandwidth, however this is not a significant issue for ports that are connected to client computers, because of the sporadic nature of most network communications.

Cisco Catalyst 4948

A Catalyst 4948 switch handles the servers at the headquarters. It has forty-eight gigabit Ethernet ports, and is designed for use in a datacenter. This switch is not oversubscribed like the client 4500 switches are. The 4948 has two ten gigabit uplinks, and is not a modular switch. However, it does have dual power supplies. We considered using a 6500 series switch in place of the 4948, however it would have been significantly more expensive, and we do not feel that it would offer any significant advantages over the 4948 in this case.

US BRANCH OFFICES

At the branch offices, we have attempted to keep the network topology simple and easy to maintain. It consists of only two devices, a switch and a router to connect to the WAN.

Cisco 2821

All American branch offices are equipped with a Cisco 2821 router. This router has two Gigabit Ethernet interfaces, as well as four HWIC and one NME slot for WAN modules. Two of the HWIC slots are filled with cards. We have one T1 CSU/DSU WIC that connects the router to the frame relay WAN. The second WAN interface card is used for backup ISDN connectivity to the headquarters. This leaves several open slots that can be used for later expansion.

Cisco Catalyst 4510R

This single switch handles all of the connections from the client computers at the branch offices. We have used the 4510R chassis, which makes it possible to add a second, redundant, Supervisor Engine if this is desired later on. The switch has a Supervisor Engine V-10GE, which supports Layer 3 switching with dynamic routing protocols, and has two ten gigabit Ethernet interfaces. This makes it possible for the branch office networks to scale out to additional switches easily with high-bandwidth interconnections. Additionally, the Supervisor Engines have four SFP gigabit Ethernet interfaces, two of which are used in our design to connect to the 2821 router. We decided to use two for redundancy. The switches have redundant power supplies.

Six forty-eight port Gigabit Ethernet modules connect to the client computers on each switch. This gives you the capacity for 288 computers at each branch offices without having to add any additional equipment. The switches can take two additional modules, for a total of 384 ports without having to add an additional switch.

KYOTO BRANCH OFFICE

Kyoto does not use the same network design that the rest of the branch offices use. The requirements were not the same. Kyoto has a higher bandwidth fractional T3 WAN frame relay connection. Like all other locations, it also has an ISDN connection to the headquarters for backup purposes.

Cisco 3845

The Cisco 3845 router connects to frame relay with a one more T3 network module. An ISDN WIC is also used for the backup connection. This leaves three network module slots and three HWIC slots available for future use. The 3845 is capable of handling full T3 lines, and multiple T3 lines better than its smaller sibling, the 3825. We took this into consideration, and wanted to provide a solution that would continue to work, even if the bandwidth that Kyoto required grew significantly.

Cisco Catalyst 3750E

Kyoto uses a stack of 3750E switches. Three of these switches are used to connect clients to the network; the fourth is used for servers. They are connected via a 64 Gbps Stackwise Plus connection that allows all four switches to act and be managed as a single switch. One switch acts as a processor for the rest. If that switch fails however, another switch in the stack will take over, providing more redundancy for En-Transit.

All of them have twenty-four gigabit Ethernet ports. This gives En-Transit some room to expand without adding additional hardware. However, it is extremely easy and relatively inexpensive to add a switch to a 3750 stack. Up to nine switches can be included in a single stack, so this provides you with a lot of headroom. The switches all have two ten gigabit uplinks. However, the router that we are using includes only Gigabit Ethernet ports, so we have opted to use a converter that Cisco sells to convert ten gigabit ports to just Gigabit Ethernet ports. We have two uplinks from the stack to the 3845 router, each from a different switch. This was done to maximize reliability. This means that the failure of a single switch cannot cut off the entire stack from its uplinks.

CLOSING INFORMATION

CONSULTING CHARGES

Our consulting charges are split into two different categories; they are also broken down by location. The two categories are the charges for designing the network, and the charges for implementing the network. You can see the specific prices and estimated hours on the Consulting Charges spreadsheet attached at the end of this report.

The charges for design and documentation cover costs like researching the equipment, finding prices, organizing the information, and documenting the purposes and reasoning behind our choice of equipment and general design. The other charges cover the implementation of the network equipment. This means physically installing the equipment, as well as configuring the software to operate as desired.

We have opted not to include estimated charges for connections, because these vary from city to city, with the distance from the telecommunications provider's central office, and your documentation implies that your company already is paying for leased lines for the Internet and frame relay.

SUMMARY

In closing, we thank you for considering our proposal and hope that we are able to assist your company in expanding your network. We understand that cost is a major factor in your considerations of our proposal. However, it is also important to look at the costs associated with downtime, and the likeliness of that downtime in a plan. Furthermore, a design that is scalable and adaptable enough to serve you in the future will save you money in the long run.

We feel that our design would be a great fit for your organization. We are also confident that our design will give En-Transit the ability to expand without having to totally redesign the network. If there are any elements of the network design that you have concerns over, please let us know. We would be happy to make any changes or additions to our design proposal to make it better meet your organization. We hope that our proposal not only meets but exceeds all of your expectations and we look forward to working with you throughout the process.

En-Transit Network Design - Equipment Listing

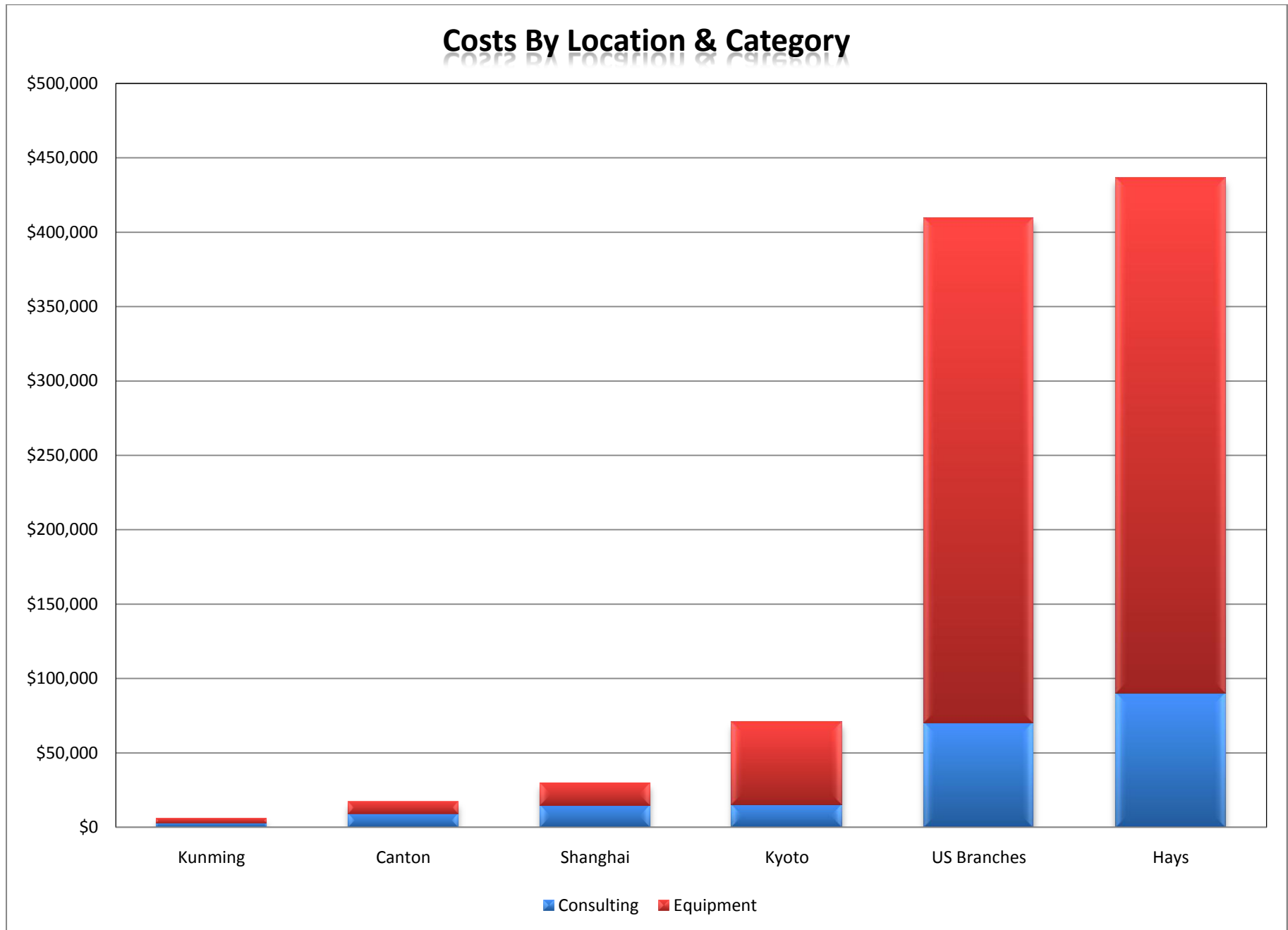| Loc.	Part Of	Model #	Description	Usage	No.	Init Price	Total Price
Kunming	2800 Router	**CISCO2811**	2x100B-TX, 2xAIM, 4xHWIC, 1xNME	Kunming to WAN	1	$1,800	$1,800
Kunming	2800 Router	**NM-16ESW**	16 port 100B-TX switch NM	Desktops to router	1	$1,075	$1,075
Kunming	2800 Router	**WIC-1B-S/T-V3**	ISDN BRI S/T WIC	Kunming to Shanghai	1	$379	$379
Canton	2800 Router	**CISCO2811**	2x100B-TX, 2xAIM, 4xHWIC, 1xNME	Canton to WAN	1	$1,800	$1,800
Canton	2800 Router	**WIC-1DSU-T1-V2**	T1 WIC with CSU/DSU	Canton to Shanghai	1	$729	$729
Canton	3750 Switch	**WS-C3750-48TS-S**	48x100B-TX, 4x SFP	Desktops to 2811	1	$5,034	$5,034
Canton	3750 Switch	**GLC-T**	1000B-T to SFP adapter	3750 to 2811	1	$299	$299
Shanghai	3800 Router	**CISCO3825**	2x1000B-T, 1xSFP, 2xNME, 4xHWIC	Shanghai to WAN	1	$6,849	$6,849
Shanghai	3800 Router	**WIC-1DSU-T1-V2**	T1 WIC with CSU/DSU	Shanghai to Canton(1), FR(2)	3	$729	$2,187
Shanghai	3800 Router	**NM-4B-S/T**	4 port ISDN BRI S/T NM	Shanghai to Kunming, HQ	1	$789	$789
Shanghai	3750 Switch	**WS-C3750-48TS-S**	48x100B-TX, 4x SFP	Desktops to 3825	1	$5,034	$5,034
Shanghai	3750 Switch	**GLC-T**	1000B-T to SFP adapter	3750 to 3825	1	$299	$299
Hays	2800 Router	**CISCO3825**	2x1000B-T, 1xSFP, 2xNME, 4xHWIC	Connects to Internet	1	$6,849	$6,849
Hays	2800 Router	**WIC-1DSU-T1-V2**	T1 WIC with CSU/DSU	2811 to Internet	1	$729	$729
Hays	ASA	**ASA5510-SEC-BUN-K9**	5x100B-T	Firewall for internal network	1	$2,745	$2,745
Hays	7200 Core	**CISCO7206VXR**	7206 chassis, 6xPort Adapter slots	Connects HQ LAN, Internet, WAN	1	$7,225	$7,225
Hays	7201 Core	**NPE-G2**	3x1000B-T	Connects WAN & FW	1	$13,831	$13,831
Hays	7202 Core	**PA-T3+**	1 port T-3 with DSU	Connects HQ to WAN	1	$2,400	$2,400
Hays	7203 Core	**PA-4B-U**	4 port ISDN U interface	Backup Connection for WAN	2	$513	$1,026
Hays	6500 Distrib.	**WS-C6506-E**	6 slot 6500 chassis	Connects Core and Access HQ LAN	2	$4,200	$8,400
Hays	6500 Distrib.	**WS-SUP720-3B**	3x1000B-T	Connects to Core 7200	2	$16,141	$32,282
Hays	6500 Distrib.	**WS-CAC-3000W**	3000W PSU for 6500	Powers Distrib 6500's	4	$2,207	$8,828
Hays	6500 Distrib.	**WS-C6506-E-Fan**	Fan tray for 6500		2	$350	$700
Hays	6500 Distrib.	**WS-X6704-10GE**	4x10GE XENPAK	Connects to access switches	4	$14,040	$56,160
Hays	6500 Distrib.	**XENPAK-10GB-SR**	XENPAK optic for 10GE		10	$2,279	$22,790
Hays	4500 Access	**WS-C4506**	5 card slot, 1 Sup slot	Connects clients to distrib.	4	$3,715	$14,860
Hays	4500 Access	**WS-X4516+10GE**	L3 Sup with 2x10G X2, 4x1G SFP	Uplinks to distrib. Switches	4	$14,529	$58,116
Hays	4500 Access	**X2-10GB-SR**	X2 Optics for 10G uplinks	Uplinks to distrib. Switches	8	$1,300	$10,400
Hays	4500 Access	**WS-X4448-GB-RJ45**	48 port 1000B-T linecard (4/switch)	Connects to clients	16	$4,321	$69,136
Hays	4500 Access	**PWR-C45-2800ACV**	Catalyst 4500 Power Supply		8	$1,439	$11,512
Hays	4948 Server Sw.	**WS-C4948-10GE-E**	48x1000B-T, 2x10G X2	Connects servers 6500s	1	$15,289	$15,289
Hays	4948 Server Sw.	**X2-10GB-SR**	X2 Optics for 10G uplinks	Uplinks to distrib. Switches	2	$1,300	$2,600

En-Transit Network Design - Equipment Listing

Loc.	Part Of	Model #	Description	Usage	No.	Init Price	Total Price
Hays	4948 Server Sw	**PWR-C49-300AC/2**	Catalyst 4948 Power Supply		1	$350	$350
Kyoto	3800 Router	**CISCO3845**	4xNM, 4xHWIC, 2x1000B-T	Connects Kyoto to WAN	1	$9,355	$9,355
Kyoto	3800 Router	**NM-1T3/E3**	1xT3/DS3 with DSU	Connects to WAN	1	$6,129	$6,129
Kyoto	3800 Router	**WIC-1B-U-V2**	1xISDN BRI with U Interface	Backup Connection for WAN	1	$523	$523
Kyoto	3750 Stack	**WS-C3750E-24TD-E**	24x1000B-T, 2x10GE X2	Connect clients(3), and servers(1)	4	$9,631	$38,524
Kyoto	3750 Stack	**CVR-X2-SFP**	10GE X2 to SFP converter	Convert 10GE uplinks to 1GE uplinks	2	$139	$278
Kyoto	3750 Stack	**GLC-T**	RJ-45 SFP module	Connects stack to Router	2	$299	$598
US Branches	2800 Router	**CISCO2821**	2x1000B-TX, 4xHWIC, 1xNME	Connects Branches to WAN	6	$2,804	$16,824
US Branches	2800 Router	**WIC-1B-U-V2**	ISDN BRI S/T WIC	Backup Connection for WAN	6	$523	$3,138
US Branches	2800 Router	**WIC-1DSU-T1-V2**	T1 WIC with CSU/DSU	Connects to WAN	6	$729	$4,374
US Branches	4500 Switch	**WS-C4510R**	10 slots, redund. SUP capable	Connects clients to WAN router	6	$9,042	$54,252
US Branches	4500 Switch	**WS-X4516-10GE**	L3 Sup with 2x10G X2, 4x1G SFP	Uplink to WAN router	6	$14,040	$84,240
US Branches	4500 Switch	**PWR-C45-2800ACV**	Catalyst 4500 Power Supply		12	$1,439	$17,268
US Branches	4500 Switch	**WS-X4448-GB-RJ45**	48 port 1000B-T linecard (6/switch)	Connects to clients	36	$4,321	$155,556
US Branches	4500 Switch	**GLC-T**	RJ-45 SFP module	Uplink to WAN router	12	$299	$3,588

Branch Office Total Prices include equipment for All Branch Offices

En-Transit Network Design - Consulting Charges

Loc.	Name	Purpose		Hours		Total Price
Kunming	Design Charge	Design of network at Kunming		2		$1,000
Kunming	WAN Connectivity	Implmtn of router and WAN connection in Kunming		5		$1,500
Canton	Design Charge	Design of network for Canton		3		$5,000
Canton	WAN Connectivity	Implmtn of router and WAN connection in Canton		10		$1,500
Canton	LANs	Implmtn of LAN/switch at Canton		5		$2,500
Shanghai	Design Charge	Design of network for Shanghai		5		$9,000
Shanghai	WAN Connectivity	Implmtn of routers and WAN connections in Shanghai		15		$3,000
Shanghai	LANs	Implmtn of LAN/switch at Shanghai		10		$2,500
Hays	Design Charge	Design networks for Hays		25		$35,000
Hays	WAN Connectivity	Implmtn of WAN connections, routers, and firewalls		20		$20,000
Hays	LAN Switching	Implmtn of LAN switches		40		$35,000
Kyoto	Design Charge	Design of network at Kyoto		5		$5,000
Kyoto	WAN Connectivity	Implmtn of WAN connection		5		$2,500
Kyoto	LAN Switching	Implmtn of LAN switches		15		$7,500
US Branches	Design Charge	Design of standard branch office network		10		$10,000
US Branches	WAN Connectivity	Implmtn of routers and WAN connections for branches		30		$24,000
US Branches	LANs	Implmtn of LAN switches		48		$36,000

Branch Office Prices and Hours Include All Branch Offices

Costs By Location & Category

Legend: ■ Consulting ■ Equipment

En-Transit Network Design - Total Costs

Sum of Cost	Column Labels		
Row Labels	**Consulting**	**Equipment**	**Grand Total**
Kunming	$2,500	$3,254	$5,754
Canton	$9,000	$7,862	$16,862
Shanghai	$14,500	$15,158	$29,658
Kyoto	$15,000	$55,407	$70,407
US Branches	$70,000	$339,240	$409,240
Hays	$90,000	$346,228	$436,228
Grand Total	**$201,000**	**$767,149**	**$968,149**

En-Transit Network Design – WAN Topology

Internet

Canton, China

T1

Shanghai, China

2xT1

Frame Relay WAN

T3

Hays, KS
HQ

ISDN BRI

Kunming, China

Fractional T3
(10 Mbps)

T1

T1

T1

T1

T1

T1

Backup
ISDN BRI

All branch offices can
connect to the HQ via
ISDN in case of a
failure, all of them are
not shown for clarity.

Kyoto, Japan

Fergus Falls, MN

Lincoln, NE

Broomfield, CO

Overland Park, KS

Seattle, WA

Portland, OR

En-Transit Network Design – Headquarters Topology

3825

Internet

T1

100B-TX

Frame Relay WAN

T3

7204

100B-TX

ASA 5510

Core Layer

Backup
8xISDN BRI

100B-TX

1xISDN BRI to each location

1000B-T

1000B-T

6506

6506

10 GbE
(L3)

Public Web Server

Distribution Layer

10 GbE
(L2)

Access Layer

4506

4506

4948

4506

4506

1000B-T

1000B-T

1000B-T

1000B-T

1000B-T

165 Users

165 Users

Internal
Servers

165 Users

165 Users

En-Transit Network Design – China Topology

En-Transit Network Design – Branch Offices

Address Prefix: 171.10.*x.x*   **En-Transit Network Design - Addressing**

Loc.	Address Start	Address End	Subnet Mask	Use
WAN	0.0	0.127	255.255.255.128	Frame Relay WAN
WAN	0.128	0.255	255.255.255.128	ISDN WAN
Hays	1.0	1.255	255.255.255.0	Servers and Hays Network Equip
Hays	2.0	3.255	255.255.254.0	Client Subnet #1
Hays	4.0	5.255	255.255.254.0	Client Subnet #2
Hays	6.0	7.255	255.255.254.0	Reserved for Future Expansion
Fergus Falls	8.0	11.255	255.255.252.0	Clients at Fergus Falls
Lincoln	12.0	15.255	255.255.252.0	Clients at Lincoln
Broomfield	16.0	19.255	255.255.252.0	Clients at Broomfield
O. Park	20.0	23.255	255.255.252.0	Clients at Overland Park
Seattle	24.0	27.255	255.255.252.0	Clients at Seattle
Portland	28.0	31.255	255.255.252.0	Clients at Portland
Kyoto	32.0	35.255	255.255.252.0	Clients at Kyoto
Shanghai	36.0	36.255	255.255.255.0	Clients at Shanghai
Canton	37.0	37.255	255.255.255.0	Clients at Canton
Kunming	38.0	38.255	255.255.255.0	Clients at Kunming