Q. **Re 2011 Capital Plan - Individual Capital Projects:**

Project B-83, Replace Network Communications Equipment-Various Sites: Provide the Newfoundland and Labrador Hydro Infrastructure Review and Proposed Design report of Hewlett- Packard Canada dated April 22, 2010 referred to in footnote 2 on p. 13 of the Report at Tab 37.

A. Please see the attached report entitled *Newfoundland Labrador Hydro Infrastructure Review and Proposed Design*.

Newfoundland Labrador Hydro Infrastructure Review and Proposed Design

Version 1.0

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Infrastructure Review and Proposed Design Newfoundland Labrador Hydro	Design Specification	

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1. Introduction

HP was contracted by Newfoundland and Labrador Hydro to review the existing legacy Network Infrastructure within their head office complex located at 500 Columbus Drive in St. John's, Newfoundland. Once a detailed understanding of the existing infrastructure was obtained, a high level network design was to be proposed to replace it.

The purpose of this document is to describe some of the existing infrastructure shortcomings and provide the robust, redundant and easily manageable proposed network architecture required to replace it. In addition to the proposed network architecture, a high level implementation plan will be included as well as a detailed quote including both hardware and professional services required to implement the proposed solution.

This document does not cover the WAN or remote sites outside of the head office facility. Power requirements necessary to facilitate the proposed design is also outside the scope of this document. Physical cabling and connection types will be discussed as they relate specifically to the proposed solution but are outside the scope of this document as far as implementation / costing. Although the WAN is outside the scope of this document, an independent third party report outlining the current network utilisation across the WAN has been provided and will be discussed. It is assumed that all information provided is accurate.

All Pricing included within this document includes Newfoundland Labrador Hydro's applicable discounts.

The principal design challenges and metrics for this project are –

- To obtain accurate Switch port counts for every closet in the head office location
- To provide an enhanced design model utilizing industry best practices that can be mirrored to other Newfoundland Labrador facilities
- To design a network infrastructure that has fewer single points of failure than exist today
- To create a design that provides high availability, redundancy and easily manageable
- To create a design that can offer the end user community an enhanced user experience and offer a better quality of service with less down time
- To create a design that can offer better support for future advanced services including video conferencing and Unified Communications, as examples
- To deliver the above as part of a non-disruptive phased implementation

2. Existing Information Gathering

During the information gathering stage required to gain a detailed understanding of the existing infrastructure and create a proposed design for this project, existing documentation was collected, compiled and reviewed. The following is a list of the information provided. Where applicable to the discussions within this document, the information outlined below will be included.

- Third party "Network Traffic Analysis" report
- Existing network architecture drawing
- Current port count requirements per closet
- Current port count requirements in core of network specifically required for servers
- Fibre cabling infrastructure drawing
- List of existing network infrastructure hardware currently in production including vendor and model number
- Knowledge gathered through conversations with Newfoundland and Labrador IT staff and several previous network related projects completed by HP within the customer's environment

NOTE: HP is not responsible for and has no means of verifying the accuracy of the data provided. As a result, it is assumed that all information provided is accurate.

3. Design Considerations / Assumptions

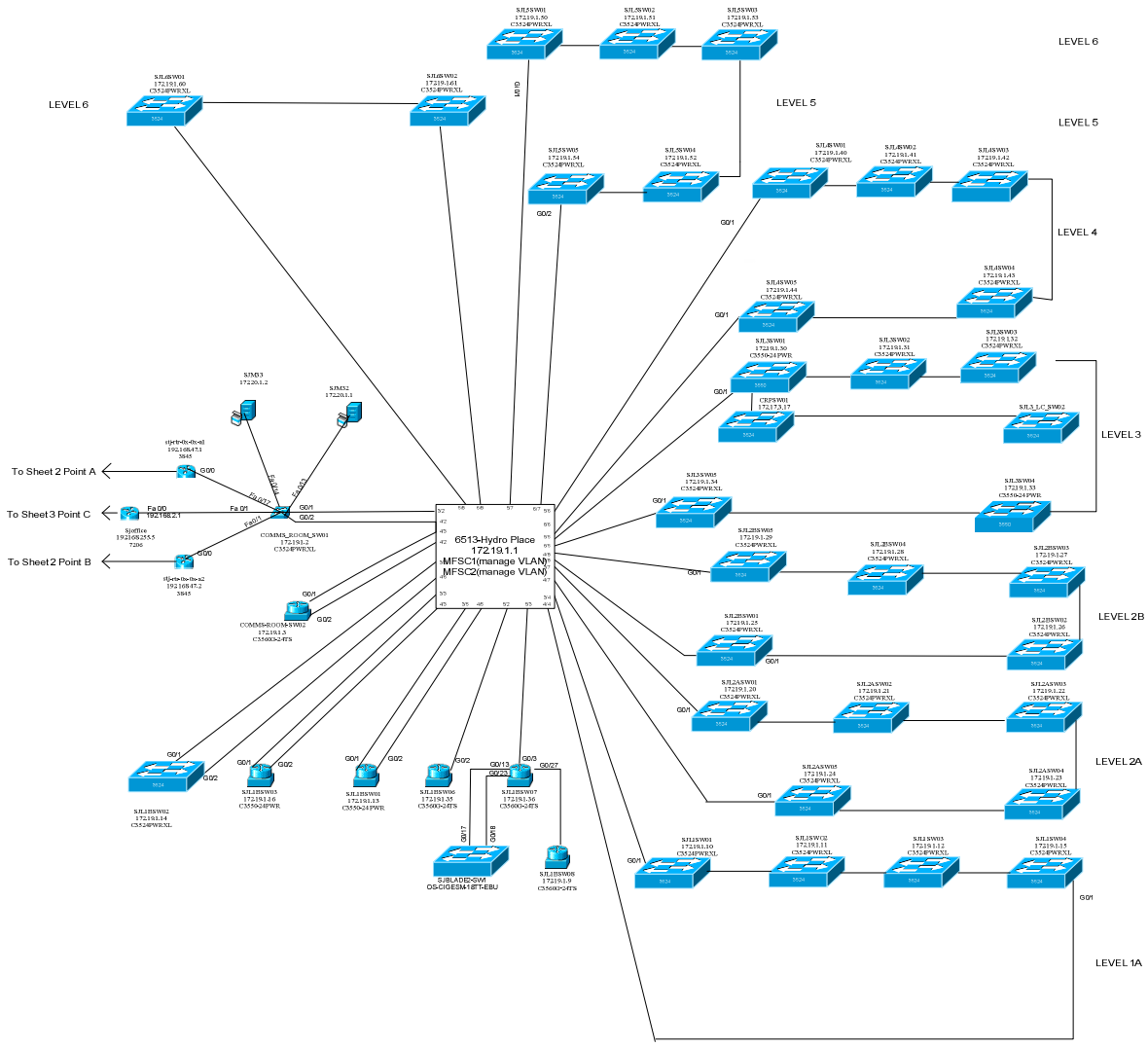
The following is a list of considerations and assumptions used while creating the proposed design for this project. The majority of the items below were provided by Newfoundland and Labrador Hydro resources through discussions, conference calls, emails etc.

- All existing closets will remain and no future expansion requiring additional closets is planned for the foreseeable future.
- Port counts used to size the solution are estimated to be as accurate as possible with the information provided. These numbers are provided in the previous section.
- Existing port count numbers per closet will be used with a 10% growth factor added.
- The end user ports within each closet must be capable of supporting 10/100/1000 Mbps speeds with Power over Ethernet capabilities built in.
- Closet uplinks will be sized to facilitate a dedicated 1 Gigabit link for every 48 end users.
- Only 24 port switches will be used for cabling aesthetics and to allow for simple migration of existing end user cabling within the closets.
- All existing fibre runs within the building are capable of supporting 1 Gigabit and 10 Gigabit speeds within the required distance specification.
- Ten Gigabit uplinks are not deemed necessary by Newfoundland and Labrador Hydro within any closet terminating end user connections.
- Ten Gigabit uplinks can be used in the Level 1B area as majority of the servers reside in this location requiring the additional throughput.
- Sufficient fibre infrastructure exists between the Comms Room and remote closets to facilitate the additional uplinks as recommended in the proposed design.
- Redundant Power System (RPS) are provided as an option but not included in the overall pricing.
- Cisco VSS technology will not be used on the 6500 switches.
- A single 6500 series, fully redundant chassis is preferred for the core.
- Advanced features support within the infrastructure to support the applications listed below.
- Although Newfoundland and Labrador Hydro understands that dual Catalyst 6500 switches in the core would offer additional redundancy, their preference is for a single fully redundant 6500 series chassis.
- Possible future application support for the following:
    - Streaming video to the desktop
    - VOIP
    - IP Security cameras
    - 802.11n wireless access points
    - GIS Application

4. Existing Infrastructure Overview / Analysis

This section will review the existing network infrastructure, existing fibre infrastructure, existing and projected port count requirements, existing hardware viability and provide a summary of existing network infrastructure deficiencies.

4.1. Existing Network Infrastructure Design Diagram



As can be seen from the above diagram, the existing network architecture follows the hierarchical network design model. The Catalyst 6513 switch serves as both the Distribution and Core Layers of the model while the majority of Access Layer functionality is facilitated by Cisco Catalyst 3500XL switches. All L3 functionality within the head office LAN is provided by the Catalyst 6513 Switch located in the core. The chassis itself incorporates two back-planes, a 32-Gbps shared switching bus and a second backplane that allows line cards to connect over a high-speed switching path into a crossbar switching fabric. The crossbar switching fabric provides a set of discrete and unique paths for each line card to both transmit data into and receive data from the crossbar switching fabric. The first generation switching fabric was delivered by the switch fabric module (WS-C6500-SFM2) which provided a total switching capacity of 256 Gbps. More recently, with the introduction of the Supervisor Engine 720, the crossbar switch fabric has been integrated into the Supervisor Engine 720 baseboard itself, eliminating the need for a standalone switch fabric module. The capacity of the new integrated crossbar switch fabric on the Supervisor Engine 720 has been increased from 256 Gbps to 720 Gbps. Although the existing Catalyst 6513 chassis has 13 slots for modules, only 5 of them (slots 9 – 13) can be used to facilitate dual fabric connected modules. Below is a list of the modules and power supplies that currently exist in the Catalyst 6513 chassis.

- 2 X Cisco Catalyst 6500 Supervisor2 Engine (WS-X6K-SUP2-2GE)
- 4 X Cisco Catalyst 6500 8 port GBIC Module (WS-X6408A-GBIC)
These are the only modules within the chassis that are not nearing or at the end of life. Although they could be reused, HP recommends trading them in for credit along with the chassis. Although they are still supported modules they are not fabric enabled and are limited to a 32 Gigabit shared bus interconnection on the chassis and are not fabric enabled. In addition, there are newer modules available with much higher port densities requiring less real estate within the chassis. These options will be presented later in the document.
- Cisco Catalyst 6500 Switch Fabric Module (WS-X6500-SFM2)
This module is not currently being utilized as there are no fabric enabled modules within the chassis.
- Cisco Catalyst 6500 Flex WAN Module (WS-X6608-T1)
- Cisco Catalyst 6500 Network Analysis Module (WS-X6380-NAM)
- 2 X Cisco Catalyst 6500 2500W Power Supply (WS-CAC-2500W)

The catalyst 6513 above is designed as a single chassis, fully redundant solution with dual modules and power supplies for redundancy. As will be highlighted in the sections that follow, the majority of the current components (modules and power supplies) within the chassis are nearing or are at the end of their useful life. The existing chassis has 13 slots of which only 5 of them fabric enabled and capable of supporting the newer high bandwidth modules such as the 10 Gigabit modules. As a result, it is HP's recommendation that Newfoundland and Labrador Hydro purchase a new 9 slot enhanced chassis in which all slots are fabric enabled as proposed in the sections that follow. In addition, this will allow for a seamless migration from the legacy catalyst 6513 chassis by enabling both to run in parallel until the migration is completed. Once the migration is completed, the existing catalyst 6513 switch can redeployed or returned for credit towards the purchase of the newly proposed solution.

The WAN links are facilitated by two Cisco 3845 Integrated Service Routers and a Cisco 7206 Router. The determination of the WAN link utilisation is outside the scope of this document. That being said, a report has been provided that shows this utilisation to be a non issue. In light of that, these three routers will be assessed as far as future viability in the section titled "Existing Hardware Viability" but will be assumed to be sufficient to facilitate the levels of utilisation documented in the report.

The majority of the existing closets have dual fibre runs back to the Catalyst 6513 which are assumed to be connected to different physical modules within the chassis for extra redundancy. Those that are single attached represent single points of failure within the architecture and will be highlighted under the deficiency section of the document. The stacks of Catalyst 3500XL switches located within the closets are interconnected via gigabit uplinks with two physically different switches within the stack uplinked back to the core.

4.2. Existing Fibre Infrastructure

The existing fibre cabling infrastructure specifications as provided indicate that all existing cabling is 50 micron Multimode fibre cabling. In addition, there exists sufficient capacity to facilitate all of the additional uplinks shown in the proposed solution. As the proposed solution makes use of 10Gigabyte connectivity between the Comms Room and Level 1B, it is assumed that the modal bandwidth of the existing fibre is sufficient to facilitate 10 Gigabyte speeds at the required distance. Below is a summary of that requirement:

MODAL BANDWIDTH	DISTANCE (METERS)
400	66
500	82
2000	300

4.3. Existing / Projected Port Count Requirements Per Closet

This section will show the existing port counts as provided by Newfoundland and Labrador Hydro on a per closet basis. In addition, a 10% future growth factor will be added to each closet and factored in to the proposed solution. HP's experience has shown this to be a reliable estimate based on past experience. The table below shows these numbers:

CLOSET	EXISTING PORT COUNT	10% PROJECTED GROWTH	PROPOSED DESIGN PORT COUNT	NUMBER OF SWITCHES REQUIRED TO FACILITATE
LEVEL 1B	126	13	139	6
LEVEL 1A	76	8	84	4
LEVEL 2A	116	12	128	6
LEVEL 2B	93	10	103	5
LEVEL 3	133	14	147	7
LEVEL 4	137	14	151	7
LEVEL 5	91	10	101	5
LEVEL 6	34	4	38	2
COMMS ROOM	24	3	27	2

4.4. Existing Hardware Viability

This section will list all existing hardware that is currently being used by Newfoundland and Labrador Hydro to facilitate their corporate infrastructure highlighting the official vendor announced dates for the key milestones within the product lifecycle. These are explained below:

End-of-Life Announcement Date	The date the document that announces the end of sale and end of life of a product is distributed to the general public.
End-of-Sale Date	The last date to order the product through Cisco point-of-sale mechanisms. The product is no longer for sale after this date.
End of Service Contract Renewal Date: HW	The last date to extend or renew a service contract for the product.
Last Date of Support: HW	The last date to receive service and support for the product. After this date, all support services for the product are unavailable, and the product becomes obsolete.

Cisco Catalyst 6500 Switch (CORE / DISTRIBUTION LAYER)

DEVICE	END OF LIFE	END OF SALE	END OF SERVICE CONTRACT RENEWAL	END OF SUPPORT
CAT6500 SUPERVISOR ENGINE (WS-X6K-SUP2-2GE)	May 11th, 2007	Nov 9th,2007	Feb 4th,2012	Nov 7th, 2012
CATOS SOFTWARE (6.X)	Jun 15th, 2005	Dec 31st, 2005	Dec 31st, 2006	Dec 31st, 2010
CAT6500 8 PORT GBIC MODULE (WS-X6408A-GBIC)	N/A	N/A	N/A	N/A
CAT6500 SWITCH FABRIC MODULE (WS-X6500-SFM2)	Mar 1st, 2006	Mar 1st, 2007	May 30th, 2011	Feb 28th, 2010
CAT 6500 FLEW WAN MODULE (WS-X6608-T1)	Feb 26th, 2007	Aug 27th, 2007	Nov 22nd, 2011	Aug 25th, 2012
CAT 6500 NETWORK ANALYSIS MODULE (WS-X6380-NAM)	N/A	Jun 24th, 2002	N/A	Jul 27th, 2007
CAT 6500 2500W POWER SUPPLY (WS-CAC-2500W)	Jul 15th, 2005	Jan 15th, 2006	April 15th, 2010	Jan 15th, 2011

OTHER INFRASTRUCTURE DEVICES (CORE / ACCESS LAYER)

DEVICE	END OF LIFE	END OF SALE	END OF SERVICE CONTRACT RENEWAL	END OF SUPPORT
CAT 3500XL SWITCHES	Feb 10th, 2003	Aug 12th, 2003	Aug 12th, 2007	Aug 12th, 2008
CAT 3550 SWITCHES	May 11th, 2005	May 2nd, 2006	Feb 2nd, 2011	May 2nd, 2011
CAT 3560G SWITCHES	N/A	N/A	N/A	N/A
CISCO 3845 ISR	N/A	N/A	N/A	N/A
CISCO 7206 ROUTER	N/A	Jan 1st, 2002	Jan 27th, 2006	Jan 27th, 2007

4.5. Summary of Existing Infrastructure Deficiencies

Below is a summary of the deficiencies noted within Newfoundland and Labrador Hydro's existing network infrastructure. These limitations will be addressed in the proposed solution that follows.

- No available switch ports exist in many areas of the infrastructure limiting growth or leading to less then optimal configurations arising in an effort to work around this limitation. Examples include:
  - Blade Center1 housing upwards of 14 servers has only a single gigabit uplink to the infrastructure when it is capable of having four uplinks connected. This greatly limits throughput and significantly limits redundancy.
  - Blade Center2 housing upwards of 14 servers has only dual gigabit uplinks to the infrastructure when it is capable of having four uplinks connected. This greatly limits throughput and significantly limits redundancy.
  - A VMware server (SJVM01) housing upwards of 15 virtual servers has only a single gigabit uplink to the infrastructure when it is capable of having six uplinks connected. This greatly limits throughput and significantly limits redundancy.
  - A VMware server (SJVM02) housing upwards of 15 virtual servers has only a single gigabit uplink to the infrastructure when it is capable of having six uplinks connected. This greatly limits throughput and significantly limits redundancy.
- Although multiple WAN links exist between the head office and remote sites, only one of them is being used at any one time due to limitations of the legacy software currently running on the Catalyst 6513 switch. If a more current, feature rich version of software were installed on the Catalyst 6500 switch facilitating the head office L3 connectivity, load balancing could be implemented across the multiple WAN links to increase throughput to the remote sites.
- As highlighted above under the "Existing Hardware Viability" section, the majority of Newfoundland and Labrador Hydro's infrastructure hardware has reached the end of its lifecycle. In HP's opinion this represents significant risk and is not acceptable practice within any enterprise network architecture.
- Advanced feature limitation within existing infrastructure due to existing hardware and software limitations. In HP's opinion, this is most evident within the 35+ Catalyst 3500XL switches facilitating the majority of the Access Layer. As outlined previously in the "Design Considerations / Assumptions" section, should Newfoundland and Labrador Hydro decide to implement any of the advanced technologies that they noted within their future plans the following notable limitations within the Catalyst 3500XL switches are worth noting:
  - Although not technical in nature, it is worth reiterating the following key dates specific to the Catalyst 3500XL:
    - End of Sale on August 12th, 2003.
    - End of Life on February 10th, 2003.
    - End of Support on August 12th, 2008.
  - The Catalyst 3500XL switches are limited to 10/100 Mbps speeds.
  - The Catalyst 3500XL switches are only stackable via 1 Gigabit uplinks. This limitation can be worsened should the Gigastack technology be used within a given stack as it can be a half duplex connection depending on physical cabling configuration.
  - The Catalyst 3500XL switches do not support Ether Channel configuration across different physical switches within the stack.

- The Catalyst 3500XL switches do not support the "voice vlan" configuration meaning that any port connecting an IP Phone must be configured as a trunk.
- The Catalyst 3500XL switches do not support NAC.
- The Catalyst 3500XL switches do not support IGMP.
- The Catalyst 3500XL switches do not support Smart port macros.
- The Catalyst 3500XL switches do not support the "BPDU Guard" feature.
- The Catalyst 3500XL switches do not support the "Backbone fast" feature.
- The Catalyst 3500XL switches do not support energywise.
- The Catalyst 3500XL switches utilise a pre-standard Power over Ethernet technology and do not support standards based 802.3af or 802.3at PoE.
- The Catalyst 3500XL switches do not support 802.1x port based authentication.
- The Catalyst 3500XL switches are 12 year old technology and as such have limited CPU and ASIC based resources to deal with high levels of multicast traffic common to video applications.
- The Catalyst 3500XL switches have very limited flash and do not support a crypto image meaning SSH is not supported for remote access and telnet must be used. This has obvious security implications.
- The Catalyst 3500XL switches have extremely limited QoS capabilities and do not support the "Auto QoS" feature.

- Several single points of failure exist within the infrastructure. These include the following noted examples:
  - A single Catalyst 3524XL switch is being used to terminate all three existing WAN routers.
  - A single Catalyst 3560 switch is being used to terminate both uplinks from Blade Center 2.
  - Several switches are daisy chained off of a previous switch and are not cabled in a redundant manner consistent with the majority of the infrastructure.

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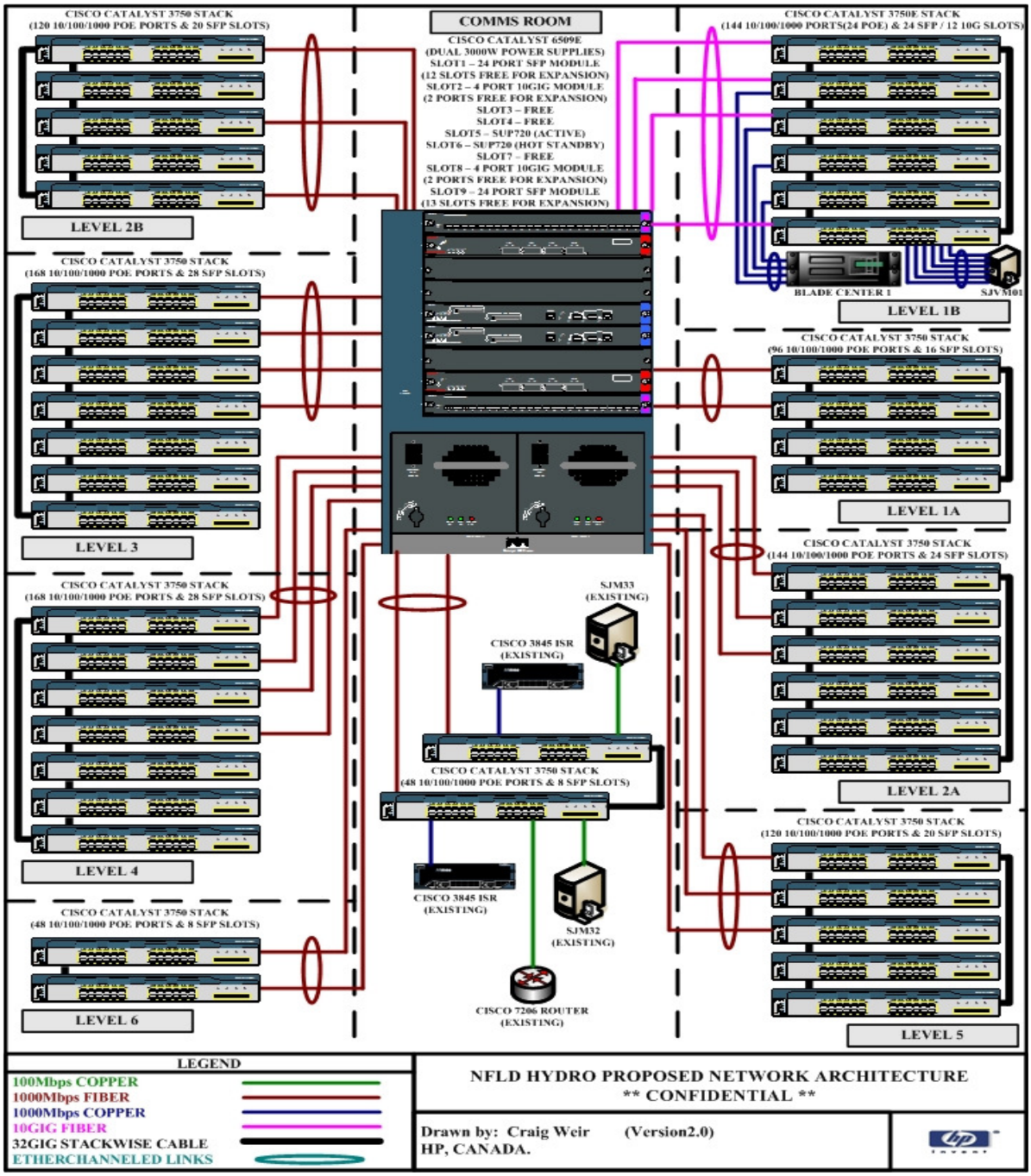
5. Proposed Infrastructure Design and Recommendations

5.1. Proposed Network Architecture Diagram



5.2. Proposed Solution Overview

As can be seen from the above proposed network infrastructure diagram, the proposed solution follows the industry standard Hierarchical network design model consisting of the Core, Distribution and Access layers. The Core and Distribution layers are facilitated by a Catalyst 6509E switch where all L3 functionality for the local area network will reside. At the Access layer, Catalyst 3750 and Catalyst 3750E switches will be used to facilitate connectivity at the edge on the local area network. Within the proposed network architecture solution, all of the deficiencies outlined within the existing network infrastructure are addressed and resolved. A detailed discussion around all individual components proposed will follow below.

5.3. Device Selection Criteria

CATALYST 6509E SWITCH

HP's recommendation is for a fully redundant, single catalyst 6509E switch to be located in the Comms Room facilitating both the Core and Distribution layers of the proposed architecture. The Cisco catalyst 6509E switch will have the following components within the chassis:

- Dual Catalyst 6500/Cisco 7600 Supervisor 720 Fabric MSFC3 PFC3B (WS-SUP720-3B)
  These modules are the brains of the switch and work in an active hot standby type configuration. In the event of a failure to the active SUP720, the redundant module will take over with no noticeable impact to users. All L2 and L3 information is replicated from the active unit to the standby unit in real-time ensuring a near immediate, seamless failover.
- Dual Catalyst 6500 24-port GigE Mod: fabric-enabled (WS-X6724-SFP)
  These modules will be used to terminate all remote closet uplinks with the exception Level 1B. The uplinks from each individual stack will be evenly distributed across the two modules ensuring seamless failover with no loss of connectivity to the remote closet end users should one fail.
- Dual Catalyst 6500 4-port 10 Gigabit Ethernet Module (WS-X6704-10GE)
  These modules will be used to terminate the Level 1B 10 gigabit uplinks. The four uplinks from the stack will be evenly distributed across the two modules ensuring seamless failover with no loss of connectivity to the server farm or end users accessing it should one fail.
- Dual Catalyst 6500 3000W AC power supplies (WS-CAC-3000W)
  The power supplies are fully redundant meaning that either one can fail with no interruption of service and no power loss to any component of the chassis.

Cisco Catalyst 6509E chassis proposed provides a fully redundant architecture. The proposed solution makes use of only 6 of the 9 fabric enabled available slots within the chassis leaving Newfoundland and Labrador Hydro with adequate future growth capabilities. In addition, the proposed modules included in the chassis allow for an additional 25 1 Gigabit and 4 10 Gigabit uplinks to be added without the need for additional modules.

Although the proposed solution includes a fully redundant, single Catalyst 6509E chassis as mandated by Newfoundland and Labrador Hydro, it is worth noting that a second chassis could be added at a later date to provide additional physical redundancy seamlessly. By simply purchasing another Catalyst 6509E chassis and fan tray, (pricing for both items are shown in the quote in Appendix B) Newfoundland and Labrador Hydro could then remove the redundant cards from the existing chassis and populate the newly acquired chassis. With the addition of a single link between the two switches and some slight configuration changes would allow for two physically separate Catalyst 6509E switches to exist in the Distribution / Core layers providing additional physical redundancy. Assuming the two Catalyst 6509E switches are located in physically separate areas, additional redundancy may be added by splitting up clustered servers between the two physical locations as well.

NOTE: Additional redundancy can be gained by physically locating the two Catalyst 6509E switches on physically separate floors / rooms within the facility. It is worth noting that the second location identified would require uplinks from all other remote closets be terminated within the location for obvious reasons. Additional uplinks may also need to be added to maintain existing throughput rates depending on the physical location chosen.

The following are some key reasons the Catalyst 6509E switch was chosen.

- Maximum Network Uptime: With Cisco IOS Software Modularity and platform, power supply, supervisor engine, switch fabric, and integrated network services redundancy provides one- to three-second stateful failover and delivers application and services continuity in a converged network, minimizing disruption of mission-critical data and services.
    - Provides packet-loss protection and the fastest recovery from network disruption
    - Features fast, one- to three-second stateful failover between redundant supervisor engines
- Scalable Performance: Provides up to 400-mpps performance with distributed forwarding architecture.
- Support for modular future growth as required. Only 6 of the 9 slots are being used.
- Future support for Advanced Services Modules including Firewall Services Module, Wireless Integrated Services Module, etc.
- Highest Level of Interface Flexibility, Scalability, and Density.
- Feature rich support for advanced technologies including Enhanced Data, Voice, and Video Services

CATALYST 3750E SWITCHES (LEVEL 1B)

HP's proposed solution is for Cisco Catalyst 3750E switches to be used for Level 1B due to the high number of servers located within that area. The Catalyst 3750E stack will be redundantly uplinked to the Core Catalyst 6509E switch located in the Comms Room. As the Catalyst 3750E switches provide support for 10 Gigabit uplinks, Hp recommends using these higher throughput interfaces to ensure that adequate bandwidth exists to provide an acceptable end user experience for access to the server farm connected to the stack. The recommended number of uplinks to facilitate this connectivity is four physical links providing an adequate full duplex throughput of 80 Gigabits. The solution proposed is designed to accommodate additional throughput if deemed necessary in the future and adequate additional ports are available in both the Catalyst 3750E stack and the Catalyst 6509E to accommodate. Adding addition uplinks to the proposed solution is as easy as purchasing additional 10 Gigabit transceivers (part number and price shown in Appendix B) as required.

The 4 uplinks between the Catalyst 3750E stack located in the Level 1B area and the Catalyst 6509E located in the Comms Room area will be configured as an Etherchannel group to allow for the full throughput utilization of all links and additional redundancy. In the Catalyst 3750E stack, the uplinks will be evenly distributed across multiple physical switches. In the Catalyst 6509E switch, the uplinks from the Level 1B stack will be evenly distributed across two physically separate modules within the Catalyst 6509E chassis. This configuration ensures that no single point of failure exists within this component of the infrastructure.

The following are some key reasons the Catalyst 3750E line of switches was chosen.

- Stacking capabilities with 64GB dedicated uplinks (directly on switch backbone) between stack members. This makes adding or removing a switch an easy task, and the configuration file is only updated, not replaced. This means that the same hostname and IP Address are maintained no matter how many switches are in the stack, easing management and monitoring issues of adding/removing devices.
- Single configuration file to manage for up to 9 switches in a stack configuration
- Single Management IP Address for all stack members
- Single IOS upgrade procedure for all stack members

- Single deployment of QoS for all stack members
- Single instance of Spanning-Tree Protocol (STP) across all stack members, decreasing the STP topology
- New Stack members can be added or Old ones removed without service interruption
- With 2 or more switches in a stack, uplinks back to the core data closet can be spread across multiple devices, increasing redundancy
- Support for 10 Gigabit uplinks

CATALYST 3750 SWITCHES (REMAINING ACCESS LAYER AREAS)

HP's proposed solution is for Cisco Catalyst 3750 switches to be used for closet device replacement in all areas servicing end user devices. Each of the Catalyst 3750 stacks will be redundantly uplinked to the Core Catalyst 6509E switch located in the Comms Room. The recommended number of uplinks to facilitate this connectivity was calculated using a ratio of 1 dedicated Gigabit uplink per 48 end users. In HP's experience, this has been an acceptable industry standard ratio; however, it is worth noting that the decision should be made on a per closet basis taking in to account the type and volume of end user traffic originating from a given area. The solution is designed to accommodate this requirement and adequate additional ports are available in both the Catalyst 3750stacks and the Catalyst 6509E to accommodate future growth requirements. Adding addition uplinks to the proposed solution is as easy as purchasing additional SFPs (part number and price shown in Appendix B) as required.

All uplinks between the Catalyst 3750 stacks located at the Access layer and the Catalyst 6509E located in the Core/Distribution Layer will be configured as an Etherchannel group to allow for the full throughput utilization of all links and additional redundancy. At the access Layer, the uplinks will be evenly distributed across multiple physical switches with the Catalyst 3750 stack. In the Core/Distribution layer, the uplinks from a single closet will be evenly distributed across two physically separate modules within the Catalyst 6509E chassis. This configuration ensures that no single point of failure exists within this component of the infrastructure.

The following are some key reasons the Catalyst 3750 line of switches was chosen.

- Stacking capabilities with 32GB dedicated uplinks (directly on switch backbone) between stack members. This makes adding or removing a switch an easy task, and the configuration file is only updated, not replaced. This means that the same hostname and IP Address are maintained no matter how many switches are in the stack, easing management and monitoring issues of adding/removing devices.
- Single configuration file to manage for up to 9 switches in a stack configuration
- Single Management IP Address for all stack members
- Single IOS upgrade procedure for all stack members
- Single deployment of QoS for all stack members
- Single instance of Spanning-Tree Protocol (STP) across all stack members, decreasing the STP topology
- New Stack members can be added or Old ones removed without service interruption
- With 2 or more switches in a stack, uplinks back to the core data closet can be spread across multiple devices, increasing redundancy

5.4. Network Device Support Requirements

Generally, network components require a maintenance contract to be purchased for coverage in case of a device failure. There are two options which can be used, either purchase a support contract with the network device, or utilize a sparing strategy, each with pros and cons.

Support Contract-

PROS	CONS
Access to Cisco TAC for incident assistance	Cost per device
CCO (Cisco Connection Online) device repository access	Possible delay in receiving new device (Next Business Day)
24 hour access to software updates	4 hour device replacement is costly

Sparing Strategy-

PROS	CONS
Minimal added Cost per device (overall percentage)	No access to Cisco TAC for incident assistance
Device is on hand, ready to replace a failed device	No contract based CCO access
Possible to be used for "testing" until required	No access to software updates

It is HP's recommendation that Newfoundland Labrador Hydro have Cisco Smartnet support on the Core Catalyst 6509E switch and the Catalyst 3750E switches located in Level 1B as the majority of the servers reside in that location. Although HP also recommends that the remaining Catalyst 3750 switch stacks throughout the infrastructure have Smartnet support as well, it is understood that this is a cost / risk analysis that must be made by Newfoundland and Labrador Hydro. Should a decision be made to use a sparing strategy on these devices, Newfoundland and Labrador Hydro should keep the above pros and cons in mind.

5.5. Redundant Power Requirements (Optional)

The devices proposed for Access layer connectivity are single power supply units. As an option, a RPS unit can provide for a second power supply, enhancing the redundancy of the switch stack. The RPS 2300 unit can provide redundant power supply for up to 6 devices. Below are the Canadian LIST prices associated with the RPS 2300 unit.

RPS 2300 P/N	Description	LIST Price
PWR-RPS2300	Cisco Redundant Power System 2300 (no PS)	$1,416
CAB-RPS2300=	RPS2300 Cable for Devices other than E-Series Switches	$177
C3K-PWR-750WAC=	Catalyst 3750-E/3560-E/RPS 2300 750WAC power supply	$1,174
C3K-PWR-1150WAC=	Catalyst 3750-E/3560-E/RPS 2300 1150WAC power supply	$1,764

6. High Level Implementation Plan

This section will attempt to formulate a high level implementation plan required to migrate the from the existing legacy infrastructure to the proposed solution described in the previous section.

NOTE: A detailed implementation plan is outside the scope of this document. The high level implementation plan shown below in step by step format is only to be used as a starting point and is by no means complete.

Within the quote provided in Appendix B, HP has included 10 days of professional services that will be used to complete the following tasks:

- Review the current configurations on the existing infrastructure equipment to determine existing configuration standard.
- Design creation / validation. The result of this task is a detailed network drawing depicting the network architecture in the core computer room, switch stacks at the edge, implemented hardware, VLAN assignment and IP addressing information. HP will work with the customer to whiteboard the detailed design; however, the customer will be responsible for transferring it to electronic format.
- Migrate the existing Cisco Catalyst 6513 CATOS infrastructure configuration to the new Cisco Catalyst 6509E switch and make any required changes to support the new architecture as outlined in the design. Ensure that the new configuration adheres to all recommended best practices and enable any new features or functionality available. Only new features that are deemed non service impacting will be enabled as part of the migration. These features will be identified and provided to Newfoundland and Labrador Hydro for approval prior to being added to the configuration.
- Work with Newfoundland and Labrador Hydro to complete the staging and subsequent testing of new Cisco Catalyst 6509E, Catalyst 3750 and Catalyst 3750E switching architecture. During the staging, all functionality will be tested to ensure seamless integration into the production environment.
- Create implementation plan, validation tests and backout procedures as required by Newfoundland and Labrador Hydro's Change Management control.
- Implement and integrate the Catalyst 6509E core switch and one stack of Catalyst 3750 edge switches into the production environment. The implementation will integrate the new components in parallel to the existing infrastructure to allow for a non service interrupting migration.

NOTE: Once the new infrastructure is implemented in parallel to the existing, Newfoundland and Labrador Hydro will complete the migration of remaining services during scheduled maintenance windows. Although HP will be available to provide support during the migration if required it is not included in the 10 days of professional services.

Should Newfoundland and Labrador Hydro decide to apply the legacy hardware in place today towards a trade-in allowance, it can be shipped back to Cisco following the migration. It is worth noting that no trade-in allowance has been included in the quote and should Newfoundland and Labrador Hydro decide to go this route the value will be calculated and including in the final quote prior to the actual implementation.

It is worth noting that without proper planning with all groups involved including but not limited to Senior Management, Project Management, Change Management, Technical, Building Infrastructure (including Power, UPS, Cabling and environmental), the chances of this project being successful are low.

Appendix – "A" Switching

Link to Cisco 6500 Data Sheets-

http://www.cisco.com/en/US/products/hw/switches/ps708/products_data_sheets_list.html

Link to Cisco 3750E Data Sheet-

http://www.cisco.com/en/US/prod/collateral/switches/ps5718/ps7077/product_data_sheet0900aecd805bbe67.html

Link to Cisco 3750 Data Sheet-

http://www.cisco.com/en/US/products/hw/switches/ps5023/products_data_sheets_list.html

Appendix – "B" Proposed Solution Quote

NOTE: Although Newfoundland and Labrador Hydro's existing discount is 45% off of list, it was their desire to have the quote reflect a 15% discount for budgetary purposes. HP has made the required change as requested.

Part Number	Description	Qty	CAD List	Unit Sell	Discount	Extd Sell
WS-C6509-E	Catalyst 6500 Enhanced 9-slot chassis,15RU,no PS,no Fan Tray	1	$11,210.00	$9,528.50	15%	$9,528.50
S733ISK9N-12233SXI	Cisco CAT6000-SUP720 IOS IP SERVICES SSH LAN ONLY (MODULAR)	1	included	na	na	na
WS-SUP720-3B	Catalyst 6500/Cisco 7600 Supervisor 720 Fabric MSFC3 PFC3B	1	$33,040.00	$28,084.00	15%	$28,084.00
CF-ADAPTER-SP	SP adapter for SUP720 and SUP720-10G	1	included	na	na	na
MEM-C6K-CPTFL1GB	Catalyst 6500 Compact Flash Memory 1GB	1	$1,292.00	$1,098.20	15%	$1,098.20
WS-SUP720-3B	Catalyst 6500/Cisco 7600 Supervisor 720 Fabric MSFC3 PFC3B	1	$33,040.00	$28,084.00	15%	$28,084.00
CF-ADAPTER-SP	SP adapter for SUP720 and SUP720-10G	1	included	na	na	na
MEM-C6K-CPTFL1GB	Catalyst 6500 Compact Flash Memory 1GB	1	$1,292.00	$1,098.20	15%	$1,098.20
WS-X6724-SFP	Catalyst 6500 24-port GigE Mod: fabric-enabled (Req. SFPs)	1	$17,700.00	$15,045.00	15%	$15,045.00
GLC-SX-MM	GE SFP, LC connector SX transceiver	12	$590.00	$501.50	15%	$6,018.00
WS-X6724-SFP	Catalyst 6500 24-port GigE Mod: fabric-enabled (Req. SFPs)	1	$17,700.00	$15,045.00	15%	$15,045.00
GLC-SX-MM	GE SFP, LC connector SX transceiver	11	$590.00	$501.50	15%	$5,516.50
WS-X6704-10GE	Cat6500 4-port 10 Gigabit Ethernet Module (req. XENPAKs)	1	$23,600.00	$20,060.00	15%	$20,060.00
XENPAK-10GB-SR	10GBASE-SR XENPAK Module	2	$3,540.00	$3,009.00	15%	$6,018.00
WS-X6704-10GE	Cat6500 4-port 10 Gigabit Ethernet Module (req. XENPAKs)	1	$23,600.00	$20,060.00	15%	$20,060.00
XENPAK-10GB-SR	10GBASE-SR XENPAK Module	2	$3,540.00	$3,009.00	15%	$6,018.00
WS-C6509-E-FAN	Catalyst 6509-E Chassis Fan Tray	1	$584.00	$496.40	15%	$496.40
WS-CAC-3000W	Catalyst 6500 3000W AC power supply	2	$3,540.00	$3,009.00	15%	$6,018.00
CAB-AC-C6K-TWLK	Power Cord, 250Vac 16A, twist lock NEMA L6-20 plug, US	2	included	na	na	na
MEM-C6K-CPTFL512M	Catalyst 6500 Sup720/Sup32 Compact Flash Mem 512MB	1	included	na	na	na
BF-S720-64MB-RP	Bootflash for SUP720-64MB-RP	1	included	na	na	na
MEM-S2-512MB	Catalyst 6500 512MB DRAM on the Supervisor (SUP2 or SUP720)	1	included	na	na	na
MEM-MSFC2-512MB	Catalyst 6500 512MB DRAM on the MSFC2 or SUP720 MSFC3	1	included	na	na	na
MEM-C6K-CPTFL512M	Catalyst 6500 Sup720/Sup32 Compact Flash Mem 512MB	1	included	na	na	na
BF-S720-64MB-RP	Bootflash for SUP720-64MB-RP	1	included	na	na	na
MEM-S2-512MB	Catalyst 6500 512MB DRAM on the Supervisor (SUP2 or SUP720)	1	included	na	na	na
MEM-MSFC2-512MB	Catalyst 6500 512MB DRAM on the MSFC2 or SUP720 MSFC3	1	included	na	na	na
MEM-XCEF720-256M	Catalyst 6500 256MB DDR, xCEF720 (67xx interface, DFC3A)	1	included	na	na	na
WS-F6700-CFC	Catalyst 6500 Central Fwd Card for WS-X67xx modules	1	included	na	na	na
MEM-XCEF720-256M	Catalyst 6500 256MB DDR, xCEF720 (67xx interface, DFC3A)	1	included	na	na	na
WS-F6700-CFC	Catalyst 6500 Central Fwd Card for WS-X67xx modules	1	included	na	na	na
MEM-XCEF720-256M	Catalyst 6500 256MB DDR, xCEF720 (67xx interface, DFC3A)	1	included	na	na	na
WS-F6700-CFC	Catalyst 6500 Central Fwd Card for WS-X67xx modules	1	included	na	na	na
WS-F6K-XENBLNKCVR	Catalyst 6500 Xenpak Blank Covers for WS-X6704-10GE	2	included	na	na	na
MEM-XCEF720-256M	Catalyst 6500 256MB DDR, xCEF720 (67xx interface, DFC3A)	1	included	na	na	na
WS-F6700-CFC	Catalyst 6500 Central Fwd Card for WS-X67xx modules	1	included	na	na	na
WS-F6K-XENBLNKCVR	Catalyst 6500 Xenpak Blank Covers for WS-X6704-10GE	2	included	na	na	na
CON-OSP-WS-C6509	ONSITE 24x7x4 Catalyst 6500 Enhanced 9-slot chassis	1	$16,107.00	$12,402.39	23%	$12,402.39
Sourced from Cisco	**Estimated delivery (as of this date): 32-52 business days ARO**					

WS-C3750G-24PS-S	Catalyst 3750 24 10/100/1000T PoE + 4 SFP + IPB Image	38	$9,198.00	$7,818.30	15%	$297,095.40
CAB-16AWG-AC	AC Power cord, 16AWG	38	included	na	na	na
CAB-STACK-50CM	Cisco StackWise 50CM Stacking Cable	38	included	na	na	na
CON-OSP-3750G24P	ONSITE 24X7X4 Cat 3750 24 10/100/1000T PoE + 4 SF	38	$1,286.00	$990.22	23%	$37,628.36
Sourced from Cisco	**Estimated delivery (as of this date): 18 business days ARO**					
WS-C3750E-24PD-S	Catalyst 3750E 24 10/100/1000 PoE+2*10GE(X2),750W,IPB s/w	1	$12,148.00	$10,325.80	15%	$10,325.80
CAB-16AWG-AC	AC Power cord, 16AWG	1	included	na	na	na
S3750EVT-12235SE	CAT 3750E IOS UNIVERSAL W/O CRYPTO WITH WEB BASED DEV MGR	1	included	na	na	na
CAB-STACK-50CM	Cisco StackWise 50CM Stacking Cable	1	included	na	na	na
CVR-X2-SFP	Cisco TwinGig Converter Module	2	included	na	na	na
CON-OSP-3750E2PS	ONSITE 24X7X4 WS-C3750E-24PD-S	1	$1,945.00	$1,497.65	23%	$1,497.65
Sourced from Cisco	**Estimated delivery (as of this date): 18 business days ARO**					
WS-C3750E-24TD-S	Catalyst 3750E 24 10/100/1000+2*10GE(X2),265W,IPB s/w	5	$11,204.00	$9,523.40	15%	$47,617.00
CAB-AC	AC Power Cord (North America), C13, NEMA 5-15P, 2.1m	5	included	na	na	na
S3750EVT-12235SE	CAT 3750E IOS UNIVERSAL W/O CRYPTO WITH WEB BASED DEV MGR	5	included	na	na	na
CAB-STACK-50CM	Cisco StackWise 50CM Stacking Cable	5	included	na	na	na
CVR-X2-SFP	Cisco TwinGig Converter Module	10	included	na	na	na
CON-OSP-3750E2TS	ONSITE 24X7X4 WS-C3750E-24TD-S	5	$1,794.00	$1,381.38	23%	$6,906.90
Sourced from Cisco	**Estimated delivery (as of this date): 52-59 business days ARO**					
X2-10GB-SR=	10GBASE-SR X2 Module	4	$2,354.00	$2,000.90	15%	$8,003.60
CAB-STACK-1M=	Cisco StackWise 1M Stacking Cable	4	$236.00	$200.60	15%	$802.40
GLC-SX-MM=	GE SFP, LC connector SX transceiver	23	$590.00	$501.50	15%	$11,534.50
Sourced from Cisco	**Estimated delivery (as of this date): 18-25 business days ARO**					
	Professional Services for Design/Implementation	10	NA	$1,510.00	NA	$15,100.00
Total Before Tax	**Please reference HP Quote # on your Purchase Order**					**$617,101.80**

This quotation is subject to Customer's purchase agreement with HP, if applicable, or in the absence of such purchase agreement, to the HP Customer Agreement, a copy of which is provided with this quotation and Customer acknowledges receiving, or failing such receipt is available from HP upon request. Any resultant order or contract will be subject to the aforementioned applicable terms. Customer's new or different terms and conditions contained in any Customer purchase order or other Customer documentation shall not apply and Customer's purchase and license of Products and Support will constitute Customer's acceptance of the aforementioned applicable terms.
The goods and services to be provided by HP pursuant to this quote is subject to HP terms and conditions of sale; SO01SP, CAM01, and as applicable, CAM02, CAM03, and CAM04.

Thank you for this opportunity to submit our quotation for your review, we hope to be favored by your valued order.