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A NETWORK FOR DAEMONS FREQUENT AND  
URGENT NET-TRADERS COMPANY (DAFUN)

DESIGNED BY ANH HOANG

## CONTENTS

EXECUTIVE SUMMARY .....	4
DETAILED INFRASTRUCTURE REPORT.....	6
WAN INFRASTRUCTURE .....	6
WAN technologies selected. ....	6
Logical diagram .....	7
Router specification.....	8
Equipment list and pricing .....	9
WAN links specification an pricing.....	11
TORONTO OFFICE NETWORK INFRASTRUCTURE.....	14
Logical diagram .....	14
Physical layout and diagram.....	15
Equipment list and pricing .....	17
Equipment list and pricing .....	32
Rack Diagram.....	34
Cooling specification .....	37
NASSAU HEADQUARTER NETWORK INFRASTRUCTURE.....	39
Logical diagram .....	39
Physical layout and diagram .....	40
Equipment list and pricing .....	40
Rack diagram.....	44
CHICAGO AND NEWYORK NETWORK INFRASTRUCTURE .....	45
Logical diagram .....	45
Physical layout and diagram .....	46
Equipment list and pricing .....	47
Rack diagram.....	49
CHICAGO AND NEW YORK COLOCATION.....	50
Logical diagram .....	50
Equipment list and pricing .....	51
RACK Diagram.....	57
Wiring Scheme .....	59
IP ADDRESSING, NAT, ROUTING .....	60
DHCP design.....	82

REDUNDANCY/FAULT TOLERANCE STRATEGIES .....	86
SECURITY MANAGEMENT.....	87
IMPLEMENTATION PLAN.....	89
TOTAL COST OF OWNERSHIP within 3 months.....	92

## EXECUTIVE SUMMARY

This executive summary is to provide an overview of the network design of DAFUN, a hedge fund that utilizes proprietary trading algorithms for buying and selling stocks, and the expected results that will meet up with the expectation and goal of the company.

The company has four offices inside and outside of the United States which locate in Toronto, Nassau, Chicago, and New York. In addition of the offices, the company also lease rack space at Solsticix to be able to host the servers. These data centers are in Chicago and New York. The proposed network design is aimed to support the increasing use for trading traffic and maximize redundancy in all these offices. The key elements for this design include high-speed connectivity, scalability, redundancy, security measurements, data center optimization.

Here is the breakdown of these elements:

1. High-speed connectivity: ASR routers and WAN routers will be implemented, fiber optic cables will be used to ensure high-bandwidth connectivity between data centers, offices and clients

2. Scalability: the company is growing, therefore a two-tier collapsed core as well as a spine and leaf architecture are applied to the network design for future growth without major changes.
3. Redundancy: back up options are always available, high availability technique such as HSRP, VRRP and fault tolerance are applied to most of the major equipment.
4. Security measurement: firewalls are implemented within every office, intrusion detection systems as well as security software such as anti-virus will be implemented on all employees' computers.
5. Data center optimization: redundant power supplies and efficient cooling systems are priority when designing network for the Chicago and New York colocations.

Overall, this network design will cost \$xxxxxx. By investing in this robust design, DAFUN can achieve high trading capabilities, high availability, and low latency.

## DETAILED INFRASTRUCTURE REPORT

In this proposal, 3 WAN technologies will be used which are Leases Lines (T1), MPLS and Ethernet WAN. Some challenges we must face when designing this network are reliability, redundancy, security, latency, and delay. Therefore, the two-tier collapsed core and spine-leaf topologies are chosen for this project as it provides the highest availability, redundancy, and scalability. ASR routers will be used to ensure the best WAN termination, ASA devices will be connected to the routers for extra layer of security, core switches will be used for distribution and stack wise of layer 2 switches are used to provide LAN connectivity with enhanced bandwidth.

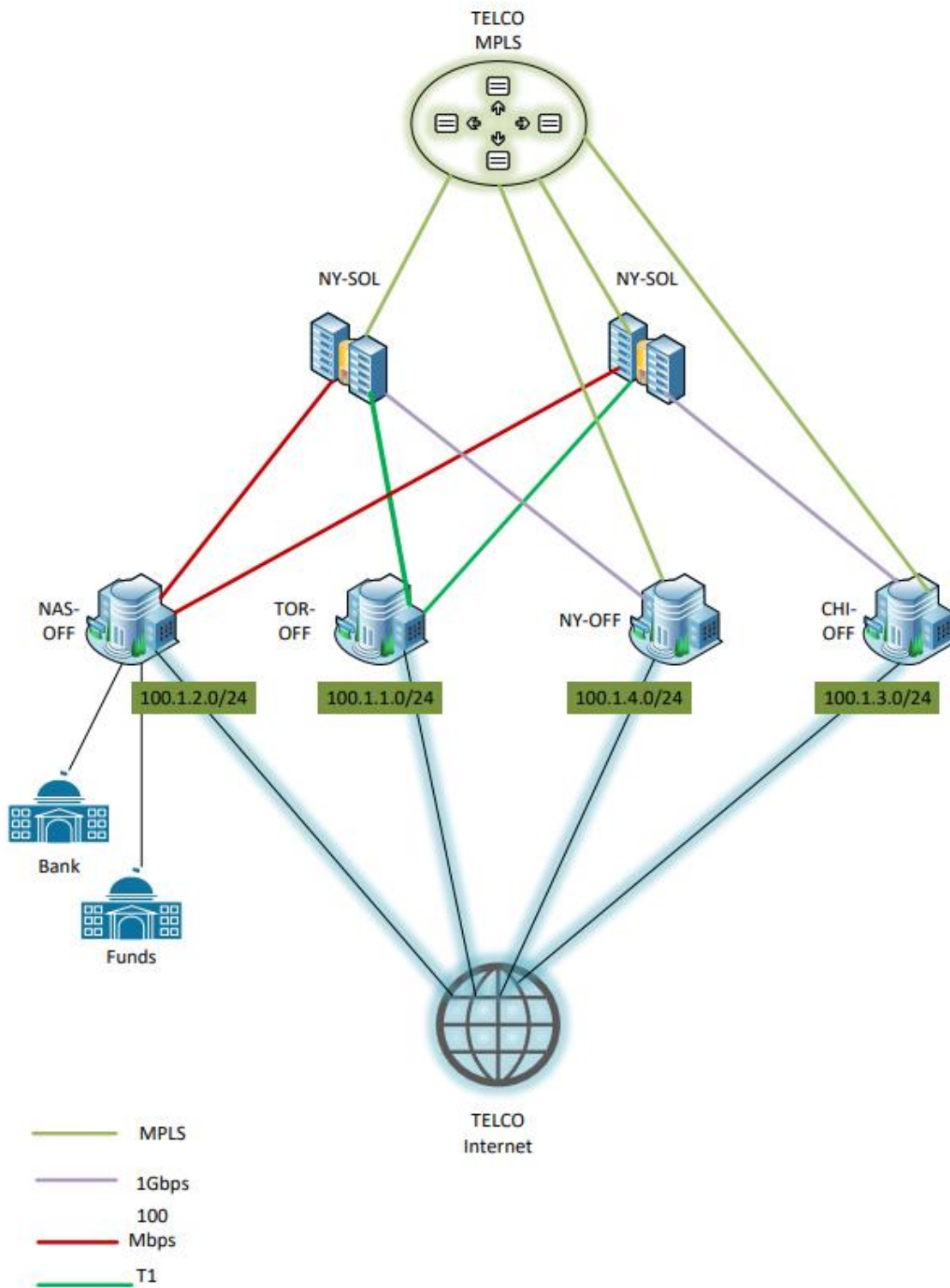
## WAN INFRASTRUCTURE

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### WAN TECHNOLOGIES SELECTED.

- Leased lines (T1)
- MPLS
- Ethernet WAN

## LOGICAL DIAGRAM



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## ROUTER SPECIFICATION

### ASR 9904



- Chassis Price: \$18,691.23
- Quantity: 2
- Height: 6U
- Modularity: Pay-as-you-grow for future scalability
- 2 Ethernet Line Card Slot
- 2 RSP card slots
- Dual redundant RSPs with integrated fabric in 2 slots
- Provide high density 100 Gigabit ethernet ports without the need to replace the chassis.
- Allows for an end-to-end IP/MPLS solution.



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## EQUIPMENT LIST AND PRICING

### **Cisco A9K-RSP440-TR ASR9K Route Switch Processor**



- Price: \$955
- The processor is the main controller and the switch fabric element in the cisco ASR 9904
- Handles routing protocols, maintaining routing tables and forwarding decisions
- 2 RSP cards to provide redundancy. One acts as an active RSP and the other would be a standby RSP.
- Memory internal with 6-GB Error-Correcting Code (ECC)-protected DRAM for A9K-RSP440-TR and 12-GB ECC-protected DRAM for A9K-RSP440-SE and Solid-state disk: two 16-GB SSDs and 8-GB embedded USBWAN links specification and pricing
- Memory external with USB 2.0 Type A receptacle

## A9K-40GE-SE Line Cards



- Price: \$5720
- Provide interfaces to connect to the Ethernet.
- In charge of the data plane functions such as packet-forwarding decision, switching and traffic management
- No hardware upgrade to the chassis or cooling system is required to deploy these line cards.
- Each line card provides simultaneous support for combined IP, MPLS, Ethernet, Layer 2 VPN (L2VPN), and Layer 3 VPN (L3VPN) services.
- 40 ports of 1 Gigabit Ethernet per line card.
- 40-Port GE Line Card, Service Edge Optimized, Requires SFPs
- Provides QoS and security functionalities such as firewall, NAT.

## WAN LINKS SPECIFICATION AN PRICING

JP TELCO provides a variety of services with different prices. After consideration about the needs for the network speed and bandwidth, the point-to-point Metro Ethernet will be used to connect locations within the US as well as the TORONTO location and a T1 line will be used to connect NASSAU to other locations. Here is the breakdown of the bandwidth between the buildings. The company guaranties its MetroEthernet service would have the latency no grater than 8ms (2ms-8ms)

- ✓ The line between TORONTO and the colocations will be **100 Mbps** as TELCO does not provide higher bandwidth for out-of-country location.
- ✓ The connections between locations within the US would be **1Gbps**
- ✓ A point-to-point **T1** will be used to connect NASSAU with the rest of the location as this is the only option offered for NASSAU.

## COST FOR WAN LINKS IN EACH LOCATION

	CHI-SOL	NY-SOL	TOTAL COST
TOR- OFF	\$2600/month	\$2400/month	\$5000/month

CHI-OFF	\$2300/month		\$2300/month
NY-OFF		\$2200/month	\$2200/month
NAS- OFF	\$12,500/month	\$12,500/month	\$25000/month

Moreover, the MPLS service is also used in conjunction with the Internet.

The MPLS would act as a back up line for CHI-OFF and NY-OFF and will be the primary connections between the CHI-SOL and NY-SOL. The bandwidth used for the service would be 1Gbps. Latency guaranties to not exceed 20ms/way and 99% uptime

- CHI-OFF: \$3200/month
- NY-OFF: \$3000/month
- CHI-SOL and NY-SOL: \$2400/month

In addition, NASSAU office also need to have connect to its bank and the United Funds. TELCO can provide this connection for a fixed monthly cost of \$1200 for the 2 connections.

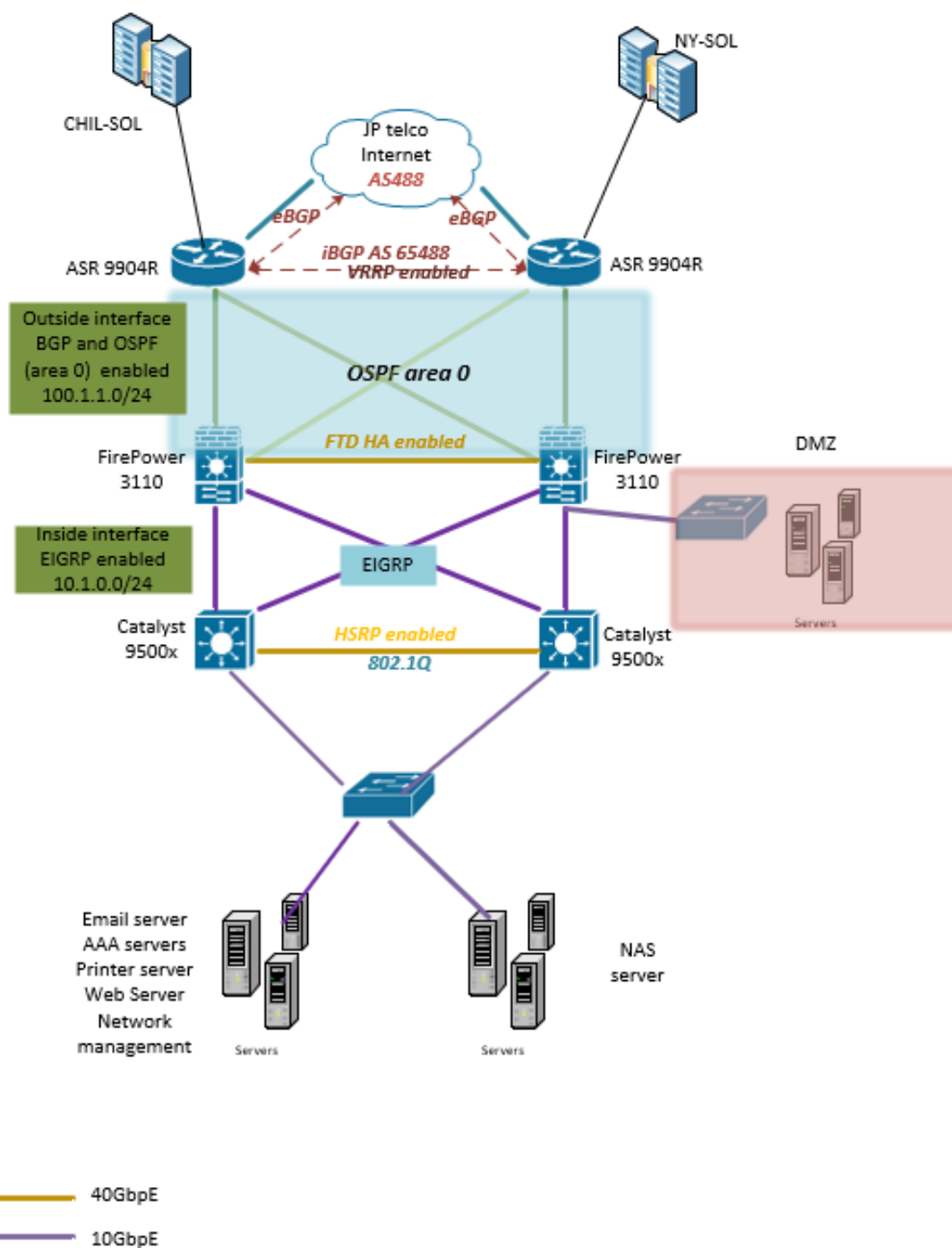
⇒ Total cost for WAN links and MPLS for every month at all locations is \$44,300.

⇒ Total cost for WAN links and MPLS for 36 months at all locations is

\$1,594,800.

## TORONTO OFFICE NETWORK INFRASTRUCTURE

### LOGICAL DIAGRAM



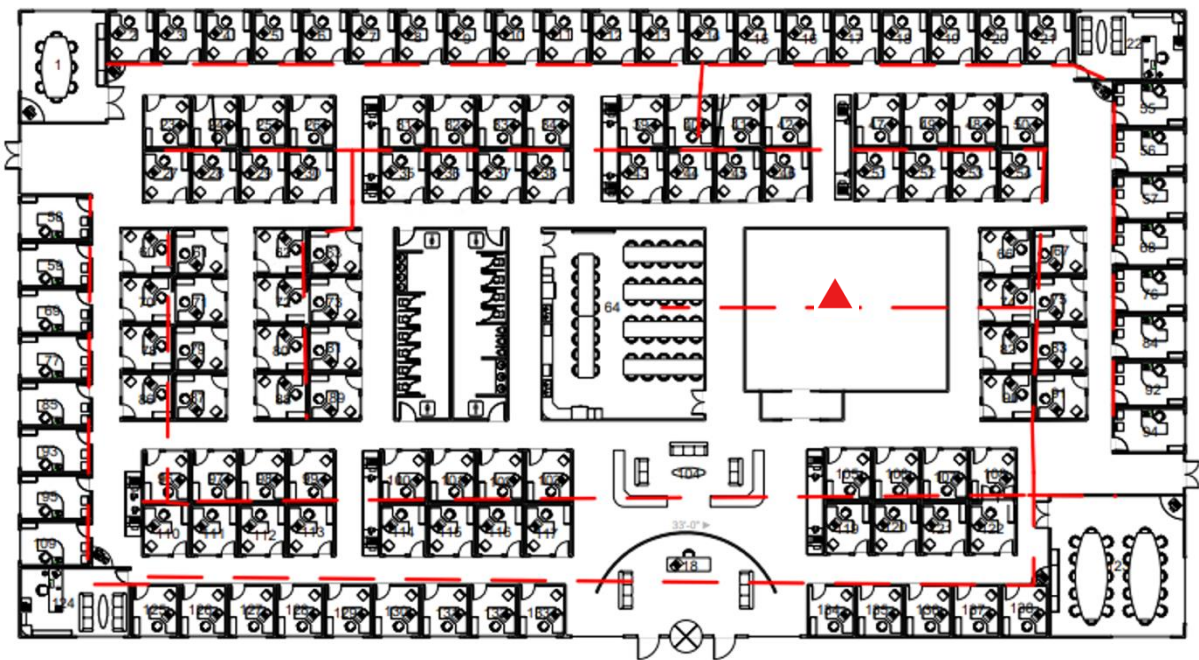
WAN and Internet topology

## PHYSICAL LAYOUT AND DIAGRAM

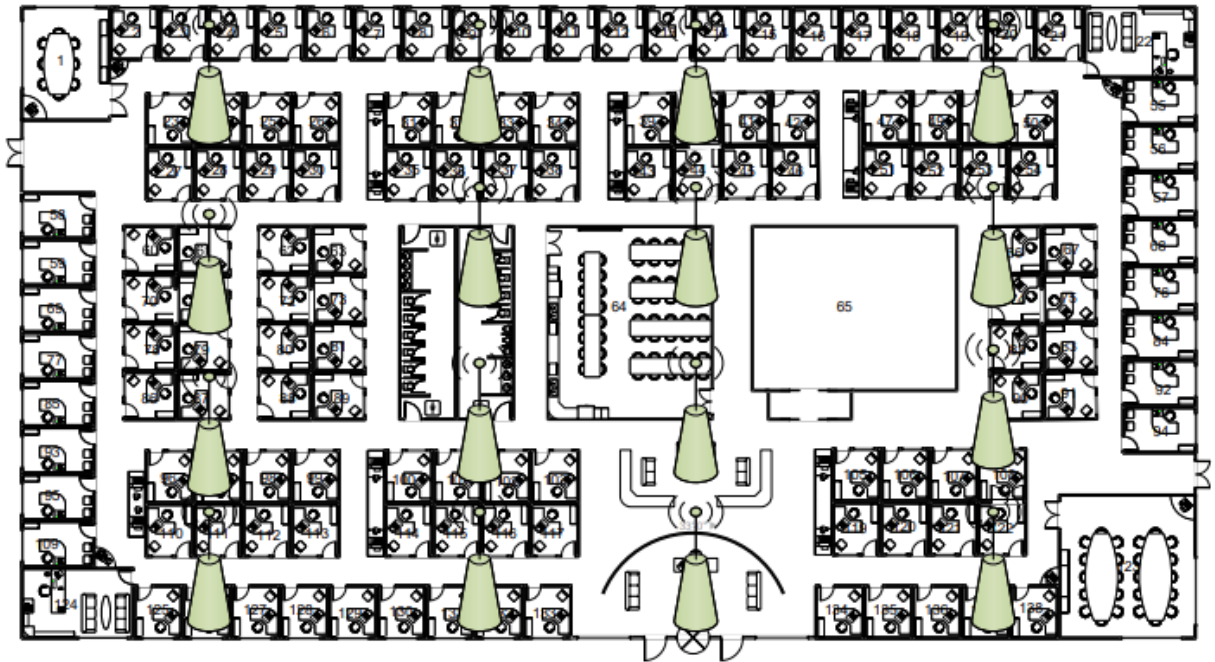
### HORIZONTAL CABLING

The Horizontal cabling extends from the data center room (Room 650) to work areas is installed in the ceiling using cable trays. The trays provide cable protection, organization, and accessibility.

Plenum cables is used to provide fire safety, improved indoor air quality and enhanced signal transmission. Cat6a is recommended to use for this type of cabling.



## WIRELESS FLOORPLAN



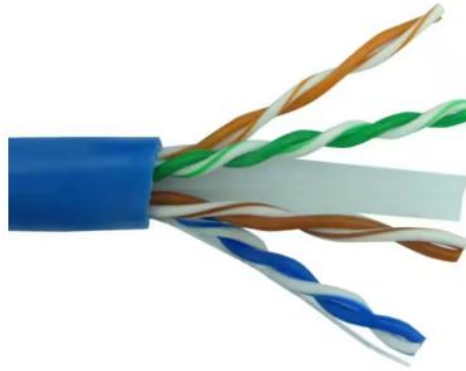


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## EQUIPMENT LIST AND PRICING

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### HORIZONTAL CABLING SPECIFICATION



- Price: \$340.89/1000ft
- Vendor: Triplet
- Model: CAT6AU-1000BL
- Data rate can be up to 10 Gbps

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### DATA CENTER SPECIFICATION (ROOM 65)

- The Data center room is located at room 65

#### **Internet router**



#### **Cisco ASR 9901**

- Price: \$6,500

- Height: 2U
- Quantity: 2
- 1 built-in RSP (8GB RAM) and 2 modular bays
- 4 built-in 10GE ports with management ports
- Provides business services such as Layer 2 and Layer 3 VPN (L2VPN and L3VPN), MPLS OAM, Layer 2 and Layer 3 Access Control Lists (ACLs), Hierarchical Quality of Service (HQoS)

## Firewalls



### **Cisco Firepower 3110 Next-Generation Firewall - firewall**

- Price: \$36,746.99
- Height 1U
- Quantity: 2
- 8 x RJ45, 8 x 1/10G SFP+
- Can run both ASA and Firewall Threat Defense (FTD)
- Supports stacked VLANs

## Core Switches (L3 witches)



### **Cisco Catalyst 9606R**

- Chassis price: \$15,330.19
- Quantity: 2
- Height 8U
- 4 line card slots (slot 1,2,5,6)
- 2 supervisor engine slots (slot 3 and 4)
- Provide advanced routing such as MPLS layer 2 and layer 3
- Provide supervisor engine redundancy to ensure continuous operation.
- Supports N + 1 redundancy
  - **Required modules for Catalyst 9606R**

C9600-LC-40YL4CD line cards



- Price: \$22,727.99
- Height: 1U
- Quantity: 8
- 44 ports in total in which 40-port 50/25/10GE, 2-port 200GE, 2-port 400GE

Cisco Catalyst 9600X Supervisor Engine 2



- Price: \$42,742.99
- Height: 1U
- Quantity: 4
- Flexible routing (IPv4, IPv6, and multicast) tables, Layer 2 tables, ACL tables, and QoS tables

## Access Switch



- Price: \$13,762.64
- Height: 1U
- Quantity: 8
- 48 ports x 10/100/1000 (PoE+)
- Support optional network modules for uplink ports
- Stacking Bandwidth Support- 1T
- Easy transition from 40G to 100G and 10G to 25G with dual-rate optics
- Support for both static and dynamic NAT and Port Address Translation (PAT)

## Power supply



### **PowerVault 114X LTO7, LTO8, LTO9**

Price: \$3999

Quantity: 6

- Height: 2U
- Ideal for backup and recovery of rack-dense servers
- Provides sufficient power within 5 minutes of an electrical outage

### **Power Distribution Unit**



### **APC Basic Rack PDU AP6020A**

Price: \$102.99

Quantity: 6

- Height: 1U
- Provided Voltage: AC 100-240 volt
- Required Voltage: AC 100-240 volt

## Servers



### ThinkSystem SR550 Rack Server

Vendor: Lenovo

Price: \$1832.02

Quantity: 6

- Height: 2U

## NAS servers



### ThinkSystem SR860 V2 Mission-Critical Server

Vendor: Lenovo

Price: \$6410.59

Quantity: 1

- Height: 4U
- Number of Processors: 2 or 4
- Memory: 32GB/18TB/TruDDR4
- Internal Hard Disk (Max) : 1474.56TB
- Offers 4 hot-swap power supplies to ensure continuous operation when adding or replacing components
- Offers scalability option to accommodate growing businesses
- Offers multiple memory slots and processors
- Designed with enhanced performance to handles demanding workloads such as data visualizations, in-memory database

### **Patch panels**



### **Leviton eXtreme 6+ QuickPort Patch Panel**

Price: \$602.99

Quantity: 6

- Height: 2U



- Provides 48 ports

## **Fiber Patch Panels**



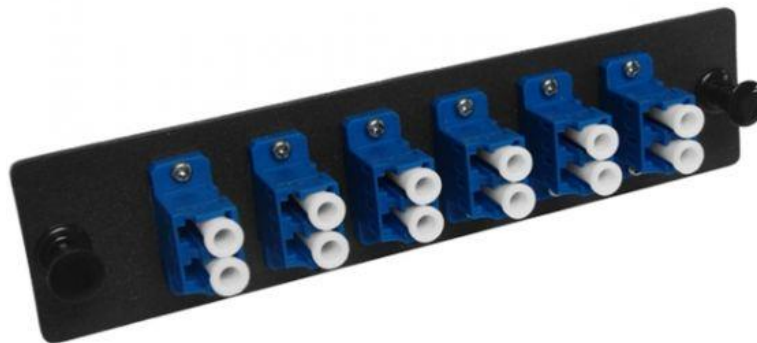
### **Fiber Breakout Patch Panel**

Vendor: Tripplite

Price: \$2,849.88

Quantity: 6

## **Single Mode Adapter**



### **Single Mode Fiber Adapter Panel**

Price: \$36.59

Quantity: 30

- Provides 12 ports for single mode fibers

### **Stacking cables for Catalyst 9300x**



### **Cisco StackWise 480 - stacking cable-3ft**

**Price: \$168.99**

- Can be used to stack up to 8 switches in a ring topology to achieve maximum of 1T bandwidth

**Rack**



### **NavePoint 42U Server Rack Cabinet**

Price: \$1482.4

Quantity: 3

- Height: 42U
- Reversible and lockable front door is glass for visibility
- Split style French rear doors are perforated to allow for increased airflow
- Lockable side panels which allow for easy access to equipment

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#### **WORKSTATION EQUIPMENT**

##### **Wireless Access point**



### **Catalyst 9136I access point**

- Price: \$2,095.55
- Quantity: 16
- Supporting the new 6-GHz band for Wi-Fi
- Designed for indoor environments with internal antennas
- 4x4 MIMO with four spatial streams
- Maximal Ratio Combining (MRC)

### **Computers**



### **Inspiron 27 All-in-One**

Price: \$1249.99

Quantity: 100

Processor: 12<sup>th</sup> Gen Intel® Core™ i7-1255U

Memory: 12 GB DDR4

Hard drive: 512 GB SSD

Display: 27.0-in. touch display Full HD (1920X1080)

Keyboard: Dell Pro Wireless Keyboard and Mouse - KM5221W

White – English

Mouse: Included

Wireless: Intel® Wi-Fi 6E AX211, 2x2, 802.11ax, Bluetooth®  
wireless card

### **Antivirus Software**

Vendor: [McAfee](#)

Price: 44.99/year for 10 devices

### **Microsoft Office**

Type: [Microsoft 365 Business Premium](#)

Price: \$22/user/month

### **Printer**



### **HP Color Laser Jet Enterprise M856x**

Price: \$5,829

Quantity: 5

- Print speed letter: Up to 55 ppm (black and color)
- Print Speed - Black (normal) Up to 56 ppm
- Print speed - Color (normal) Up to 56 ppm
- Resolution (black) Up to 1200 x 1200 dpi
- Resolution (color) Up to 1200 x 1200 dpi
- Prints up to 11x17"; 4x550-paper trays and stand

- Number of print cartridges 4 toner cartridges (1 each for black, cyan, magenta, yellow)
- Memory, standard 1.5 GB
- Memory, maximum 3.5 GB

## Office Phone



### Cisco IP Phone 7861

Price: \$285.99

Quantity: 100

- Screen 396 x 162 pixel (3.5 in. / 89 mm)
- Ethernet switch 10/100
- Full duplex speakerphone

## EQUIPMENT LIST AND PRICING

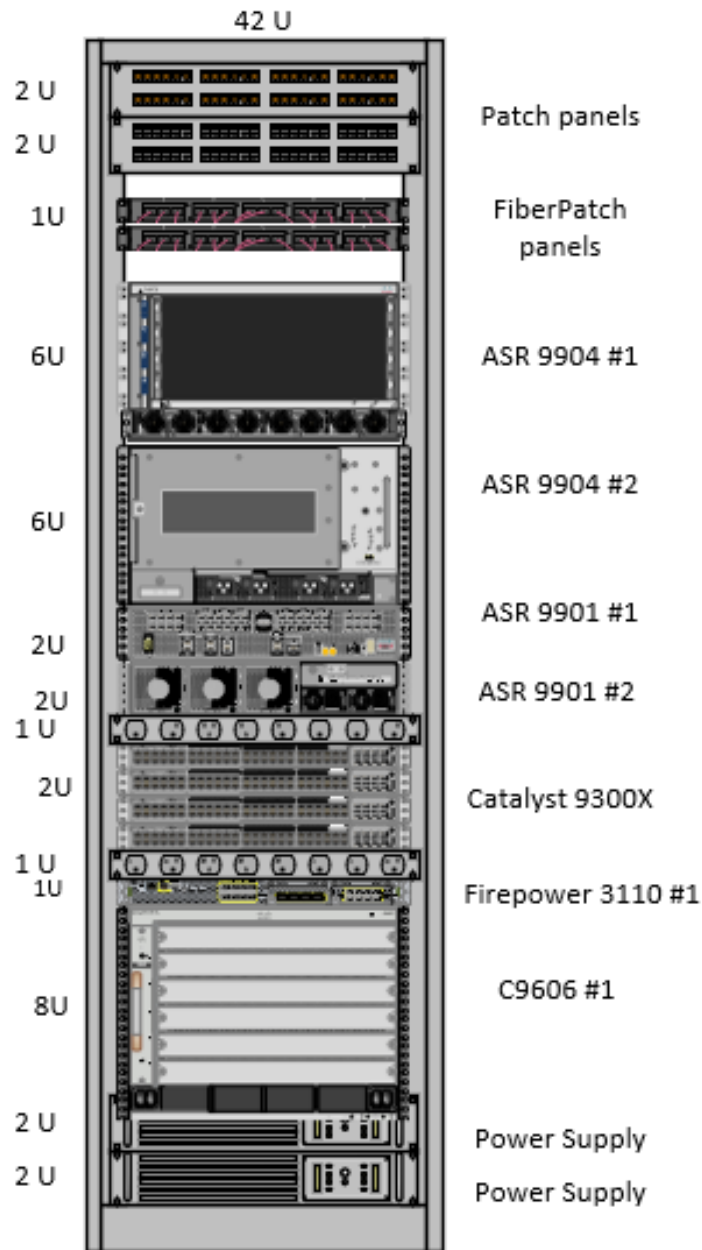
Model	Quantity	Unit Cost	Total cost
<b>ASR 9904</b>	2	\$18,691.23	\$37,382.46
<b>A9K-40GE-SE Line Cards</b>	2	\$5720	\$11,440
Cisco ASR 9901	2	\$6500	\$13,000
Cisco Firepower 3110	2	\$36,746.99	\$73,494
Cisco Catalyst 9606R	2	\$15,330.19	\$30,660
C9600-LC-40YL4CD line cards	8	\$22,727.99	\$181,824
Cisco Catalyst 9600X Supervisor Engine 2	4	\$42,742.99	\$170,972
Cisco Catalyst 9300X	8	\$13,762.64	\$110,101
PowerVault 114X LTO7	6	\$3999	\$23,994
Power Distribution	6	\$102.99	\$618
ThinkSystem SR550 Rack Server	6	\$1832.02	\$10,992



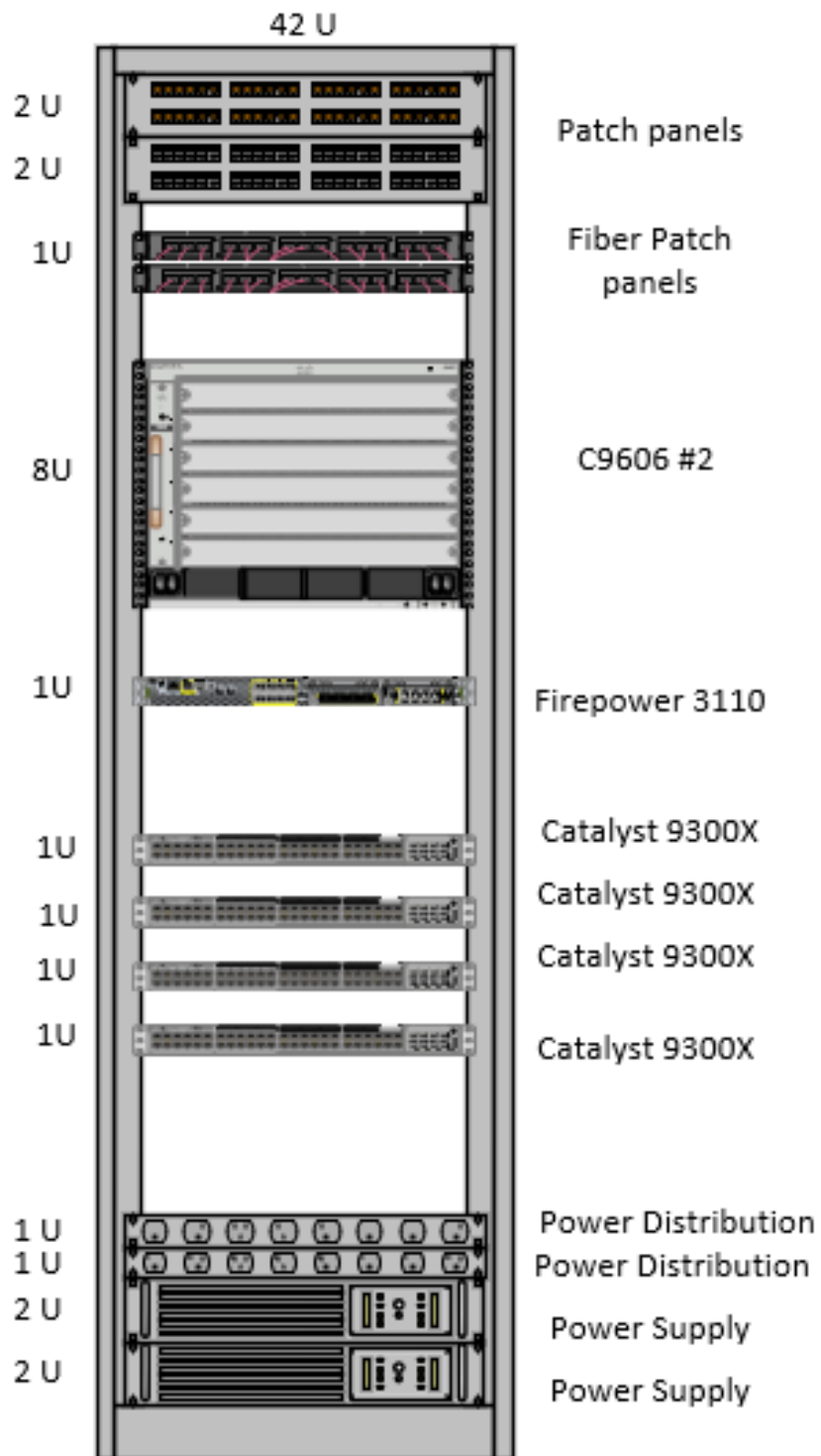
ThinkSystem SR860 V2	1	\$6410.59	\$6,411
Leviton eXtreme 6+ QuickPort Patch Panel	6	\$602.99	\$3,618
Fiber Breakout Patch Panel	6	\$2,849.88	\$17,099
Single Mode Fiber Adapter Panel	30	\$36.59	\$1,098
NavePoint 42U	2	\$1482.4	\$2,965
Wireless Access point	16	\$2,095.55	\$33,529
Dell Inspiron 27 All-in-One	100	\$1249.99	\$124,999
HP Color Laser Jet Enterprise	5	\$5,829	\$29,145
Office Phone 7861	100	\$285.99	\$28,599
Overall cost	\$911,940.46		

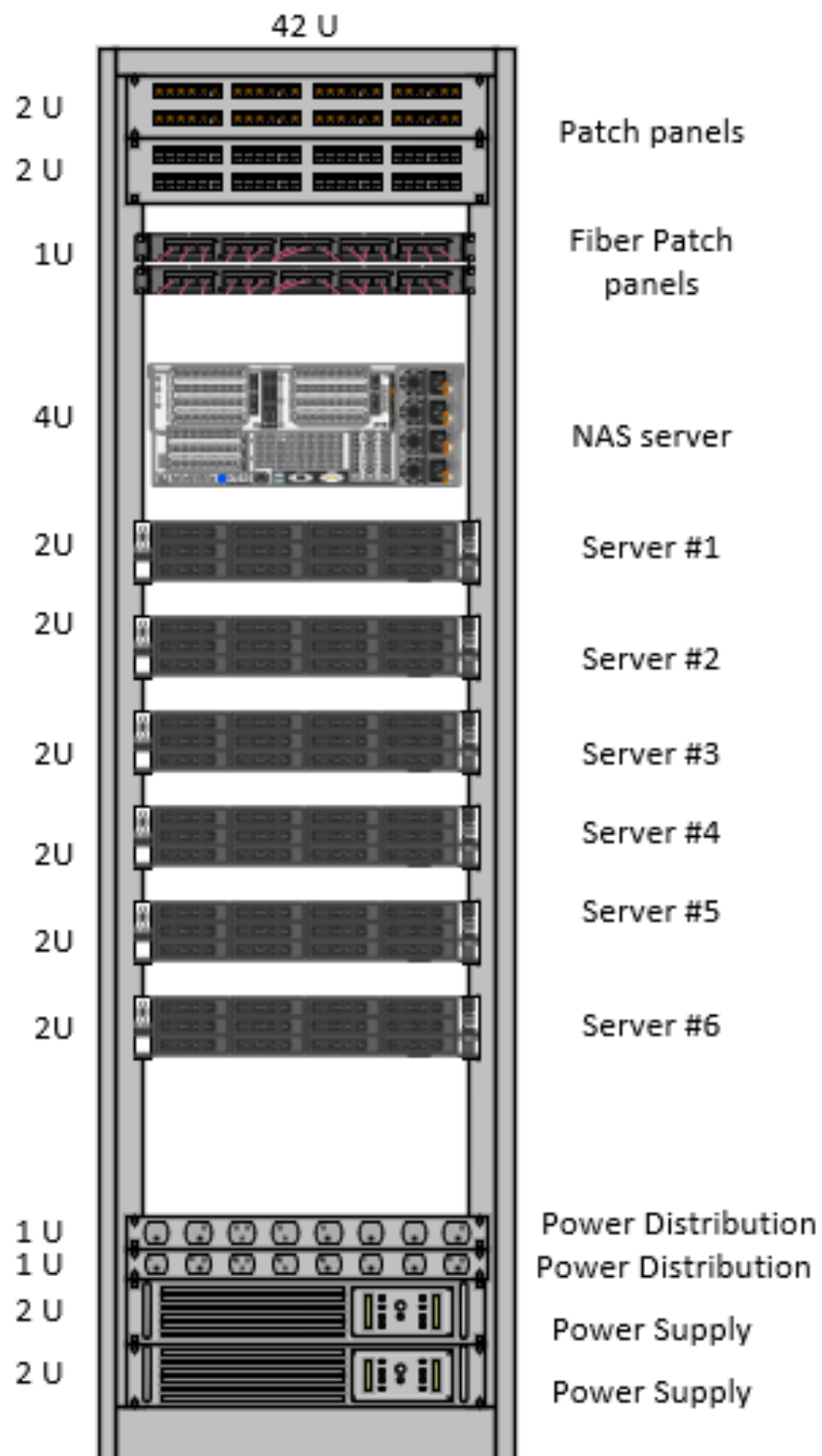
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## RACK DIAGRAM



**Rack #1**

**Rack #2**

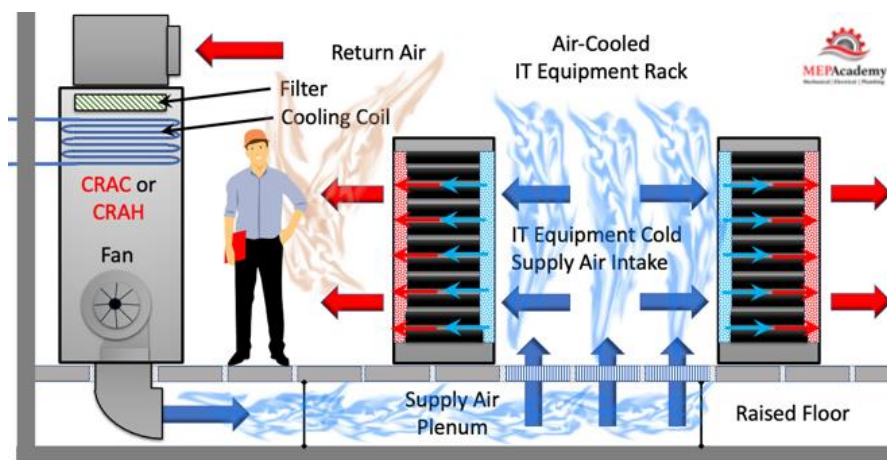
**Rack #3**

## COOLING SPECIFICATION

Data centers generate a considerable amount of heat due to power consumption devices such as servers, NAS, and networking equipment (routers, switches, firewalls ...). Therefore, proper cooling and ventilation is crucial for every data center to ensure optimal operation and prevent disruption.

Some data centers in the world are built in cold climate area to make use of the natural weather. The CHI-SOL and NY-SOL colocations are built in relatively cold areas; therefore, it is an advantage we already have when chosen Solsticix. However, we cannot depend on nature temperature since it fluctuates though seasons. We need mechanical cooling systems.

According to cisco, within the data centers, we need to have a CRAC unit (computer room air conditioner). This unit will remove excess heat from the room and turn it into cool air. The cool air will be pushed down onto the void beneath the room floor. Grilles will be placed on the floor, near the servers to allow the cool air flow back into the servers.

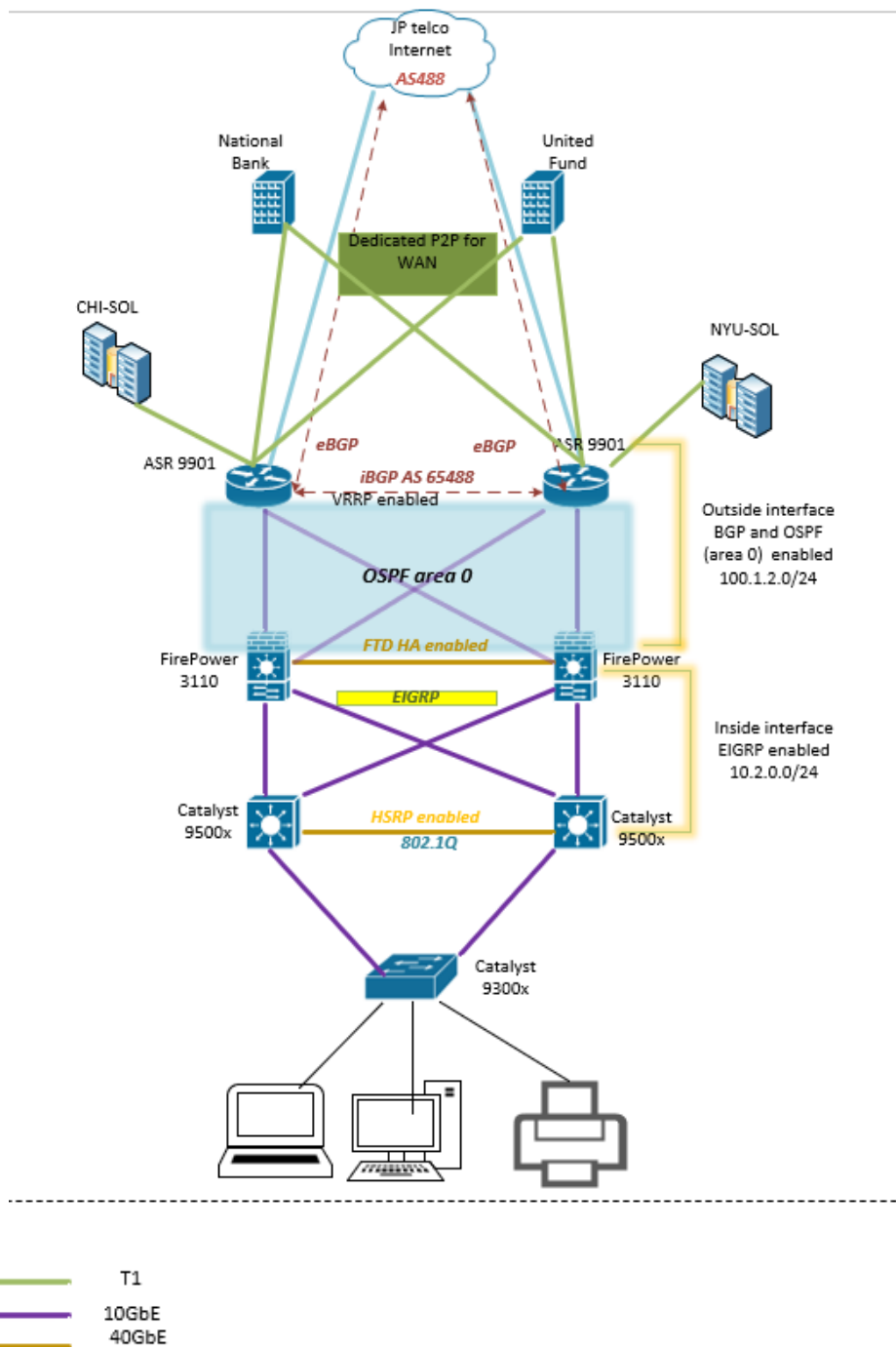


Data center cooling mechanism

In addition to the mechanic cooling, choosing proper networking devices also play a big part in HVAC. According to the book CCNA Data center written by Cisco, using Unified fabric (converged SAN) can reduce the need for unnecessary cablings and create more efficient airflow. In addition, the catalyst routers, switches, and fire power that are chosen for the data centers also have redundant fan trays. One of the interesting aspects of these devices are if a fan tray fails, other fans will speed up to cover for the failure one, giving the network team more time to repair.

# NASSAU HEADQUARTER NETWORK INFRASTRUCTURE

## LOGICAL DIAGRAM



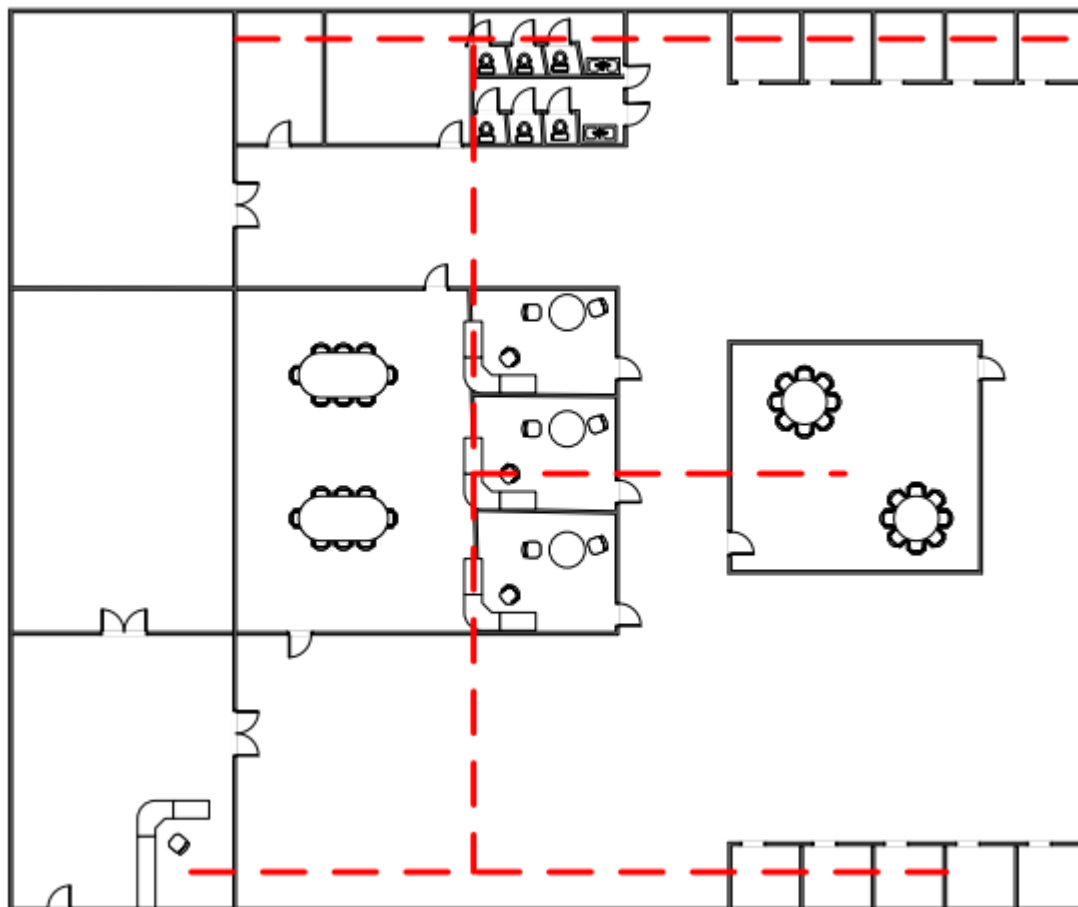
**NASSAU WAN Topolog**

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## PHYSICAL LAYOUT AND DIAGRAM

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### HORIZONTAL CABLING



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### EQUIPMENT LIST AND PRICING

- Most of the equipment are the same from the Toronto office, except for the core switches. Nassau uses Catalyst 9500x as core switches not Catalyst 9606R





Catalyst 9500x

Price: \$27,675.99

Quantity: 2

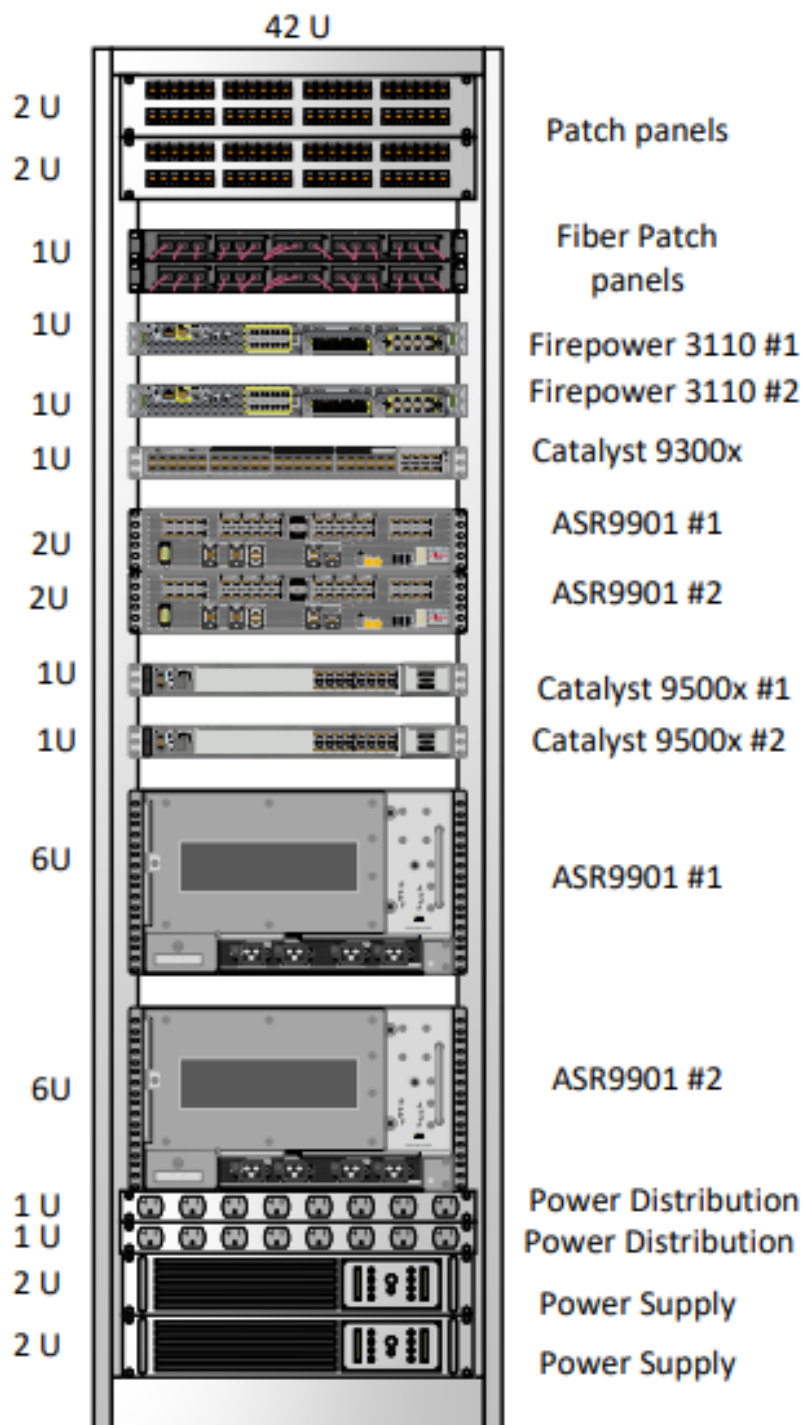
- Height: 1U
- Provides 40 SFP+ ports
- Designed to support 10G and 40G ethernet
- Provide enhanced security features support with 256-bit and 128-bit AES on 40 ports
- Designed with hot swappable power supplies and fan for increases availability

### **Total equipment cost for NASS-OFF**

<b>Model</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Total cost</b>
Cisco ASR 9901	2	\$6500	\$13,000
Cisco Firepower 3110	2	\$36,746.99	\$73,494
Catalyst 9500x	2	\$42,742.99	\$85,486
Cisco Catalyst 9300X	1	\$13,762.64	\$13,763
PowerVault 114X LTO7	2	\$3999	\$7,998
Power Distribution	2	\$102.99	\$206
ThinkSystem SR550 Rack Server	6	\$1832.02	\$10,992
ThinkSystem SR860 V2	1	\$6410.59	\$6,411
Leviton eXtreme 6+ QuickPort Patch Panel	4	\$602.99	\$2,412
NavePoint 42U	1	\$1482.4	\$1,482
Dell Inspiron 27 All-in-One	2	\$1249.99	\$2,500

HP Color Laser Jet Enterprise	1	\$5,829	\$5,829
Office Phone 7861	2	\$285.99	\$572
Overall cost			\$224,145

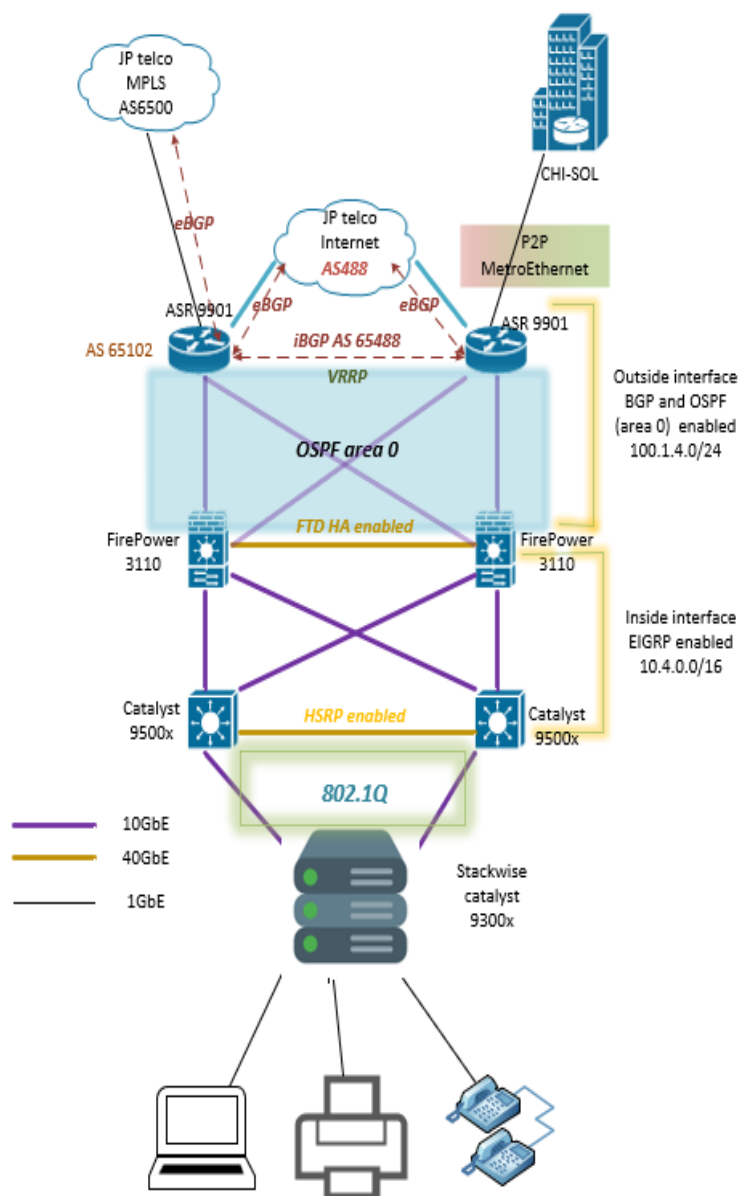
## RACK DIAGRAM



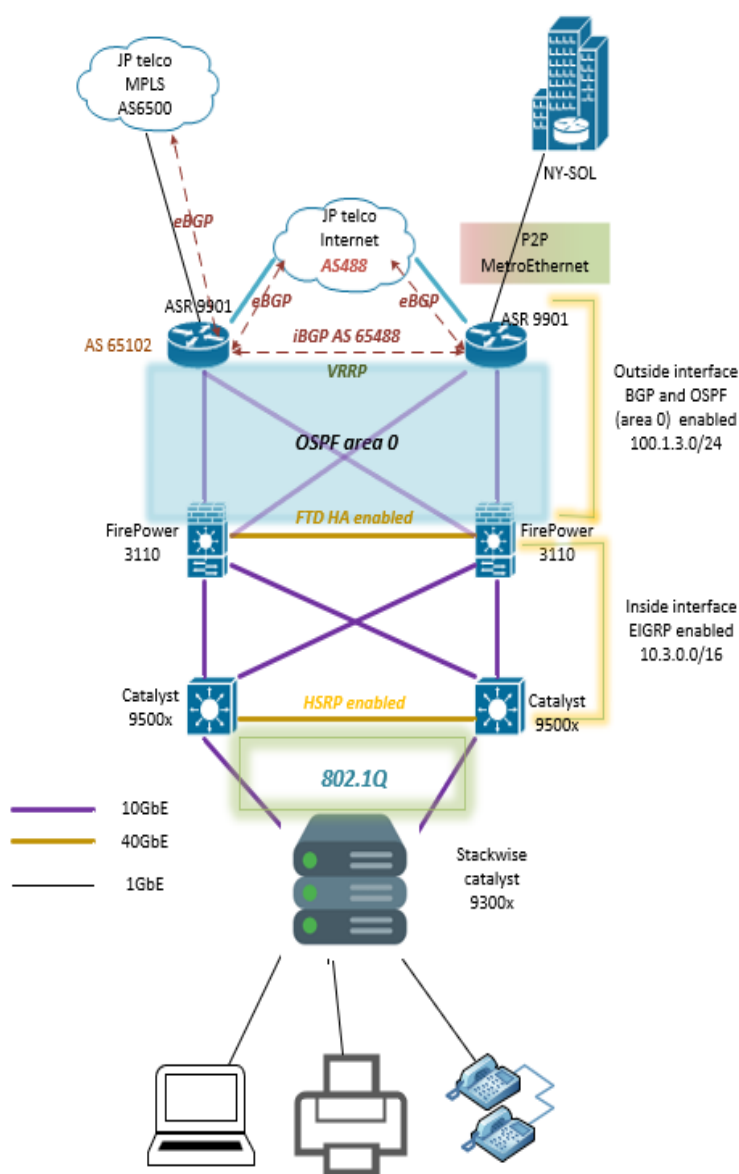
**NASSAU Rack**

## CHICAGO AND NEWYORK NETWORK INFRASTRUCTURE

### LOGICAL DIAGRAM



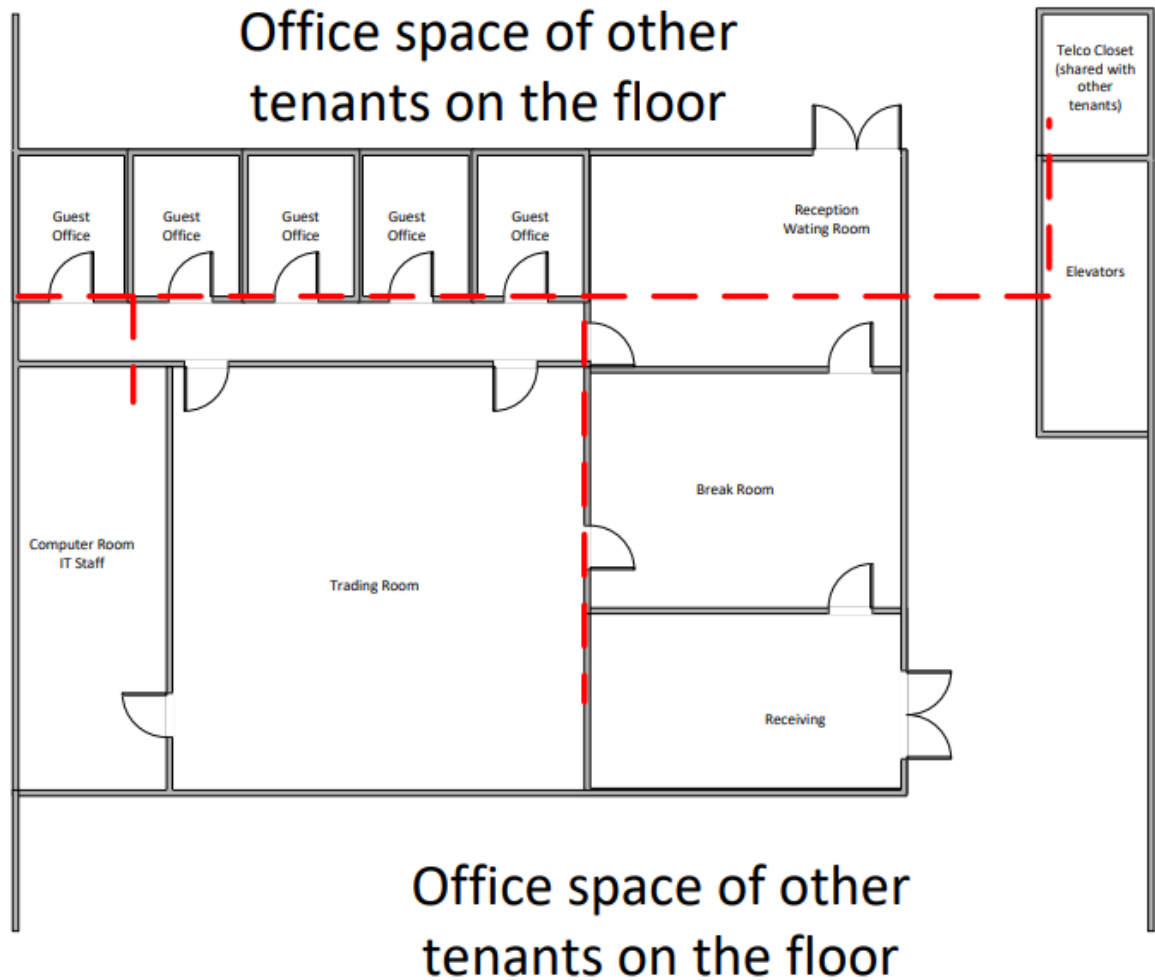
NY-OFF topology



CHI-OFF topology

## PHYSICAL LAYOUT AND DIAGRAM

### HORIZONTAL CABLING



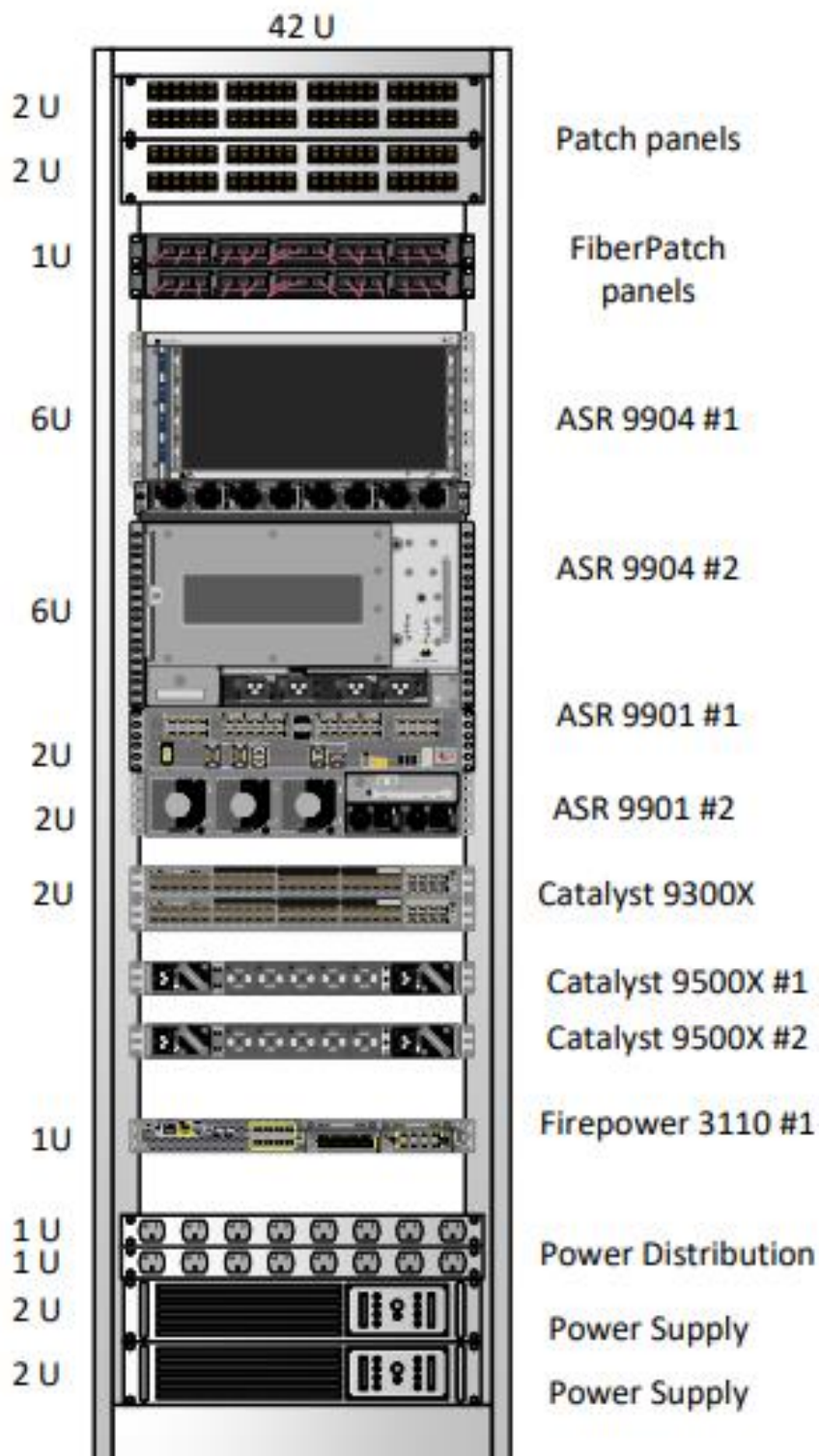
## EQUIPMENT LIST AND PRICING

Model	Quantity	Unit Cost	Total cost
Cisco ASR 9901	2	\$6500	\$13,000
ASR 9904	2	\$18,691.23	\$37,382
A9K-40GE-SE Line Cards	2	\$5720	\$0
Cisco A9K-RSP440-TR ASR9K Route Switch Processor	2	\$955	\$11,440
Cisco Firepower 3110	2	\$36,746.99	\$1,910
Catalyst 9500x	2	\$42,742.99	\$73,494
Cisco Catalyst 9300X	1	\$13,762.64	\$85,486
PowerVault 114X LTO7	2	\$3999	\$13,763
Power Distribution	2	\$102.99	\$7,998

Leviton eXtreme 6+ QuickPort Patch Panel	2	\$602.99	\$206
Fiber Breakout Patch Panel	2	\$2,849.88	\$1,206
NavePoint 42U	1	\$1482.4	\$5,700
Dell Inspiron 27 All-in-One	25	\$1249.99	\$1,482
HP Color Laser Jet Enterprise	2	\$5,829	\$31,250
Office Phone 7861	25	\$285.99	\$11,658
Overall cost	\$297,437		



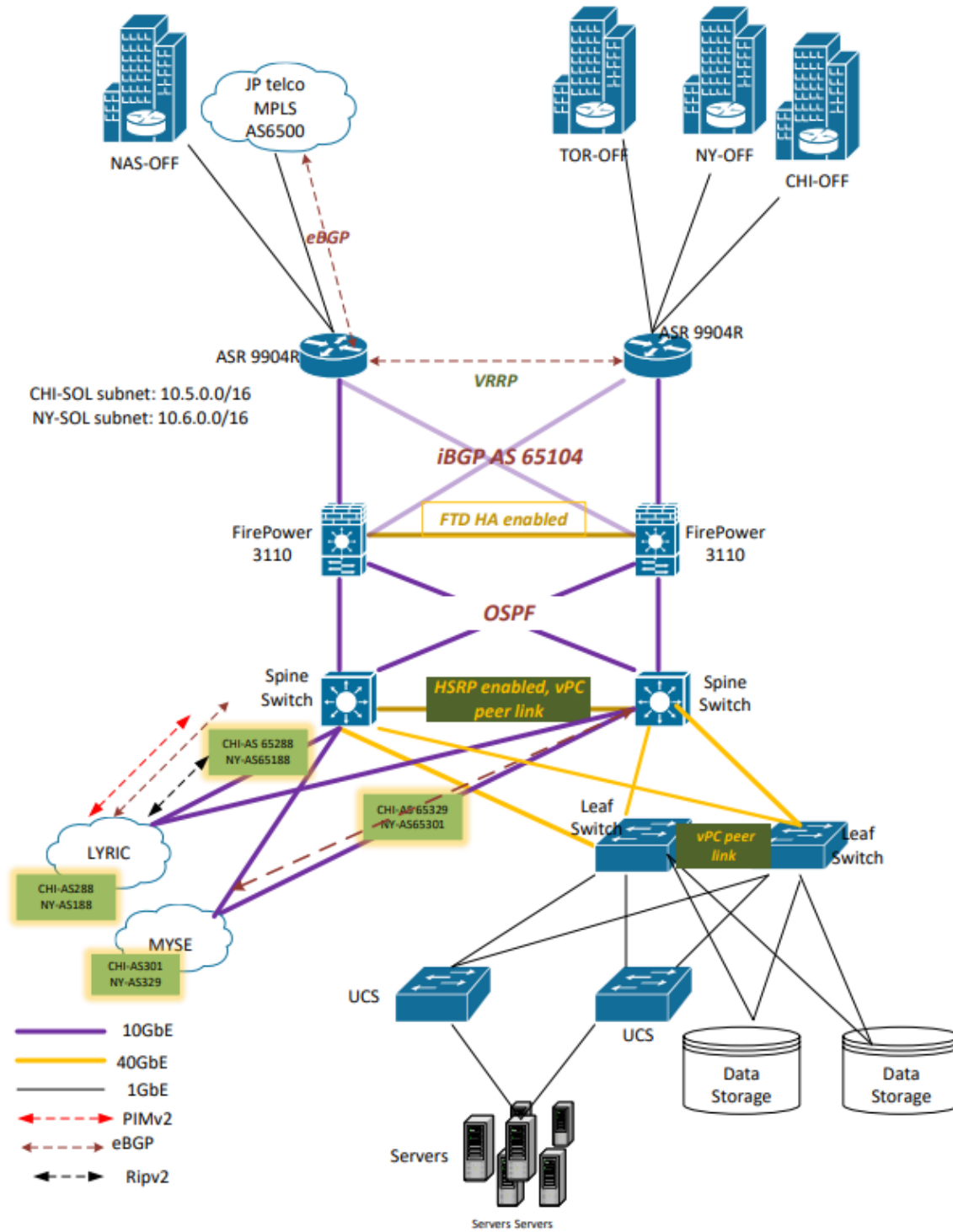
## RACK DIAGRAM



CHI (NY) rack

## CHICAGO AND NEW YORK COLOCATION

### LOGICAL DIAGRAM



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## EQUIPMENT LIST AND PRICING

### Spine Switch



#### Cisco Nexus 9364C

Price: \$72,442.72

Quantity: 4

- Height: 2U
- Supports 124 Tbps bandwidth.
- Provide 16 ports for MACsec encryption.
- Additional licenses require for IP unicast, IP multicast.

#### C9364C modules



## N9K-C9364C Line card

Price: \$35,000.00

Quantity: 4

## Leaf Switch



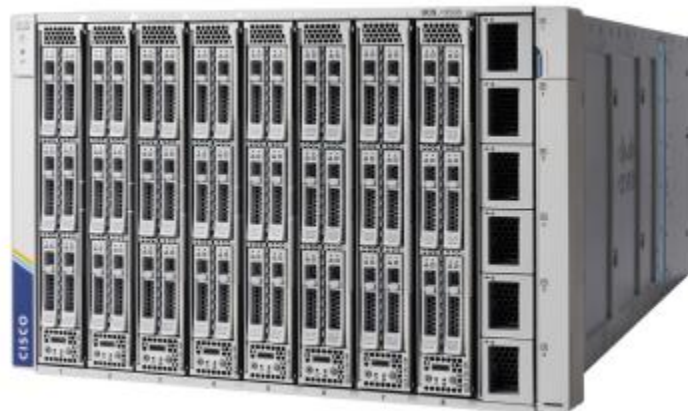
Cisco Nexus 9332C

Price:

Quantity: 4

- Height: 1U
- Supports 6.4 Tbps of bandwidth.
- Provides 8 ports for MACsec encryption.

## Cisco Unified Computing system



Cisco UCS X9508 Chassis

Price: \$6,974.92

Quantity: 4

- Height: 7RU
- Provides 8 flexible module slots
- Support a broader range of workloads.
- Simplifies management and improve scalability



Cisco UCS 64108 Fabric interconnect

Price: \$23,829.99

Quantity: 2

Height: 2U

- Provides 10/25/40/100 Gigabit Ethernet, FCoE and Fiber Channel switch offering up to 7.42 Tbps throughput and up to 108 ports
- 16 unified ports (port numbers 1-16) that can support 10/25-Gbps SFP28 Ethernet ports or 8/16/32-Gbps Fibre Channel ports, 72 10/25-Gbps Ethernet SFP28 ports (port numbers 17-88), 8 1/10/25-Gbps Ethernet SFP28 ports (port numbers 89-96), and 12

40/100-Gbps Ethernet QSFP28 uplink ports (port numbers 97-108)

- Provide 1 network management port, one console port and one USB port



Cisco IFM 9108-25G module

Price: \$7,211.99

Quantity: 8

#### Overall cost for the data centers

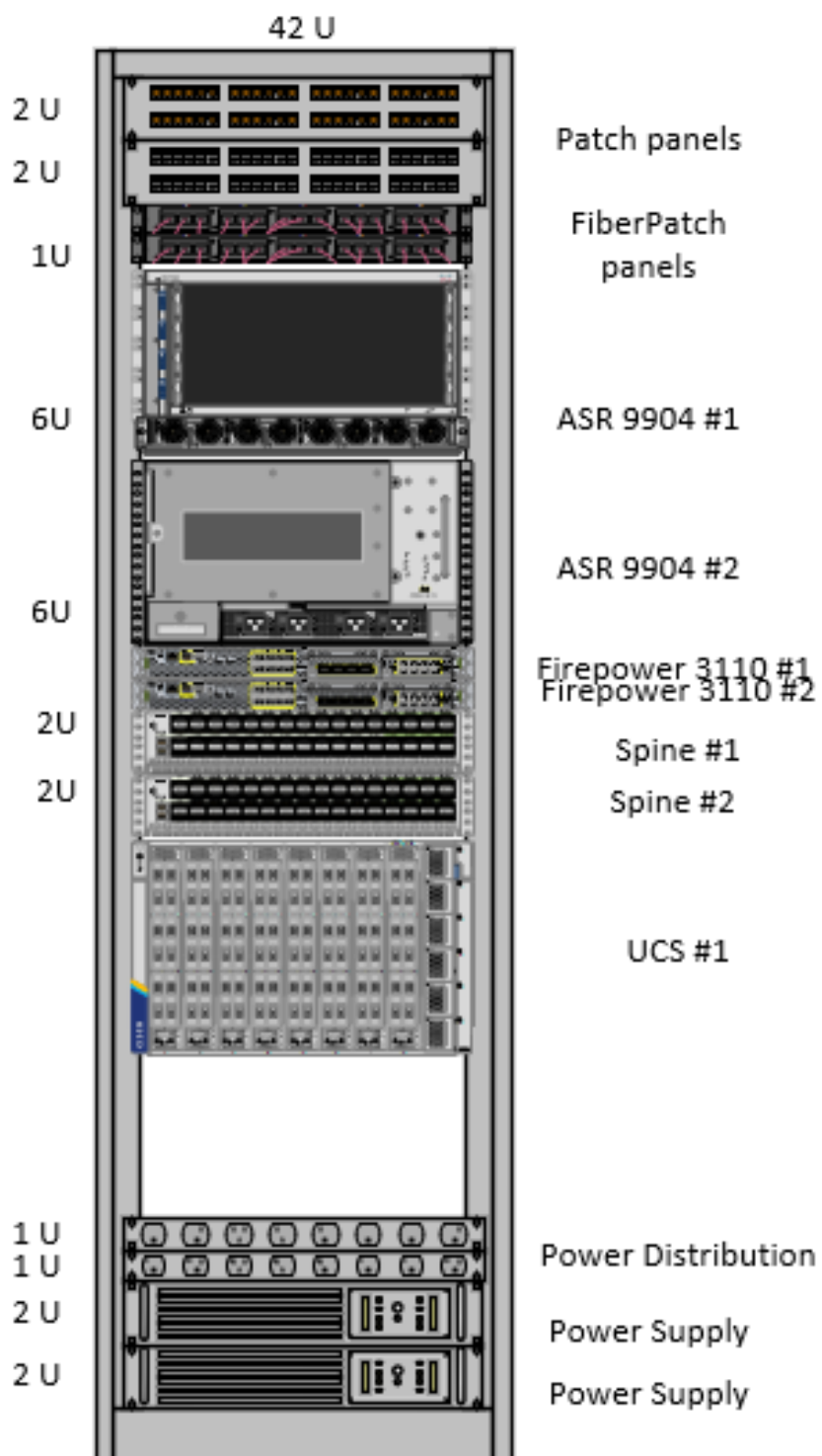
Model	Quantity	Unit Cost	Total cost
Cisco ASR 9901	2	\$6500	\$13,000
Cisco IFM 9108-25G module	8	\$7,211.99	\$57,696
ASR 9904	2	\$18,691.23	\$37,382

Cisco UCS X9508 Chassis	4	\$6,974.92	\$27,900
Cisco UCS 64108 Fabric interconnect	2	\$23,829.99	\$47,660
<b>N9K-C9364C Line card</b>	4	\$35,000	\$140,000
Cisco Firepower 3110	2	\$36,746.99	\$73,494
<b>Cisco Nexus 9364C</b>	4	\$72,442.72	\$289,771
Cisco Catalyst 9300X	1	\$13,762.64	\$13,763
PowerVault 114X LTO7	2	\$3999	\$7,998
Power Distribution	2	\$102.99	\$206
Leviton eXtreme 6+ QuickPort Patch Panel	2	\$602.99	\$1,206
Fiber Breakout Patch Panel	2	\$2,849.88	\$5,700

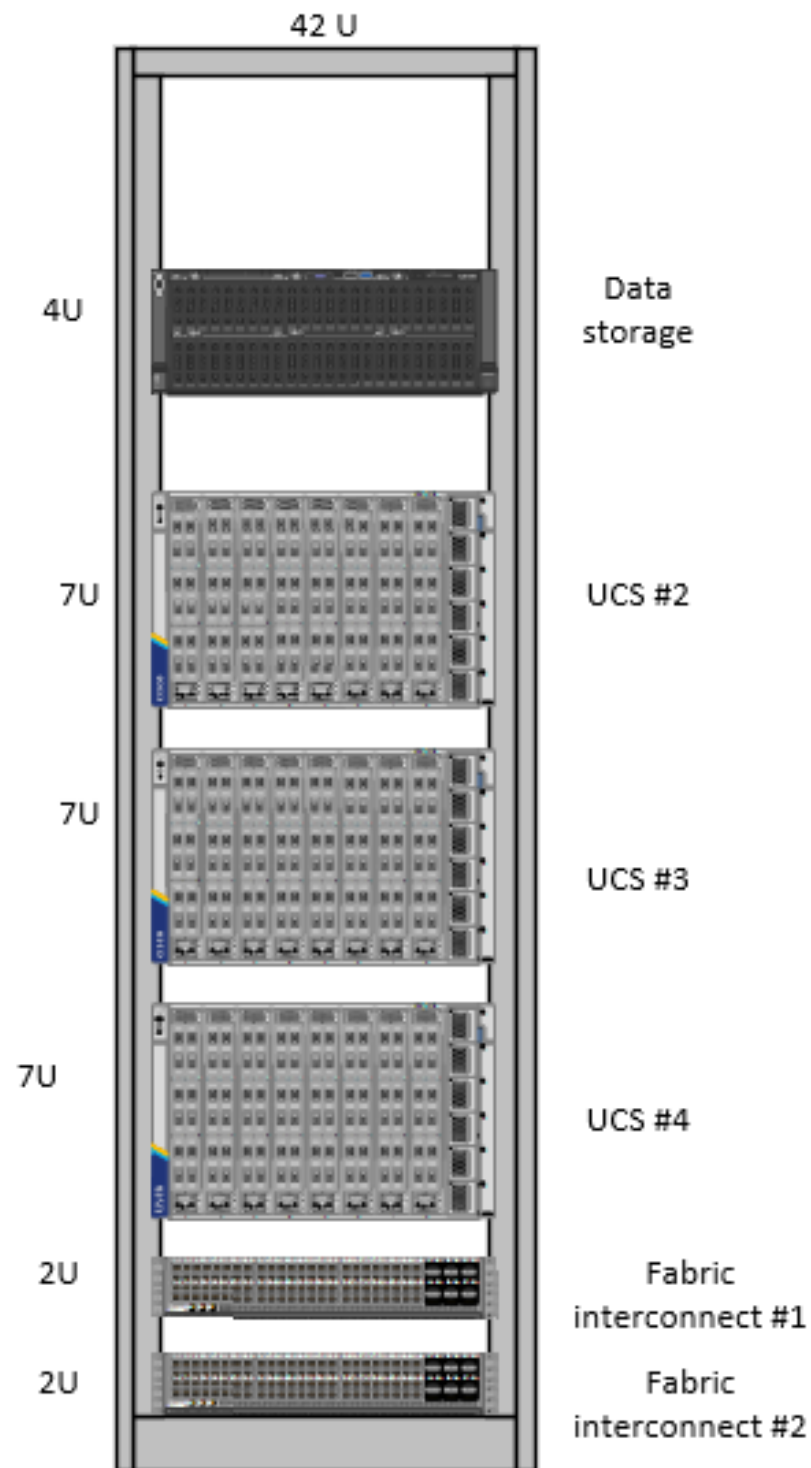
NavePoint 42U	2	\$1482.4	\$2,965
Overall cost	\$725,696		



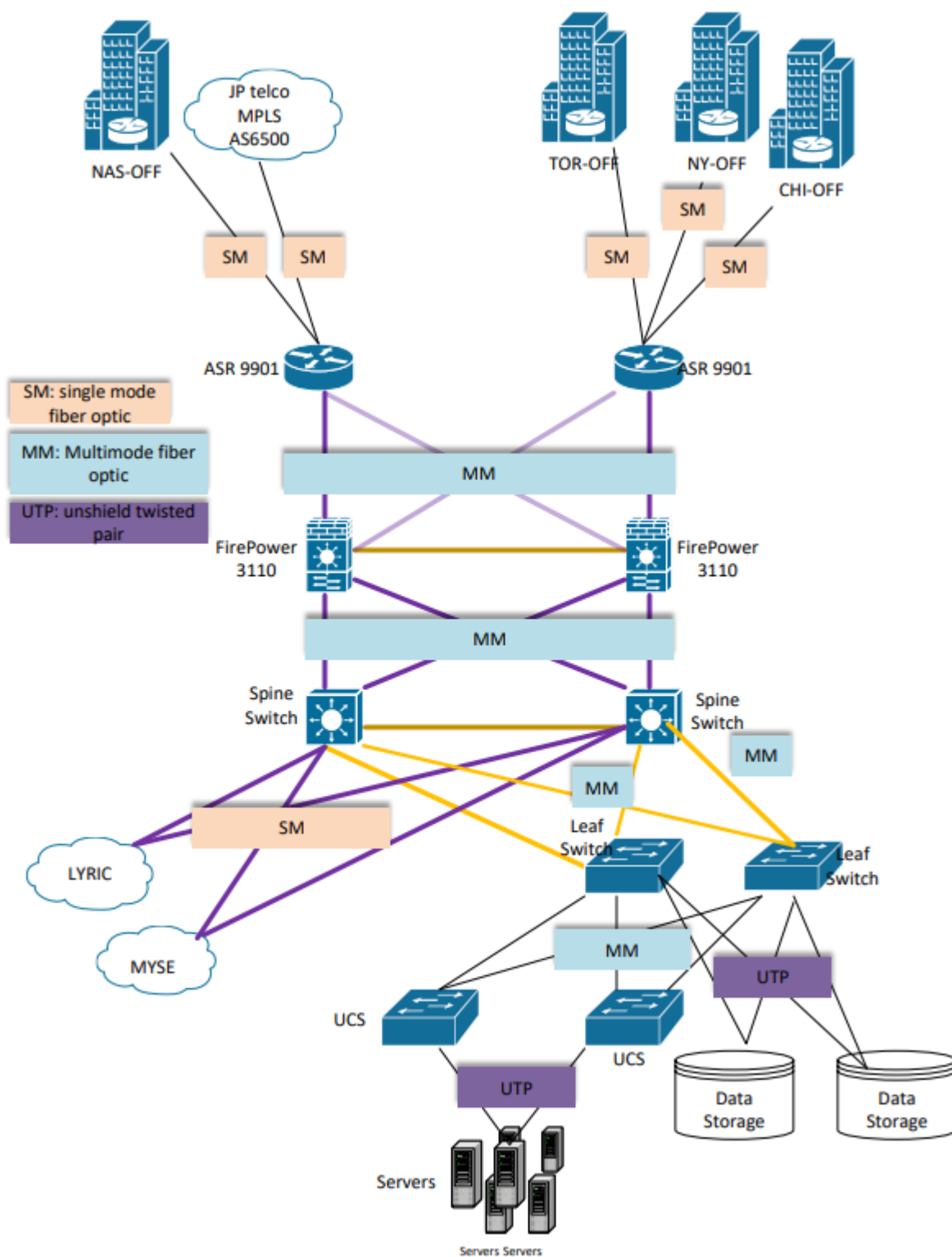
## RACK DIAGRAM



Rack #1

**Rack #2**

## WIRING SCHEME



## IP ADDRESSING, NAT, ROUTING

### VLAN IDS AND IP SUBNETS LIST

VLAN ID	VLAN DESCRIPTION	SUBNET	MASK
CHICAGO DATA CENTER			
10	Quote Receiver	10.250.1.0	/24
20	Trade Execution	172.17.1.0	/24
30	Trading Engine	10.5.1.0	/24
40	Data Base	10.5.2.0	/24
50	Trade Input	10.5.3.0	/24
60	Accounting	10.5.4.0	/24
70	Trade strategy	10.5.5.0	/24
80	Customer web	10.5.6.0	/24
90	Management	10.5.7.0	/24
100	Core Switch1 to Router1	10.5.8.0	/29
101	Core Switch 1 to Router2	10.5.8.8	/29

102	Core Switch 2 to Router1	10.5.8.16	/29
103	Core Switch 2 to Router 2	10.5.8.24	/29
NEWYORK DATA CENTER			
10	Quote Receiver	10.250.2.0	/24
20	Trade Execution	172.17.2.0	/24
30	Trading Engine	10.6.1.0	/24
40	Data Base	10.6.2.0	/24
50	Trade Input	10.6.3.0	/24
60	Accounting	10.6.4.0	/24
70	Trade strategy	10.6.5.0	/24
80	Customer web	10.6.6.0	/24
90	Management	10.6.7.0	/24
100	Core Switch1 to Router1	10.6.8.0	/29
101	Core Switch 1 to Router2	10.6.8.8	/29
102	Core Switch2 to Router1	10.6.8.16	/29

103	Core Switch 2 to Router 2	10.6.8.24	/29
TORONTO OFFICE			
104	Upper Management	10.1.1.0	/24
105	Human resources	10.1.2.0	/24
106	Legal Counsel	10.1.3.0	/24
107	Operation and Accounting	10.1.4.0	/24
106	Marketing and Client	10.1.5.0	/24
108	Software and IT	10.1.6.0	/24
109	Trade strategy Analyst	10.1.7.0	/24
110	Miscellaneous	10.1.8.0	/24
111	Wireless	10.1.9.0	/24
112	Printer	10.1.10.0	/24
113	FW outside	100.1.1.0	/24
114	FW inside	10.1.11.0	/24
119	VOIP	10.1.12.1	/24

120	DMZ	10.1.13.0	/24
121	Room 65	10.1.14.0	/24
122	DMZ management	10.1.15.0	/24
123	Room 65 management	10.1.16.0	/26
NASSAU			
115	Management	10.2.1.0	/24
116	LAN	10.2.2.0	/24
113	FW outside	100.1.2.0	/24
114	FW inside	10.2.3.0	/24
CHICAGO OFFICE			
109	Trade strategy Analyst	10.3.1.0	/24
115	Management	10.3.2.0	/24
117	Support department	10.3.3.0	/24
118	Printer	10.3.4.0	/24
113	FW outside	100.1.3.0	/24

114	FW inside	10.3.5.0	/24
NEWYORK OFFICE			
109	Trade strategy Analyst	10.4.1.0	/24
115	Management	10.4.2.0	/24
117	Support department	10.4.3.0	/24
118	Printer	10.4.4.0	/24
113	FW outside	100.1.4.0	/24
114	FW inside	10.4.5.0	/24

### STATIC IP ADDRESSING

TORONTO OFFICE			
Device	Interface	IP add	Subnet masks
Router 1	S0/0	To be assigned by TELCO	
	E0/1	100.1.1.1	/24
	E0/2	100.1.1.2	/24
	VRRP	100.1.1.3	/24



Router 2	S0/0	To be assigned by Telco	
	E0/1	100.1.1.3	/24
	E0/2	100.1.1.4	/24
	VRRP	100.1.1.3	
Firepower 1 and 2 (HA pair)	DMZ	10.1.13.1	/24
	Inside	10.1.11.1	/24
	Outside	100.1.1.5	/24
Public DNS	Eth0	10.1.13.2	/24
Email server	Eth0	10.1.13.3	/24
Webserver	Eth0	10.1.13.4	/24
AAA servers	Eth0	10.1.14.1	/24
Stack wise Core Switches	VLAN 104	10.1.1.1	/24
	VLAN 105	10.1.2.1	/24
	VLAN 106	10.1.3.1	/24
	VLAN 107	10.1.4.1	/24

	VLAN 106	10.1.5.1	/24
	VLAN 108	10.1.6.1	/24
	VLAN 109	10.1.7.1	/24
	VLAN 110	10.1.8.1	/24
	VLAN 111	10.1.9.1	/24
HSRP between Core Switches	VLAN 104	10.1.1.2	/24
	VLAN 105	10.1.2.2	/24
	VLAN 106	10.1.3.2	/24
	VLAN 107	10.1.4.2	/24
	VLAN 106	10.1.5.2	/24
	VLAN 108	10.1.6.2	/24
	VLAN 109	10.1.7.2	/24
	VLAN 110	10.1.8.2	/24
	VLAN 111	10.1.9.2	/24
Management IP address			

Management server	Eth0	10.1.14.3	/24
Core switch 1	VLAN 123	10.1.16.1	/24
Core Switch 2	VLAN 123	10.1.16.2	/24
Access switch 1	VLAN 123	10.1.16.3	/24
Access switch 2	LAAN 123	10.1.16.4	/24
Work area end device IP address list			
Printer 1	Eth0	10.1.10.1	/24
Printer 2	Eth0	10.1.10.2	/24
Printer 3	Eth0	10.1.10.3	/24
Printer 4	Eth0	10.1.10.3	/24
Printer 5	Eth0	10.1.10.3	/24
Access point 1	n/a	10.1.9.1	/24
Access point 2	n/a	10.1.9.2	/24
Access point 3	n/a	10.1.9.3	/24
Access point 4	n/a	10.1.9.4	/24

Access point 5	n/a	10.1.9.5	/24
Access point 6	n/a	10.1.9.6	/24
Access point 7	n/a	10.1.9.7	/24
Access point 8	n/a	10.1.9.8	/24
Access point 9	n/a	10.1.9.9	/24
Access point 10	n/a	10.1.9.10	/24
Access point 11	n/a	10.1.9.11	/24
Access point 12	n/a	10.1.9.12	/24
Access point 13	n/a	10.1.9.13	/24
Access point 14	n/a	10.1.9.14	/24
Access point 15	n/a	10.1.9.15	/24
Access point 16	n/a	10.1.9.16	/24

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NASSAU OFFICE			
Device	Interface	IP add	Subnet masks

Router 1	S0/0	To be assigned by Telco	
	E0/0	100.1.2.1	/24
	E0/1	100.1.2.2	/24
	E0/2	100.1.2.3	/24
Router 2	S0/0	To be assigned by Telco	
	E0/0	100.1.2.4	/24
	E0/1	100.1.2.5	/24
	E0/2	100.1.2.6	/24
Firewall 1 and 2 (HA Pair)	Inside	10.2.3.1	/24
	Outside	100.1.2.7	/24
Stack-wise core switches	VLAN115	10.2.1.1	/24
	VLAN 116	10.2.2.1	/24
HSRP between core switches	VLAN115	10.2.3.1	/24
	VLAN 116	10.2.4.1	/24
Printer	Eth0	10.2.2.1	/24
Management IP address			
Router 1	VLAN 115	10.2.1.2	/24

Router 2	VLAN 115	10.2.1.3	/24
Core switch 1	VLAN 115	10.2.1.4	/24
Core switch 2	VLAN 115	10.2.1.5	/24
Firewall 1	VLAN 115	10.2.1.6	/24
Firewall 2	VLAN 115	10.2.1.7	/24
Access Switch 1	VLAN 115	10.2.1.8	/24
Access Switch 1	VLAN 115	10.2.1.9	/24

CHICAGO OFFICE			
Device	Interface	IP add	Subnet masks
Router 1	S0/0	To be assigned by Telco	
	E0/0	100.1.3.1	/24
	E0/1	100.1.3.2	/24
Router 2	S0/0	To be assigned by Telco	
	E0/0	100.1.3.3	/24
	E0/1	100.1.3.4	/24
Firewall 1 and 2	Inside	10.3.5.1	/24

(HA Pair)	Outside	100.1.3.5	/24
HSRP between core switches	VLAN115	10.3.1.1	/24
	VLAN109	10.3.2.1	/24
	VLAN 117	10.3.3.1	/24
	VLAN 118	10.3.4.1	/24
	VLAN113	100.1.3.10	/24
	VLAN114	103.5.10	/24
Printer	Eth0	10.3.4.10	/24
Management IP address			
Router 1	VLAN 115	10.3.2.2	/24
Router 2	VLAN 115	10.3.2.3	/24
Core switch 1	VLAN 115	10.3.2.4	/24
Core switch 2	VLAN 115	10.3.2.5	/24
Firewall 1	VLAN 115	10.3.2.6	/24
Firewall 2	VLAN 115	10.3.2.7	/24
Access Switch 1	VLAN 115	10.3.2.8	/24
Access Switch 1	VLAN 115	10.3.2.9	/24

NEW YORK OFFICE			
Device	Interface	IP add	Subnet masks
Router 1	S0/0	To be assigned by Telco	
	E0/0	100.1.4.1	/24
	E0/1	100.1.4.2	/24
Router 2	S0/0	To be assigned by Telco	
	E0/0	100.1.4.3	/24
	E0/1	100.1.4.4	/24
Firewall 1 and 2 (HA Pair)	Inside	10.4.5.1	/24
	Outside	100.1.4.5	/24
HSRP between core switches	VLAN115	10.4.1.1	/24
	VLAN109	10.4.2.1	/24
	VLAN 117	10.4.3.1	/24
	VLAN 118	10.4.4.1	/24
	VLAN113	100.1.4.10	/24
	VLAN114	10.4.5.10	/24
Printer	Eth0	10.4.4.10	/24



Management IP address			
Router 1	VLAN 115	10.4.2.2	/24
Router 2	VLAN 115	10.4.2.3	/24
Core switch 1	VLAN 115	10.4.2.4	/24
Core switch 2	VLAN 115	10.4.2.5	/24
Firewall 1	VLAN 115	10.4.2.6	/24
Firewall 2	VLAN 115	10.4.2.7	/24
Access Switch 1	VLAN 115	10.4.2.8	/24
Access Switch 1	VLAN 115	10.4.2.9	/24

CHICAGO DATA CENTER			
Device	Interface	IP add	Subnet masks
Router 1	E0/0	10.5.8.1	/29
	E0/1	10.5.8.17	/29
	E0/2	100.1.2.20	/24
	VRRP	10.5.8.5	/24
Router 2	E0/0	10.5.8.9	

	E0/1	10.5.8.24	/24
	E0/2	100.1.1.10	/24
	E0/3	100.1.4.10	/24
	E0/4	100.1.3.25	/24
	VRRP	10.5.8.10	/29
Spine switch 1	VLAN 10	10.250.1.1	/24
	VLAN 20	172.17.1.1	/24
	VLAN 30	10.5.1.1	/24
	VLAN 40	10.5.2.1	/24
	VLAN 50	10.5.3.1	/24
	VLAN 60	10.5.4.1	/24
	VLAN 70	10.5.5.1	/24
	VLAN 80	10.5.6.1	/24
	VLAN 90	10.5.7.1	/24
	VLAN 100	10.5.8.3	/24

	VLAN101	10.5.8.11	/24
	VLAN102	10.5.8.19	/24
	VLAN 103	10.5.8.27	/24
Spine switch 2	VLAN 10	10.250.1.2	/24
	VLAN 20	172.17.1.2	/24
	VLAN 30	10.5.1.2	/24
	VLAN 40	10.5.2.2	/24
	VLAN 50	10.5.3.2	/24
	VLAN 60	10.5.4.2	/24
	VLAN 70	10.5.5.2	/24
	VLAN 80	10.5.6.2	/24
	VLAN 90	10.5.7.2	/24
	VLAN 100	10.5.8.2	/24
	VLAN101	10.5.8.10	/24
	VLAN102	10.5.8.18	/24

	VLAN 103	10.5.8.26	/24
HSRP between core switches	VLAN 10	10.250.1.3	/24
	VLAN 20	172.17.1.3	/24
	VLAN 30	10.5.1.3	/24
	VLAN 40	10.5.2.3	/24
	VLAN 50	10.5.3.3	/24
	VLAN 60	10.5.4.3	/24
	VLAN 70	10.5.5.3	/24
	VLAN 80	10.5.6.3	/24
	VLAN 90	10.5.7.3	/24
Quote Receiver	Eth0	10.250.1.11	/24
Trade Execution	Eth0	172.17.1.11	/24
Trading Engine	Eth0	10.5.1.11	/24
Data Base	Eth0	10.5.2.11	/24
Trade Input	Eth0	10.5.3.11	/24

Accounting	Eth0	10.5.4.11	/24
Trade strategy	Eth0	10.5.5.11	/24
Customer web	Eth0	10.5.6.11	/24
Management IP address			
Router 1	VLAN 90	10.5.7.11	/24
Router 2	VLAN 90	10.5.7.11	/24
Spine Switch 1	VLAN 90	10.5.7.11	/24
Spine Switch 2	VLAN 90	10.5.7.11	/24
Leaf Switch 1	VLAN 90	10.5.7.11	/24
Leaf switch 2	VLAN 90	10.5.7.11	/24
Firewall 1	VLAN 90	10.5.7.11	/24
Firewall 2	VLAN 90	10.5.7.11	/24
Fabric interconnect 1	VLAN 90	10.5.7.11	/24
Fabric interconnect 1	VLAN 90	10.5.7.11	/24

NEW YORK DATA CENTER			
Device	Interface	IP add	Subnet masks
Router 1	E0/0	10.6.8.1	/29
	E0/1	10.6.8.17	/29
	E0/2	100.1.2.21	/24
	VRRP	10.5.8.4	/24
Router 2	E0/0	10.6.8.9	
	E0/1	10.6.8.24	/24
	E0/2	100.1.1.11	/24
	E0/3	100.1.4.11	/24
	E0/4	100.1.3.26	/24
	VRRP	10.5.8.12	/29
Spine switch 1	VLAN 10	10.250.2.1	/24
	VLAN 20	172.17.2.1	/24
	VLAN 30	10.6.1.1	/24

	VLAN 40	10.6.2.1	/24
	VLAN 50	10.6.3.1	/24
	VLAN 60	10.6.4.1	/24
	VLAN 70	10.6.5.1	/24
	VLAN 80	10.6.6.1	/24
	VLAN 90	10.6.7.1	/24
	VLAN 100	10.6.8.3	/24
	VLAN101	10.6.8.11	/24
	VLAN102	10.6.8.19	/24
	VLAN 103	10.5.8.27	/24
Spine switch 2	VLAN 10	10.250.2.2	/24
	VLAN 20	172.17.2.2	/24
	VLAN 30	10.6.1.2	/24
	VLAN 40	10.6.2.2	/24
	VLAN 50	10.6.3.2	/24

	VLAN 60	10.6.4.2	/24
	VLAN 70	10.6.5.2	/24
	VLAN 80	10.6.6.2	/24
	VLAN 90	10.6.7.2	/24
	VLAN 100	10.6.8.2	/24
	VLAN101	10.6.8.10	/24
	VLAN102	10.6.8.18	/24
	VLAN 103	10.6.8.26	/24
HSRP between core switches	VLAN 10	10.250.2.3	/24
	VLAN 20	172.17.2.3	/24
	VLAN 30	10.6.1.3	/24
	VLAN 40	10.6.2.3	/24
	VLAN 50	10.6.3.3	/24
	VLAN 60	10.6.4.3	/24
	VLAN 70	10.6.5.3	/24



	VLAN 80	10.6.6.3	/24
	VLAN 90	10.6.7.3	/24
Quote Receiver	Eth0	10.250.2.11	/24
Trade Execution	Eth0	172.17.2.11	/24
Trading Engine	Eth0	10.6.1.11	/24
Data Base	Eth0	10.6.2.11	/24
Trade Input	Eth0	10.6.3.11	/24
Accounting	Eth0	10.6.4.11	/24
Trade strategy	Eth0	10.6.5.11	/24
Customer web	Eth0	10.6.6.11	/24
Management IP address			
Router 1	VLAN 90	10.6.7.11	/24
Router 2	VLAN 90	10.6.7.11	/24
Spine Switch 1	VLAN 90	10.6.7.11	/24
Spine Switch 2	VLAN 90	10.6.7.11	/24

Leaf Switch 1	VLAN 90	10.6.7.11	/24
Leaf switch 2	VLAN 90	10.6.7.11	/24
Firewall 1	VLAN 90	10.6.7.11	/24
Firewall 2	VLAN 90	10.6.7.11	/24
Fabric interconnect 1	VLAN 90	10.6.7.11	/24
Fabric interconnect 1	VLAN 90	10.6.7.11	/24

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## DHCP DESIGN

TORONTO OFFICE					
VLAN	Description	Numbers of users	First address	Last address	Default gateway
104	Upper Management	5	10.1.1.1	10.1.1.50	10.1.1.10
105	Human resources	5	10.1.2.1	10.1.2.50	10.1.2.10

106	Legal Counsel	5	10.1.3.1	10.1.3.50	10.1.3.10
107	Operation and Accounting	20	10.1.4.1	10.1.4.70	10.1.4.10
106	Marketing and Client	10	10.1.5.1	10.1.5.60	10.1.5.10
108	Software and IT	30	10.1.6.1	10.1.6.100	10.1.6.10
109	Trade strategy Analyst	20	10.1.7.1	10.1.7.100	10.1.7.10
110	Miscellaneous	10	10.1.8.1	10.1.8.50	10.1.8.10
111	Wireless	100	10.1.9.1	10.1.9.200	10.1.9.10

CHICAGO OFFICE					
VLAN	Description	Numbers of users	First address	Last address	Default gateway
109	Trade strategy	20	10.3.1.1	10.3.1.100	10.3.1.5
117	Support department	unknown	10.3.3.1	10.3.3.100	10.3.3.5

NEW YORK OFFICE					
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VLAN	Description	Numbers of users	First address	Last address	Default gateway
109	Trade strategy	20	10.4.1.1	10.4.1.100	10.4.1.5
117	Support department	unknown	10.4.3.1	10.4.3.100	10.4.3.5

## NAT

NAT (Network address translation) is a method to translate private IP addresses to public IP addresses and vice versa. This technique has solved one of the greatest problems in the 21<sup>st</sup> century, IPv4 exhaustion by allowing users from different networks using the same private IP addresses. This technique has also enhanced the security and privacy system by hiding the private addresses from the outside world.

NAT brings convenience and enhanced security. However, there are some factors that need to be considered when configuring NAT. For example, NAT can cause some latency on the network since it adds some extra overhead to the packets. Moreover, NAT offers 3 different techniques: static, dynamic, and Port address. After thorough consideration, NAT overload (PAT) is chosen to convert all private IP addresses into one single public address. The web server will be the only exception with static NAT, which will ensure the server always has the same IP address. NAT will be configured on the firewalls where outside interfaces and inside interfaces are separated.

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## ROUTING

DAFUN's infrastructure is built following Cisco top-down approaches. The company's requirements, goals and objectives are all taken into consideration to select the right switching and routing protocols. Here are some requirements for DAFUN in order to meet up with the increasing trading traffic.

- Load balancing capabilities
- Ultra-low latency: minimize network latency, quick convergence time.

Therefore, routing protocols that emphasizes speed and efficiency will be used.

- ✓ BGP: this routing protocol is used on ASR routers to receive services from TELCO. Although the protocol does not offer much in lowering the latency it can handle large traffic sufficiently
- ✓ OSPF: the protocol is known for its quick convergence time. It can quickly adapt to network changes and reconfiguring optimal paths. The protocol is essential for the design where speed and scalability are crucial.
- ✓ EIGRP: the protocol is used within the DAFUN network since it has quick convergence time, efficient use of bandwidth, and low usage of network resources.
- ✓ PIM: the protocol is used to receive multicast data from the financial quote service providers (LYRIC). The protocol ensures a fast and reliable transmission between the provider and the data centers.

- ✓ MPLS: the protocol is used to connect between sites since MPLS is more reliable than the Internet and more secure.

## REDUNDANCY/FAULT TOLERANCE STRATEGIES

A brief downtime in the system can cause an unimaginable financial damage to DAFUN. Here are some redundancy and fault tolerance strategies that will be applied to the network to prevent unnecessary loss.

### 1. Redundant Hardware

Stack wise switches are implemented on the distribution layers as well as the access layers to provide network redundancy. This is a technology developed by cisco that allows multiple switches to function as one switch (1 control plane and one data plane)

Cisco catalyst switch series are specifically chosen for this purpose. The switches will act as core switches and access switches depends on the series number. However, there is one disadvantage that we need to know is if one of the switches goes down, the bandwidth will decrease. Therefore, an advanced version of stack wise is also considered, virtual stack wise. If stack wise switches are treated as 1 control plane and 1 data plane, the virtual stack wise is multiple control planes and 1 data plane. The virtual stack wise switches can be connected from different locations to form a single virtual switch. The need to use stack wise cables is eliminated. This technique not only provide redundancy but also flexibility for the network.

### 2. Network redundancy

Each ASR routers will have 2 connections to TELCO to ensure continuous connection, dynamic protocols such as OSPF and BGP are also used to provide fault tolerance. LACP is also applied within the internal network of DAFUN to leverage the links

### 3. Automated Failover

HSRP (Hot Standby Router Protocol) and Virtual Router Redundancy Protocol (VRRP) are implemented on ASR routers and switches.

## SECURITY MANAGEMENT

Security measurement plays a crucial role in protecting sensitive financial data for DAFUN. As a result, measurement options are carefully considered and elected to ensure the highest level of reliability.

### 1. Access control

Strong and proper access controls will be configured on routers and firewalls to ensure only authorized personnels will have the access to specific internal data

### 2. Firewalls and IDS

Cisco firepower and IDS software will be implemented to protect the network against unauthorized access as well as monitor traffic for

suspicious activities. The engineer teams will be alerted before attacks happen.

### 3. AAA servers

AAA servers are implemented on the network to perform authentication, authorization, and accounting. The server simplifies management in centralizing these tasks, enhance the security level with strong authentication measures. RADIUS and TACAS+ protocol will be used in conjunction with the AAA.



## IMPLEMENTATION PLAN

After all these crucial considerations are made, implementation plan is the final part to complete this network project. This plan will include recommendations for deploying and transitioning the network design smoothly with minimal disruption.

### Project schedule

Date of Completion	Milestone
July 10	Planning and designed completed.  The documents are distributed to the executives
July 17	Last day to receive comments on the design for future edits
July 31	Final planning design is distributed
August 3	Leased lines are implemented  between locations by TELCO

September 30	Pilot implementation done on CHI-OFF and CHI-Sol including deploy and migration
October 1	Documentation and training for the IT staffs and end-users
October 15	Last day to receive feedbacks from the users and the IT staff
November 1	Implementation done on the NY-OFF and the NY-SOL including deploy and migration
November 7	Last day to receive feedbacks from the users and the IT staff
November 30	Implementation done on TOR-OFF and NASS-OFF including deploy and migration

In addition, there are some potential risks that can delay the network project.

Here are some common factors:

1. Vendor/Supplier Delay
2. Permitting and approvals delay
3. Changes in requirements after reviewed and used by the company
4. Staffing and training
5. Human errors
6. Environment factor

## TOTAL COST OF OWNERSHIP WITHIN 3 MONTHS

Description	Cost
Wan Links	\$1,594,800
Toronto equipment	\$911,940.46
Nassau equipment	\$224,145
New york equipment	\$297,437
Chicago equipment	\$297,437
Chicago data center	\$725,696
New York data center	\$725,696
Total cost	\$3,865,211



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