CS 6843
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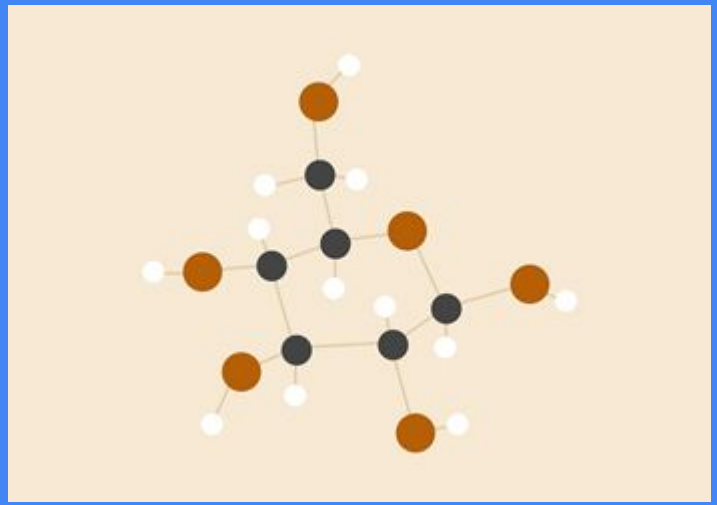
Final Exam Project

Warlon Zeng
Alan Ni
Chukwuyuem J. Onvibe
Matthew Chan
Tsung-Cheng Tsai
Kai Chen Hsieh



Overview

- What’s the Problem?
- What’s Going On?
- Path to Solution
- IP Addressing Schema
- Network Architecture Design
- Relevant Protocols
- Access Technologies
- ISPs Application Profiles

What’s the Problem?

- People complaining about the **slow-access on files**, **email** and **VoIP** when there are excess amount users trying to access the same resource or server.
- This condition is called **performance degrade**.

What’s Going On?

- The company is planning significant expansion into the new markets by **decreasing time-to-market** for their core set of products and **increasing the global workforce hiring**, making networks more **congested**.
- The bottleneck may contain different reasons including **location**, **bandwidth**, and **interface limits**.

Path to Solution

- IP Addressing Schema
- Network Architecture Design
- Relevant Protocols
- Access Technologies
- ISPs Application Profiles

Main Office & Regional Headquarters

Main Office

- Boston, MA, **210**

Regional headquarters

- Paris, France, **130**
- Buenos Aires, Argentina, **130**
- Sydney, Australia, **130**

In accounting/finance, human resources, legal, corporate IT, facilities management, executive management and strategy groups.
Total number of employees across all HQ offices is about **600**.

Global Client Centers

- Berlin, **200**
- Atlanta, **150**
- Tokyo, **150**

Employing approximately **500** high quality designers, engineers and architects.

Lower-level Support Staff Departments

- China, **750**
- Canada, **750**
- United Arab Emirates, **750**
- Malaysia, **750**

Employing **3000** people.

Software Development Centers

- Israel, **70**
- India, **140**
- Ukraine, **90**

A total of **300** employees working on multiple client-server and web-based software projects to support global operations, AutoCAD, and other drawing packages and document management systems and many others.

Call Center

- Puerto Rico, **100**

Supports customer inquiries and complaints.

Sales organization

- There are approximately **30** small and medium size offices major geographical areas (Americas, Europe/Middle East, Asia Pacific) to a total of **1000** employees.
- Most of the sales employees are **mobile**.

IP Addressing Schema

- Use Class A addressing range
  - 10.10.0.0~10.255.255.255
  - Private IPv4 Addresses
- Use Class C subnet masks:
  - 255.255.255
  - 255.255.254
- VLAN IP corresponds to IP Addresses
- VLAN # are set default

Class A

Network Bits	Subnet Mask	Number of Subnets	Number of Hosts
/8	255.0.0.0	0	16777214
/9	255.128.0.0	2 (0)	8388606
/10	255.192.0.0	4 (2)	4194302
/11	255.224.0.0	8 (6)	2097150
/12	255.240.0.0	16 (14)	1048574
/13	255.248.0.0	32 (30)	524286
/14	255.252.0.0	64 (62)	262142
/15	255.254.0.0	128 (126)	131070
/19	255.255.224.0	2048 (2046)	8190
/20	255.255.240.0	4096 (4094)	4094
/21	255.255.248.0	8192 (8190)	2046
/22	255.255.252.0	16384 (16382)	1022
/23	255.255.254.0	32768 (32766)	510
/24	255.255.255.0	65536 (65534)	254
/25	255.255.255.128	131072 (131070)	126
/26	255.255.255.192	262144 (262142)	62
/27	255.255.255.224	524288 (524286)	30
/28	255.255.255.240	1048576 (1048574)	14
/29	255.255.255.248	2097152 (2097150)	6
/30	255.255.255.252	4194304 (4194302)	2

Sample Calculation for 255.255.255

VLAN Address: 10.10.0.0; Netmask bits: 24; Subnet Mask: 255.255.255.0

10.10.0.0

```
Address:   10.10.0.0           00001010.00001010.00000000 .00000000
Netmask:   255.255.255.0 = 24  11111111.11111111.11111111 .00000000
Wildcard:  0.0.0.255           00000000.00000000.00000000 .11111111
=>
Network:   10.10.0.0/24        00001010.00001010.00000000 .00000000 (Class A)
Broadcast: 10.10.0.255         00001010.00001010.00000000 .11111111
HostMin:   10.10.0.1           00001010.00001010.00000000 .00000001
HostMax:   10.10.0.254         00001010.00001010.00000000 .11111110
Hosts/Net: 254                 (Private Internet)
```

10.10.1.0

```
Address:   10.10.1.0           00001010.00001010.00000001 .00000000
Netmask:   255.255.255.0 = 24  11111111.11111111.11111111 .00000000
Wildcard:  0.0.0.255           00000000.00000000.00000000 .11111111
=>
Network:   10.10.1.0/24        00001010.00001010.00000001 .00000000 (Class A)
Broadcast: 10.10.1.255         00001010.00001010.00000001 .11111111
HostMin:   10.10.1.1           00001010.00001010.00000001 .00000001
HostMax:   10.10.1.254         00001010.00001010.00000001 .11111110
Hosts/Net: 254                 (Private Internet)
```

Sample Calculation for 255.255.254

VLAN Address: 10.23.0.0; Netmask bits: 23; Subnet Mask: 255.255.254.0

10.23.0.0

```
Address:   10.23.0.0           00001010.00010111.0000000 0.00000000
Netmask:   255.255.254.0 = 23  11111111.11111111.1111111 0.00000000
Wildcard:  0.0.1.255           00000000.00000000.0000000 1.11111111
=>
Network:   10.23.0.0/23        00001010.00010111.0000000 0.00000000 (Class A)
Broadcast: 10.23.1.255         00001010.00010111.0000000 1.11111111
HostMin:   10.23.0.1           00001010.00010111.0000000 0.00000001
HostMax:   10.23.1.254         00001010.00010111.0000000 1.11111110
Hosts/Net: 510                 (Private Internet)
```

10.23.2.0

```
Address:   10.23.2.0           00001010.00010111.0000001 0.00000000
Netmask:   255.255.254.0 = 23  11111111.11111111.1111111 0.00000000
Wildcard:  0.0.1.255           00000000.00000000.0000000 1.11111111
=>
Network:   10.23.2.0/23        00001010.00010111.0000001 0.00000000 (Class A)
Broadcast: 10.23.3.255         00001010.00010111.0000001 1.11111111
HostMin:   10.23.2.1           00001010.00010111.0000001 0.00000001
HostMax:   10.23.3.254         00001010.00010111.0000001 1.11111110
Hosts/Net: 510                 (Private Internet)
```

Main Office IP Addressing Schema

Main Office – Boston, MA						
Vlan #	Vlan IP	Subnet mask	IP	People	Devices	Department/Function
0	10.10.0.0	255.255.255.0	10.10.0.1～ 10.10.0.50		50	VOIP
1	10.10.1.0	255.255.255.0	10.10.1.1～ 10.10.1.90	30	90	Accounting/ Finance
2	10.10.2.0	255.255.255.0	10.10.2.1～ 10.10.2.90	10	30	HR
3	10.10.3.0	255.255.255.0	10.10.3.1～ 10.10.3.90	30	90	Legal
4	10.10.4.0	255.255.255.0	10.10.4.1～ 10.10.4.90	30	90	Corporate IT
5	10.10.5.0	255.255.255.0	10.10.5.1～ 10.10.5.60	20	60	Facilities management
6	10.10.6.0	255.255.255.0	10.10.6.1～ 10.10.6.60	20	60	Executive management
7	10.10.7.0	255.255.255.0	10.10.7.1～ 10.10.7.120	40	120	Strategy groups
8	10.10.8.0	255.255.255.0	10.10.8.1～ 10.10.8.90	30	90	Treasury
9	10.10.9.0	255.255.255.0	10.10.9.1～ 10.10.9.50		10	Server
10	10.10.10.0	255.255.255.0	10.10.10.1～ 10.10.10.10		10	Printer
Total				210	700	

Regional Headquarters - Paris, France

Regional HQ – Paris, France						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.26.0.0	255.255.255.0	10.26.0.1～ 10.26.0.40		40	VOIP
1	10.26.1.0	255.255.255.0	10.26.1.1～ 10.26.1.60	20	60	Accounting/ Finance
2	10.26.2.0	255.255.255.0	10.26.2.1～ 10.26.2.15	5	15	HR
3	10.26.3.0	255.255.255.0	10.26.3.1～ 10.26.3.45	15	45	Legal
4	10.26.4.0	255.255.255.0	10.26.4.1～ 10.26.4.60	20	60	Corporate IT
5	10.26.5.0	255.255.255.0	10.26.5.1～ 10.26.5.30	10	30	Facilities management
6	10.26.6.0	255.255.255.0	10.26.6.1～ 10.26.6.30	10	30	Executive management
7	10.26.7.0	255.255.255.0	10.26.7.1～ 10.26.7.90	30	90	Strategy groups
8	10.26.8.0	255.255.255.0	10.26.8.1～ 10.26.8.60	20	60	Treasury
9	10.26.9.0	255.255.255.0	10.26.9.1～ 10.26.9.40		8	Server
10	10.26.10.0	255.255.255.0	10.26.10.1～ 10.26.10.8		8	Printer
Total				130	446	

Regional Headquarters - Buenos Aires, Argentina

Regional HQ –Buenos Aires, Argentina						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.27.0.0	255.255.255.0	10.27.0.1～ 10.27.0.40		40	VOIP
1	10.27.1.0	255.255.255.0	10.27.1.1～ 10.27.1.60	20	60	Accounting/ Finance
2	10.27.2.0	255.255.255.0	10.27.2.1～ 10.27.2.15	5	15	HR
3	10.27.3.0	255.255.255.0	10.27.3.1～ 10.27.3.45	15	45	Legal
4	10.27.4.0	255.255.255.0	10.27.4.1～ 10.27.4.60	20	60	Corporate IT
5	10.27.5.0	255.255.255.0	10.27.5.1～ 10.27.5.30	10	30	Facilities management
6	10.27.6.0	255.255.255.0	10.27.6.1～ 10.27.6.30	10	30	Executive management
7	10.27.7.0	255.255.255.0	10.27.7.1～ 10.27.7.90	30	90	Strategy groups
8	10.27.8.0	255.255.255.0	10.27.8.1～ 10.27.8.60	20	60	Treasury
9	10.27.9.0	255.255.255.0	10.27.9.1～ 10.27.9.50		10	Server
10	10.27.10.0	255.255.255.0	10.27.10.1～ 10.27.10.10		10	Printer
Total				130	450	

Regional Headquarters - Sydney, Australia

Regional HQ –Sydney, Australia						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.28.0.0	255.255.255.0	10.28.0.1～ 10.28.0.40		40	VOIP
1	10.28.1.0	255.255.255.0	10.28.1.1～ 10.28.1.60	20	60	Accounting/ Finance
2	10.28.2.0	255.255.255.0	10.28.2.1～ 10.28.2.15	5	15	HR
3	10.28.3.0	255.255.255.0	10.28.3.1～ 10.28.3.45	15	45	Legal
4	10.28.4.0	255.255.255.0	10.28.4.1～ 10.28.4.60	20	60	Corporate IT
5	10.28.5.0	255.255.255.0	10.28.5.1～ 10.28.5.30	10	30	Facilities management
6	10.28.6.0	255.255.255.0	10.28.6.1～ 10.28.6.30	10	30	Executive management
7	10.28.7.0	255.255.255.0	10.28.7.1～ 10.28.7.90	30	90	Strategy groups
8	10.28.8.0	255.255.255.0	10.28.8.1～ 10.28.8.60	20	60	Treasury
9	10.28.9.0	255.255.255.0	10.28.9.1～ 10.28.9.50		10	Server
10	10.28.10.0	255.255.255.0	10.28.10.1～ 10.28.10.10		10	Printer
Total				130	450	

Global Client Center - Berlin

Global Client Center - Berlin						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.11.0.0	255.255.255.0	10.11.0.1～10.11.0.40		40	VOIP
1	10.11.1.0	255.255.255.0	10.11.1.1～10.11.1.240	80	240	Designer
2	10.11.2.0	255.255.255.0	10.11.2.1～10.11.2.180	60	180	Engineer
3	10.11.3.0	255.255.255.0	10.11.3.1～10.11.3.180	60	180	Architect
4	10.11.4.0	255.255.255.0	10.11.4.1～10.11.4.50		10	Server
5	10.11.5.0	255.255.255.0	10.11.5.1～10.11.5.10		10	Printer
Total				200	660	

Global Client Center - Atlanta

Global Client Center - Atlanta						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.12.0.0	255.255.255.0	10.12.0.1～10.12.0.30		30	VOIP
1	10.12.1.0	255.255.255.0	10.12.1.1～10.12.1.150	50	150	Designer
2	10.12.2.0	255.255.255.0	10.12.2.1～10.12.2.150	50	150	Engineer
3	10.12.3.0	255.255.255.0	10.12.3.1～10.12.3.150	50	150	Architect
4	10.12.4.0	255.255.255.0	10.12.4.1～10.12.4.40		8	Server
5	10.12.5.0	255.255.255.0	10.12.5.1～10.12.5.7		7	Printer
Total				150	495	

Global Client Center - Tokyo

Global Client Center - Tokyo						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.13.0.0	255.255.255.0	10.13.0.1～10.13.0.30		30	VOIP
1	10.13.1.0	255.255.255.0	10.13.1.1～10.13.1.150	50	150	Designer
2	10.13.2.0	255.255.255.0	10.13.2.1～10.13.2.150	50	150	Engineer
3	10.13.3.0	255.255.255.0	10.13.3.1～10.13.3.150	50	150	Architect
4	10.13.4.0	255.255.255.0	10.13.4.1～10.13.4.50		8	Server
5	10.13.5.0	255.255.255.0	10.13.5.1～10.13.5.7		7	Printer
Total				150	495	

Lower-level support staff department - China

Lower--level support staff department - China						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.14.0.0	255.255.255.0	10.14.0.1～10.14.0.200		200	VOIP
1	10.14.1.0	255.255.255.0	10.14.1.1～10.14.1.250	250	250	Department1
2	10.14.2.0	255.255.255.0	10.14.2.1～10.14.2.250	250	250	Department2
3	10.14.3.0	255.255.255.0	10.14.3.1～10.14.3.250	250	250	Department3
4	10.14.4.0	255.255.255.0	10.14.4.1～10.14.4.100		20	Server
5	10.14.5.0	255.255.255.0	10.14.5.1～10.14.5.20		20	Printer
Total				750	990	

Lower-level support staff department - Canada

Lower--level support staff department - Canada						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.15.0.0	255.255.255.0	10.15.0.1～10.15.0.200		200	VOIP
1	10.15.1.0	255.255.255.0	10.15.1.1～10.15.1.250	250	250	Department1
2	10.15.2.0	255.255.255.0	10.15.2.1～10.15.2.250	250	250	Department2
3	10.15.3.0	255.255.255.0	10.15.3.1～10.15.3.250	250	250	Department3
4	10.15.4.0	255.255.255.0	10.15.4.1～10.15.4.100		20	Server
5	10.15.5.0	255.255.255.0	10.15.5.1～10.15.5.20		20	Printer
Total				750	990	

Lower-level support staff department - United Arab Emirates

Lower--level support staff department - United Arab Emirates						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.16.0.0	255.255.255.0	10.16.0.1～10.16.0.200		200	VOIP
1	10.16.1.0	255.255.255.0	10.16.1.1～10.16.1.250	250	250	Department1
2	10.16.2.0	255.255.255.0	10.16.2.1～10.16.2.250	250	250	Department2
3	10.16.3.0	255.255.255.0	10.16.3.1～10.16.3.250	250	250	Department3
4	10.16.4.0	255.255.255.0	10.16.4.1～10.16.4.100		20	Server
5	10.16.5.0	255.255.255.0	10.16.5.1～10.16.5.20		20	Printer
Total				750	990	

Lower-level support staff department - Malaysia

Lower--level support staff department - Malaysia						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.17.0.0	255.255.255.0	10.17.0.1～10.17.0.200		200	VOIP
1	10.17.1.0	255.255.255.0	10.17.1.1～10.17.1.250	250	250	Department1
2	10.17.2.0	255.255.255.0	10.17.2.1～10.17.2.250	250	250	Department2
3	10.17.3.0	255.255.255.0	10.17.3.1～10.17.3.250	250	250	Department3
4	10.17.4.0	255.255.255.0	10.17.4.1～10.17.4.100		20	Server
5	10.17.5.0	255.255.255.0	10.17.5.1～10.17.5.20		20	Printer
Total				750	990	

Software Development Center - Israel

Software Development Center - Israel						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.18.0.0	255.255.255.0	10.18.0.1～10.18.0.30		30	VOIP
1	10.18.1.0	255.255.255.0	10.18.1.1～10.18.1.120	30	120	Global operations support
2	10.18.2.0	255.255.255.0	10.18.2.1～10.18.2.80	20	80	AutoCAD support
3	10.18.3.0	255.255.255.0	10.18.3.1～10.18.3.40	10	40	Drawing packages support
4	10.18.4.0	255.255.255.0	10.18.4.1～10.18.4.40	10	40	Document Management systems support
5	10.18.5.0	255.255.255.0	10.18.5.1～10.18.5.40		8	Server
6	10.18.6.0	255.255.255.0	10.18.6.1～10.18.6.8		8	Printer
Total				70	326	

Software Development Center - India

Software Development Center - India						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.19.0.0	255.255.255.0	10.19.0.1～10.19.0.40		40	VOIP
1	10.19.1.0	255.255.255.0	10.19.1.1～10.19.1.200	50	200	Global operations support
2	10.19.2.0	255.255.255.0	10.19.2.1～10.19.2.200	50	200	AutoCAD support
3	10.19.3.0	255.255.255.0	10.19.3.1～10.19.3.80	20	80	Drawing packages support
4	10.19.4.0	255.255.255.0	10.19.4.1～10.19.4.80	20	80	Document Management systems support
5	10.19.5.0	255.255.255.0	10.19.5.1～10.19.5.50		10	Server
6	10.19.6.0	255.255.255.0	10.19.6.1～10.19.6.8		8	Printer
Total				140	638	

Software Development Center - Ukraine

Software Development Center - Ukraine						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.20.0.0	255.255.255.0	10.20.0.1～10.20.0.40		40	VOIP
1	10.20.1.0	255.255.255.0	10.20.1.1～10.20.1.140	35	140	Global operations support
2	10.20.2.0	255.255.255.0	10.20.2.1～10.20.2.140	35	140	AutoCAD support
3	10.20.3.0	255.255.255.0	10.20.3.1～10.20.3.40	10	40	Drawing packages support
4	10.20.4.0	255.255.255.0	10.20.4.1～10.20.4.40	10	40	Document Management systems support
5	10.20.5.0	255.255.255.0	10.20.5.1～10.20.5.50		10	Server
6	10.20.6.0	255.255.255.0	10.20.6.1～10.20.6.8		8	Printer
Total				90	418	

Sales Organization - Medium Office

Sales Organization - Medium Office (80 people)						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.21.0.0	255.255.255.0	10.21.0.1～10.21.0.10		10	VOIP
1	10.21.1.0	255.255.255.0	10.21.1.1～10.21.1.30	10	30	Department1
2	10.21.2.0	255.255.255.0	10.21.2.1～10.21.2.30	10	30	Department2
3	10.21.3.0	255.255.255.0	10.21.3.1～10.21.3.250	60	250	Mobile Users
4	10.21.4.0	255.255.255.0	10.21.4.1～10.21.4.20		4	Server
5	10.21.5.0	255.255.255.0	10.21.5.1～10.21.5.10		10	Printer
Total				80	334	

Sales Organization - Small Office

Sales Organization - Small Office (40 people)						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.22.0.0	255.255.255.0	10.22.0.1～10.22.0.5		5	VOIP
1	10.22.1.0	255.255.255.0	10.22.1.1～10.22.1.15	5	15	Department1
2	10.22.2.0	255.255.255.0	10.22.2.1～10.22.2.15	5	15	Department2
3	10.22.3.0	255.255.255.0	10.22.3.1～10.22.3.250	30	250	Mobile Users
4	10.22.4.0	255.255.255.0	10.22.4.1～10.22.4.20		4	Server
5	10.22.5.0	255.255.255.0	10.22.5.1～10.22.5.5		5	Printer
Total				40	294	

Sales Organization - America

Sales Organization - America						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.23.0.0	255.255.254.0	10.23.0.1~10.23.1.100	80	355	Medium office1
2	10.23.2.0	255.255.254.0	10.23.2.1~10.23.3.100	80	355	Medium office2
4	10.23.4.0	255.255.254.0	10.23.4.1 ~ 10.23.5.100	80	355	Medium office3
6	10.23.6.0	255.255.254.0	10.23.6.1 ~ 10.23.7.60	40	315	Small office1
8	10.23.8.0	255.255.254.0	10.23.8.1 ~ 10.23.9.60	40	315	Small office2
Total				320	1695	

Sales Organization - Europe/Middle East

Sales Organization - Europe/Middle East						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.24.0.0	255.255.254.0	10.24.0.1~10.24.1.100	80	355	Medium office1
2	10.24.2.0	255.255.254.0	10.24.2.1~10.24.3.100	80	355	Medium office2
4	10.24.4.0	255.255.254.0	10.24.4.1 ~ 10.24.5.100	80	355	Medium office3
6	10.24.6.0	255.255.254.0	10.24.6.1 ~ 10.24.7.60	40	315	Small office1
8	10.24.8.0	255.255.254.0	10.24.8.1 ~ 10.24.9.60	40	315	Small office2
Total				320	1695	

Sales Organization - Asia Pacific

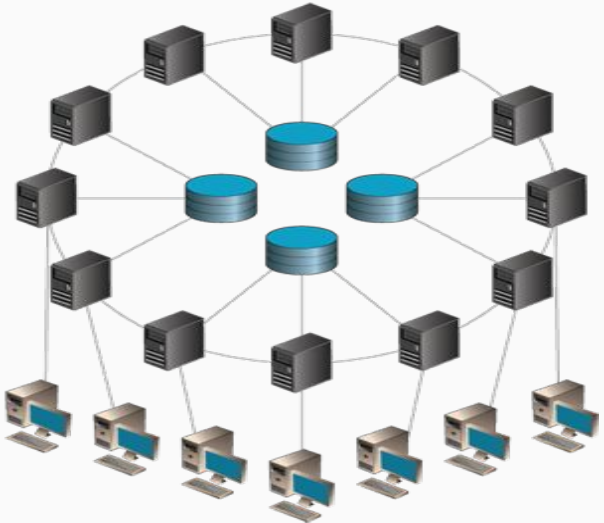
Sales Organization – Asia Pacific						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.25.0.0	255.255.254.0	10.25.0.1~10.25.1.100	80	355	Medium office1
2	10.25.2.0	255.255.254.0	10.25.2.1~10.25.3.100	80	355	Medium office2
4	10.25.4.0	255.255.254.0	10.25.4.1 ~ 10.25.5.100	80	355	Medium office3
6	10.25.6.0	255.255.254.0	10.25.6.1 ~ 10.25.7.60	40	315	Small office1
8	10.25.8.0	255.255.254.0	10.25.8.1 ~ 10.25.9.60	40	315	Small office2
10	10.25.10.0	255.255.254.0	10.25.10.1 ~ 10.25.11.60	40	315	Small office3
Total				360	2010	

Call Center - Puerto Rico

Call-center – Puerto Rico						
Vlan #	Vlan IP	Subnet Mask	IP	People	Devices	Department/Function
0	10.29.0.0	255.255.255.0	10.29.0.1~10.29.0.20		20	VOIP
1	10.29.1.0	255.255.255.0	10.29.1.1~10.29.1.100	100	100	Call center
2	10.29.2.0	255.255.255.0	10.29.2.1~10.29.2.100		20	Server
3	10.29.3.0	255.255.255.0	10.29.3.1~10.29.3.20		20	Printer
Total				100	160	

Network Architecture Design

- Multiple client-servers emphasize a distributed system to uphold transparency, openness, concurrency, security, resilience to failure, and scalability
- Network architecture will be re-architectured to resolve these problems:
  - Server location
  - VLAN - Link aggregation
  - Backup and mirror Server
  - Heartbeat channels for detecting server down
  - Clean network environment

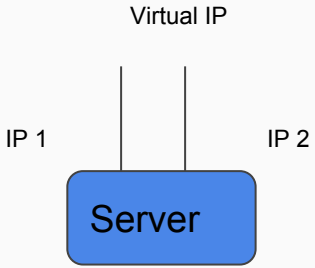


Server Location

- Physical distance of servers reflect in the delay time of access directly
- Building the servers at proper locations minimizes delay.
- 1 mirror e-mail server for each main continent (North America, Europe, Asia, etc).
- These e-mail servers have different web portals but with same domain name as e-mail address.
    - There will be individual servers for other general purpose servers (file server, VOIP) in every branch division unit of the company.
        - These servers require more bandwidth and lower delay.

VLAN - Link Aggregation

- Link aggregation is a special case of VLAN
  - Requires software/hardware supporting on both switches and devices.
  - Allows combining multiple different ethernet interfaces as one virtual interface.
- Traffic going through the IP on this virtual interface will be distributed among multiple physical interfaces, which increases much loading capacity.

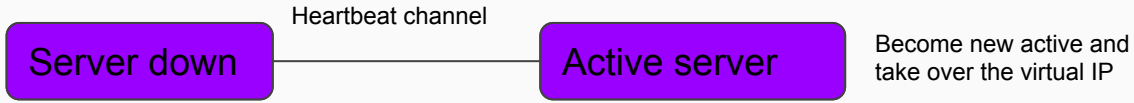


Backup and Mirror Server

- Backup servers and mirror servers will be added into cluster sets (high availability).
- When the active server is providing the service, the backup (passive) server will be in standby mode and mirroring the data from active server.
    - Passive server will become active when the original active server goes down.

Heartbeat Channels Used for Detecting Server Down

- Extra IP and ethernet interfaces will be assigned for both active and passive servers as heartbeat channels.
  - These channels allow active and passive servers to monitor the status of each other.
- When the active server goes down, the passive server becomes the new active server and start taking over the VLAN virtual IP on link aggregation interfaces.
  - The users will not notice the IP changes after servers switched over.



Clean network environment

- Using another type of port-based VLAN to isolate the local network traffic of different offices
  - Give us a cleaner environment in local network
- The subnet mask will be set properly on each device to make sure they belong to the right subnet.
  - These devices from different subnets can still access each other through routing protocol.

Relevant Protocols

- TCP - Emails, File Transfers
- UDP - Streaming, VoIP
- DHCP - Mobile connection
- HTTP - Hypertext Transfer Protocol
- FTP - File Transfer Protocol
- SMTP - Simple Mail Transfer Protocol

Transmission Control Protocol

- Connection-oriented reliable transport
- Reliable, in-order delivery
  - Flow control
    - Timeout events (Timer)
    - Sequence numbers, pipelined segments and Acknowledgements (ACK)
  - Connection setup
    - 3-way Handshake
- For regular applications on the internet that rely on transmission such as **Email** and **File Transfer**.

User Datagram Protocol

- Connectionless transport
- Unreliable, unordered delivery
  - Focused in delivering on low latency
  - Cut and dry - no handshaking
- For streaming applications on the internet that rely on minimal latency such as **VoIP**.

Dynamically Host Control Protocol

- Dynamically obtain IP Addresses from the network server
  - Renew lease
  - Holds addresses on connection
- Dynamically obtain IP Addresses from the network server. For workstations, laptops, and **mobile devices** that **comes** and **goes**.

Access Technologies

- Ethernet
  - Cable broadband
  - Coaxial copper
- Wi-fi
  - IEEE 802.11 standards
    - For performance: 802.11/n/ac

ISPs Application Profiles

ISPs Application Profiles				
Location (users)	**Telecom**	**Protocol**	**Acceptable Delay**	**Recommended bandwidth**
Boston, MA (210)	Verizon	TCP, UDP, DHCP	10 ms	2 x 1Gb / s
Paris, France (130)	Orange S.A.	TCP, UDP, DHCP	200 ms	250Mb / s
Buenos Aires, Argentina (130)	Telecom Argentina	TCP, UDP, DHCP	150 ms	250Mb / s
Sydney, Australia (130)	Telstra	TCP, UDP, DHCP	250 ms	250Mb / s
Berlin (200)	Deutsche Telekom AG	TCP, UDP, DHCP	200 ms	1 Gb / s
Atlanta (150)	AT&T Uverse	TCP, UDP, DHCP	75 ms	500MB / s
Tokyo (150)	Nippon Telegraph & Tel	TCP, UDP, DHCP	250 ms	1 Gb / s
China (750)	China Telecom	TCP, UDP, DHCP	300 ms	2 x 1Gb / s
Canada (750)	Rogers	TCP, UDP, DHCP	50 ms	2 x 1Gb / s
UAE (750)	Etisalat	TCP, UDP, DHCP	200 ms	2 x 1Gb / s
Malaysia (750)	Time	TCP, UDP, DHCP	250 ms	2 x 1Gb / s
Israel (70)	Bezeq	TCP, UDP, DHCP	200 ms	250Mb / s
India (140)	BEAM Telecom	TCP, UDP, DHCP	300 ms	250Mb / s
Ukraine (90)	Ukrtelecom	TCP, UDP, DHCP	250 ms	250Mb / s
Puerto Rico (100)	Claro Puerto Rico	TCP, UDP, DHCP	150 ms	250Mb / s