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NEW YORK UNIVERSITY

Computer Networking

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VITA PHARMA NETWORK DESIGN AND ARCHITECTURE

FINAL PRESENTATION REPORT

Team 10

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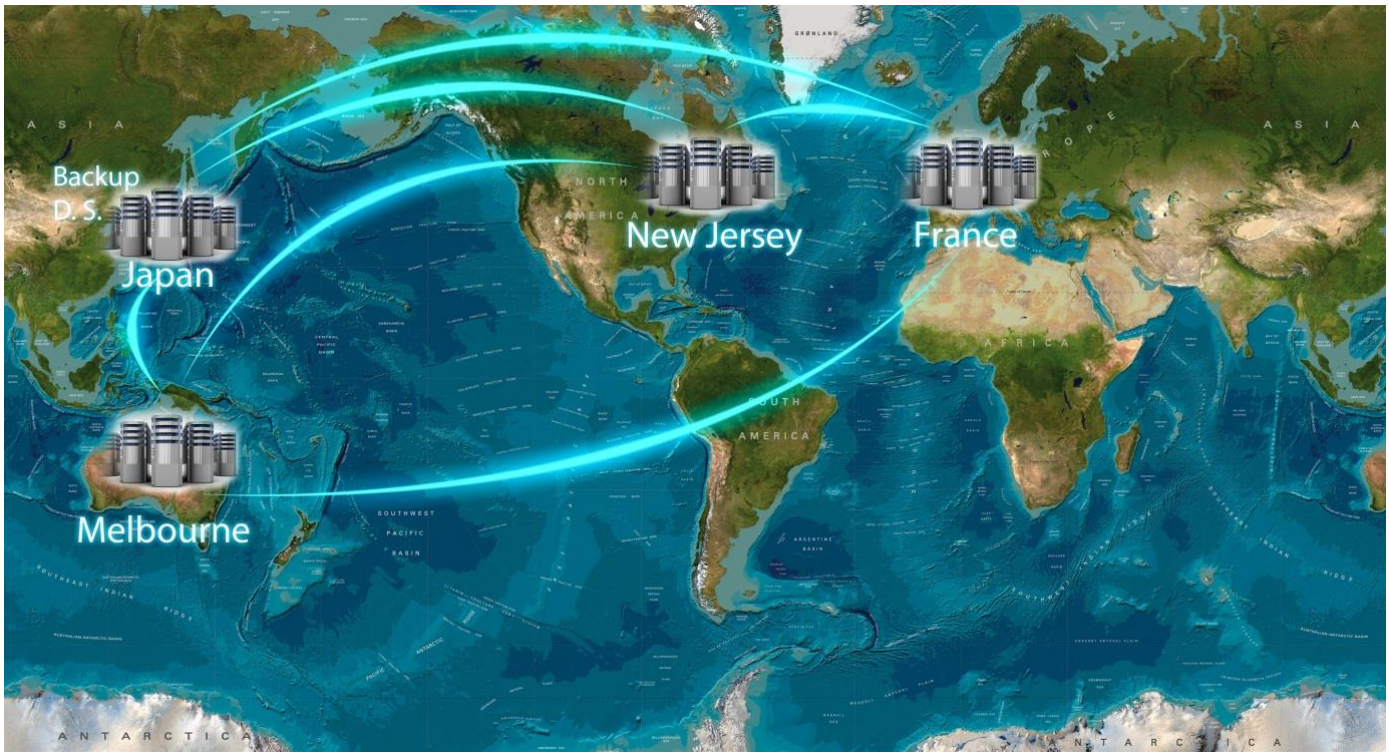
Chapter 1

Global Network and Data Centres Design

Map of Global Network and connectivity to Data Centre



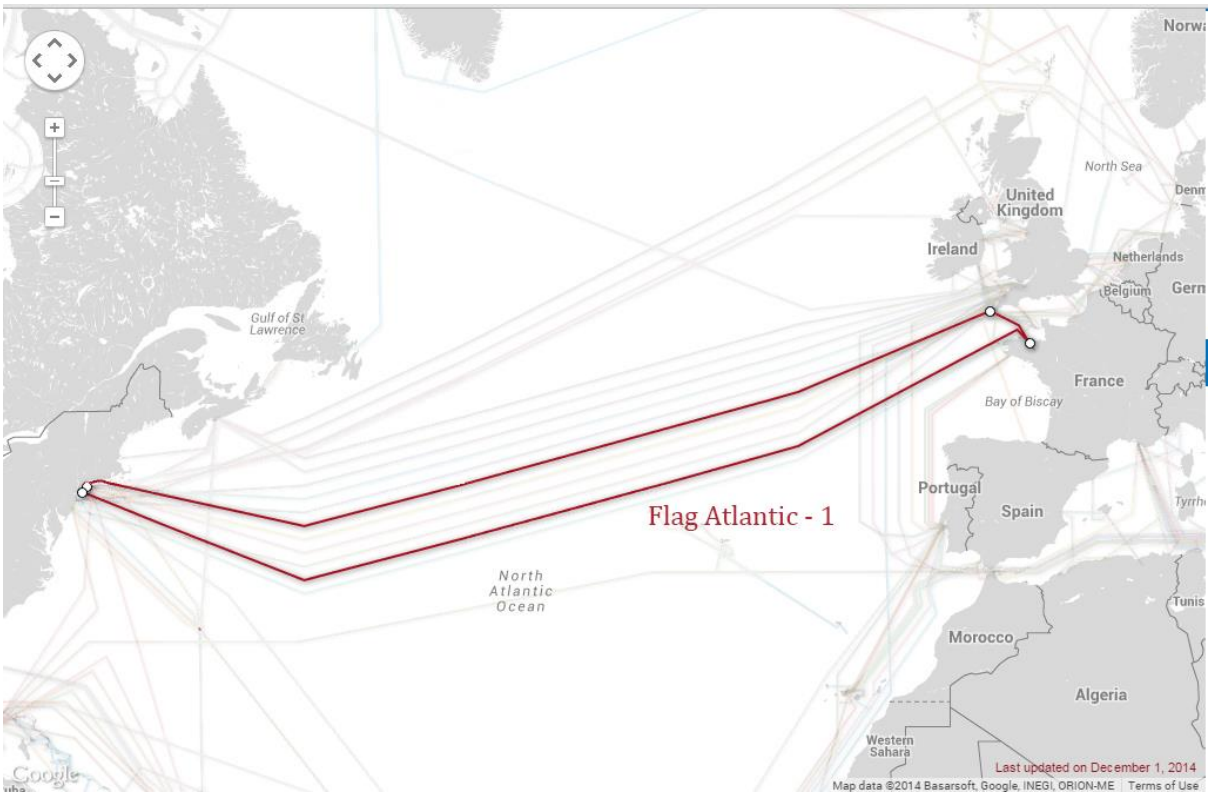
Data centre location and relation between the locations:

Name	From	To	Cable Name	Purpose
Data Centre 1	New Jersey	France	Flag Atlantic -1	Primary
Data Centre 2	France	Australia	SeaMeWe -3	Primary
Data Centre 3	Japan	New Jersey	New Cross Specific cable system	Backup
Data Centre 4	Australia	Japan	Australia – Japan cable	Primary

Reasons to choose this Location:

- **Cooling and Climate**
  - As data centre holds the most important data of the organization, we should select it by keeping the climate of the location in mind. It has to be in cool and dry areas which will protect it from the heat and help them stay cool.
  - Climate also plays major factor while selecting data centres as we should try to avoid the areas where there are sudden climate changes which might directly affect the data centres.
- **Access to power today and in future**
  - We should select the areas where tremendous amount of electricity is available at cheaper cost. The areas where there is no cut off in electricity are to be selected as data centres needs to be up and running continuously to prevent the data loss.
- **Proximity to risk**
  - We should not select data centres in areas prone to natural disaster.
- **Data security**
  - We cannot take any changes when it comes to data security. Location should be selected in such a way that the data remains safe and does not fall in wrong hands. All the employees working at data centre should go under background security check.
- **Submarine Cable network**
  - Submarine cable is laid on the sea bed between land-based stations to carry telecommunication signal across the ocean. It provides high speed and is ideal for data centres communication.

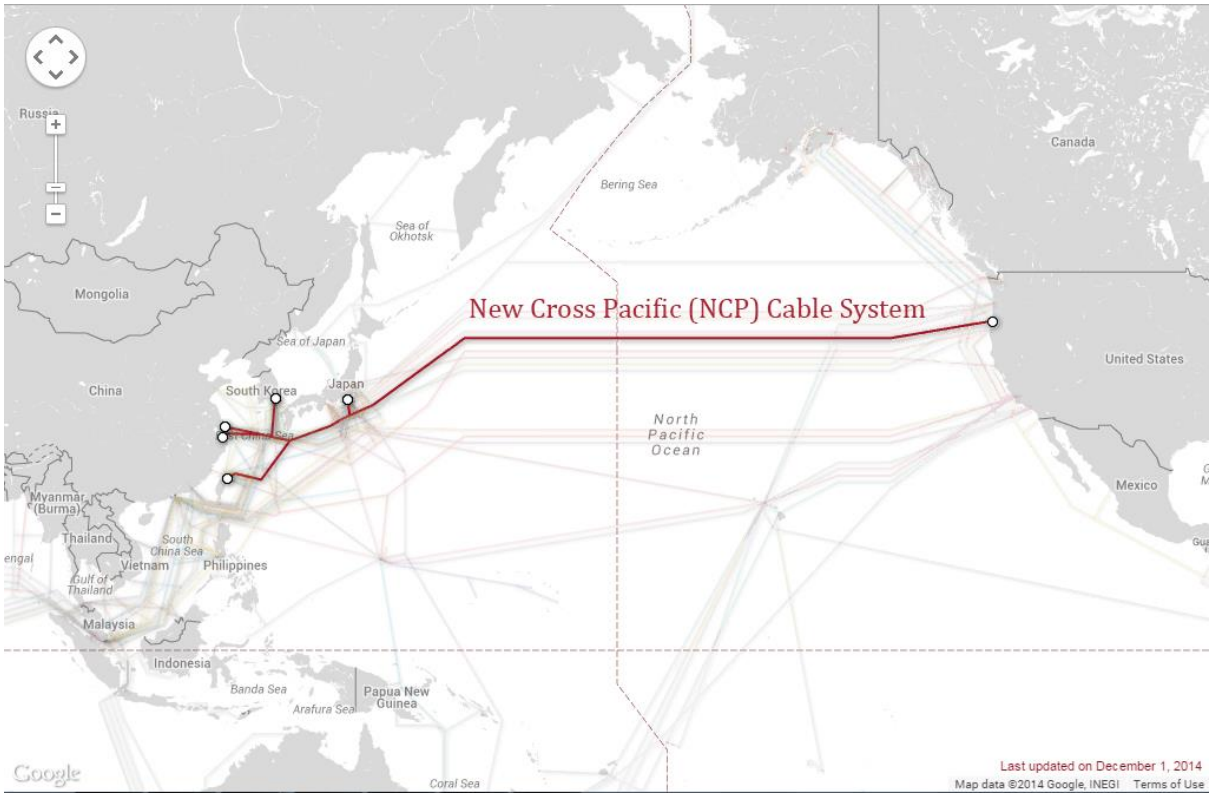
USA to France cable



The submarine cable used to connect USA to France is Flag Atlantic – 1. It is made up of six fibre pair, dual cable loop system with a combined design capacity of 4.8 Tbps using Dense Wave Division Multiplexing (DWDM) technology.

It is owned and managed by FLAG telecom. It has capacity of carrying more than 200 hours of digital video, 30 million clear voice channels or more than 2 trillion bits of IP or data traffic every second.

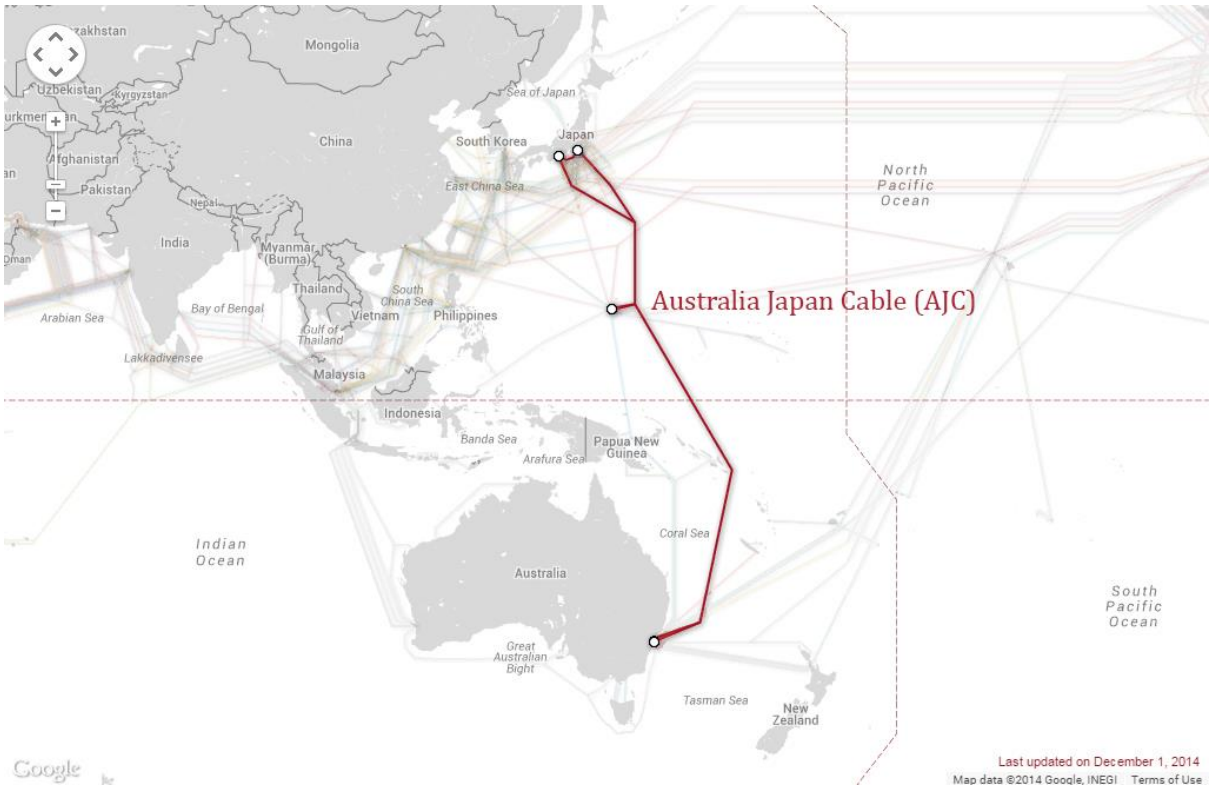
USA to Japan cable



The **New Cross Pacific [NCP] Cable System** is a new generation high capacity fibre-optic submarine cable system across the Pacific Ocean directly connecting the US and Asia with countries such as China, Korea, Taiwan, Japan and the US.

It is owned and managed by Chunghwa Telecom, KT Corporation, China Telecom, China Mobile, China Unicom and a US based company.

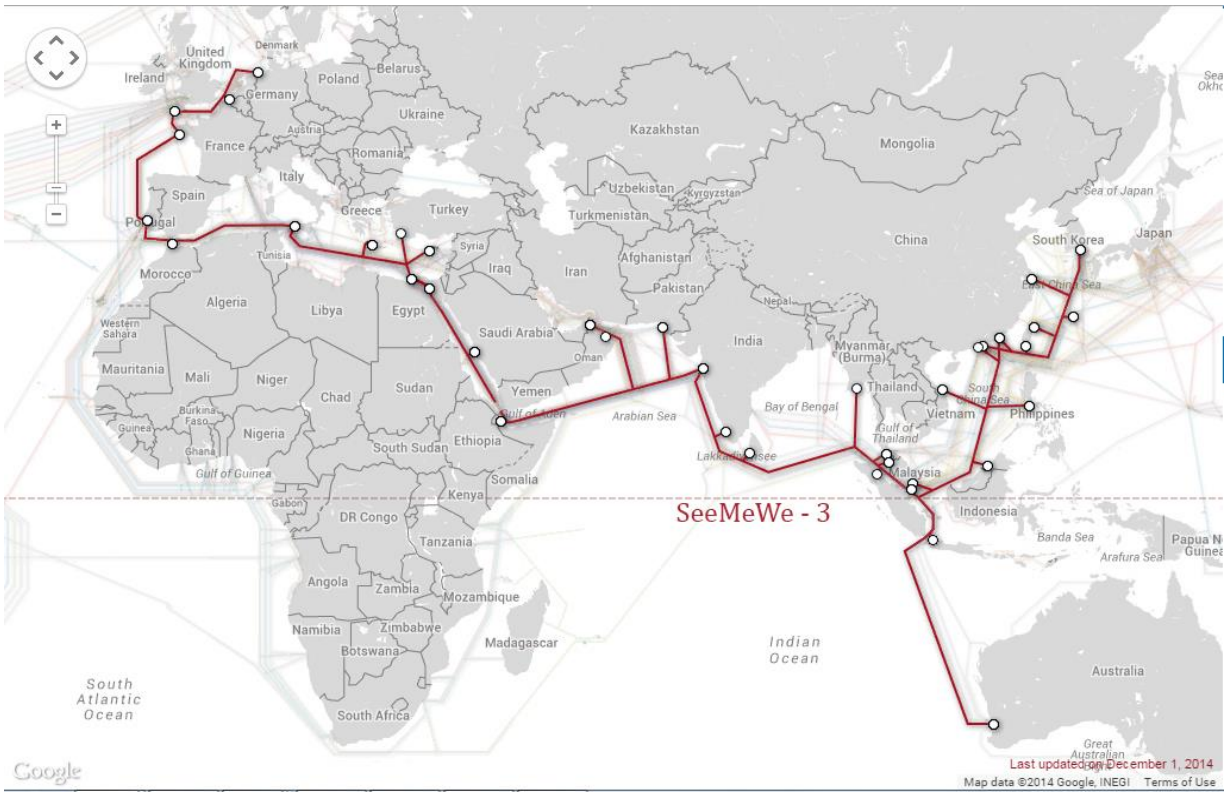
Japan to Melbourne cable



Australia-Japan Cable (AJC) is a submarine cable directly connecting Australia and Japan, via Guam. AJC also provides access to high capacity, high volume, low – unit cost trans-pacific and inter – asia via guam and japan. It was upgraded to 100G technology in late 2013.

It is currently equipped to carry 1000GB/S and has potential capacity of over 5000 GB/S.

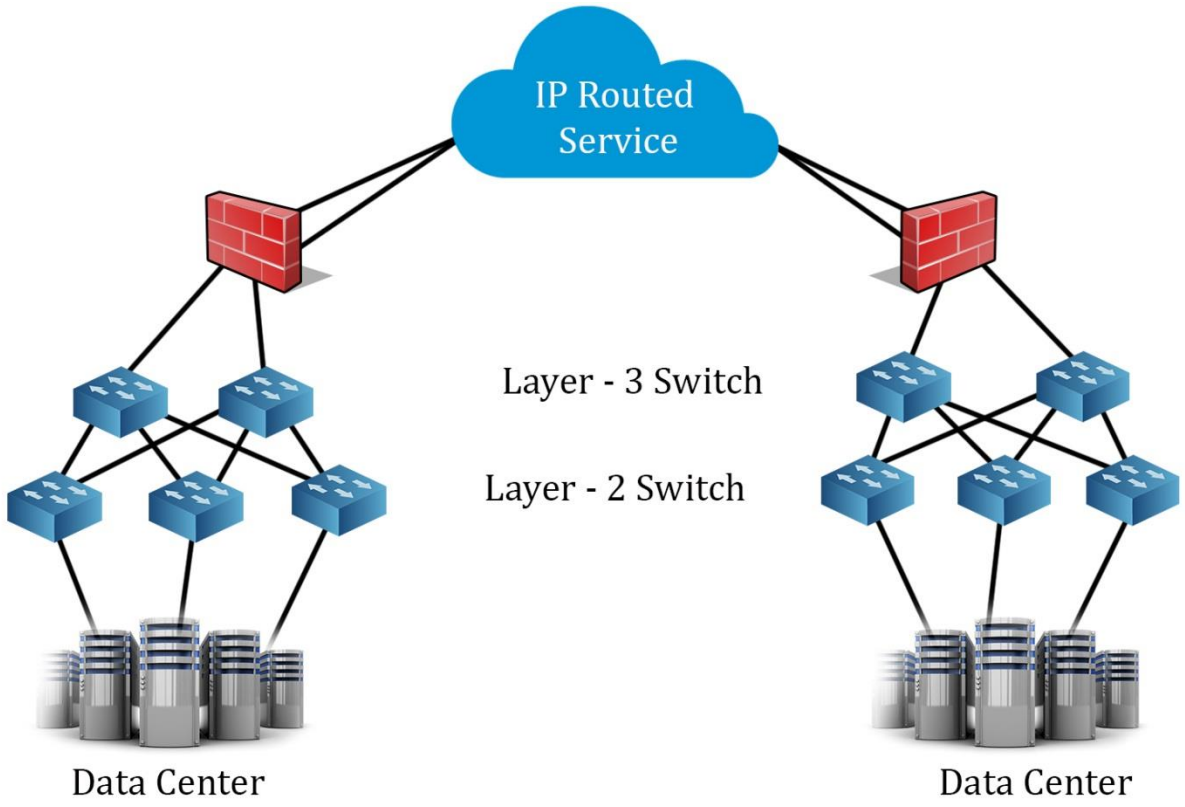
Australia to France cable



SEE-ME-WE 3 is the longest optical telecommunication submarine cable in the world and was completed in late 2000. It is operated by France Telecom and China Telecom and is administered by Singtel, a telecommunication operator owned by Government of Singapore.

It is 39000 kilometres long and uses Wavelength Division Multiplexing (WDM) to increase the capacity and enhance the quality of signal, especially over long distances. It has two fibre pairs, each carrying 48 Wavelengths of 10 Gb/S.

Data Centre (Communication between two continents)



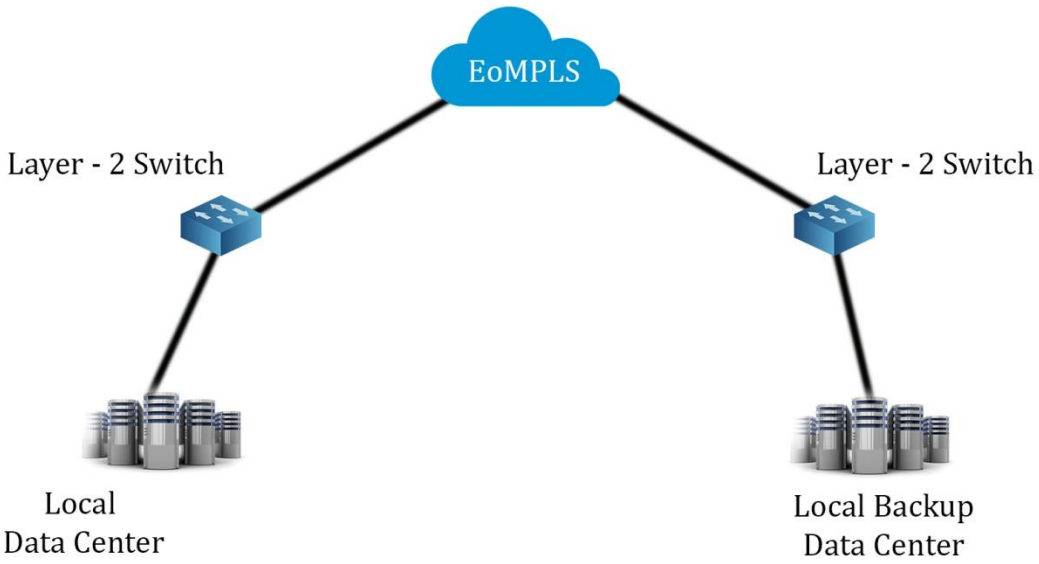
Above structure of Data centre connectivity shows how one data centre is connected to other data centre on different geography.

Firstly, servers from data centre are connected with the layer 2 switches and then those are connected to layer 3 switches. Here network use two, layer 3 switches for efficient data transfer and backup purpose.

Here we user layer 3 switch instead of router because switch is more efficient then routers and Layer 3 switch has all the functionality which router has.

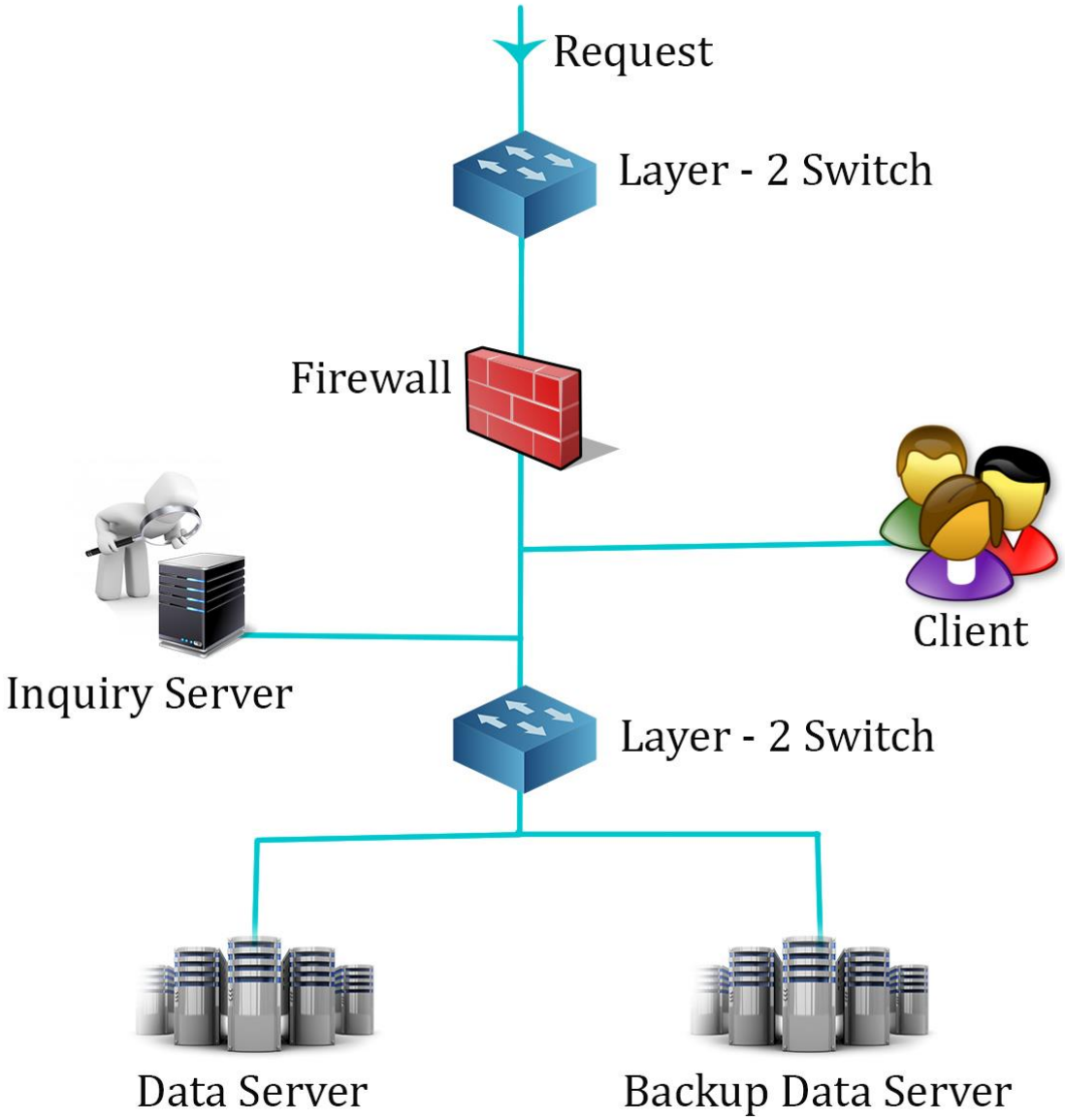
Data Centre (Internal communication between Local DC & Backup DC)

Local data centre is connected with backup data centre with layer 2 switch and then switches are connected with Ethernet over MPLS.



Data Centre Internal design

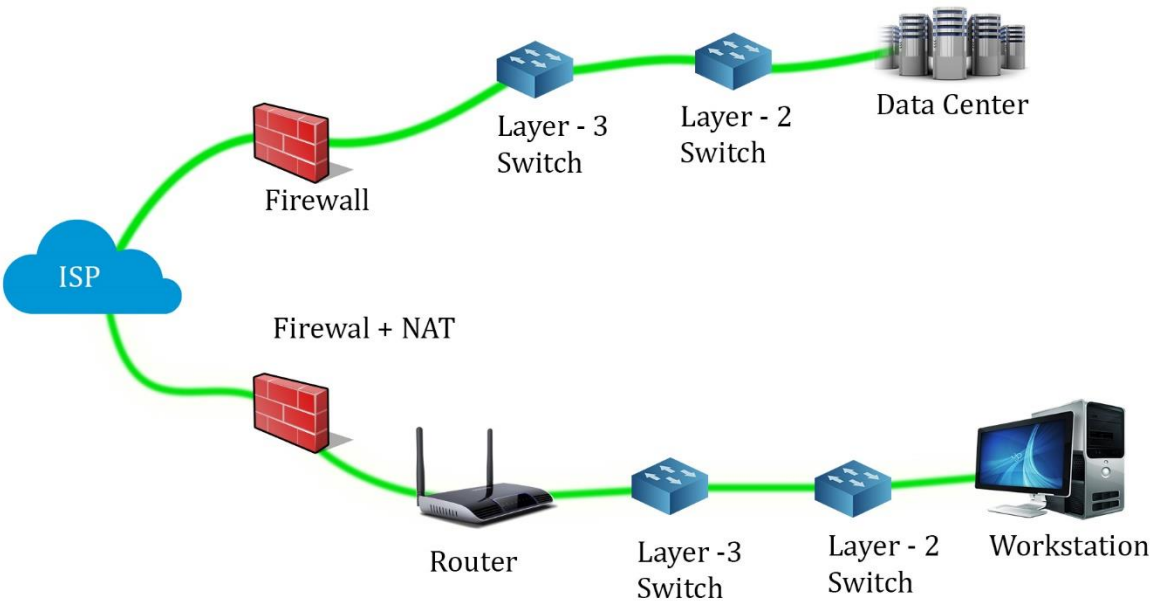
When the request comes at the Layer – 2 switch, it has to pass through the firewall. The inquiry server checks whether the request is legit or not and authenticate the legit requests and registers the date, time and IP Address of the requesting person. Even the employees who are handling the data centres has to go through the authentication process of the inquiry server. Then the request is send to data centre via a layer – 2 switch.



Communication between Data Centre and Host in Office

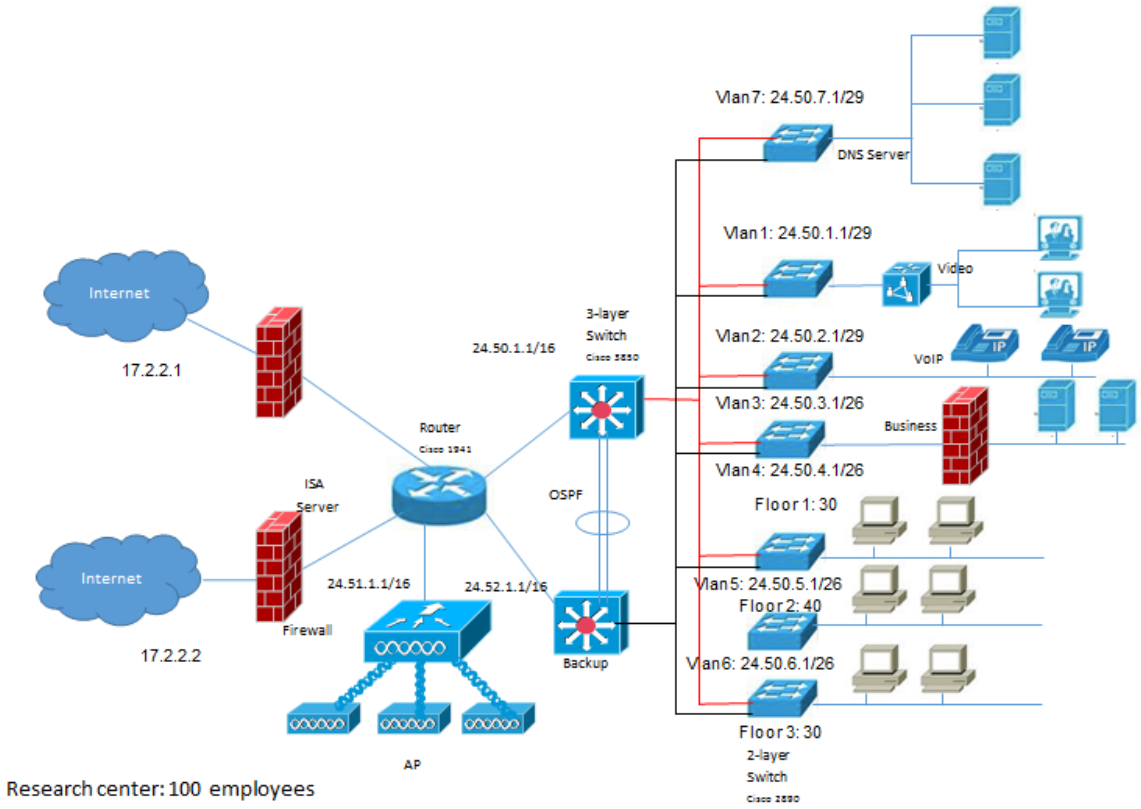
Diagram below depicts the scenario of communication between users in office and data centre.

Here network design gives clear idea about how packet generated from user travels to data centre for particular data request.


Layer - 3
Switch
Layer - 2
Switch
Data Center
Firewall
ISP
Firewal + NAT
Router
Layer -3
Switch
Layer - 2
Switch
Workstation

Chapter 2

Local Network design and connectivity



Above diagram shows the internal structure of Local Area Network (LAN) at each office in the network.

Here the structure of local network is very simple and easy to understand with high reliability and strong connectivity to outside world.

Each floor is connected with separate VLAN. This VLAN contains IP phones and computers. There are two, layer 3 switches and all VLANs connected with each of switches. We use OSPF deciding which switch a packet transfer through.

DNS server is also available locally at each location office so it will help to reduce the look up time and process the request very fast and efficient.

Layer 3 switch is connected to a router. Also access control points connected to router for wireless connectivity in local area. Now this router has connectivity two ISPs with separate firewall.

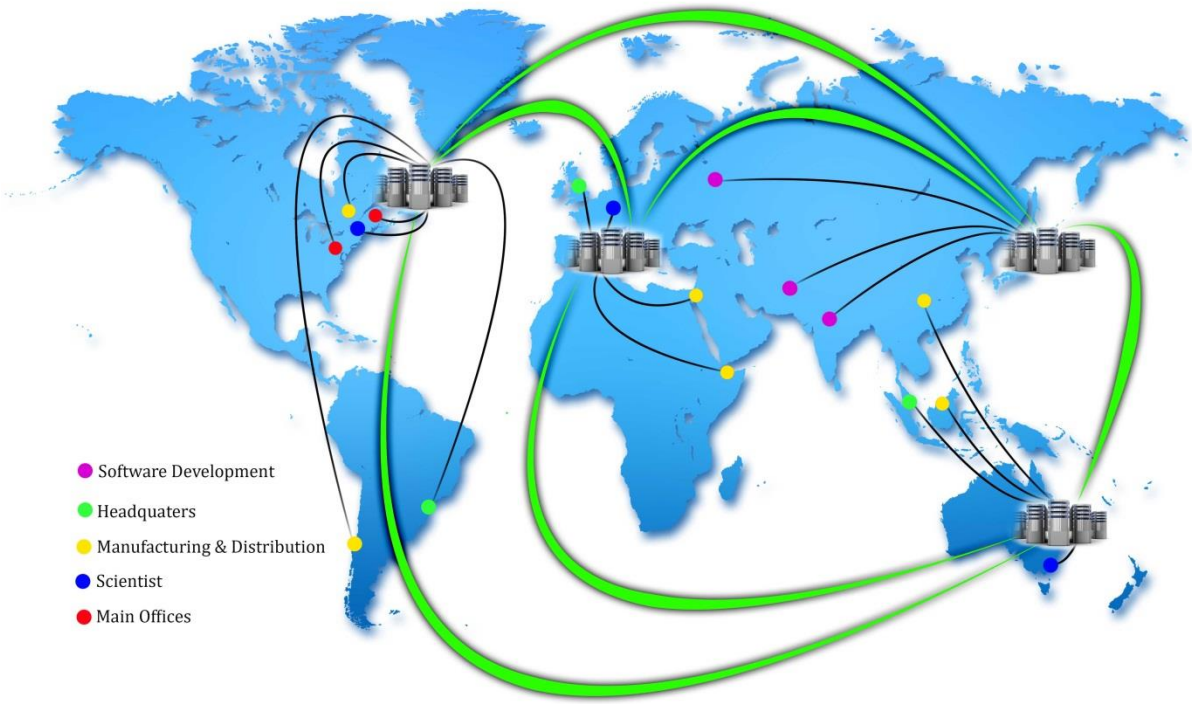
Here we have implemented NAT (Network Address translator) in the firewall. So with minimal number of public IP, More number of people communicates with outside world.

Detail Network infrastructure:

At office level, we segregate traffic using different VLAN structure for different purpose. Like video/audio, voice and data.

So, high volumes of data are never bottleneck for voice call and not degrade the quality of voice call in the high volume of data transfer request.

In Local network, there are also firewall/security mechanisms which protect from accessing the important data access and protect confidential data from virus and malware.



Chapter 3
IP Scheme design and connectivity

The IP schemes of different offices is shown below:

Research centre

location	Public IP address	VLan Number	VLan subnet IP address	Subnet Mask	IP address range	Actual people	How many devices supported most	Note
New York	17.2.1.1	1	24.50.1.1	255.255.255.224	24.100.1.1~24.100.1.30	10	30	video
		2	24.50.2.1	255.255.255.128	24.100.2.1~24.100.2.126	50	126	VOIP
		3	24.50.3.1	255.255.255.192	24.100.3.1~24.100.3.62	30	62	App
		4	24.50.4.1	255.255.255.128	24.100.4.1~24.100.4.126	50	126	PC
		5	24.50.5.1	255.255.255.128	24.100.5.1~24.100.5.126	50	126	PC
		6	24.50.6.1	255.255.255.128	24.100.6.1~24.100.6.126	50	126	PC
		7	24.50.7.1	255.255.255.252	24.100.7.1~24.100.7.2	-----	2	Proxy DNS
Melbourne	172.3.1.1	1	25.50.1.1	255.255.255.128	25.100.1.1~25.100.1.30	10	30	video
		2	25.50.2.1	255.255.255.192	25.100.2.1~25.100.2.126	50	126	VOIP
		3	25.50.3.1	255.255.255.128	25.100.3.1~25.100.3.62	30	62	App
		4	25.50.4.1	255.255.255.128	25.100.4.1~25.100.4.126	50	126	PC
		5	25.50.5.1	255.255.255.128	25.101.4.1~25.101.4.62	50	126	PC
		6	25.50.6.1	255.255.255.128	25.101.5.1~25.101.5.30	50-	126	PC
		7	25.50.7.1	255.255.255.252	25.101.6.1~25.101.6.14	-----	2	Proxy DNS
Zurich	126.7.1.1	1	23.50.1.1	255.255.255.128	23.100.0.1~23.100.0.126	10	30	video
		2	23.50.2.1	255.255.255.128	24.100.2.1~24.100.2.126	50	126	VOIP
		3	23.50.3.1	255.255.255.128	24.100.3.1~24.100.3.62	20	62	App
		4	23.50.4.1	255.255.255.128	24.100.4.1~24.100.4.126	50	126	PC
		5	23.50.5.1	255.255.255.128	25.101.4.1~25.101.4.62	50	126	PC
		6	23.50.6.1	255.255.255.192	25.101.5.1~25.101.5.30	50	126	PC
		7	23.50.7.1	255.255.255.224	25.101.6.1~25.101.6.14	-----	2	Proxy DNS

Software development

location	Public IP address	VLan Number	VLan subnet IP address	Subnet Mask	IP address range	Actual people	How many devices supported most	Note
Pakistan	192.16.1.1	1	25.100.0.0	255.255.255.128	25.100.0.1~25.100.0.126	20	126	App 1
		2	25.100.1.0	255.255.255.128	25.100.1.1~25.100.1.126	20	126	App 2
		3	25.100.2.0	255.255.255.128	25.100.2.1~25.100.2.126	20	126	App 3
		4	25.100.3.0	255.255.255.0	25.100.3.1~25.100.3.254	40	254	App 4
		5	25.100.4.0	255.255.255.192	25.100.4.1~25.100.4.62	-----	62	IP phone

		6	25.100.5.0	255.255.255.224	25.100.5.1~25.100.5.30	-----	30	Video Conferencee quipment
		7	25.100.6.0	255.255.255.240	25.100.6.1~25.100.6.14	-----	14	Local Data Center
		8	25.100.7.0	255.255.255.252	25.100.6.1~25.100.6.2	-----	2	Proxy DNS
India	128.3.11.1	1	25.101.0.0	255.255.255.128	25.101.0.1~25.101.0.126	20	126	App 5
		2	25.101.1.0	255.255.255.128	25.101.1.1~25.101.0.126	20	126	App 6
		3	25.101.2.0	255.255.255.128	25.101.2.1~25.101.2.126	20	126	App 7
		4	25.101.3.0	255.255.255.0	25.101.3.1~25.101.3.254	40	254	App 8
		5	25.101.4.0	255.255.255.192	25.101.4.1~25.101.4.62	-----	62	IP phone
		6	25.101.5.0	255.255.255.224	25.101.5.1~25.101.5.30	-----	30	Video Conferencee quipment
		7	25.101.6.0	255.255.255.240	25.101.6.1~25.101.6.14	-----	14	Local Data Center
		8	25.101.7.0	255.255.255.252	25.101.6.1~25.101.6.2	-----	2	Proxy DNS
Russia	167.3.12.12	1	23.100.0.0	255.255.255.128	23.100.0.1~23.100.0.126	20	126	App 9
		2	23.100.1.0	255.255.255.128	23.100.1.1~23.100.1.126	20	126	App 10
		3	23.100.2.0	255.255.255.128	23.100.2.1~23.100.2.126	20	126	App 11
		4	23.100.3.0	255.255.255.128	23.100.3.1~23.100.3.126	20	126	App 12
		5	23.100.4.0	255.255.255.128	23.100.4.1~23.100.4.126	20	126	App 13
		6	23.100.5.0	255.255.255.192	23.100.5.1~25.101.5.62	-----	62	IP phone
		7	23.100.6.0	255.255.255.224	23.100.5.1~23.100.5.30	-----	30	Video Conferencee quipment
		8	23.100.7.0	255.255.255.240	23.100.7.1~25.100.7.14	-----	14	Local Data Center
		9	23.100.8.0	255.255.255.252	23.100.8.1~23.100.8.2	-----	2	Proxy DNS

Manufacturing and distribution facilities

location	Public IP address	VLan Number	VLan subnet IP address	Subnet Mask	IP address range	Actuall people	How many devices supported most	Note
China	192.168.1.0	1	25.190.0.0	255.255.255.0	25.190.0.1-25.190.0.254	200	254	App1
		2	25.190.1.0	255.255.255.0	25.190.1.1-25.190.1.254	200	254	App2
		3	25.190.2.0	255.255.255.0	25.190.2.1-25.190.2.254	200	254	App3
		4	25.190.3.0	255.255.255.0	25.190.3.1-25.190.3.254	200	254	App4
		5	25.190.4.0	255.255.255.0	25.190.4.1-25.190.4.254	200	254	App5
		6	25.190.5.0	255.255.255.248	25.190.5.1-25.190.5.6	-----	6	IP phone
		7	25.190.6.0	0	25.190.6.1-25.190.6.6	-----	6	video
Chile	172.3.1.1	1	24.190.0.0.	255.255.255.192	24.190.0.1-24.190.0.62	25	62	App1
		2	24.190.1.0	255.255.255.192	24.190.1.1-24.190.1.62	25	62	App2
		3	24.190.2.0	255.255.255.192	24.190.2.1-24.190.2.62	25	62	App3

		4	24.190.3.0	255.255.255.192	24.190.3.1-24.190.3.62	25	62	App4
		5	24.190.4.0	255.255.255.192	24.190.4.1-24.190.4.62	50	62	App5
		6	24.190.5.0	255.255.255.248	24.190.5.1-24.190.5.62	-----	6	IP phone
		7	24.190.6.0	255.255.255.248	24.190.6.1-24.190.6.62	-----	6	video

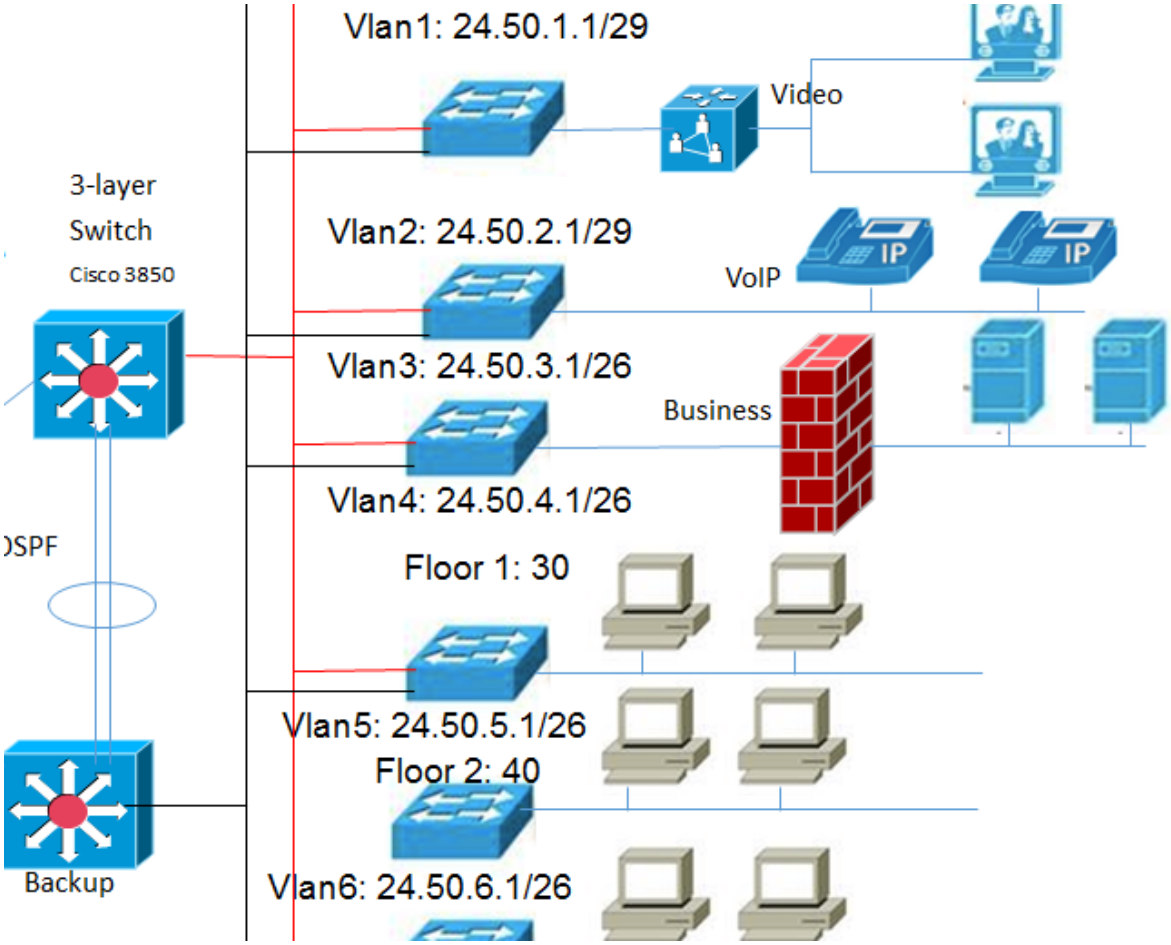
Sale Department

location	Public IP address	VLan Number	VLan subnet IP address	Subnet Mask	IP address range	Actuall people	How many devices supported most	Note
America (medium 100users)	10.6.13.80	1	24.80.0.1	255.255.255.248	24.80.0.1~24.80.0.6	-----	6	Video conference device
		2	24.80.1.1	255.255.255.248	24.80.1.1~24.80.1.6	-----	6	VoIP
		3	24.80.2.1	255.255.255.240	24.80.2.1~24.80.2.14	-----	14	Business local data center
		4	24.80.3.1	255.255.255.192	24.80.3.1~24.80.3.62	30	62	Office User
		5	24.80.4.1	255.255.255.248	24.80.4.1~24.80.4.6	-----	6	Proxy DNS server
		Wlan	24.80.0.0	255.255.0.0	24.80.0.1~24.80.255.254	70	2^16	Mobile User
(small 40users)	128.3.11.1	1	24.90.0.1	255.255.255.252	24.90.0.1~24.90.0.2	-----	2	Video conference device
		2	24.90.1.1	255.255.255.252	24.90.1.1~24.90.0.2	-----	2	VoIP
		3	24.90.2.1	255.255.255.248	24.90.2.1~24.90.2.6	----	6	Business Local data center
		4	24.90.3.1	255.255.255.240	24.90.3.1~24.90.3.14	8	14	Office User
		5	24.90.4.1	255.255.255.252	24.90.4.1~24.90.4.2	-----	2	Proxy DNS server
		Wlan	24.90.0.0	255.255.0.0	24.90.0.1~24.90.255.254	32	2^16	Mobile User

Chapter 4

Voice and network data architecture

For Voice and Data network architecture, here network receives voice and data packets through different VLANs. So, in provided image it is clear that data comes from (VLAN 4, 5 & 6) and voices come from (VLAN 1 & 2).



Chapter 5

Protocol requirement on different layers

Application Layer Protocol:

DHCP: Dynamic Host Configuration Protocol – allocation of host dynamically through wireless access points

DNS: Domain Name Server – It helps to reduce the DNS look up time and help to servers request more quickly

HTTPS: Hyper Text Transfer Protocol with Security protection – for securely web surfing

NTP: Network Time Protocol - It helps to synchronize data centres and maintain integrity

Telnet: For telephony use

SMTP: Simple Mail Transfer Protocol - It required for communication between mail client and mail server

SSL – Secure socket Layer – it requires for Application layer security

H.323 – VoIP protocol – Video and audio conference

Transport Layer Protocol:

UDP – User Datagram Protocol – voice and IP phone data transfer

TCP – Transmission Control protocol – Reliable data transfer

Internet Layer Protocol:

IPv4 – Internet Protocol

ICMP – The Internet Control Message Protocol

ARP – Address Resolution Protocol (Get MAC address from IP address)

OSPF – One IGP to decide the transfer path of one packet.

Link Layer Protocol:

RoCEv2 – RDMA over Converged Ethernet v2 (Routable) – High speed data transfer between two data centres.

PPP – point to point protocol

STP – Prevent broadcast storm occurs at data-link layer.

Heartbeat Protocol – **Heartbeat** is a periodic signal generated by hardware or software to indicate normal operation or to synchronize other parts of a system. Usually a heartbeat is sent between machines at a regular interval on the order of seconds.

Chapter 6

Bandwidth estimation and Calculation

Accounting and Finance – 15 + 15 (All People have computer)
Functions and Job profile:
Generate report, analysed financial data and use financial software to make reports and audits.

Data required: Medium volume of data (Files of 10 to 50 MBs), voice, Emails, Web surf
Protocol at application Layer: HTTPS, H.323, SMTP, Telnet, SSL
Bandwidth Requirement:

Bandwidth calculation: (per month per user)
Web browsing: 120 hrs (1.055 GBs) per Month & Multimedia Web 80 hrs (2.188 GBs)
Video Streaming: 10 hrs (10.7 GBs)
Document Uploads/Downloads (Presentation and Docs): 500 per Month (10 MB each document)(4.89 GBs)
Email with attachment: 200 per month (3 MB attachment – 0.5859 GBs)
Email without attachment: 400 per month (5 Kb each - 0.001 GBs)
Chat: 540 hrs per month (.04 GBs)
Downloads (Upgrade and updates): 10 hrs per month (5 GBs)

Total – 27.803 GB Per Person Per Month

Human Resource – 5 (All People have computer)
Functions and Job profile:
Generate report, schedule interview over skype, Tax information & reports.

Data required: Medium volume of data (Files of 50 to 100 MBs), voice, Emails, Web surf
Protocol at application Layer: HTTPS, H.323, SMTP, Telnet, SSL
Bandwidth Requirement: 3000 E-mails (5kb) = 0.225 GBs, with attachments = 0.300 GBs
Web browsing = 1.565 GBs
Video call (interview using skype) = 64 GBs
Software updates = 2 GBs

Total – 68.09 GB Per Person Per Month

Legal – 15 (All People have computer)
Functions and Job profile:
Analyse files, legal report.

Data required: Medium volume of data (Files of 10 to 500 MBs each file), voice, Emails, Web surf
Protocol at application Layer: HTTPS, H.323, SMTP, Telnet, SSL
Bandwidth Requirement: (per month per user)
Web browsing: 120 hrs (1.055 GBs) per Month & Multimedia Web 80 hrs (2.188 GBs)
Video Streaming: 90 hrs (96.4 GBs)
Email with attachment: 200 per month (20 MB attachment - 3.90 GBs)
Email without attachment: 800 per month (75 Kb each - 0.05 GBs)
Downloads (Upgrade and updates): 10 hrs per month (5 GBs)

Total – 108.593 GB Per Person Per Month

Corporate IT – 33 (All People have computer)
Functions and Job profile:
Software Trouble shoots and updates, generate accounts for newly hired employees.

Data required: Medium volume of data (Files of 10 to 500 MBs), voice, Emails, Web surf
Protocol at application Layer: HTTPS, H.323, SMTP, Telnet, SSL
Bandwidth Requirement: 100 emails = 0.075 GBs,
With attachment = 0.090 GBs
Updates and backup: 1 TBs, web browsing: 10 Gbs

Total – 1.01 TB

Facilities Management -25 (10 People have computer)
Functions and Job profile:
Scanning, copy, help desk

Data required: Emails, Web surf
Protocol at application Layer: HTTPS, SMTP, Telnet, SSL,H.323
Bandwidth Requirement: (per month per user)

Web browsing: 160 hrs (1.407 GBs) per Month & Multimedia Web 80 hrs (2.188 GBs)
Email with attachment: 50 per month (20 MB attachment – 0.98 GBs)
Email without attachment: 700 per month (75 Kb each - 0.0500 GBs)
Downloads (Upgrade and updates): 5 hrs per month (2.5 GBs)

Total – 7.125 GB Per Person Per Month

Executive Management – 15 (15 People have computer)
Functions and Job profile:
Manage the business and communication with higher authority people like CEO and CFO, assuring budgets and business decision.

Data required: voice, Emails, Web surf
Protocol at application Layer: HTTPS, H.323, SMTP, Telnet, SSL
Bandwidth Requirement:
Voice: 10 GBs,
Email = 1200 mails per month 0.9 GBs,
Web surf = 1.2 GBs,
Software update: 5 GBs

Total – 17.125 GB Per Person Per Month

Strategy groups – 60 (60 People have computer)
Functions and Job profile:
Analysing the data, OLAP activities, Prepare decks and documents.

Data required: high volume of data (Files of 50 MBs to 2 GBs), voice, Emails, Web surf
Protocol at application Layer: HTTPS, SMTP, Telnet, SSL
Bandwidth Requirement: (per month per user)
Web browsing: 30 hrs (0.26 GBs) per Month & Multimedia Web 80 hrs (0.821 GBs)
Video Streaming: 60 hrs (64.2 GBs)
Document Uploads/Download (Presentation and Docs): 100 per Month (750 MB each document)(73.24 GBs)
Email with attachment: 200 per month (20 MB attachment - 3.90 GBs)
Email without attachment: 800 per month (75 Kb each - 0.05 GBs)
Chat: 540 hrs per month (.04 GBs)
Downloads (Upgrade and updates): 10 hrs per month (15 GBs)

Total: 157.511 GB per person per Month

Sale Department

Functions and Job profile:
Generate report, analyze marketing data and use software to make reports and audits, collect information, communicate with local facility and distribution center or HQ, customer service.

Data required: Medium volume of data (Files of 10 to 50 MBs), voice, Emails, Web surf
Protocol at application Layer: HTTPS, H.323, SMTP, Telnet, SSL
Employees: total 1000
300 in America (100*1 medium size company,40*5 small size company)
200 in Europe(80*1 medium size company,40*3 small size company)
100 in Middle East(60*1 medium size company,40*1 small size company)
400 in Asia Pacific(60*1 medium size company,40*3 small size company)

Bandwidth Requirement:

Bandwidth calculation: (per month per user)
Web browsing: 120 hrs (1.055 GBs) per Month & Multimedia Web 80 hrs (2.188 GBs)
Video Streaming: 15 hrs (3.15 GBs) in SD
Document Uploads/Downloads (Presentation and Docs): 500 per Month (1 MB each document)(0.489 GBs)
Email with attachment: 200 per month (3 MB attachment – 0.6 GBs)
Email without attachment: 600 per month (15 Kb each - 0.009 GBs)
Chat: 100 hrs per month (0.059 GBs)
Downloads (Upgrade and updates): 10 hrs per month (5 GBs)
Total – 12.146 GB Per Person Per Month
Medium company (100 employees)
12.146GB*100employees/(25days*8hours*3600seconds)= 0.0016869444GB/s
Estimate Bandwidth: 50Mbps price: $70/month
Small company (40 employees)
12.146GB*40employees/(25days*8hours*3600seconds)= 0.00067477776GB/s
Estimate Bandwidth: 25Mbps price: $60/month

Research centre

Function and job:
1 Doing research on the medicine including the composition of medicine, the molecule form.
2 Making experiment to analysis and writing report about the experiment result.
3 Demonstrating the feasibility of one medicine.
4 discussing with other researchers

Data required: high volume of data (Files of 50 MBs to 2 GBs), Emails, Web surf
Protocol at application Layer: HTTPS, SMTP, Telnet, SSL
Bandwidth Requirement: (per month per user)
Web browsing: 60 hrs (0.528 GBs) per Month & Multimedia Web 15 hrs (0.411 GBs)
Document Uploads/Download (Presentation and Docs): 300 per Month (60 MB each document)(17.579 GBs)
Email with attachment: 400 per month (3 MB attachment - 1.172 GBs)
Email without attachment: 800 per month (15 Kb each - 0.012 GBs)
Chat: 150 hrs per month (0.088 GBs)
Downloads (Upgrade and updates): 10 hrs per month (5.469 GBs)

Total –25.259 GB Per Person Per Month
25.259 * 100 / 25 / 8/3600 = 0.0035GBs (per user per second)
Bandwidth estimated: 75Mbps $80 per month

Manufacturing and Distribution Facilities

Manufacturing and distribution facilities: 1. Manufacture Medicine 2. Transport Medicine to other countries.
China (distribution employee : 200, manufacture employee:800)
Canada (distribution:100)
Chile (distribution:25; manufacture:125)
UAE (distribution:100)
Israel(distribution:100, manufacture:300)
Malaysia(distribution:75,manufacture:175)

Taking China for example:

Distribution department:200 (all people have computers)
Web browsing : 140 hours 1.23GB/month

Email: Email with attachment: 200 per month (3 MB attachment – 0.5859 GBs)
Email without attachment: 400 per month (5 Kb each - 0.001 GBs)
Chat: 80 hours 0.047GB/month
Downloads (Upgrade and updates): 10 hours per month (5 GBs)

Total : 7GB per month per people

Manufacturing department: 50(not every people have computers)
Download(Updates new design schema): 5 hours per month(3GBs)
Web browsing: 70 hours 0.6GB/month
Chat: 10 hours 0.006GB/month

Total: 3.6GB per month per people
Bandwidth Calculation:(7*200+3.6*50)/25*8*3600 = 22Mbps
So our bandwidth is better to be 50 Mbps

Latency statistics country specific by Verizon (MS)

	Nov 2014											Dec 2013
Sydney to Tokyo (150.000)	116.769	114.118	115.390	114.075	114.061	114.055	114.078	117.070	121.723	136.279	117.038	117.54
Sydney to Melborne (40.000)	12.341	12.356	12.350	12.352	12.355	12.339	12.351	12.359	12.343	12.354	12.353	12.530
Australia to UK (405.000)	290.225	286.131	305.874	301.016	294.003	310.907	305.024	304.124	298.419	293.924	292.594	288.889
Australia to US (210.000)	154.575	154.799	154.332	153.758	153.779	153.759	153.774	153.805	153.731	153.921	153.690	154.116
Chile to US (150.000)	99.078	97.730	98.636	98.627	98.768	98.834	98.631	98.856	122.395	110.596	110.097	110.209
Singapore to Sydney (150.000)	103.403	101.069	100.545	99.262	100.818	100.453	100.868	99.259	100.405	100.578	101.476	100.459
NA to Intra EMEA	88.067	88.046	88.827	88.836	88.464	88.789	88.385	88.731	89.079	88.419	89.496	90.036

(110.000)												
NA to India (380.000)	293.393	285.620	253.937	279.740	289.906	273.684	276.699	288.691	285.906	265.110	269.594	274.103
Hong Kong to US (230.000)	152.100	152.194	155.080	168.440	167.816	168.204	167.334	168.110	166.528	168.251	159.646	156.873

Latency Statistics between continents (MS)

	Nov - 2014											**Dec - 2013**
Trans Atlantic (90.000)	72.486	75.019	72.845	78.914	78.246	78.663	74.045	72.275	76.771	79.019	78.642	75.181
Europe (30.000)	11.740	11.849	11.677	11.627	11.702	11.647	11.696	11.766	13.602	13.911	13.870	13.911
North America (45.000)	35.834	35.388	35.741	35.665	35.924	35.972	35.859	36.920	37.131	38.264	38.140	39.084
Intra-Japan (30.000)	8.629	8.388	8.818	8.338	8.689	8.289	8.298	8.182	8.385	9.820	10.805	10.475
Trans Pacific (160.000)	109.797	109.762	109.700	109.784	109.654	109.665	109.671	109.669	109.665	110.973	111.757	111.327
Asia Pacific (125.000)	96.065	95.538	97.376	95.899	95.669	95.116	97.160	95.312	96.641	97.384	95.940	99.837
Latin America (140.000)	137.234	142.068	144.063	147.838	150.417	146.642	140.536	140.690	143.051	137.299	137.644	137.079
EMEA to Asia Pacific (250.000)	161.106	142.132	123.219	146.992	158.393	139.635	136.264	161.888	158.436	143.249	142.032	143.244

Kind of Data	Bandwidth needed	Department	Bandwidth allocated/person(Mbps)	Maximun Distance(km)	Minimum Distance(km)	Delay(ms)
Voice	11.2Kbps	Reaserch Center	30	12934	200	11 --- 53
		Sales	2			16.2 --- 58.7
		Software Development	10			12.12 --- 54.2
		Head Quarters	10			12.12 --- 54.2
		Factory	2			16.2 --- 58.7
File Transfer	64Mbps(8MB per second)	Reaserch Center	30			2187.2 --- 2186.4
		Sales	2			32011 --- 32053
		Software Development	10			6411 --- 6453
		Head Quarters	10			6411 --- 6453
		Factory	2			32011 --- 32053
Video	512kbps	Reaserch Center	30			28 --- 70.7
		Sales	2			267 --- 300.5
		Software Development	10			62 --- 104.7
		Head Quarters	10			62 --- 104.7
		Factory	2			267 --- 300.5

Delay = transmission time + propagation delay + processing delay + queueing delay

According to some paper studying processing delay and queueing delay, the sum of processing delay and queueing delay for 10000 UDP samples of sizes between 32 and 1450 bytes on one route is about 0.2ms. We assume that we need 50 routers to transfer our data to the destination in average case(actually that is a large number). So we take the sum of processing delay and queueing delay as a constant value 10ms.

Queue delay and processing delay is usually negligible compared to other two kinds of delays , so in our calculation they are ignored.

Take some countries for example:

American to China:

Propagation delay = D/s = 7223*1.6*10^3m/3*10^8m/s = 38ms

Transmission delay = L/R = 1GB*8/80Gbit/s = 100ms

Total delay = 138ms

American to France:

Propagation delay = D/s = 4760*1.6*10^3/3*10^8 = 25ms

Transmission delay = L/R = 700MB*8/100Gbit/s = 56ms

Total delay = 91ms

American to Melbourne:

Propagation delay = D/s = 9164*1.6*10^3m/3*10^8m/s=49ms

Transmission delay = L/R=1GB*8/80Gbit/s=100ms

Total delay = 149ms

China to Japan:

Propagation delay = D/s = 3045*10^3/3*10^8m/s = 10ms

Transmission delay = L/R = 1GB*8/100Gbit/s = 80ms

Total delay = 90ms

Japan to Melbourne:

Propagation delay = D/s = 8254*10^3/3*10^8 = 28ms

Transmission delay = L/R = 1GB*8/80Gbit/s = 100ms

Total delay = 128ms

Chapter 7

All Technologies and Service Provider

Best ISP Providers for different countries according to reports:

- France: Orange and Vodafone
- USA: Verizon and AT&T
- Australia: Telstra and Optus
- Japan : NTT and Softbank

3-layer-switch: Cisco 3850

2-layer-switch: Cisco 2960

Router: Cisco 2514

Wireless AP: 1142

Chapter 8

Reference & Web Links

Following are the web links for references:

http://www.ntt.net/english/service/sla_ts.html
Above link includes network availability, jitter and avg. packet loss throughout the world.

http://www.netindex.com/download/allcountries/
Bandwidth and Download speed by continent and country

http://www.ciscopress.com/articles/article.asp?p=1745631&seqNum=3
MPLS Understanding and research

http://www.firewall.cx/cisco-technical-knowledgebase/cisco-routers/336-cisco-router-8021q-router-stick.html
Cisco Guide VLAN and router Stick

http://www.submarinecablemap.com/#/
To identify Strong connectivity between locations

https://gigaom.com/2011/12/10/latimer-where-to-build-data-center/
http://www.datacentermap.com/
Data centre location and important things about data centre

http://www.cisco.com/c/en/us/products/collateral/data-center-virtualization/data-center-interconnect/white_paper_c11_493718.html
Data centre architecture and Design