Computer Networking Project

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Abstract

This report is about a company named Global Tech, the issues faced by the company and solutions to overcome those networking issues. This company has signed a contract with Global Design Alternatives (GDA), headquartered in France, Argentina and Australia. The ongoing complaints are about slow access to files, email delivery, poor voice quality and various applications crashing due to poorly designed network. To solve these issues the company has planned to decrease time-to-market for their core set of products and increasing the global workforce hiring. The solutions are planned as follows : We have planned to redesign the global network architecture, new IP addressing schema for every office and location, Redesign all local lans etc.

Motivation

To solve the issues for ongoing complaints about slow access to files, email delivery, poor voice quality and various applications crashing due to poorly designed network we have come up with some solutions as follows:
- Redesign the Global Network architecture.
- Develop new IP addressing schema.
- Work on the data centers location.
- Redesign Local LAN's
- Developing protocols, take care of security issues and throughput.
- Manage servers and allocate bandwidth as required.

Introduction

In today's world of Technology and competitiveness where internet is growing with such a fast pace, the companies are growing too to manage the ongoing growth and be in sync with the current technologies. With this comes the issues of network architecture, security, bandwidth management, resource management, IP addressing schema, managing the data centers and servers.

GDA being a global company faces the same issues and we are responsible to tackle these by developing a blueprint of Network Architecture Diagram which will then be implemented to overcome the said problems and work towards the growth of company.

HeadQuarters of GDA:
- Global Design Alternatives is a global company which is headquartered in Paris, France, Buenos Aires, Argentina, and Sydney, Australia.
- These headquarters consist of following departments - Accounting/Finance, Human Resources, Legal, Corporate IT, Facilities Management and strategy groups.
- The total number of employees across these locations are 600.

The HR department is responsible to manage resources, which contains the personally identifiable information such as social security numbers, names and addresses of employees. The financial department contains the critical financial data for the entire organization. The treasury department is also a part of the finance department which has access to trading markets of the

company. The legal department checks the legality of all the contracts the company signs. Corporate IT department works with technical projects the company is undertaking.

Global Client Centers:
- The global client centers of GDA are located in Berlin, Atlanta and Tokyo.
- Consist of total 500 employees across the locations.

Lower-level support departments:
- Located in China, Canada, United Arab Emirates.
- Total number of employees 3000 people.

Sales organization :
- 30 small and medium size offices in each of the major geographical areas.
- Americas, Europe/Middle East and Asia Pacific
- Total number of employees 1000.
- Sales employees are Mobile

Software development centers:
- Located in Israel, India and Ukraine.
- Total number of employees 300.
- multiple client-server and web-based software projects to support global operations, AutoCAD and other drawing packages, document management systems and many others.

Call center:
- Located in Puerto Rico.
- Supports customer inquiries and complaints.

At GDA, All apps are developed using Microsoft ASP.NET technology. Citrix/VDI is used to access files and folders on the network.

For a company, its headquarters data centers are the most important ones as all the traffic flows through one of these. Hence, we cannot afford data centers servers to fail. At any given time, at least one will definitely face some problem and fail. The traffic flowing through this should be at least redirected to some other server or the servers should be reliable enough. We need the network where the data is transferred to and fro at an average speed so that the there are no delays in data transfer.

As this is a global firm, highly sensitive data will be passing through the network, hence we need protocols which are highly secured.
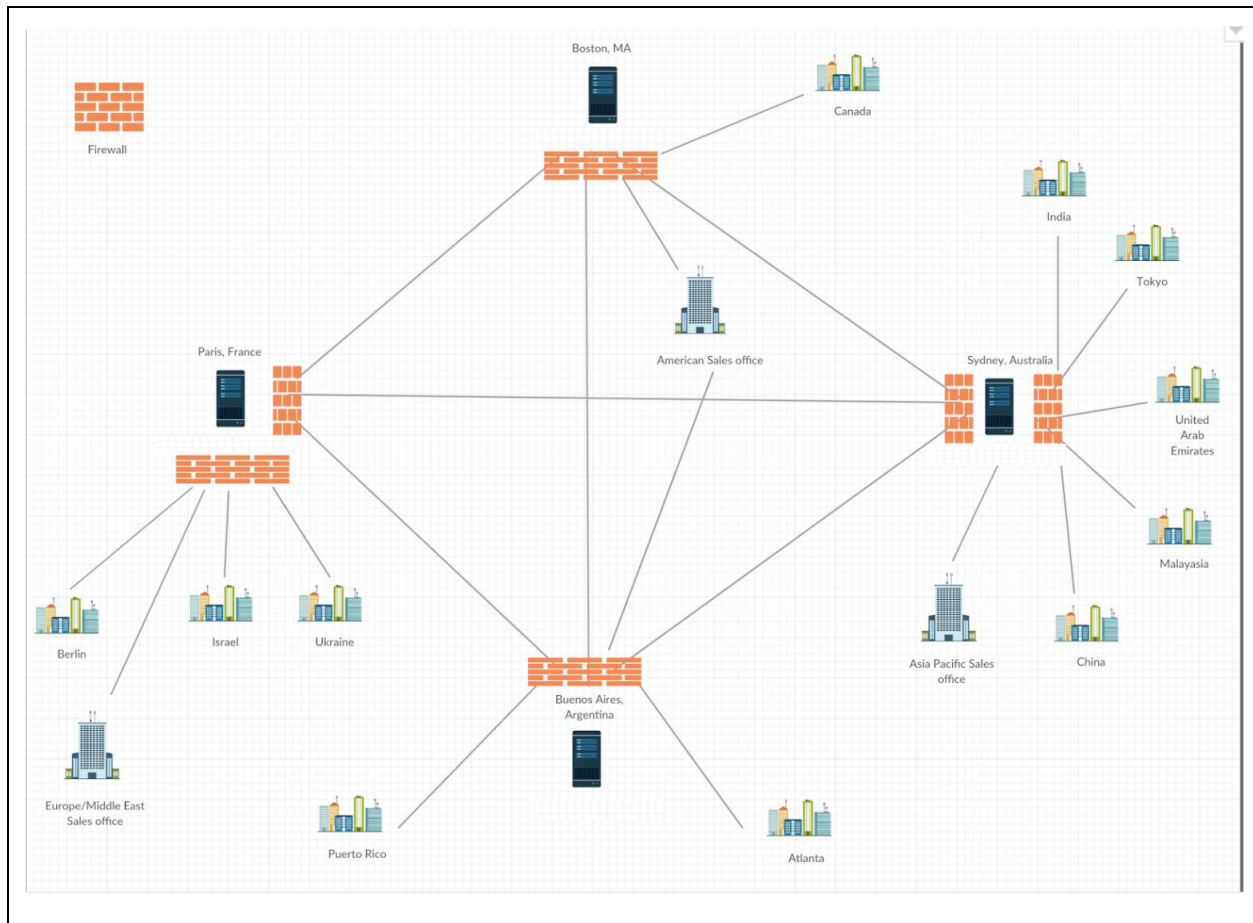
# General Locations of Offices of GDA

Block Diagram for Communication
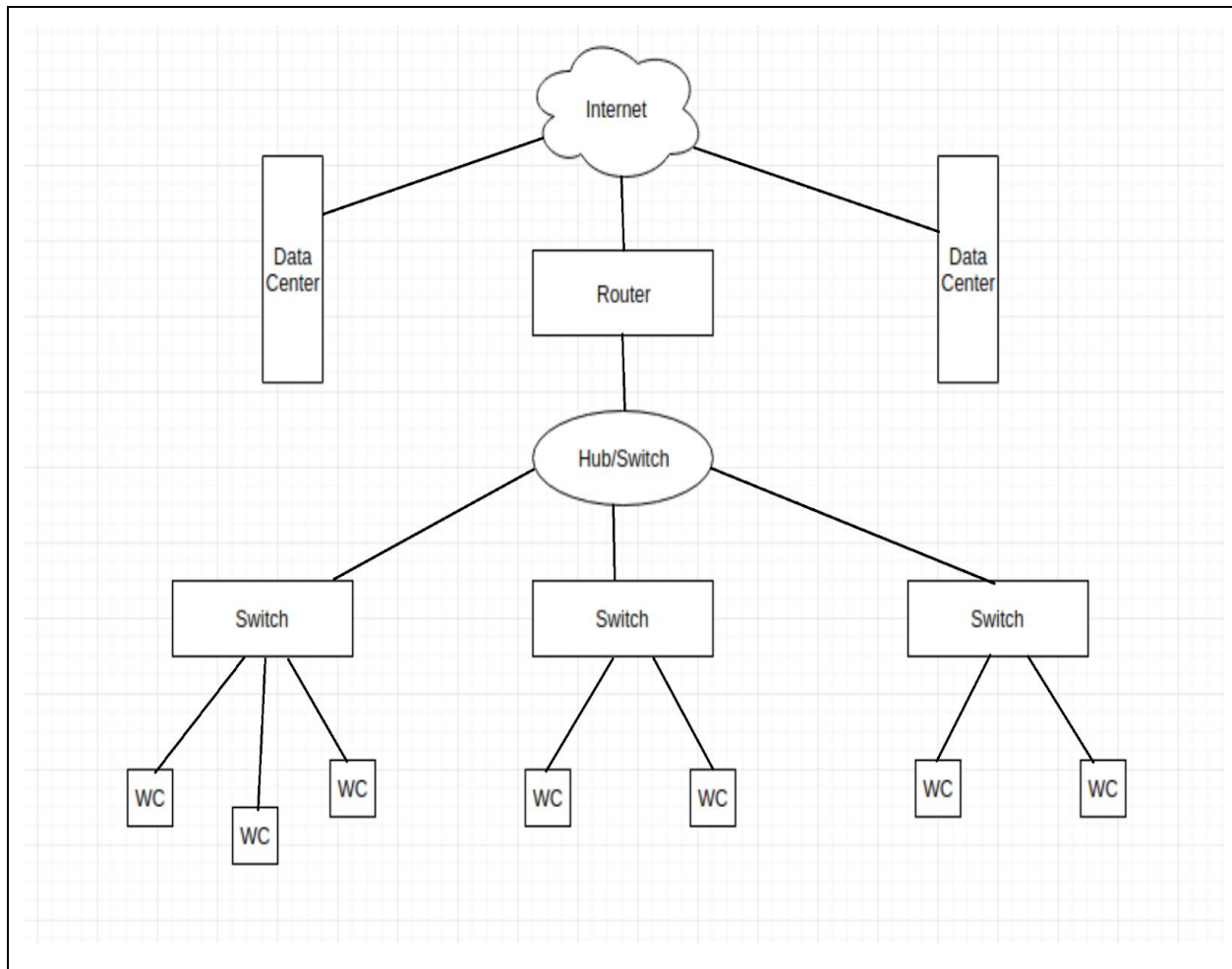
Network Design for GDA:

Data Centers

Data Center is the brain of a company which provides facilities that help in the centralising the IT operations of a company. It is the place where data is managed and stored and it requires sturdy and stable infrastructure. The data center locations play an important role in the system because of the factors like data speed and latency. There is need for data centers in the major geographical areas which include America, Europe and Middle East and Asia Pacific.
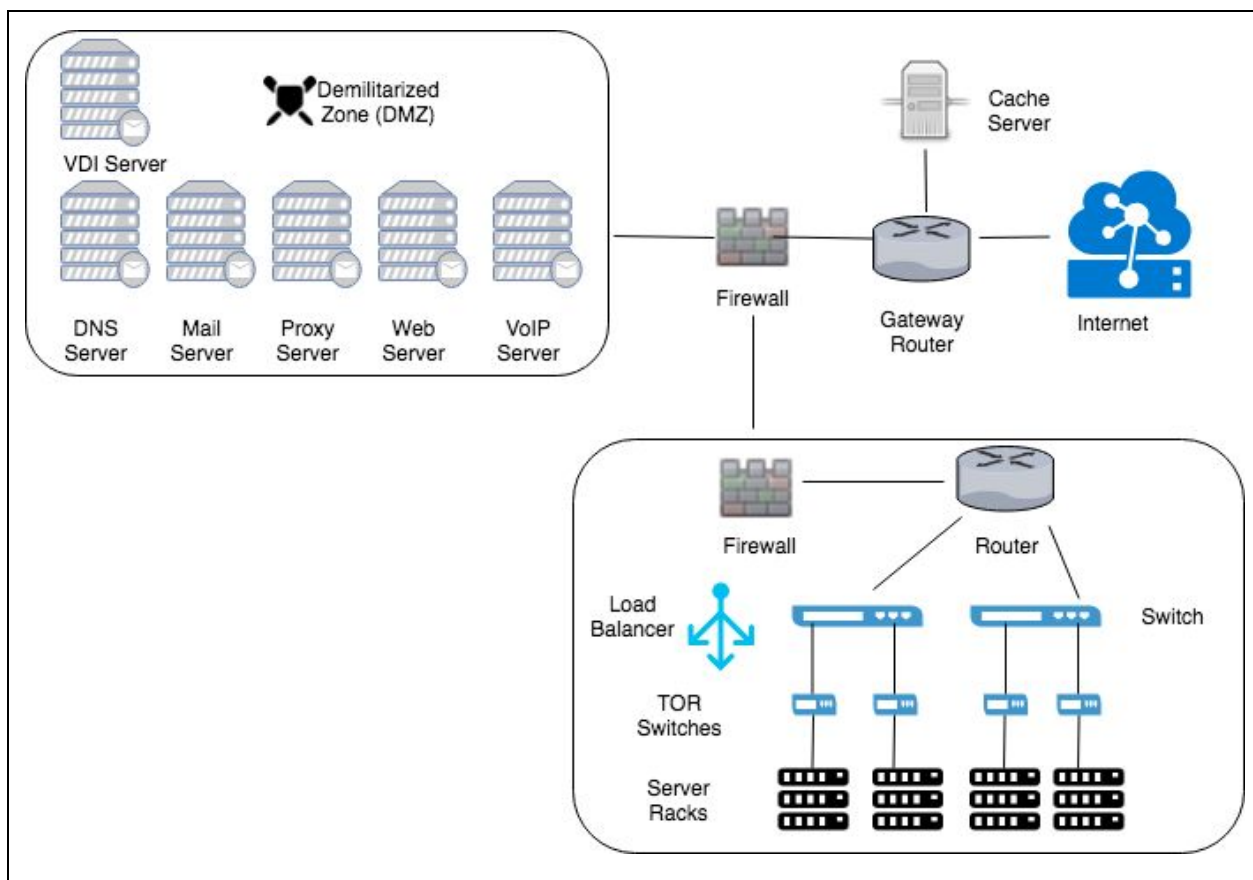

There are various critical factors which are considered while making a location decision. The following factors which play a key role include :
1. Servers
2. Power distribution and cooling
3. Networking equipment
4. Proximity to customers and skilled workforce

5. Geographical factors for expansion

Location where data centers can be opened are :
1. Dallas and Houston for the America region because of the fact that it is closer to Mexico and Central America. Also there is a tax concession which is an advantage allowed by the government. Other places like New York and Seattle are Technology hubs but establishment of the data centres in these location is very expensive considering all the above mentioned factors.
2. Portugal for the European and Middle Eastern region because of its strategic location and eco friendly environment because of its photovoltaic solar power generation system. Since, this is a cold place, so there is a greater chance of expansion because of cold weather.
3. Singapore for the Asia Pacific region because of the world class environment funded infrastructure it has. It is also considered as the multinational headquarters for Asia Pacific region of many multinational companies.
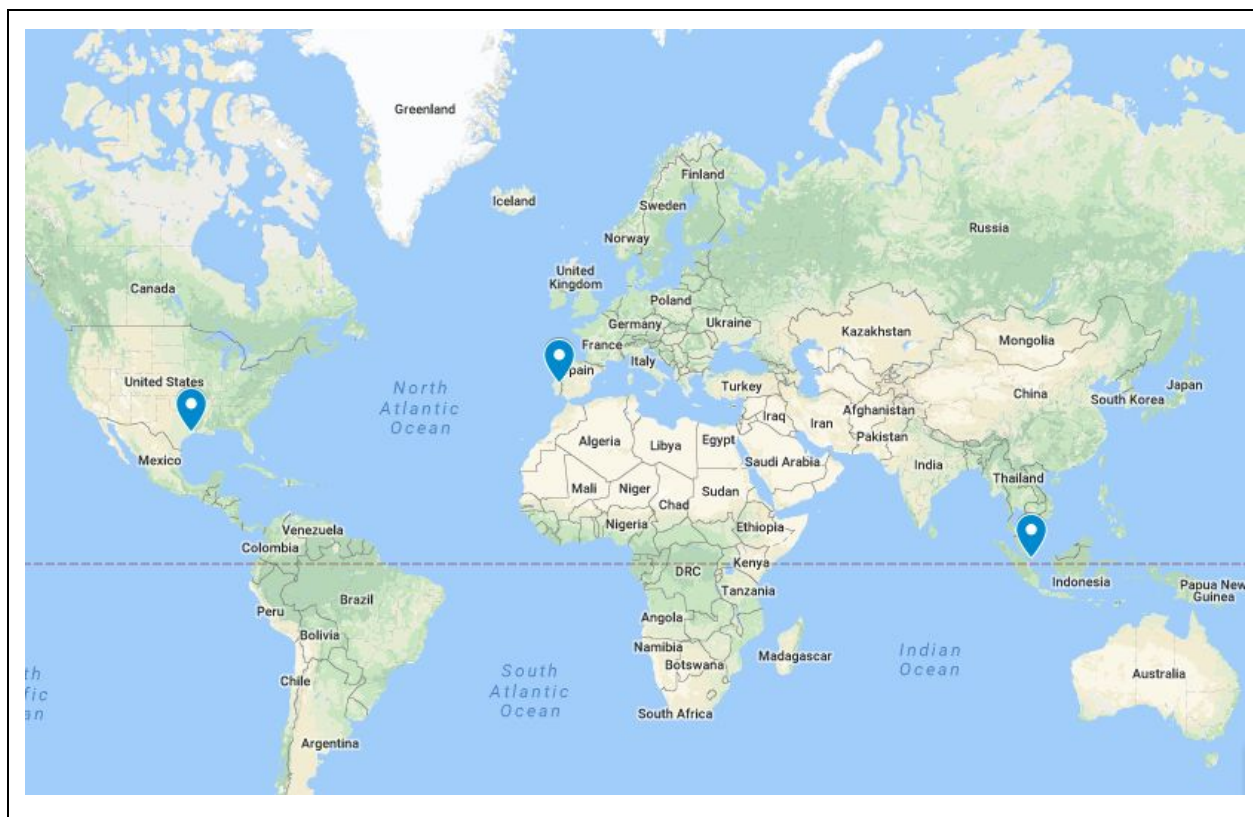
There is a need to have data center backup where the backing up and archiving of the data, application is done. Also, in case of some issue with the data center, the infrastructure of the backup system is used. It is needed to be assured that the backup data center is able to properly

support the data management and its processing. This can be achieved by using GridGain in-memory database system which can help in providing a solution for the highly available and high performance applications. Backup of data is taken periodically in case of any issues.

IP Addressing Schema

There is a need to have an IP addressing schema for the company which will play a key role in the system because of a need for quite a good number of standalone machines which may be located on the same floor of a building. Also, there may be a need to setup a network with approximate number of hosts as thousand in several building across different geographical locations.Therefore, there is a need for subnetting which is dividing the network into subnets for a stable and secure network architecture.

Few factors which will be affected by the prospective network size are
1. Class of network which is applied for
2. Network number received
3. Scheme of IP address which is used for the network

Design process of the IP addressing schema includes choosing the class, considering the scope of growth for the company and subnetting process.

We evaluated the Classes A, B,C for the addressing schema and realised that Class A is most suitable one. In class A, the network number uses the first eight bits of the IP address as network part and remaining 24 bits as the host part of the IP address. The addressing helps in identifying the country, city, office building and subnet in the office which is VLAN.

Few assumptions and restrictions are made so that we do not break any case and can have a stable subnetting schema. They are as follows:

- Class A of addressing schema is used 10.0.0.0/8.
- Maximum number of hosts in a VLAN is 254.
- Total number of countries where the offices exist is between 15 and 128
- Total number of cities in a country is less than or equal to 7.
- Each city will have a maximum of 4 office buildings.
- Total number of VLANs in a building is less than equal to 16.

IP Address	Country Name
10.0.0.0/15	United States of America
10.2.0.0/15	Japan
10.4.0.0/15	Poland
10.6.0.0/15	Argentina
10.8.0.0/15	India
10.10.0.0/15	Ukraine
10.12.0.0/15	Australia
10.14.0.0/15	China
10.16.0.0/15	France
10.18.0.0/15	Germany
10.20.0.0/15	Canada
10.22.0.0/15	UAE
10.24.0.0/15	Malaysia
10.26.0.0/15	Puerto Rico

Now, according to the problem statement we have different parts of the organisations across the geographical locations which include main head office, regional headquarters, global client centers, sales organisations office, low level support staff offices, Software development centers and active call centers.

Head Office and Headquarters in regions which include France, Argentina, and Australia :

- Total number of employees : 600
- Average number of employees in one office : 150 (600/4)
- Average growth rate of company expected : 30% per year
- Average growth rate of employees expected in 4 years : 10% per year
- Expected number of employees after 4 years : 878
- Subnet for IP address in each office is : /22 which gives us 1024 IP address

- Average number of resources required : 200

Headquarter Location	Range of IP address
Boston	10.0.0.1 - 10.0.1.254
Buenos Aires	10.6.0.1 - 10.6.1.254
Sydney	10.12.0.1 - 10.12.1.254
Paris	10.16.0.1 - 10.16.1.254

Global Client Centers which include Berlin, Atlanta and Tokyo :

- Total number of employees : 500
- Average number of employees in one office : 167 (500/3)
- Average growth rate of company expected : 30% per year
- Average growth rate of employees expected in 4 years : 10% per year
- Expected number of employees after 4 years : 732
- Subnet for IP address in each office is : /22 which gives us 1024 IP address
- Average number of resources required : 150

Global Client Center Location	Range of IP Address
Berlin	10.18.0.1 - 10.18.1.254
Atlanta	10.0.64.1 - 10.0.65.254
Tokyo	10.2.0.1 - 10.0.1.254

Support Staff Office (Low-level) in China, Canada, United Arab Emirates and Malaysia :

- Total number of employees : 3000
- Average number of employees in one office : 750 (3000/4)
- Average growth rate of company expected : 30% per year
- Average growth rate of employees expected in 4 years : 10% per year
- Expected number of employees after 4 years : 4392
- Subnet for IP address in each office is : /20 which gives us 4096 IP address

- Average number of resources required : 500

Support Staff Office Location	Range of IP address
China	10.14.0.1 - 10.14.11.254
Canada	10.20.0.1 - 10.20.11.254
United Arab Emirates	10.22.0.1 - 10.22.11.254
Malaysia	10.24.0.1 - 10.24.11.254

Software Development Centers in India, Israel and Ukraine :

- Total number of employees : 300
- Average number of employees in one office : 100 (300/3)
- Average growth rate of company expected : 30% per year
- Average growth rate of employees expected in 4 years : 10% per year
- Expected number of employees after 4 years : 439
- Subnet for IP address in each office is : /23 which gives us 512 IP address
- Average number of resources required : 150

Development Center Location	Range for IP address
India	10.8.0.1 - 10.8.1.254
Poland	10.4.0.1 - 10.4.1.254
Ukraine	10.10.0.1 - 10.10.1.254

Call Center in Puerto Rico :

- Total number of employees : 100
- Average number of employees in one office : 100
- Average growth rate of company expected : 30% per year
- Average growth rate of employees expected in 4 years : 10% per year
- Expected number of employees after 4 years : 146

- Subnet for IP address in each office is : /24 which gives us 256 IP address
- Average number of resources required : 50

Call Center Location	Range of IP address
Puerto Rico	10.26.0.1 - 10.26.1.254

Sales Organisations Office which is highly distributed in the regions of America, Europe/Middle East and Asia Pacific :

- Total number of employees : 1000
- Average number of employees in one office : 333(1000/3)
- Average growth rate of company expected : 30% per year
- Average growth rate of employees expected in 4 years : 10% per year
- Expected number of employees after 4 years : 1464
- Subnet for IP address in each office is : /21 which gives us 2048 IP address
- Average number of resources required : 200

Bandwidth Allocation

Layer Wise Protocols:

Application Layer	Application Layer Protocol	Transport Layer Protocol
Email	SMTP, IMAP, POP3	TCP
VoIP	Skype proprietary	TCP or UDP
Shared File Services	Citrix VDI	TCP
Video Conferencing	Audio/Video Codecs, RTP	UDP
Web	HTTPS	TCP

Policy based network management, bandwidth reservation, Type of Service, Class of Service, and Multi-Protocol Label Switching (MPLS)

Headquarters
Total Number of Employees at each office: 150

1. Email :
Assumption:
   ● Emails per day - 50   (during office hours)
   ● Average Email size - 250 Kb
   ● Working hours per day - 8 hrs
Total MB Usage per user: 50 * 250 kb = 12.5 MB
Total MB Usage Overall: 12.5 MB * 150 = 1875 MB
Required Bandwidth: 1875 MB / (8 * 60 * 60 sec) = 0.0819 Mbps

2. VoIP :
Assumption:
   ● Employee using this service at a time - 50
Technology - G.728
Bandwidth - 32 Kbps
Total MB Usage per sec = 50 * 32 kbps = 1500 kbps
Required Bandwidth: 1.5 Mbps

3. Internet Usage :
Since all applications are web-based hence high internet speed is must for all the employees.
Assumption:
   ● Average web-page size - 5MB

- Simultaneous loading of website by 50 employees

Required bandwidth: 5 MB * 50 = 250 Mbps

4. Video Conferencing :
Assumption:
- HD video call takes - 3+3 Mbps speed (uploading and downloading stream)
- Simultaneous users – 20

Bandwidth Required: 6 MB * 20 = 120 Mbps

5. Shared File Services – Citrix VDI :
Assumption:
- Employees simultaneously downloading/uploading data - 50
- Required speed by per employee - 5 Mbps

Required Bandwidth: 5 Mb * 50 = 250 Mbps

Total Bandwidth Required: 0.08 + 3.2 + 250 + 120 + 250 = 623.28 Mbps
Bandwidth Delay: 1.6 ms
Since the organization is growing we can expect 10% increase in the data transfer year on year for next 5 years. For stable network considering 10% increase, optimum bandwidth speed should be 1.0 Gbps.

Sales (Small Offices)

Assuming there are total 20 offices with 20 employee each.
Email:
Assumption:
- Emails per day - 200   (during office hours)
- Average Email size - 300 Kb

Total MB Usage per day: 200 * 300 kb * 20 = 1200 MB
Required Bandwidth: 1200 MB / (8 * 60 * 60 sec) = 40 kbps = 0.040 Mbps

VoIP :
Technology - G.728
Bandwidth - 32 Kbps
Required Bandwidth = 20 * 32 kbps = 640 kbps = 0.640 Mbps

Internet Usage :
Since all applications are web-based hence high internet speed is must for all the employees.
Assumption:
- Average web-page size - 5MB
- Simultaneous loading of website by 5 employees

Required bandwidth: 5 MB * 5 = 25 Mbps

4. Video Conferencing :
Assumption:
- HD video call takes - 3+3 Mbps speed (uploading and downloading stream)

- Simultaneous users – 5

Required Bandwidth: 6 MB * 5 = 30 Mbps

5. Shared File Services – Citrix VDI :

Since the customer data is stored which is frequently required by the sales department hence high speed is required.

Assumption:
- Employees simultaneously downloading/uploading data - 20
- Required speed by one employee - 10 Mbps

Required Bandwidth: 10 Mb * 20 = 200 Mbps

Bandwidth Delay: 5 ms

Total Bandwidth required: 0.040 + 0.640 + 25 + 30 + 200 = 255.644 Mbps

Since the organization is growing we can expect 10% increase in the data transfer year on year for next 5 years. For stable network considering 10% increase, optimum bandwidth speed should be 500 Mbps.

Sales (Medium Offices)

Assuming there are total 10 offices with 60 employee each.

1. Email:

Assumption:
- Emails per day - 300   (during office hours)
- Average Email size - 300 Kb

Total MB Usage per day: 300 * 300 kb * 60 = 5400 MB

Required Bandwidth: 5400 MB / (8 * 60 * 60 sec) = 187 kbps = 0.18 Mbps

2. VoIP :

Technology - G.728

Bandwidth - 32 Kbps

Required Bandwidth = 60 * 32 kbps = 1920 kbps = 1.9 Mbps

3. Internet Usage :

Since all applications are web-based hence high internet speed is must for all the employees.

Assumption:
- Average web-page size - 5MB
- Simultaneous loading of website by 40 employees

Required bandwidth: 5 MB * 40 = 200 Mbps

4. Video Conferencing :

Assumption:
- HD video call takes - 3+3 Mbps speed (uploading and downloading stream)
- Simultaneous users – 15

Required Bandwidth: 6 * 15 = 90 Mbps

5. Shared File Services – Citrix VDI :

Since the customer data is stored which is frequently required by the sales department hence high speed is required.

Assumption:
1. Employees simultaneously downloading/uploading data - 50
2. Required speed by one employee - 10 Mbps

Required Bandwidth: 10 Mb * 50 = 500 Mbps
Total Bandwidth required: 0.18 + 1.9 + 200 + 90 + 500 = 792.08 Mbps
Bandwidth Delay: 1.2 ms
Since the organization is growing we can expect 10% increase in the data transfer year on year for next 5 years. For stable network considering 10% increase, optimum bandwidth speed should be 1.5 Mbps.

Software Development Centers

Assuming there are 100 employee in each of the 3 offices.
1. Email:
Assumption:
- Emails per day - 30   (during office hours)
- Average Email size - 200 Kb

Total MB Usage per day: 30 * 200 kb * 100 = 600 MB
Required Bandwidth: 600 MB / (8 * 60 * 60 sec) = 20 Mbps

2. VoIP :
Technology - G.728
Active users - 20
Bandwidth - 32 Kbps
Required Bandwidth = 20 * 32 kbps = 64 kbps = 0.064 Mbps

3. Internet Usage :
Since web applications are used to support global operations hence high internet speed is must for all the employees.
Assumption:
- Average web-page size - 5MB
- Simultaneous loading of website by 70 employees

Required bandwidth: 5 MB * 70 = 350 Mbps

4. Video Conferencing :
Assumption:
- HD video call takes - 3+3 Mbps speed (uploading and downloading stream)
- Simultaneous users – 5

Required Bandwidth: 6 MB * 5 = 30 Mbps

5. Shared File Services – Citrix VDI
Backups of the data will be stored in the Citrix VDI
Assumption:

New York University

- Employees simultaneously downloading/uploading data - 50
- Required speed by one employee - 10 Mbps

Required Bandwidth: 10 Mb * 50 = 500 Mbps

Total Bandwidth required: 20 + 0.064 + 350 + 30 + 500 = 900.064 Mbps
Bandwidth Delay: 1.1 ms
Since the organization is growing we can expect 10% increase in the data transfer year on year for next 5 years. For stable network considering 10% increase, optimum bandwidth speed should be 1.5 Gbps.

Global Client Center

Assuming there are 167 employee in each of the 3 offices.
1. Email:
Assumption:
- Emails per day - 70   (during office hours)
- Average Email size - 500 Kb

Total MB Usage per day: 70 * 500 kb * 167 = 5845 MB
Required Bandwidth: 5845 MB / (8 * 60 * 60 sec) = 0.255 Mbps

2. VoIP :
Technology - G.728
Active users - 50
Bandwidth - 32 Kbps
Required Bandwidth = 20 * 32 kbps = 1600 kbps = 1.6 Mbps

3. Internet Usage :
Since web applications are used to support global operations hence high internet speed is must for all the employees.
Assumption:
- Average web-page size - 10MB
- Simultaneous loading of website by 100 employees

Required bandwidth: 10 MB * 100 = 1000 Mbps

4. Video Conferencing :
Assumption:
- HD video call takes - 3+3 Mbps speed (uploading and downloading stream)
- Simultaneous users – 20

Required Bandwidth: 6 MB * 20 = 120 Mbps

5. Shared File Services – Citrix VDI :
Backups of the data will be stored in the Citrix VDI
Assumption:
- Employees simultaneously downloading/uploading data - 100
- Required speed by one employee - 10 Mbps

Required Bandwidth: 10 Mb * 100 = 1000 Mbps

New York University

Total Bandwidth required: 206 + 1.6 + 1000 + 120 + 1000 = 2327.6 Mbps

Bandwidth Delay: 0.4 ms

Since the organization is growing we can expect 10% increase in the data transfer year on year for next 5 years. For stable network considering 10% increase, optimum bandwidth speed should be 4.0 Gbps.

Lower Level Support Staff

Assuming there are 600 employee in each of the 4 offices.

1. Email:

Assumption:
- Emails per day - 300   (during office hours)
- Average Email size - 200 Kb

Total MB Usage per day: 300 * 200 kb * 600 = 36000 MB

Required Bandwidth: 36000 MB / (8 * 60 * 60 sec) = 1.25 Mbps

2. VoIP :

Technology - G.728

Active users - 600

Bandwidth - 32 Kbps

Required Bandwidth = 600 * 32 kbps = 19.2 Mbps

3. Internet Usage :

Since web applications are used to support global operations hence high internet speed is must for all the employees.

Assumption:
- Average web-page size - 5MB
- Simultaneous loading of website by 500 employees

Required bandwidth: 5 MB * 500 = 2500 Mbps

4. Video Conferencing :

Assumption:
- HD video call takes - 3+3 Mbps speed (uploading and downloading stream)
- Simultaneous users – 10

Required Bandwidth: 6 MB * 10 = 60 Mbps

5. Shared File Services – Citrix VDI :

Backups of the data will be stored in the Citrix VDI

Assumption:
- Employees simultaneously downloading/uploading data - 100
- Required speed by one employee - 10 Mbps

Required Bandwidth: 10 Mb * 100 = 1000 Mbps

Total Bandwidth required: 1.25 + 19.2 + 2500 + 60 + 1000 = 3580.45 Mbps

Bandwidth Delay: 0.28 ms

New York University

Since the organization is growing we can expect 10% increase in the data transfer year on year for next 5 years. For stable network considering 10% increase, optimum bandwidth speed should be 5.7 Gbps.

Call Center

Assuming there are 100 employee.
1. Email:
Assumption:
- Emails per day - 300   (during office hours)
- Average Email size - 200 Kb

Total MB Usage per day: 300 * 200 kb * 600 = 36000 MB
Required Bandwidth: 36000 MB / (8 * 60 * 60 sec) = 1.25 Mbps

2. VoIP :
Technology - G.728
Active users - 100
Bandwidth - 32 Kbps
Required Bandwidth = 100 * 32 kbps = 3.2 Mbps

3. Internet Usage :
Since web applications are used to support global operations hence high internet speed is must for all the employees.
Assumption:
- Average web-page size - 5MB
- Simultaneous loading of website by 10 employees

Required bandwidth: 5 MB * 10 = 50 Mbps

4. Shared File Services – Citrix VDI :
Backups of the data will be stored in the Citrix VDI
Assumption:
- Employees simultaneously downloading/uploading data - 100
- Required speed by one employee - 10 Mbps

Required Bandwidth: 10 Mb * 100 = 1000 Mbps

Total Bandwidth required: 1.25 + 3.2 + 50 + 1000 = 1054.45 Mbps
Bandwidth Delay: 0.94 ms
Since the organization is growing we can expect 10% increase in the data transfer year on year for next 5 years. For stable network considering 10% increase, optimum bandwidth speed should be 1.6 Gbps.

Server Management

Web Server

All the web services will be handled by a centralized web server. For a well established company, web server should be up and running all the time. For this there should be backup server to service the requests in case the main server goes down. Since all the web-applications are developed in Microsoft ASP.NET, so it is advisable to use **Internet Information Server (IIS) by Microsoft**.

To reduce the time response, Web Caching should be used. Recently accessed files are stored temporarily. Reverse proxy helps in decreasing the load on the server by caching static and dynamic files. Web Caching should be implemented on server-side by using reverse proxy method. Web Caching can also be implemented on client-side i.e. on the browser.

Proxy server

Proxy server is a server which act as an intermediate between the client accessing resources from other servers. Proxy Servers, if installed in local offices can cache data thereby speeding up the internet access and provides security, as mentioned in the security section.

Email Server

While it is possible to run your own mail server, it is often not the best option for a variety of reasons. Here is a list of required components in a mail server:

- Mail Transfer Agent
- Mail Delivery Agent
- IMAP and/or POP3 Server
- Spam Filter
- AntiVirus
- Webmail
- appropriate DNS records
- an SSL certificate

Because they have so many moving parts, mail servers can become complex and difficult to set up, and hence we recommend using a hosted version of *Microsoft Exchange* as an email server as it provides the aforementioned components, is affordable and provides unparalleled quality services. Since it is easily scalable, it is a better fit for a growing organization like **GDA**.

Data Server

The task of the data server is to not only store data but also provide functionality of data mining, data analysis. Microsoft's Ms-SQL server will be the database management system as we are already using ASP.NET based web-applications.

DNS Server

DNS server helps in caching response of recently or also regularly DNS requests. This helps in reducing the response time thereby increasing the overall speed of the internet network. It makes more sense in having DNS server at the local offices rather than having a centralized DNS server.

Load Balancer

Load Balancer is used to maximize the throughput, minimize the response time and thus optimize the overall usage. Load Balancer distributes the request from the client onto all the available resources.

VPN Server

For an organization like GDA, which would benefit from having its own IP network, so as to have its servers and host communicate to each other in a secure way, deploying and maintaining a VPN server provides great value.

VDI Server

Virtual Desktop Infrastructure, or VDI, allows employees, especially the software development team, running a user desktop inside a virtual machine that lives on a server in the datacenter, to provide access to huge resources without actually downloading them.

Access Technologies

LAN

A local area network is a local interconnected group of computers or devices that shares a same wired or wireless link within a small area, which in our case is a local office. Devices connected to a LAN can access common resources like

WAN

A wide area network is a telecommunications network that extents to a large geographic area such as across cities, states, or countries. WAN is used by us to connect all offices in a large region.

VLAN

A virtual LAN is used to connect different physical LANs. We can set-up our network to connect different devices from different LANs with Ethernet or Wi-Fi. Ethernet: Ethernet is the most commonly used LAN. Ethernet that controls the data that is transmitted. Ethernet provides good speed, cost and ease of installation Wi-Fi: a wireless local area network that uses radio waves to connect computers and other devices to the Internet.

VPN

A virtual private network helps to access a private network from the public network and lets users to transmits data across the shared network. With VPN, the application has the benefits of functionality, security and management of the private network. For employees not in the office and wants to securely access a company's network can use it through VPN. Geographically separated offices can be securely connected with VPN.

Security

VPN and IPSec

Rather than deploying and maintaining a Private network, which can be very costly, we propose **GDA** use a Virtual Private Networks(VPN). With this VPN server, **GDA's** interoffice network traffic is actually sent over the public internet, rather than physically independent network. Providing confidentiality works by encrypting the internal traffic before sending over the public network.

A VPN server basically provides secure remote access to this private network. For example in figure below, When employee at Boston HQ wants to communicate some confidential data with employee at Paris regional HQ, a secure encrypted payload is sent to the internet, with the help of a router that supports converting vanilla IPv4 datagrams to IPsec datagrams. This data actually travels over public internet, but can only be accessed on Virtual private networks, remotely. The computers on the private network can share a single connection to the Internet through Network Address Translation(NAT).
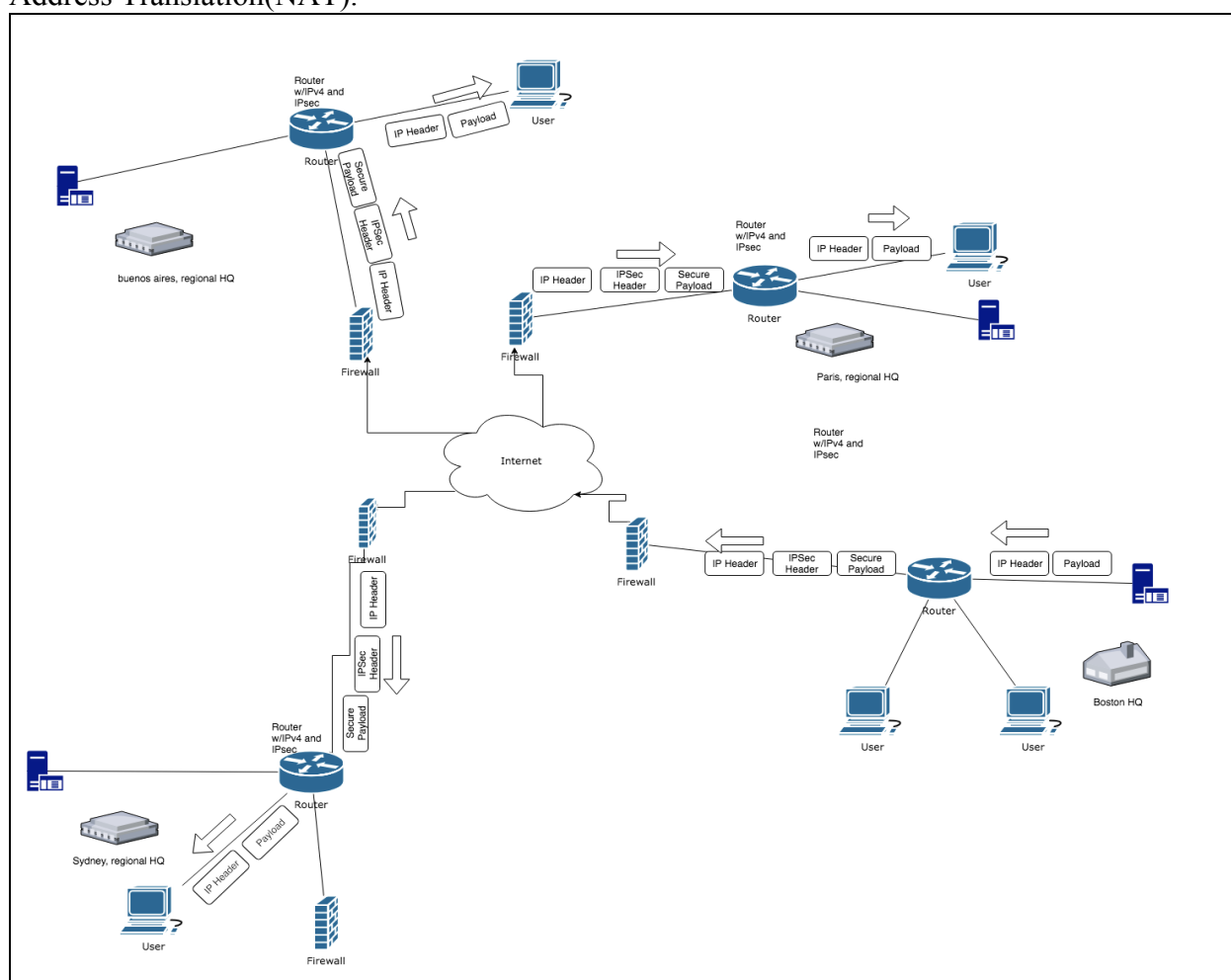

Fig 1: Virtual Private Network with IPSec datagrams

Firewalls

The network architecture diagram shows the need of firewalls in the context of the entire network. Firewalls allow the network administrator of the system to control access between public internet and the private network within **GDA** organization. It primarily serves:

- Passing all traffic from inside to outside of the organization's network and vice versa, through the firewalls
- Follow Security policies set by the network administrator, locally to the firewall, and filter the traffic as per those

While Firewalls themselves are vulnerable to attacks and can be penetrated, hence giving a false sense of security, we suggest making sure they are designed properly, installed with great attention to detail and should be manufactured from leading vendors like *CIsco* and *Checkpoint*.

Demilitarized Zones (DMZs)

DMZ includes the organization's servers that need to communicate with the outside entities, such as its public Web server and its authoritative DNS server. Types of servers which generally interact with public networks are Web Servers, FTP Servers, DNS Servers, Email Servers, etc. We suggest using an additional firewall incase of a DMZ, to isolate it in case of an attack and hence confidently allow the services in DMZ to access sensitive information and resources.

Intrusion Detection Systems (IDS)

While the firewalls do packet-level filtering, which are also specific to the applications, using the application gateway, sometimes, a deep packet inspection is necessary, which looks beyond the headers, to identify different types of attacks. IDS sensors generate alerts when it comes across malicious traffic, which an Intrusion Prevention System(IPS) removes the malicious traffic. The IDS sensor is placed between switches to inside the private network (in this case, private network of GDA). DMZs are also monitored by IDS sensors.

Proxy Servers

Clients, instead of directly requesting from other servers, requests the resources like web page, file or other resources from the proxy server. Proxy Server then analyses the requests to simplify and to control its complexity. It then requests the target server these resources and forward it to client after receiving it from the target server. It also helps protecting client by hiding its IP address.

Data Security and Encryption

For an organization like GDA, a lot of sensitive information is being stored and processed and transferred fairly regularly. Some of the data included is,

- HR application: personally identifiable information, such as social security numbers, names and addresses of employees

- Financial Management System: financial data for the entire organization, clients, etc.
- Customer specific data for sales and Marketing
- Highly Confidential Analytics and product development software

Such data and resources should be stored and transmitted in an encrypted form, while also maintaining backups of the same.

SSL/TLS should be strictly used for all the traffic, even for the internal networks, particularly the suite of applications that deal with sensitive data.

Confidential emails can also be encrypted before being sent, if deemed absolutely necessary.

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