PROJECT REPORT

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In the competitive world of vast internet and wireless communication, multi-players games are becoming more popular.The report of this project describes the network architecture for GAMES4ALL(G4A). In this report, a network is implemented to handle the required number of players. This report calculates how much link capacity is required by the server required for all regions to maintain 200 games.

Given Information

- Form the given information there are three main regions and again those three main regions are divided into sub-regions. The three main regions are. Europe: it is divided into two regions (Paris, Helsinki) and the load was divided into 50%/50%. Asia: it is divided into three regions (India, China, and South Korea) and their load was divided into 34%/33%/33%. North America: it is divided into two regions (San Jose and New York) and their load was divided into 50%/50%.

- 200 similar games are divided for every region. Europe consists of 50% games (100), Asia consists of 25% games (50) and North America consists of 25% games (50).

Network Architecture

In this report I have used Hierarchical network architecture design for its scalability, availability and security reasons. As the main requirement of the project is scale-up when ever servers are required, so that Instead of using Access-Aggregation-core topology 2-tier Clos topology was used to produce high-capacity networks. In Access-Aggregation-core topology data is forwarded on bridging (Because of spanning tree protocol on the control plane) whereas Clos topology works on both routing and bridging(Bridging was supported only at racks).

The network architecture of the Clos are having three layers. The layer at the top was called Spine (Network device used Switch) and second layer is called leaf (Network device used Switch) the last layer was servers.Spines are used to connect every leaves in the network. The leaf and server are placed at same hardware rack with switches on top so called leaf switches as TOR(Top Of The Rack) switch.

Equal-cost multi-path routing(ECMP) was used to forward a packet between spine and leaf. To achieve the bridging at the edges of the network new virtualization solution was used VXLAN(Virtual Extensible Local Area Network).

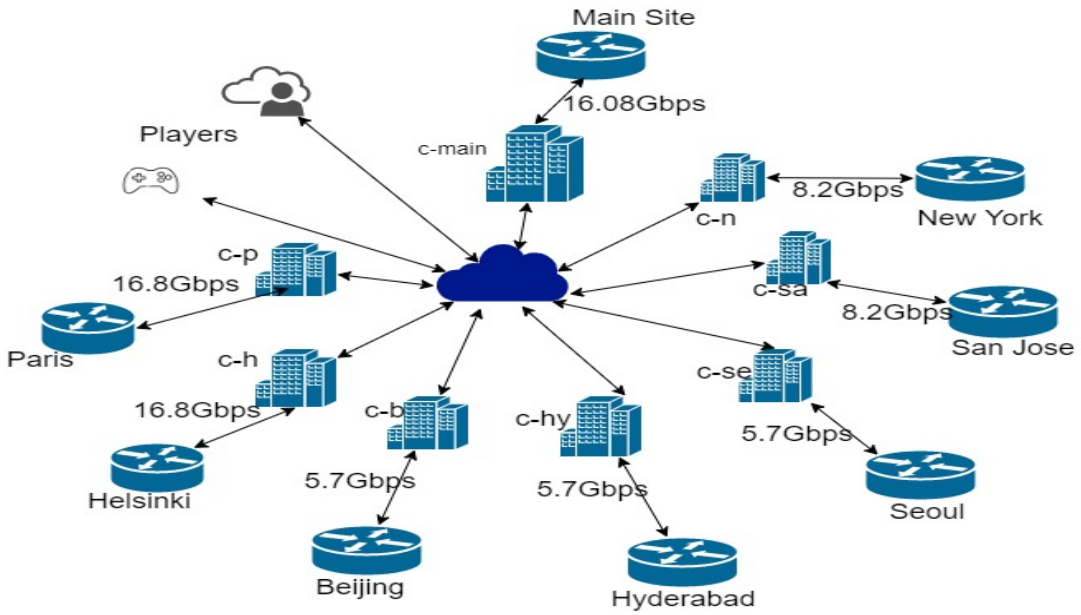

Figure 1: Overview

The main requirement for every customer in the network is non-blocking network, this non-blocking network can maintained with respect of the up-link and down-link speeds. If the network over-subscription ratio was 1:1 then the network is non- blocking network. For every one down-link there is separate up-link. In the below a Clos based topology network was shown which consists of ISP(Internet Service Providers), Routers, Spine Switches, TOR switches and servers.Every player in the region should download game form the internet.

Link Speed

Each player needs around 256Kbps of up/down speed. There are 1000 players per map so up/down speed required = **256Mbps.**

Europe region

For Paris there are 50 games so that link speed is (50*256Mbps = **12.8Gbps**).
For Helsinki there are 50 games so that link speed is (50*256Mbps = **12.8Gbps**).

Asia region

For Beijing there are 17 games so that link speed is (17*256Mbps = **4.32Gbps**).
For Hyderabad, there are 17 games so that link speed is (17*256Mbps = **4.32Gbps**).
For Seoul, there are 16 games so that link speed is (16*256Mbps = **4.09Gbps**).

North America region

For San Jose there are 25 games the link speed of that region is (25*256Mbps = **6.41Gbps**).
For New York, there are 25 games the link speed of that region is (25*256Mbps = **6.41Gbps**).

SPU to handle games

Mainly the SPU consists of three servers these all servers are kept in one virtual circuit. If there are more than 3 servers in the virtual circuit then there will be an increment in load and traffic the board may experience some difficulty.

- In the Europe region they are 50 games per each sub-region the SPU required for each sub-region is (50/3=17). The total SPU required for Europe is 34.
- In Asia there are 17 games per each city the SPU required for each region is (17/3 =6) servers.The total SPU required for Asia is 18.
- In North America are 25 games per each city the SPU required for each region (25/3 =9) servers. The total SPU required for North America is 18.

Region	No.of SPU
Europe	34
Asia	18
North America	18
Total	70

The total data to be downloaded for every 30Min's in Europe region was 100*1000*100 Kbytes = **10Gbytes**. The same data is 50*1000*100 Kbytes = **5Gbytes** for all cities in Asia and 50*1000*100 Kbytes = **5Gbytes** for all cities in North America.

To provide uninterrupted gaming experience the game should be launched within 10secs.Within 10secs the player download the required software to enter into the game.

- For Europe region per city = 50*1000*100*8000/10 = **4Gbps**.
- For Asia region per city = 17*1000*100*8000/10 = **1.36 Gbps**.
- For North America region per city = 25*1000*100*8000/10 = **2 Gbps**.
- For main site link capacities = 4*2+1.36*3+2*2 = **16.08Gbps**.

From above calculated link capacities.

City	ISP	Link Capacities
Main Site	C_Main	8Gbps+8Gbps+100Mbps
Helsinki	C_H	8Gbps+8Gbps+1Gbps
Paris	C_P	8Gbps+8Gbps+1Gbps
Hyderabad	C_HY	4Gbps+2Gbps
Beijing	C_B	4Gbps+2Gbps
Seoul	C_SE	4Gbps+2Gbps
San Jose	C_SA	8Gbps+1Gbps
New York	C_N	8Gbps+1Gbps

Generic City Architecture

Let assume there is **n** port switch.The number of links it can produce is n*n/2. Most of the Clos topology having servers at one speed and up-link at high speed because with fewer spine switches to support 1:1 over-subscription ratio(Which is non-blocking network) and it also reduces cost of cabling and reduces monitoring many switches.

- **Europe Region (Any city)**:
  - For Spine **Cisco SF350-24 24-Port 1/10** Managed Switches are used. Two Spine switches are used to provide **redundancy**
  - For Leaf switch **Cisco Catalyst 4948 10/100/1000BASE-T** Managed Switches are used. Two Leaf switches are used to provide **redundancy**
  - For Routers **Cisco Network Convergence System 540 Router 24x 1GE/10GE** are used. Two Routers are used to provide **redundancy**

- **Asia Region (Any city)**:
  For Leaf and Spine **Cisco SF350-24 24-Port 1/10** Managed Switches are used

- **North America Region (Any city)**:
  For Leaf and Spine **Cisco SF350-24 24-Port 1/10** Managed Switches are used

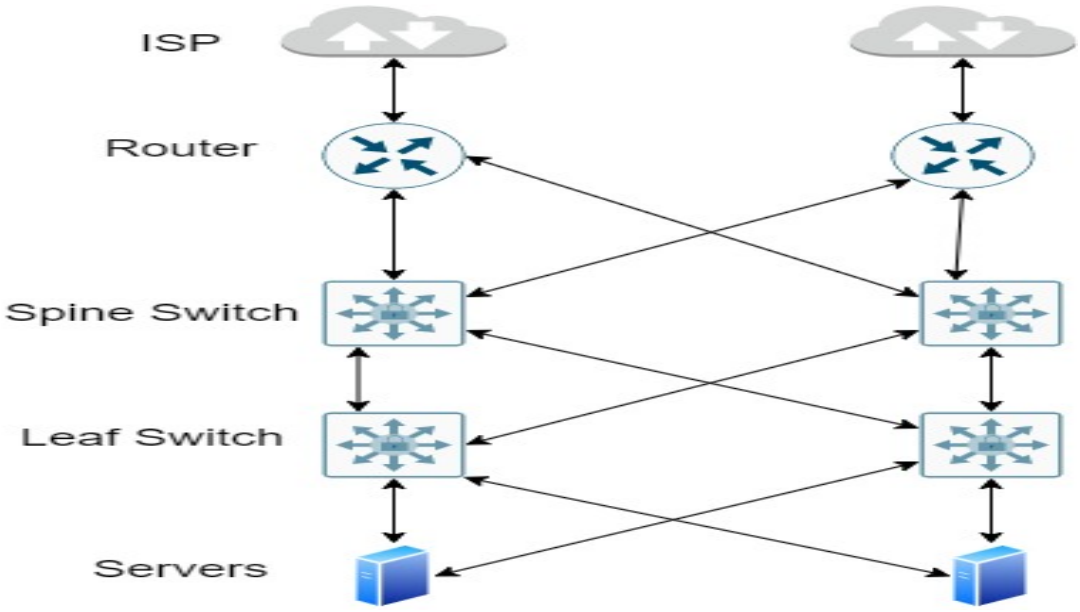

Figure 2: City architecture

Ports for Europe,Asia And North America region			
Region	**Ports at each routers**	**Ports at each spine**	**Ports at each leaf**
Europe	2x10GE(N),1GE(N)& 4x10GE(S)	4x10GE(N)& 4x10GbE(S)	4x10GbE(N)& 8x1GbE(S),9x1GbE(S)
Asia	1x10GE(N),1GE(N)& 2x10GE(S)	2x10GbE(N)& 2x10GbE(S)	2x10GbE(N)& 3x1GbE(S),3x1GbE(S)
North America	1x10GE(N),1GE(N)& 2x10GE(S)	2x10GbE(N)& 2x10GbE(S)	2x10GbE(N)& 5x1GbE(S),5x1GbE(S)

Growth

- **Europe Per Region:** Total games added are 25 so the total link speed is 75*256Mbps = **19.2Gbps** and to download game in 10secs the speed will be $75 \times 1000 \times 100 \times 8000/10$ = **6Gbps**.
  The new link capacity after growth will be 8Gbps+8Gbps+8Gbps+2Gbps (26Gbps).The above mentioned switches for Europe can maintain these link capacities and can handle new servers(+9).

- **Asia Per Region:** Total games added are 9 so the total link speed is 26*256Mbps = **6.7Gbps** and to download game in 10secs the speed will be $26 \times 1000 \times 100 \times 8000/10$ = **2.08Gbps**.

The new link capacity after growth will be 8Gbps+2Gbps (9.08Gbps).The above mentioned switches for Asia can maintain these link capacities and can handle new servers(+3).

- **North America Per Region:** Total games added are 9 so the total link speed is 34*256Mbps = **8.7Gbps** and to download game in 10secs the speed will be 34×1000×100×8000/10 = **2.72Gbps**.
  The new link capacity after growth will be 8Gbps+4Gbps (11.44Gbps).The above mentioned switches for North America can handle these link capacities and can handle new servers(+3).

Region	Link Speed	SPU	Link Capacities
Europe(per Region)	26Gbps	25	8Gbps+8Gbps+8Gbps+2Gbps
Asia(per Region)	9.2Gbps	9	8Gbps+2Gbps
North-America(per Region)	11.4Gbps	12	8Gbps+4Gbps

Monitoring Tool

To monitor the above network **PRTG** monitoring tool was used. As it is used,x PRTG was agent-less and configured for centralized monitoring.There are four parameters that are taken to monitor the above network using PRTG.

- **Average Response Time:** Measuring the duration of every request cycle.It helps to find, how much time it takes to genrate response or serve a request. The lesser the time, the better the gaming experience.
- **Network round trip:** The network round trip time is to monitor, how much time it takes to send packets from Sender to receiver(time for reachable to servers).
- **Uptime:** The Uptime finds, the amount of time that a servers are running properly and stayed up.
- **Traffic analysis:** PRTG tool has this another sensor traffic analysis, as it breakdowns the traffic by protocols, IP address and connections to find anomalies and take control over the network.

The PRTG server notifies the administration if any link failures on the network and alerts when server is not responding or server failed through text message.

Some of the other monitoring tools to monitor the networks are: **Nagios, Zabbix**