# Project

To design a network architecture for G4A there is a need to consider values of specific parameters given so we could calculate capacity links required for all regions from main site to maintain 200 games simultaneously.

The general architecture consists of Routers, Switches, Servers (main site) placed and links assigned to each connection connected to specific port.

**Given data:**

1) 1000 players per map.
2) 256 Kbps up/down speed for each player.
3) 200 simultaneous games and load divided for
   (i) Europe region(Paris, Helsinki) is 50/50
   (ii) Asia region(China, India, South Korea) is 33/33/33
   (iii) North America(San Jose, New york) is 50/50
4) Player need to download 100 Kbytes every 30 minutes on average to maintain the game.

**Calculation part:**

For each player 256Kbps up/down speed, hence for 1000 players the required speed is 256Mbps (256Kbps * 1000 players).

Total number of simultaneous games are 200, for each region total games to be distributed are 100 games for Europe region, 50 games for Asia region and 50 games for North America region, i.e; in Europe each 50 games for Paris and Helsinki, in Asia each 17 games for Beijing, Hyderabad and Seoul, in North America each 25 games for San Jose and New york

With this given data , we can calculate capacity links to be provided for each region from main site to maintain all these games simultaneously .

**Links speed required for every region:**

**For Europe region** :

50*256Mbps = 12.8 Gbps => 12.8 Gbps each for Paris and Helsinki

**For Asia region** :

17*256Mbps = 4.32 Gbps => 4.32 Gbps each for Beijing , Hyderabad and for Seoul

**For North America region** :

25*256Mbps = 6.41 Gbps => 6.41 Gbps each for San jose and New york

These are capacities which have been selected for links at deployment time .

Hence, total 52Gbps network capacity is required from main site to regional networks from internet to run 200 simultaneous games and players need to download 100Kbytes data from city server to continue gaming on average time 30 minutes and a maximum of 60 minutes per game. Therefore player need to download 100 kbytes data every 30 minutes.

Proof that 52 Gbps capacity is enough for handling 200 games :

52 G/256 M= 52000M / 256M = 203 games approx…

**Required SPUs to handle 200 games simultaneously** :

Consider each physical server has 3 virtual machines which are stacked in it. Main purpose is to use virtual servers is players can spin-up and spin-down . A Physical server can be configured with 2-8 virtual machines but if more than 5 virtual machines are configured in a single entity then there will be increase in load and traffic management may have some trouble. Since traffic is proportional to number of players in city .

Virtual servers are purely for gaming purpose and each can run only one game at a time .

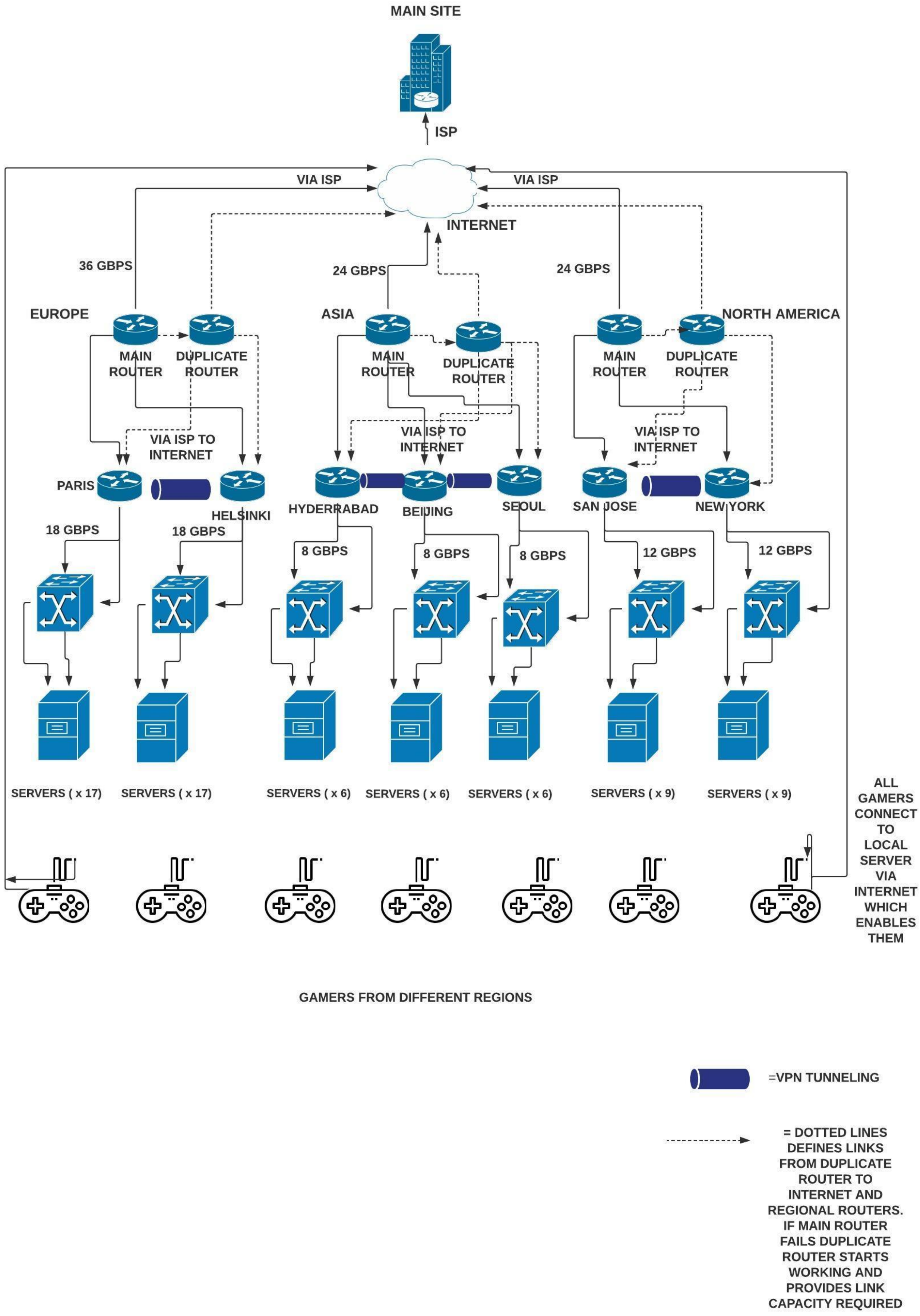
Since we have stacked three virtual entities in one SPU/physical server we get:

(i) For Europe region, we need 50 servers per each city since each city has 50 games running.
So, 50/3 = 17 SPUs for each city . so 34 SPUs / Physical server for entire Europe region .

(ii) For Asia region, we need 17 servers per each city since each city has 17 games .
So, 17/3 =6 SPUs for each city. So 18 SPUs for entire Asia region.

(iii) For North America region, we need 25 servers per each city since each city has 25 games
So, 25/3=9 SPUs for each city. So 18 SPUs for entire North America region.

So overall required Physical Servers/ SPUs(each has 3 VMs stacked in it)= 34 SPUs + 18 SPUs + 18 SPUs = 70 SPUs/Physical Servers.




NETWORK ARCHITECTURE OF G4A

**Explanation on Network Architecture**

The basic architecture of network is hierarchical and network devices in the architecture are dependent on **Internet.**

There are 3 geographically distributed gaming environments which enables layers to play the game from their respective regions .

These 3 regions are Asia , Europe and North America and each region is divided into number of cities where games are distributed. Here Each city has it's own network having servers and managing their own gaming requirements.

Asia region has three cities Hyderabad, Seoul and Beijing . Europe region has two cities Paris and Heisinki, North America has San Jose and New York.

Each region has two routers, one is main router and other is duplicate router, main task is players need to play games smoothly in every region and if there is any failure impact in main router the duplicate router which is in cluster form starts working and forwards the link capacity (speed required) received from Internet.

Flow of network is from

Main site Router → ISP → Internet → Regional ISP → Regional router

Regional routers are connected to city routers through internet since it is easy and flexible way to have seamless connectivity .

Each respective regional networks and city networks are connected by IP Sec VPN connection for ensuring security purpose because they are conneccted through internet.

All cities are connected to main site to co-ordinate software updates, player information etc. and main point to be noted is main site does not host games.

**Gamers connecting to servers:**

In the design , gaming computers connect to gaming servers via internet and it enables or redirects them to nearest available local site because hosts (players) cannot directly connect to server.

Gamers can access the game through internet which enables them to nearest local site which has access to play the game . Consider for a single server, what actually happens is they would be launched in a sequence i.e. once 1000 players have signed up that one server will be launched, then that server will be active (on average) 30 min. Once that game is over, a new game will be launched on that server, lasting again (average) 30 min. However they no need to wait till first game completes, if another 1000 players are ready who also downloaded required 100 Kbytes from server, the second game starts.

**Link capacities defined in network architecture :**

(i) Link capacity inside region

(a) For Europe region, from main router to Paris city router 18 Gbps and from main router to Helsinki city router 18 Gbps. We already calculated speeds required for each city, it is 12.8 Gbps and additional is for each gamer to download 100 Kbytes before game starts.

(b) For Asia region, from main router to each city router (Hyderabad , Beijing and Seoul) is 8 Gbps. We calculated that 4.32 Gbps for each city and additional is for each player to download 100Kbytes before game start.

(c) For North America , from main router to each city router (San Jose and New York) is 12 Gbps .We calculated 6.42 Gbps for each city network and additional is for each player to download 100 Kbytes before game starts.

(ii) Link capacity between cities to main site

(a) For Europe region : Link capacity provided from main site to Europe region router is 36 Gbps and from regional router it will be distributed to each city router (18 Gbps) as per requirement .

(b) For Asia region : Link capacity provided from main site to Europe region router is 24 Gbps and from regional router it will be distributed to each city router (8 Gbps) as per requirement .

(c) For North America region : Link capacity provided from main site to Europe region router is 24 Gbps and from regional router it will be distributed to each city router (12 Gbps) as per requirement .

- - - - - -> dotted lines from each duplicate router(from main site and alsoo to city routers) in network defines that if main router has any failure impact then the duplicate router will start working and it transmits the link capacity to city routers which it received from main site. Note: They only work when main router has any failure impact, they will be idle/stable when there is no problem with main router in general time.

Pipe symbol resembles VPN connection from region network to city network in architecture.

From each City router to Switch and from Switch to Servers we established multiple links in order to achieve resiliency . so if one link fails to transmit, the other will start working and starts trasnmittingg data.

**GROWTH**:

If G4A wants to run more simultaneous games by installing more servers then growth of network can be drawn from increase in number of servers and increase in speed (capacity links) from main site to regional network.

Consider total number of games has been increased from count 200 to 400 and they are distributed among the regions. We will find **growth in number of server** for handling 400 games and **growth in speed** which is required to handle 400 games .

Consider for Asia region where load is divided equally into 33/33/33 and for each city of Asia region they need to handle 34 games.

From calculation part we know that speed required for Asia region is 4.32 Gbps for each city (they had 17 games each city) and required speed to handle 34 games in each city is

34 * 256Mbps = 8.7 Gbps => 8.37 Gbps each for Beijing , Hyderabad and for Seoul.

Similarly if we proceed with the above calculation for different regions we get values of link speed which are mentioned in below table.

Table 1: Growth in speed

| Region | Total no. of cities | Games per each city before adding more (200) games | Speed before growth | Games per each city after adding more (200) games | **Speed after growth** | Total number of games in each region |
|---|---|---|---|---|---|---|
| Asia | 3 | 17 | 4.32 Gbps | 34 | **8.7 Gbps** | 34*3=102 |
| Europe | 2 | 50 | 12.8 Gbps | 100 | **25.6 Gbps** | 100*2=200 |
| North America | 2 | 25 | 6.41 Gbps | 50 | **12.8 Gbps** | 50*2=100 |

From calculation part we know that total number of required servers are 70 where each physical server consists 3 virtual servers which are stacked in it( i.e. 1 SPU = 3 virtual serverss) and each virtual server can run one game at a time.

To find total number of required servers for handling 400 games , we consider example of region Europe, where we need 50 servers for 50 games in each city and 50/3= 17 SPUs for each city in Europe (before growth).

Therefore when 400 games are distributed for three regions , Europe will need to handle 200 games and 100 games for each city, so required number of SPUs are 100/3= 34 SPUs(approx..) for each city in Europe (after growthh) .

Similarly if we proceed with above calculation we get required number of servers after growth which are mentioned in below table.

Table 2: Growth in servers

| Region | Total no. of cities | Games per each city before adding more (200) games | Servers before growth | Games per each city after adding more (200) games | **Servers after growth** | Total number of games in each region |
|---|---|---|---|---|---|---|
| Asia | 3 | 17 | 50 | 34 | **100** | 34*3=102 |
| Europe | 2 | 50 | 25 | 100 | **50** | 100*2=200 |
| North America | 2 | 25 | 25 | 50 | **50** | 50*2=100 |

In general , we can find how many games per minute can be handled by network

**Before growth** :

For Europe region

→50 games/30min = 5/3= 2 games per minute

1 game / 30 sec Paris and HeIsinki per site

Twice amount of capacity as transfer done on 30 sec which is load time.

After Growth:

100/30 min = 10/3 = 4 games per minute

Twice amount of capacity as transfer done on 30 sec which is load time.

**COST OF RESILIENCY**:

Cost of resiliency can be defined within connectivity between router to switch or switch to router and we use link aggregation , so data can be transmitted even if one path doesn't work.

Another way of defining cost of resiliency is when main router has any failure. Here we use another router which is connected as a cluster with the main router and if there is any problem occurred with main router , duplicate router will handle the routing and this is also known as hot-stand by.

**COST OF REDUNDANCY**:

As already mentioned cost of redundancy is defined among regions and to maintain the network/game play, more stand-by servers are installed and at least 70 stand by servers need to be installed to just maintain network gameplay . we can also put duplicate resources at lower end and we can replicate.

**POTENTIAL SINGLE POINT OF FAILURES**:

Potential single point of failures mostly happens to a router. There will be a lag in gameplay for a while due to SPOF in main router and to prevent this a duplicate router has been connected as a cluster with the main router which can access capacity links from main site / SPU and can transmit data to multilayer switch .

**ROUTER FAILURE IN NETWORK** :

Here, main router failure in network/gameplay leads to lag for a while and player will have interruption and since we have connected a duplicate router with main one and there is transmission of data , player can continue his gaming .

**CHALLENGES ON MANAGAEMENT AND OPERATION OF NETWORK**:

From network architecture we can conclude that network is mainly managed via virtual severs which provide capacity links to different regions via routers/switches and along this they also handle the network if there is any growth in network by G4A to run more games .

Network is completely operated by L2/L3 switches , Routers (one main and other duplicate) , servers, main site and most importantly ISP in SPUs .

**MONITORING**:

The use of network monitoring is to monitor any computer network for any slow or failing components and it will notify network administrator in case of any failed routers , switches and servers when they go down or any other trouble .

When monitoring device detects any failure it immediately alerts maintenance group and they rectify it. Monitoring device frequently keep track of status of system in use, to have earliest warning of failures, and monitoring tool logs details of speed, throughput, uplink , downlink, uptime vs downtime availability , bandwidth values , data rates and to monitor **traffic** to find traffic traces.

One such example of monitoring tool is PRTG Network Monitor .

PRTG Network Monitor ensures that network administrators are notified before outages occurs and it also supports remote management , various notification methods .

Features of PRTG :

(i) Flexible alerting
(ii) In-Depth Reporting
(iii) GUI configuration.

Another example of monitoring protocol is SNMP:

SNMP is a popular management protocol which is used to monitor network and SNMP works by sending PDU’s (protocol data units) between SNMP managers and agents, notification is passed from agents to manager and monitoring tool will record and analyze information of device performance after rectifying occurred failures.

SNMP has a network management system which has a tool set on server to monitor each and every device so information can be communicated to admin and admin make use of SNMP to manage the computer network by getting details on amount of bandwidth used, admin is notified if any failure through text message and to collect error reports .

In this network, monitoring tool is for **servers, routers, switches of main site and regional networks, internet usage** etc. (these are to be monitored for our network)