

Networks and Protocols

The International manufacturing Corporation



L3 - Group1 -

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1- General Topology

1. Wire connection

Wire connection is an old design (over 30 years), but the performance always make it first in terms of speed and it's a very inexpensive solution. Wired networks are more secure than their wireless counterparts. However, there are different technologies to create a wired network. We will review them and discuss on each of them what are their advantages and disadvantages. We thus choose the technology that suits best to our needs.

a. The Ethernet

This is the oldest, most powerful and most used network both in private homes than among professionals. Its success is due to many advantages it offers: in addition of its low cost, the network is more scalable because you can add components to infinity, change the architecture of your network or add one or multiple PCs without changing the parameters of already connected PCs. You can connect to your PC over the farthest. For example, a switch or hub will usually be necessary past the 150 meters. The technology we currently have is cat3cables. These cables were widely spread in the 1990s but now have a speed much too low (10 Mb/s theoretical, 0.08 Mb/s in practice) even for VoIP communications! This type of cable is over for our new network design. With a better performance, we make the obvious choice of Cat 5 cables. Since the full implementation of cables in the building needs renovation, it is very expensive, and scalability concerns, we choose to connect each of our desktops with Category 6 cables! This type of cable, similar to the 100BaseT, is backward compatible with Category 5 and 5e, and can transmit data at rates up to 250 MHz, with theoretical speeds of 1 Gb/s (1000BaseT). It will therefore incorporate VoIP to our design! Price for 100 meters: about **£40** for cat6.

b. Switch/Hub

A correct solution is to use cables rights 100BaseT with a sufficient flow to connected equipment. These cables will be connected to a hub, or better, a switch. The main difference between a hub and a switch is that the hub will send data packets to all computers that are connected, and very slowly. Conversely, the switch will send its data only to the target computer and relay the information much faster!

Indeed, the hub shares the bandwidth among all the PCs using it, unlike the switch which dedicates a channel to the maximum bandwidth between itself and each PC. In addition, the hub provides a single collision domain for all devices while the switch has only one port for communication. Some switch has a process to have no collision, but they are too expensive to implement throughout our network. Given the performance, we choose switch rather than the current hubs. They are available with 4, 8, 16 and 32 ports.

Ethernet Switch were chosen in a range of 4 types of connectivity: 4 ports (**£ 100**), 8 ports (**£ 500**), 16 ports (**£ 1.200**), and 32ports (**£ 2.500**).

2. Wireless Network

Wireless networks are increasingly used. They have many advantages over wired networks: in addition to not pierce the walls for the passage of cables, we can move the PC/laptop as we wish. Their major drawbacks are their higher cost, and still lower performances in terms of liability. The biggest problem is the security, still very low comparing to an ethernet network. The main reason for this weakness is simple: anyone with a wireless network device can "hear" (known as sniffer) the information! Nevertheless, encryption techniques have evolved over the revisions of the standard Wifi.

a. *Topology*

To access our nomad network (Wifi), we choose to place one or more wireless hubs (about £ 150) on each floor, connected to a switch for the entire building. We must be careful to provide a cable of sufficient speed to all users of the floor. Only laptops are equipped with Wifi technology, local desktops will be connected by ethernet only.

b. *Security*

The old technology was the WEP (Wireless Equivalent Privacy) crackable in a few seconds, so we quickly migrate to the WPA (Wi-Fi Protected Access) and WPA2. The standard known as Wifi 802.11 is the most widely used technology. The version n (802.11n) is now the most used and best value for money, it allows transfer rates up to 54 MB/s. But how to identify our users...?

3. Authentication

a. *Wifi*

The Wifi hot spot requires no configuration: it must be able to open Internet access to users that do not exist in the information system, which the computer can be configured anyhow (fixed IP addresses or DHCP, address range redundant in the corporate LAN, etc.). So there is almost no user management, authentication is usually the simplest.

Such a wireless network should be completely separate from the company. It consists of a network of hot spots Wi-Fi connected to a specialized appliance (for example the Nomadix Wireless Gateway - AG-2100: about £ 500).

This equipment is responsible for authenticating visitors: when he's connected, the customer is in a captive web portal and can only enter a username and a password. These data are defined and stored in the directory protected: Active Directory, including profiles and domestic visitors to the company. Anyone wishing to connect must be known to the directors of the company. We can imagine a Cisco Controller model 4402 (about £ 4200) that could accomplish this task.

Once authenticated, access is open to the Internet and the connection between the client and the terminal is encrypted using the WPA2 security standard (whose key is provided via the 802.1x protocol).

b. LAN: the network of the enterprise

The local area network (LAN) automatically provides access to Internet and intranet. Users are known and the client configuration is fully controlled. This allows greater flexibility in authentication and security. The login and password of the user is asked in the end of the starting routine of his desktop. The directory is, in the same way as Wifi, the local Active Directory.

4. Access to internet

We use a DS3/T3 high speed metro dedicated internet access provided by BAIS.

High Speed Internet Access and Failover Options

	DS3/T3	OC3	Metro GigE
Speed	3-45 Mb/sec	45-155 Mb/sec	5-1000 Mb (1Gig)/sec
Failover Option	T3 to T1	OC3 to DS3	GigE to any
Access Equipment	Cisco 7100/7200	Cisco 7200	Cisco 3550

All high speed access solutions are offered in [Tiered](#) or [Burstable](#) mode

This service includes the following features:

- ✓ Preconfigured Customer Premise Equipment (CPE)
- ✓ Circuit ordering and provisioning--from order to install
- ✓ IP address allocation
- ✓ Primary and/or secondary DNS services
- ✓ Custom domain name registration and administration
- ✓ Router
- ✓ CSU/DSU
- ✓ Redundant ISDN, DSL, T1 or DS3 (failover) connections (a secondary back-up connection that provides access service in the event the primary connection should fail)
- ✓ A network access router (Cisco 7200) and associated software and cabling: about **£ 3.000**
- ✓ package for **£ 400** per month for each implantation site (Annecy, Geneva, Birmingham)

5. The telephone network

Nowadays, companies have two main choices in telephony:

✓ VOIP technology (Voice Over IP) that allows you to talk via Internet or other network accepting TCP/IP. The main equipment is a gateway or router that is equipped with a gateway. A typical example is the Cisco 1861 Integrated Services Router, which costs about **£ 2,100**. Phones must be analogical and only requires a single line telephone equipped with a broadband Internet speed.

✓ PSTN (Public Switched Telephone Network), the telephone network in which a subscriber station is connected to a telephone exchange (as in every household with a regular phone). The main equipment is a PBX (it is already provided since we had ISDN) phones are more expensive because they must be digital, and you need a line of type T0 for 2 handsets (4 lines for 8 handsets) which is very expensive. In addition, the business package provided by phone companies for international calls are about £ 0.12/min, £ 0.09 on a mobile phone and £ 0.04 locally. So, on average, employees spend $\left(\frac{1}{3} * 0.12 + \frac{1}{3} * 0.09 + \frac{1}{3} * 0.04\right) * 15min * 20journs = \textbf{£24.90/month!}$

Communication costs in VoIP correspond approximately to the price of a local communication in the country corresponding to PSTN. Today, the best quality and least expensive is the VoIP by the price of the devices and monthly operating expenses.

The price of an IP phone is about £ 120, for example the Cisco IP Phone 7961G. It is equipped with 2 ethernet ports 10 or 100BaseT and facilitates internal calls through the dial.

Here are some other advantages of VoIP:

- Low cost: landline international 0/min, Mobile France £ 0.035, £ 0.050 UK mobile, mobile Switzerland £ 0.040/min $\left(\frac{3}{6} * 0 + \frac{1}{6} * 0.035 + \frac{1}{6} * 0.05 + \frac{1}{6} * 0.04\right) * 15min * 20journs = \textbf{£21.9/month}$
- Subscription to a provider of VoIP services and pay monthly fees for light unlimited calls within a certain geographic area (here, the United Kingdom, Switzerland and France).
 - Low taxes, since calls are carried over the Internet, governments have not heavily taxed telephone services to VoIP
 - Portability, can call collaborators / partners wherever they are: no price difference.
 - Features: call forwarding, call waiting, voice mail, caller ID, three-way call, send data (documents and images) simultaneously, videoconferencing ...

Over 5 years, the cost of PSTN amount to £ 3,112,500 for the entire enterprise. For VoIP, not including savings due to services provided by this device, the company will spend **£ 2,737,500**. A difference of £ 375,000. All IP phones would cost about 300,000: we save £ 75,000 in the first 5 years after that, everything is profit!

II. Inter-site links

1. France (Annecy)

In our system plan, Annecy has two locations: Manufacturing and Test Chambers. These two sites are separated by 35 meters, which is a very short distance! The wired solution is clearly excluded since 35metres trench + salary + insulation of the cable would cost about £ 3500. The test chambers are not places with a lot of employees; it does not seem useful to have a very good bandwidth and excellent signal. The wireless solution therefore seems to be the simplest and least expensive (range Linksys by Cisco Wireless-G = approximately **£ 60**). We could still find directional antennas for a point-to-point connection with a lower price. Indeed, since the buildings are facing each other, no obstacle is expected, but these solutions are very rare and under-secured.

2. Switzerland (Geneva, Plan-Les-Ouates)

In Switzerland, there are two of our sites: Head Quarter in Geneva, and the Server/Data Farm, in Plan-les-Ouates, located 3.5km south. These two sites are too remote for wireless, wiring the ground would be too expensive, and WiMax is not an option since there are reliefs between the two relay points. A solution a little more expensive was that of the antenna raised, but unfortunately the proximity of an airport limits the height of plants 35 meters high. Since the Mont Salève culminates at 1300 meters, this solution is unthinkable ... The last solution would be the connection via an ip cloud (here the internet) secure (VPN), each site group by country will be connected. The fact that the Server/Data Farm is common to the entire international network even more justifies to do not necessarily go by the HQ, even if it is nearby.

3. United Kingdom (Birmingham)

In England, our company has established two sites: Regional Sales and Distribution, which are separated by a road, at most 50 meters. The Wifi could be feasible, but for security reasons and strength of signal, the device could suffer from dysfunctions rather quickly. Since both are led to communicate a lot (same field of work and thousands of employees in each site), the solution of the cable connection is possible. For about **£ 4,500** including costs/work permit/wages, our two sites will communicate 15 to 20 times faster than through an international VPN. This will also permit the Distribution building to access the internet via the Regional Sales' T3 connection.

4. Union among all sites

As mentioned previously, the backbone of our international company is implemented by a VPN Client connection tunnel based on the ATM protocol (X.25 tending to be outdated). This network is of course encrypted and therefore allows the union of 3 different countries intranets securely while supporting multiple levels of QoS. A typical formula of this type of connection to the "International Area 1" could cost **£ 300** for putting into service and **£ 310** per month.

http://translate.google.co.uk/translate?hl=en&sl=fr&tl=en&u=http%3A%2F%2Fwww.swisscom-fixnet.ch%2Ffxres%2Fkmu%2Fc_vpn_liste_de_prix_sans_vdsl_fr.pdf

III• Special Cases

1. Server/Data Farm

File servers manage the creation, moving, deleting, reading, modification or blocking of any user file. Files are stored in hard drives and handled according to customer requests.

Each evening, outside of working hours, an automatic batch loads to save any changes and creations made on posts during the day.

Mail servers respond to requests for delivery of electronic messages. The servers store incoming messages and send messages to recipients. In terms of licensing and security, this solution will enable the long-term profitability and accelerate this type of communication has become indispensable in the world of business communication.

A web server will allow us to consult more quickly all documents such as the World Wide Web (html/php...) and increase productivity. Each consultation of an online document causes the sending for a new request on this server.

DHCP and DNS servers will be run under Linux Server. Indeed, a Linux Server formation during 5 days costs £ 2,200 per person. A Windows Server license would cost too much to our company (several thousands of pounds for a few licenses.), even if the administration would be much easier and does not require experience.

2. The Test Chambers

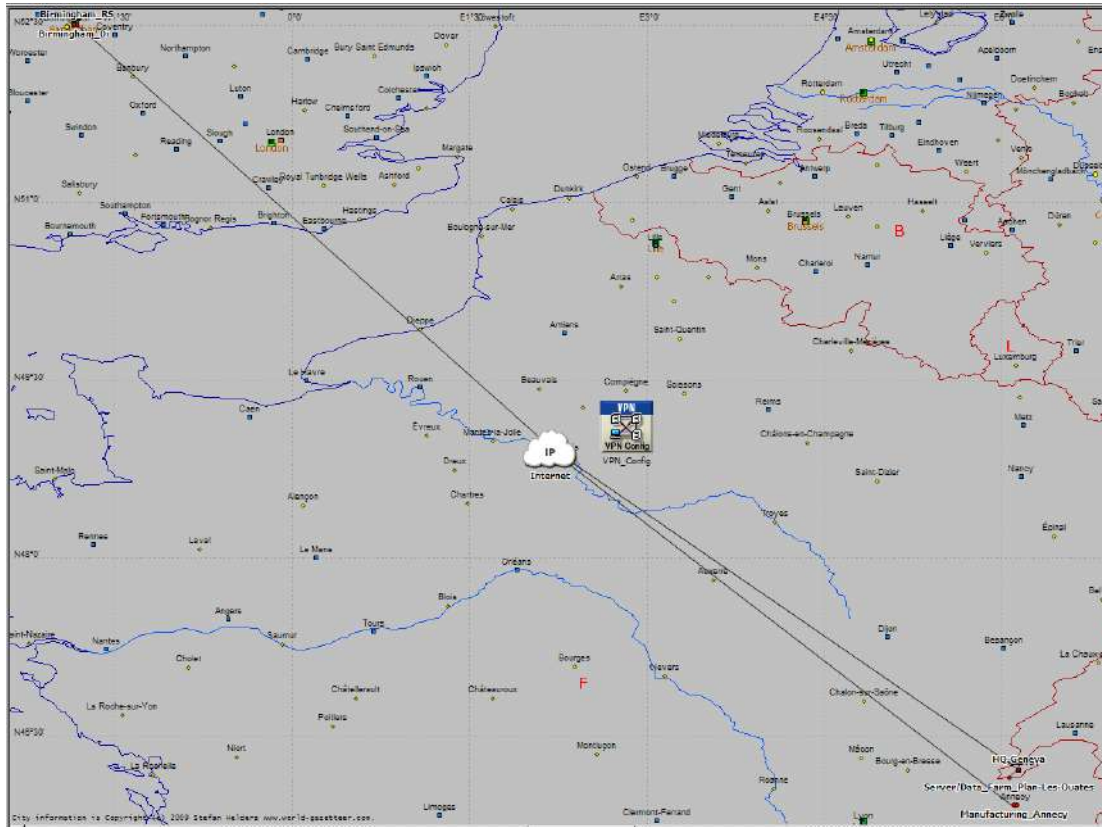
Test chambers are spaces undergoing changes in temperature and humidity extremes. For this, it is unthinkable to place any computer or other equipment linked to our network: it would be subject to far too many malfunctions. These rooms are magnetically isolated, no wave is supposed to enter for the tests. Despite this, access to internet or corporate intranet must be possible outside experiences. For this, we establish a wireless hub outside these rooms, which cannot penetrate the walls when the rooms are closed, but will offer wireless access (via a PDA or a laptop) when the door is open.

3. Limited Voice

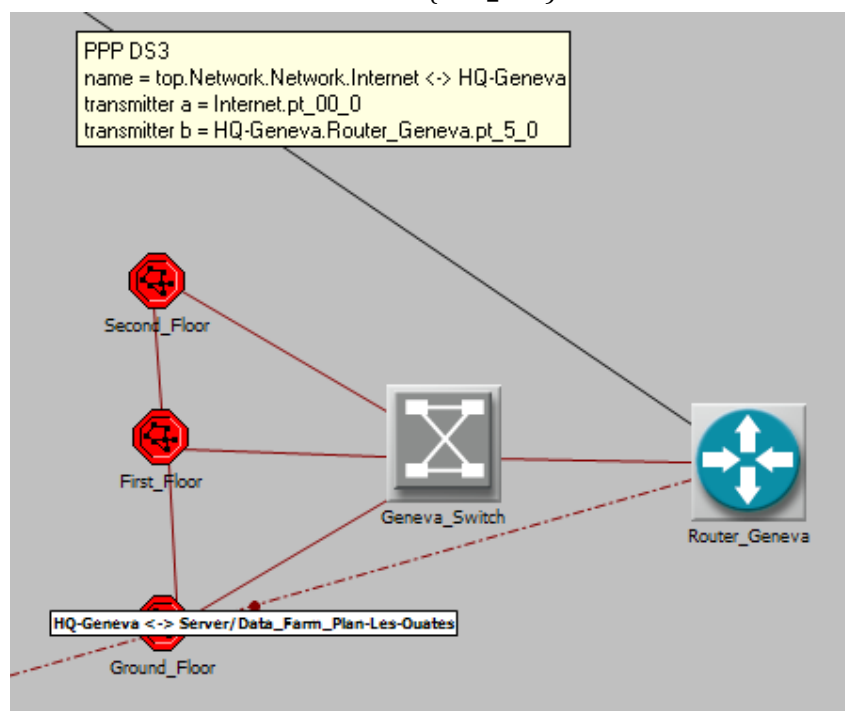
The gatekeeper is the software that provides the intelligence of the bridge. A gatekeeper has two main services: the management of permissions and address resolution. In other words, when a customer wants to make a VoIP call, it must do so through the gatekeeper. Then it provides an address resolution to the customer destination. Unfortunately, prices of devices such as "Cisco Multimedia Conference Manager" or "Configuration Cisco CallManager 3.3 Gatekeeper" were not communicated by Cisco. We therefore have no idea of the cost price of such restrictions. In the

specification, only 4+4 = 8 users are restricted to internal calls only, so it is thinkable to implement this solution only in case of obligation.

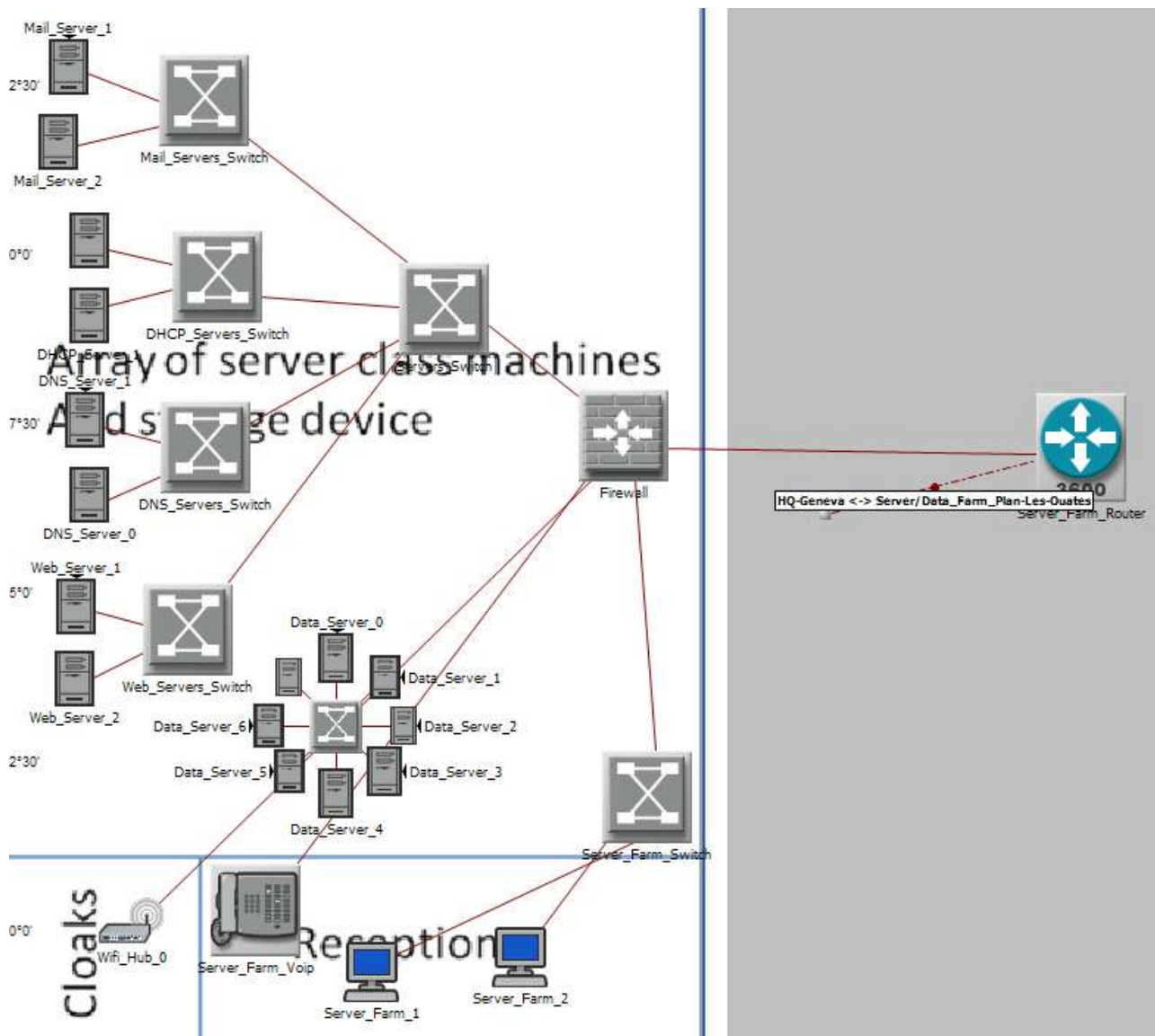
IV. OPNET Appendices



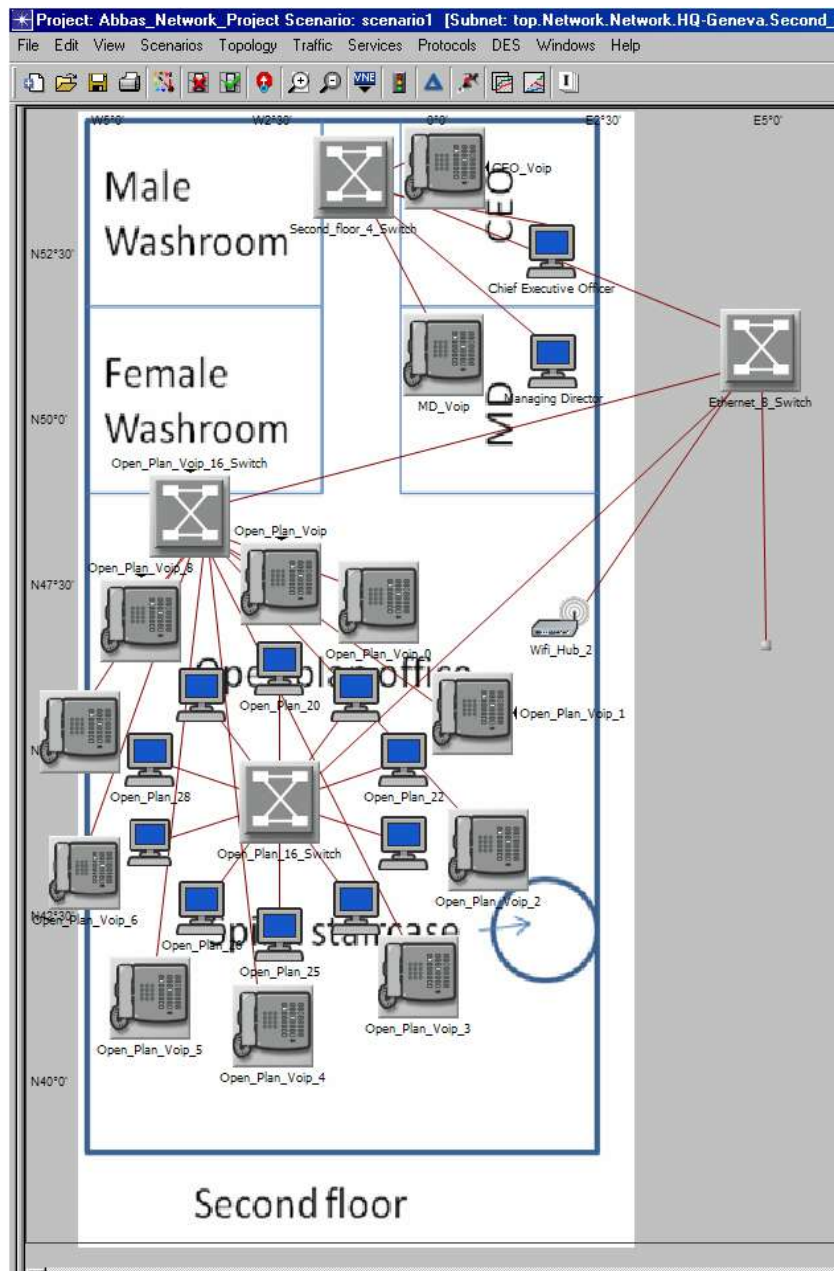
Global Europe WAN: the 3 sites are linked to an ip_cloud (the internet) with virtual VPN secure links (PPP_DS3).



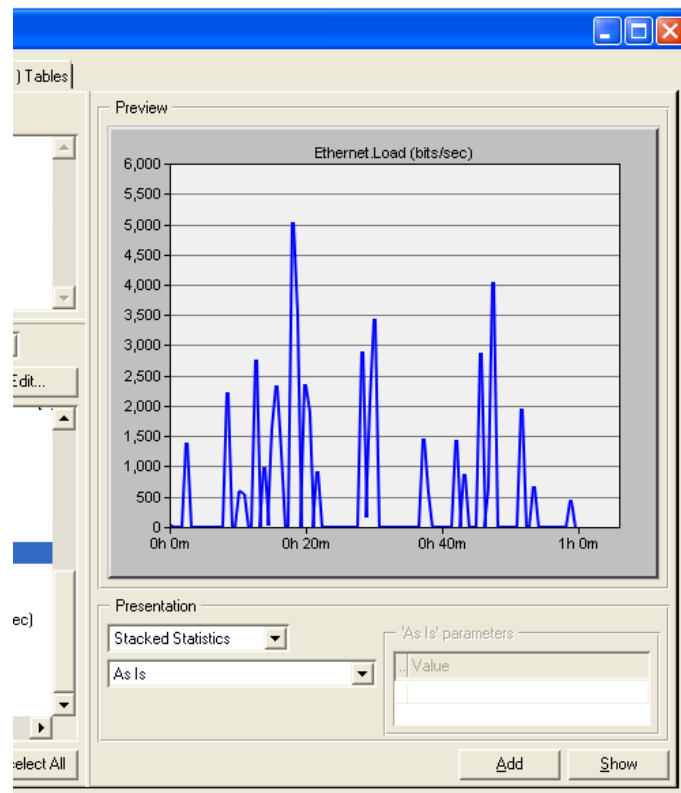
Site 1 network: Geneva. The 3 grounds are linked between each other and to all goes to a switch then a router, giving access to the international VPN. All communications with the Server/Data Farm is directly routed via the Geneva Router.



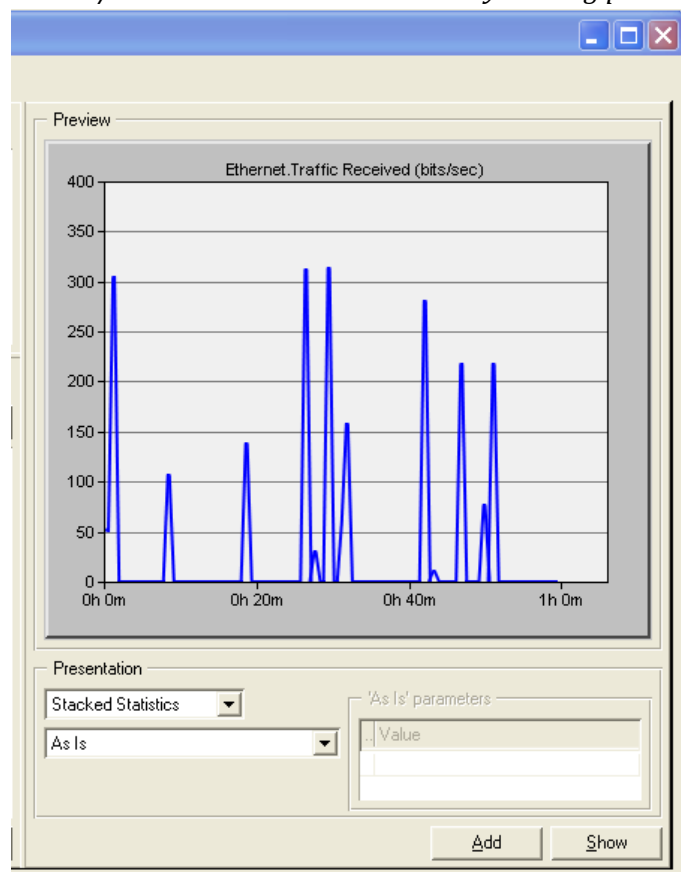
Server/Data Farm network: Plan-les-Ouates. All Servers are doubled; one is a clone to the other. The 8 RAID Data Servers contains all the files and data to the 2500 users.



HQ Geneva network: Second Floor. One switch for the VoIP, one for the Open Plan LAN.
The MD and the CEO have their own VoIP and switch



HQ Geneva network: Second Floor, Open_Plan_25 Station node: Ethernet Load (bits/sec)
We can observe a pick to 5kb/sec loaded: the node is correctly sending packets through network.



HQ Geneva network: Second Floor, Open_Plan_25 Station node: Traffic received (bits/sec)
We can observe a pick to 320b/sec received: the node is correctly connected to the VPN network.