T.E.I. PIRAEUS

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MSc in DATA COMMUNICATIONS

COURSEWORK

MODULE:

Network Operating Systems

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First Section – Executive Summary

In our century it is widely known that a well based and developed Information System is one of the greatest advantages that an organization could have to achieve its economic targets and fulfil its potential against other companies. It is also known and a general consensus that when someone refers to Information Systems, means in practice a computer network which supports the daily procedures of an organization constantly and securely and provides smooth access to the organization's resources that are requested each time by the employees of every hierarchical level .

Major companies in our days have a large number of computers in operation, often located far apart and these computers must be connected with each other or to the needed resources creating a large network or , in technical terms , a WAN (Wide Area Network).

Data and communication technologies are day by day integrating offering reliable solutions and new services that can support almost every aspect of daily activities. File sharing or generally resource sharing, client-server services, video conference, mobile access, web services and the internet are only some of the implementations that take place in every well respected company nowadays and enhance the productivity and the potency of a modern company.

Nowadays we are moving towards the era of ubiquitous high-speed networks which can offer to the staff mobility and data liability, carrying data, voice and even more multimedia services. The old traditional logic of lonely employees doing their job on their personal computers saving their work on diskettes or CD-ROMs is the image of an old company which does not follow the evolution and which could have several problems from the crash of just one computer!

As it is expected, technological evolution follows the progress of our mind and of our aspect about the organisation and the structure of a human society. None piece of information cannot obtain its maximum value if it cannot be shared and propagated to others. By the same way organising the Information System of a company wisely can bring critical advantages and accelerate the inter-company's procedures. Even more, productivity rises by the availability of information in a well structured system. The era of paper must be considered as obsolete. Just think the fact that now, the available technology guarantees that a request from a far point of sale can be delivered at the main storage of a company in a few seconds wherever this point can be in all over the world. Speed of service towards the customers is today a decisive factor for the viability of companies. Even in scientific labs the team work is the factor of success over a given project. We should encourage and promote those principles among any company in order to achieve cooperation and successful rundown update and feedback to all levels of company's hierarchy.

Nowadays several sophisticated technologies offer those solutions that are needed to implement not an ideal situation, but a powerful tool which can bring the semantic differential. Those solutions are not an academic project but the result of the technological progress. Hardly tested and long time implemented solutions offer us now the certainty and the assurance that those systems will definitely be effective and lucrative for any company. This is sure because we don't have to face with an one and only business solution. Those systems are adaptive to the needs of the company, its complexion and its economic potency.

In our case all those elements, referred above, can be implemented to create a well structured and organised local branch in Greece. The elements are shown easily and logically. We have the main firm's resources, part of those have to be available here in Greece. The given departments represent the organisational structure and with a little analysis can determine the way by which the Information System will be organised. R&D Department which has 10 employees is the first cell of our new born organism. Central Administration Dept with its internal structure consisted of the secretarial, administration and the technical staff follows. Then there is the Sales Department which is logically connected to the given Point of Sales in Athens, Piraeus, Thessalonica, Herakleio and Patras and finally the Economic Department with its 3 accounting staff. As it is understood the structure of the Information System isn't anything different from our own human concept about the organisation of a company. The difference comes when we have to

think about properties and access rights that we may give to these people. As you may already have imagined the technologies that we are going to implement here, allow us to determine the access levels not only of each department but also the rights of each person. This exactly is the great advantage of these systems. They can offer personalized services to each member of the Branch. Each employee will have access exactly were he needs to and not to the whole system [1]. It is recommended here to create a special group of members which will be the Directors or Managers Group which will have enriched rights in the company's system in order to manage the department they supervise. In this group General Director or CEO will belong too.

Physical connectivity between the buildings and the point of sales can be provided by several means and the most effective and affordable ones will be selected. Furthermore, the technical details will be presented and discussed but here it is enough to say that trustworthy and reliable technologies will be used in order to achieve the maximum positive result. The heart of this new organism is the Network Operating System which will be the Windows 2000 Server OS. This system is very well documented and supported and widely tested as well. The local job market can provide skilled personnel to support the new systems, personnel that are available and do not rise the expenses of the company. We could propose other complex or more pretentious OS (Operating System) and materializations of a plan but the purpose of the Information System is to serve us and not to make us slaves of it. The maintenance of this system is a very important factor and we should be able to have the maximum possible choices in the selection of our supporting staff. The more complex and pretentious a system is the more difficult becomes the finding of specialized staff.

Second Section – Technical Analysis

In this section a more technical and detailed analysis will be given in order to complete the understanding of the proposed solution. This section will be divided into some parts, making more structured this lucubration. Before proceeding it is needed to keep ourselves focused to the size of the Greek Branch and its needs. One major factor of the delay and sometimes of the miscarriage of various networking projects here in Greece is the fact that we generally don't estimate well the proportion of Greek companies implementing complex and heavy solutions raising the cost and turning trusted solutions into failure.

Before we continue, it is needed to see the general network design which is shown at *Fig.1*. Considering the options we have available, some alternative issues may arise. The main building can be connected to the Firm's network via a high speed ADSL connection of 1024/512 Kbps implementing a VPN connection which seems enough for the present needs but a leased line can be installed in the future. Another issue is the connection of the two company's buildings which can be made by several means depending the distance between them and the funds that could be available. We can establish an optic fiber, a wireless connection or a simple cable to connect them changing in each option the equipment that controls this connection. Since optic means are more secure, offer high speed connection and the distance permits the cost it is proposed to use them. POSs are connected with the main building via VPN connections of smaller ADSL lines having ISDN backup lines. VPN connections are discussed later.

The Greek Branch has a maximum personnel number of 30 people which may increase. The proposed system will be able to satisfy future needs and changes. This is another great advantage of Windows 2000 Server OS and in one word is called scalability. Easy integration of new users or units is important in a well respected and ascending company. Windows 2000 have the ability to grow with the organization and a new user will be immediately able to begin collaborating with its counterparts. A great tool which is offered and will be discussed later, Active Directory (AD), will enable all departments to easily share computing resources regardless of organizational structure or location. This characteristic gives us the potential for serious savings on shared hardware and software costs. Another advantage is the Kerberos System that is used for authentication and it is an industry standard respected and recognized for reliable encryption [2]. Generally, Windows 2000

System is based on industry standards technologies such as LDAP, DNS, TCP/IP, SMTP, Kerberos etc. These protocols make it possible to integrate Windows 2000 Directory Information with other enterprise level directory systems.

Reviewing this little introduction of the technical part it is purposive to recapitulate the abilities and the benefits of the proposed solution which enables the acting as one organization of the company's consisting parts.

Enterprise wide collaboration, centralized Information Technology (IT) initiatives and support, lower Total Cost of Ownership (TCO), improved reliability, enhanced Network Security, scalability and easy system integration are some of the advantages of the situation that is going to be implemented in the local Greek Branch in order to collaborate with the firm's global network [3].

I. Hardware-Software Components

Beginning from the smaller cell of the branch, the Points of Sales (POS), it is suggested to use a smart solution for the connection with the main buildings of the company. At long last, here in Greece too, fast connections to the Internet are offered via ADSL lines. It is obvious that we are going to use them in order to bring connectivity between the POS and the main building. VPN (Virtual Private Network) [4] connections will be implemented and all traffic will be encapsulated within IPSec secure tunnels. ADSL technology can in the same time provide telephony services to the public telephony network. The analysis of VPN connections will be examined in the topic of networking which follows later. This suggestion may seem expensive but today technology offers capable ADSL modem/routers which have integrated firewall, routing and alternative connectivity capabilities in very reasonable prices. With a simple switch we can establish the POS small network which will be consisted by 2 Personal Computers (PC) and 2 Printers, and it is shown at *Fig.2*. We could use a multi purpose device in order to have Fax – Telephone – Printer and Scanner services such as the HP LaserJet 3030 (440,00 €) . Since we will equip the company with new computers we suggest the buy of modern units like P4 processor 3,0 GHz, 512 MB RAM DDR 400 MHz, HDD 80 Gb etc at an average cost of 750 €with 17" TFT screens (400 €). The main point on the subject of PCs is that they must be identical in order to achieve smooth centralized administration. The company's network computers must be controlled, updated and maintained from the NOC. Printers should be a laser printer and a dot matrix printer like OKI Microline ML – 3320 which is very liable and tested (approx. 551, 00 €) for the printing of notices of receipt for the customers. Those Printers can be shared among computers of the POS and in under some circumstances a document could be printed straightly from some main company's computers which will be able to recognize those printers. The Operating System of the computers will be Windows XP Professional and Microsoft Office Products will be installed, which will accompany the new computers. Furthermore POS will be clients of the company's ERP System in order to bring off orders and have a useful connection to the catalogue of the products' main storage of the company.

At the main buildings, separated departments will be equipped by same computer units for the users and network printers will offer print services to all personnel. A device like HP Laser 1300 N (469, 00 €) established in each department will be adequate and even exaggerative for their needs. Some OKI ML – 521 (700, 00 €) printers can exist in the sales department for the prints that need pin printers and one of them can be located at the Economic Department for the accounting prints which use to be in this format too.

A Network Operating Center (NOC) will be created at the main building and there it is reasonable to be located the Central Administration Department too. A computer room well equipped with refrigeration machines will be part of this Department and will host servers and high-tech connection devices. There will be located the main router, the firewall device and the servers including application server, Web Server, DNS server and the one Domain Controller (DC). Intranet's DNS server will control access to the Firm's and Company's Directories and applications. External router and server will serve customers that may use a Web-based Sales system connected

securely with the company's ERP system while at the same time DNS service will answer to external requests. This topology enhances security and discriminates the intranet from the public environment. Alternative servers and another DC will be located at the second building for purposes of replication, security and authentication including a UNIX server for the needs of the R&D Department. The DC of this building will be able to take over if the other DC fails. *Fig.3* and *Fig.4* show the two buildings' infrastructure. The servers can be IBM XSERVER 235 series (2.085,00 €) which are certified for Windows 2000 Applications and an SQL Server can serve the ERP System.

All servers must implement RAID arrays for the hard disks in order to achieve ceaseless operability and backup processes must be scheduled. Generally an administration policy has to be designed by the Administration Dept and back office procedures must take place during low workload times. Here, it is not needed to analyse those procedures but they are very important for the efficiency and the reliability of the Information System. Since the branch is small each server can offer several services and act for example as DNS and DHCP (offering IP addresses to clients) in the same time.

For the needs of the R&D Dept we can use Samba software witch is popular Linux-Windows integration software. Samba offers the ability to authenticate users using LDAP and Kerberos and join an Active Directory domain as a member server providing Linux/UNIX servers with the ability to fully participate in Windows networks and here this is exactly our case [5].

Finally in this part it is vital to emphasise in the use of UPS devices due to the several problems that are taking place in Greece concerning electricity. In each major building we propose the establishment of UPS MGE COMET EXT 4,5 KVA (2.385,00 €) devices and at the POS UPS MGE LI EVOL 1500 VA (504, 00 €) will be enough for each POS. The main UPS systems may seem overmuch but we have to always keep in mind that we do not design a system to last only one year. Future additions should be satisfied by the existing system.

In this part infrastructure details were presented and some basic software demands were exposed. Prices that were referred will be useful later but it is fair to have some indicative costs in mind.

II. VPN Connections - Directory Services   (For the purposes of the Coursework)

As Basic Services of the proposed Information System we can consider the VPN Connections and the Directory Services..

A VPN is a private network that is implemented over a public network such as the Internet. Traffic and data are transferred across the network using tunnelling techniques that create virtual paths between and among various nodes. Generally a VPN connection includes tunnelling, encryption, authentication and access control. The approaches that can be met are the LAN-to-LAN tunnelling and Client-to-LAN Tunnelling witch is our case for the POS.

VPN tunnelling takes place with the use of protocols that establish paths through the Internet to allow the transfer of data between nodes. Among the primary protocols are PPTP (Point-to-Point Tunnelling Protocol), L2TP (Layer 2 Tunnelling Protocol) and IPSec (IP Secutrity Protocols). The data that is transferred over a public network includes encapsulation to provide confidentiality. Authentication and access control utilize simple password authentication and some more sophisticated methods use key exchange like Diffie-Hellman key exchange.

By VPN individual PCs, applications and small networks (by large implementations whole LANs can be connected) connect through the public network to an organization's WAN or LAN. The most common application for this is connecting ADSL users and mobile employees to the corporate VPN. The VPN protocol can be applied either in hardware or software. ADSL routers endpoint routers incorporate hardware VPN functionality within the router itself and other solutions suggest a separate network device connected between the ADSL endpoint and LAN [6].

LAN-to-LAN approach can be used in our case in order to connect the Greek Branch with the firm's global network something which can save serious economical funds and lower cost of our total solution. Of course a broadband connection should be used in this case in order not to have

bandwidth and high traffic problems. However, it seems very logical for our needs connecting the Greek Branch using VPN with the Firm instead of using a very costly leased line.

Now we are going to present the Directory Services that are going to be implemented, making an introduction to the whole aspect and a reference to the logical structure of the company's Information System presenting some implementations and requirements that operate as the link to the previous sections. Some concepts that are already mentioned will be clearer and more understood here.

As it was mentioned before Active Directory (AD) is a powerful characteristic of Windows 2000 Server that provides the capability for distributed networking environments. This is possible because it implements a centralized place to store information on network resources and its users. It also acts as a central authority for network security as it verifies a user's identity and controls his access to the resources that are managed by the directory service [7]. Generally Active Directory eliminates redundant management tasks, reduces visits of the Helpdesk to the network's PCs and maximizes IT resources. These are great advantages talking about technical matters. To be more precise on the matter of security Windows 2000 and AD support multiple authentication protocols such as Kerberos, X.509 certificates and smart cards. These combined with the offered access control model, enables consistent security services for internal desktop users, dial-up remote users and external users. Application integration and synchronization mechanisms ensure interoperability and allows to company to deploy directory enabled networking.

Proceeding to more practical matters AD uses objects to represent network resources which are users, groups, machines, devices and applications. Containers are used to represent organizational units such as Sales and Economic Department, or collections of related resources such as printers. By this way it is easy to form a tree structure containing all these objects similar to the very familiar structure of folders and subfolders in Windows Operating Systems [8]. User objects have attributes that determine their comportment and their access rights in the network. Users can be divided into groups creating teams and making easier their administration. A user can inherit its group rights or have extra rights adapted to its needs. This is making much easier the affiliation of new users in the network ensuring easy scalability. Lots of rules can be implemented such as bandwidth control in order to achieve adequate resources there that they are needed. As it is shown here the AD model reflects the model that we have in mind organizing hierarchically a company. Now we have to discriminate the components of AD. As we mentioned we have Organisational Units (OU) that are used to divide a given namespace (DNS name) and are associated with AD containers. An OU is established to provide an administrative boundary. OUs can contain other OUs or even leaf objects such as users, printers and computers. In general a domain should not exceed the 10 OUs [9]. OUs are the factor that can help us very much because, by using them properly, allow us to avoid the creation of useless domains which require at least two servers each. Each domain requires two domain controllers and additional domain controllers add an increased administrative load on the central management function [10].

Now, it is clear that under the parent firm.com we are going to create the greece.firm.com witch is going to be its child in terms of DNS, and under this subdomain we are going to create the organisational structure that is emerging from our analysis (***Fig.5***). The trusted relation between those domains will ensure the access of the Greek branch to global information from the firm's sites.

As it is shown at ***Fig.6*** according to the above analysis we are going to have the following OUs and users structure in the Greek branch:

1. R&D OU
2. Central Administration OU
3. Economics OU
4. Managers OU
5. Sales OU
6. POS OU witch will be under Sales

Creating groups of users such as sales staff or administration personnel we can give access rights to individuals in order to access needed resources and applications according to their responsibilities. For example the person witch supports the POS points in each city will have access to administration resources at the Central Administration OU and the person that controls sales will have access to the company's ERP application. This is going to happen automatically when this person logs on from any computer in the company's network with its unique username and password. Members of each OU will have access to the global firm's resources which will be given from the firm's administration centre and will be compatible with their responsibilities.

At the same time an internal server will provide access to the intranet's web content where they could be internal operating instructions, rules of the company or documents. There a mail server will be implemented too from which the personnel will have personal mail addresses, being an internal web mail server.

More analysis of those operations will be given from future consideration of the proposed project following the above guidelines.

III. VoIP (For the purposes of the Coursework)

The revolution of TCP/IP and networking brought new integrated services at the proscenium which are in fact *Value-added Services.* One major of those is Voice over IP (VoIP) which uses the computer network and infrastructure in order to provide telephony services. This eliminates the cost of internal phone calls in a company and as you can imagine a whole company's WAN can operate by this way. That means that a call from the Greek Branch to the offices of the firm can cost nothing!

Special protocols such as MGCP, SIP and H.323 are used to offer those services and special devices called IP phones make this wonderful operation to function [11]. With the use of an H.323 server and a gateway the service of VoIP can cooperate with the PSTN (the public network) but this will demand expenditures that we don't have to make. Furthermore those technologies are not yet mature and widely tested. But free calls between POSs and the company are very important and able to save us from a serious expenditure. Since there are VPN connections POSs become members of the company's WAN and are reachable with a VoIP call.

This technology supports Fax functions too but the document support which will be offered from our Information System will be enough.

Nowadays the industry has adopted the H.323 protocol and QoS operations take place in order to ensure quality of the calls. Special devices that we have to use, such as Cisco IP phones cost more than conventional devices but the final advantage that we gain is very important.

IV. Economic Fixtures

Economic studies that have been made by large companies such as Cybersource [12] and IDC [13] show that finally open source free solutions are not as inexpensive as they are rumoured to be.

As it was mentioned at the start of this study cost is not always the most important factor to decide what Operating System will be used. Windows 2000 are mature and ensure more readily available and skilled IT personnel on the open market. The above studies show that staffing costs for Linux servers are higher than for systems under Windows 2000. Additional to these is that Windows servers tend to carry greater numbers of more complicated workloads and their environment is definitely friendlier to the average user. Prices that are going to be presented here are taken from a study that has been made at the Cooperative Bank of Corinthia when its network was overviewed last month. Some demonstrative costs follow.

During this coursework some of those prices were referred and here a synopsis will be made and some additional information will be given.

The prices that follow are divided in categories based on the assumption that 30 PCs, 7 servers, 9 network printers, 6 dot matrix printers, 7 routers of different kind, 2 24-port switches, 5 6-port switches, 1 hardware firewall and the adjust software will be installed. This is a demonstrative cost analysis that may change depending on the techniques that will finally be used. It is important to say that always backup equipment should exist in order to cover unexpected damages. That is why identical hardware must be used in order to avoid complex configurations and additional effort to succeed ceaseless operation of the Information System.

H/W - S/W	Quantity	Price
PCs + screens	40	36.000 €
HP LaserJet 3030	5	2.200 €
OKI Microline 3320	6	3.300 €
OKI ML 521	2	1.400 €
HP Laser Printer 1300n	8	3.700 €
IBM Servers x235	7	21.000 €
Interconnecting Devices	Approx.	10.000 €
UPS Systems	7	7.000 €
Variable needed S/W		15.000 €

This table is general and gives a total cost of 100.000 € which is a serious investment that will surely cover future needs. Adding configuration and cabling costs the project should not cost over 150.000 € The solution proposed will bring smooth access and easy maintenance of the company's network and will allow shared resources to serve company's needs.

Figures Appendix

Figures that are shown here were designed with the Smartdraw ver. 7 Suite Edition.
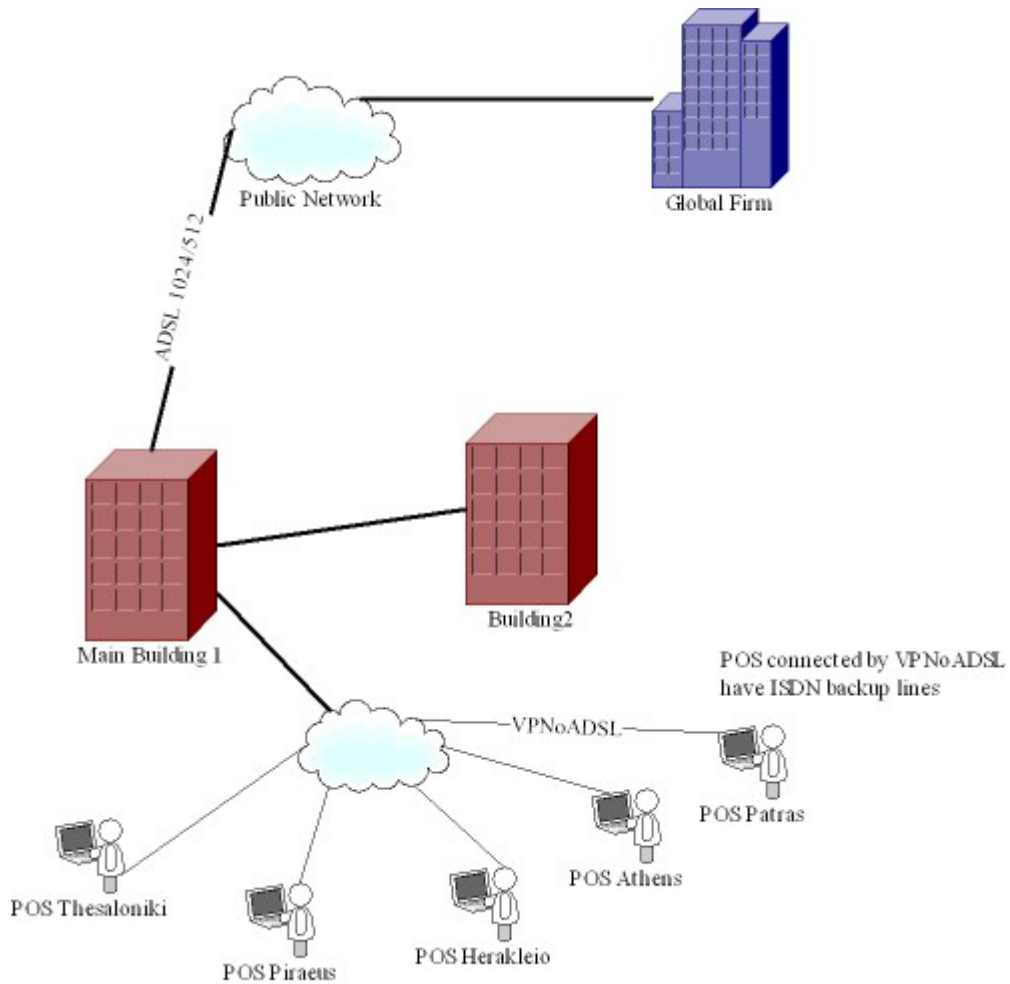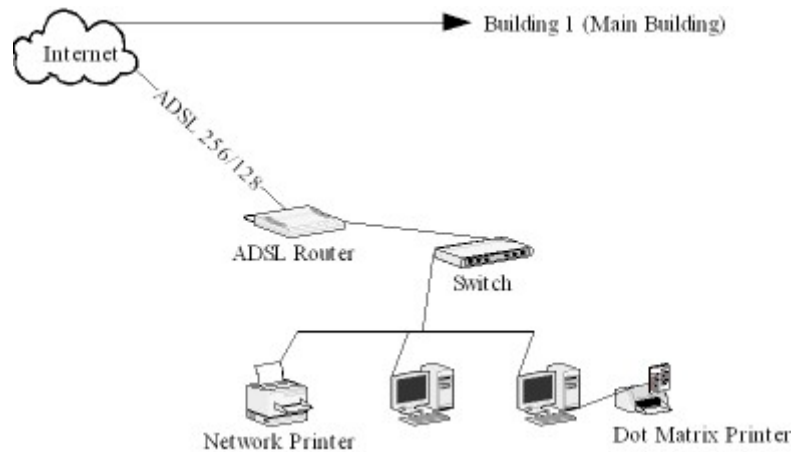

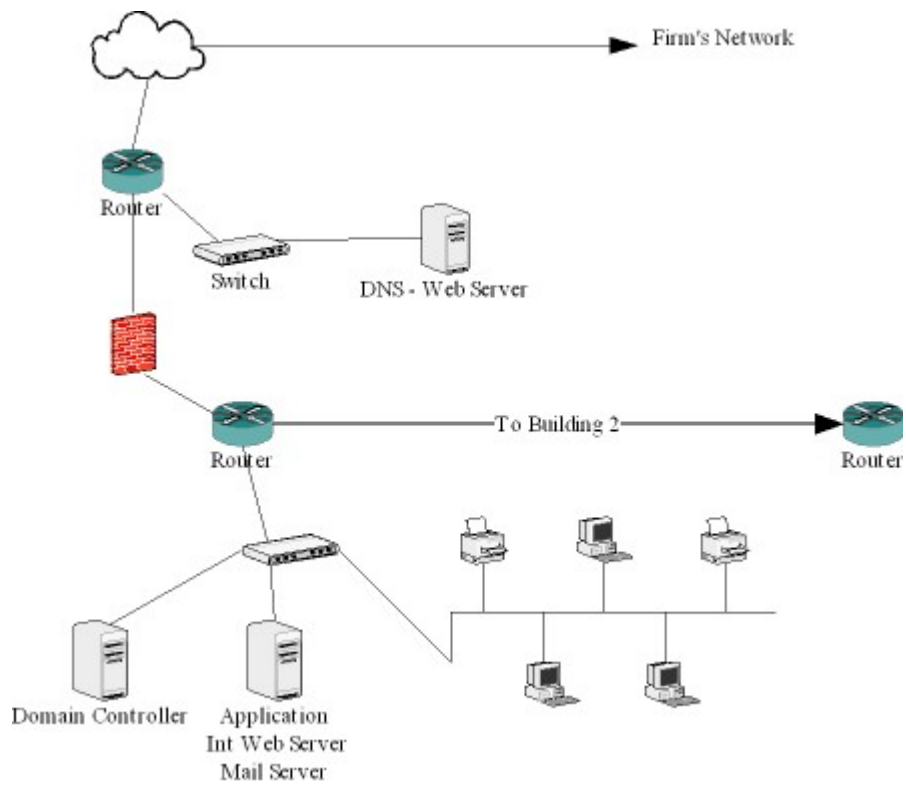*Fig.1* Network Design

Fig.2 POS network
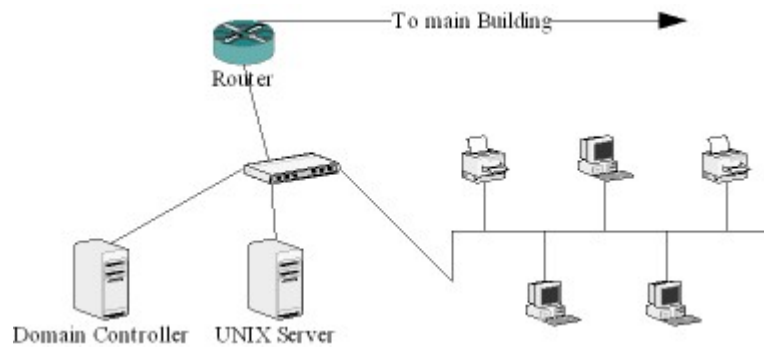

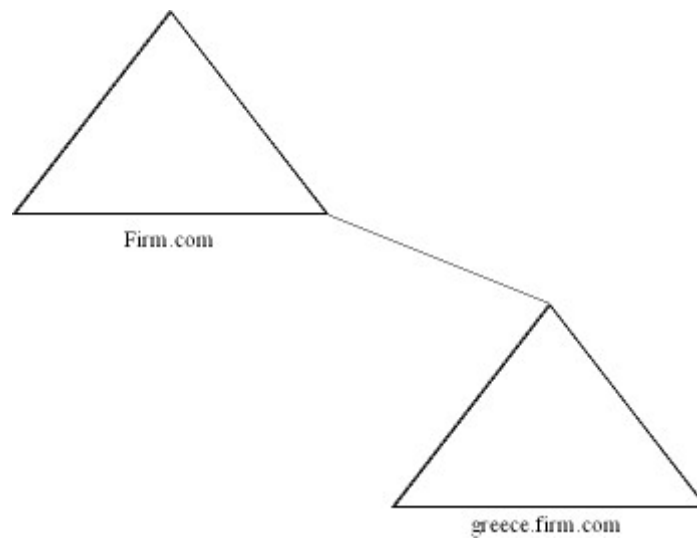*Fig.3* Main Building 1 Infrastructure

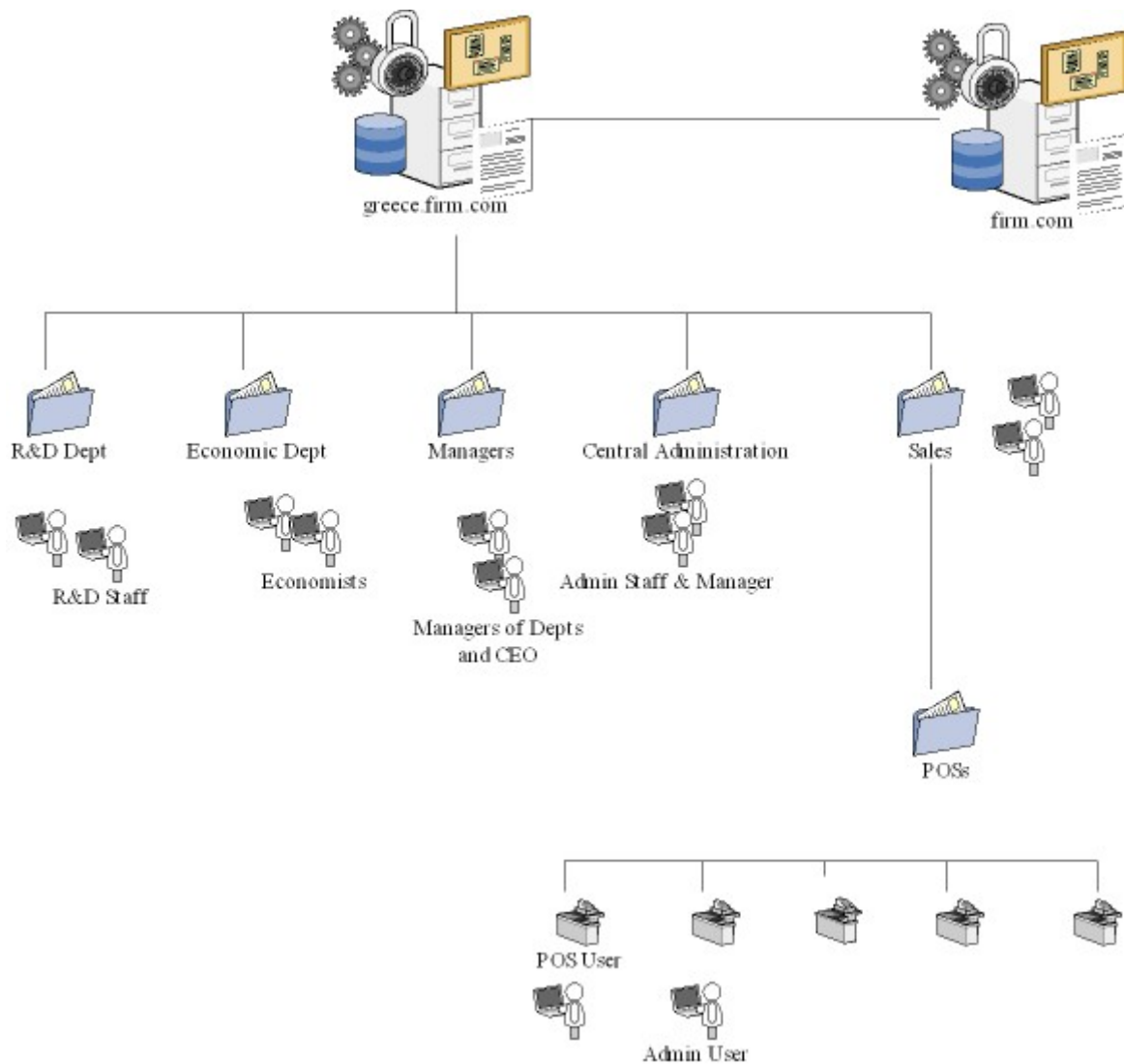*Fig.4* Building 2 Infrastructure

Fig.5 Active Directory Tree

Fig.6 Active Directory Structure

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