UTILISATION OF SUBNETWORKS THROUGH DISTRIBUTED GATEWAY.

A project paper submitted to the Graduate School in partial fulfillment of the requirements for the degree of Master of Science (Information Technology), Universiti Utara Malaysia.

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ABSTRACT

There is increasing use of Internet in a LAN environment. Reliance on hardware and software that are mostly costly and difficult to maintain brings about problems for organisations with a small budget. Moreover, many networks available in these types of organisations, especially schools and colleges, are not fully utilised. This is especially true in terms of access to the Internet, Besides being a viable alternative to proxy server softwares, IP masqeurading allows the interconnection of subnetworks and distribution of gateways in a multiple internal LAN environment. For the server, which acts as the gateway to the Internet, Freesco, an IP masqeurading distribution which is Linux based, is used. The Windows 2000 OS is used on the client machines, A distributed gateway based on alternative routes to other gateways in different subnetworks will minimise the event of users having disconnection problems. Hence this ensures reliable and continuous Internet connection through an alternative subnetwork in the event of a connection failure in an adjoining subnetwork.

ABSTRAK

Terdapat peningkatan ketara penggunaan Internet dalam persekitaran LAN. Penggantungan kepada perkakasan dan perisian yang mahal dan sukar untuk diselenggara memberi masaalah kepada organisasi yang mempunyai sumber kewangan yang terhad. Kebanyakkan sistem rangkaian yang terdapat dalam organisasi sebegini , seperti di sekolah dan kolej, tidak di manfaatkan sepenuhnya. Perkara ini lebih ketara dalam isu seperti akses ke Internet. Selain daripada menjadi alternatif kepada perisian pelayan proxy, IP masqeurading membolehkan sambungan antara sub rangkaian dan pengagihan gateway dalam persekitaran LAN. Bagi pelayan, yang bertindak sebagai gateway kepada Internet, Freesco, suatu distribusi IP masqeurading yang berasaskan sistem operasi Linux, di gunakan. Windows 2000 digunakan untuk komputer pelanggan. Gateway yang disebarkan kepada sub rangkaian yang lain akan meminimakan permasaalahan terputus sambungan. Oleh itu, ini dapat memastikan sambungan ke Internet yang berterusan dan efisien walau pun dalam keadaan sambungan yang terputus dalam suatu sub rangkaian.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Today's wired organisation relies on access to the Internet for email and web access. Networked PCs require access via the local area network (LAN) rather than through a dedicated modem and telephone line connection at each PC. Many computer labs, especially in schools and teacher training colleges use LAN connections and are able to access the Internet through an Internet Service Provider (ISP). Some of these LANs rely on hardware solutions like routers or internet sharing hubs. Some use proxy server softwares that are easily available in the market. While proxy server software is a reasonably cheap solution compared to having each PC connecting to a modem, problems of persistent disconnections are not uncommon. Furthermore, any applications that we might want to use on the PC, like Netscape, some telnet and file transfer protocol (FTP) clients must have proxy server support. Internet protocol masquerading (IP Masq) doesn't require any such special application support.

The contents of the thesis is for internal user only

gateway 1 and for gateway 2, the DNS server is set as 192.168.10.1. For client machines in both networks, there were not much configuration being made since IP addressing was set automatic because DHCP was enabled.

3.2 Internet connection through an alternative subnetwork

For interconnection of both networks 192.168.0.0 and 192.168.10.0 in the second phase of the project, there are two practical choices, namely:

- Bridging
- Routing

For this project, routing was used. Routers can be used to interconnect extended LANs in such a way that the traffic generated on one LAN is better isolated from the traffic generated on the other LAN (Walrand, 1998). Two network interface cards (NIC) were installed to fascilitate interconnection of the sub LANs. Thus both gateways not only provide access to the Internet but also act as internal routers interconnecting both sub LANs.

The second phase of the project interconnects two sub LANs as illustrated in Figure 7.

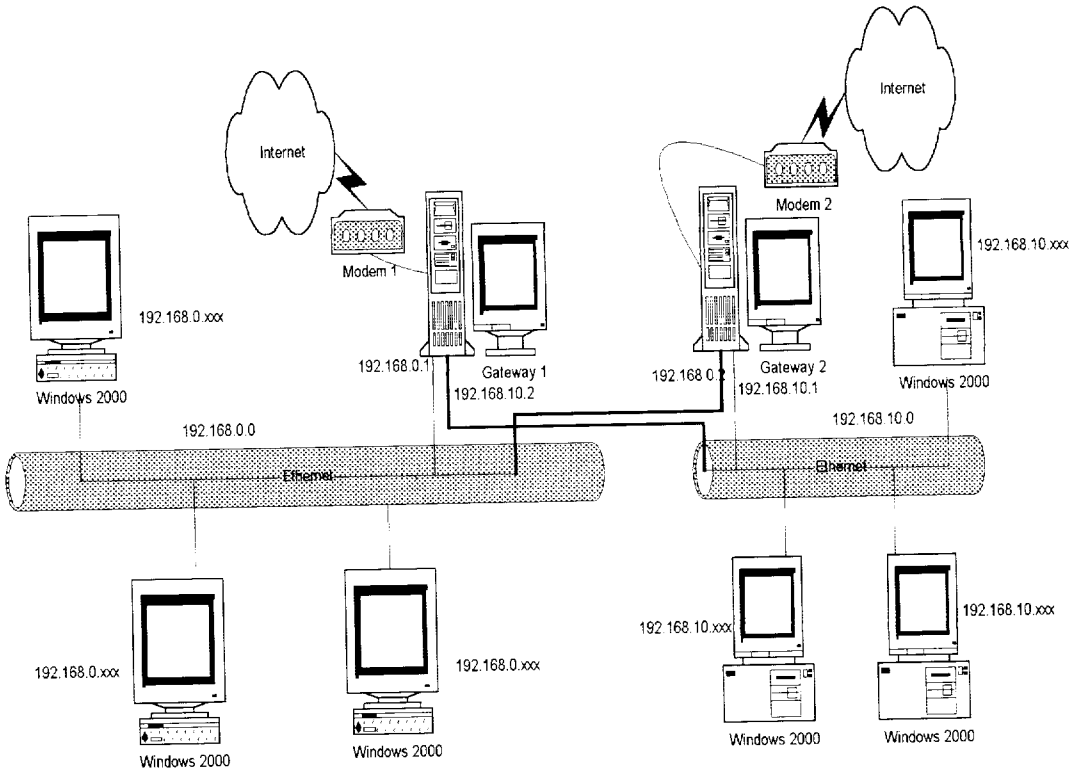

Figure 7 An example of two interconnected sub LANs using IP masquerading

This approach enables clients on network 192.168.0.0 to also access the Internet through gateway 2 and clients on network 192.168.10.0 to access the Internet through gateway 1 in the event of a connection failure in either networks.

The set up for both gateways are now different from the first phase where the sub LANs were seperated. The IP addresses of the first and second network interfaces respectively in gateway 1 are 192.168.0.1 and 192.168.10.2 whereas for gateway 2, the IP addresses are 192.168.10.1 and 192.168.0.2.

The client machines on both subnetworks were configured so that each PC on each subnetwork is able to access the Internet either from gateway 1 or gateway 2. With Windows 2000 installed on all client machines, network 192.168.0.0 was configured with the preferred DNS server being 192.168.0.1 and the alternate DNS server is 192.168.0.2. Client machines on network 192.168.10.0 were similarly configured with the preferred DNS server now being 192.168.10.1 and alternate DNS server is 192.168.10.2.

Since all internal IP masqueraded machines should not have official Internet assigned addressees, there must be specific and accepted way to allocate addresses to those machines without conflicting with anyone else's Internet addresses.

RFC 1918 is the official document on which IP addresses are to be used on a non-connected or private network. There are 3 blocks of numbers set aside specifically for this purpose. The Internet Assigned Numbers Authority (IANA) has reserved the following three blocks of the IP address space for private networks:

- 10.0.0.0 - 10.255.255.255
- 172.16.0.0 - 172.31.255.255
- 192.168.0.0 - 192.168.255.255

The first block is referred as 24-bit block, the second as 20-bit block, and to the third as 16-bit block. The first block is a single class A network number, while the second block is a set of 16 contiguous class B network numbers, and third block is a set of 255 contiguous class C network numbers. For this project, the preference is to use the 192.168.0.0 network with a 255.255.255.0 Class-C subnet mask for the first sub LAN and 192.168.10.0 network with a 255.255.255.0 Class-C subnet mask for the second sub LAN. 192.168.0.1 and 192.168.10.1 are the internal gateways to get out to the external network. 192.168.0.0, 192.168.10.0 and 192.168.0.255, 192.168.10.255 are the network

and broadcast addresses respectively (these addresses are reserved). These addresses are avoided to enable the network to work properly.

DNS server converts Internet addresses between human readable form (example: www.abc.net) and computer readable form (example: 195.2.83.113) and back This local caching DNS server can reduce traffic between the local network and and Internet Service Provider (ISP) and increase speed of connections to servers on the internet (Gaskin, 1999). To set up DNS server we have to know the ISP DNS address. For this project, since the ISP used is the one provided by TMNet, the ISP DNS address is 202.188.0.133.

DHCP server provides automatic configurations of the local networks computers. It makes the job of network administrator easier. Every computer on the network must have his own IP address and it must also know the DNS address and gateway. DHCP server supply every computer on the network with this information (Gaskin, 1999). For this project, the DHCP is enabled for configuration on the local clients and DHCP server will do the rest, otherwise we have to enter all this addresses manually.

We can have full access to the gateway via telnet connection. Unlike http control service in the Freesco web panel, it doesn't have any restrictions and we can edit the config files from the workstation via telnet connection.

Another component required to use Internet resources is application software for workstations, which are IBM PC compatibles with the MS Windows 2000 operating system. This version of MS Windows is better equipped with Internet client software, in particular Internet Explorer compared to previous versions.

The other applications covered in each workstation have at least the following Internet services:

- Telnet (client with a VT100 / VT220 emulation).
- FTP (client with graphical user interface).
- WWW (Netscape Navigator version 4.0 onwards besides Windows 2000 built in Internet Explorer).

Helper applications were also included to support:

- MPEG audio and video files.
- PostScript files.
- PDF (Portable Document Format) files.
- Compressed files (ZIP, Z, GZ, TAR)

The majority of the above applications are free, some of them are low cost shareware.

CHAPTER 4

FINDINGS

4.0 Introduction

This project looks at the development of computer lab models based on the IP masquerading LAN Internet gateway as well as the interconnection of two sub LANs for connection to the Internet.

4.1 LAN-Internet connection through the use of IP masquerading servers.

Configuration of client machines were done without any problems. For the first network, i.e 192.168.0.0, every client machine were able to detect each other using the built in Packet Internet Groper (PING) program for Windows 2000. With Dynamic Host Configuration Protocol (DHCP) enabled, every client on the network have their own assigned IP addresses. The same is true for the second network, 192.168.10.0. Unlike proxy servers, through IP masquerading there is no need for any configuration of browser programs on client machines for access to the Internet.

For server set up, the freesco distribution was downloaded in 3 minutes and initially installed on a 1.44 MB floppy disk. Once booted from the floppy, it was copied and moved to the hard disk without any problems. This was to make use of swap file from the hard disk to increase amount of memory. Setting up the gateway from the hard disk in network 192.168.0.0 was done without any problems. The modem and the NIC were also detected without much problems. The same was observed for network 192.168.10.0.

Once the freesco gateways at 192.168.0.1 and 192.168.10.1 were up and running, clients in each network were able to utilise the web control panel. However this was restricted to trusted users with password access provided by the administrator. Figure 8 shows an example of a web control panel screen as viewed from client in network 192.168.0.0.

Once the network setup enabled the PCs to communicate and gateways were properly configured, web access and other basic Internet services was readily available. This shows that a basic PC with minimal hardware and software resources can be a reliable LAN Internet server, thus drastically reducing costs as compared to a proxy software server based approach.

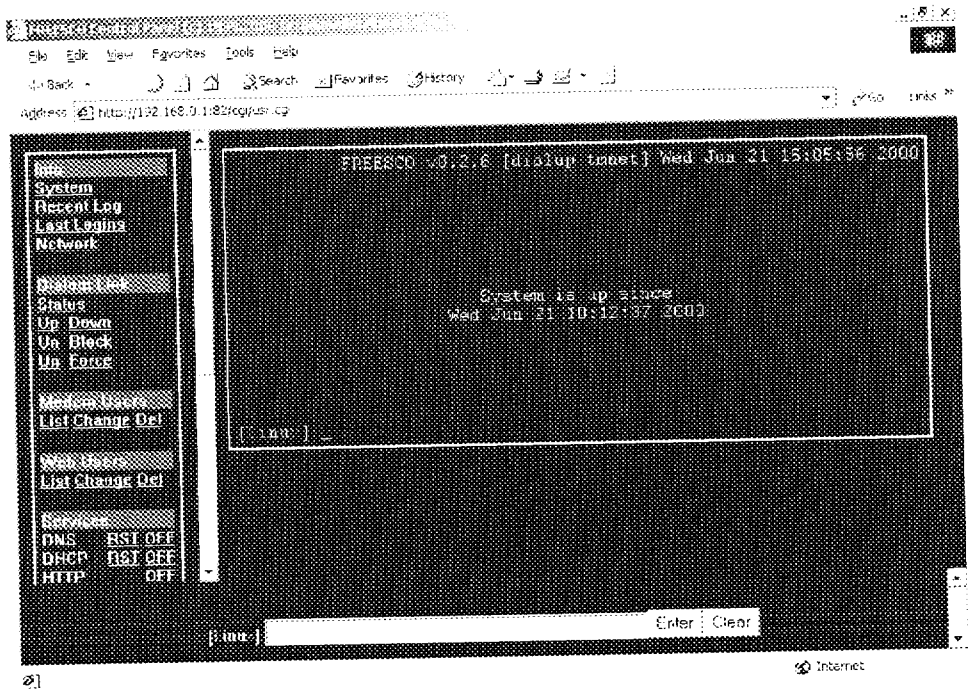

Figure 8 Freesco web control panel

4.2 Continuous Internet connection through an alternative subnetwork.

Freesco 2.6 was installed in both servers without much problems except for the detection of the two NICs on each server for alternative Internet connections. However, this was eventually overcome by first checking the BIOS and making sure there was no conflict with an existing serial port or IRQ. After checking the file var/log/log it was learned that names eth0 and eth1 have been

swapped. The alternative was to swap the interface names in advanced setup in freesco through options 72 and 73 from memory, change "first network interface" to eth1 and second to eth0.

With the gateways also functioning as internal routers in each network, client machines in each network were able to communicate with each other through these routers.

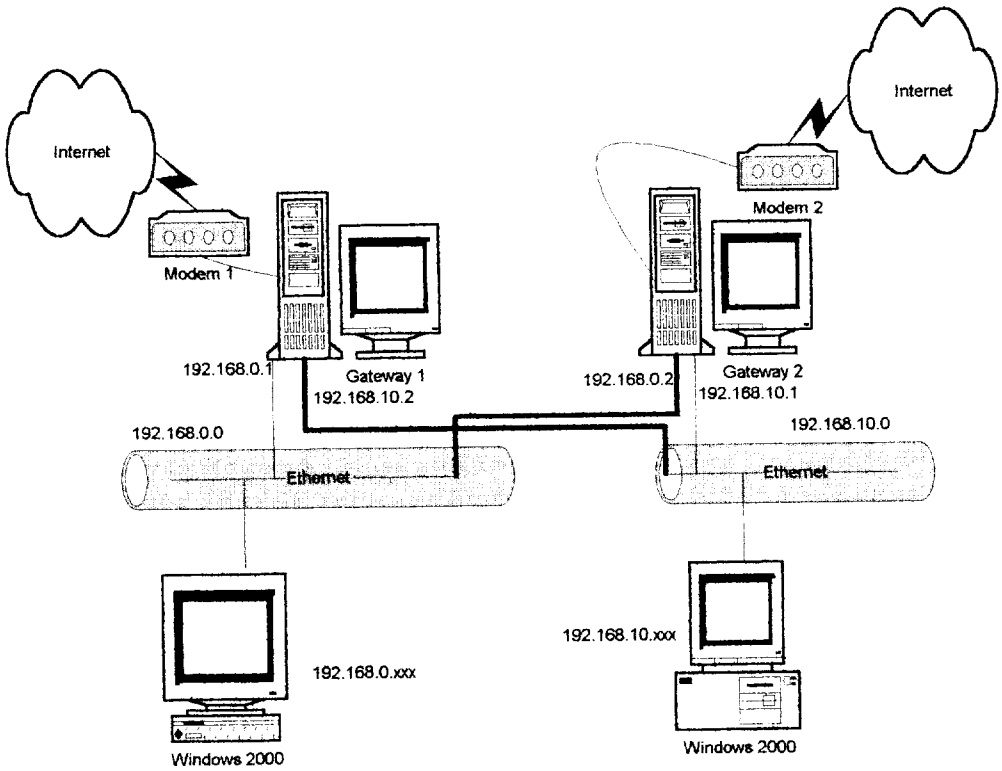

Figure 9 Distributed gateway

Once the network setup enabled the PCs to communicate and gateways were properly configured, access to the Internet was not a problem. Both gateways in networks 192.168.0.0 and 192.168.10.0 were very stable especially in low traffic. Heavy traffic affected access speeds, especially when both computer labs, consisting of 20 PCs each, were fully occupied although this situation of maximum use of Internet in both sub LANs was rare. However, speed problems were negligible for basic use such as surfing the web.

Modem 1	**Modem 2**	**Clients in network**	**Internet**
On	Off	192.168.0.0 and 192.168.10.0	On
Off	On	192.168.0.0 and 192.168.10.0	On

Table 3 Internet access in subnetworks

As shown in Table 3 (refer also Figure 9), it was also found that a disconnection of modem in one sub LAN, did not affect access to the Internet as long as connection in the other sub LAN was secure. This conforms with findings in the paper 'Designing Large-Scale IP Internetworks' from Cisco Systems technology information (2000) that most networks are designed with multiple paths so there are alternatives in case a failure occurs. Other factors

beyond control, for example PSTN line disturbances and TMnet server problems affected Internet access.

4.3 Hints and other findings

- There are several online technical documentations, including HOWTOs on IP masquerading.

- For editing and configuration purposes on freesco via telnet, there are some problems with the built in Windows 2000 telnet program. Try a different telnet client, like PuTTY.

- It is recommended to use hard disk drive compared to floppy disk. Its faster on booting and least succeptable to error. The swap file is a good feature especially if we are using it as a print server.

- In internet options in the browser software make sure access to the Internet via a proxy server is disabled. However do check connect to the Internet via LAN.

- If we want to run the gateway without display and keyboard/mouse hardware as well, be sure to configure the BIOS to operate without a keyboard so that the machine will automatically boot without errors after power failures or other problems.

- To immediately boot the gateway so that Internet connection will be available when client machines boot up, edit the user script, /rc/rc_user and put a line under the startup section: control up.

- Use internal ISA modems because it has some advantages over external modems, for several reasons:

    1) They have built in 16550A UART chips, which means we get proper performance on old machines even if the ports in the machines are only slow 16450/8250's.

    2) They're usually slightly faster because we don't have the added latency of sending the data over a serial cable.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.0 Discussion

Computer labs with Internet access based on IP masquerading can be a viable alternative to those based on the current set up of proxy servers mostly using ethernet networks and dial up modems on PSTN telephone lines. The presence of distributed gateways also ensures broken access to the Internet is kept to a minimum. This is an important feature in IP masquerading which provides an option for alternate gateways where this is not available in proxy server softwares. The server set up, using the freesco 2.6 distribution is not too complex and if suitable hardware is chosen, any problems that may arise can be easily overcome. Although client PCs need not necessarilly be Windows based, Windows 2000 was maintained in the PCs as it was originally installed in the previous proxy server based network. The ethernet wired with 10 base2 coaxial cables is the current network design with very minor changes being made for this project. The only alterations made were for the purpose of interconnection of sub LANs using the two NICs installed in both gateways.

5.1 Suggestion for a computer lab model

Computer labs today needs to be networked and have access to the Internet. Unfortunately, this has become a costly affair, more so for schools and colleges with very limited budget. The increasing popularity of Linux as the alternative to Windows could be a blessing for these types of organisations. In line with the Malaysian National Information Technology Council's proposal (Computimes; August 7, 2000) to create equitable access to information among the people, the further decrease on hardware and software costs can be a contributing factor towards realising this goal and hence address the digital divide among the people. The recent encouraging breakthrough in the development of molecular electronics (IN-TECH; August 1, 2000) which promises to revolutionise computer processor speed with tremendous cost savings is another positive development.

Used 486 machines can be purchased at minimal cost these days. These machines, with some extra RAM and hard disk space added on, are enough for Linux to run on.

Suggestion for Server

1. Freesco IP masquerading server using Pentium 100 MHz.

2. Print servers based on freesco IP masquerading using 486DX-100 MHz machines.

Suggestion for Clients

1. 486DX-100 MHz machines using the Linux OS.

2. Office suite based on the Linux OS, for example Staroffice, which is another free application.

3. For Internet browsing, Netscape for Linux.

A possible design of interconnected computer labs could be as follows.

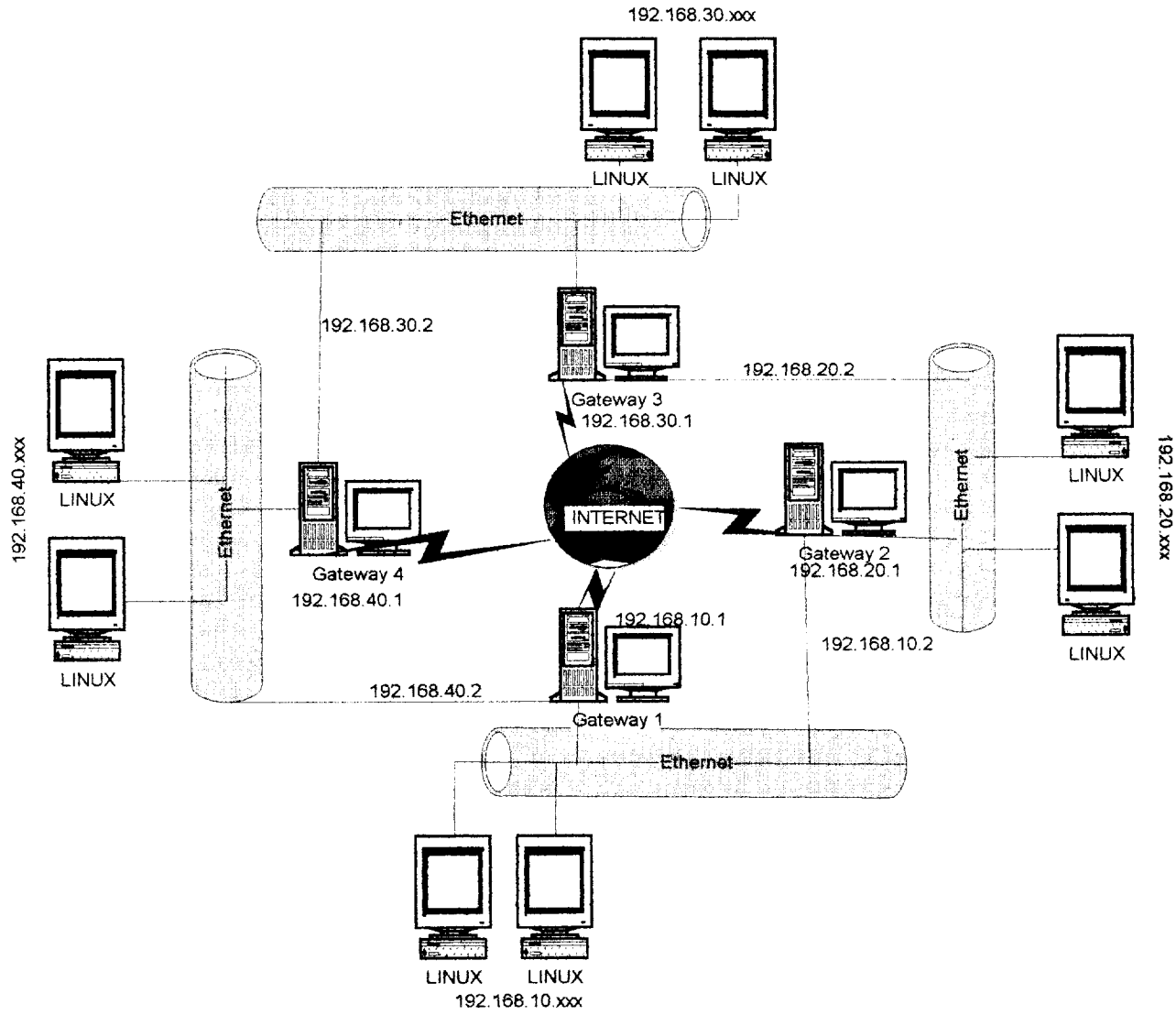

Figure 10 Distributed gateway of subnetworks in a Linux only environment

5.2 Conclusion

Freesco was developed in the open source tradition as an alternative to routing products offered by the more established networking hardware solution providers. This provides management one way to decrease expenses.

This research is far from complete in terms of providing a cost effective solution in the utilisation of sub networks for Internet access but the free and open source environment of Linux of which this project's IP masquerading is based on, can be further exploited to addresss issues such as bandwidth. If this can be overcome it will hopefully increase user satisfaction, particularly access to the Internet in a LAN environment. Coupled with the potential of the increased use of diskless computers and the future development of molecular electronics, further cost reduction is possible.

Implementing a functional internetwork is no simple task. Many challenges must be faced in areas like connectivity, reliability, network management and flexibility. Each area is key in establishing an efficient and effective internetwork.

Another essential consideration, reliable service, must be maintained in any internetwork. Individual users and entire organizations depend on consistent, reliable access to network resources. Furthermore, network management must provide centralized support and troubleshooting capabilities in an internetwork. Configuration, security, performance, and other issues must be adequately addressed for the internetwork to function smoothly. Flexibility, the final concern, is necessary for network expansion and new applications and services, among other factors.

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