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College of Computer Science and Information Technology

NETWORK ADDRESS TRANSLATION (NAT)

**A graduation project is submitted to the computer science
department in partial fulfillment of the requirements for the
degree of Bachelor in computer science.**

BY

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SUPERVISOR CERTIFICATION

I certify that the preparation of this project entitled

NETWORK ADDRESS TRANSLATION (NAT) ,

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**Was made under my supervision at General computer science
branch of University of Qadisiyah department in partial fulfillment of
the requirements for the degree of Bachelor of science in computer
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DEDICATION

ACKNOWLEDGMENTS

ABSTRACT

After increasing the proportion of users of the Internet and the need of each user to the IP address of his own Internet connection while IPv4 no longer meet these needs due to poor distribution, resulting in a lack of availability of public IP address for each user.

A solution called network address translation or so-called (NAT). This solution we can simply from if we had to impose a company of 10 people using the Internet in their work, before this solution had to buy public IP of the isp for each individual to be able to use Internet at the same time. With this solution, we can only buy one public IP that everyone uses.

Here is the main idea behind the use of NAT, which is the separation between the IP addresses used in the private network located at work or home, and the IP addresses used on the Internet. Thus there will be two types of IP addresses:

Private IP: This is the IP address used to distinguish the devices within the private network. We select this address freely, although there are standards that we prefer to abide by, one condition is not to repeat the same address for two devices within the network, or repeat the address with another address in another network or even with an online address will not affect anything.

Real IP: is the address used on the Internet, and distributed real IP addresses available for use across countries and then cities within countries in a manner similar to the distribution of telephone number.

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GLOSSARY

Abbreviation	Definition
NAT	Network address translation
IP	Internet protocol

CHAPTER 1 : INTRODUCTION

Packet Tracer is a cross-platform visual simulation tool designed by **Cisco** Systems that allows users to create network topologies and imitate modern computer networks. The software allows users to simulate the configuration of **Cisco** routers and switches using a simulated command line interface .

In addition to simulating certain aspects of computer networks , Packet Tracer can also be used for collaboration . As of Packet Tracer 5.0 , Packet Tracer supports a multi-user .

System that enables multiple users to connect multiple topologies together over a computer network .^[6] Packet Tracer also allows instructors to create activities that students have to complete .

[1] Packet Tracer is often used in *educational settings as a learning aid* .^{[7][8]} Cisco Systems claims that Packet Tracer is useful for network experimentation .

1.2 COMPUTER NETWORKS

Computer Network is a system for connecting two or more devices using a communication system technology to exchange information , resources and data available to the network such as (a printer) or (application software) of any kind , as well as allowing direct communication between user . In general , the study of computer networks is one of the branches of communication science. [4][5] .

History of network development :

The computer networks went through a long timeline until they reached the current era , and they continued with

their various types and equipment and technological techniques in the development and progress . Data transmission speeds became great. The types of cables used to connect devices and networks differed , The timeline for computer networks can be summarized as follows: [4] [5] [3]

- * 1934 : this year was the beginning of the so _ called search engines and hyperlinks; this was by belgian paul othelle , who aimed to collect all the information and spread it around the world.
- * 1940 : george spitz – one of the fathers of the computer through history – began using an electrical device to send orders to a number of new york computers using telegraph lines.
- * 1950 : this year saw the emergence of the concept of networks and the link between the various devices in the world of communications and computer , and the first attempts to connect the devices are the connection between military radar devices.
- * 1964 : American Airlines, in partnership with IBM, launched the SPARE system to connect computers to each other using telephone lines. Researchers at dartmouth college developed the dartmouth sharing system, and a year later used a computer to direct telephone calls at the research Institute massachusetts Institute of technology.
- * 1965 : Thomas Marrell and Lawrence Roberts created the first wide network (WAN).
- * 1977 : in this world, some commercial services were developed using networks, Via a protocol (X.25).
- * 1980 : Network protocol that regulate communication and data transmission over computer networks.
- * 1991 : this year, domestic broadband lines were launched.
- * 1996 : Dr. Brent invented a 56K modem.

* 2000 : domestic ADSL lines used to connect households to the internet have emerged after six years, the number of users has reached 13 million.

* 2005 : Cloud storage. [3][4][5]

1.3 TYPES OF COMPUTER NETWORKS

*LAN (Local Area Network).

*WAN (Wide Area Network).

*PAN(Personal Area Network).

*Local Area Network (LAN) :

A Local Area Network (LAN) is a network that is confined to a relatively small area. It is generally limited to a geographic area such as a writing lab, school, or building.

Computers connected to a network are broadly categorized as servers or workstations . Servers are generally not used by humans directly , but rather run continuously to provide "services" to the other computers (and their human users) on the network. Services provided can include printing and faxing , software hosting , file storage and sharing , messaging , data storage and retrieval, complete access control (security) for the network's resources, and many others.[2]

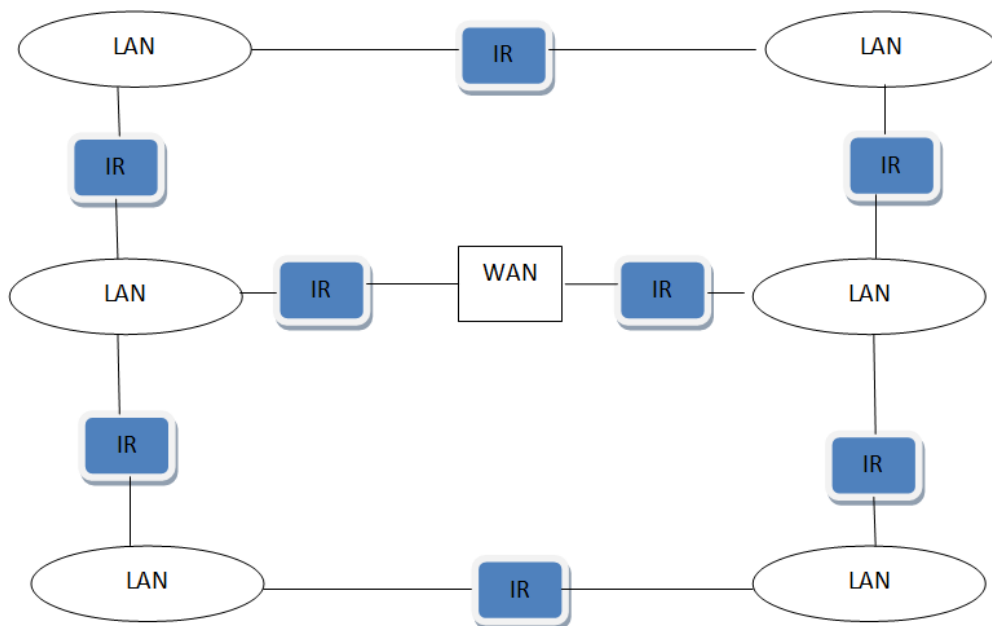
*Wide Area Network (WAN) :

Wide Area Networks (WANs) connect networks in larger geographic areas, such as Florida, the United States, or the world. Dedicated transoceanic cabling or satellite uplinks may be used to connect this type of global network.

Using a WAN, schools in Florida can communicate with places like Tokyo in a matter of seconds, without paying enormous phone bills. Two users a half-world apart with workstations equipped with microphones and a webcams might teleconference in real time. A WAN is complicated. It uses multiplexers, bridges, and routers to connect local and metropolitan networks to global communications networks like the Internet. To users, however, a WAN will not appear to be much different than a LAN.[3][4]

***Personal Area Network (PAN) :**

A personal area network (PAN) is a computer network used for data transmission amongst devices such as computers, telephones, tablets and personal digital assistants. PANs can be used for communication amongst the personal devices themselves (interpersonal communication), or for connecting to a higher level network and the Internet (an uplink) where one master device takes up the role as internet router . A PAN may be carried over wired computer buses such as USB and FireWire .[4]



INTERNETWORK
FIGURE(1_1)

TYPES OF COMPUTER NETWORKS

1.4 ADVANTAGES OF COMPUTER NETWORKS

Computer networks are among the most inventive of the world's advances and technological advances because of their rapid and easy exchange of information and data. The benefits of innumerable networks are:[5]

- *connect various types of devices and computers in the network to each other, such as : printers, projectors (data:show); to save the prices of these high devices, and to enable all network users to use.

- *contribute to reduce the time and effort required to transfer data between different network devices, without the need to use other means of transport and storage, by placing data in the database; to

allow users to access the network to the information they want within the terms of specific terms and conditions.

*connect computers to the internet, allowing access to and access to a large amount of information on the internet.[3]

1.5 IP Class

In the world of communications and the Internet there are general protocols to deal between the devices and servers to ensure the connection correctly and access information quickly and correctly one of these protocols is the protocol(ip). and the word (ip) is a shortcut to the word Internet protocol ... The function of this protocol give each device number Or a specific address (to clarify the idea as an example of each of us a phone number of his own , To send a message to Ahmed must know his number and send to that number so as not to go to the message Mohammed is the wrong person)Also in the world of the Internet there is the same idea .. So He can access the Internet with his own address called ip address [2].

There are two IP Class :

- 1.IPV4 (Internet Protocol).
- 2.IPV6 (Internet Protocol).

1.IPV4 :

IP Address consists of 32 bits and divides into four boxes of numbers Each box contains a number from 0 to 255 and thus their sum is 256 Each of these fields is called Octet, which is the number 8. Each cell contains any number from 2^1 to 2^8 (Two S-8) .. The main form of the IP address is the following: xxxx where x varies from 0 to 255 .. This

allows us to give addresses to 4.3 billion people .. but with the development of means of communication and the spread of Internet culture ... The number of people entering the world has increased significantly, which led to the entry into force of these addresses .. It was necessary to discover a new way to give it a sign that gives us more space than the intestines With the increasing number of subscribers who enter the Internet every day.[2]

2.IPV6 :

The problem was that they were working on the creation of a new version of the Internet Protocol, known as IPv6 or IPv6, which provides a very large number of addresses (about 340 trillion trillion) This version uses 128 bits for one address (for example on new titles: 2001: 1234: 5678: 9: 1: 2: 3: 4) and thus providing a large number of addresses, which gives us a lot of space to expand our applications connected to the Internet. The person has more than 5000 addresses currently .. which solve many of the problems facing him A lot of companies and institutions in the use of IP address and one common for all the devices of the company to access the Internet through the protocol NAT ... And only a different but unified internal address in the Internet.[2]

What are the effects of this release or how will it affect me?

You will not feel any change in your Internet connection, browsing or normal use of the Internet ... unless your modem, network device or



operating system does not support this new type of address.[3][2]

Note: Mostly all operating systems, browsers and computers support IPv6
finally :

The new version of this protocol will greatly benefit the quantum leap in the number of devices connected to the Internet such as mobile phones and home control systems and mobile devices such as iPad and Galaxy Tab and much more, which allows us to develop rapidly towards the development of smart systems connected to the Internet and remote control.[2]

TYPES OF IP ADDRESS :

Private IP addresses are meant to be used on private networks like home and office networks. They are the same as public IP addresses at a protocol level, however they differ organizationally. These addresses can only be used within a single administration which means that they are not to be used on the wider internet.[6][7]

The IP ranges for private addresses are –

Class A: Start address – 10.0.0.0 End Address – 10.255.255.255

Class B: Start address – 172.16.0.0 End Address – 172.31.255.255

Class C: Start address – 192.168.0.0 End Address – 192.168.255.255

Public IP addresses include all other IP addresses which do not include any of the private IP addresses reserved by Internet standard groups. It can be accessed over the internet. A device is only accessible within a local area network by using a private IP address. However, if one of the devices in LAN wants to be accessible over the internet, then in that case this device must be connected to the internet by using a public IP address.



* Private IP addresses conserve addresses as two or more separate networks can have same private IP addresses assigned to different computers. Thus, public IP addresses are valid on the internet. On the other hand, private IP addresses are invalid on the internet.[7]

Comparison between Public IP and Private IP address:[7]

	Public IP Address	Private IP Address
Defintion	Used for identification of a home network to the outside world	Used for identification of a network device inside the home network
Uniqueness	It is unique throughout the entire network	Two or more separate networks can have same private IP addresses assigned to different computers
Example	202.60.23.1	192.168.0.3
Usage	Used on the Internet or other WAN	Used on a Local Area Network; for computers not directly connected to the internet

TABLE (1_1) PRIVATE IP & PUBLIC IP

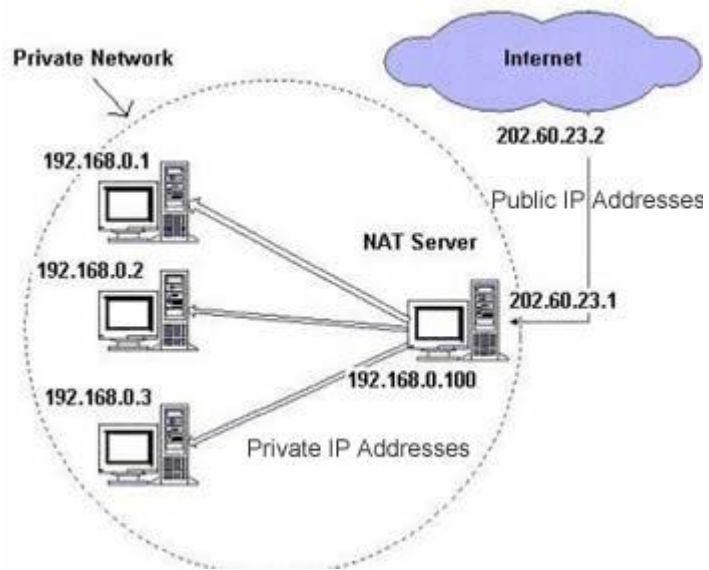


FIGURE (1_2) IP ADDRESSES

CHAPTER 2 : TECHNOLOGY OF NAT

2.1 What is NAT ?

- **NAT** is a router function where IP addresses (and possibly port numbers) of IP datagrams are replaced at the boundary of a private network.
- ***NAT** is a method that enables **hosts** on private networks to communicate with hosts on the **internet**.
- ***NAT** is run on routers that connect private networks to the public internet, to replace the **IP address-port pair** of an IP packet with another IP address-port pair. [9]
- * **NAT (network address translation)** is a technique to cover multiple clients behind one router. Kristian Kohntopp explained the technology very well in his article. [9]
- ****Network address translation (NAT)** is one of those rare information technology buzzwords that does exactly what its name implies. In this case, it translates one network address into another network address. The most popular use for NAT is to connect an internal network to the Internet. The proliferation of hosts that now connects to the Internet is causing a shortage of IP addresses, so NAT is a key tool for connecting corporate networks using private IP addresses to the Internet. Since Cisco provides the bulk of the routers that connect to the Internet, we're going to show you how to set up NAT using the Cisco Internetwork Operating System (IOS). [10]

2.2 ADVANTAGES OF NAT

In addition to the convenience and low cost of network address translation, the lack of full-duplex communication may in some cases be seen as an advantage rather than as a deficiency. Network address translation means relying on one device in the network to initiate any connection with hosts outside the network, which prevents any malicious activity originating from outside the network from accessing the devices within it. This can improve the reliability of local systems by stopping worms. Many firewalls that use network address translation use this aspect as a key element in their work.

The greatest benefit of network address translation is a practical solution to address space consumption problems for IPv4 address space. Networks that needed to have IP addresses of Class B / C IP addresses can now be linked to the Internet under IP (many home networks do this).[9]

2.3 DISADVANTAGES OF NAT

Users behind paths that translate the network address do not have real end-to-end connectivity and can not participate in some Internet protocols. Services that require the creation of non-network (TCP) connections or non-state protocols (UDP) can be disrupted. Unless the network address translation process performs certain actions to support the protocol, the incoming packets will not be able to reach its destination within the network. Some protocols can deal with a single layer of network address translation between passive hosts (eg, passive mode), with the help of the application layer gateway, but fail when both systems are separate from Internet with a network address translation layer.[10]

Close contact is a key principle in the Internet. Current Internet documents are considered a network address translation violation of cross-contact, but network address translation has an effective role. A great concern is the use of IP address translation in IPv6, where many designers believe that IPV6 has been found to eliminate the need to translate the network address.

Some ISPs only provide their customers with "local" IP addresses. Therefore, these customers are forced to enter the

Internet through a network address translation layer. This is what some say by saying that such companies do not provide Internet service properly.[10]

****MAIN USES OF NAT :**

- Pooling of IP addresses
- Supporting migration between network service providers
- IP masquerading
- Load balancing of servers

2.4 TYPES OF NAT

There are total mainly Three types of NAT

- 1.Static NAT**
- 2.Dynamic NAT(DNAT)**
- 3.Port Address Translation(PAT)**

But very few network engineers also believe that NAT can be of below types:

NAT which modify only IP addresses.

NAT which modify IP addresses and Port Numbers.

NAT that use a single IP Address.

NAT that Dynamically allocate IP Addresses to flows.

- **Static NAT**—A consistent mapping between a real and mapped IP address. Allows bidirectional traffic initiation.
- **Dynamic NAT**—A group of real IP addresses are mapped to a (usually smaller) group of mapped IP addresses , on a first come, first served basis.Only the real host can initiate traffic.

- **Dynamic Port Address Translation (PAT)** —A group of real IP addresses are mapped to a single IP address using a unique source port of that IP address.[7]

2.5 HOW TO USE NAT ?

A. Basically, NAT allows a single device, such as a router, to act as an agent between the Internet (or public network) and a local network (or private network), which means that only a single unique IP address is required to represent an entire group of computers to anything outside their network [10]

configure NAT :

In order to configure traditional NAT, you need to make at least one interface on a router (NAT outside) and another interface on the router (NAT inside) and a set of rules for translating the IP addresses in the packet headers (and payloads if desired) need to be configured. In order to configure Nat Virtual Interface (NVI) , you need at least one interface configured with NAT enable along with the same set of rules . [9]

*The order in which the transactions are processed using NAT is based on whether a packet is going from the inside network to the outside network or from the outside network to the inside network. Inside to outside translation occurs after routing, and outside to inside translation occurs before routing.

*Specific terms are used to identify the various NAT addresses:

Inside Local – the specific IP address assigned to an *inside* host behind a NAT-enabled device (usually a *private* address).

- **Inside Global** – the address that identifies an *inside* host to the *outside* world (usually a *public* address). Essentially, this is the dynamically or statically-assigned public address assigned to a private host.
- **Outside Global** – the address assigned to an *outside* host (usually a *public* address).
- **Outside Local** – the address that identifies an *outside* host to the *inside* network. Often, this is the **same** address as the Outside Global. However, it is occasionally necessary to translate an outside (usually *public*) address to an inside (usually *private*) address. [8][9]

*For simplicity , it is generally acceptable to associate **global** addresses with **public** addresses, and **local** addresses with **private** addresses. However, remember that public-to-public and private-to-private translation is still possible. **Inside** hosts are within the local network, while **outside** hosts are external to the local network. [9]

NOTE:

Using NAT to connect to the Internet allows you to:

- * Use only one public, registered IP address for Internet access for many thousands of private IP addresses at your site.
- * Change Internet service providers (ISPs) easily, without readdressing the majority of hosts on your network.
- * Hide the identity of hosts on your local network behind the single public IP address to keep outside hosts from easily targeting them[9].

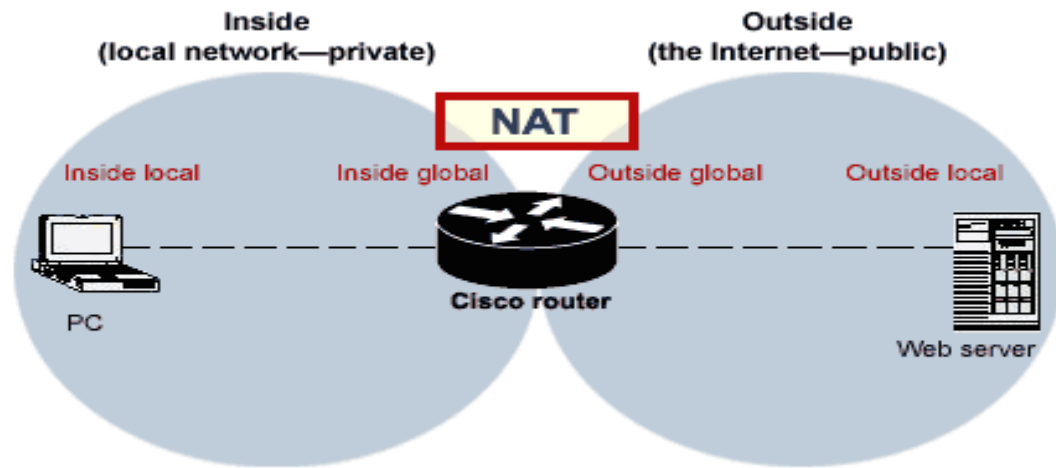


FIGURE (2_3) structure NAT

We will discuss how to use the net in detail and how it works in the third chapter .