



Foreword

- With the development of the Internet and the increase of network applications, limited public IPv4 addresses have become the bottleneck of network development. To solve this problem, Network Address Translation (NAT) was introduced.
- NAT enables hosts on an internal network to access an external network. It not only helps alleviate IPv4 address shortage but also improves the security of the internal network as NAT prevents devices on the external network from directly communicating with hosts on the internal network that uses private addresses.
- This course describes the motivation behind NAT, and implementations and application scenarios of different types of NAT.

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Objectives

- On completion of this course, you will be able to:
 - Understand the motivation behind NAT.
 - Master NAT classification and implementations.
 - Master NAT selection in different scenarios.

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Contents

- NAT Overview
- Static NAT
- Dynamic NAT
- NAPT and Easy IP
- NAT Server

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Motivation Behind NAT

- As the number of Internet users increases, public IPv4 addresses become scarcer.
- What's worse, uneven allocation of these addresses has resulted in a severe shortage of available public IPv4 addresses in some areas.
- To overcome public IPv4 address shortage, it is necessary to use transition technologies.

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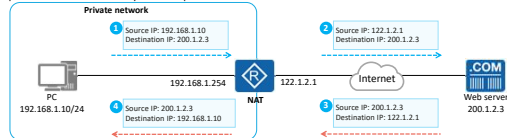
Private IP Addresses

- Public IP addresses: managed and allocated by a dedicated organization and can be used for direct communication on the Internet
- Private IP addresses: can be used by organizations or individuals randomly on internal networks, but cannot be used for direct communication on the Internet
- The following Class A, B, and C addresses are reserved as private IP addresses:
 - Class A: 10.0.0.0–10.255.255.255
 - Class B: 172.16.0.0–172.31.255.255
 - Class C: 192.168.0.0–192.168.255.255

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NAT Implementation

- NAT translates IP addresses in IP data packets. It is widely used on live networks and is usually deployed on network egress devices, such as routers or firewalls.
- Typical NAT application scenario: Private addresses are used on private networks (enterprises or homes), and NAT is deployed on egress devices. For traffic from an internal network to an external network, NAT translates the source addresses of the data packets into specific public addresses. For traffic from an external network to an internal network, NAT translates the destination address of the data packets.
- NAT+private addresses effectively conserve public IPv4 addresses.



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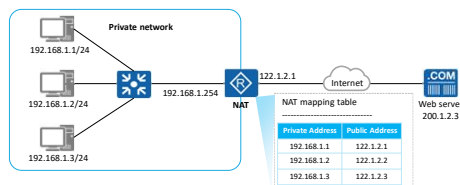
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Static NAT Implementation

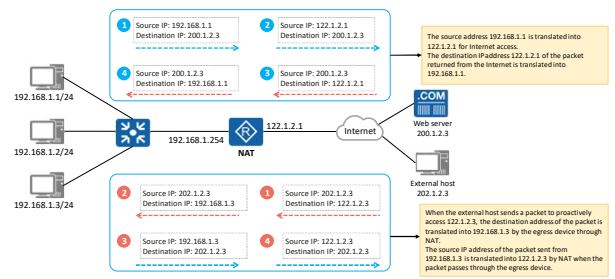
- Static NAT: A private IP address is mapped to a fixed public IP address.
- Bidirectional access: When an internal host with a private IP address accesses the Internet, the egress NAT device translates the private IP address into a public IP address. Similarly, when an external network device sends packets to access an internal network, the NAT device translates the public address (destination address) carried in the packets into a private address.



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Static NAT Example



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Configuring Static NAT

- Method 1: Configure static NAT in the interface view.

```
[Huawei-GigabitEthernet0/0/0] nat static global [ global-address ] inside [ host-address ]
```

global [global-address] is used to configure an external public IP address, and **inside** [host-address] is used to configure an internal private IP address.

- Method 2: Configure static NAT in the system view.

```
[Huawei] nat static global [ global-address ] inside [ host-address ]
```

The command format in the system view is the same as that in the interface view. After this configuration, enable static NAT on a specific interface.

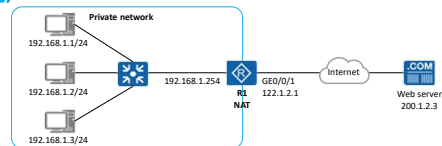
```
[Huawei-GigabitEthernet0/0/0] nat static enable
```

This command enables static NAT on the interface.

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Example for Configuring Static NAT



- Configure static NAT on R1 to map private addresses of internal hosts to public addresses in one-to-one mode.

```
[R1] interface GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1] ip address 122.1.2.1 24
[R1-GigabitEthernet0/0/1] nat static global 122.1.2.1 inside 192.168.1.1
[R1-GigabitEthernet0/0/1] nat static global 122.1.2.2 inside 192.168.1.2
[R1-GigabitEthernet0/0/1] nat static global 122.1.2.3 inside 192.168.1.3
```

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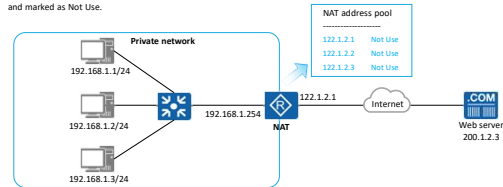


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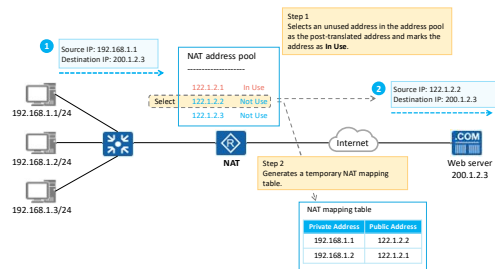
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3. **Dynamic NAT**
4. NAT and Easy IP
5. NAT Server

Dynamic NAT Implementation

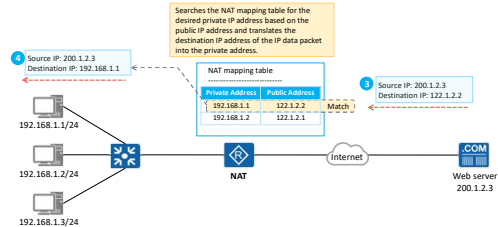
- Dynamic NAT: A private IP address is mapped to a public IP address from a NAT address pool containing a group of public IP addresses. Static NAT strictly maps addresses in one-to-one mode. As a result, even if an internal host is offline for a long time or does not send data, the public address is still occupied by the host.
- Dynamic NAT prevents such address wastes. When an internal host accesses an external network, an available IP address in a NAT address pool is temporarily assigned to the host and marked as In Use. When the host no longer accesses the external network, the assigned IP address is reclaimed and marked as Not Use.



Dynamic NAT Example (1)



Dynamic NAT Example (2)



Configuring Dynamic NAT

1. Create an address pool.

```
[Huawei] nat address-group group-index start-address end-address
```

Configure a public address range. *group-index* specifies the address pool ID, and *start-address* and *end-address* specify the start and end addresses of the address pool, respectively.

2. Configure an ACL rule for NAT.

```
[Huawei] acl number [Huawei-acl-basic-number] rule permit source source-address source-wildcard
```

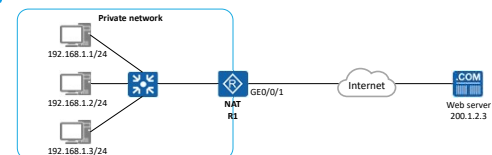
Configure a basic ACL to match the source address range that requires dynamic NAT.

3. Configure outbound NAT with the address pool in the interface view.

```
[Huawei-GigabitEthernet0/0/0] nat outbound acl-number address-group group-index [ no-pat ]
```

Associate the ACL rule with the address pool for dynamic NAT on the interface. The *no-pat* parameter specifies that port translation is not performed.

Example for Configuring Dynamic NAT



- Configure dynamic NAT on R1 to dynamically map private addresses of internal hosts to public addresses.

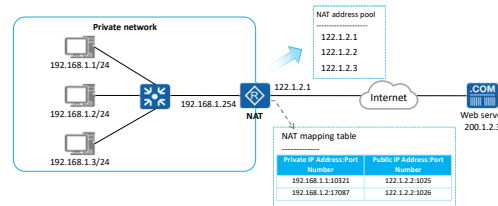
```
[R1] nat address-group 1 122.1.2.1 122.1.2.3
[R1] acl 2000
[R1-acl-basic-2000] rule 5 permit source 192.168.1.0 0.0.0.255
[R1-acl-basic-2000] quit
[R1] interface GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1] nat outbound 2000 address-group 1 no-pat
```

Contents

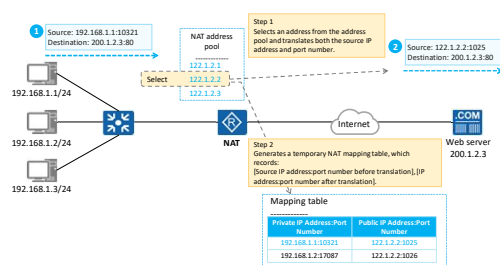
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NAPT Implementation

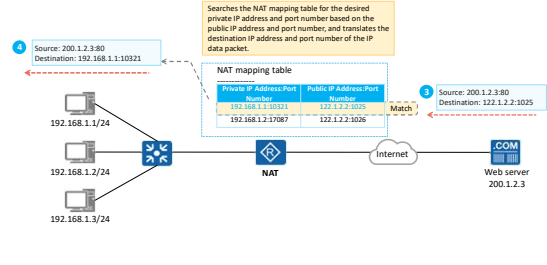
- Dynamic NAT does not translate port numbers. It belongs to No-Port Address Translation (No-PAT). In this mode, the mapping between public and private addresses is still 1:1, which cannot improve public address utilization.
- Network Address and Port Translation (NAPT): translates both IP addresses and port numbers from multiple internal hosts to one public IP address in an address pool. In this way, 1:n mapping between public and private addresses is implemented, which effectively improves public address utilization.



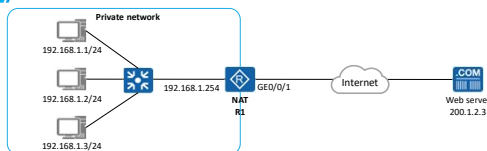
NAPT Example (1)



NAPT Example (2)



Example for Configuring NAPT

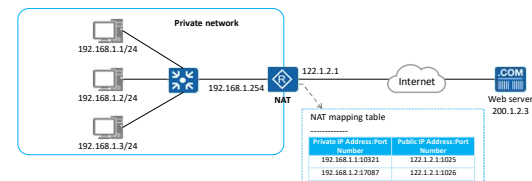


- Configure NAPT on R1 to allow all hosts with private IP addresses on the internal network to access the public network through 122.1.2.1.

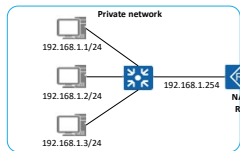
```
[R1]nat address-group 1 122.1.2.1 122.1.2.1
[R1]acl 2000
[R1-acl-basic-2000]rule 5 permit source 192.168.1.0 0.0.0.255
[R1-acl-basic-2000]quit
[R1]interface GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1]nat outbound 2000 address-group 1
```

Easy IP

- Easy IP: translates both IP addresses and transport-layer port numbers. The implementation of Easy IP is the same as that of NAPT. The difference is that Easy IP does not involve address pools. It uses an interface address as a public address for NAT.
- Easy IP applies to scenarios where public IP addresses are not fixed, such as scenarios where public IP addresses are dynamically obtained by egress devices on private networks through DHCP or PPPoE dialup.



Example for Configuring Easy IP



- Configure Easy IP on R1 to allow all hosts with private IP addresses on the internal network to access the public network through 122.1.2.1.

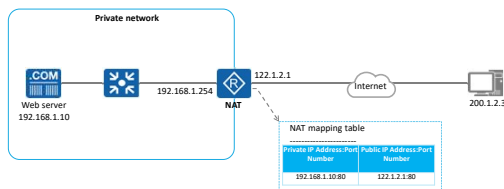
```
[R1-acl-basic-2000]rule 5 permit source 192.168.1.0 0.0.0.255
[R1-acl-basic-2000]quit
[R1]interface GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1]nat outbound 2000
```

Contents

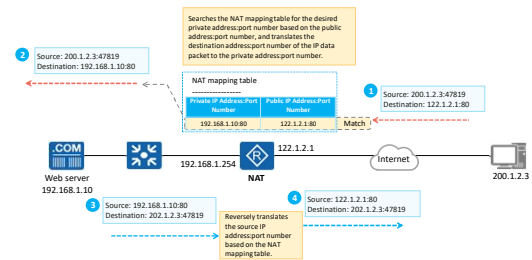
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NAT Server

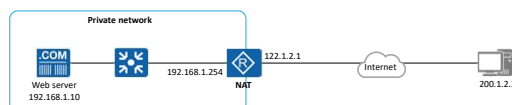
- NAT Server: maps an internal server to a public network through a one-to-one mapping between a [public IP address:port number] and a [private IP address:port number]. This function is used when the internal server needs to provide services for the public network.
- An external host proactively accesses the [public IP address:port number] to communicate with the internal server.



NAT Server Example



Example for Configuring NAT Server



- Configure NAT Server on R1 to map the internal server's IP address 192.168.1.10 and port number 80 to the public IP address 122.1.2.1 and port number 8080.

```
[R1]interface GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1]ip address 122.1.2.1 24
[R1-GigabitEthernet0/0/1]nat server protocol tcp global 122.1.2.1 www inside 192.168.1.10 8080
```

Quiz

1. What types of NAT can enable external devices to proactively access an internal server?
2. What are the advantages of NAT over No-PAT?



Summary

- Using private addresses on private networks and using NAT at the network egress effectively reduce the number of required public IPv4 addresses. NAT effectively alleviates the shortage of public IPv4 addresses.
- Dynamic NAT, NAT, and Easy IP provide source address translation for private network hosts to access the public network.
- NAT Server enables internal servers to provide services for public networks.
- Static NAT provides one-to-one mapping and supports bidirectional communication.



Contents

- File Transfer
- Telnet
- DHCP**
- HTTP
- DNS
- NTP

DHCP

Dynamic Host Configuration Protocol

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Issues Faced by Manual Network Parameter Configuration (1)

Too Many Hard-to-Understand Parameters

IPv4 address configuration:

IP address: . . .

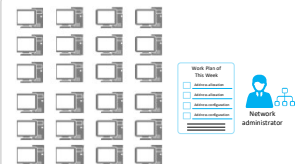
Mask: . . .

Gateway: . . .



- Common users are not familiar with network parameters and misconfiguration often occurs, resulting in network access failure. Random IP address configuration may cause IP address conflicts.

Huge Workload

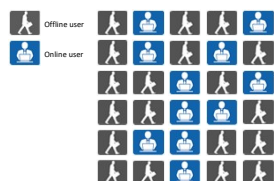


- Network administrators centrally configure network parameters, with heavy workloads and repetitive tasks.
- Network administrators need to plan and allocate IP addresses to users in advance.



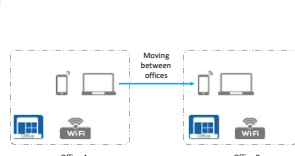
Issues Faced by Manual Network Parameter Configuration (2)

Low Utilization



- On an enterprise network, each user uses a fixed IP address. As a result, the IP address utilization is low, and some IP addresses may remain unused for a long time.

Poor Flexibility

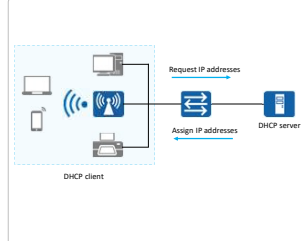


- Wireless local area networks (WLANs) allow for flexible station (STA) access locations. When a STA moves from one wireless coverage area to another, the IP address of the STA may need to be reconfigured.

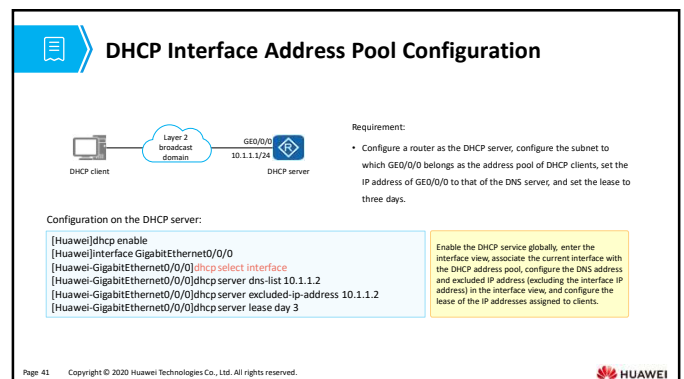
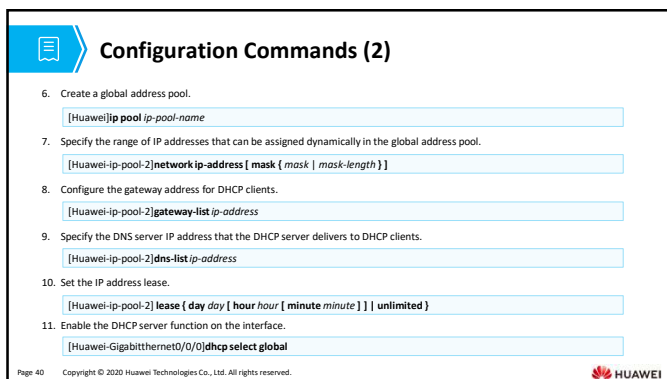
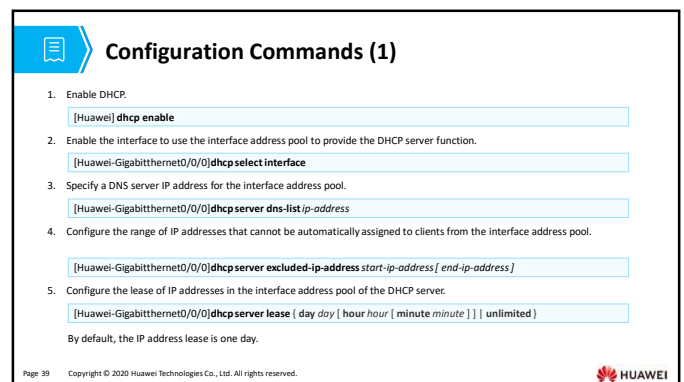
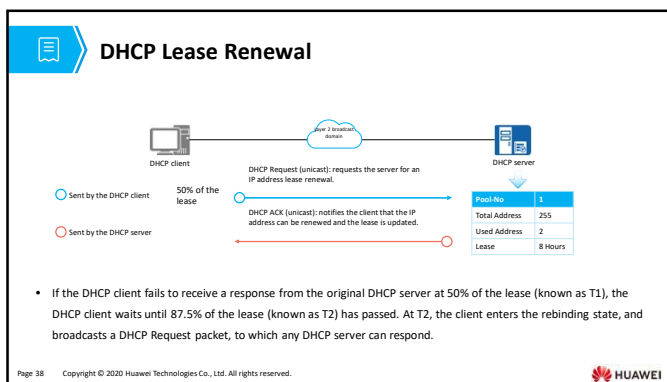
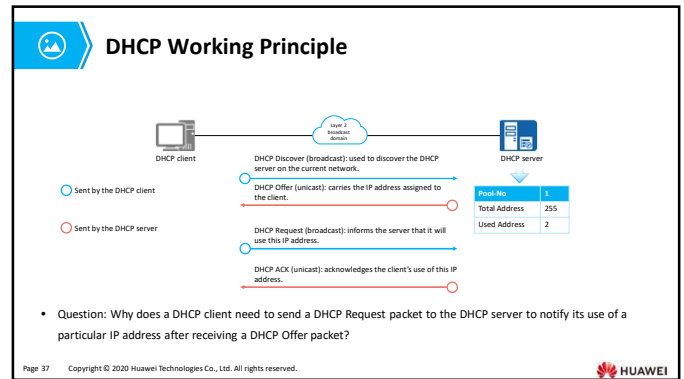
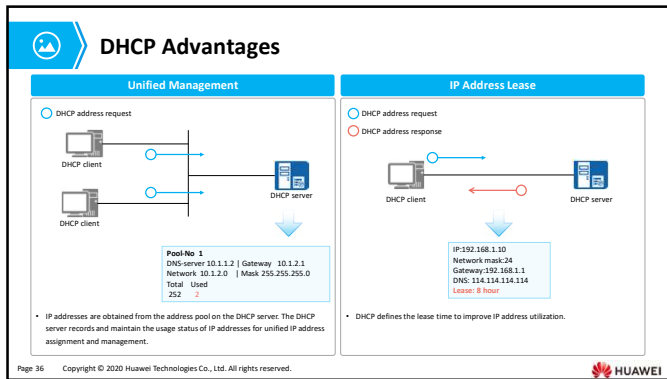


Basic Concepts of DHCP

DHCP Working Principle



- To overcome the disadvantages of the traditional static IP configuration mode, the Dynamic Host Configuration Protocol (DHCP) is developed to dynamically assign suitable IP addresses to hosts.
- DHCP adopts the client/server (C/S) architecture. Hosts do not need to be configured and can automatically obtain IP addresses from a DHCP server. DHCP enables host plug-and-play after they are connected to the network.





DHCP Global Address Pool Configuration



Requirement:

- Configure a router as the DHCP server and configure the global address pool **pool2** to assign IP addresses (on the subnet 1.1.1.0/24) to DHCP clients. Set both the gateway address and DNS address to 1.1.1.1, set the lease to 10 days, and enable GE0/0/0 to use the global address pool.

Configuration on the DHCP server:

```
[Huawei]dhcp enable
[Huawei]ip pool pool2
Info: It's successful to create an IP address pool.
[Huawei-ip-pool-pool2]network 1.1.1.0 mask 24
[Huawei-ip-pool-pool2]gateway-list 1.1.1.1
[Huawei-ip-pool-pool2]dns-list 1.1.1.1
[Huawei-ip-pool-pool2]lease day 10
[Huawei-ip-pool-pool2]quit
[Huawei]interface GigabitEthernet0/0/0
[Huawei-GigabitEthernet0/0/0]dhcp select global
```

- Enable the DHCP service globally and configure the global address pool **pool2**. Configure the address range, gateway address, DNS address, and lease for **pool2**.
- Select the global address pool on a specific interface (GE0/0/0). When GE0/0/0 receives a DHCP request, it assigns an IP address from the global address pool.



Assignment

- Lab 4.3 – NAT
- Lab 5.3 – DHCP
- Both are in the HCIA Datancom Lab Guide