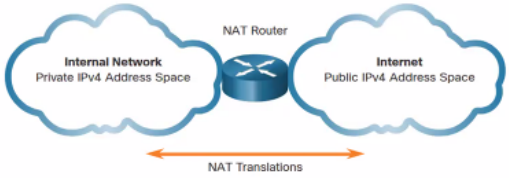
6.1 NAT Characteristics

NAT Characteristics
IPv4 Address Space

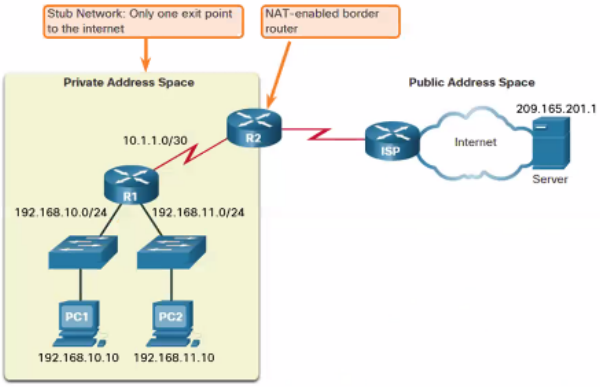
- Networks are commonly implemented using private IPv4 addresses, as defined in RFC 1918.
- Private IPv4 addresses cannot be routed over the internet and are used within an organization or site to allow devices to communicate locally.
- To allow a device with a private IPv4 address to access devices and resources outside of the local network, the private address must first be translated to a public address.
- NAT provides the translation of private addresses to public addresses.

Class	Activity Type	Activity Name
A	10.0.0.0 – 10.255.255.255	10.0.0.0/8
B	172.16.0.0 – 172.31.255.255	172.16.0.0/12
C	192.168.0.0 – 192.168.255.255	192.168.0.0/16



NAT Characteristics
What is NAT

- The primary use of NAT is to conserve public IPv4 addresses.
- NAT allows networks to use private IPv4 addresses internally and translates them to a public address when needed.
- A NAT router typically operates at the border of a stub network.
- When a device inside the stub network wants to communicate with a device outside of its network, the packet is forwarded to the border router which performs the NAT process, translating the internal private address of the device to a public, outside, routable address.



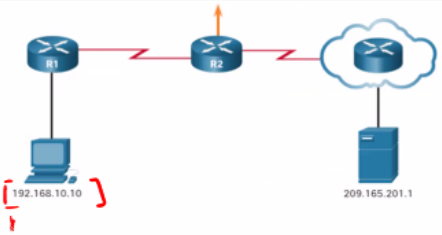
NAT Characteristics
How NAT Works

PC1 wants to communicate with an outside web server with public address 209.165.201.1.

1. PC1 sends a packet addressed to the web server.
2. R2 receives the packet and reads the source IPv4 address to determine if it needs translation.
3. R2 adds mapping of the local to global address to the NAT table.
4. R2 sends the packet with the translated source address toward the destination.
5. The web server responds with a packet addressed to the inside global address of PC1 (209.165.200.226).
6. R2 receives the packet with destination address 209.165.200.226. R2 checks the NAT table and finds an entry for this mapping. R2 uses this information and translates the inside global address (209.165.200.226) to the inside local address (192.168.10.10), and the packet is forwarded toward PC1.

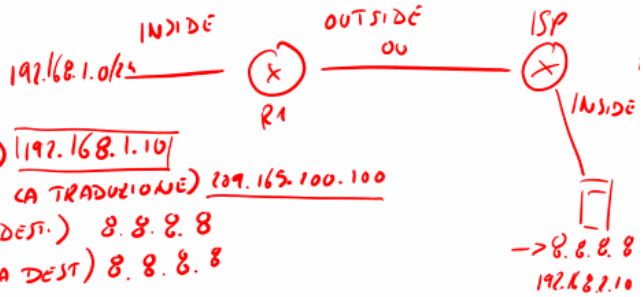
NAT Table

Inside Local	Inside Global	Outside Local	Outside Global
192.168.10.10	209.165.200.226	209.165.201.1	209.165.201.1



NAT Characteristics

NAT Terminology



NAT includes four types of addresses:

- Inside local address
- Inside global address
- Outside local address
- Outside global address

NAT terminology is always applied from the perspective of the device with the translated address:

- **Inside address** - The address of the device which is being translated by NAT.
- **Outside address** - The address of the destination device.
- **Local address** - A local address is any address that appears on the inside portion of the network.
- **Global address** - A global address is any address that appears on the outside portion of the network.

NAT - TABLE
INS. LOCAL | OUTSIDE GLOBAL
192.168.1.10 | 209.165.200.100

NAT Characteristics

NAT Terminology (Cont.)

Inside local address

The address of the source as seen from inside the network. This is typically a private IPv4 address. The inside local address of PC1 is 192.168.10.10.

Inside global addresses

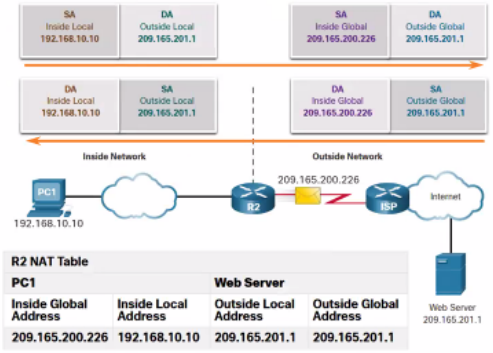
The address of source as seen from the outside network. The inside global address of PC1 is 209.165.200.226

Outside global address

The address of the destination as seen from the outside network. The outside global address of the web server is 209.165.201.1

Outside local address

The address of the destination as seen from the inside network. PC1 sends traffic to the web server at the IPv4 address 209.165.201.1. While uncommon, this address could be different than the globally routable address of the destination.



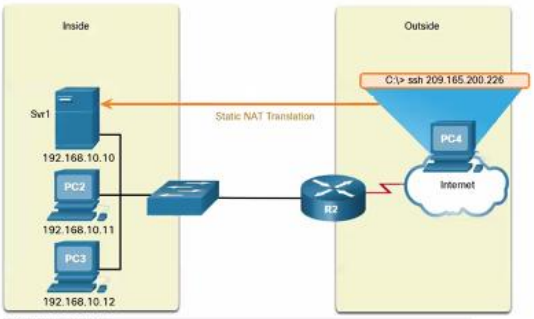
R2 NAT Table			
PC1		Web Server	
Inside Global Address	Inside Local Address	Outside Local Address	Outside Global Address
209.165.200.226	192.168.10.10	209.165.201.1	209.165.201.1

Types of NAT

Static NAT

Static NAT uses a one-to-one mapping of local and global addresses configured by the network administrator that remain constant.

- Static NAT is useful for web servers or devices that must have a consistent address that is accessible from the internet, such as a company web server.
- It is also useful for devices that must be accessible by authorized personnel when offsite, but not by the general public on the internet.



Static NAT Table

Inside Local Address	Inside Global Address - Addresses reachable via R2
192.168.10.10	209.165.200.226
192.168.10.11	209.165.200.227
192.168.10.12	209.165.200.228

Note: Static NAT requires that enough public addresses are available to satisfy the total number of simultaneous user sessions.

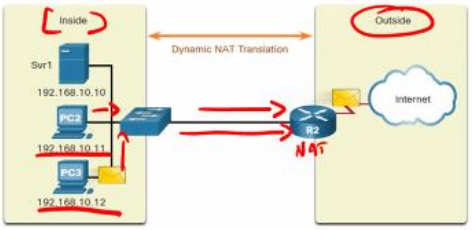
Types of NAT

Dynamic NAT

Dynamic NAT uses a pool of public addresses and assigns them on a first-come, first-served basis.

- When an inside device requests access to an outside network, dynamic NAT assigns an available public IPv4 address from the pool.
- The other addresses in the pool are still available for use.

Note: Dynamic NAT requires that enough public addresses are available to satisfy the total number of simultaneous user sessions.



IPv4 NAT Pool

Inside Local Address	Inside Global Address Pool - Addresses reachable via R2
192.168.10.12	209.165.200.226
Available 192.168.10.11	209.165.200.227
Available	209.165.200.228
Available	209.165.200.229
Available	209.165.200.230

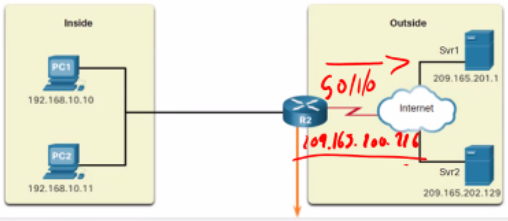
192.168.10.16 209.165.200.126

Types of NAT

Port Address Translation

Port Address Translation (PAT), also known as NAT overload, maps multiple private IPv4 addresses to a single public IPv4 address or a few addresses.

- With PAT, when the NAT router receives a packet from the client, it uses the source port number to uniquely identify the specific NAT translation.
- PAT ensures that devices use a different TCP port number for each session with a server on the internet.



NAT Table with Overload

Inside Local IP Address	Inside Global IP Address	Outside Local IP Address	Outside Global IP Address
192.168.10.10:1555	209.165.200.226:1555	209.165.201.1:80	209.165.201.1:80
192.168.10.11:1331	209.165.200.226:1331	209.165.202.129:80	209.165.202.129:80

SOCKET = IP + PORTA
RANDOM (49152 - 65535)

Types of NAT

NAT and PAT Comparison

Summary of the differences between NAT and PAT.

NAT - Only modifies the IPv4 addresses

Inside Global Address	Inside Local Address
209.165.200.226	192.168.10.10

PAT - PAT modifies both the IPv4 address and the port number.

Inside Global Address	Inside Local Address
209.165.200.226:2031	192.168.10.10:2031

NAT	PAT
One-to-one mapping between Inside Local and Inside Global addresses.	One Inside Global address can be mapped to many Inside Local addresses.
Uses only IPv4 addresses in translation process.	Uses IPv4 addresses and TCP or UDP source port numbers in translation process.
A unique Inside Global address is required for each inside host accessing the outside network.	A single unique Inside Global address can be shared by many inside hosts accessing the outside network.

Types of NAT

Packets without a Layer 4 Segment

Some packets do not contain a Layer 4 port number, such as ICMPv4 messages. Each of these types of protocols is handled differently by PAT.

For example, ICMPv4 query messages, echo requests, and echo replies include a Query ID. ICMPv4 uses the Query ID to identify an echo request with its corresponding echo reply.

PING 192.168.2.10
L> ICMP = QUERY ID 1
L> ICMP = QUERY ID 2
L> ICMP 3

Note: Other ICMPv4 messages do not use the Query ID. These messages and other protocols that do not use TCP or UDP port numbers vary and are beyond the scope of this curriculum.

[192.168.1.10 : 1]

NAT Advantages and Disadvantages

Advantages of NAT

NAT provides many benefits:

- NAT conserves the legally registered addressing scheme by allowing the privatization of intranets.
- NAT conserves addresses through application port-level multiplexing.
- NAT increases the flexibility of connections to the public network.
- NAT provides consistency for internal network addressing schemes.
- NAT allows the existing private IPv4 address scheme to remain while allowing for easy change to a new public addressing scheme.
- NAT hides the IPv4 addresses of users and other devices.

Disadvantages of NAT

NAT does have drawbacks:

- NAT increases forwarding delays.
- End-to-end addressing is lost.
- End-to-end IPv4 traceability is lost.
- NAT complicates the use of tunneling protocols, such as IPsec. VPN
- Services that require the initiation of TCP connections from the outside network, or stateless protocols, such as those using UDP, can be disrupted.