Networking

Network Address Translation

Network Address Translation (NAT)

- Guiding Question: How does Network Address Translation (NAT) enable private network devices to communicate with external networks while improving security and conserving IP addresses?

- Students will:
  - Explain the purpose of NAT and why it is essential for modern networks.
  - Identify and describe the differences between Static NAT, Dynamic NAT, PAT (NAT Overload), and NAT64.
  - Understand how NAT conserves public IP addresses while allowing private network devices to access the internet.

Why Do We Need NAT?

- IPv4 is the most common type of address used in networks and on the internet.
- But only 4.3 billion IPv4 addresses exist, and we've run out.
- To get around this, Private IP address ranges are used inside homes, schools, and businesses:
  - `10.0.0.0` to `10.255.255.255`
  - `172.16.0.0` to `172.31.255.255`
  - `192.168.0.0` to `192.168.255.255`
- These private IPs can't be routed directly on the internet.
- **So how do devices with private IPs access websites, servers, and services online?**

What is Network Address Translation?

- NAT lets private IP devices access the internet using one shared public IP.
- It changes the source IP address on outgoing packets.
- The router keeps track of which device sent what packets.
- Improves security by hiding internal IP addresses.

How NAT Works

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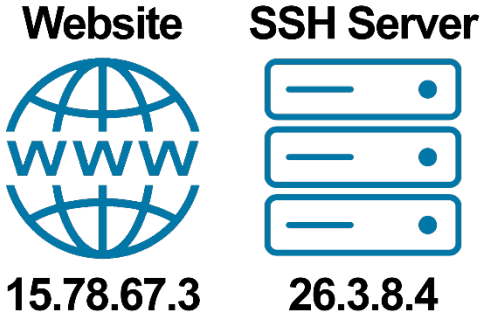
  1. Private device sends a packet with a private IP address.
  2. Router changes the source IP to its public IP.
  3. Router tracks the translation in a NAT table.
  4. Incoming replies are sent to the correct internal device.
- **Example:**
  - Sasha (IP: `10.10.20.50`) wants to visit a website.
  - Router changes her IP to `94.1.1.1` (a public IP).
  - Website replies to `94.1.1.1`.
  - Router remembers Sasha and sends the reply to her.

Types of NAT

- **Static** - One private IP is always matched to one public IP.
  - Used when a device needs a consistent public identity.
  - Common for web servers or network devices that must always be reachable.
- **Dynamic** - Private IPs are mapped to a pool of public Ips.
  - The public IP used may change each time.
  - Only works if enough public IPs are in the pool.
- Both methods use one-to-one mapping.

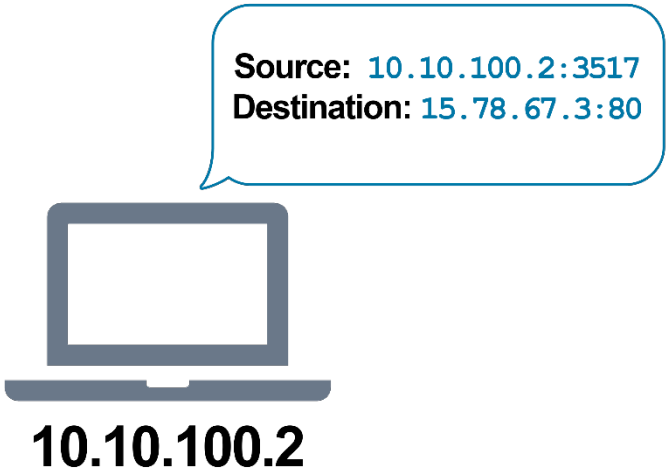
Port Address Translation (PAT)

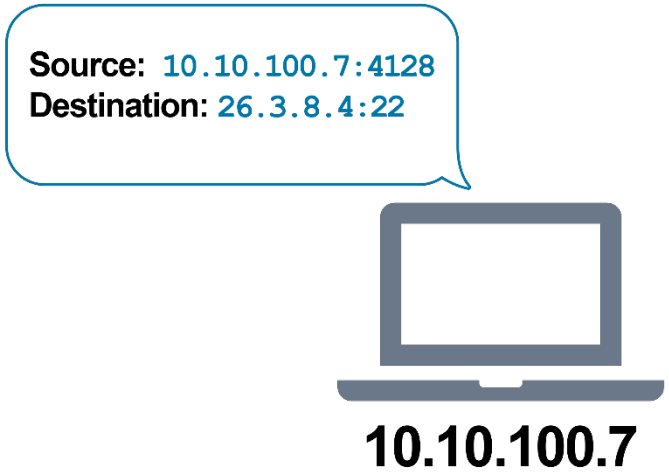
- Also called NAT Overload.
- Multiple private devices share one public IP.
- Each connection uses a unique port number.
- Tracks which device sent each request using IP:Port.
- **Example:**
  - Sasha uses `94.1.1.1:10001` to browse the web.
  - Jonas uses `94.1.1.1:10002` at the same time.
  - Router sends responses to the correct user using port info.



Public IP: 9.16.1.55

Internal IP: 10.10.100.1





Website

15.78.67.3

SSH Server

26.3.8.4

Public IP: 9.16.1.55

Internal IP: 10.10.100.1

Source: 9.16.1.55:1015
Destination: 15.78.67.3:80

Source: 9.16.1.55:1016
Destination: 26.3.8.4:22

NAT Table	
10.10.100.7:4128	9.16.1.55:1015
10.10.100.2:3517	9.16.1.55.1016
10.10.100.35:6644	9.16.1.55.1017

10.10.100.2

10.10.100.7

NAT64 – IPv6 to IPv4

- IPv6 is the future, but a lot of the internet still runs on IPv4.
- NAT64 allows IPv6-only devices to talk to IPv4-only services.
- It translates between IPv6 and IPv4 addresses.
- Helpful for networks transitioning to IPv6

NAT Benefits Summary

- Conserves public IP addresses.
- Adds privacy and security by hiding internal Ips.
- PAT makes NAT even more efficient.
- NAT64 helps transition from IPv4 to IPv6.