

NAT and PAT

Course Title: Computer Networks



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Lecture Outline



1. Private Network
2. NAT
3. NAT Operation
4. Pooling of IP Address
5. PAT
6. Load Balancing of Servers
7. Advantage/Disadvantage

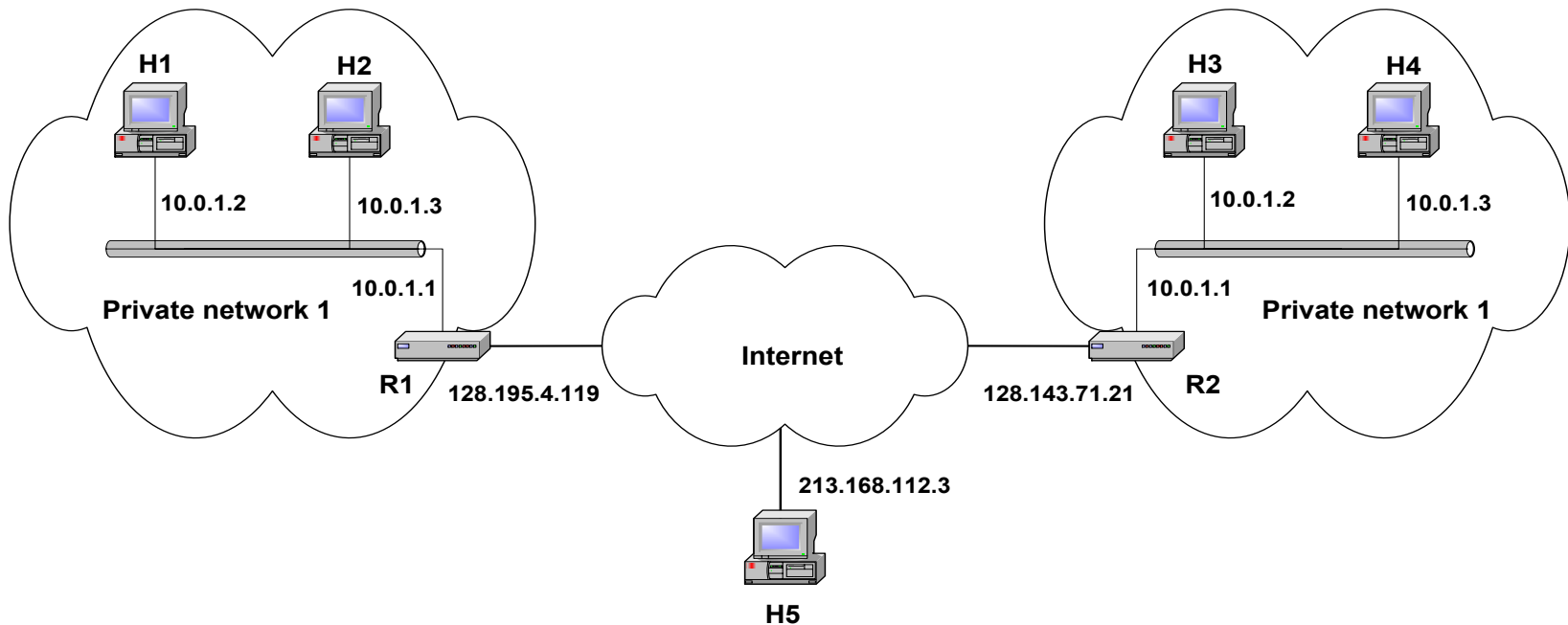


Private Network

- *Private IP* network is an IP network that is not directly connected to the Internet. IP addresses in a private network can be assigned arbitrarily. Not registered and not guaranteed to be globally unique
- Generally, private networks use addresses from the following experimental address ranges (*non-routable addresses*):
 - 10.0.0.0 – 10.255.255.255/8
 - 172.16.0.0 – 172.31.255.255/16
 - 192.168.0.0 – 192.168.0.255/24



Private Addresses





Network Address Translation (NAT)

- A long-term solution is using IPv6.
- A short-term solution to the problem is CIDR (Classless Inter Domain Routing) and NAT.
- NAT is a way to conserve IP addresses.
- Can be used to hide a number of hosts behind a single IP address.
- Uses private addresses:
 - 10.0.0.0-10.255.255.255,
 - 172.16.0.0-172.32.255.255 or
 - 192.168.0.0-192.168.0.255

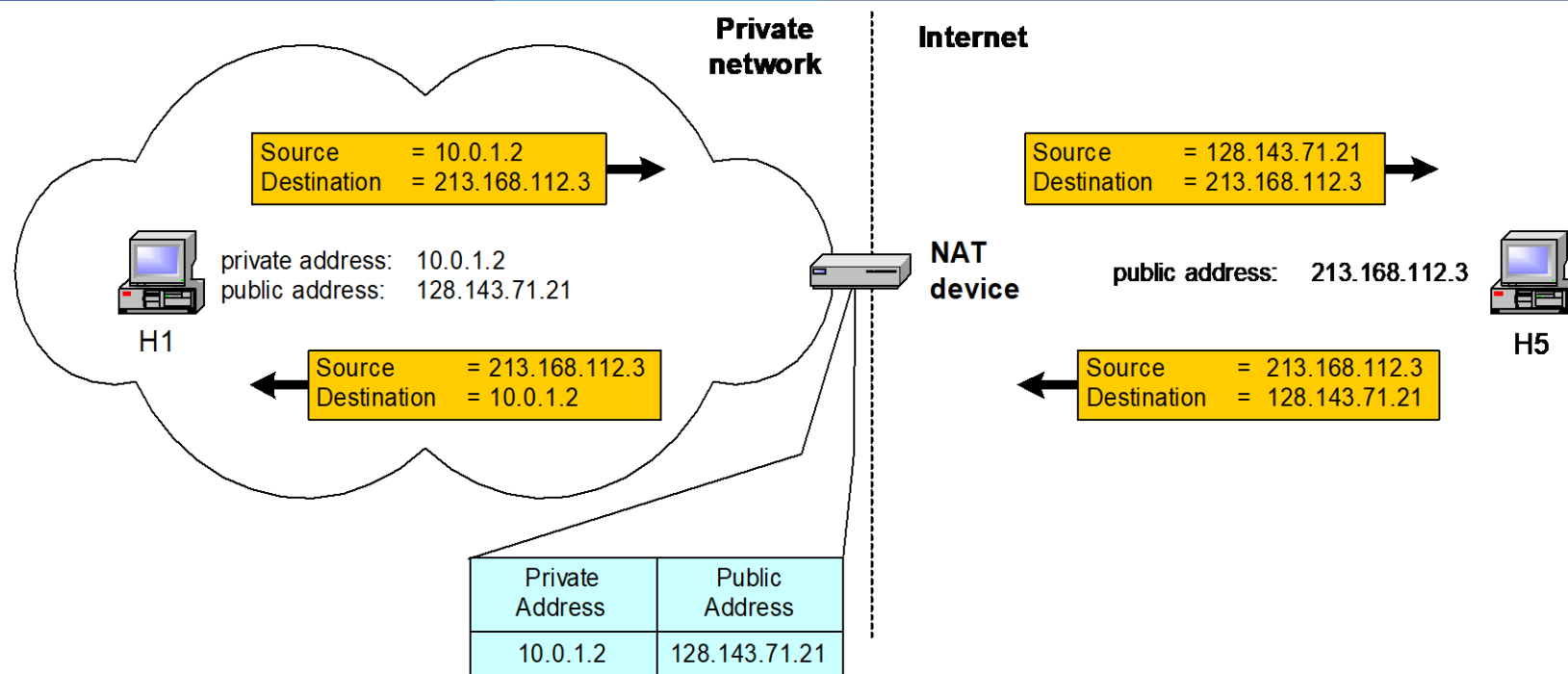
NAT



- 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.



Basic Operation of NAT



NAT device has address translation table
One to one address translation

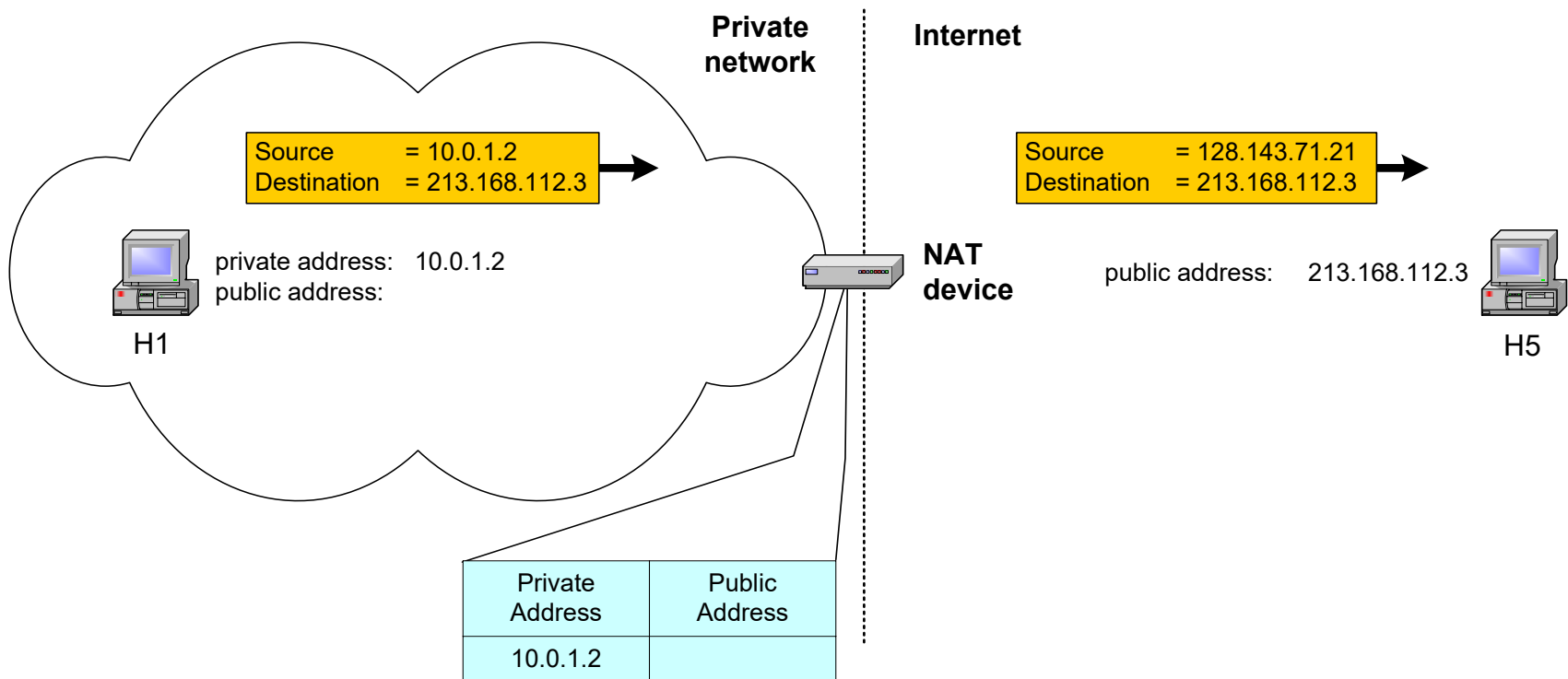


Pooling of IP Addresses

- **Scenario:** Corporate network has many hosts but only a small number of public IP addresses
- **NAT solution:**
 - Corporate network is managed with a private address space
 - NAT device, located at the boundary between the corporate network and the public Internet, manages a pool of public IP addresses
 - When a host from the corporate network sends an IP datagram to a host in the public Internet, the NAT device picks a public IP address from the address pool, and binds this address to the private address of the host



Pooling of IP Addresses



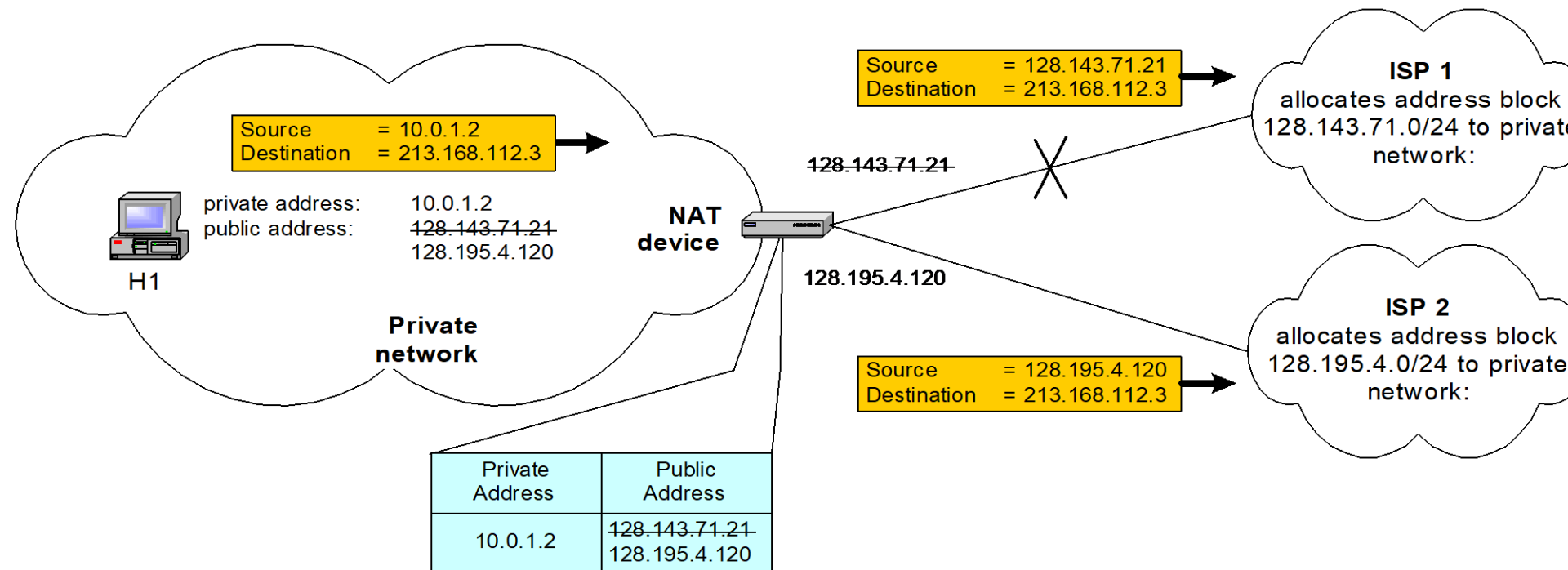
Pool of addresses: 128.143.71.0-128.143.71.30

Supporting Migration between Network Service Providers



- **Scenario:** In CIDR, the IP addresses in a corporate network are obtained from the service provider. Changing the service provider requires changing all IP addresses in the network.
- **NAT solution:**
 - Assign private addresses to the hosts of the corporate network
 - NAT device has static address translation entries which bind the private address of a host to the public address.
 - Migration to a new network service provider merely requires an update of the NAT device. The migration is not noticeable to the hosts on the network.

Supporting Migration between network service Providers



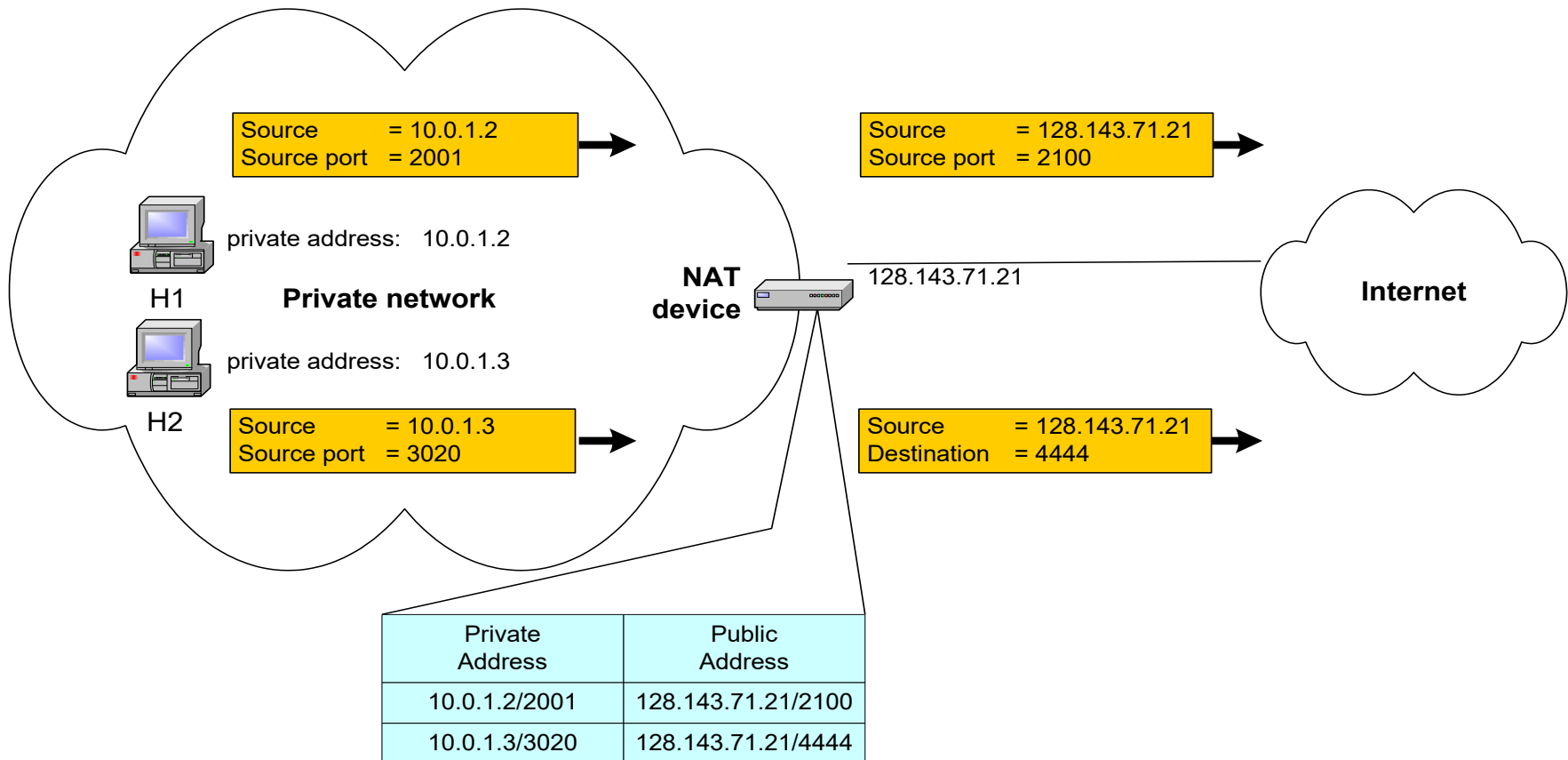


IP Masquerading – PAT

- This is also called Port Address Translation (PAT).
- **Scenario:** Single public IP address is mapped to multiple hosts in a private network.
- **PAT solution:**
 - Assign private addresses to the hosts of the corporate network.
 - PAT device modifies the port numbers for outgoing traffic.



IP Masquerading



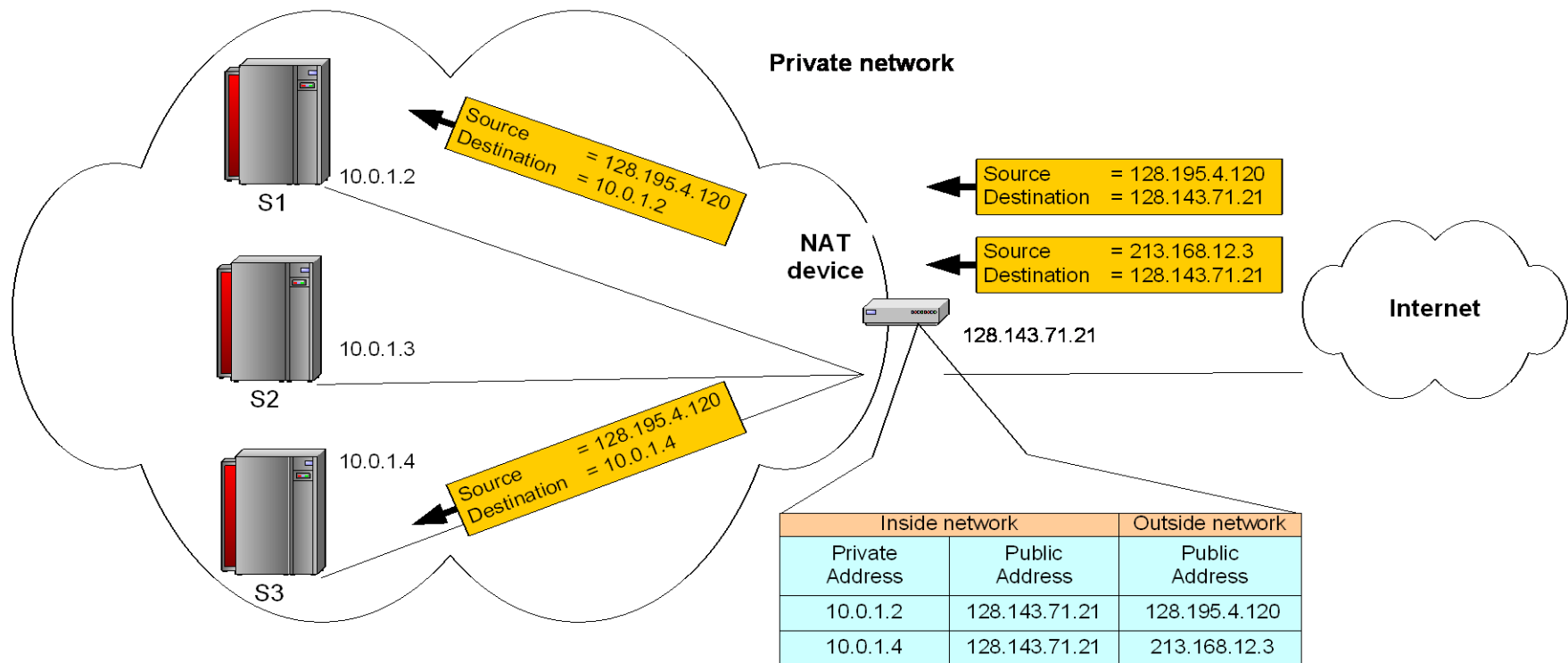


Load Balancing of Servers

- **Scenario:** Balance the load on a set of identical servers, which are accessible from a single IP address
- **PAT solution:**
 - Here, the servers are assigned private addresses
 - PAT device acts as a proxy for requests to the server from the public network.
 - The PAT device changes the destination IP address of arriving packets to one of the private addresses for a server.
 - A sensible strategy for balancing the load of the servers is to assign the addresses of the servers in a round-robin fashion.



Load Balancing of Servers





Concerns about NAT & PAT

- **Performance:**
 - Modifying the IP header by changing the IP address requires that NAT recalculates the IP header checksum.
 - Modifying port number requires that PAT recalculates TCP checksum.
- **Fragmentation**
 - Care must be taken that a datagram that is fragmented before it reaches the NAT/PAT device, is not assigned a different IP address or different port numbers for each of the fragments.

Advantage



- The main advantage of NAT/PAT is that it can prevent the depletion of IPv4 addresses.
- NAT/PAT can provide an additional layer of security by making the original source and destination addresses hidden.
- NAT/PAT provides increased flexibility when connecting to the public Internet.
- NAT/PAT allows to use private IPv4 addressing system and prevent the internal address changes if the service provider is changed.

Disadvantage



- NAT/PAT is a processor and memory resource consuming technology, since NAT/PAT need to translate IPv4 addresses for all incoming and outgoing IPv4 datagrams and to keep the translation details in memory.
- NAT/PAT may cause delay in IPv4 communication.
- NAT/PAT cause loss of end-device to end-device IP traceability.

Summary of NAT & PAT

- › NAT: NAT is Network Address Translation. This is a router function where IP addresses of IP datagrams are replaced at the boundary of a private network and enables hosts on private networks to communicate with hosts on the Internet.
- › PAT: PAT is Port Address Translation, and it is also called IP Masquerading. When a single public IP address is mapped to multiple hosts in a private network, PAT assigns private addresses to the hosts and modifies the port numbers for outgoing traffic.
- › Together, they are called NAPT.
- › *Draw an excellent diagram explaining NAT & PAT.*

Summary of NAT & PAT

› *Advantages & Disadvantages of NAPT*

- › NAPT prevents the depletion of IPv4 addresses.
- › NAPT provides an additional layer of security by making the original source and destination addresses hidden.
- › NAPT provides increased flexibility when connecting to the public Internet.
- › NAPT allows to use private IPv4 addressing system and prevent the internal address changes if the service provider is changed.
- › NAPT is a processor and memory resource consuming technology, since NAPT need to translate IPv4 addresses for all incoming and outgoing IPv4 datagrams and to keep the translation details in memory.
- › NAPT may cause delay in IPv4 communication.
- › NAPT cause loss of end-device to end-device IP traceability.

Summary of NAT & PAT

› *Draw a Table explaining how NAT works.*

INSIDE NETWORK			OUTSIDE NETWORK	
Private IPs	Ports	My Public IP	Public IPs	Port
Private IP 1	Port 1	My Public IP	Public IP X	Port of Public IP X
Private IP 2	Port 2	My Public IP	Public IP Y	Port of Public IP Y
Private IP 3	Port 3	My Public IP	Public IP X	Port of Public IP X
Private IP 4	Port 4	My Public IP	Public IP Y	Port of Public IP Y



References

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