

Network Address Translation (NAT)

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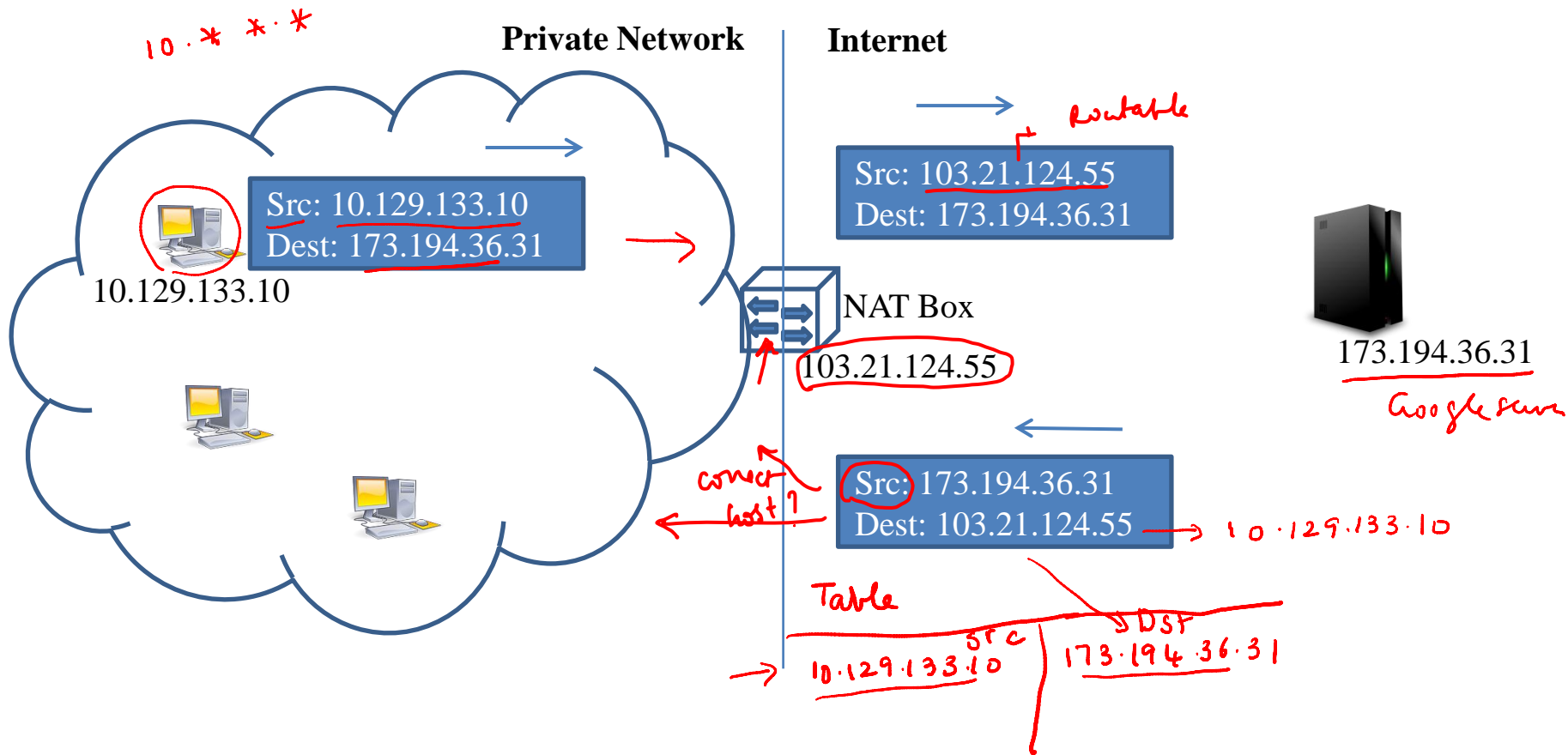
Introduction

- NAT: Another solution to address IPv4 address exhaustion
4000 hosts
- Example: An organization with 4000 hosts.
Assign multiple class C addresses (*16* ~ 4000 IP addresses)
- How about managing with just a single IP addresses?

Solution Approach

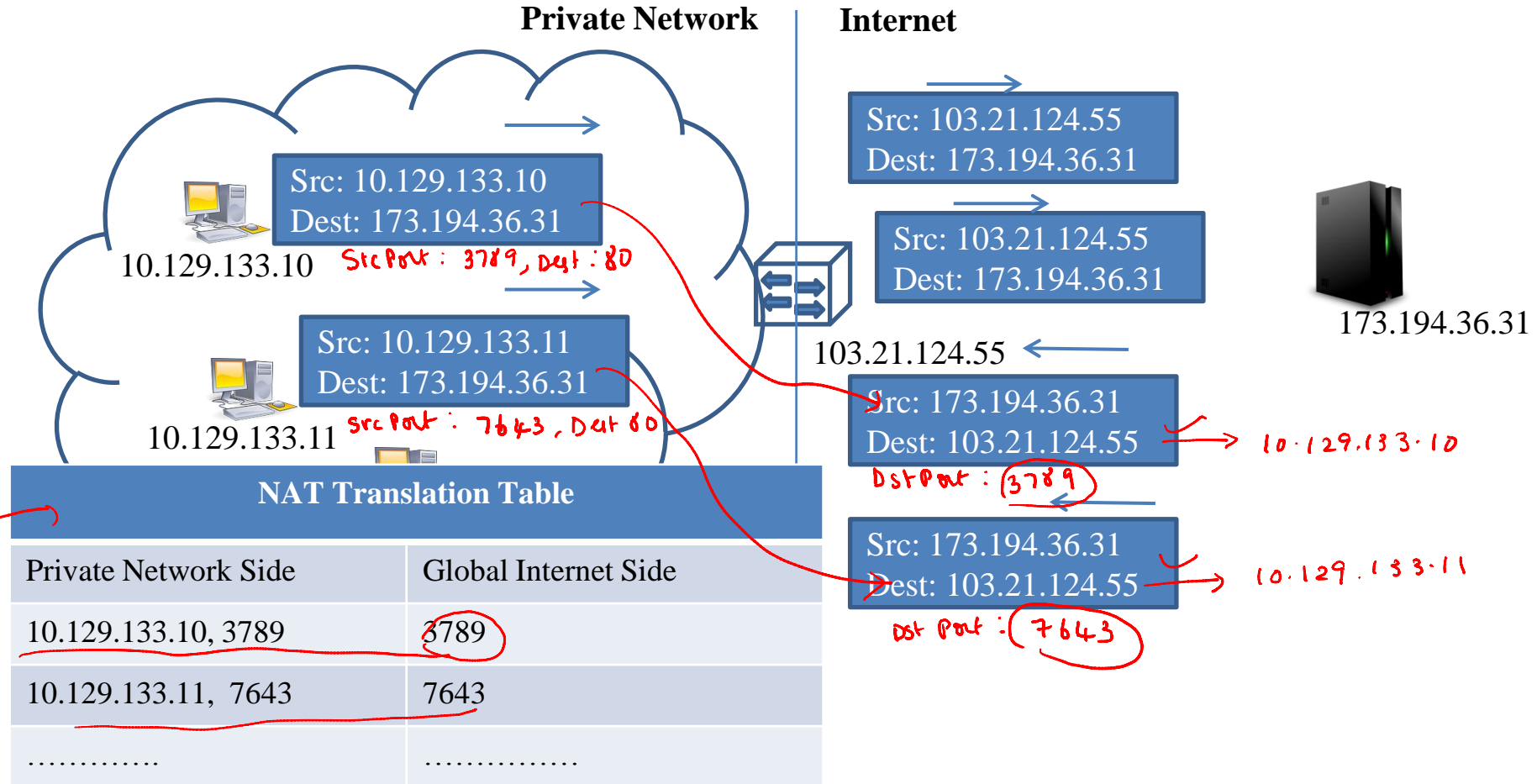
- Use private address space within the organization
 - Any one can use this space, addresses not routable in the global Internet
 - A: 10.0.0.0 through 10.255.255.255; B: 172.16.0.0 through 172.31.255.255; C: 192.168.0.0 through 192.168.255.255
- Connect to Internet via a NAT router
 - NAT router has a global routable IP address (pool of IP addresses) and does address Translation (IP Masquerading)

Example

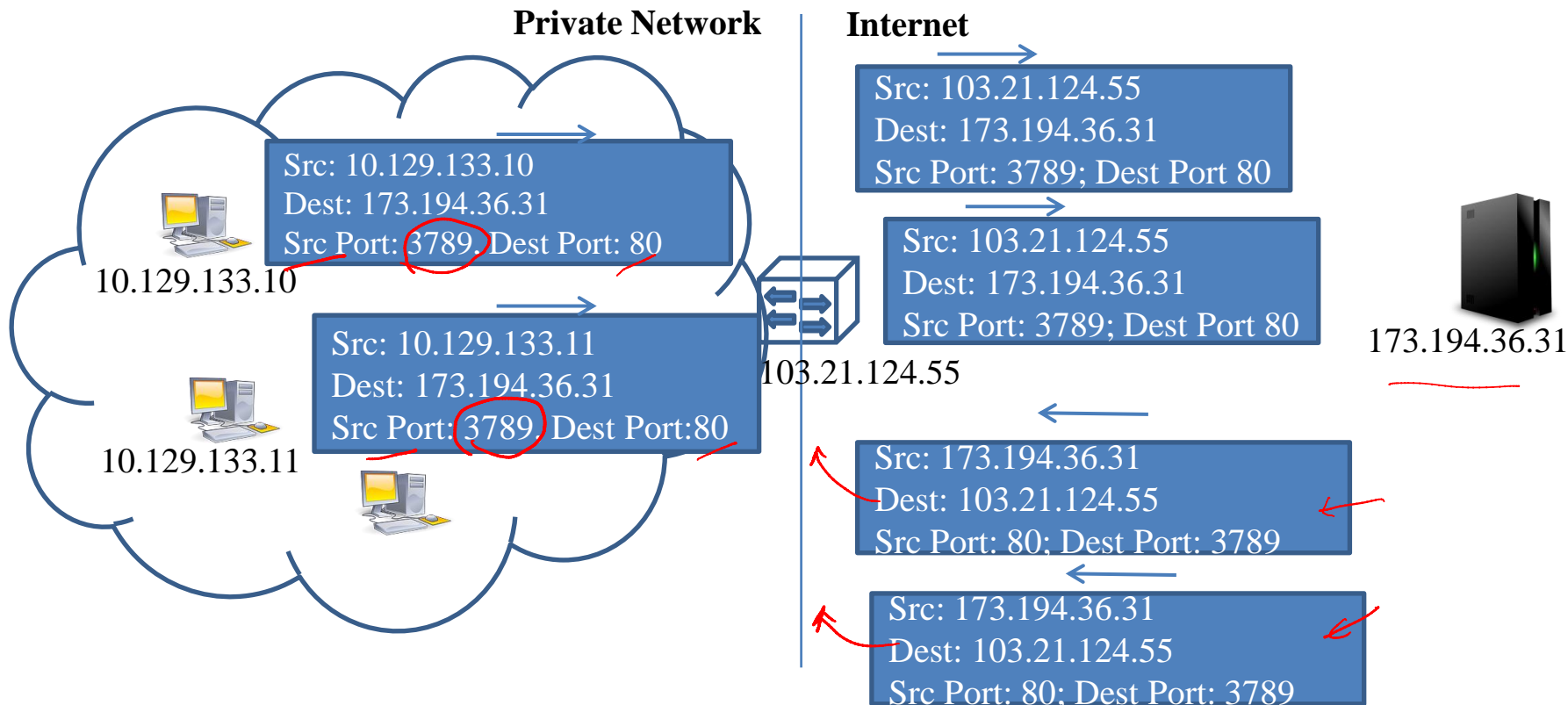


application process
transport layer ports

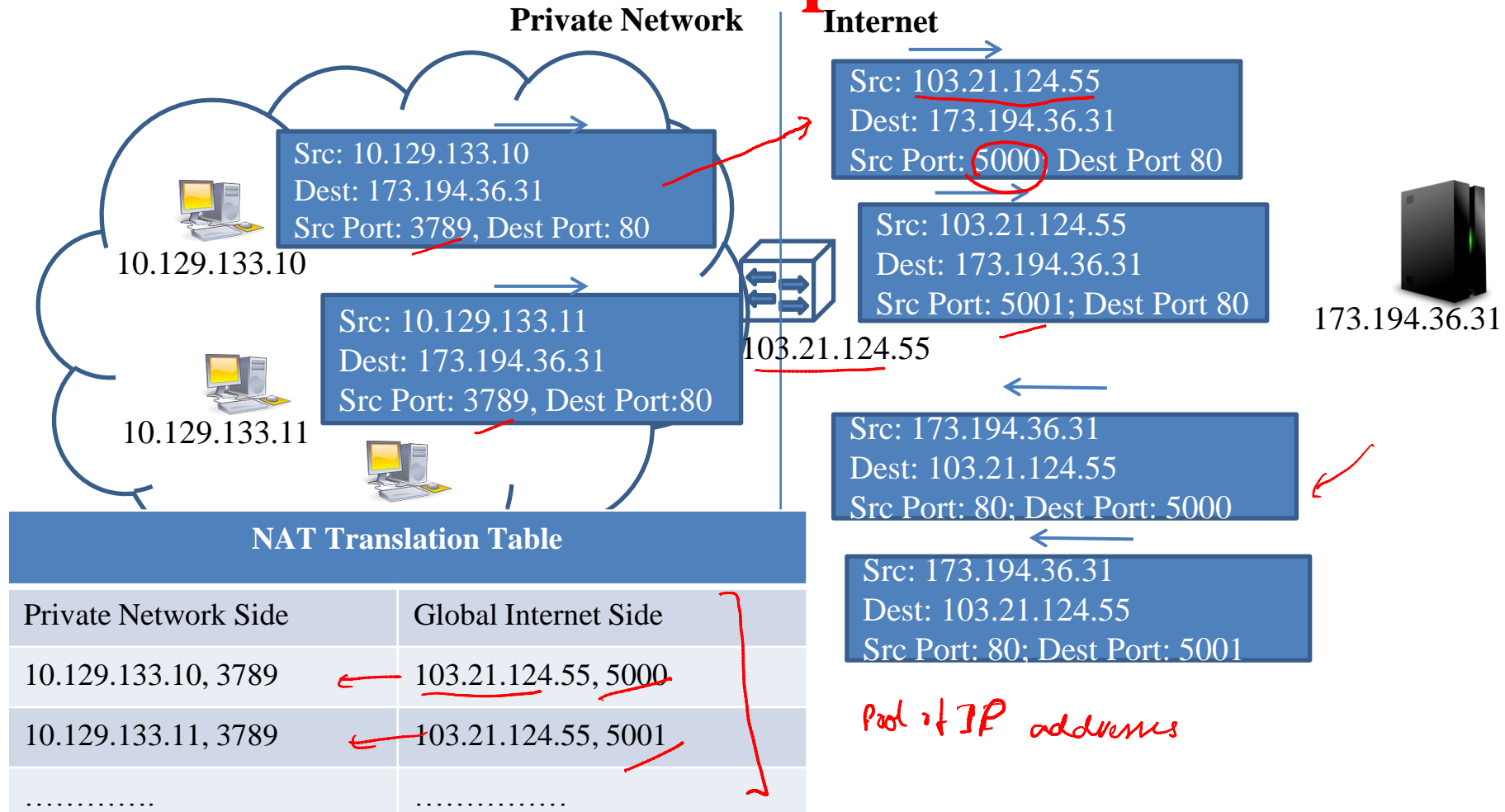
Example



Example

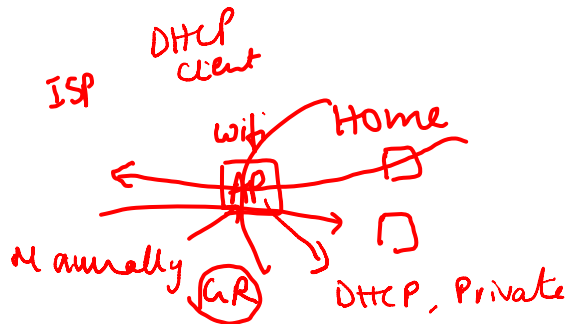


Example



Points to Note

- Usage Scenario: Within organizations, Home settings (e.g. WiFi AP), Load balancing server
- When using single IP address, how many connections can be supported by NAT?
80
 - Roughly 2^{16} ~ 60,000 (some ports are reserved)



Port - 16 bits



Advantages

- Provides significant IPv4 address savings
- Can easily switch service providers
 - Some organizations do static NAT (just map IP addresses, ports irrelevant)
- Provides a level of protection against attacks
 - Addresses of machines not visible to outside world

Handwritten diagram illustrating static NAT:
A red bracket groups the IP address $222.23.5.4$ (labeled class B) and the IP address $224.52.6.7$. An arrow points from $222.23.5.4$ to $224.52.6.7$. The text $10.*.*.*$ is written to the left of the bracket.

Handwritten text: NAT

Handwritten diagram illustrating a network configuration:
An arrow points to the IP address $172.16.*.*$ (labeled class B). Below it, the IP address $130.12.*.*$ is shown with an arrow pointing down to $165.1.*.*$. A red bracket groups the IP addresses $172.16.*.*$ and $130.12.*.*$.

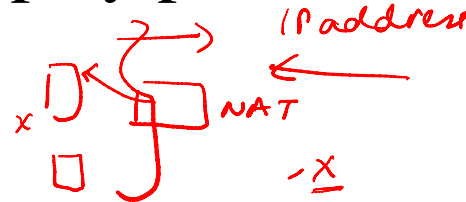
Disadvantages

- NAT is a ‘black sheep’: Violates Internet principles
 - ports are for addressing processes not hosts
 - NAT operates at network layer but looks into higher-layer headers *modifying ports*
 - Don’t know who you are communicating with?
- Doesn’t work over encrypted headers *port*

- NAT needs an understanding of many higher layer protocols
 - Some packets may carry IP information in higher layers (e.g. FTP, DNS, ICMP)
- Difficult to support servers, peer-to-peer applications behind NAT
 - UPnP (universal plug and play protocol helps to some extent)

application
layer
packets as well

↳ BitTorrent



Summary

- NAT is another solution to IPv4 address shortage problem
- Based on private IP addresses in combination with address/port translation
- Impure architecturally but very widely used
- Here to stay till widespread IPv6 deployment