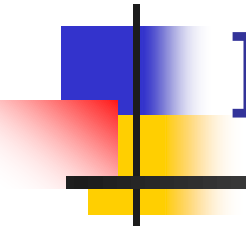

IPv4 (Part III)

รศ.ดร.อนันต์ ผลเพิ่ม

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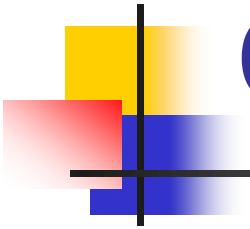
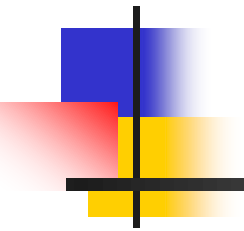
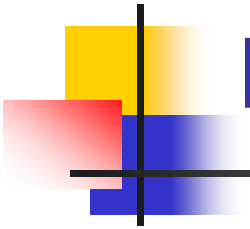


Outline

- IP Fundamental Operation
- Internet Protocol
- Addressing
- Supporting Protocol
  - ARP
  - ICMP: ping + traceroute
  - NAT
  - DHCP



Network Address Translation (NAT)



Network Address Translation (NAT)

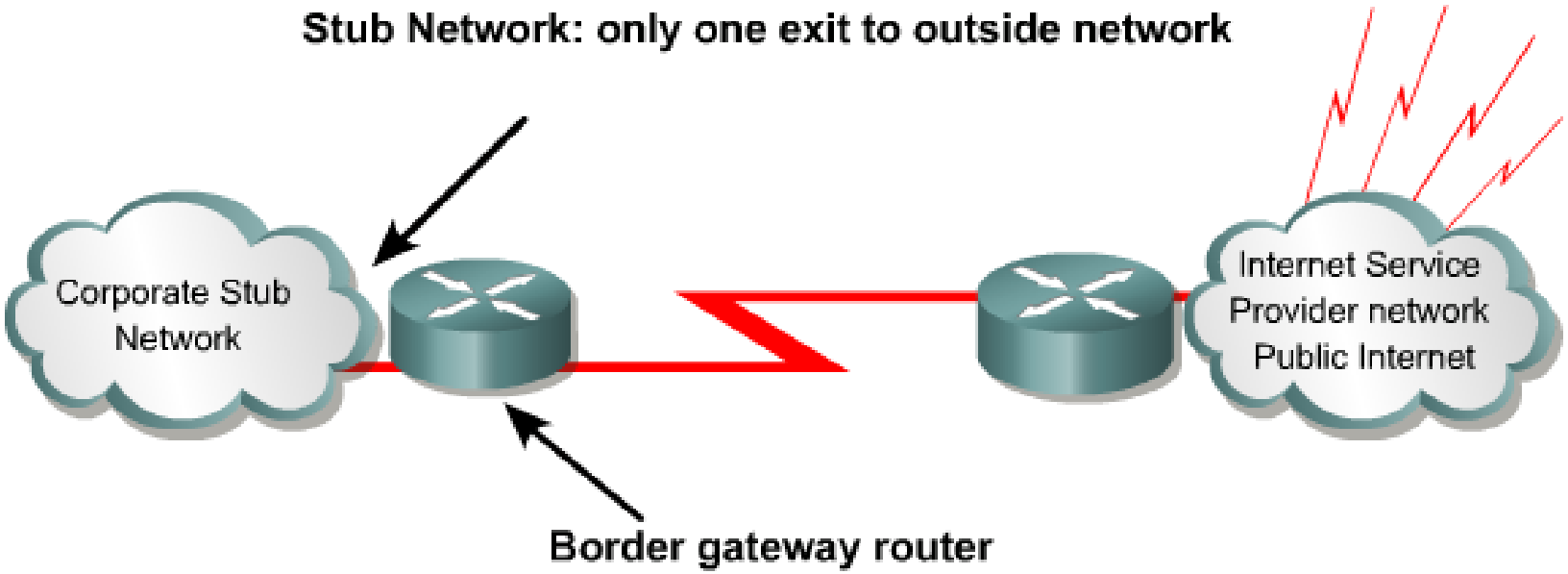
- Private Network
  - Good practice to use private address
- Map local addresses to (real) public IP address(es)
- Security (not expose internal details)
- Alleviate IP depletion

Private IP address

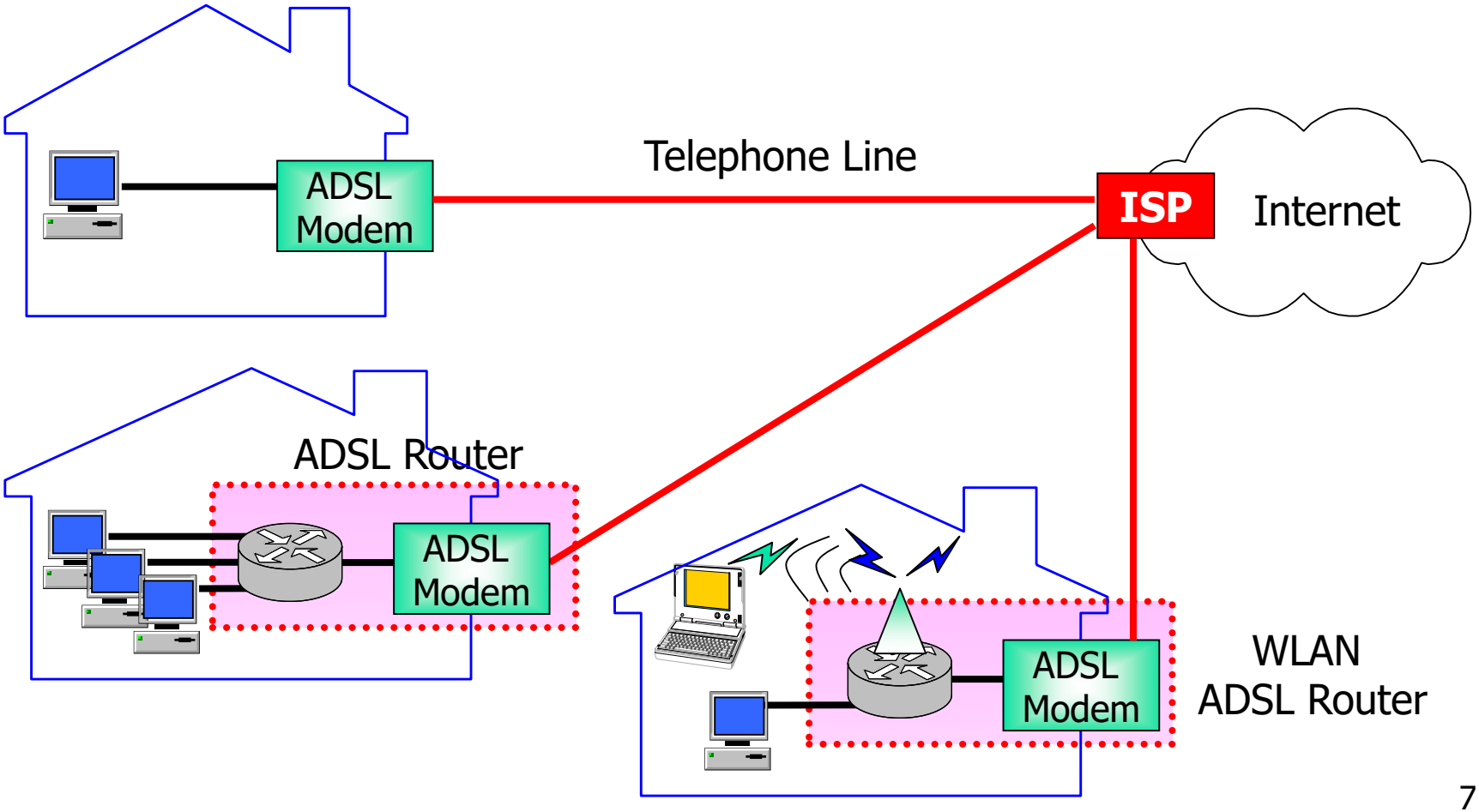
Class	RFC 1918	CIDR prefix
A	10.0.0.0 – 10.255.255.255	10.0.0.0/8
B	172.16.0.0 – 172.31.255.255	172.16.0.0/12
C	192.168.0.0 – 192.168.255.255	192.168.0.0/16

Stub Network

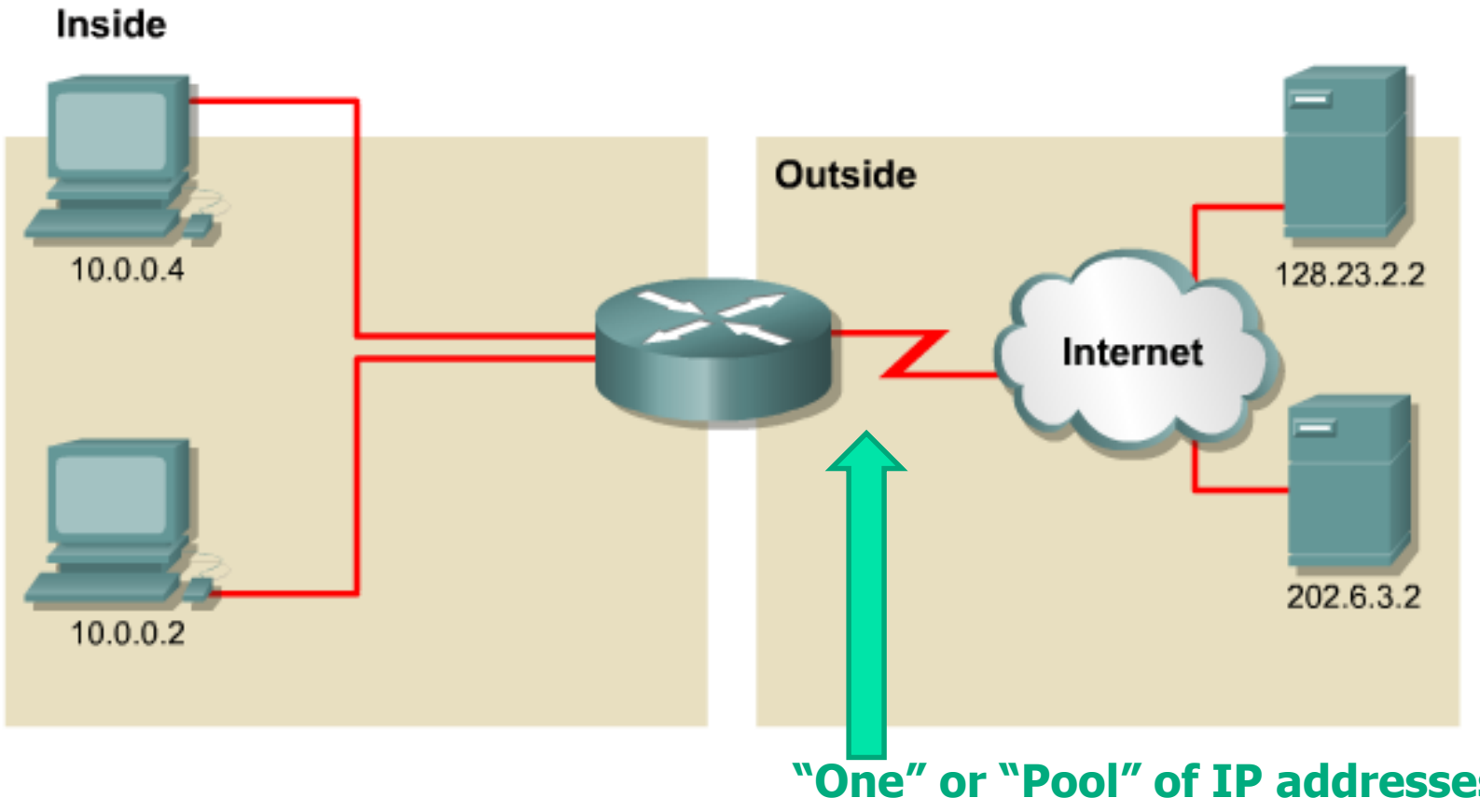
- Operates at the border of a stub network



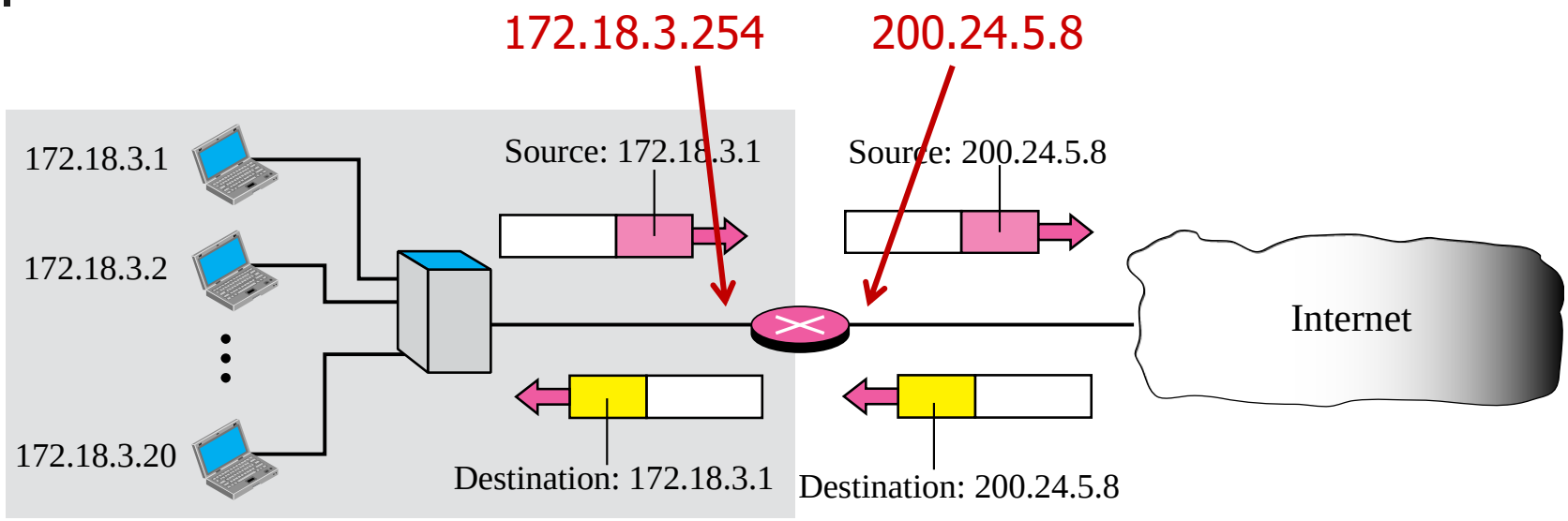
Stub Network Example
ADSL Connection



NAT


Inside
10.0.0.4
10.0.0.2
Outside
128.23.2.2
Internet
202.6.3.2
"One" or "Pool" of IP addresses

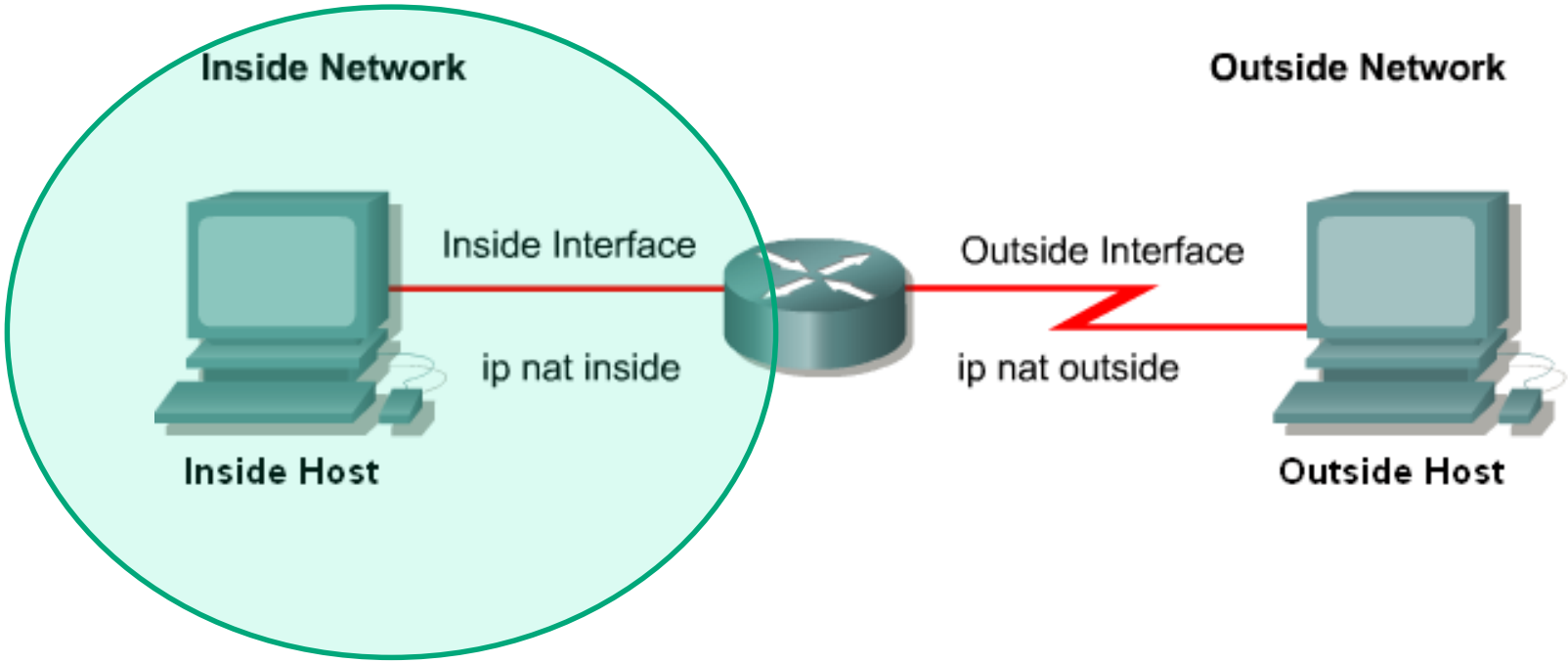
Example



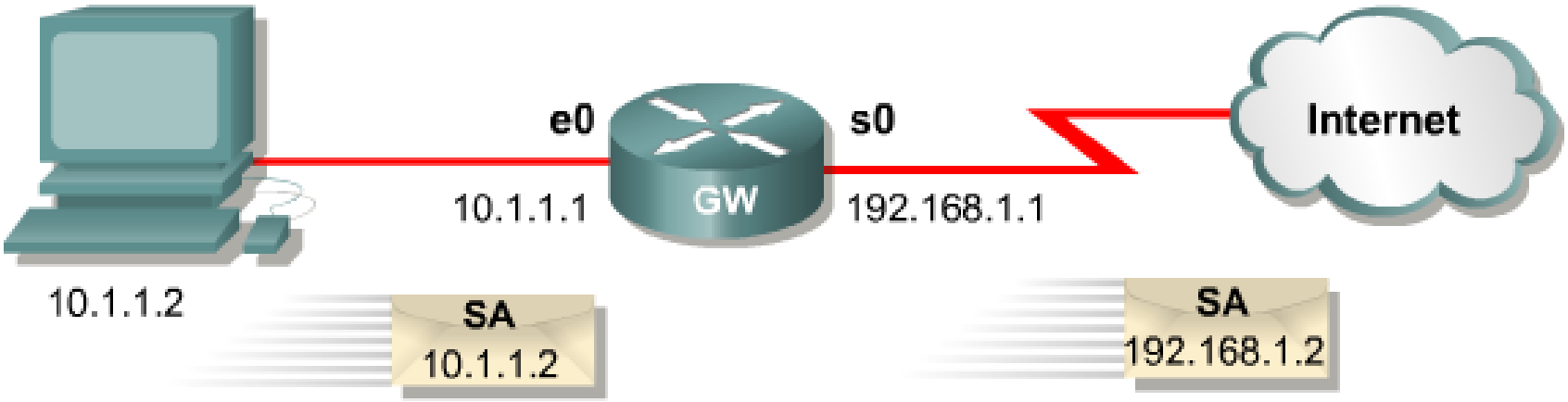
Site using private addresses

Configure NAT

- Static Translation
- Dynamic Translation

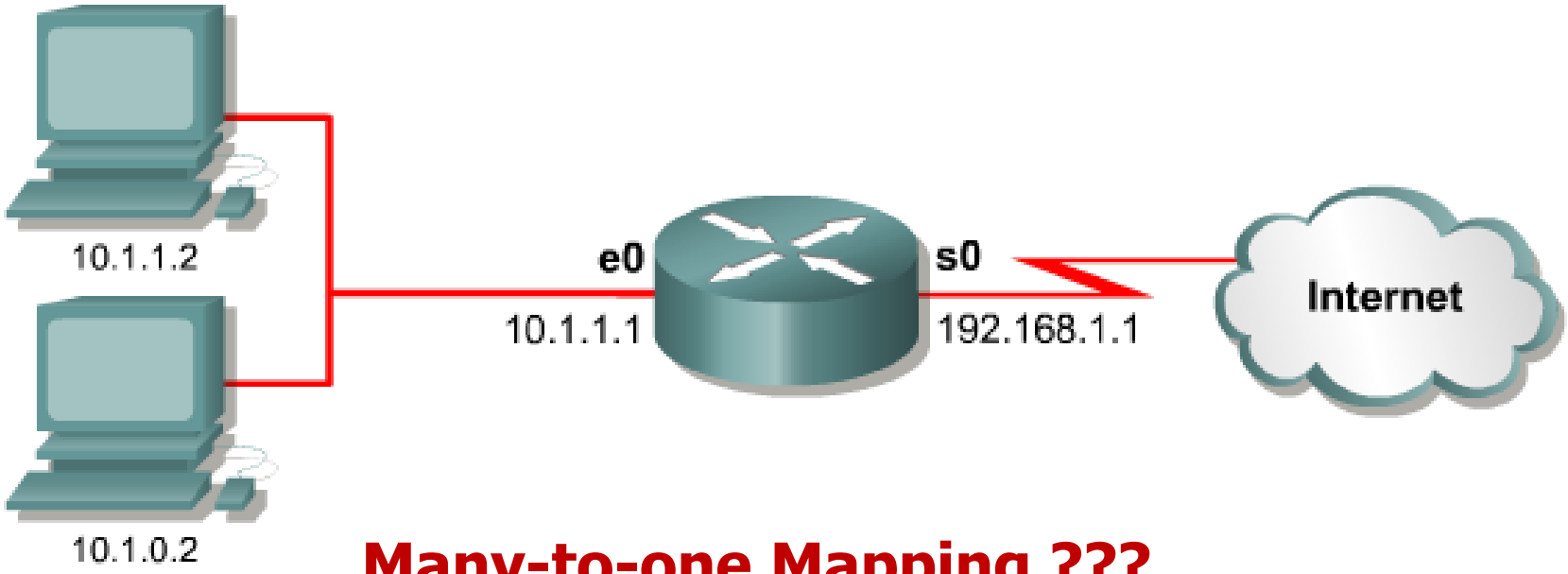


Static Translation




```
hostname GW
!
ip nat inside source static 10.1.1.2 192.168.1.2
!
interface ethernet 0
  ip address 10.1.1.1 255.255.255.0
  ip nat inside
!
interface serial 0
  ip address 192.168.1.1 255.255.255.0
  ip nat outside
!
```

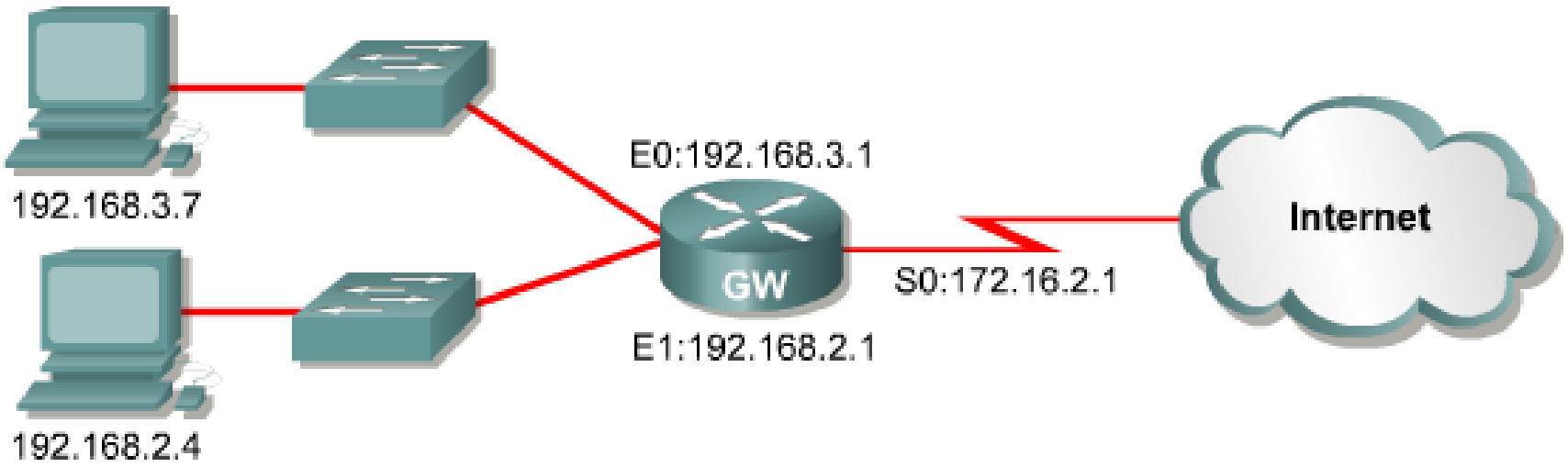
Dynamic Translation



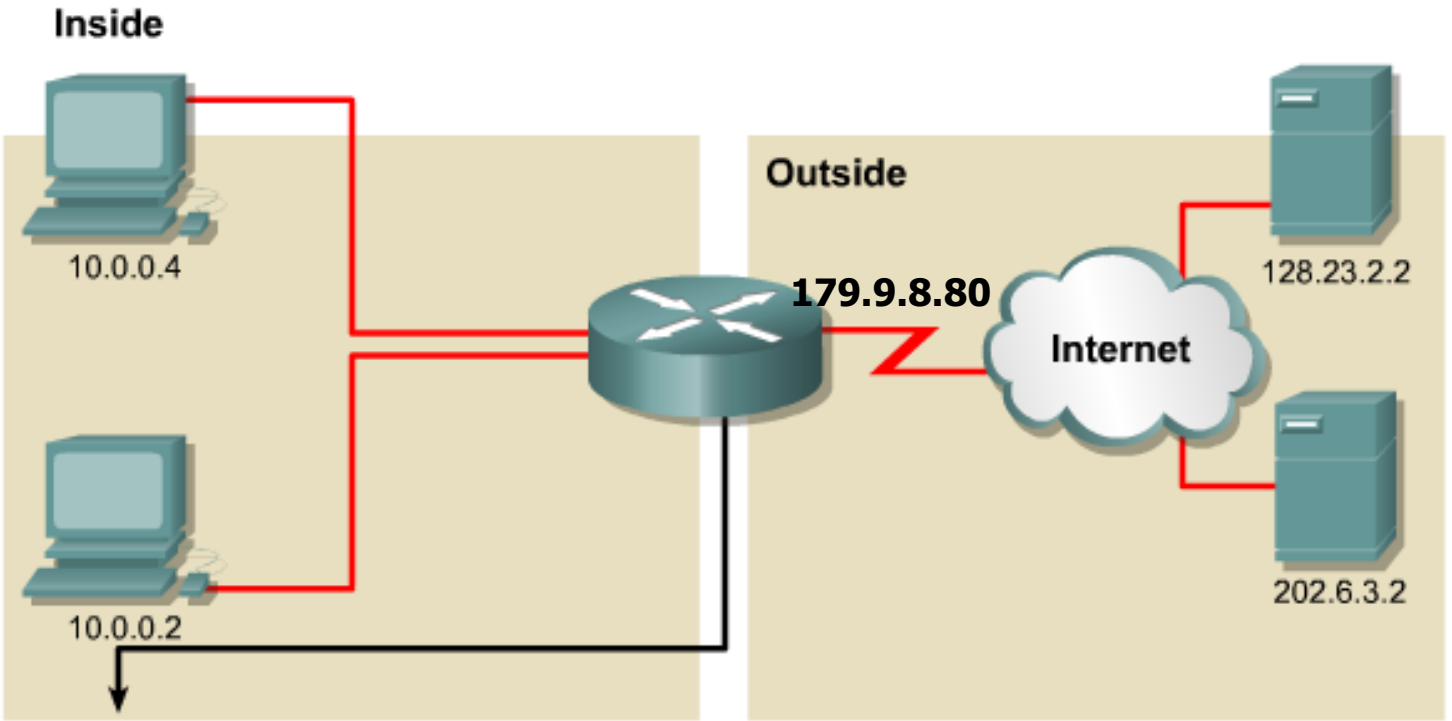
Many-to-one Mapping ???

Many inside IP → one outside IP

PAT: Port Address Translation (Overloaded NAT)

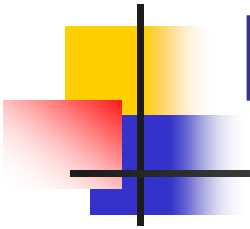


PAT



NAT Table with Overload

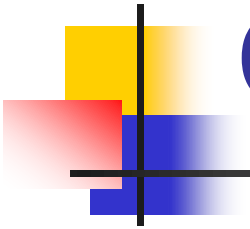
Inside Local IP Address	Inside Global IP Address	Outside Local IP Address	Outside Global Address
10.0.0.2:1331	179.9.8.80:1331	202.6.3.2:80	202.6.3.2:80
10.0.0.4:1555	179.9.8.80:1555	128.23.2.2:80	128.23.2.2:80



Disadvantages of NAT

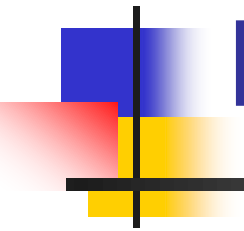
- Delay
- Loss of end-to-end ability
- Might not work with some applications

HW: Find out what application does not work with NAT ? Please explain.



Outline

- IP Fundamental Operation
- Internet Protocol
- Addressing
- Supporting Protocol
  - ARP
  - ICMP: ping + traceroute
  - NAT
  - **BOOTP/DHCP ← Application Protocol**



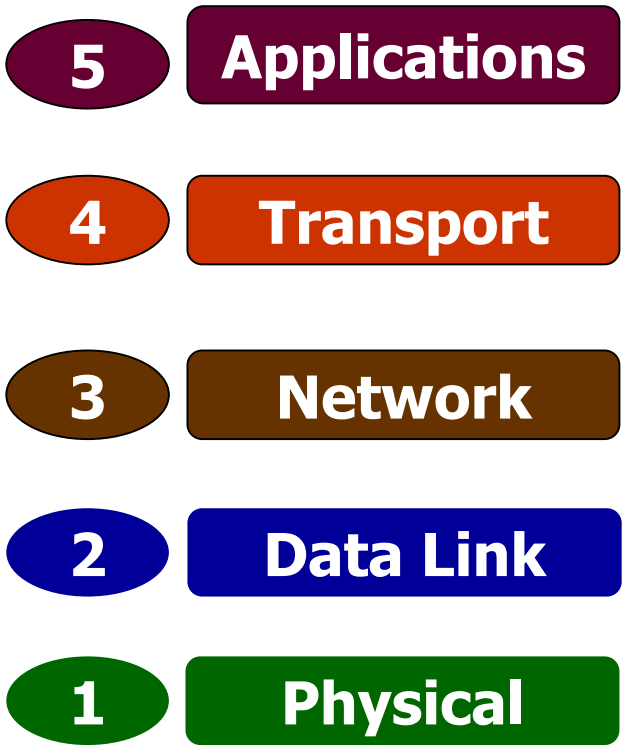
Bootstrap Protocol (BOOTP)

BOOTP

- RFC951 (Sep 1985) for RARP replacement
- Diskless terminal
- Discover its own IP address
- Download executable image file
- Small program built in chip
  - BOOTH and TFTP
- Application Protocol
  - Encapsulated in IP and UDP

http://www.davewentzel.com/sites/default/files/vt510.jpg

TCP/IP Protocol Suite
(Internet Model)



User service and interface

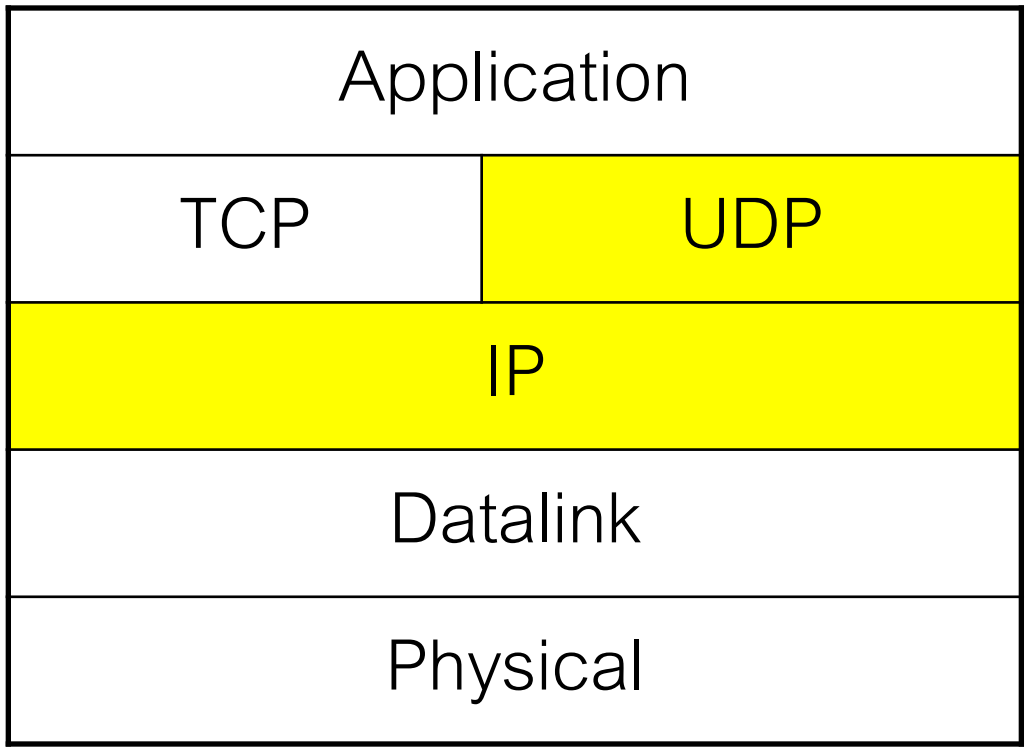
Process delivery + Error (TCP/UDP)
Reliable end-to-end (whole message)

Move packets from source to destination
Packet end-to-end (across network)

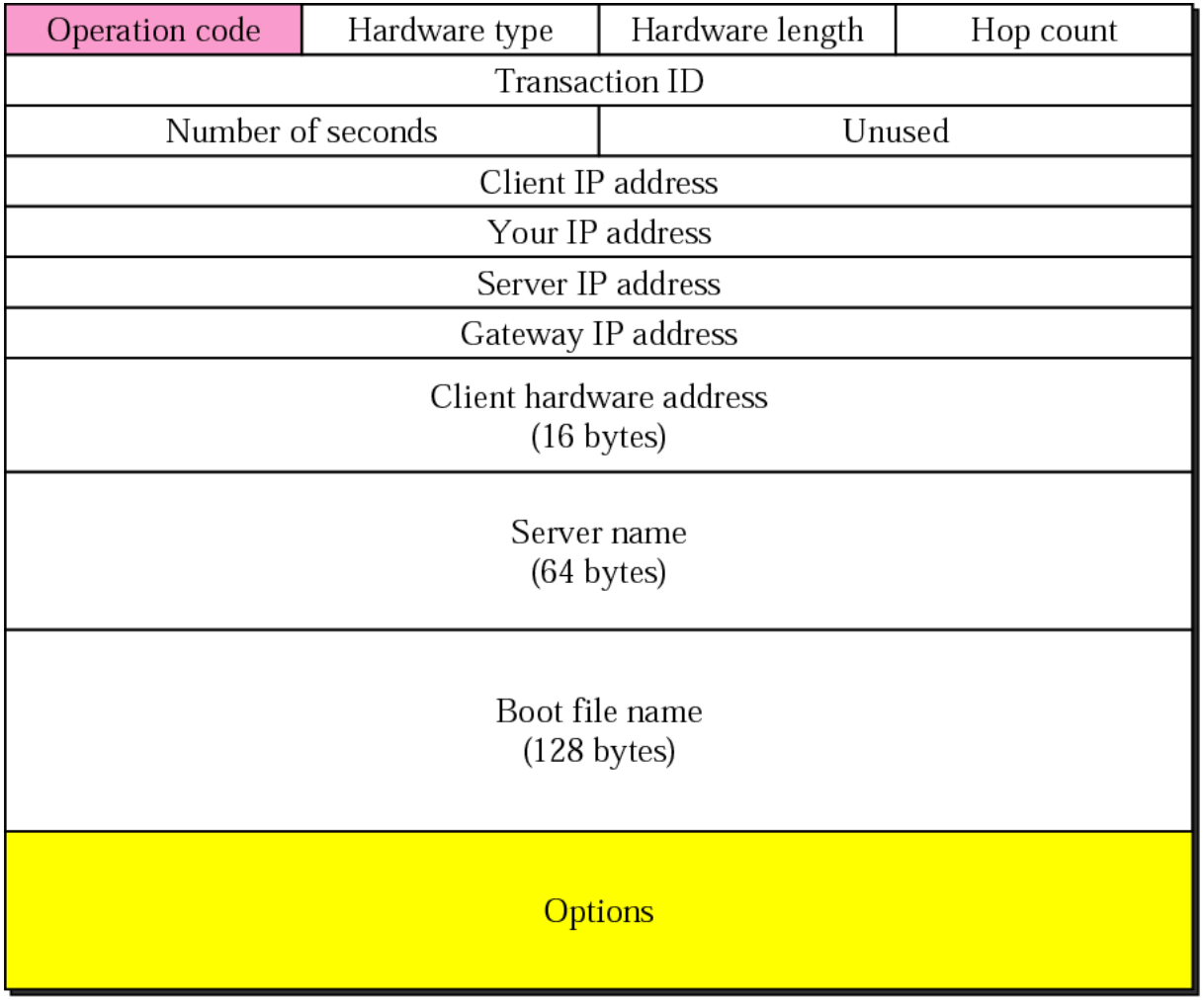
Provide frames
Node-to-node (same network segment)

Transmission bit streams
(mechanical and electrical spec)

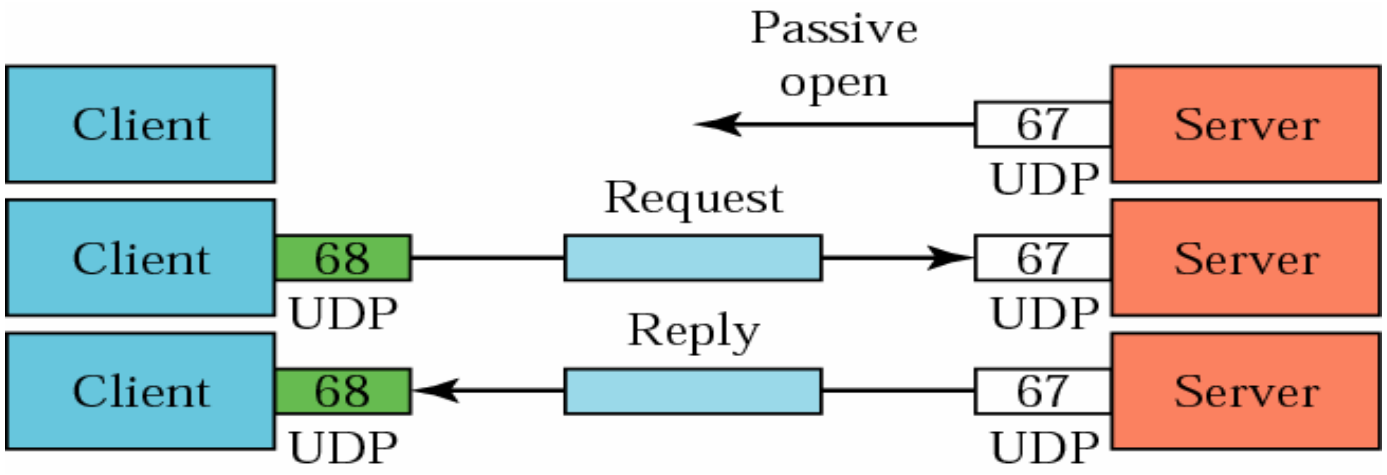
TCP/IP protocol Suite

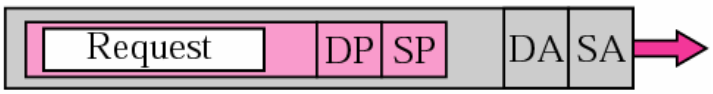


BOOTP packet format



Operation



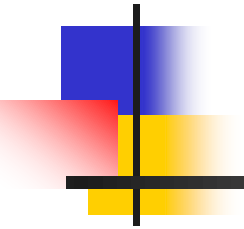


SP: Source port (68)
DP: Destination port (67)

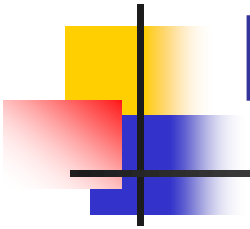
SA: Source address (All 0s)
DA: Destination address (All 1s)

SP: Source port (67)
DP: Destination port (68)

SA: Source address (Server unicast address)
DA: Destination address (All 1s or client unicast address)



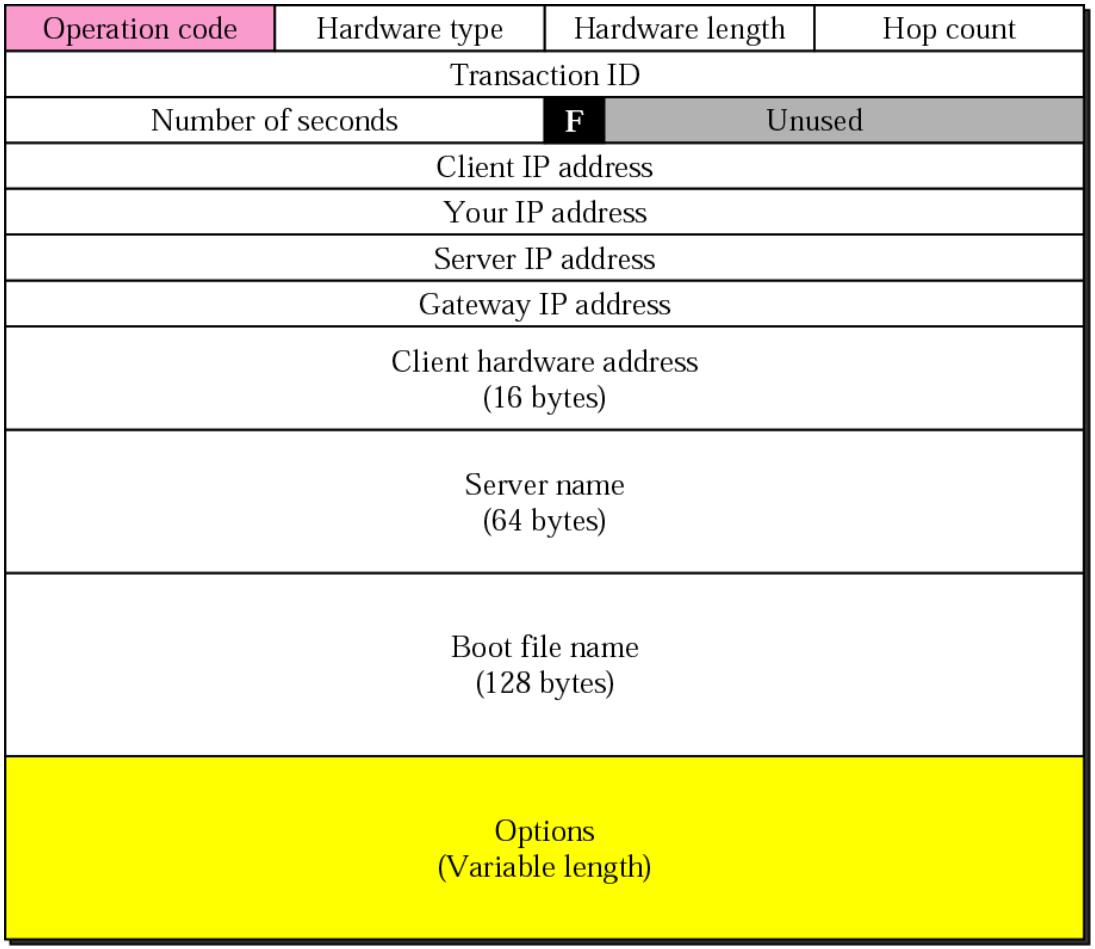
Dynamic Host Configuration Protocol (DHCP)



DHCP

- BOOTP Enhancement
- RFC 1531 (Oct 1993 – 8 yrs. After BOOTP)
- Same message structure as BOOTP
- Can choose among many DHCP servers

DHCP packet

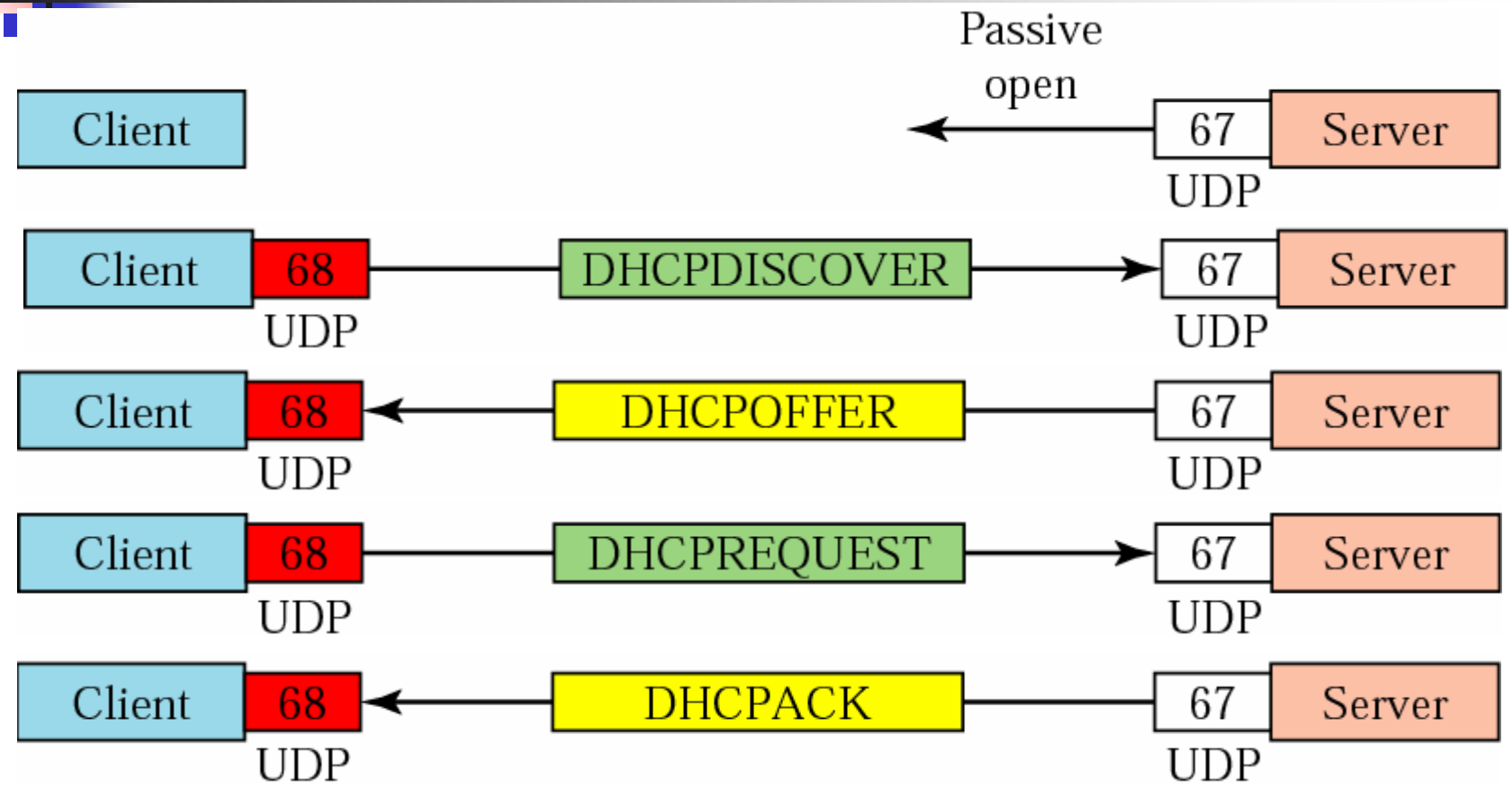

Operation code
Hardware type
Hardware length
Hop count
Transaction ID
Number of seconds
F
Unused
Client IP address
Your IP address
Server IP address
Gateway IP address
Client hardware address
(16 bytes)
Server name
(64 bytes)
Boot file name
(128 bytes)
Options
(Variable length)

Operation

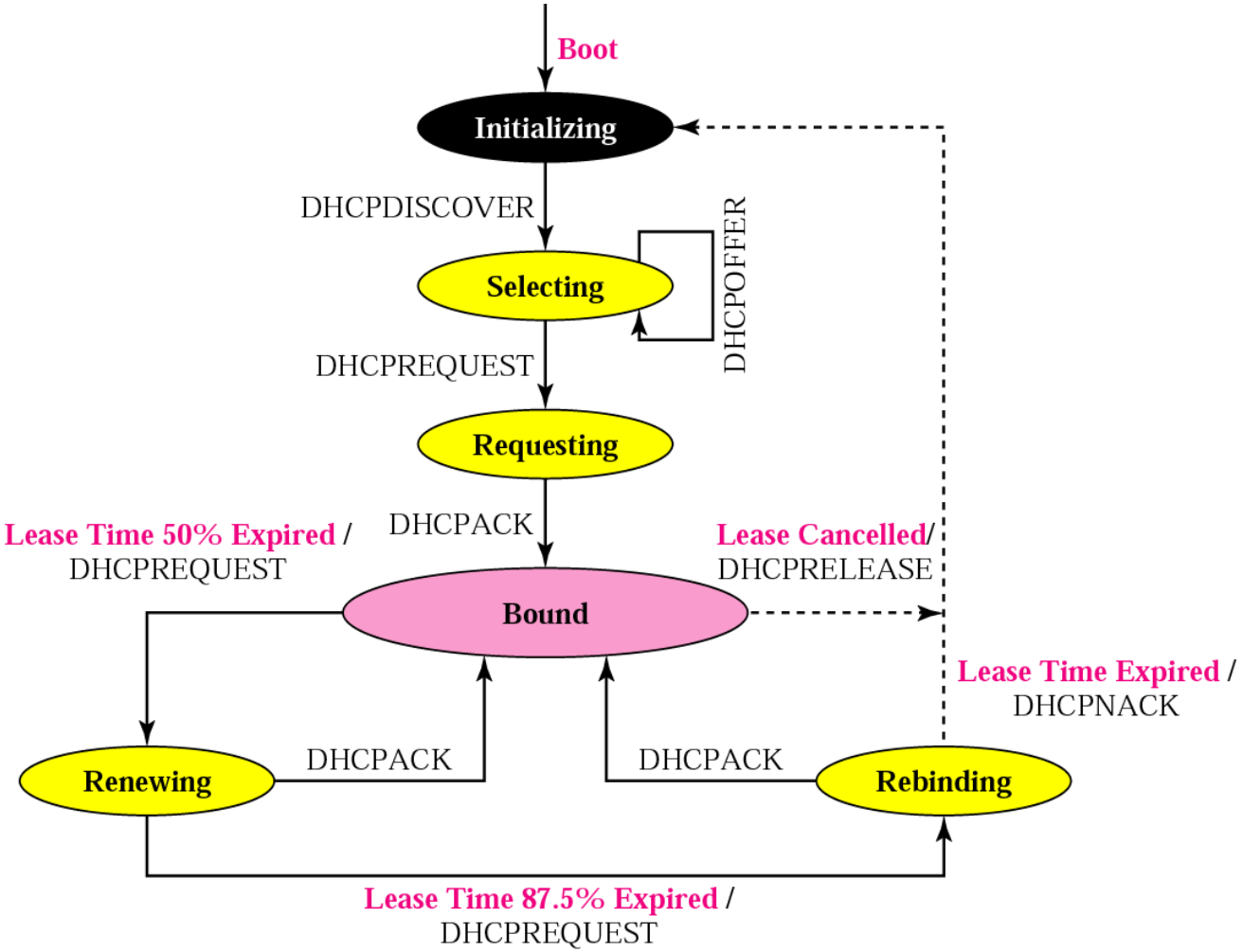
Ethernet Frame		IP		UDP	DHCP Request	
SRC MAC: MAC A		IP SRC: ?		UDP	CIADDR: ?	GIADDR: ?
DST MAC: FF:FF:FF:FF:FF:FF		IP DST: 255.255.255.255		67	Mask:?	CHADDR: MAC A

CIADDR : Client IP Address
GIADDR: Gateway IP Address
CHADDR: Client Hardware Address

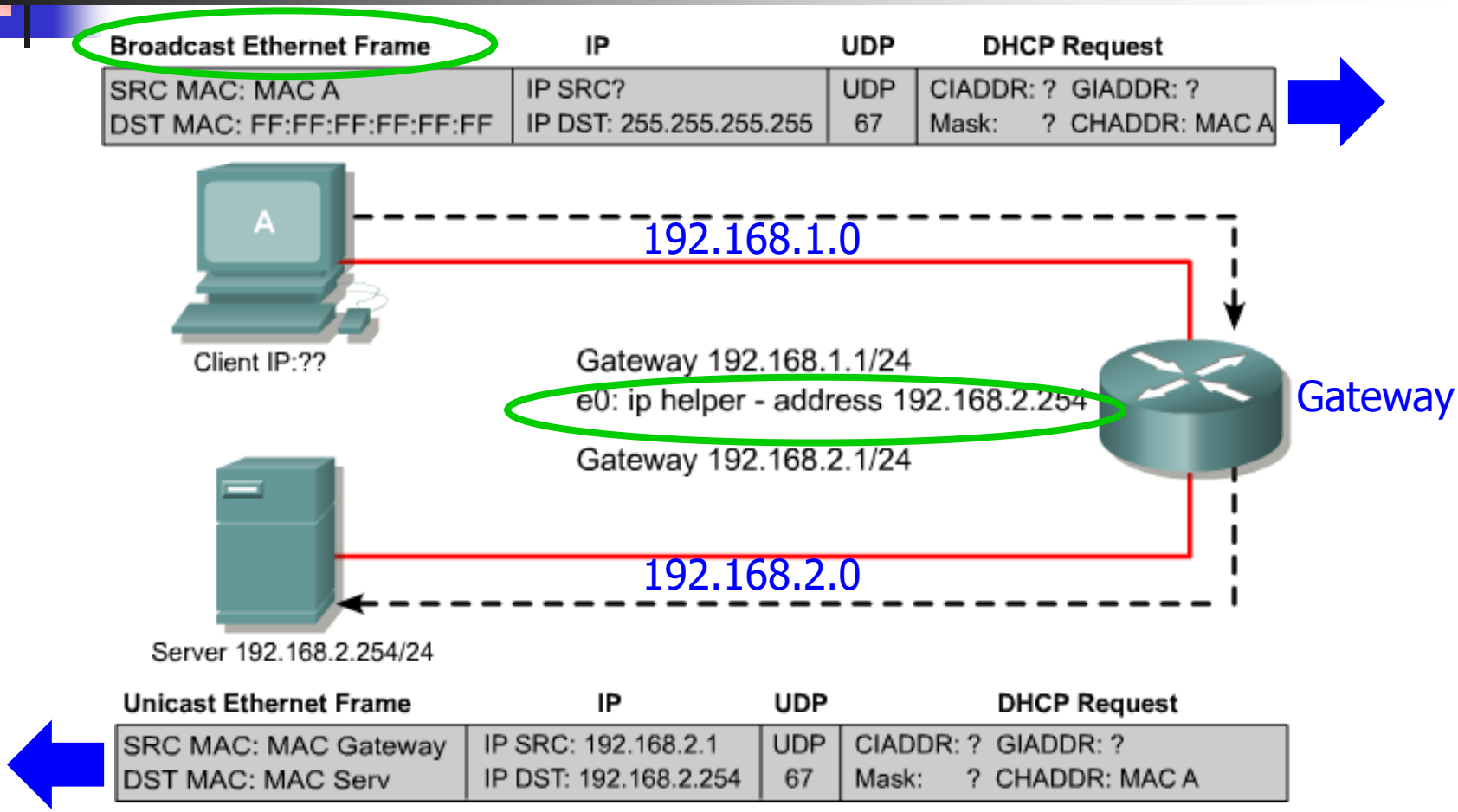
DHCP Message



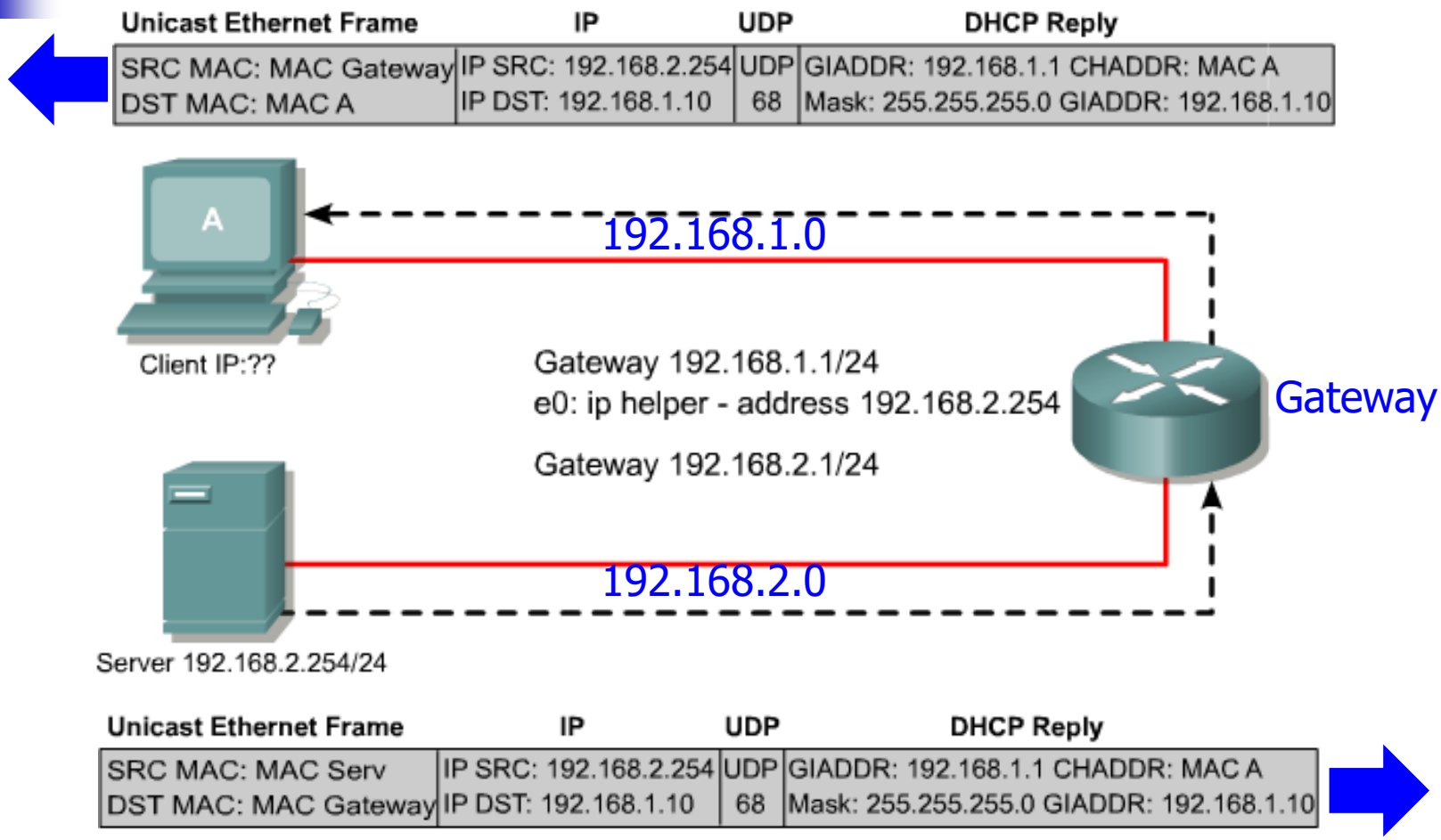
DHCP transition diagram

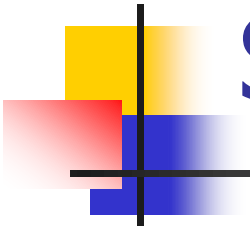


DHCP Relay


Broadcast Ethernet Frame
IP
UDP
DHCP Request
SRC MAC: MAC A
DST MAC: FF:FF:FF:FF:FF:FF
IP SRC?
IP DST: 255.255.255.255
UDP
67
CIADDR: ? GIADDR: ?
Mask: ? CHADDR: MAC A
A
Client IP:??
192.168.1.0
Gateway 192.168.1.1/24
e0: ip helper - address 192.168.2.254
Gateway 192.168.2.1/24
Gateway
192.168.2.0
Server 192.168.2.254/24
Unicast Ethernet Frame
IP
UDP
DHCP Request
SRC MAC: MAC Gateway
DST MAC: MAC Serv
IP SRC: 192.168.2.1
IP DST: 192.168.2.254
UDP
67
CIADDR: ? GIADDR: ?
Mask: ? CHADDR: MAC A

DHCP Relay


Unicast Ethernet Frame
IP
UDP
DHCP Reply
SRC MAC: MAC Gateway
DST MAC: MAC A
IP SRC: 192.168.2.254
IP DST: 192.168.1.10
UDP
68
GIADDR: 192.168.1.1 CHADDR: MAC A
Mask: 255.255.255.0 GIADDR: 192.168.1.10
A
192.168.1.0
Client IP:??
Gateway 192.168.1.1/24
e0: ip helper - address 192.168.2.254
Gateway 192.168.2.1/24
Gateway
192.168.2.0
Server 192.168.2.254/24
Unicast Ethernet Frame
IP
UDP
DHCP Reply
SRC MAC: MAC Serv
DST MAC: MAC Gateway
IP SRC: 192.168.2.254
IP DST: 192.168.1.10
UDP
68
GIADDR: 192.168.1.1 CHADDR: MAC A
Mask: 255.255.255.0 GIADDR: 192.168.1.10



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