DHCP & NAT

Module : Computer Networks
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Dynamic Host Configuration Protocol (DHCP)

- Every device that connects to a network needs an IP address.
  - Network administrators assign static IP addresses to routers, servers, and other network devices whose locations (physical and logical) are not likely to change.
  - User computers in an organization often change locations, physically and logically.
    - Desktop clients do not require a static address.
    - A workstation can use any address within a range of addresses.
    - This range is typically within an IP subnet.

Dynamic Host Configuration Protocol (DHCP)

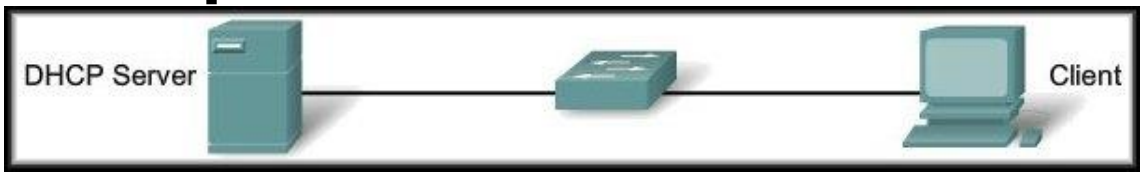
- Administrators typically prefer a network server to offer DHCP services.
  - Scalable.
  - Relatively easy to manage.

- In a small office/home network a router/wireless Access Point can be configured to provide DHCP services without the need for an expensive dedicated server.

DHCP Operation

- Address Allocation Methods:
  - Manual:
    - The IP address for the client is pre-allocated by the administrator and DHCP conveys the address to the client.
  - Automatic:
    - DHCP automatically assigns a permanent IP address to a client with no lease period.
  - Dynamic:
    - DHCP assigns, or leases, an IP address to the client for a limited period of time.

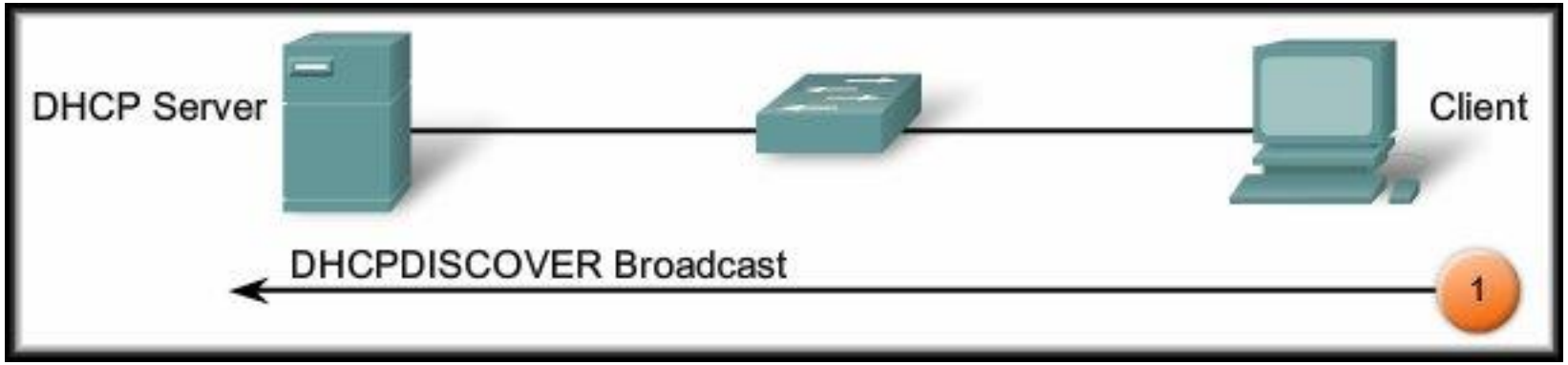
DHCP Operation



- Dynamic Allocation:
  - DHCP works in a client/server mode.
    - When the client connects, the server assigns or leases an IP address to the device.
    - The device connects to the network with that leased IP address until the lease period expires.
    - The host must contact the DHCP server periodically to extend the lease.
    - The leasing of addresses assures that addresses that are no longer used are returned to the address pool for use by other devices.

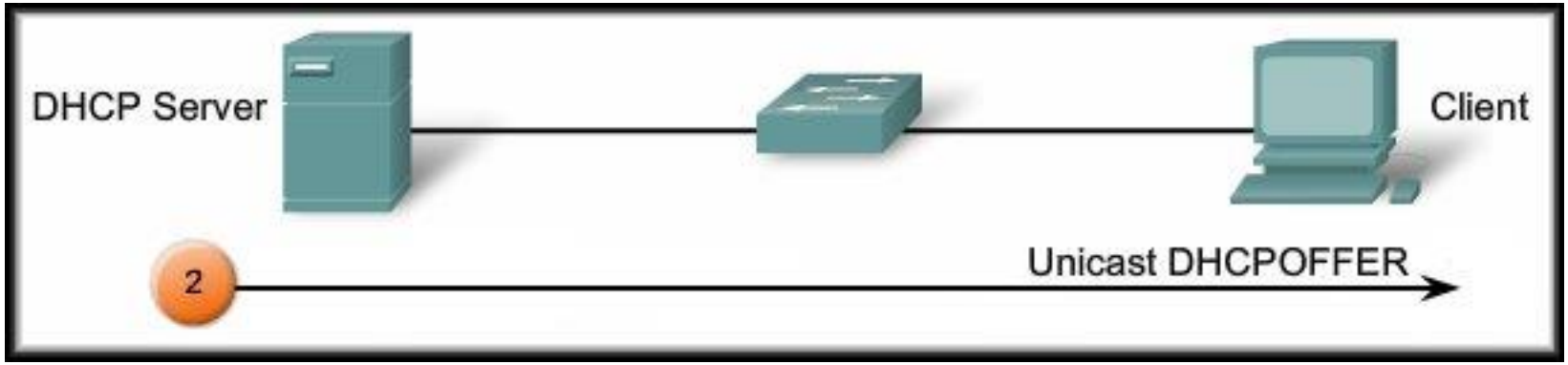
DHCP Operation

- Dynamic Allocation: 4 Step Process.
  - DHCPDISCOVER:
    - The client broadcasts a DHCPDISCOVER message.
    - The DHCPDISCOVER message finds the DHCP server(s) on the network.



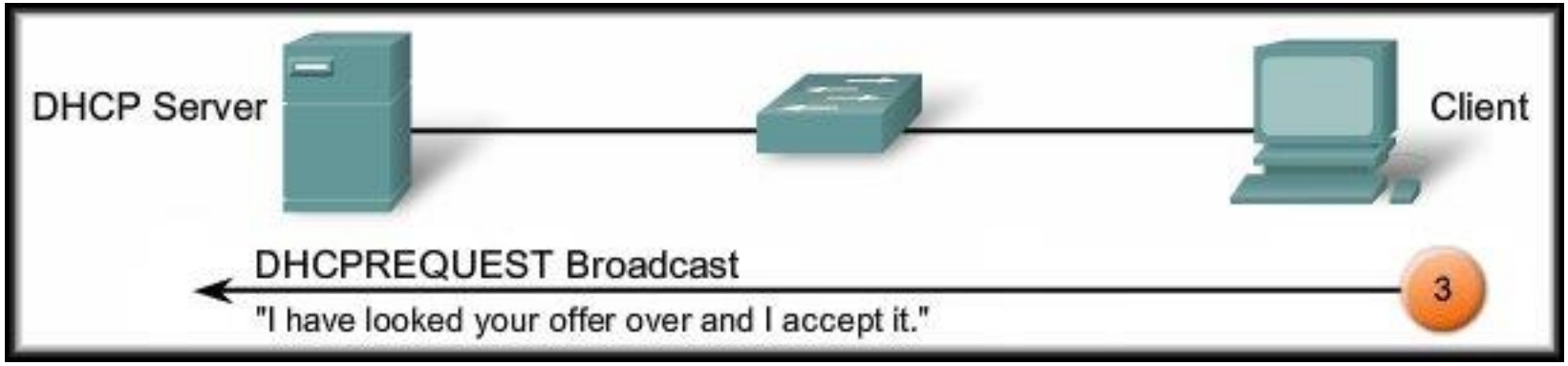
DHCP Operation

- Dynamic Allocation: 4 Step Process.
  - DHCPOFFER:
    - The server responds with a DHCPOFFER.
    - The DHCPOFFER message is sent as a unicast and contains an available IP address to lease.



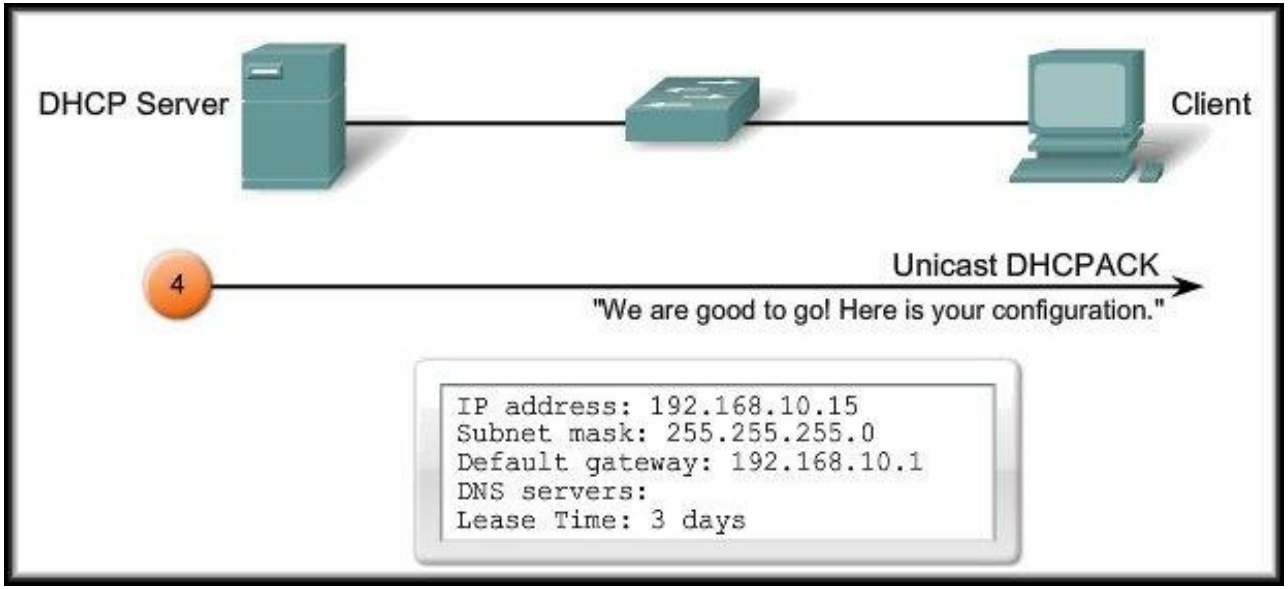
DHCP Operation

- Dynamic Allocation: 4 Step Process.
  - DHCPREQUEST:
    - The client responds with a broadcast of a DHCPREQUEST message.
    - When used for obtaining a lease, it serves as an *acceptance notice to the selected server* and an implicit decline to any other servers.
    - Also used for lease renewal and verification.



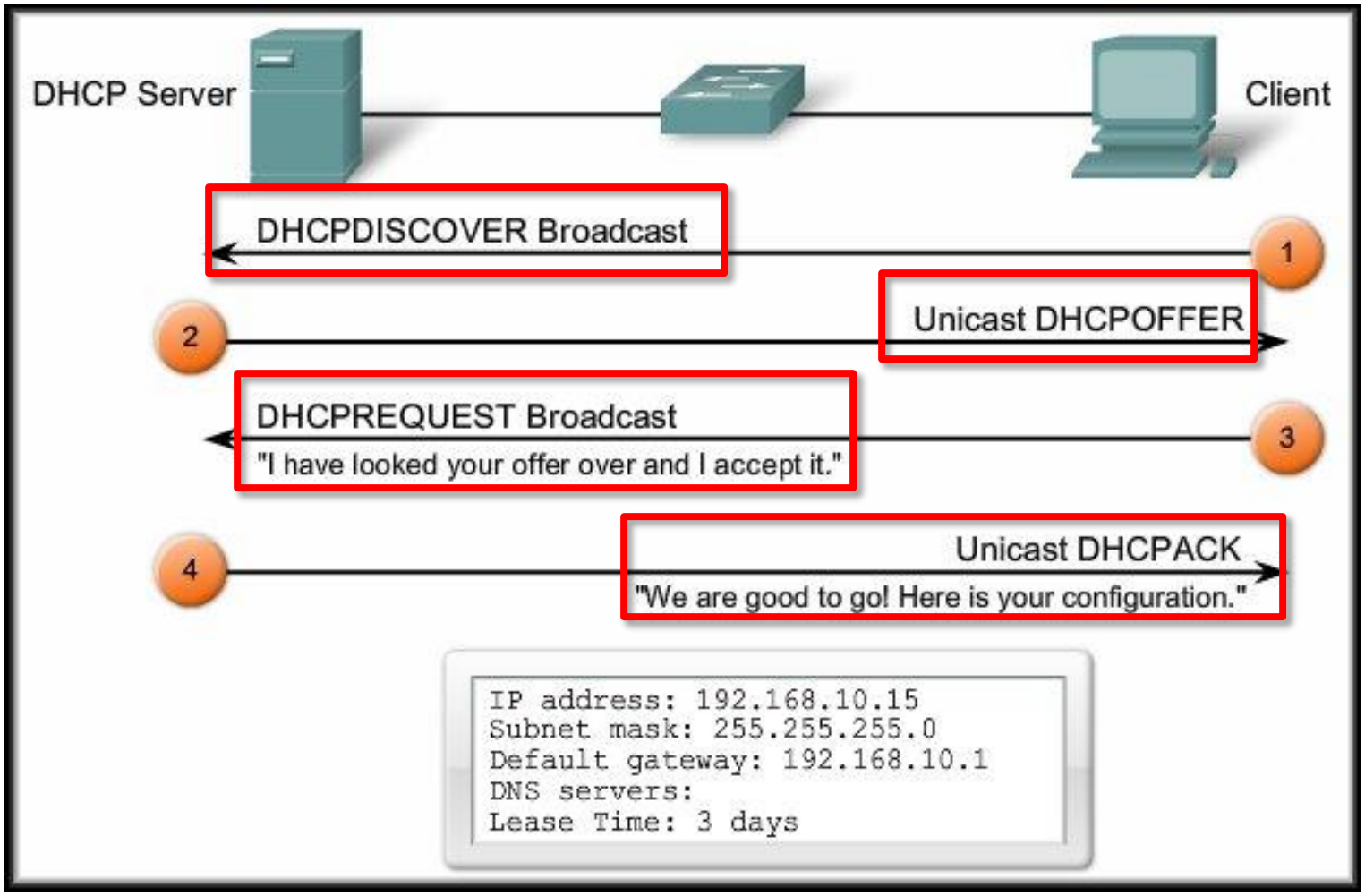
DHCP Operation

- Dynamic Allocation: 4 Step Process.
  - DHCPACK:
    - The server verifies the lease information and responds with a DHCPACK message.
    - The client logs the information and sends an ARP request to verify that the address is unique.

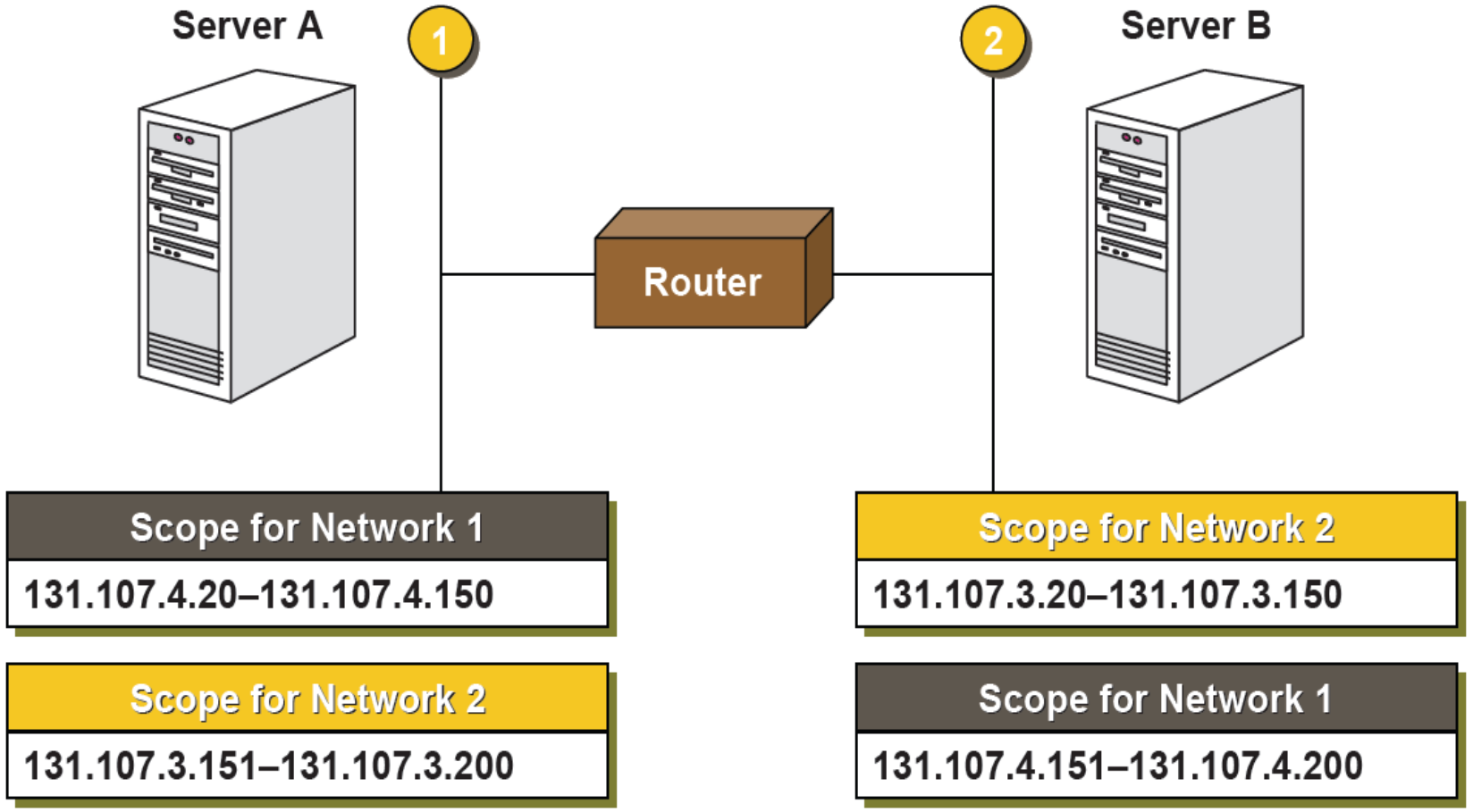


DHCP Operation

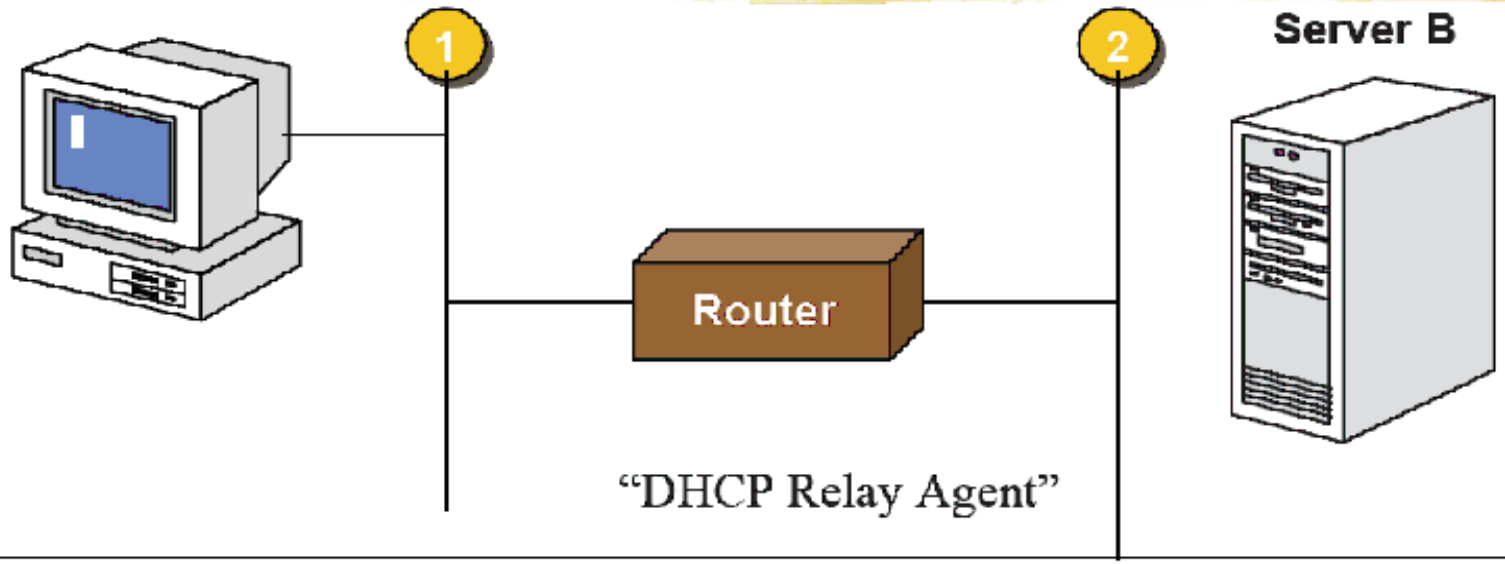
- Dynamic Allocation: 4 Step Process.



Implementing Multiple DHCP Servers

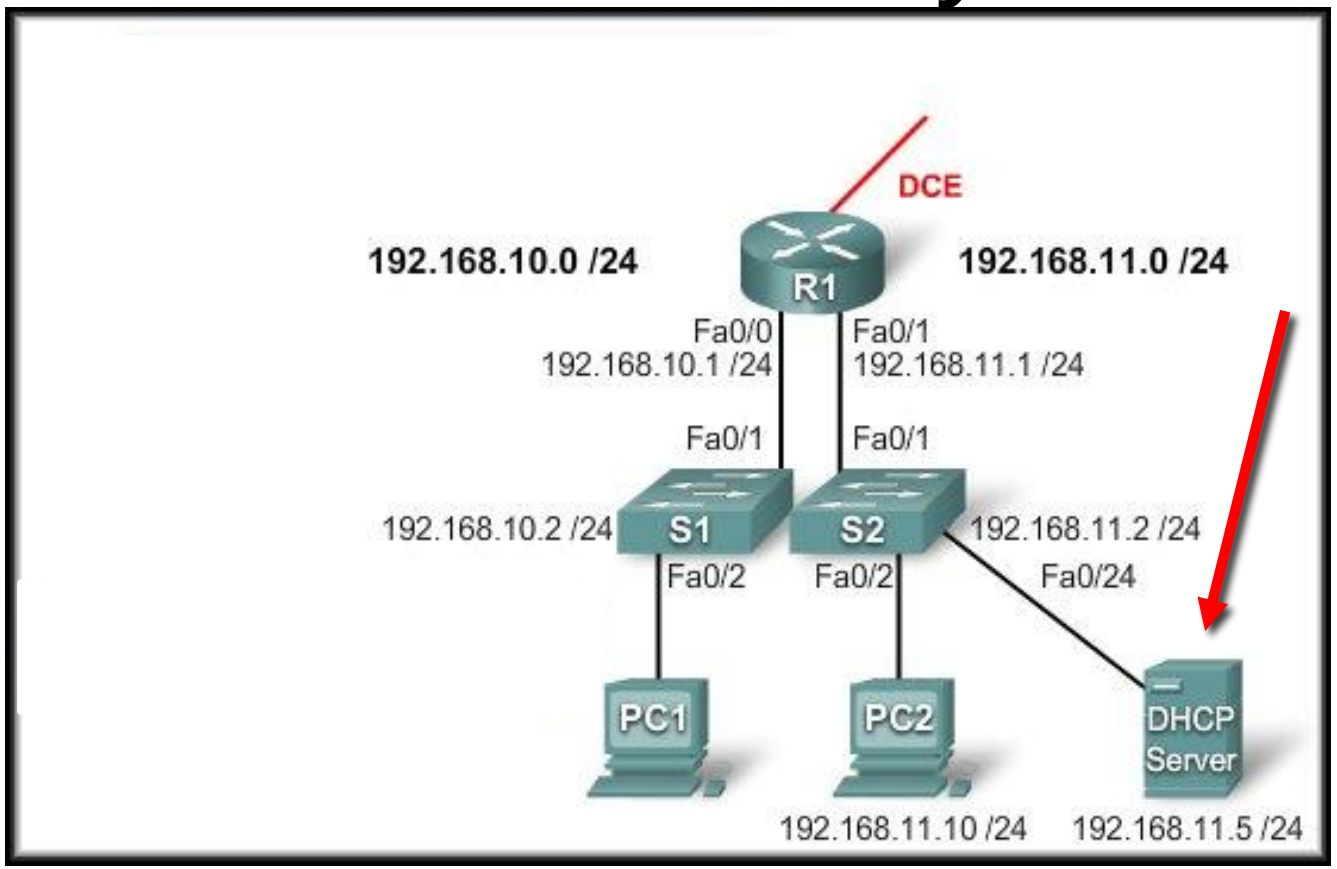


DHCP through a Relay Agent



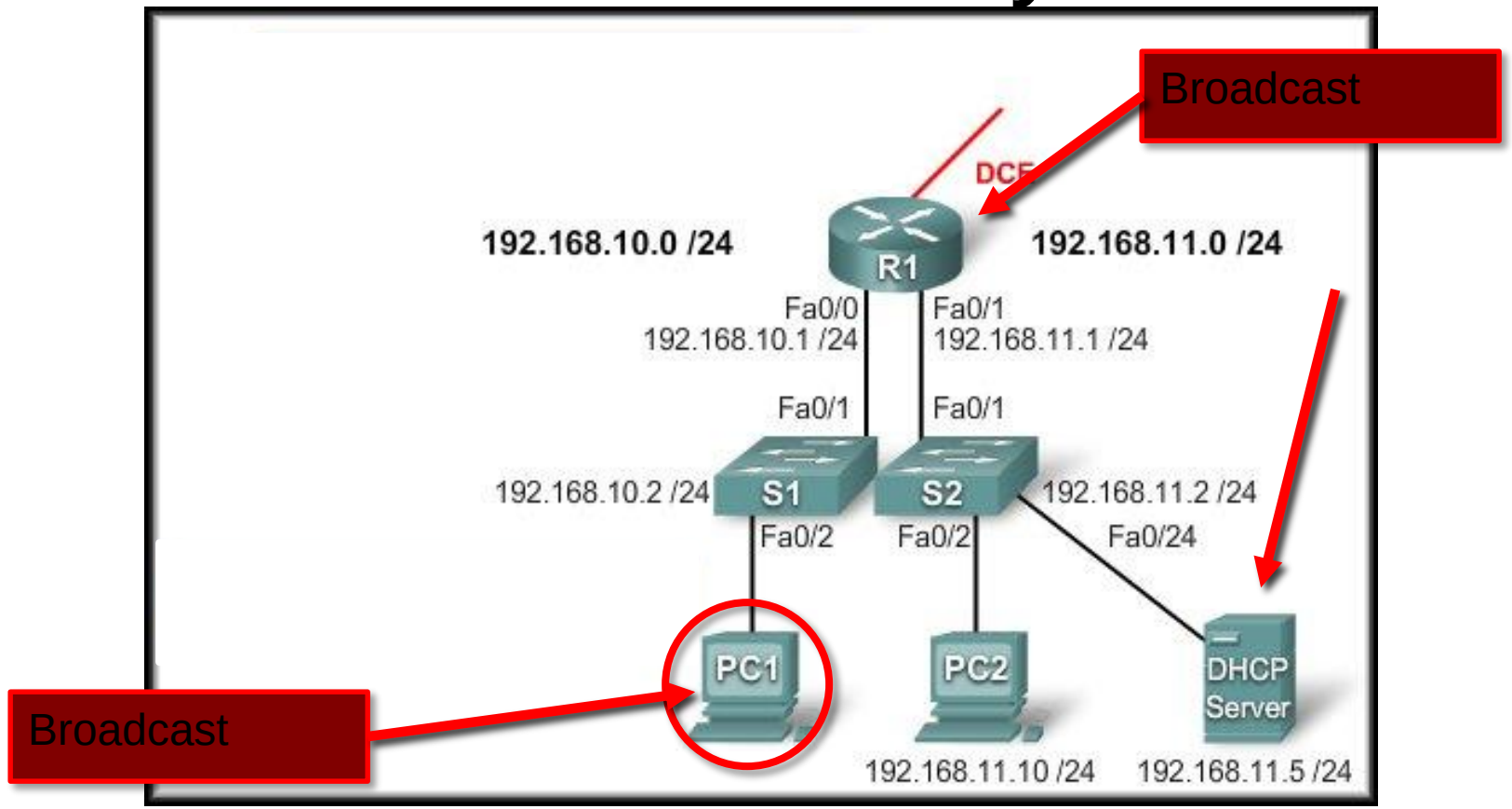
- Router listens on port 67, intercepts DHCP Discover message and forwards (unicast) the request to one or more DHCP servers.
  - places Router incoming IP address in the Router-address field
  - increments hop-count by 1
- DHCP server recognizes this request is coming from Router & not-the-client
  - sends unicast reply to the router
  - router replies to the client

DHCP Relay



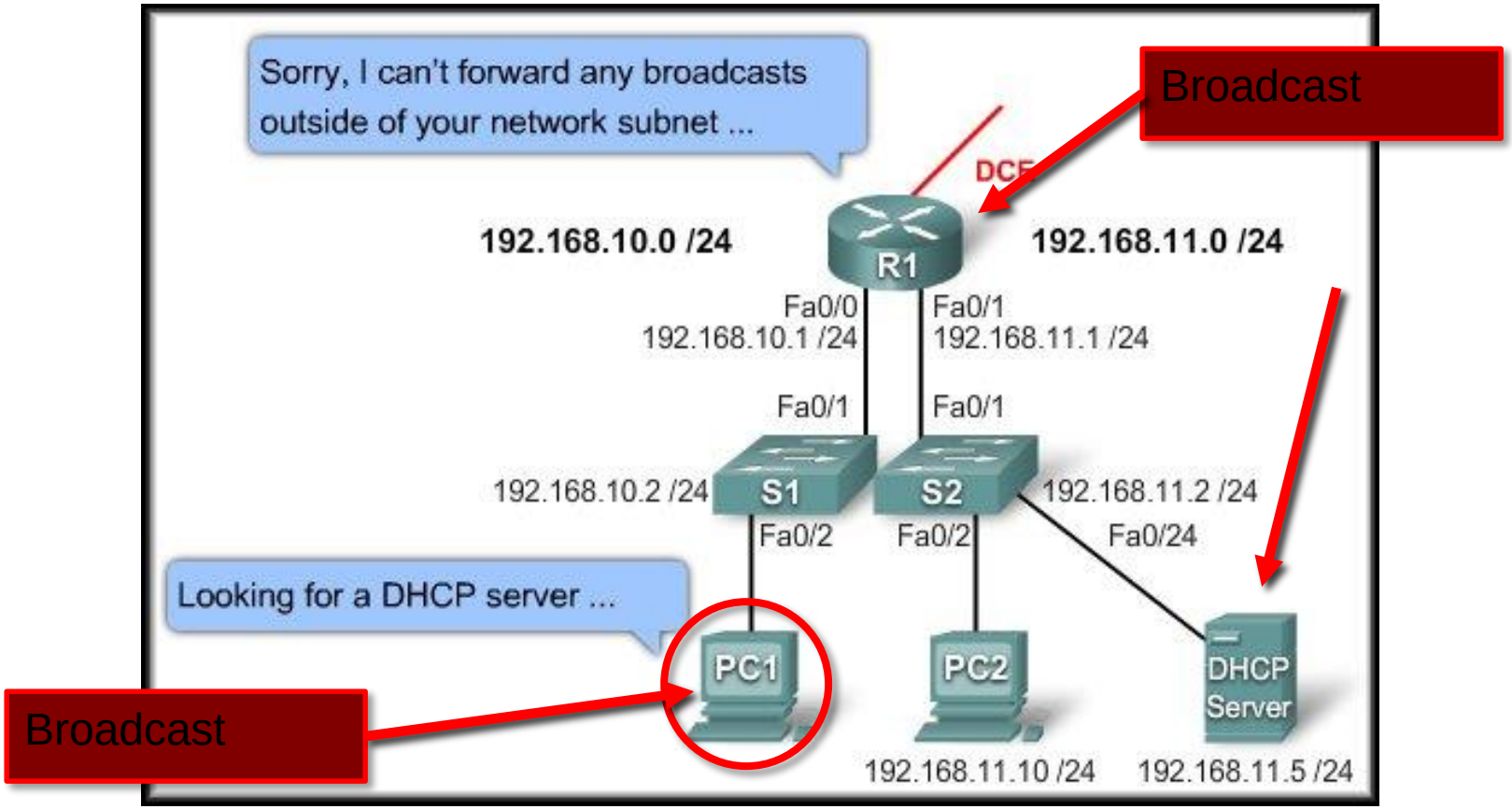
- In a complex hierarchical network, enterprise servers are usually contained in a server farm.
- These servers may provide DHCP, DNS, TFTP, and FTP services for the clients.

DHCP Relay



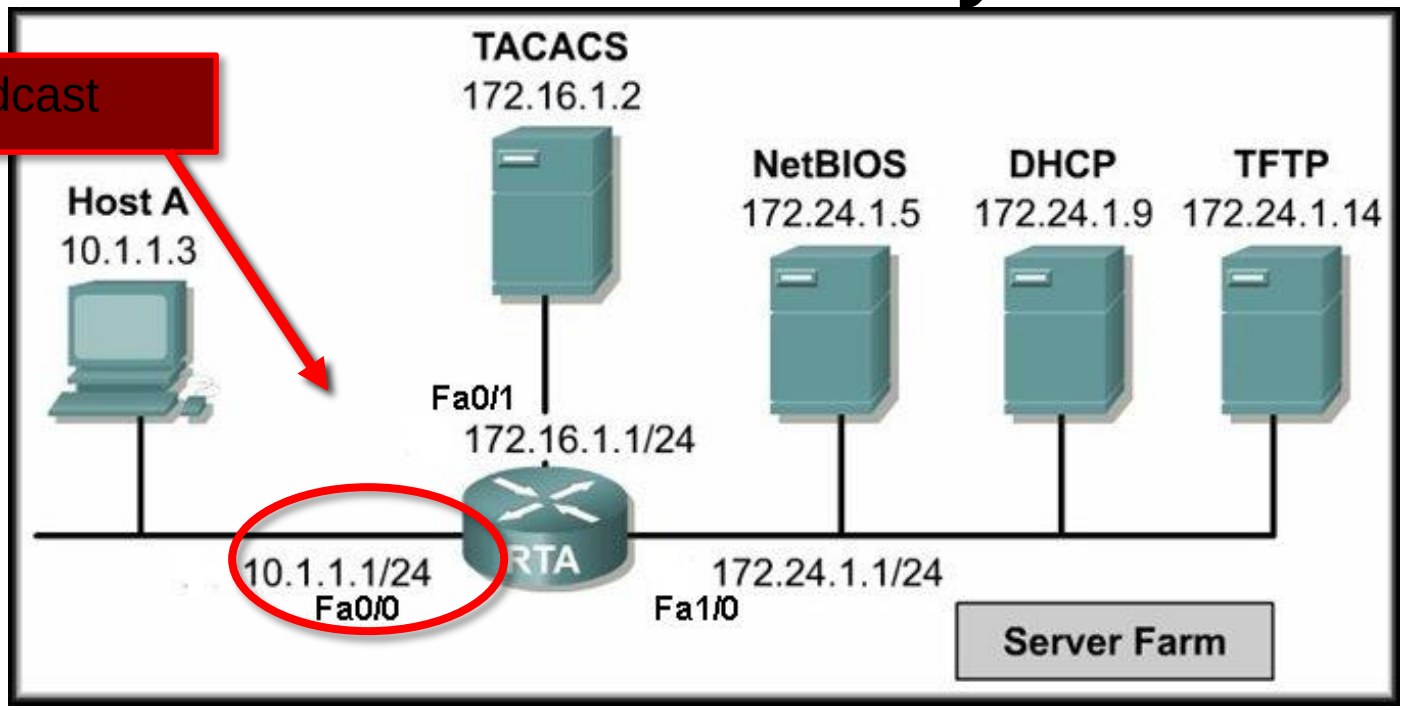
- PC1 either tries to obtain an IP configuration or attempts to renew its address.
- In addition, other network services use broadcasts to find a TFTP server or an authentication server.

DHCP Relay



- The solution is DHCP Relay.
- By configuring a helper address feature on intervening routers and switches the device will forward DHCP broadcasts, and others, to the appropriate server.

DHCP Relay

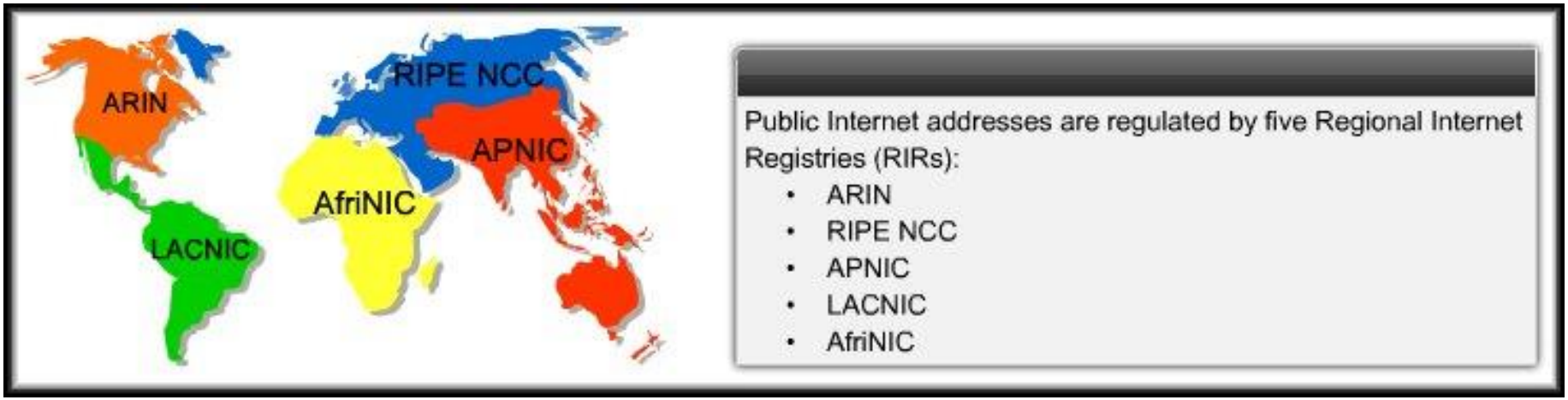


- To configure RTA Fa0/0 *(the interface that receives the Host A broadcasts)* to relay DHCP broadcasts to the DHCP server, use the following commands:

```
RTA(config)#interface fa0/0
RTA(config-if)#ip helper-address 172.24.1.9
```

Scaling Networks With NAT (Network Address Translation)

- All public Internet addresses must be registered with a Regional Internet Registry (RIR).
- Organizations can lease public addresses from an ISP.
- Only the registered holder of a public Internet address can assign that address to a network device.



Scaling Networks With NAT

- Private Internet Addresses:
  - These are reserved private Internet addresses drawn from three blocks.
  - These addresses are for private, internal network use only.
  - RFC 1918 specifies that private addresses are not to be routed over the Internet.

Class	RFC 1918 Internal Address Range	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

Scaling Networks With NAT

- Private Internet Addresses:

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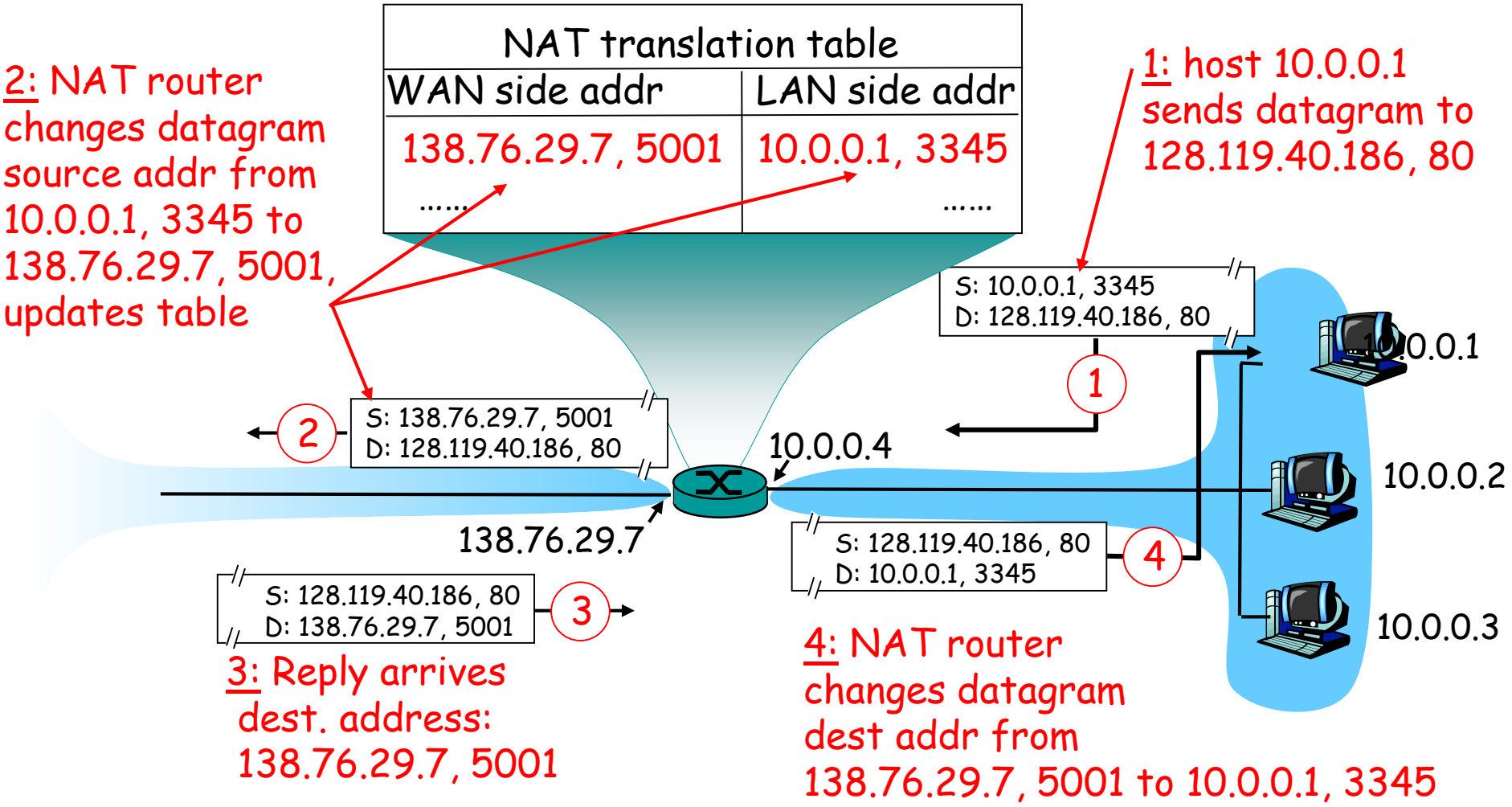
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16

  - Two Issues:
    - You cannot route private addresses over the Internet.
    - There are not enough public addresses to allow organizations to provide one to every one of their hosts.
  - Networks need a mechanism to translate private addresses to public addresses at the edge of their network that works in both directions.
  - Solution – NAT.

NAT: Network Address Translation



NAT: Network Address Translation

- 16-bit port-number field:
  - 60,000 simultaneous connections with a single LAN-side address!
- NAT is controversial:
  - routers should only process up to layer 3
  - violates end-to-end argument
    - NAT possibility must be taken into account by app designers, e.g., P2P applications
  - address shortage should instead be solved by IPv6

References

- IBM Redbook TCP/IP DHCP - Section 3.7
- IBM Redbook TCP/IP NAT - Section 3.1.7