

DHCP, ARP, DNS, TCP/UDP

Mohammad S. Hasan

Dynamic Host Configuration Protocol (DHCP)

2

- Allows dynamic IP addressing
 - ▣ Provides IP configuration information for computers when they are booted
- IP “loaned” short term to network clients
- Easy to set up
- Difficult to trace a machine by IP address

Dynamic Host Configuration Protocol (DHCP)

3

- Allows a client to be configured automatically over the network.
 - ▣ machines do not have to have to be configured by hand / manually
- New machines can be added to the IP network more easily
- Less chance of error
 - ▣ for example, duplicate IP addresses being configured

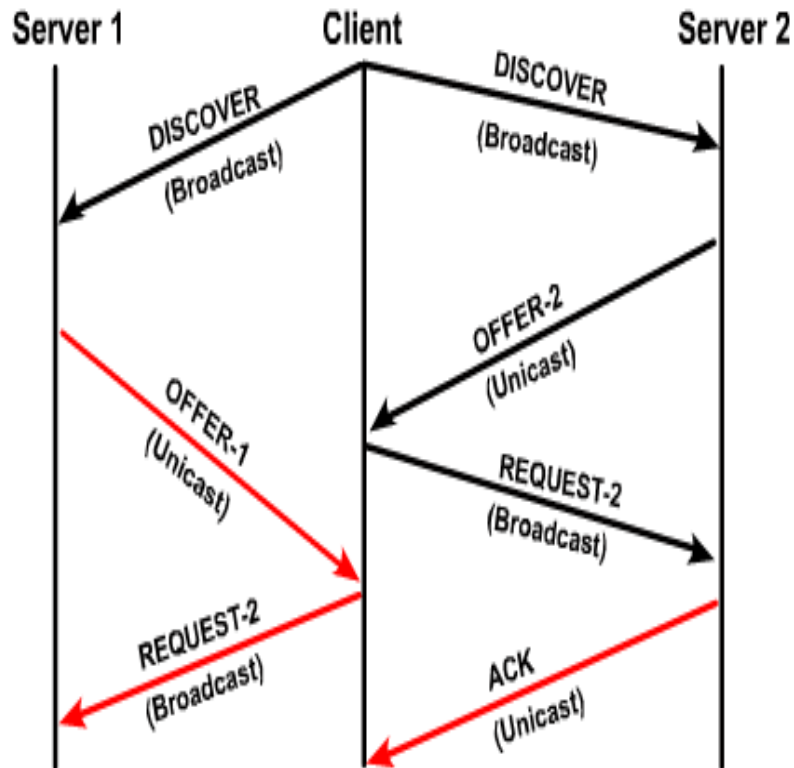
Dynamic Host Configuration Protocol (DHCP)

4

- More efficient if a low number of IP addresses
- When a DHCP client issues a request
 - ▣ the DHCP server/manager looks in its static table
 - ▣ If an entry does not exist it allocates one from its table of available addresses (scope)

DHCP operation

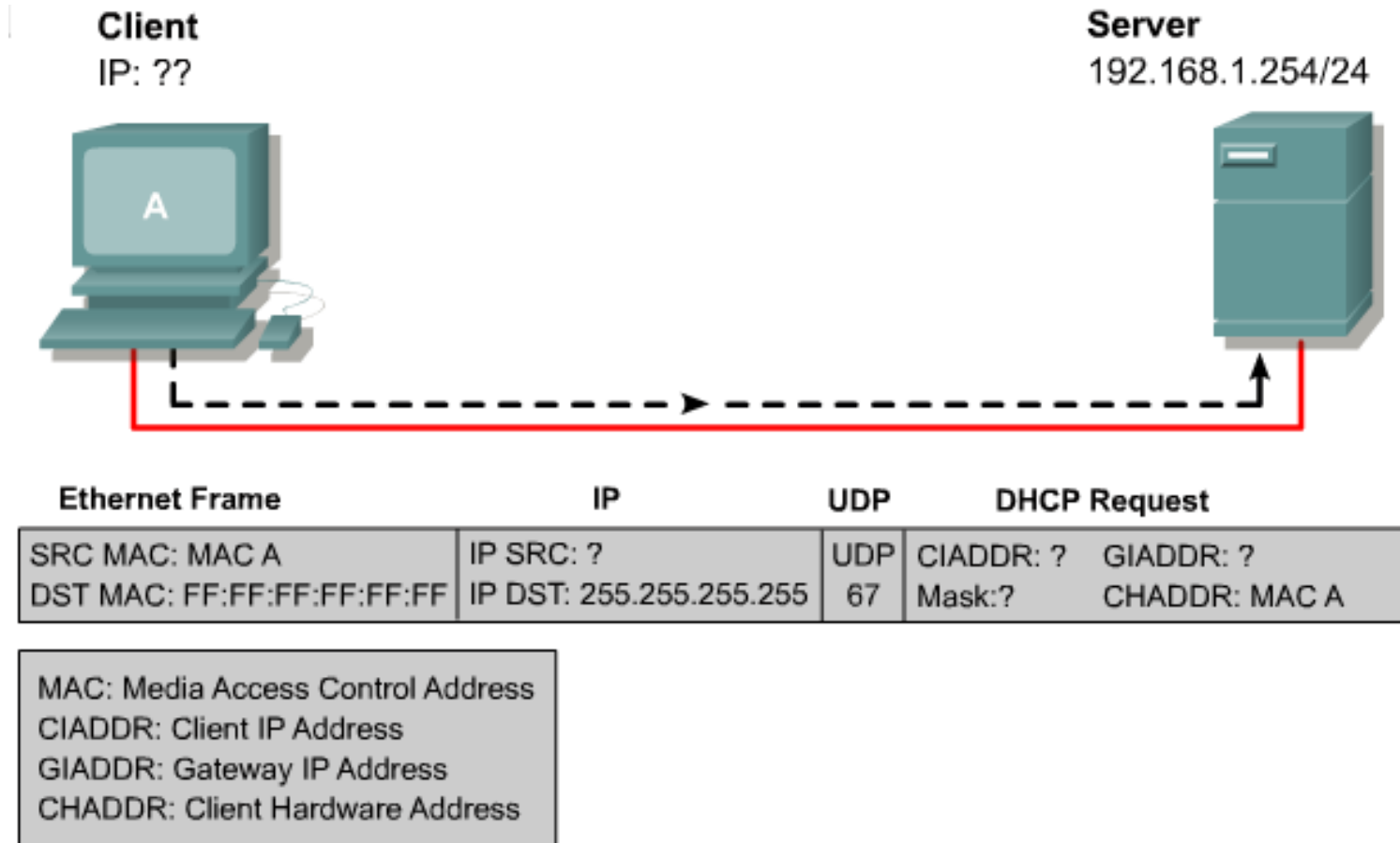
5



- DHCP client broadcasts DHCPDISCOVER packet on local subnet
- DHCP servers send OFFER packet with lease information
- DHCP client selects lease and broadcasts DHCPREQUEST packet
- Selected DHCP server sends DHCPACK packet

DHCP operation

6



DHCP operation

7

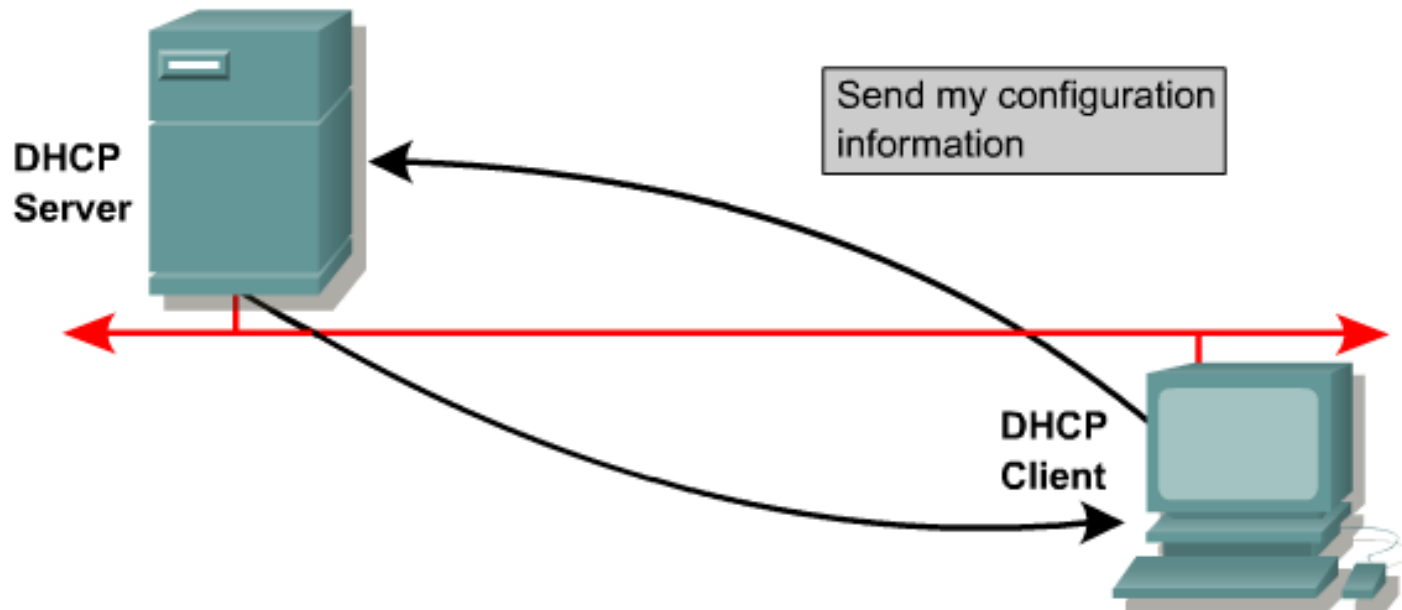


Ethernet Frame	IP	UDP	DHCP Reply
SRC MAC: MAC Serv DST MAC: MAC A	IP SRC: 192.168.1.254 IP DST: 192.168.1.10	UDP 68	CIADDR: 192.168.1.10 GIADDR: ? Mask: 255.255.255.0 CHADDR: MAC A

MAC: Media Access Control Address
CIADDR: Client IP Address
GIADDR: Gateway IP Address
CHADDR: Client Hardware Address

DHCP operation

8



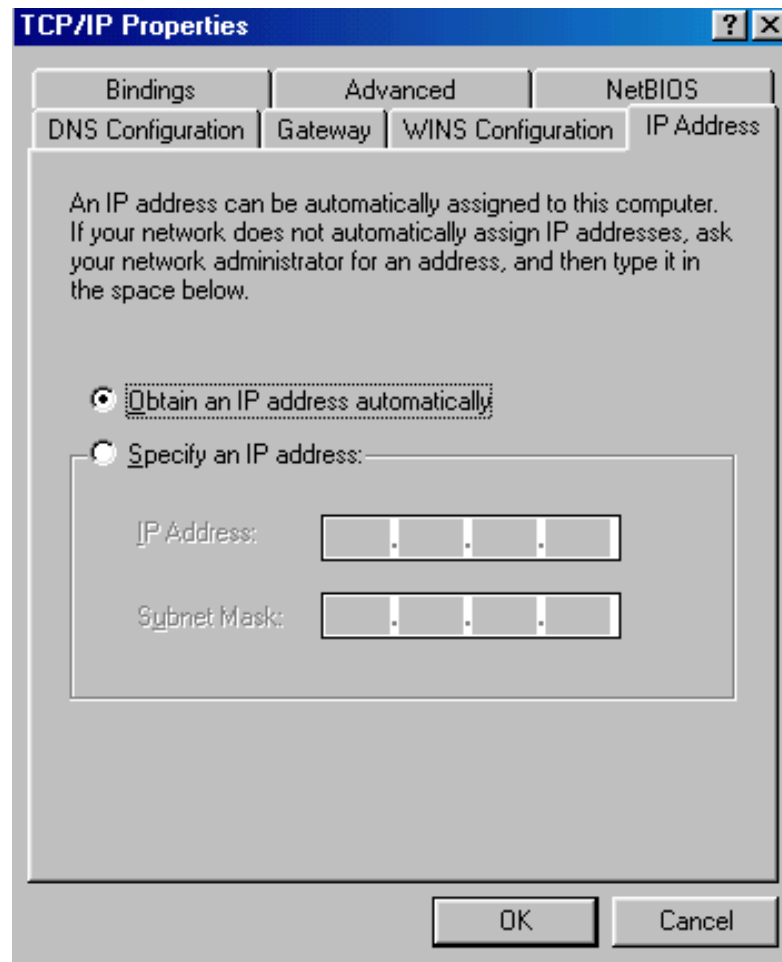
Here is Your Configuration:

- IP Address: 192.204.18.7
- Subnet Mask: 255.255.255.0
- Default Routers: 192.204.18.1, 192.204.18.3
- DNS Servers: 192.204.18.8, 192.204.18.9
- Lease Time: 5 days

DHCP, ARP, DNS, TCP/UDP

Using DHCP in MS Windows

9



DHCP, ARP, DNS, TCP/UDP

DHCP (cont.)

10

- When DHCP is in use, there is no need to configure the following items when installing TCP/IP on a computer
 - ▣ IP address
 - ▣ subnet mask
 - ▣ default gateway address
 - ▣ WINS server address
 - ▣ DNS address
 - ▣ etc.

DHCP Servers

11

- ❑ The DHCP server provides these information based on the domain administrator's configuration
- ❑ A DNS computer can also run the DHCP service
- ❑ DHCP communications are done over UDP ports 67 and 68

DHCP Address Types

12

- We can configure DHCP with a list of known Hardware address : IP address pairs
- We can create a pool of available IP addresses for computers that the DHCP server did not know about previously
- Internet Service Providers (ISP) use pools of addresses

DHCP Address Requests

13

- When a DHCP request comes from a known hardware address
 - ▣ the server always sends the same assigned IP address.
 - ▣ Mandatory for Web servers
- When a DHCP request comes from an unknown hardware address
 - ▣ an IP address can be assigned from a pool of available addresses.
 - ▣ When they are released, these addresses can be recycled

DHCP Message Format

14

0	8	16	24	31
OP	HTYPE	HLEN	HOPS	
TRANSACTION IDENTIFIER				
SECONDS ELAPSED		FLAGS		
CLIENT IP ADDRESS				
YOUR IP ADDRESS				
SERVER ADDRESS				
ROUTER IP ADDRESS				
CLIENT HARDWARE ADDRESS (16 OCTETS)				
SERVER HOST NAME (64 OCTETS)				
BOOT FILE NAME (128 OCTETS)				
OPTIONS (VARIABLE)				

DHCP Stages

15

- Stage 1- IP lease request
 - ▣ The client broadcasts a DHCPDISCOVER packet (a request for the location of a DHCP server)
- Stage 2- IP lease offer:
 - ▣ All DHCP servers on the local segment see the broadcast and
 - ▣ return a DHCPOFFER packet, which contains an IP address & other information

DHCP Stages

16

- Stage 3- IP lease selection
 - ▣ If the client receives more than one offer
 - It selects the offer that has the longest lease or
 - the one that provides the best Information)
 - ▣ It broadcasts a message (DHCPREQUEST) asking to lease the IP address in the offer

DHCP Stages

17

- Stage 4- IP lease acknowledgement
 - ▣ The DHCP server that made the offer responds to the message with a DHCPACK packet
 - ▣ All other DHCP servers withdraw their offers

IP Address & DHCP

18

- IP addresses are “leased” to a client for a certain time (e.g. 3 days)
- When half of the time period has expired, the client tries to renew the lease with the DHCP server from which it obtained it

IP Address & DHCP (cont.)

19

- If a renewal is not granted after $7/8$ of the lease has expired, the client broadcasts a renewal request to any DHCP server
- If this request is unsuccessful, the client must immediately stop using the IP address

Media Access Control (MAC)

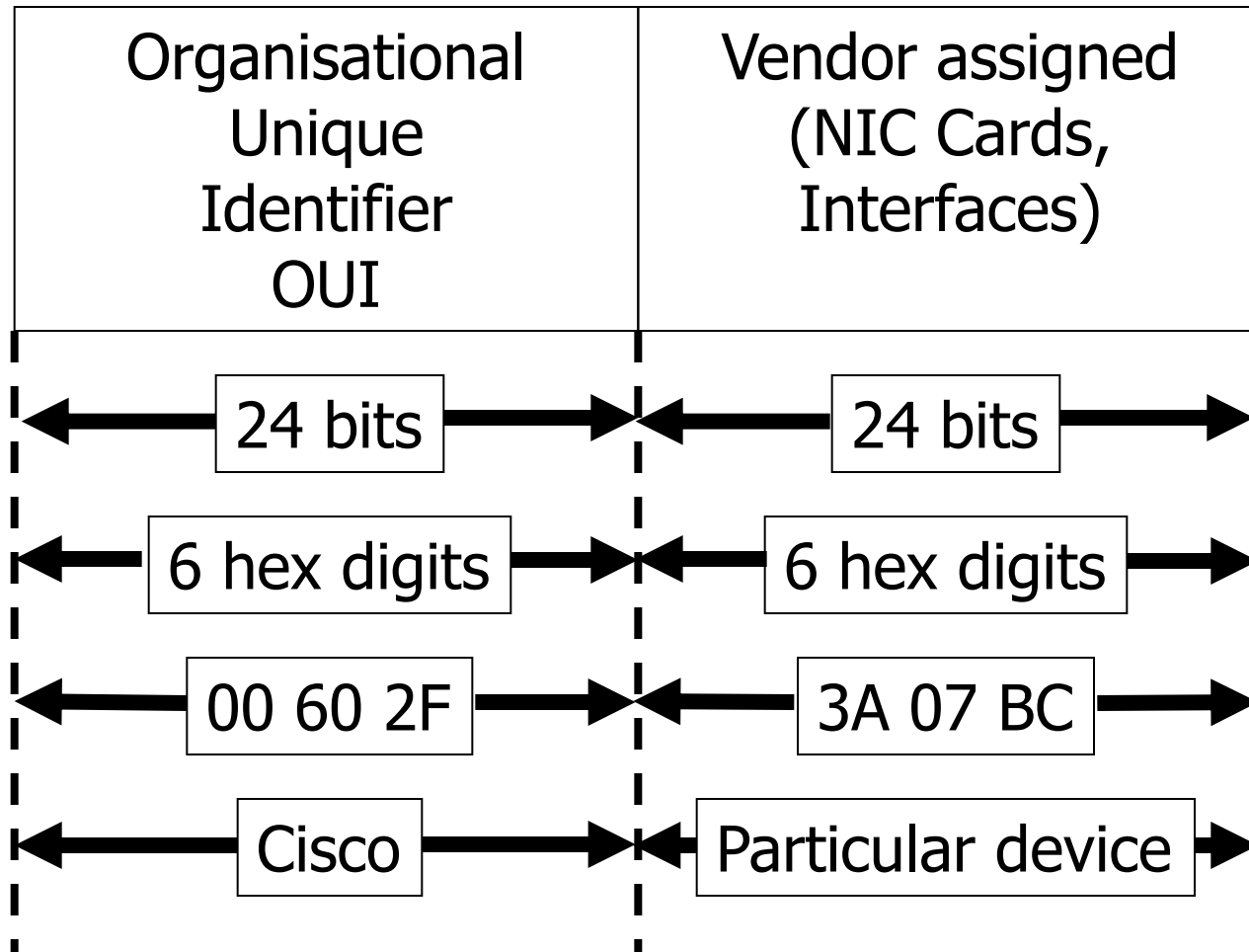
Addressing

20

- Without a name computers cannot be accessed
- At the data link layer, a header, and possibly a trailer, is added to upper layer data.
- Header and trailer contain control information intended for the data link layer entity in the destination system.
- Data from upper layer entities is encapsulated in the data link layer header and trailer.

MAC Address

21



DHCP, ARP, DNS, TCP/UDP

MAC - Flat structure

22

- MAC addresses give hosts a permanent, unique ID.
- The number of possible addresses is extremely large - over 2 trillion!
- One major disadvantage
 - ▣ they have no structure and are considered flat address spaces.
 - ▣ Different vendors have different OUIs, but they're like personal identification numbers.
 - ▣ As your network grows, this disadvantage becomes a real problem.

Address Resolution Protocol (ARP)

23

- A LAN does not use IP addresses to deliver frames
 - ▣ When an IP packet encounters the destination LAN after traversing the Internet, how does the packet find the destination workstation?
 - ▣ Even though the destination workstation may have an IP address, a LAN uses the MAC address
- ARP translates an IP address into a MAC address so a frame can be delivered to the proper workstation

Address Resolution Protocol (ARP)

24

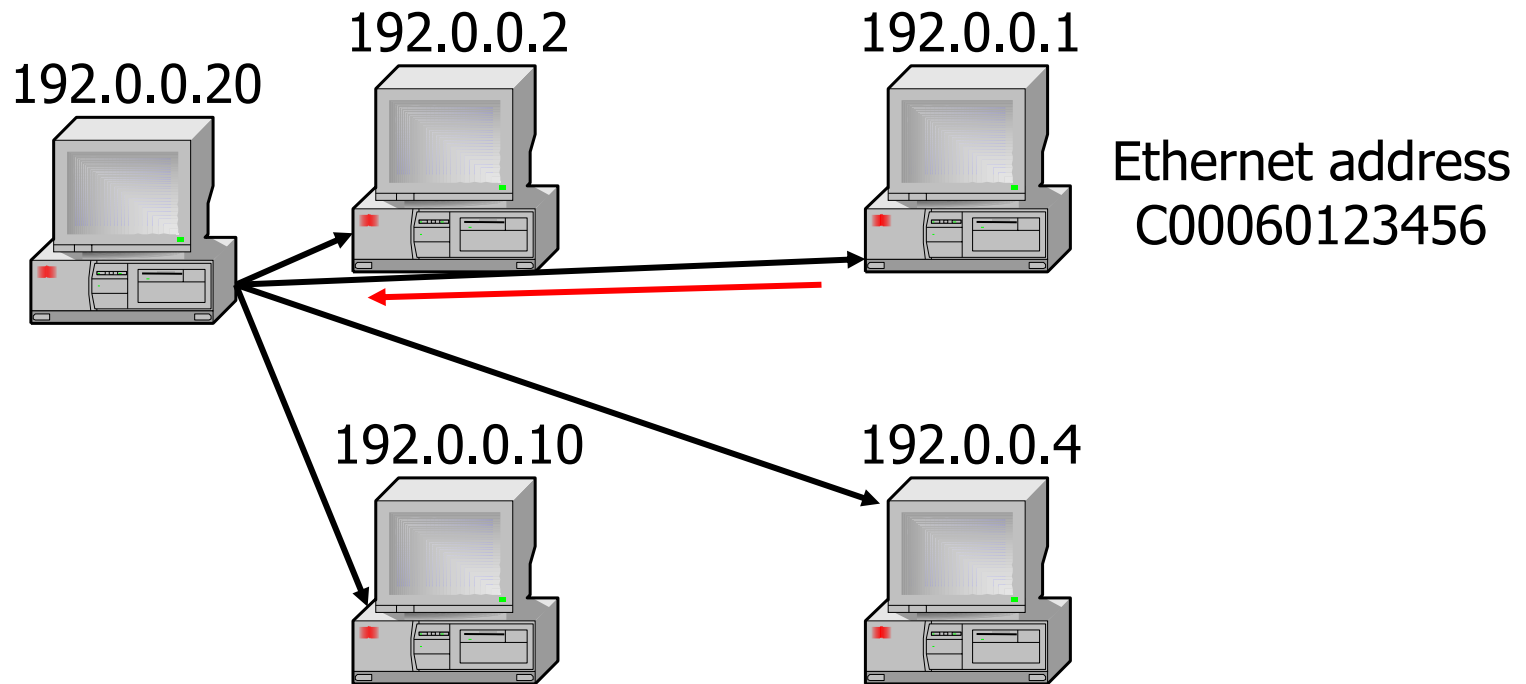
- The IP packets are sent encapsulated in LAN or WAN frames such as Ethernet, Token-Ring or ATM
 - ▣ Q. How does the host know the correct Ethernet destination address to put in the frame ?
 - ▣ A. It uses ARP to map from the IP destination address to the Ethernet destination address

Ethernet Destination Address	Ethernet Source Address	Length	IP header	Payload
------------------------------------	-------------------------------	--------	-----------	---------

ARP example

25

- ARP request to station 192.0.0.1



ARP (cont.)

26

- The host broadcasts an ARP request packet which contains the IP address of the required station
- The station which has that IP address replies directly (unicast) returning the correct IP address
- Now the IP packet can be sent directly to the correct Ethernet address

Addressing & ARP

27

- TCP/IP is designed for many different types of physical network
 - ▣ Ethernet
 - ▣ Token Ring
 - ▣ Leased line
- Each has its own format for physical addressing

Addressing & ARP (cont.)

28

- ❑ To run successfully on all existing & future physical networks, IP addressing must be independent of the physical layer
- ❑ You have no control over the address assigned to your network interface
- ❑ The manufacturer encodes the address onto the interface

Addressing & ARP (cont.)

29

- If the card fails & is replaced, the machine's physical address changes
- The IP address is assigned by you to each machine to suit your particular network topology

ARP in Action

30

- Machines send data to each other using the physical address
- We want to send data to another computer's IP address
- We need somehow to map the IP address to the physical address
- The ARP protocol is used to do this

ARP in Action (cont.)

31

- Machine A wants to send data to Machine B whose IP address is aaa.bbb.ccc.ddd
- Machine A Sends a broadcast packet, with 0806 in the type field
 - ▣ Who has IP address aaa.bbb.ccc.ddd?
- Machine B recognises its own IP address & responds, 'Hello, that's me! Here is my hardware address.'

ARP - Screen capture from the Network Analyser

32

The screenshot displays the Wireshark interface with the following components:

- Packet List:** A table of captured packets. Packet 18 is highlighted, showing it is an ARP request from source 10.10.10.4 to the broadcast address.
- Packet Details:** A hierarchical view of packet 18. It shows the Ethernet II header (broadcast destination), the ARP request structure (protocol type 0x00000001), and the raw packet data. Blue boxes and arrows highlight specific fields: the source MAC and IP, the hardware and protocol addresses, and the source and destination addresses.
- Packet Bytes:** A hex dump of the packet data at the bottom, showing the raw bytes of the Ethernet frame and the ARP request.

Annotations in the image:

- Hardware and Protocol:** Points to the ARP request structure fields: Hardware type: Ethernet (0x0001), Protocol type: ARP (0x00000001), Hardware size: 6, and Protocol size: 4.
- Hardware address length and protocol address length:** Points to the Hardware size: 6 and Protocol size: 4 fields.
- Source and Destination Address:** Points to the Sender MAC address, Sender IP address, Target MAC address, and Target IP address fields.

DHCP, ARP, DNS, TCP/UDP

ARP in Action (cont.)

33

- Machine A now has B's physical address
 - ▣ The IP frame can now be coded into a properly addressed Ethernet frame
- The answer is held in a cache so that the next time A has data for B it can simply look in the cache for its physical address
 - ▣ Frequently used addresses stay in the cache
 - ▣ Others time out so as not to waste memory space

Example of the ARP Cache Entries

34

❑ EMU\$ multinet show/arp

❑ MultiNet ARP table:

❑ Host Network Address	Ethernet Address	Arp Flags
❑ -----	-----	-----
❑ [UNKNOWN] (IP 193.128.77.24)	00:40:01:41:21:1D	Temporary
❑ [UNKNOWN] (IP 193.128.77.28)	02:60:8C:6B:85:F3	Temporary
❑ [UNKNOWN] (IP 193.128.77.6)	AA:00:04:00:03:04	Temporary
❑ [UNKNOWN] (IP 193.128.77.21)	00:00:44:00:AF:F9	Temporary
❑ [UNKNOWN] (IP 193.128.77.10)	08:00:20:05:06:43	Temporary
❑ [UNKNOWN] (IP 193.128.77.25)	00:00:21:29:74:68	Temporary

Domain Name Service DNS

35

- IP addresses are very difficult to remember
- DNS translates easier to remember text names
 - ▣ `www.staffs.ac.uk`
- into IP addresses
 - ▣ E.g. `128.10.20.30`
- When a host requires a domain name translation it makes the request to its local Domain Name Server

Domain Naming

36

- Each name in DNS can be split up into a series of domains
- Example: `www.soc.staffs.ac.uk`
 - ▣ `uk` = domain of the UK
 - ▣ `ac.uk` = academic domain within the UK
 - ▣ `staffs.ac.uk` = Staffordshire University domain within UK academic
 - ▣ `soc.staffs.ac.uk` School of computing domain within Staffordshire University within UK academic

Domain Name Servers

37

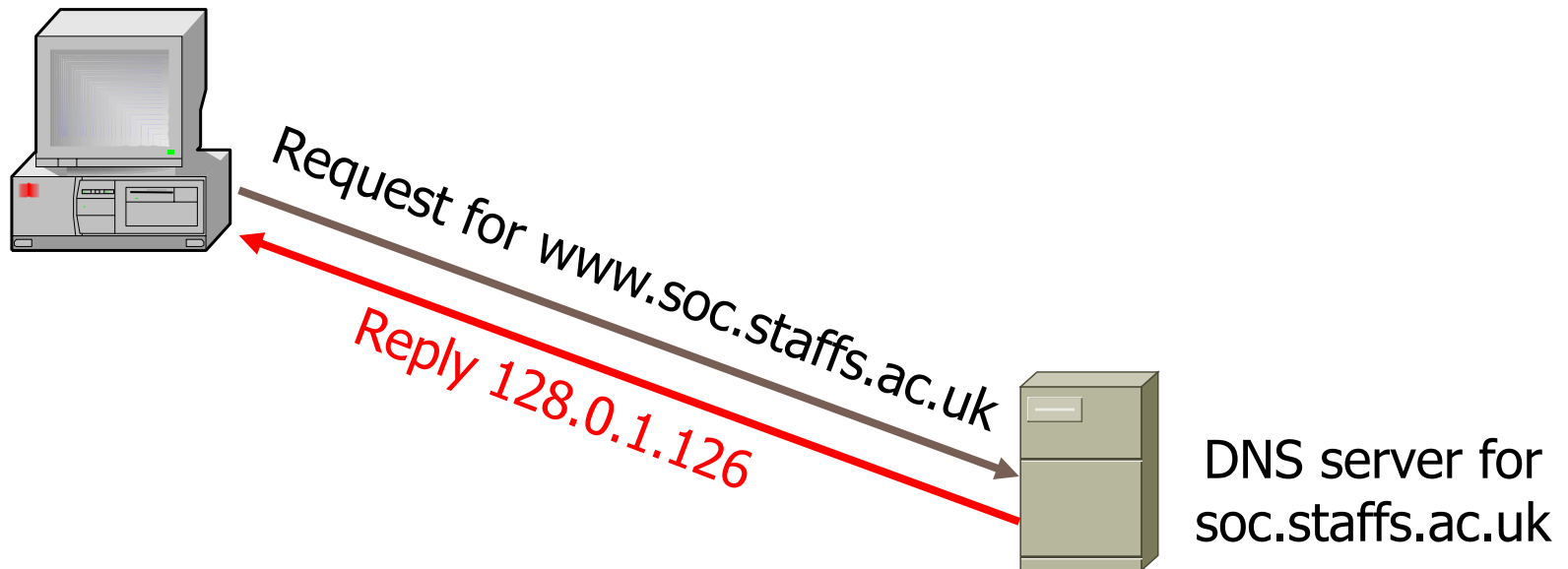
- Each domain name server is responsible for a different domain
- The first request will go to the local domain server
- DNS server can react in 3 different way
 - ▣ DIRECT - sends back the correct IP address
 - ▣ RECURSIVE - if it doesn't know the IP address it makes a request to another DNS server for the IP address then sends back the IP address
 - ▣ INDIRECT - sends back the IP address of another DNS server

Direct DNS

38

- Server knows the DNS IP address so responds directly

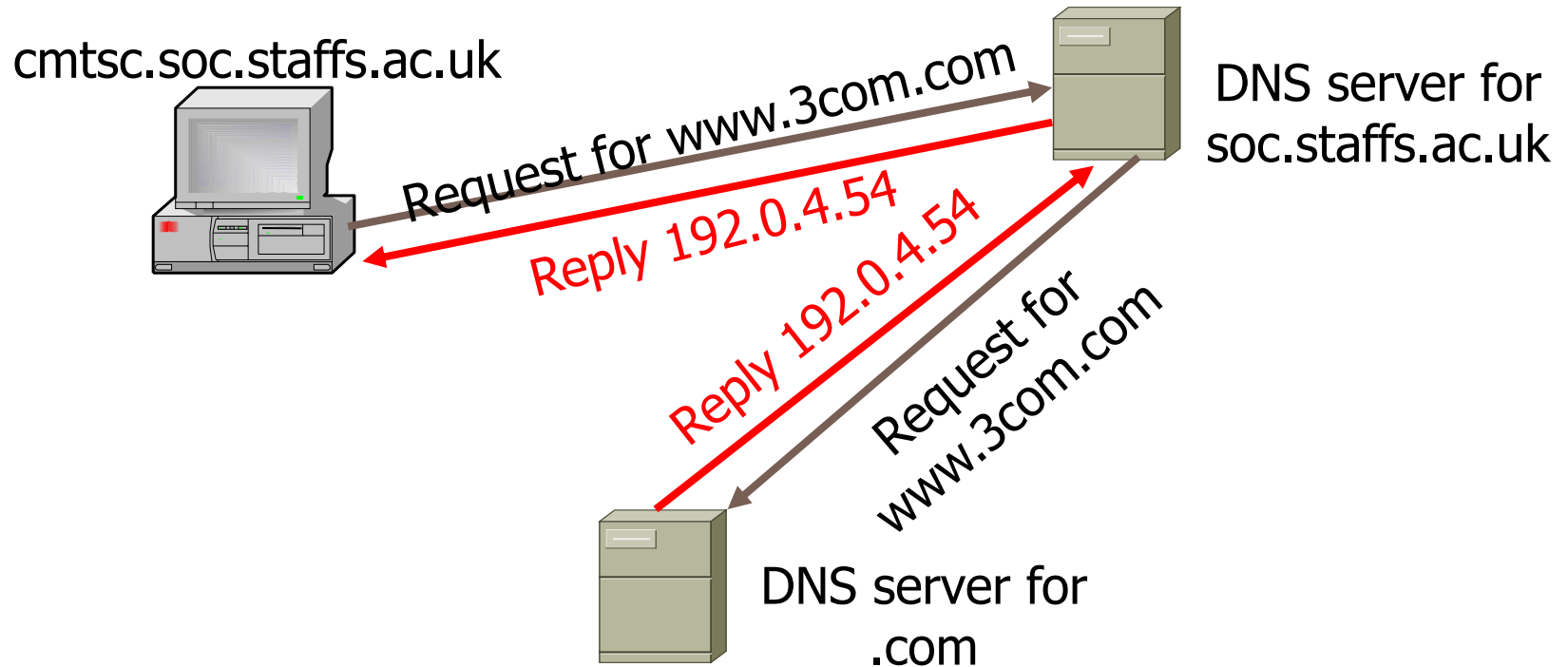
cmtsc.soc.staffs.ac.uk



Recursive DNS

39

- The DNS makes a request on behalf of the client then returns the correct IP address



Indirect DNS

40

- The server returns the address of another DNS server which the client must send its request to itself.

