# Internet Protocols EBU5403
# Live Lecture B3/B4
# Tutorial and Office Hour

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<table>
<tr><th></th><th>Part 1</th><th>Part 2</th><th>Part 3</th><th>Part 4</th></tr>
<tr><td>Ecommerce + Telecoms 1</td><td colspan="2">Richard Clegg</td><td colspan="2" rowspan="2">Cunhua Pan</td></tr>
<tr><td>Telecoms 2</td><td colspan="2">Michael Chai</td></tr>
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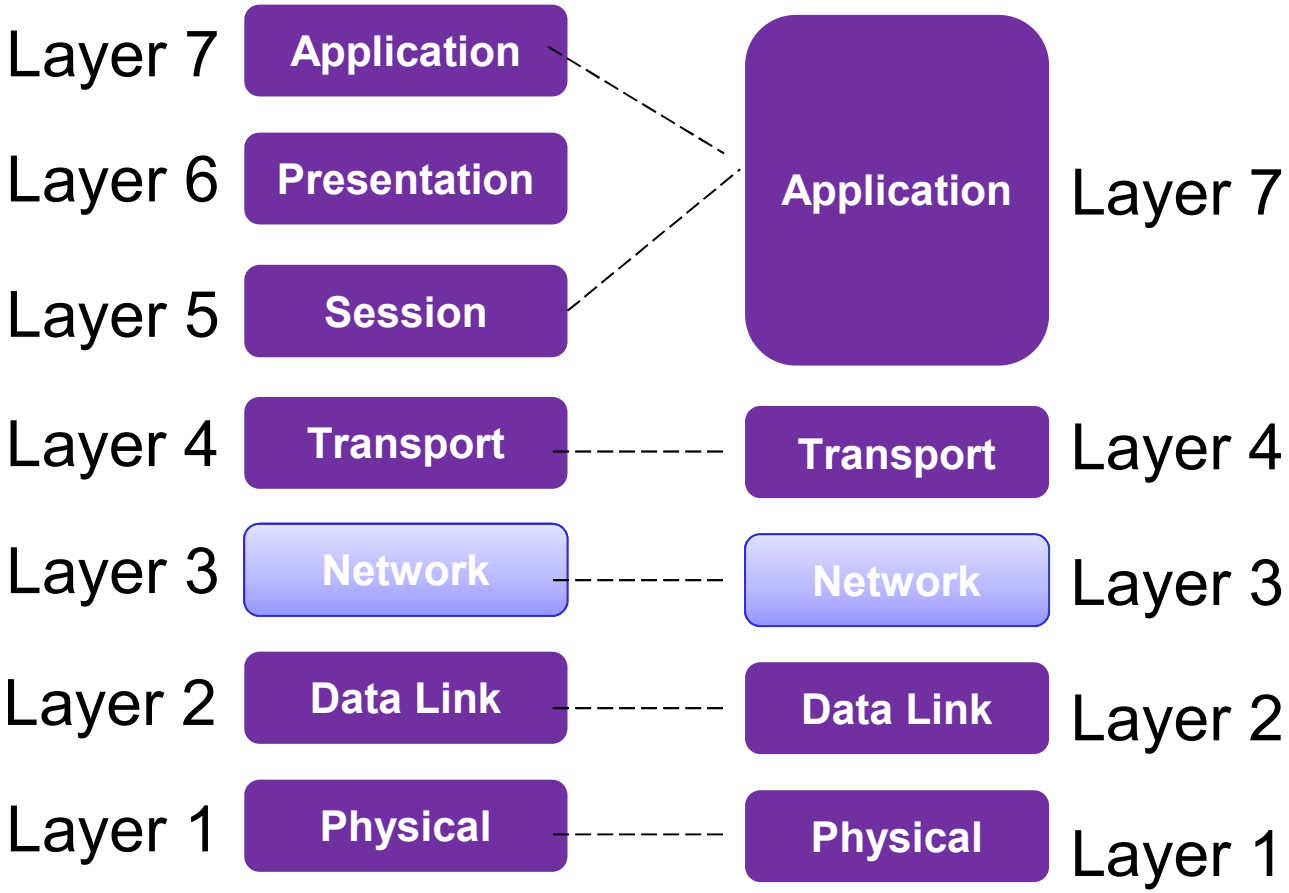
# Structure of course

- Part A
  - Introduction to IP Networks
  - The Transport layer (part I)
- Part B
  - The Transport layer (part II)
  - The Network layer (part I)
  - Class test
- Part C
  - The Network layer (part II)
  - The Data link layer (part I)
  - Router lab tutorial (assessed lab work after this week)
- Part D
  - The Data link layer (part II)
  - Network management and security
  - Class test

# Layers in this life lecture



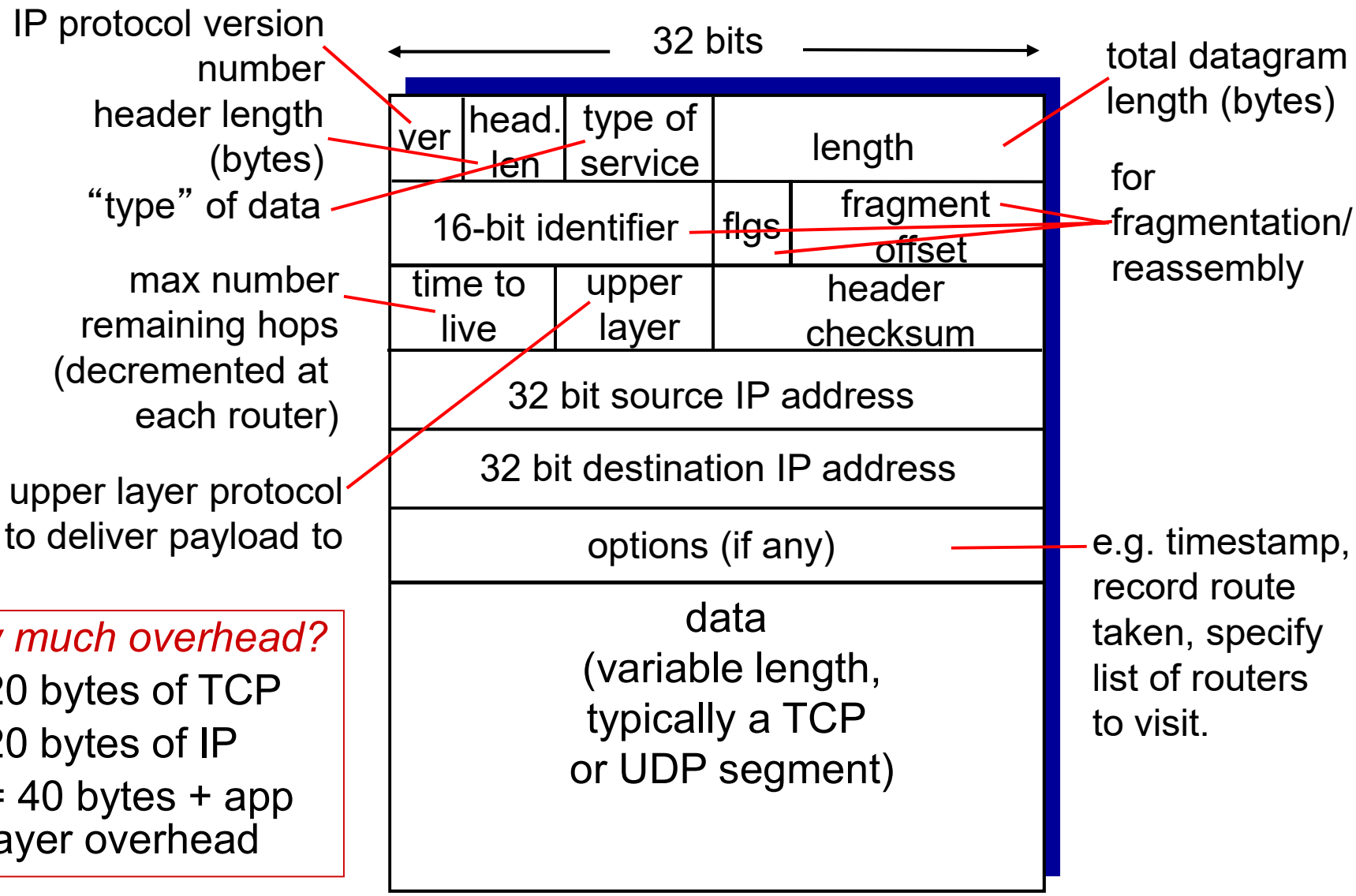
# Class test details

- Wed. Nov.11th at 13:50. Test is 40 minutes.
- You must stay in the room for the whole test.
- No calculators, mobile phones, headphones, laptops.
- No books or notes of any kind.
- No talking. No copying or letting people copy.
- Don't open the test until you are told to do so.
- Stop writing when you are told.
- If you break the rules you get zero marks.
- Put QM ID number and Class number on test.
- Revise: Layers model, Throughput and Utilisation, IP addresses and subnetting.
- Rooms: S103(class 1-4), S104(class5-8), S403(class9-12), S404(class13-16).

# Reminder of lecture contents

- Lecture B3
  - IP datagram format
  - IP fragmentation
- Lecture B4
  - IP addressing
  - Classful addresses
  - Creating sub nets
  - Dynamic Host Configuration Protocol (DHCP)

# IP datagram format

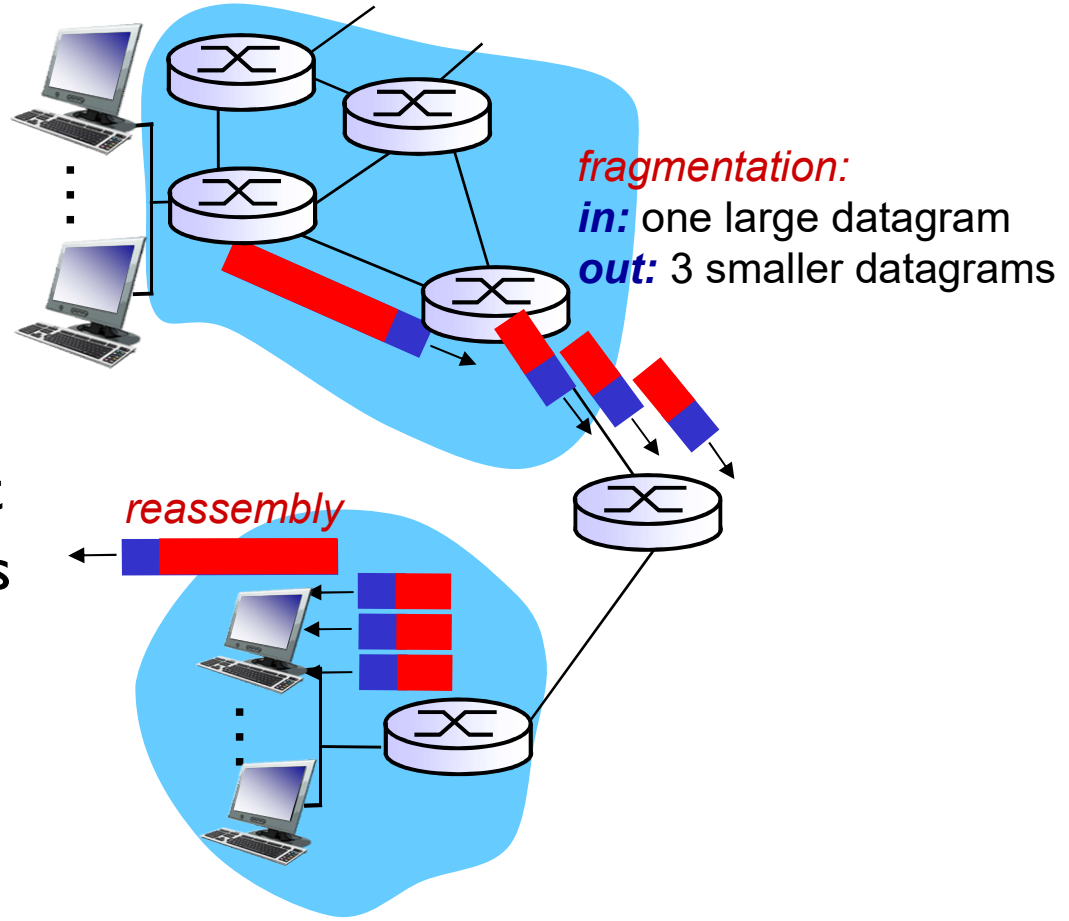



*how much overhead?*

- 20 bytes of TCP
- 20 bytes of IP
- = 40 bytes + app layer overhead

# IP fragmentation, reassembly

- network links have MTU (max.transfer size) - largest possible link-level frame
  - different link types, different MTUs
- large IP datagram divided ("fragmented") within net
  - one datagram becomes several datagrams
  - "reassembled" only at final destination
  - IP header bits used to identify, order related fragments



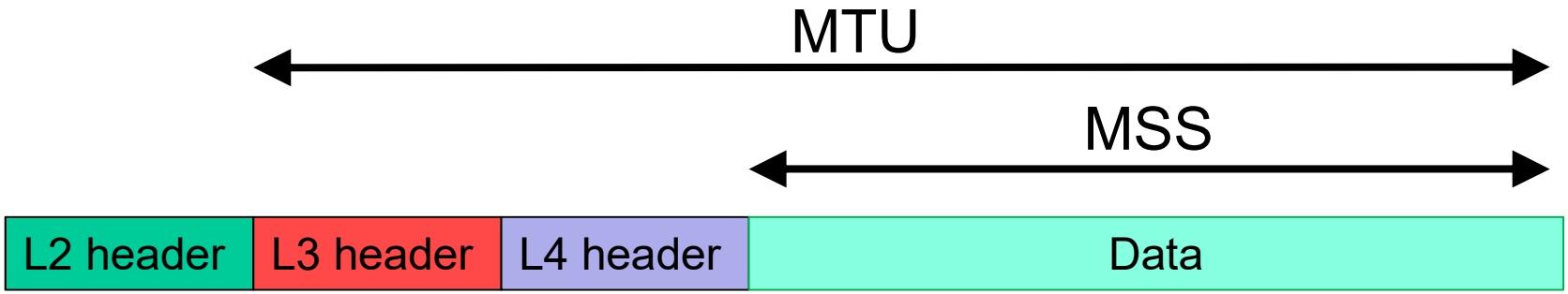
# MSS and MTU reminder

Maximum segment size

Maximum transfer unit

MTU = MSS (data) +L4 header + L3 header

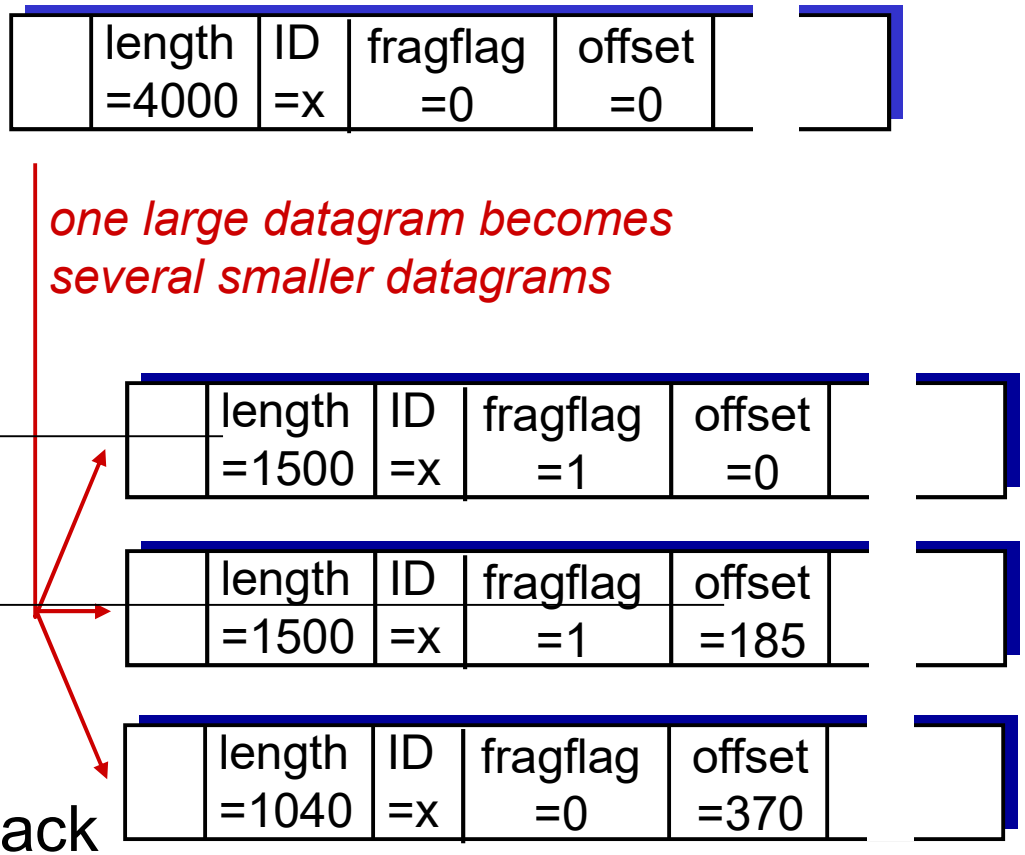
Note: To L2 the L3 and L4 header are “just data”.
To L3, the L4 header is “just data”.



# IP fragmentation, reassembly

*example:*

- 4000 byte datagram
- MTU = 1500 bytes




Dividing by 8 is just a hack to make the offset fit in a small number of bits

# IP packet fragmentation Q1

- A datagram has 3000 bytes. (This is the size at layer 3 including the layer 3 header).
- It is sent over a network with MTU 1500 bytes.
- How many fragments must it be split into?

# IP packet fragmentation Q1

- A datagram has 3000 bytes. (This is the size at layer 3 including the layer 3 header).
- It is sent over a network with MTU 1500 bytes.
- How many fragments must it be split into?
- Three fragments. The datagram has 2980 bytes of layer 3 data and 20 bytes of layer 3 header.
  - Note that to layer 3 the layer 4 header is simply data.
- With an MTU of 1500 bytes each fragment can carry 20 bytes of layer 3 header and 1480 bytes of layer 3 data.
- 2 fragments carry 2960 bytes of layer 3 data.
- We need 3 fragments to carry all 2980 bytes.

# IP packet fragmentation Q 2

- A datagram has 2600 bytes. (This is the size at layer 3 including the layer 3 header).
- It is sent over a network with MTU 1300 bytes.
- It is split into 3 fragments. For the third fragment give:
  length, offset and fragflag

# IP packet fragmentation Q 2

- A datagram has 2600 bytes. (This is the size at layer 3 including the layer 3 header).
- It is sent over a network with MTU 1300 bytes.
- It is split into 3 fragments. For the third fragment give the length, offset and fragflag

  1 fragment carries 1300 – 20 = 1280 bytes of layer 3 data. Datagram 2600-20 = 2580 bytes data.
- The first two packets carry 1280x2 = 2560 bytes.
- Third packet length = 2580-2760 = 20 bytes data + 20 bytes header = 40 bytes
- Offset = 2560/8 = 320
- Fragflag = 0 (no following fragments)

# Subnets and / notation (revision)

- Example 129.66.24.5/27

Host part 5 bits
(32 bits – 27 bits)

Network part (27 bits – because it is /27)

10000001.01000010.00011000.00000101

Network address is the address with all the host bits set to zero – address like any other but represents the network.

10000001.01000010.00011000.00000000

Network address: 129.66.24.0/27

The network address is also the first usable IP address in the block

Broadcast address (sends to everyone) is the address with all the host bits set to one.

10000001.01000010.00011000.00011111

Broadcast address: 129.66.24.31/27

# Subnets and / notation (revision)

- Example 129.66.24.5/27

Network part (27 bits – because it is /27)

Host part 5 bits
(32 bits – 27 bits)

10000001.01000010.00011000.00000101

Hosts can be given any IP address with any combination of bits in the host part EXCEPT for the broadcast address.

10000001.01000010.00011000.00000000

Earliest network address: 129.66.24.0/27

10000001.01000010.00011000.00011110

Latest network address: 129.66.24.30/27

Address range from 129.66.24.0-29.66.24.30

# Creating a subnetwork

- If we want to split a network into subnetworks the first question is how big must that subnetwork be?
- Subnetwork sizes must be powers of 2 e.g. 2, 4, 8, 16, 32…
- (Strictly speaking one of these addresses is the broadcast address).
- So if we need 390 hosts then we must create a subnet of size 512 – enough room for 511 hosts and 1 broadcast address.
- 512 is 2^9 = so we need 9 host bits. The network is a /23 (32 bits in IP address – 9 bits for host = 23 bits)
- NOTE: In the real world you might want to leave room in case the subnetwork got more hosts later.

# Subnetting Q1

- What IP addresses are in the same range as192.168.28.67/27
  - A. 192.168.28.64-192.168.28.95
  - B. 192.168.28.0-192.168.28.255
  - C. 192.168.0.0-192.168.255.255
  - D. 192.16.28.64-192.168.28.127

# Subnetting Q1

- What IP addresses are in the same range as192.168.28.67/27
  - **A. 192.168.28.64-192.168.28.95**
  - B. 192.168.28.0-192.168.28.255
  - C. 192.168.0.0-192.168.255.255
  - D. 192.16.28.64-192.168.28.127
  - /24 takes up the first three bytes so we know that the addresses are 192.168.28.x
  - 67 in binary is 01000011 – the first three (red) bits are the (fixed) network part. The blue bits are the host part.
  - Therefore the first network address is 01000000 and the last is 01011111 these correspond to 64 and 95.
  - Note that 192.168.28.95 is the broadcast address.
  - The broadcast address is the address with the leftmost red bits (network address) fixes and the rightmost blue bits (host address) all set to 1.

# Subnetting Q2

- What is the broadcast address for the IP address192.124.123.54/22
  - A. 192.124.123.255
  - B. 192.124.122.255
  - C. 192.124.123.0
  - D. 192.124.128.0

# Subnetting Q2

- What is the broadcast address for the IP address192.124.122.54/22
  - **A. 192.124.123.255**

The broadcast address FINAL address in subnet – same first 22 bits but the other 10 bits set to 1.

We know that 16 is the first two bytes so the broadcast address begins 192.124.x.x

22-16 is 6 the first 6 bits of the byte 3 are the network part.

122 in binary is 01111010 setting the host part to 1s giving 01111011 which is 123.

For the fourth byte it must all be 1s and we know that 11111111 is 255 so the broadcast address is 192.124.123.255

# Subnetting Q3

- What is the first IP address in the range containing the host 211.222.202.26/29
  - A. 211.222.202.0
  - B. 211.222.0.0
  - C. 211.222.202.24
  - D. 211.222.202.16

# Subnetting Q3

- First address in 211.222.202.26/29

**C. 211.222.202.24**

For a /29 we know that the first three bytes are fixed (/24 is first three bytes) so the address must be 211.222.202.x

The next 5 bits are the network address with 3 for the host address.

26 is 00011010 where red is the network part.

First number in this range is 00011000 which is 24.

Hence the first IP address is 211.222.202.24

# Subnetting Q4

- You have been given a network 144.123.4.0/24. You want to break it into subnetworks. The first subnetwork contains 43 hosts. The second contains 20 hosts. What is the network address for the second subnetwork.

A. 144.123.4.32/26
B. 144.123.4.64/26
C. 144.123.4.32/27
D. 144.123.4.64/27

# Subnetting Q4

- You have been given a network 144.123.4.0/24. You want to break it into subnetworks. The first subnetwork contains 43 hosts. The second contains 20 hosts. What is the network address for the second subnetwork.

A. 144.123.4.32/26
B. 144.123.4.64/26
C. 144.123.4.32/27
**D. 144.123.4.64/27**

# Subnetting Q4

- You have been given a network 144.123.4.0/24. Networks of 43 and 20 hosts.

43 hosts – require room for 64 IP addresses. 64 is $2^6$ or 6 bits for host. Hence 32-6 = 26 bits for network. Network is /26. The network address is 144.123.4.0/26.
It starts at 144.32.4.0 and finishes at 144.32.4.63.

Last address is 00111111 (network red)(host blue)

Second network must have room for 32 hosts. 32= or 5 bits. Network is /27. The network address is 144.123.4.64/27

01000000 (network red)(host blue)

# Dynamic Host Configuration Protocol Q1

- A network interface is given an Ethernet (MAC) address when it is manufactured. Why not also give it an IP address?

# Dynamic Host Configuration Protocol Q1

- A network interface is given an Ethernet (MAC) address when it is manufactured. Why not also give it an IP address?

- A host that always has the same IP address can only connect to one network.

# DHCP Q2 true or false

- A) The server must broadcast as the client has not got an IP address
- B) The connection should use TCP in case of lost packets
- C) The DHCP server can be anywhere in the world, the network layer can take data to anywhere.
- D) DHCP is used by the client to obtain an Ethernet (MAC) address.

# DHCP true or false

- A) The server must broadcast as the client has not got an IP address  TRUE
- B) The connection should use TCP in case of lost packets

  FALSE – TCP could not set up a connection if the client has no IP (how does it handshake).
- C) The DCHP server can be anywhere in the world, the network layer can take data to anywhere.

  FALSE – Broadcast only reaches the subnet
- D) DHCP is used by the client to obtain an Ethernet (MAC) address.

  FALSE – the client has a MAC it needs an IP

# What have we learned

- Internet protocol basics
  - IP datagram format
  - IP fragmentation
  - IP addressing
- Creating sub networks
  - Classful addresses
  - Creating sub nets
- Dynamic Host Configuration Protocol (DHCP)