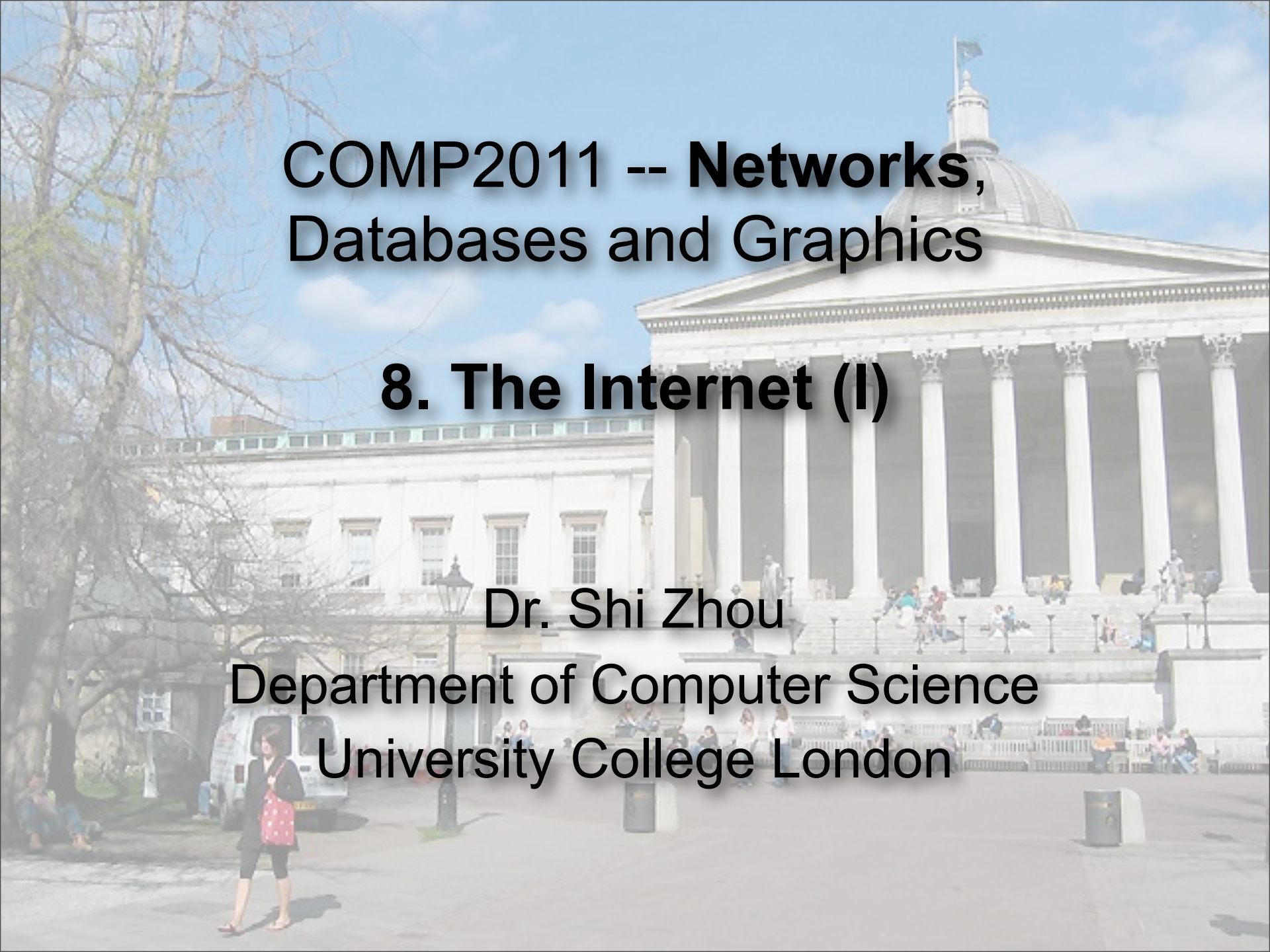

COMP2011 -- **Networks**, Databases and Graphics

8. The Internet (I)

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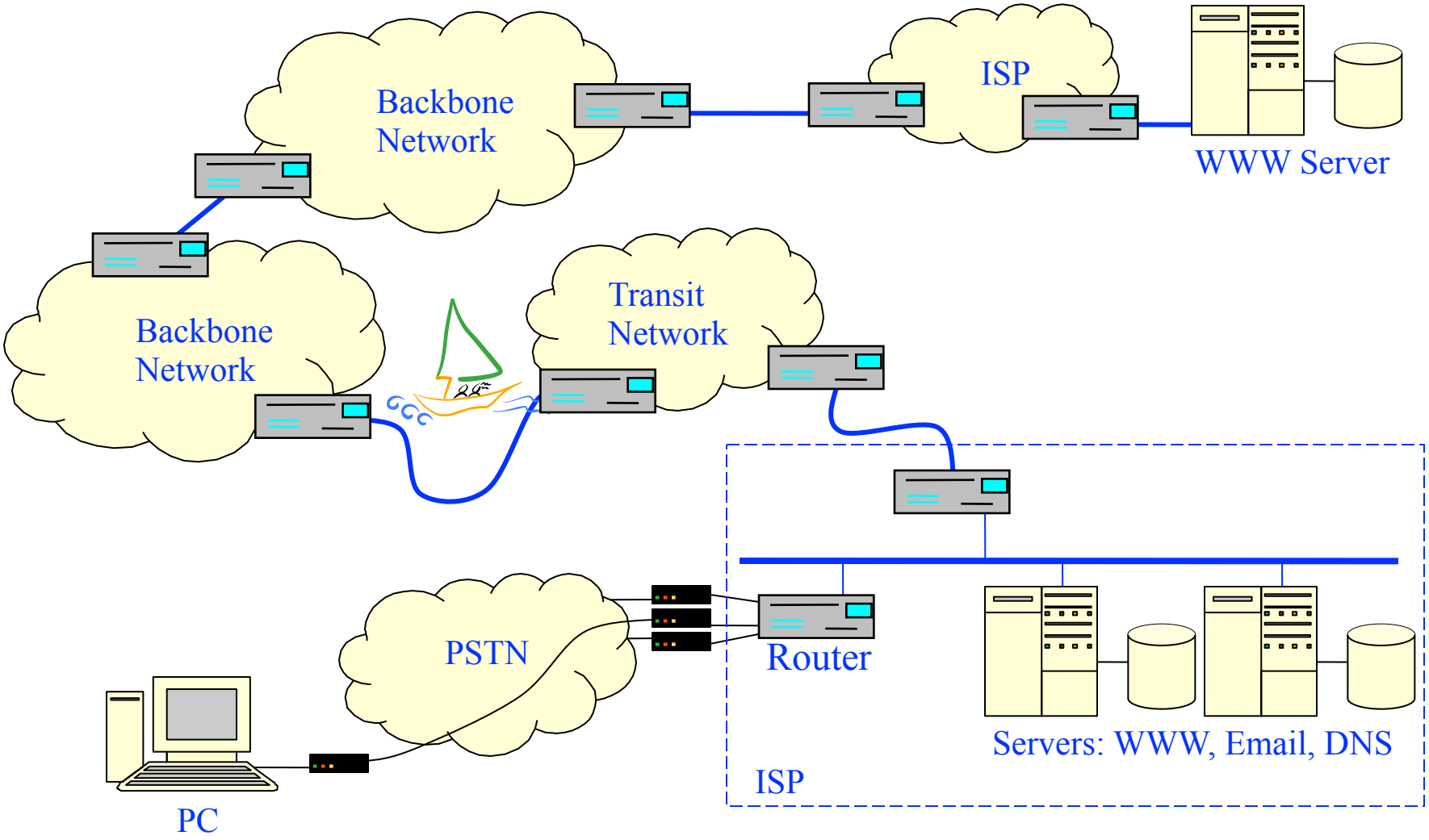
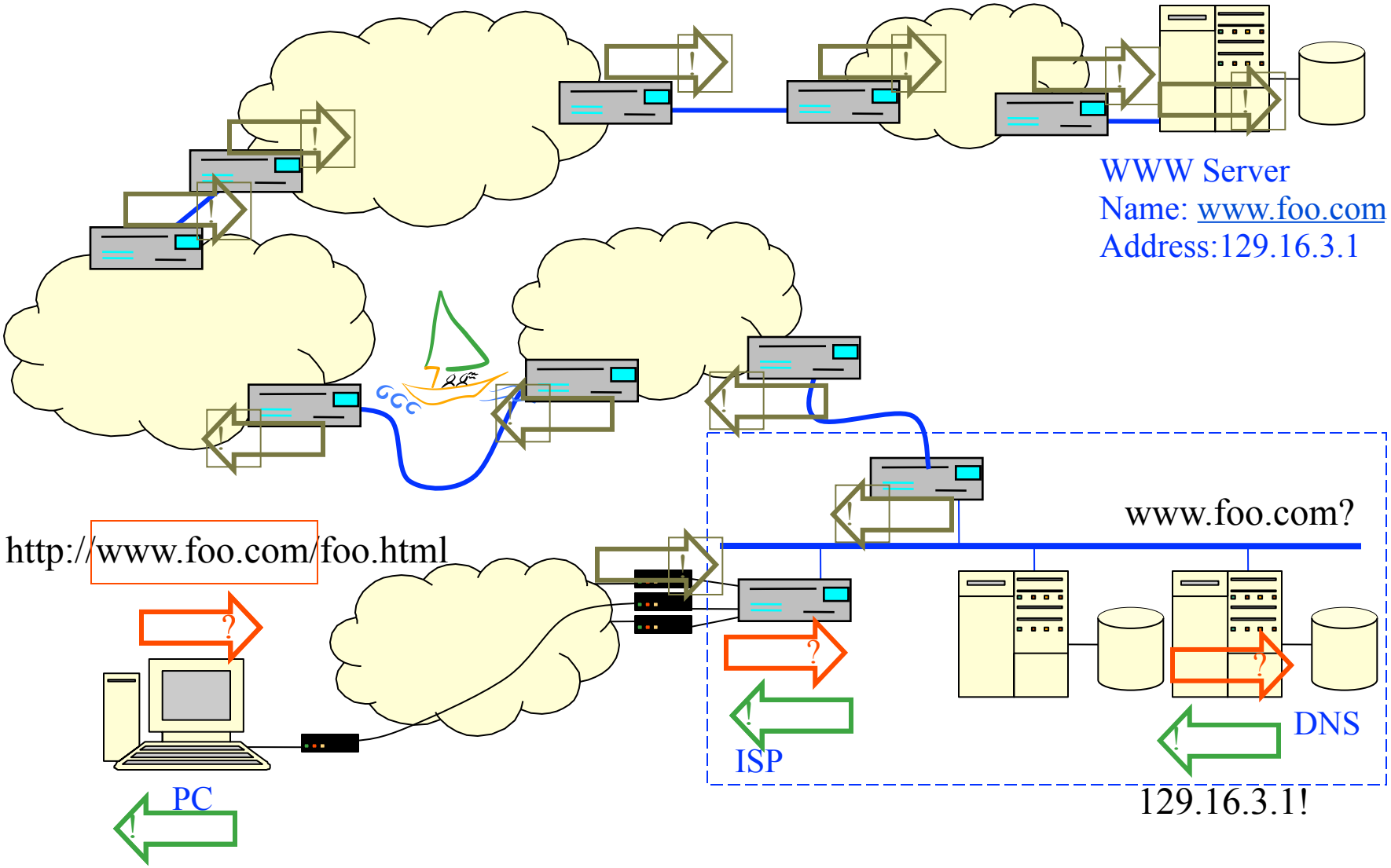
Department of Computer Science
University College London

The Internet – an example

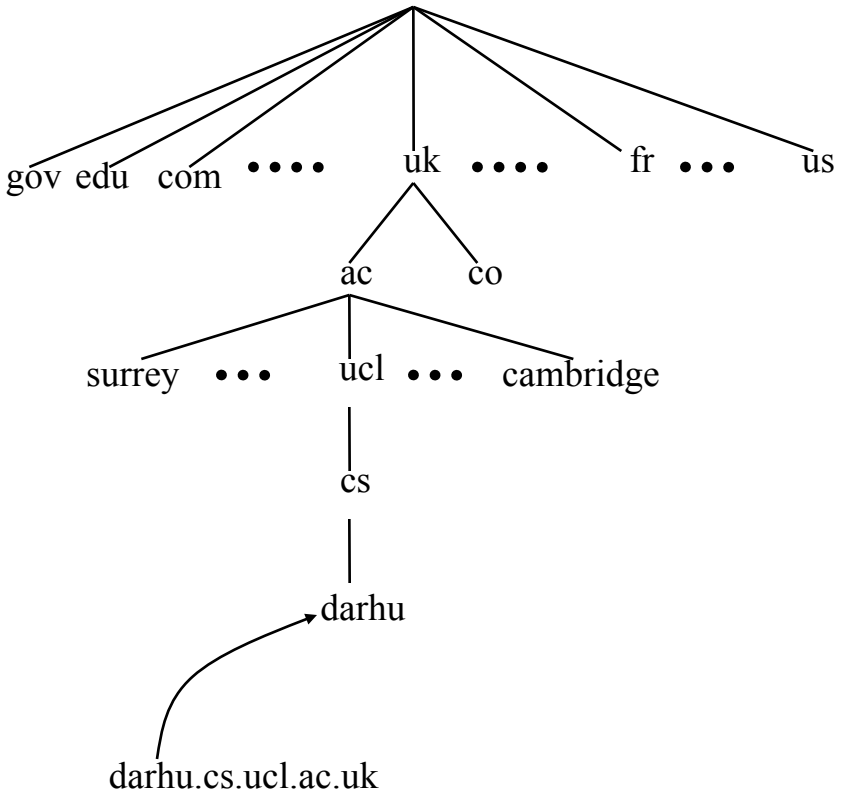


The Internet – an example



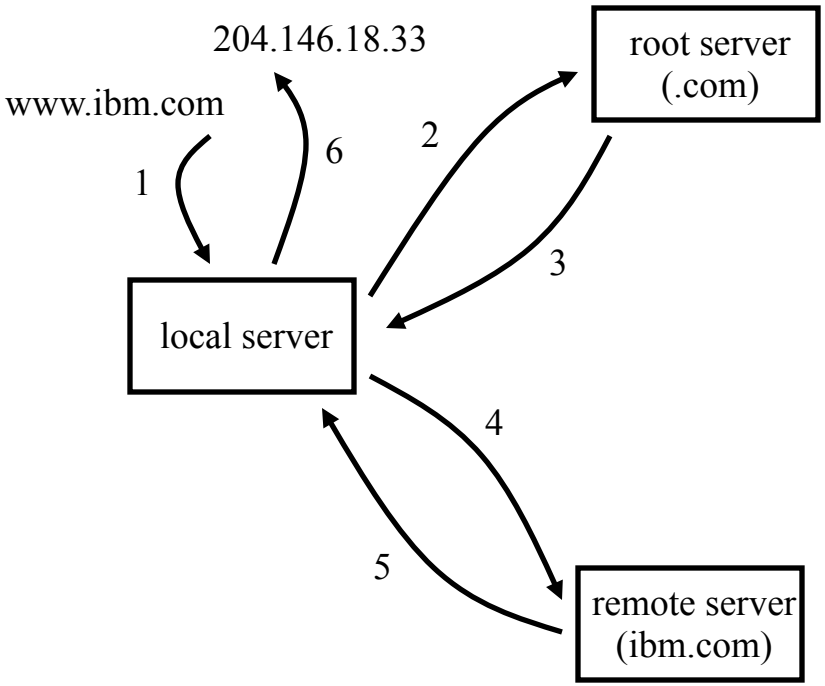
DNS [1]

- Global, distributed name space
- Nodes form a tree:
  - Hierarchical delegation
- Domain:
  - single IP network, e.g.: cs.ucl.ac.uk
  - multiple IP networks: ibm.com
- DNS servers:
  - servers for each domain



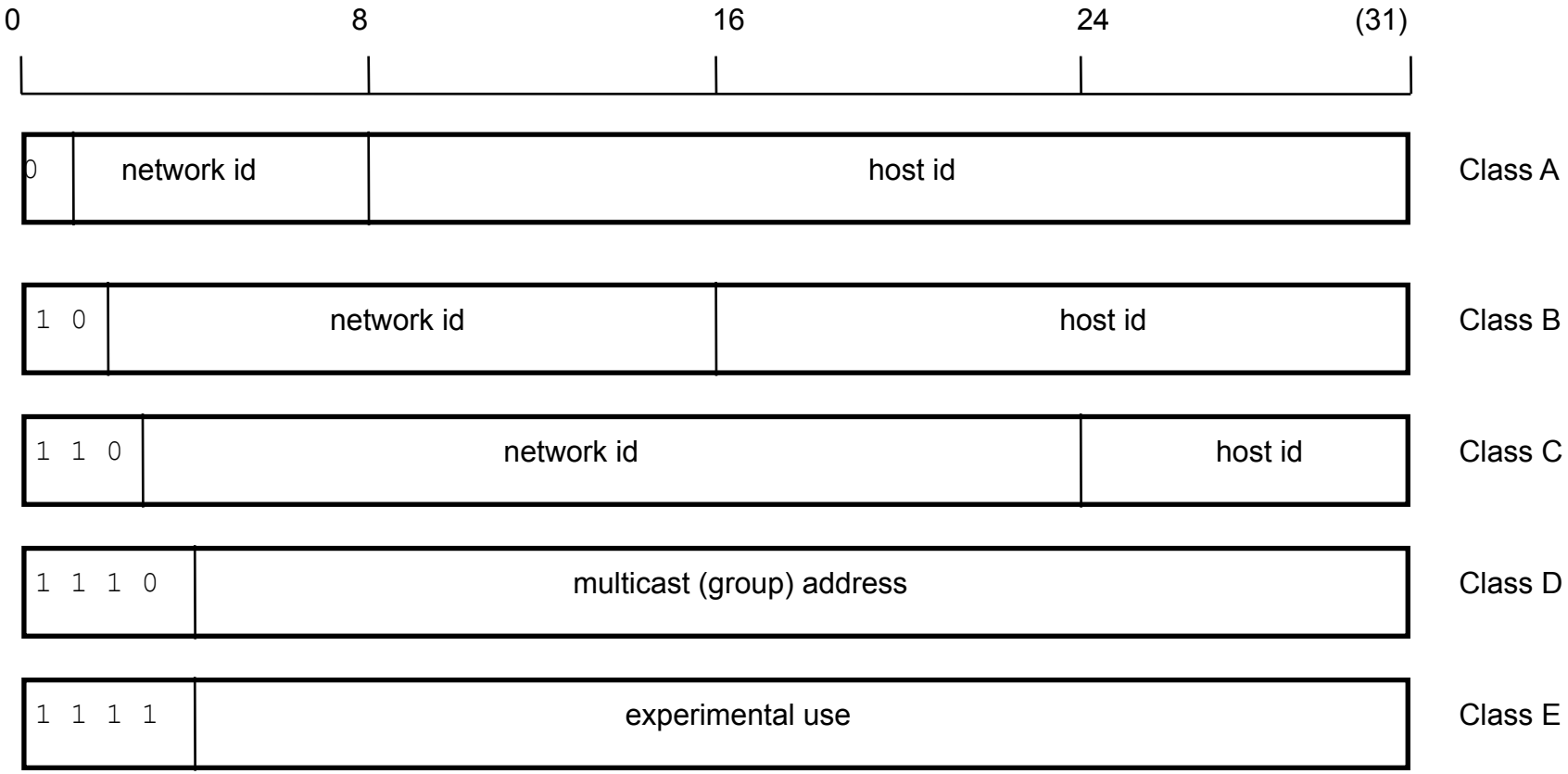
DNS [2]

- Query to local server:
  - iterative mode
  - recursive
- Authoritative answer:
  - from domain server
- Non-authoritative answer:
  - from cache at local server



- Resource Records:
  - A (address) : gives IP address for a host name
  - PTR (pointer): gives host name for an IP address
  - MX (mail) : give name of mail server for a host name

IPv4 addresses: original assignment



e.g. marston.cs.ucl.ac.uk: 128.16.20.1 (class B)

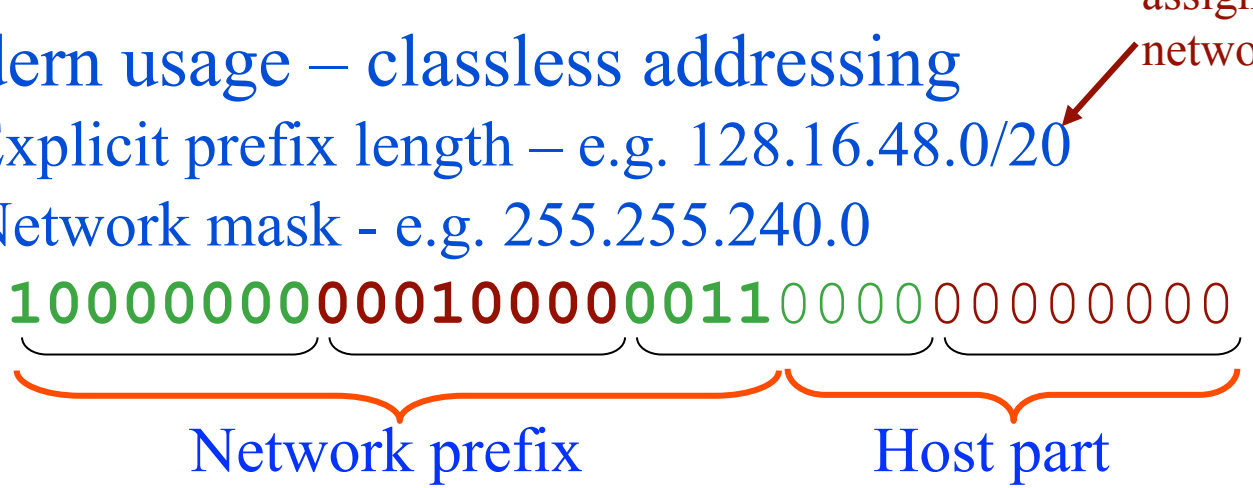
Not all addresses available -- some addresses are "lost" inside a network,
e.g. *cs.ucl.ac.uk* has class B addresses with 64K host ids, many of which are not used, but can't be used by any other network.

IP addresses for dial-up users

- Internet Assigned Numbers Authority (IANA)
  - Regional Internet Registry (RIR)
    - ARIN, RIPE, APNIC, LACNIC, AfriNIC
- ISP: fewer active users than subscribers
- Do not need unique IP address per subscriber
- Pool of addresses:
  - user allocated IP address from pool
  - IP address used for dial-up session
  - returned to pool at end of session
  - next session may be using different address

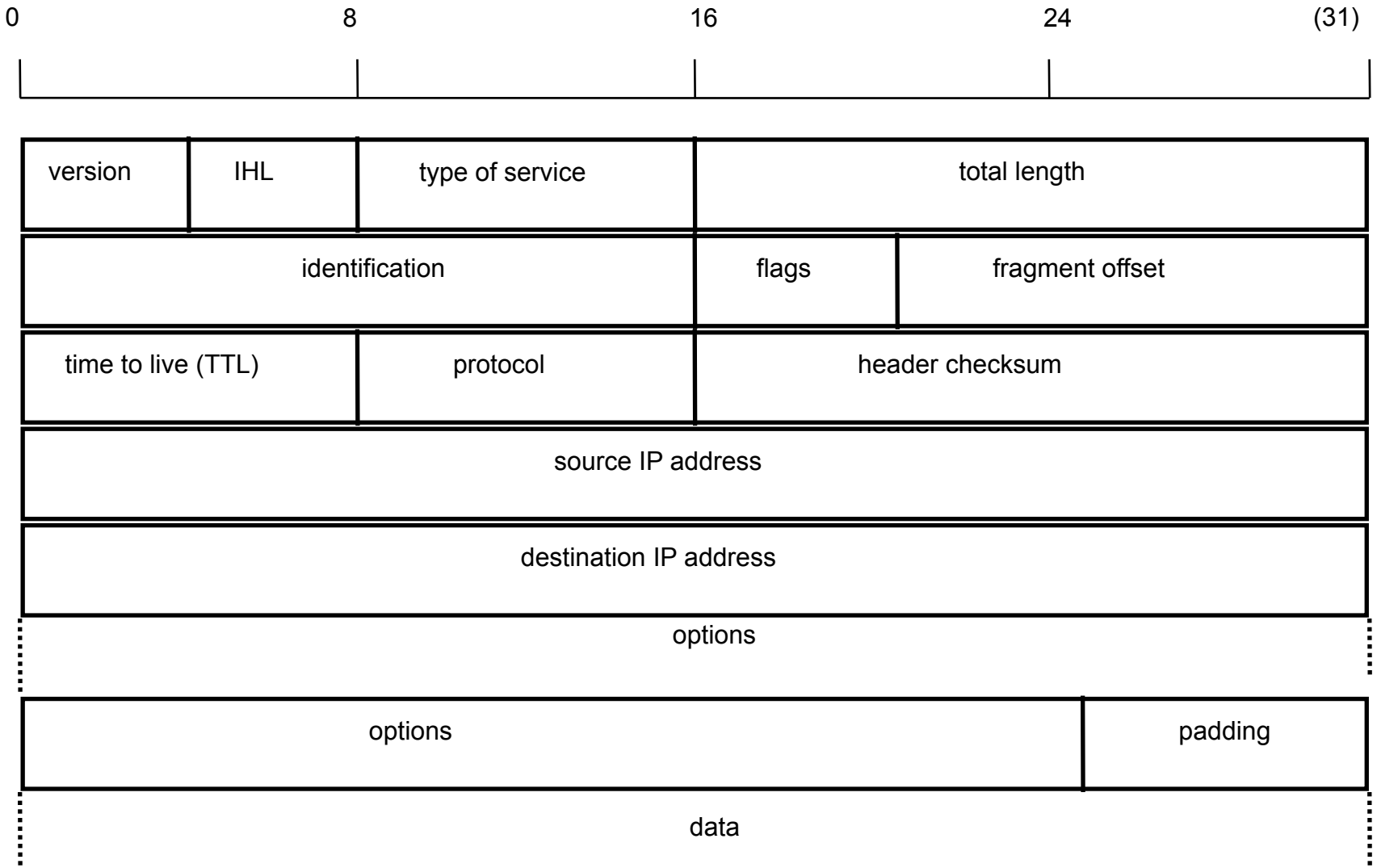
Addresses and Networks

- Modern usage – classless addressing
  - Explicit prefix length – e.g. 128.16.48.0/20
  - Network mask - e.g. 255.255.240.0

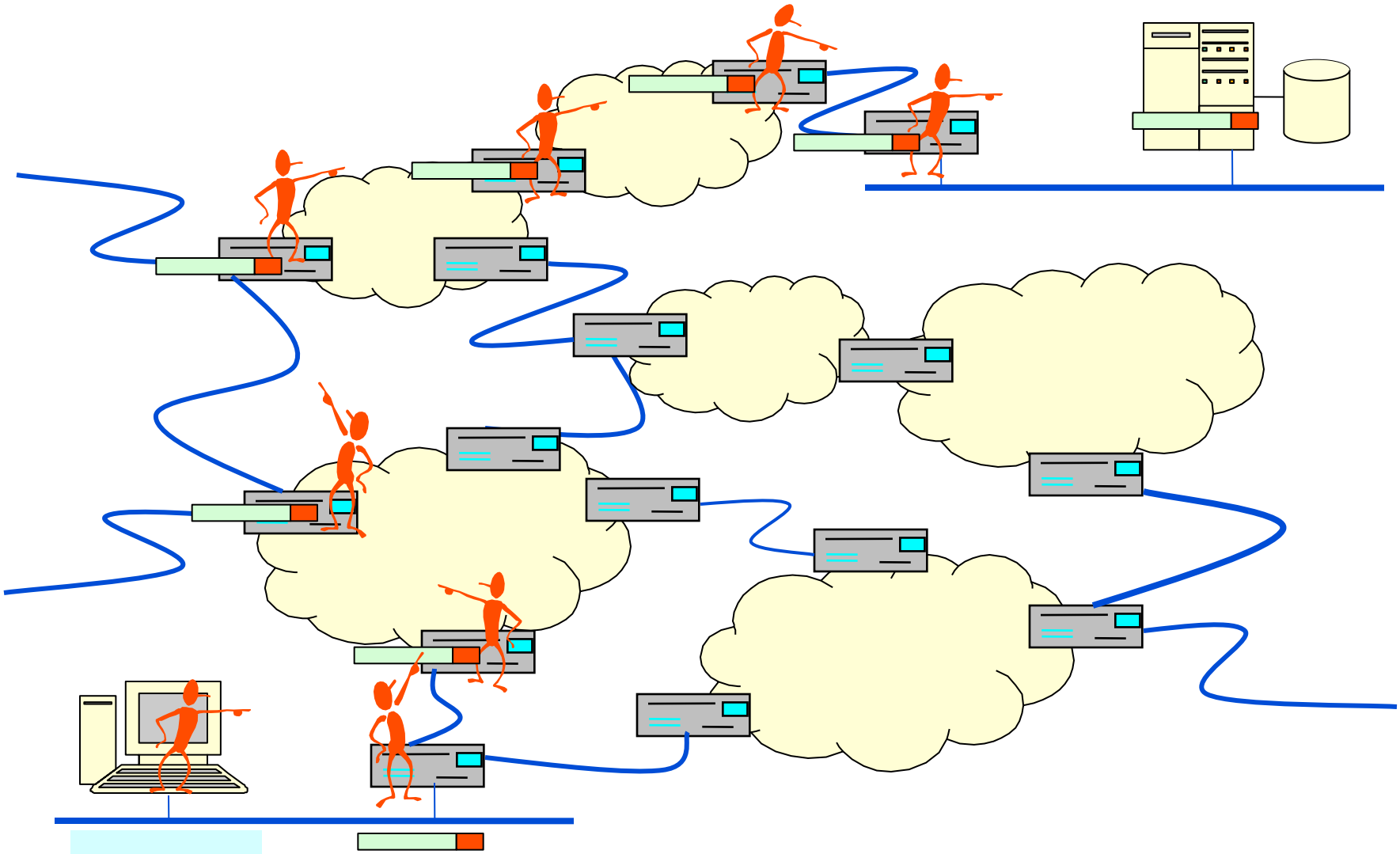


- "IP Network" or "IP Subnet"
  - Set of hosts with same network prefix
- Inter-subnet traffic must go via a router
- Intra-subnet traffic must not

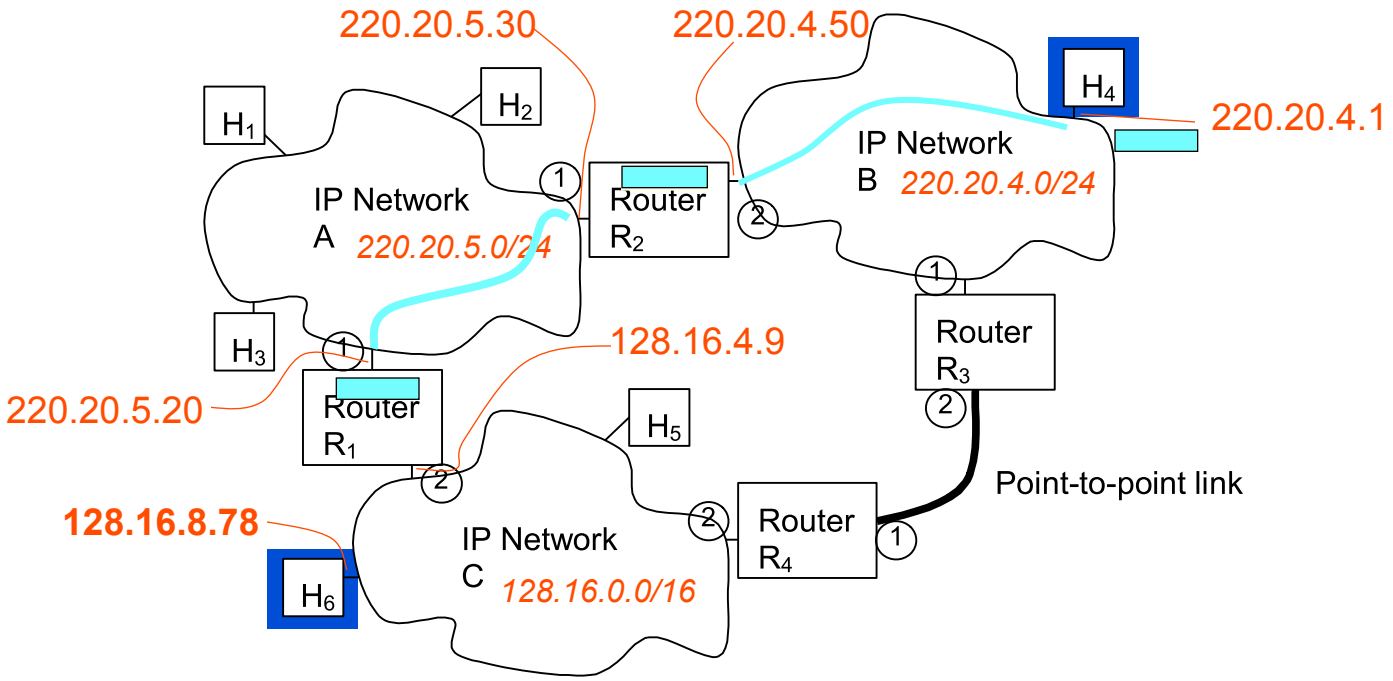
The Internet Protocol v4



IP Forwarding



IP Forwarding - detail



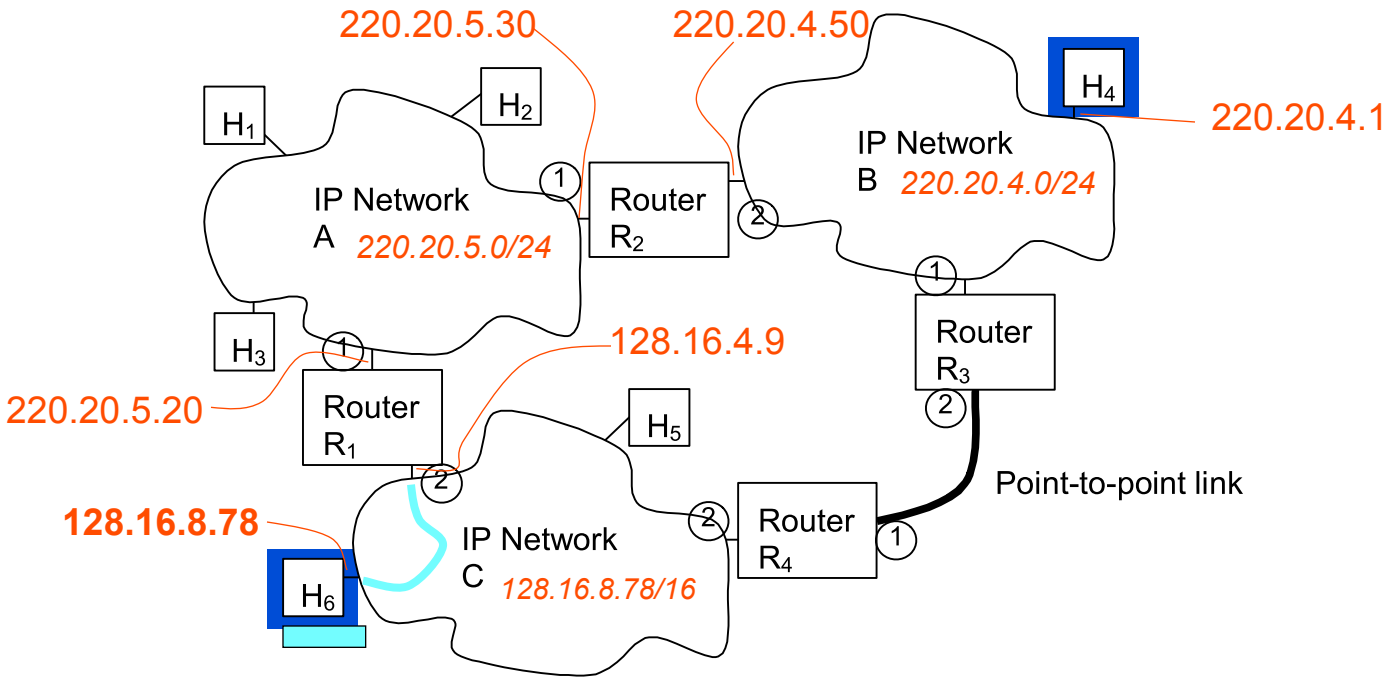
H_4

Prefix	Next hop
default	**220.20.4.50**
220.20.4/24	local

R_2

Prefix	Interface	Next hop
220.20.4.0/24	2	local
220.20.5.0/24	1	local
128.16.0.0/16	**1**	**220.20.5.20**

IP Forwarding – detail



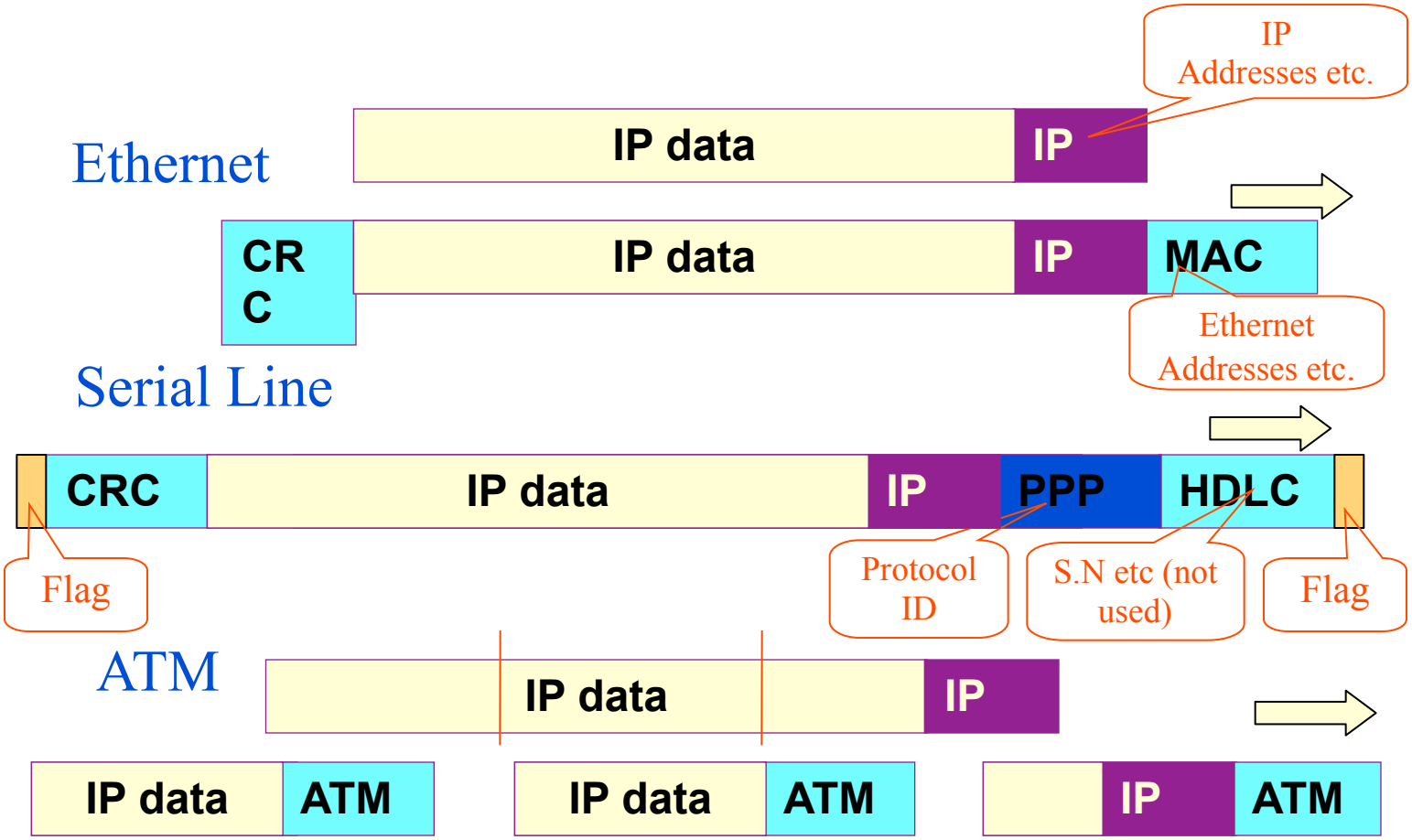
R_1

Prefix	Interface	Next hop
220.20.4.0/24	1	220.20.5.30
220.20.5.0/24	1	local
128.16.0.0/16	**2**	**local**

How do IP Datagrams Travel?

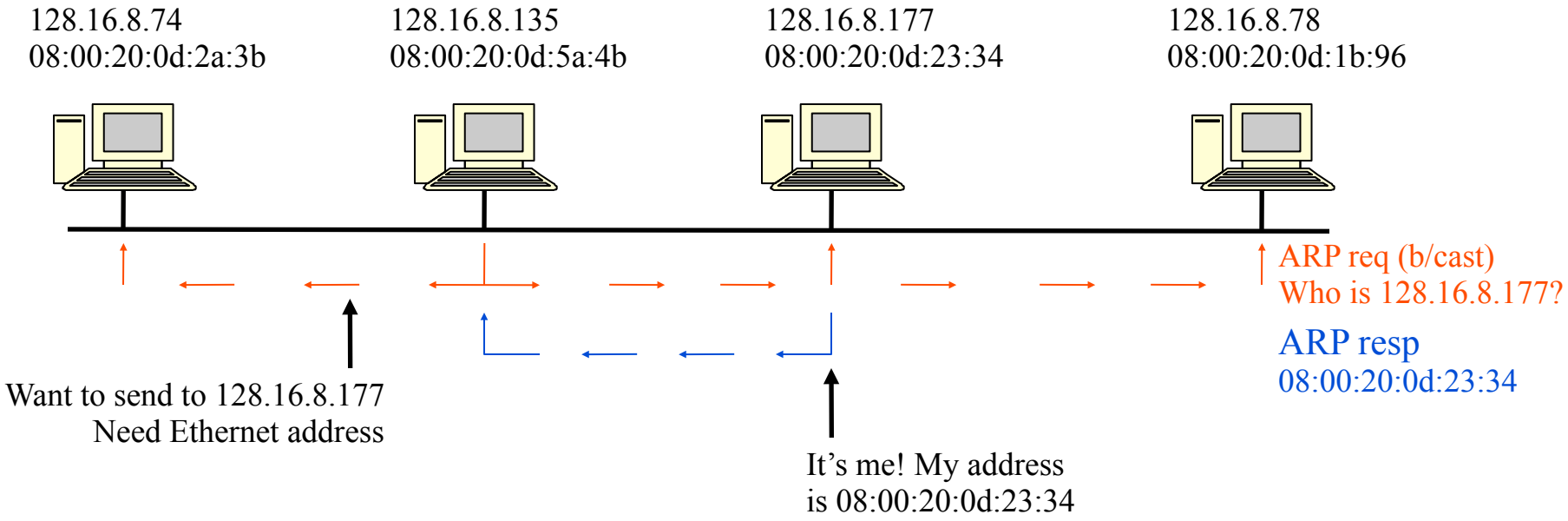
- Ethernet – understands Ethernet frames and Ethernet addresses
- ATM – understands ATM addresses, cells and VCs
- **No network technologies understand IP addresses**
- **No network technologies understand IP datagram headers**
- IP datagrams must be treated as data
  - Encapsulation
- We must have “physical addresses”
  - Ethernet addresses, ATM addresses etc.
  - Address resolution: IP address →”physical address”

Encapsulation - three examples



Note: ATM is a virtual circuit technology & a VC has to be set up before IP datagrams can be sent.

Address Resolution: ARP on a LAN



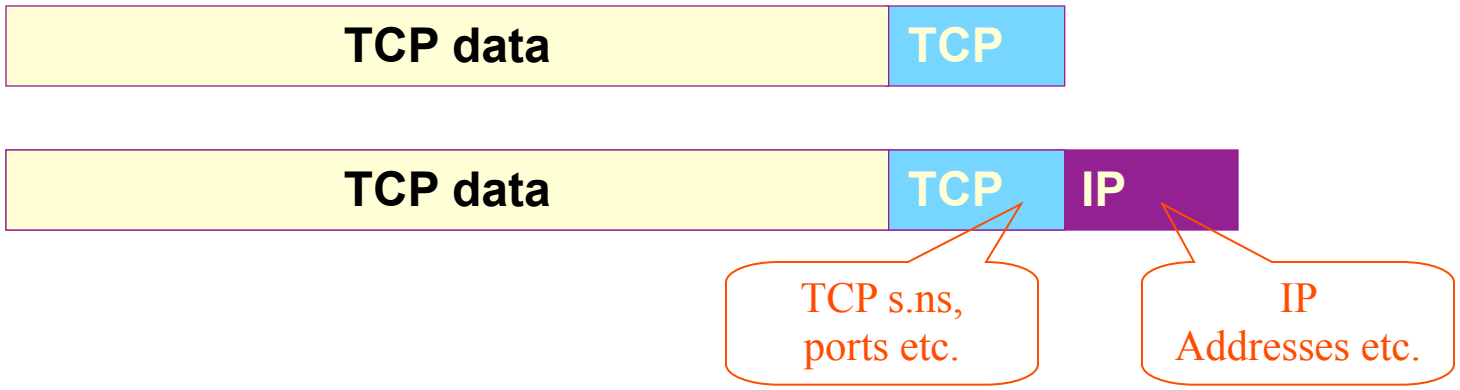
- ARP results are cached
  - Timeout if not "refreshed"
- All hosts learn mapping for requestor

Summary so far

- IP – connectionless service, global addresses, no guarantees about delivery, may deliver out of order, normally no QoS guarantees
- Routers
- Mappings to network technologies - LANs, WANs etc.
- Suppose we want reliable sequenced delivery?
  - TCP
- Suppose we don't?
  - UDP

Transmission Control Protocol - TCP

- Reliable, sequenced delivery
  - ARQ operation
  - Connection oriented
- Flow control
  - Variable window
- “End-to-end” - routers are not aware of TCP



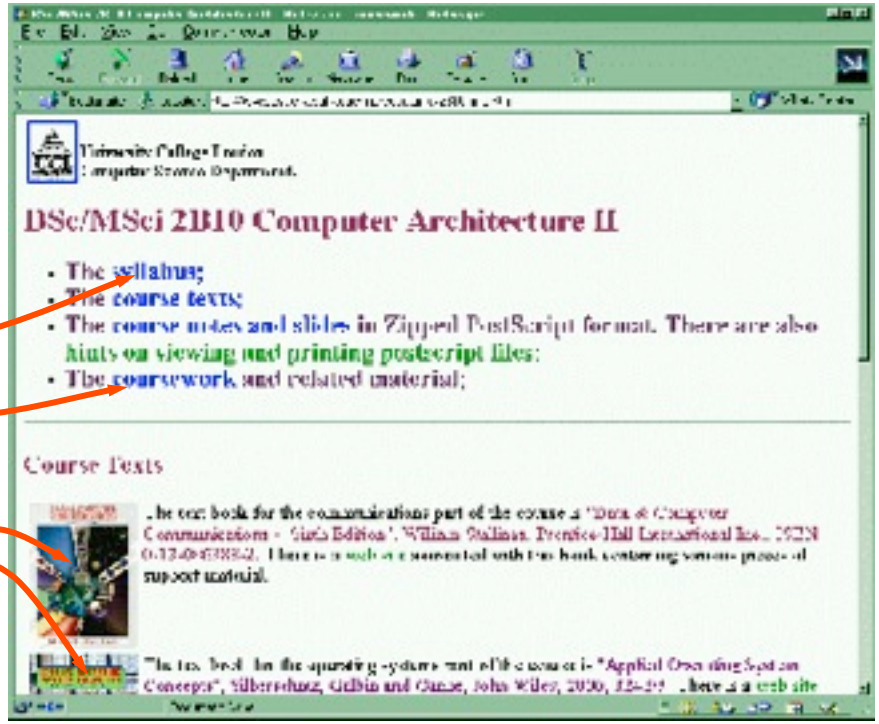
TCP (and UDP) Ports

- IP addresses identify hosts
- Ports identify processes
  - Like telephone extension numbers
  - When packet arrives OS looks at ports and chooses process
- “Well-known” ports
  - HTTP (WWW server) 80
  - FTP (FTP server) 21
  - Telnet (Remote rlogin) 23
  - SMTP (Email) 25
  - Rlogin (Unix remote login) 513

TCP Example – The WWW

Links: URLs (references to other pages)

Embedded objects: Images, Applets etc.



Text: Words + HTML tags

- To retrieve text, images etc. we need reliable, sequenced delivery
- Separate TCP connection for each component (in parallel)
  - Use IP address of server, TCP port 80

URL Format

<protocol>://<domain name>/<path name>

protocol: http, https, ftp

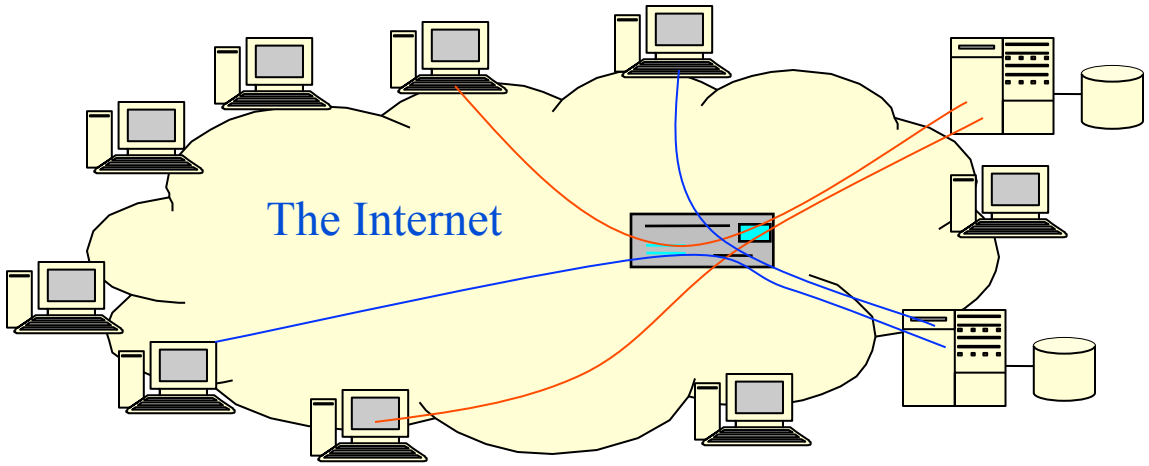
Domain name: name of host e.g. sonic.cs.ucl.ac.uk

Note: www.cs.ucl.ac.uk identifies web server at cs.ucl.ac.uk

Path name: used by target to identify page requested

Note: port number determined by protocol: 80 for http

TCP and Network Congestion



- Routers can become congested
  - Packets delayed, eventually some are dropped
- TCP knows about dropped packets – retransmits
- TCP implementations slow down (reduce the window)
- **Congestion is avoided**

The End