Network Layer and Internetworking

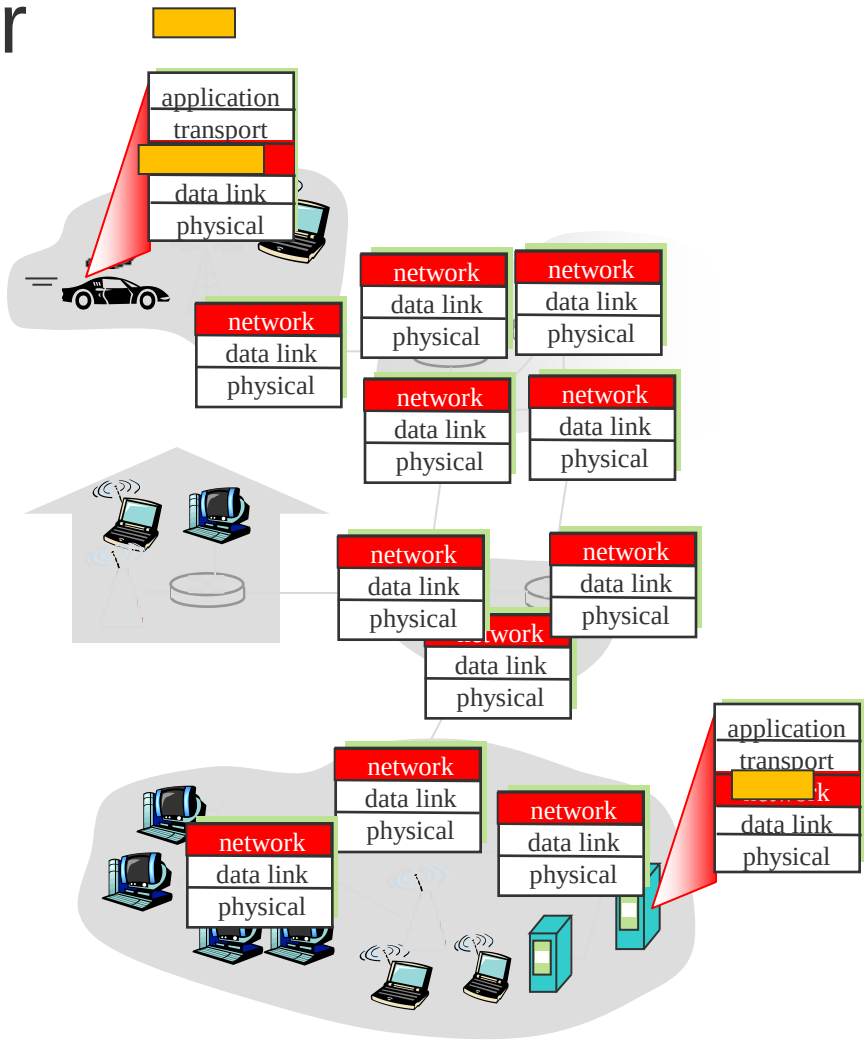
Andy Carpenter

(Andy.Carpenter@manchester.ac.uk)

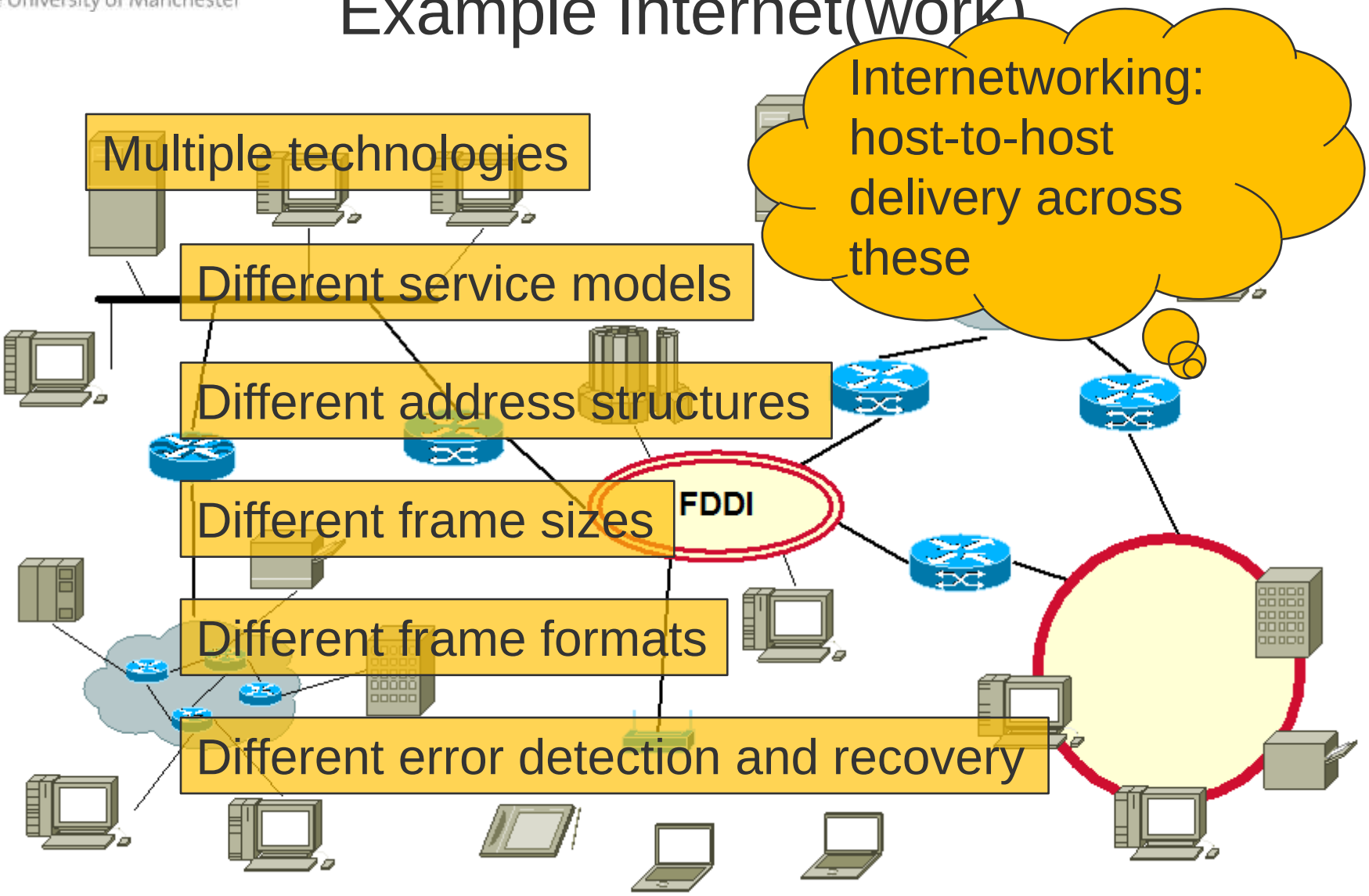
Elements these slides come from Kurose and Ross, authors of "Computer Networking: A Top-down Approach", and are copyright Kurose and Ross

Network Layer

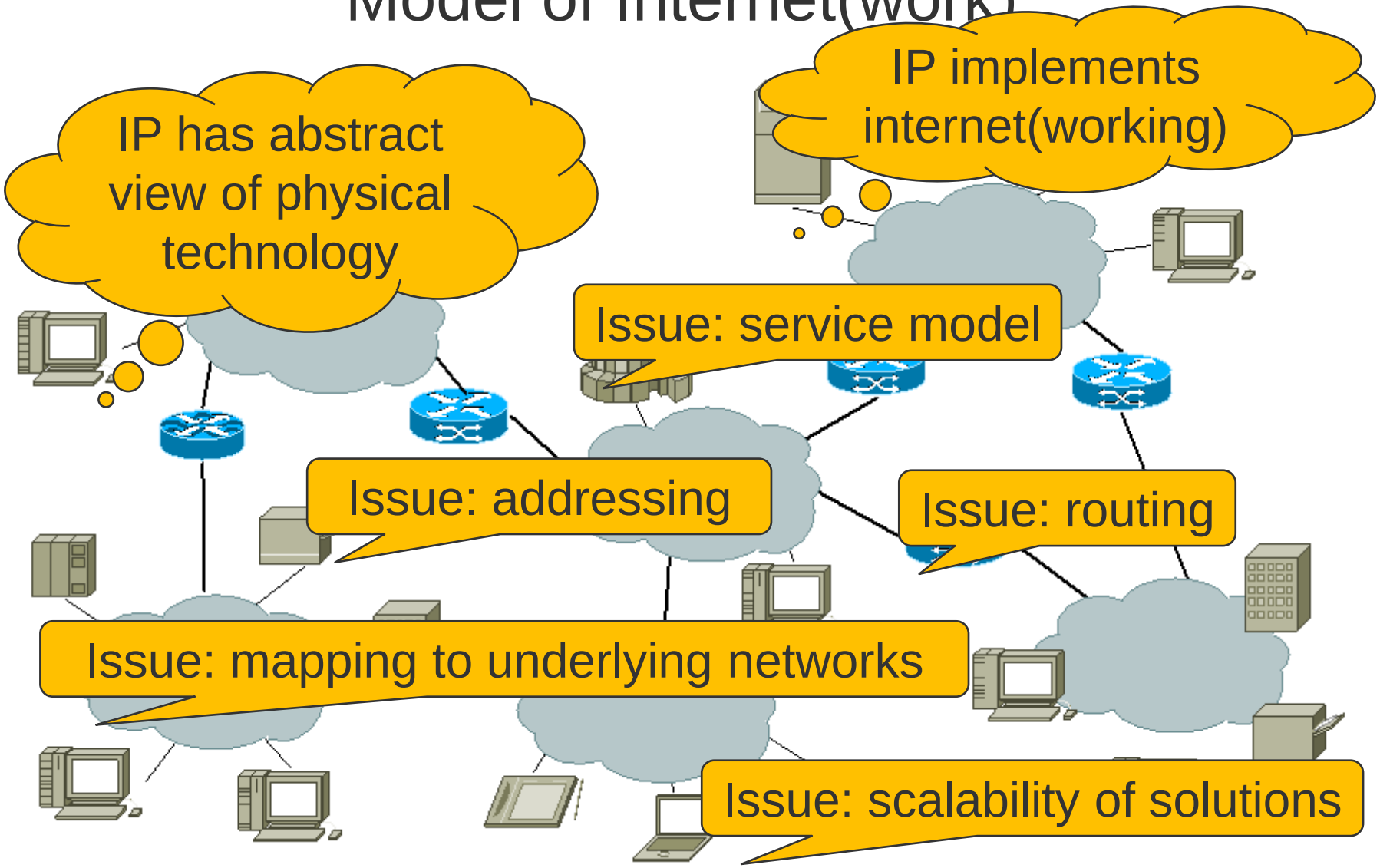
- Transports segments between hosts
- In every host and router
- Segments in frames
- Issues:
  - spanning the globe
  - service model
  - coordination
  - minimise data
  - minimal manual setup
  - forwarding & routing



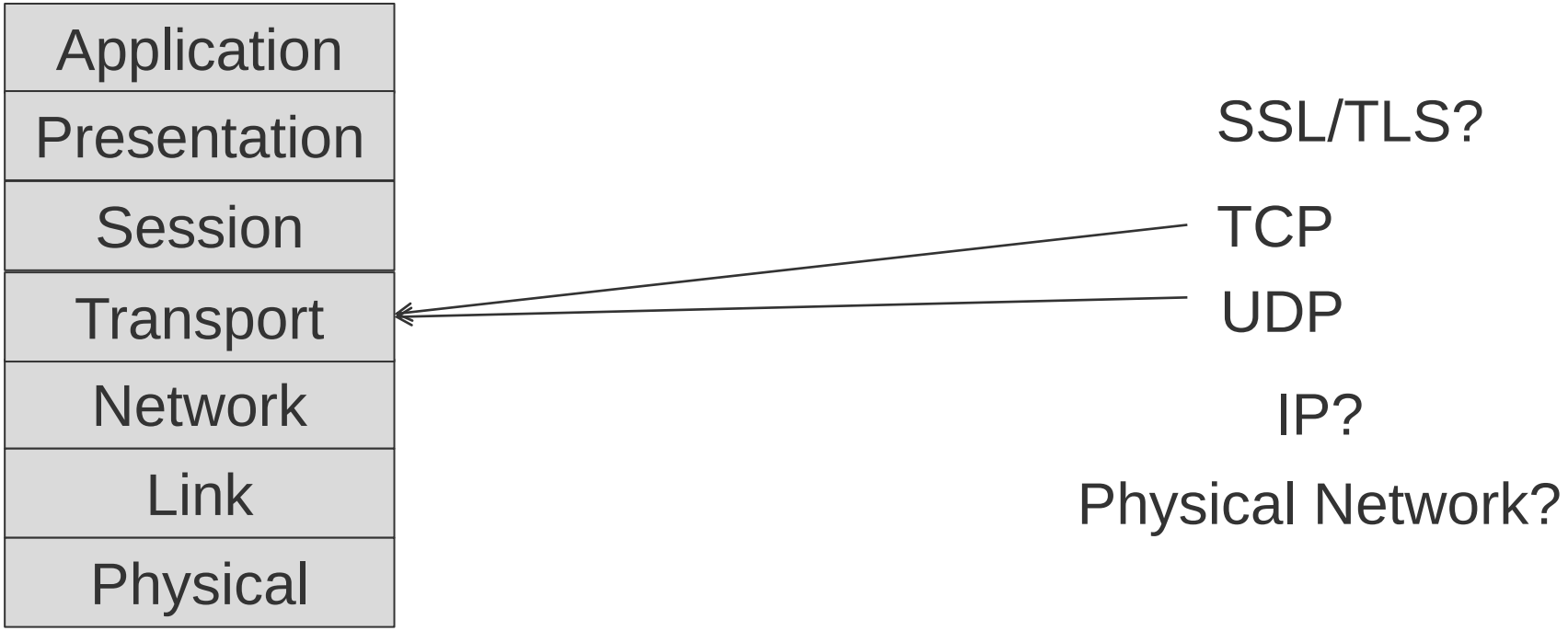
Example Internet(work)



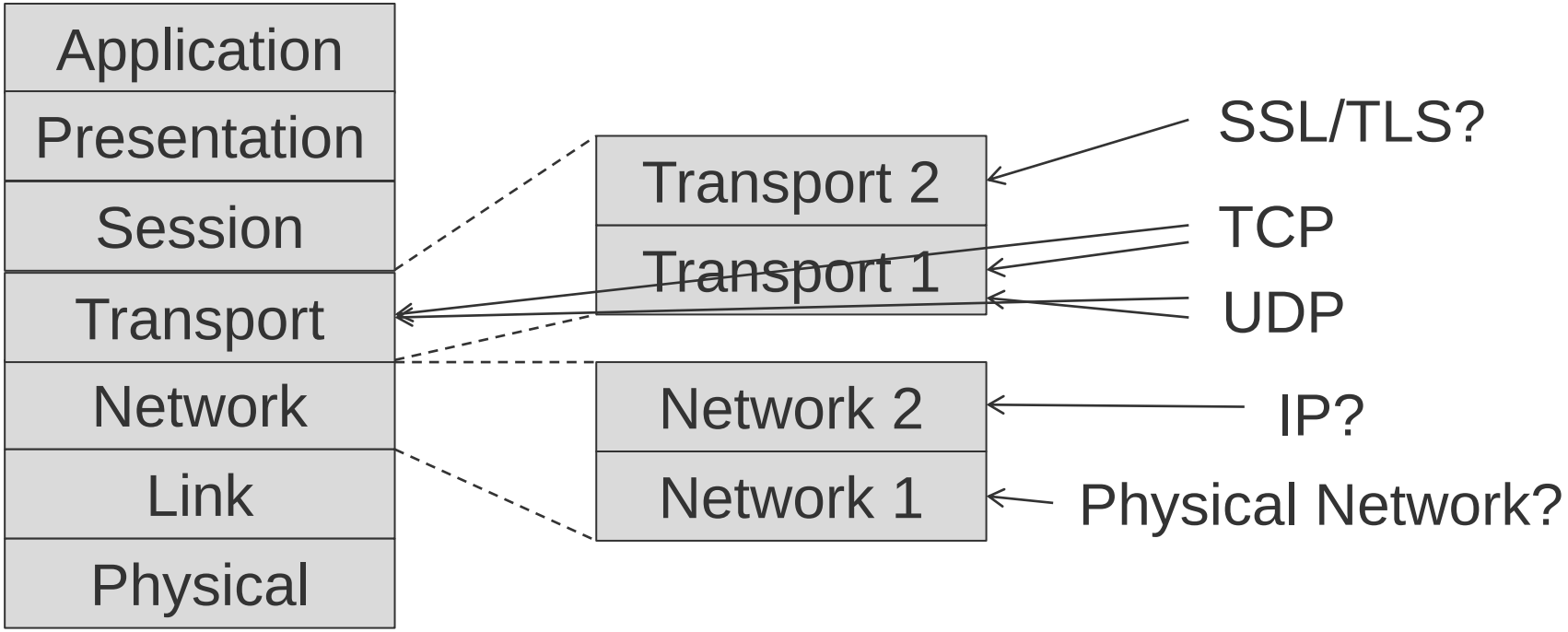
Model of Internet(work)



Internet Network Layers



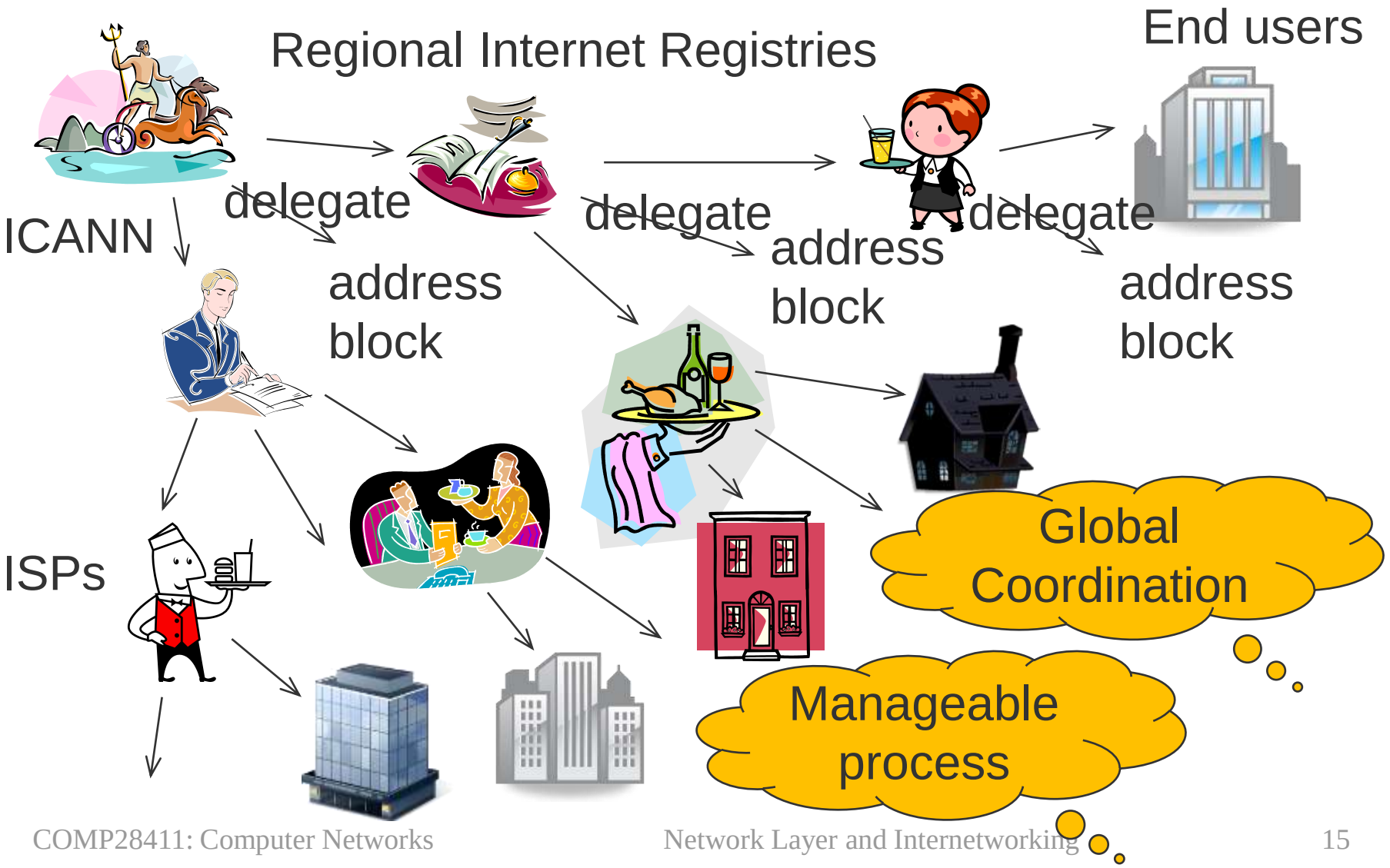
Internet Network Layers



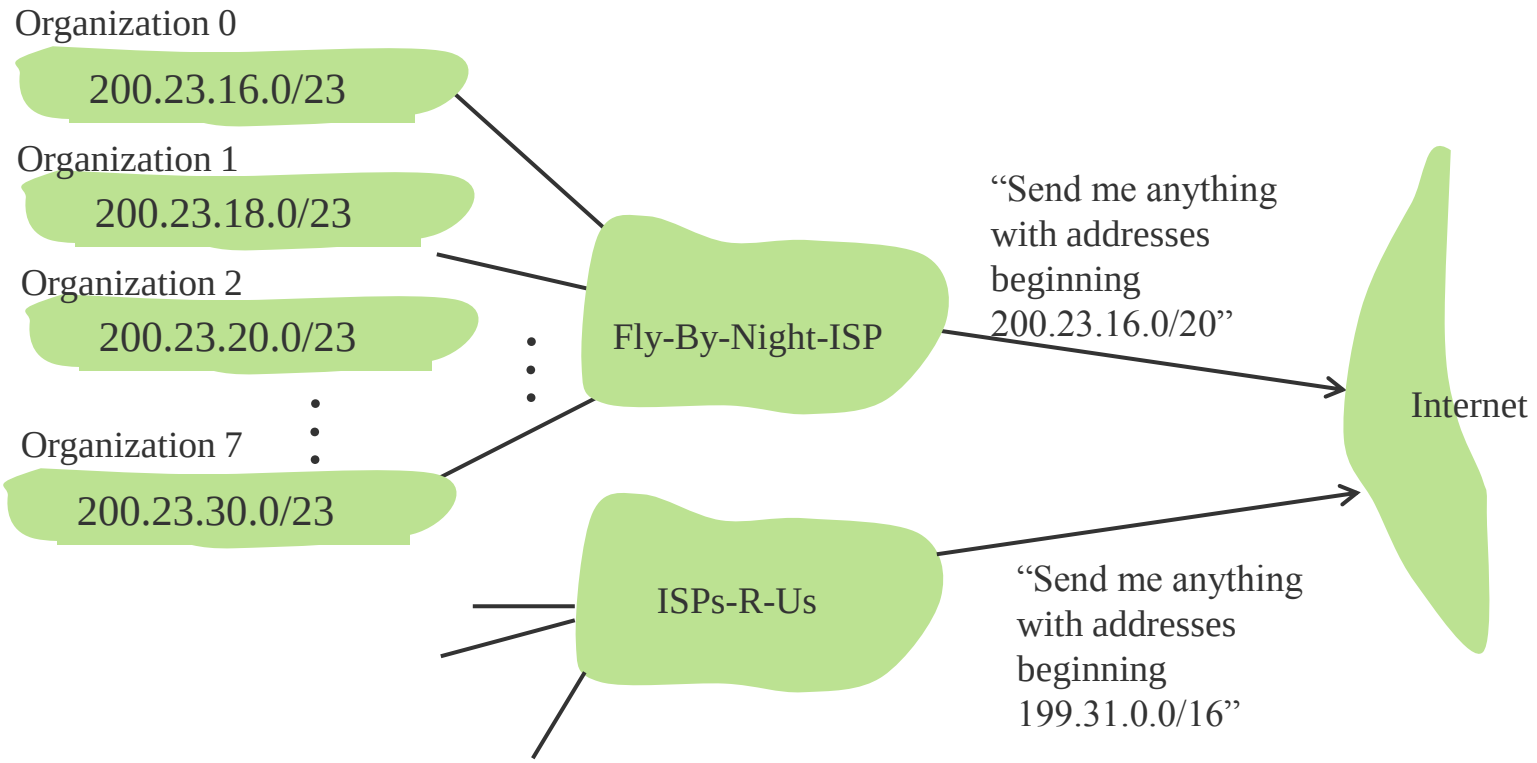
IP: Service Model

- Created via service models of underlying networks
  - can only promise achievable
- Connectionless:
  - places minimal demands on underlying networks
  - datagrams may be delivered out of order
- Unreliable:
  - no error recovery implemented in network by IP
  - although delivery not guaranteed, is best effort
  - reasons for datagrams not being delivered:
    - datagram corruption, physical link failure
    - congestion causing datagrams to be discarded

Coordination: Addresses



Minimise Data: Routing



- Hierarchical addressing allows efficient advertisement of routing information:
- Address Block Aggregation

Network Address Translation (NAT)

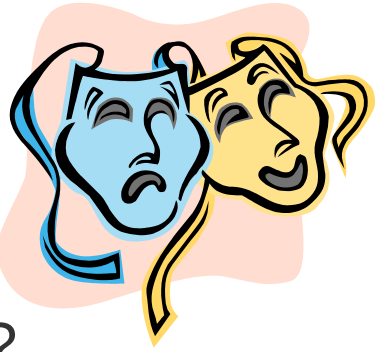
P&D: 4.3.5

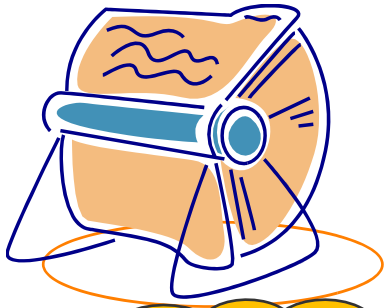
- Another way to conserve address; also some security
- Addresses unique only within local/corporate network
- Interact with rest of Internet via “NAT Box”
  - translates local addresses to globally unique ones
  - uses pool of globally unique addresses
- Relies on fact that at any point in time:
  - only subset of computers interact with the Internet
- Requires that applications:
  - not to put IP address in application data

Minimise Manual: Host

Need Local information?

xx.xx.xx.xx





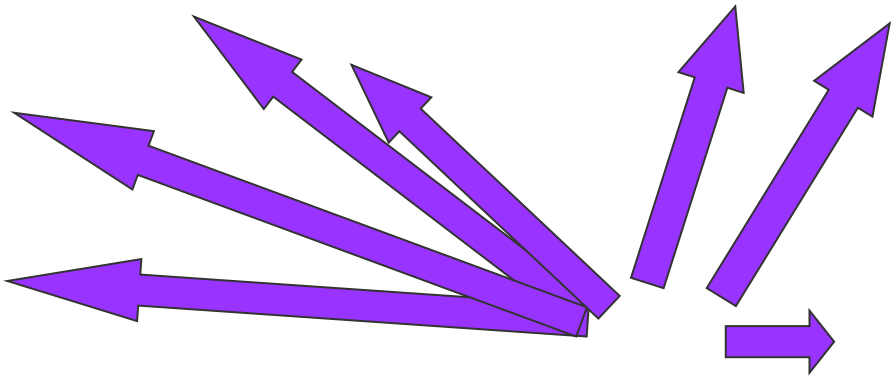
Need Information about Network?

DHCP

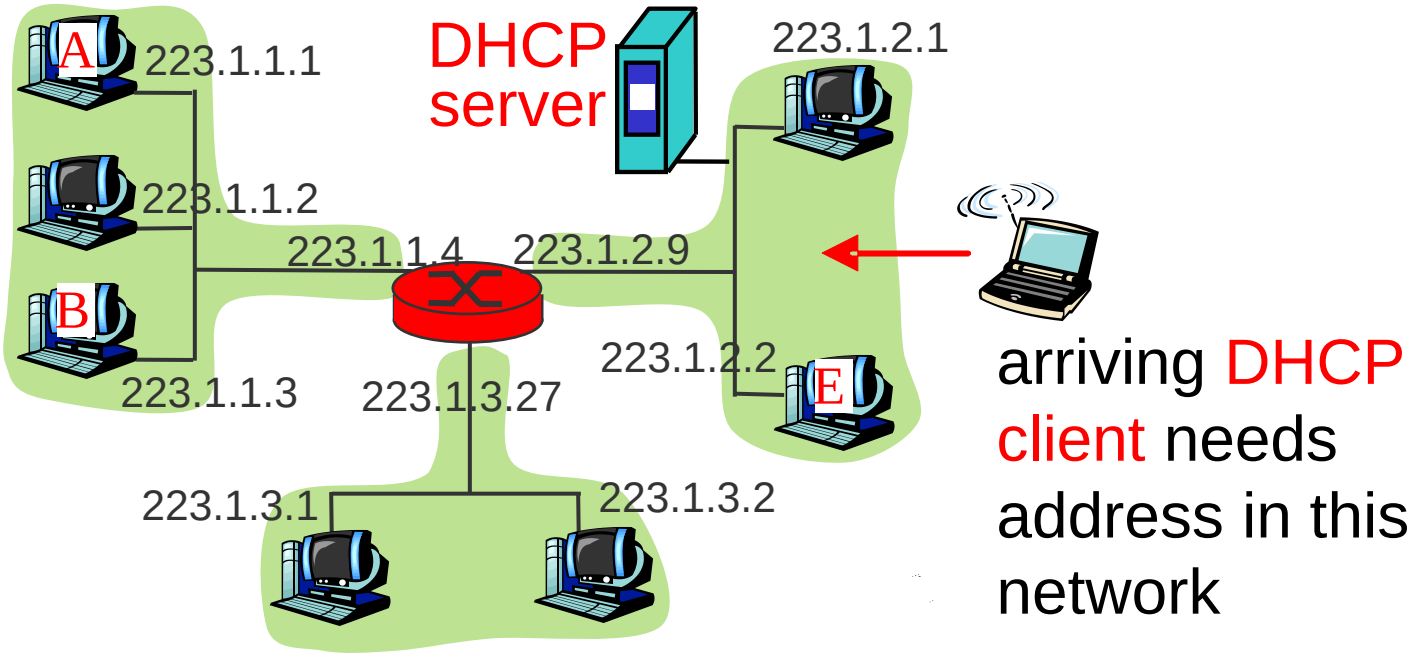
xx.xx.xx.xx ⟷ yy:yy:yy:yy:yy:yy

How find?

ARP

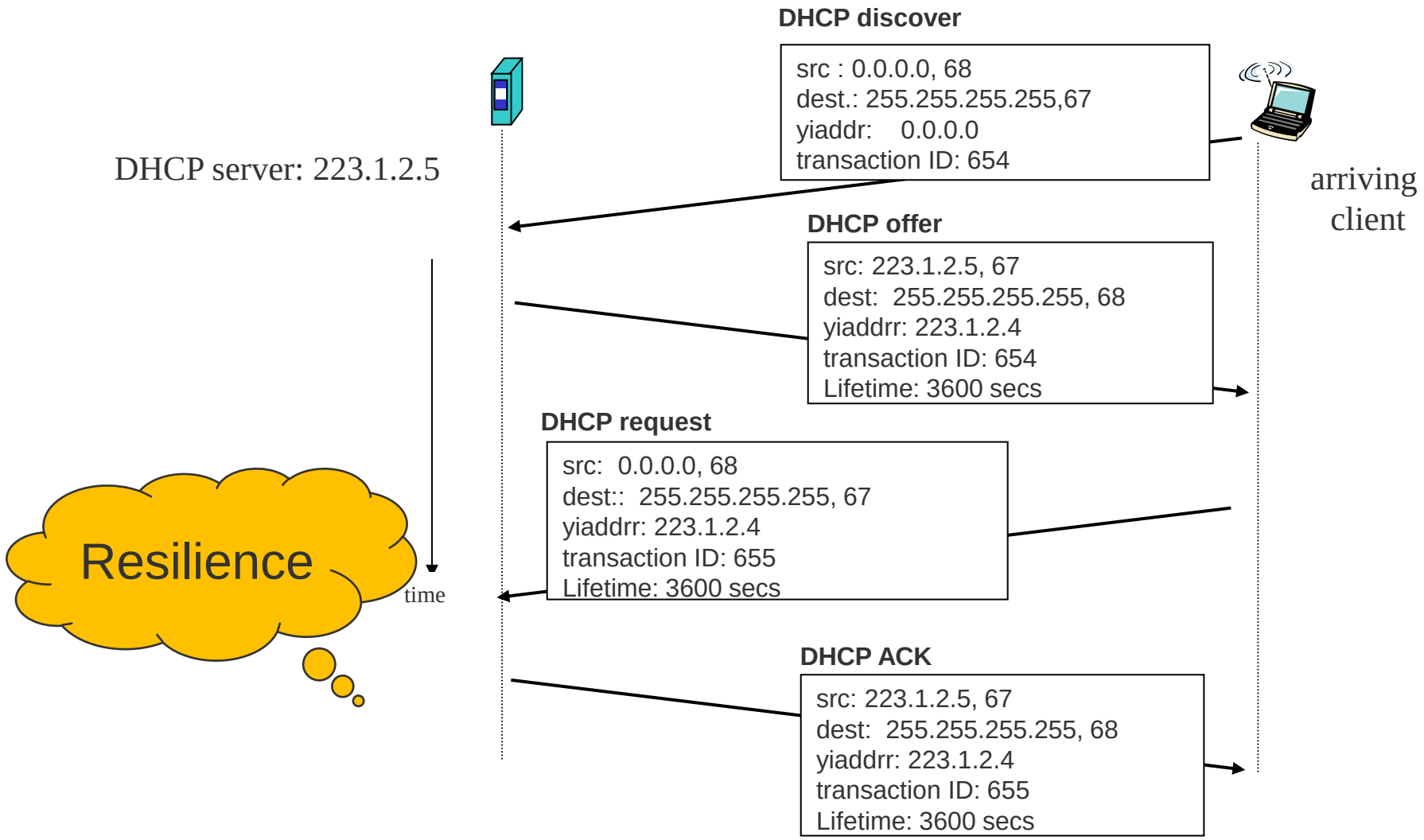


Minimise Manual: DHCP

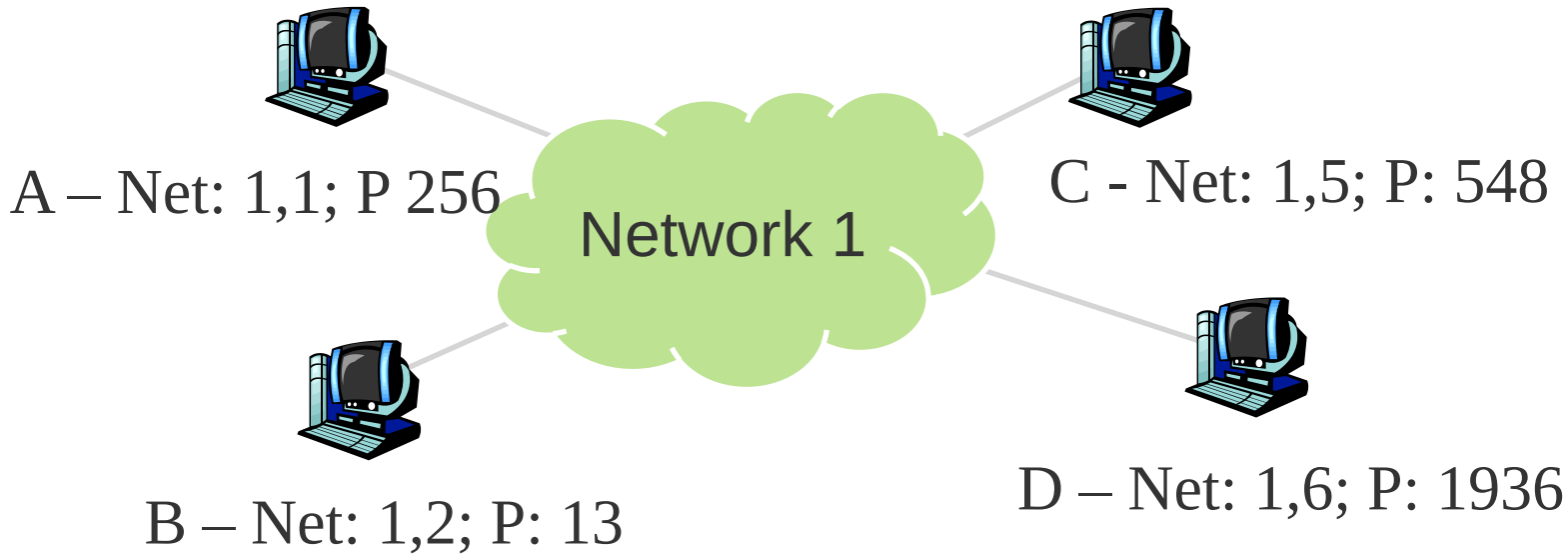


- Dynamic Host Configuration Protocol

Minimise Manual: DHCP

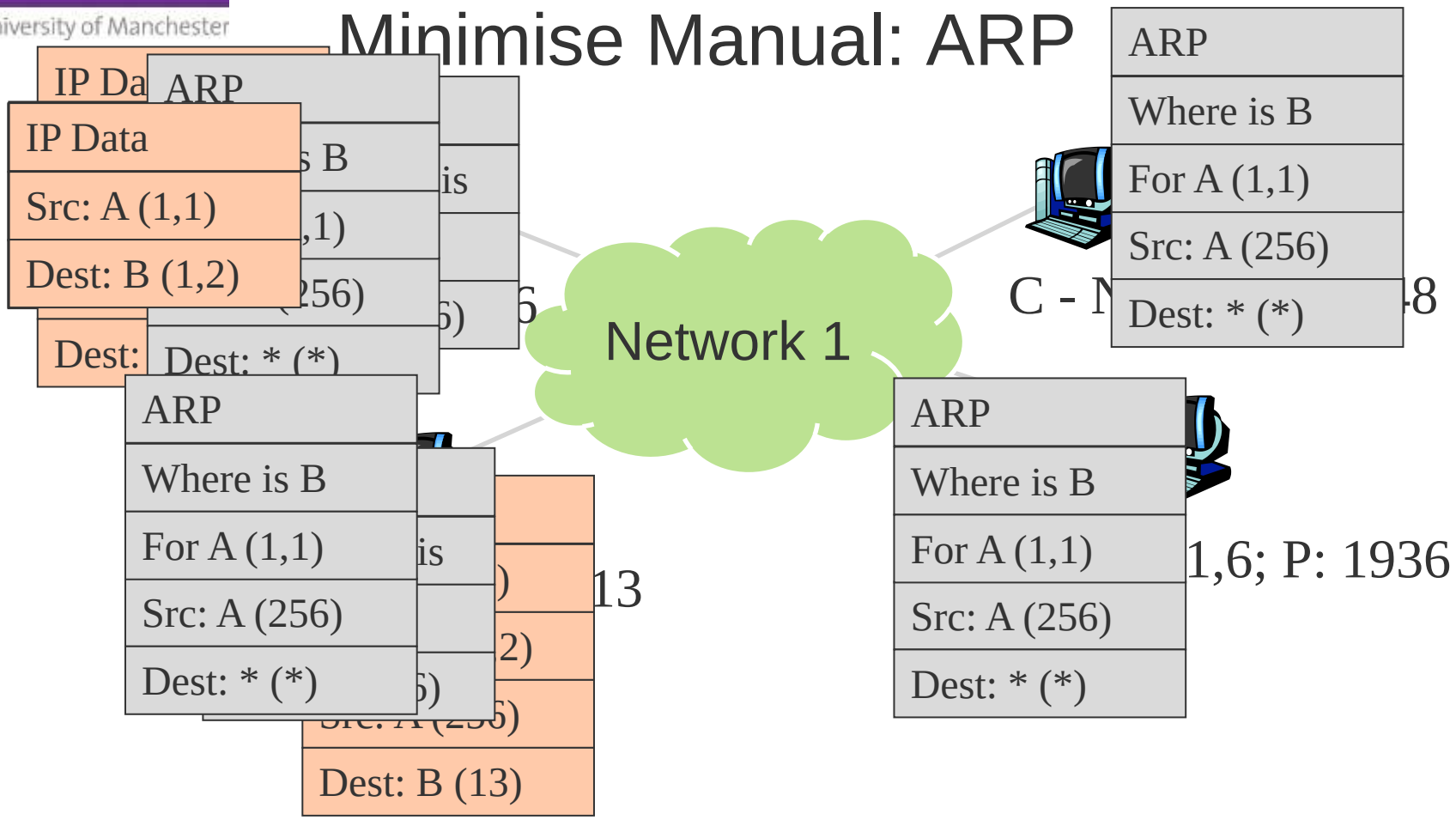


Minimise Manual: ARP



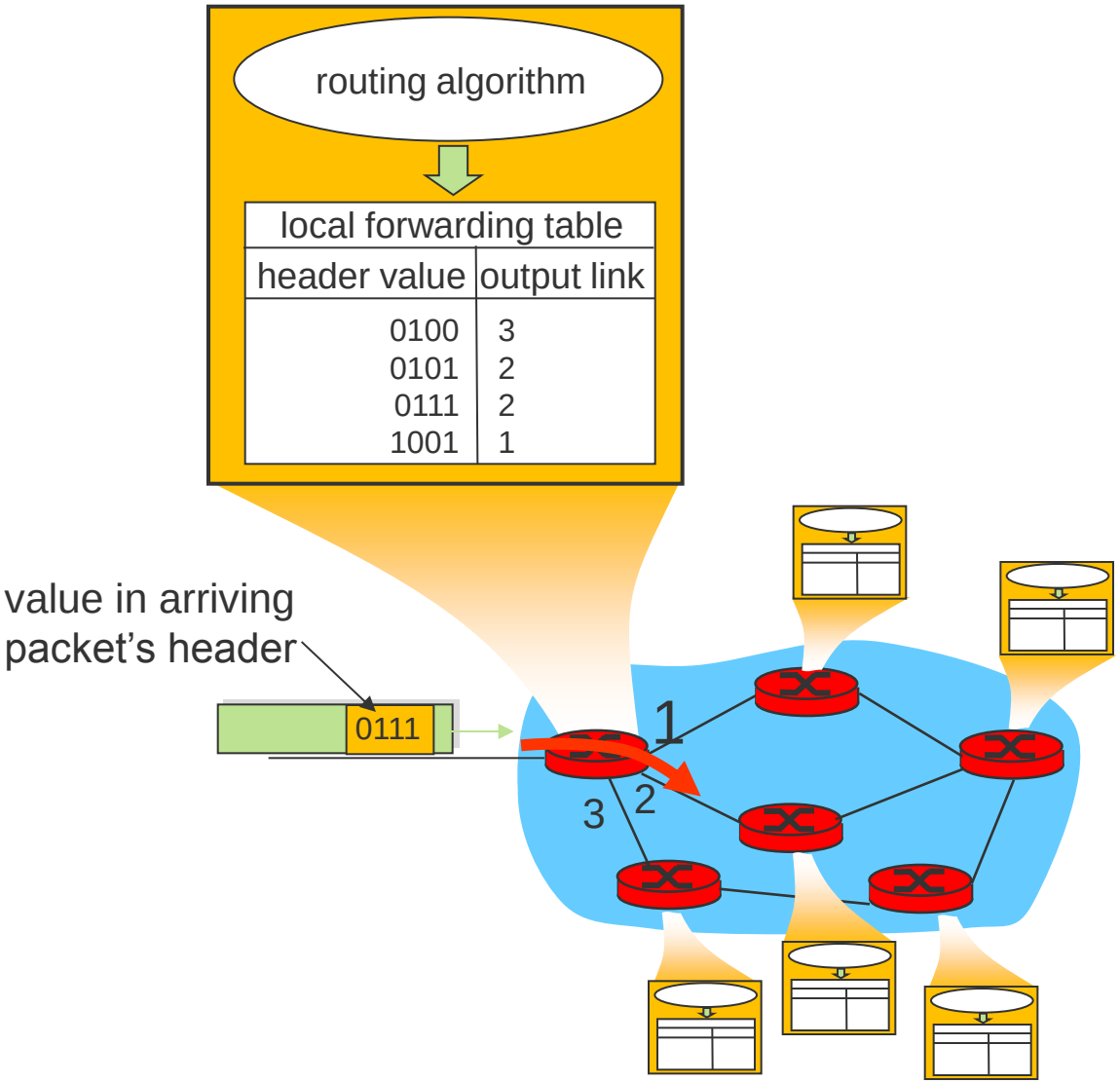
- Address Resolution Protocol

Minimise Manual: ARP



- Address Resolution Protocol

Minimise Manual: Router



P&D: 4.3.5

Internet Protocol Version 6 (IPv6)

- Main motivation was to deal with growth of Internet
- Adding more scalable addresses means changing:
  - datagram format and software on all computers
- Opportunity for other fundamental changes; wish list:
  - support for resource allocation, auto-configuration
  - security support, improved option mechanism
  - support for real-time services
  - enhanced routing functionality (mobile host support)
- Many wish list features now added to IPv4
- Transition plan (IPv4 $\rightarrow$ IPv6) also part of design goal

IPv6: Addressing

- 2^{128} or 3.4×10^{38} addresses; every atom on planet!
  - for realistic utilisation: 1500 per square foot of surface
- Address space is partitioned; again decoded by ms bits
- Partitioning is for usage not address structure; e.g.:
  - aggregatable unicast addresses; c.f. CIDR
  - encapsulating other address spaces
    - IPv4, NSAP (ISO), IPX (Novell)
  - locally (link or site) significant/unique addresses
  - multicast addresses
  - lots reserved to solve future problems

IPv6: Multicast/Anycast Addressing

- Multicast partition:
  - sub-fields for flags, scope and group identifier
  - current scopes: link, site, organisation, planet
  - values spread over possible to allow extension
  - 14 is planet, 15 is unassigned (solar system/universe?)
- Anycasting partition:
  - group only only need to deliver to one (nearest?)
  - e.g. accessing service from group of servers
  - routing system chooses actual destination

Summary

- Provide host-to-host delivery across multiple networks
- Provides simple service model
  - places minimum demands on underlying networks
- Defines own addressing scheme and packet format
- Addresses must be mapped to underlying addresses
- Datagrams must be fitted into physical frames
- Must address scalability issues:
  - size and updating of routing tables
    - hierarchy to address, subnetting, supernetting
- Eventually unable to cope, IPv6 being introduced