COMP28411: Computer Networks
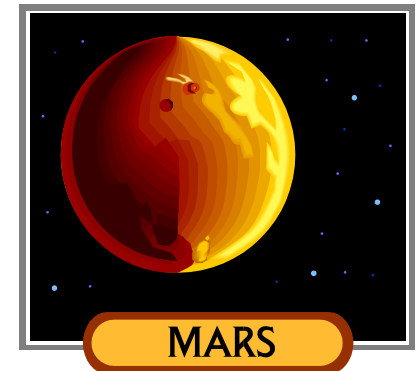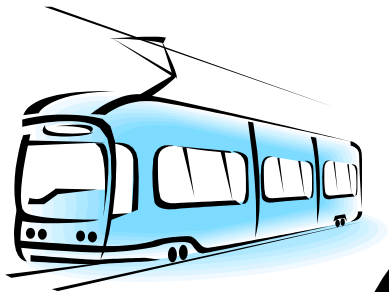
Andy Carpenter KB 2.119

Nick Filer IT 405

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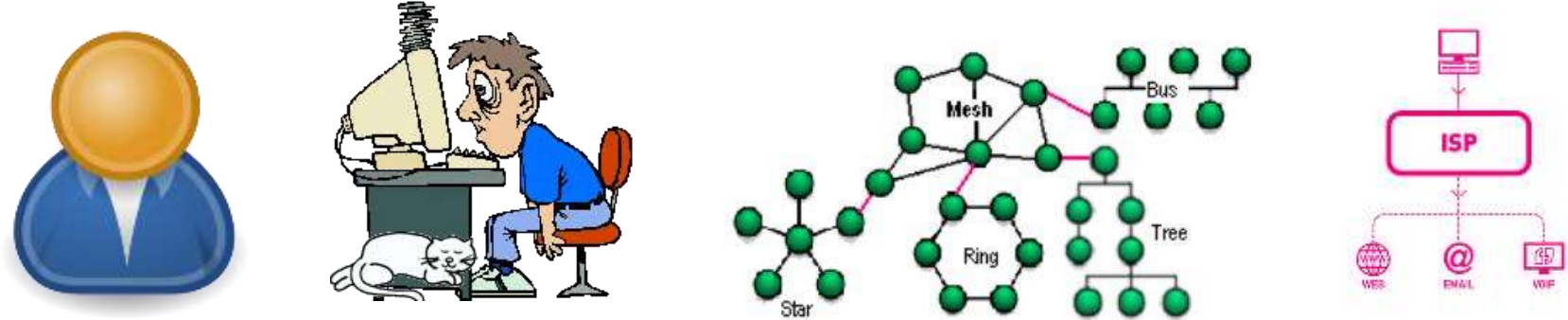
Computer Networks
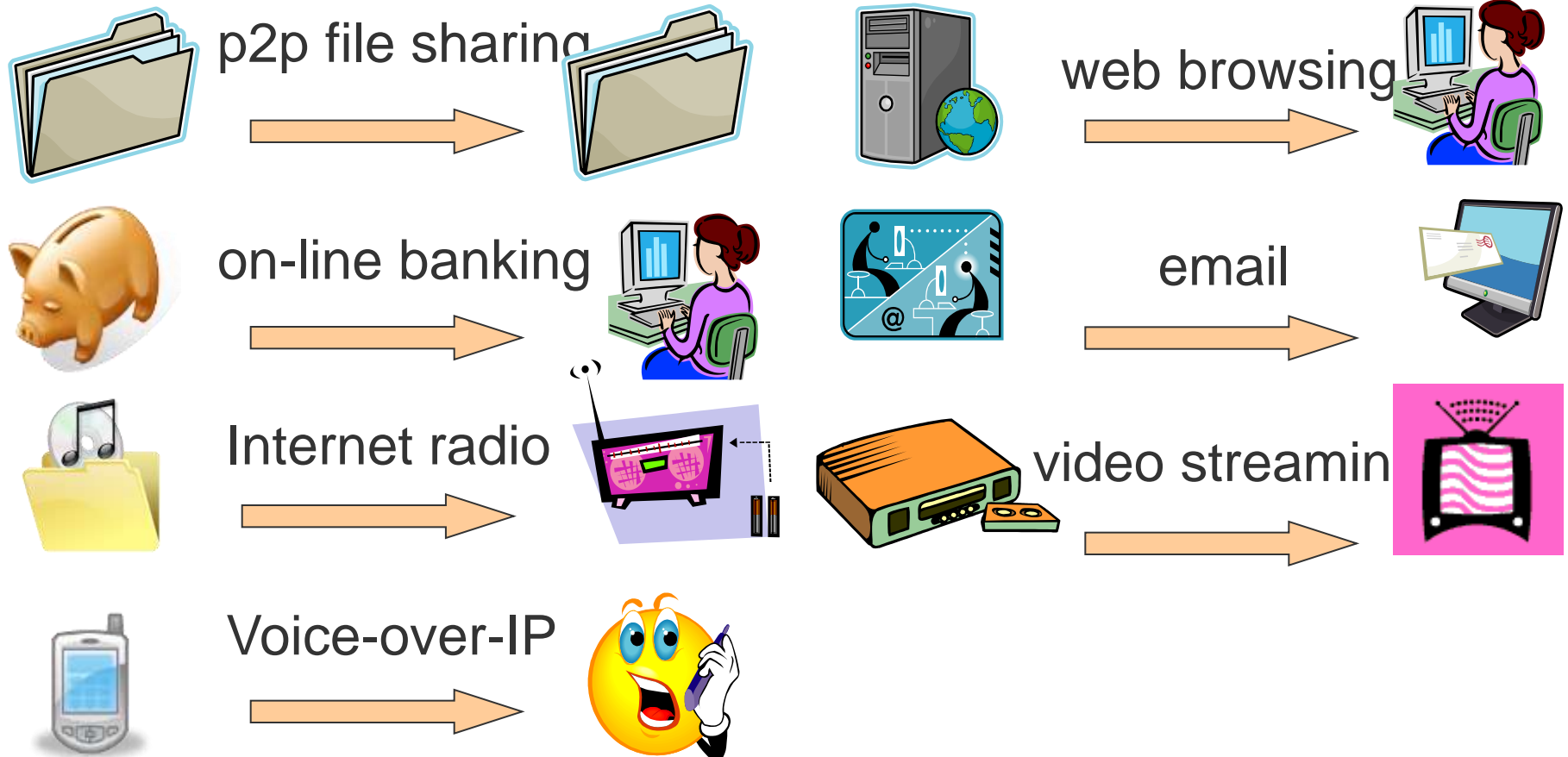
Ubiquitous

Use all of the time

What Is a Network?

Depends on perspective

Depends on use

User's View

p2p file sharing

web browsing

on-line banking

email

Internet radio

video streaming

Voice-over-IP

Applications View

distributed processes

Internet as Platform

API   Service

socket

API   Service

socket

communications channel

QoS parameters:
Reliable
Secure
Low delay
High throughput
…

network
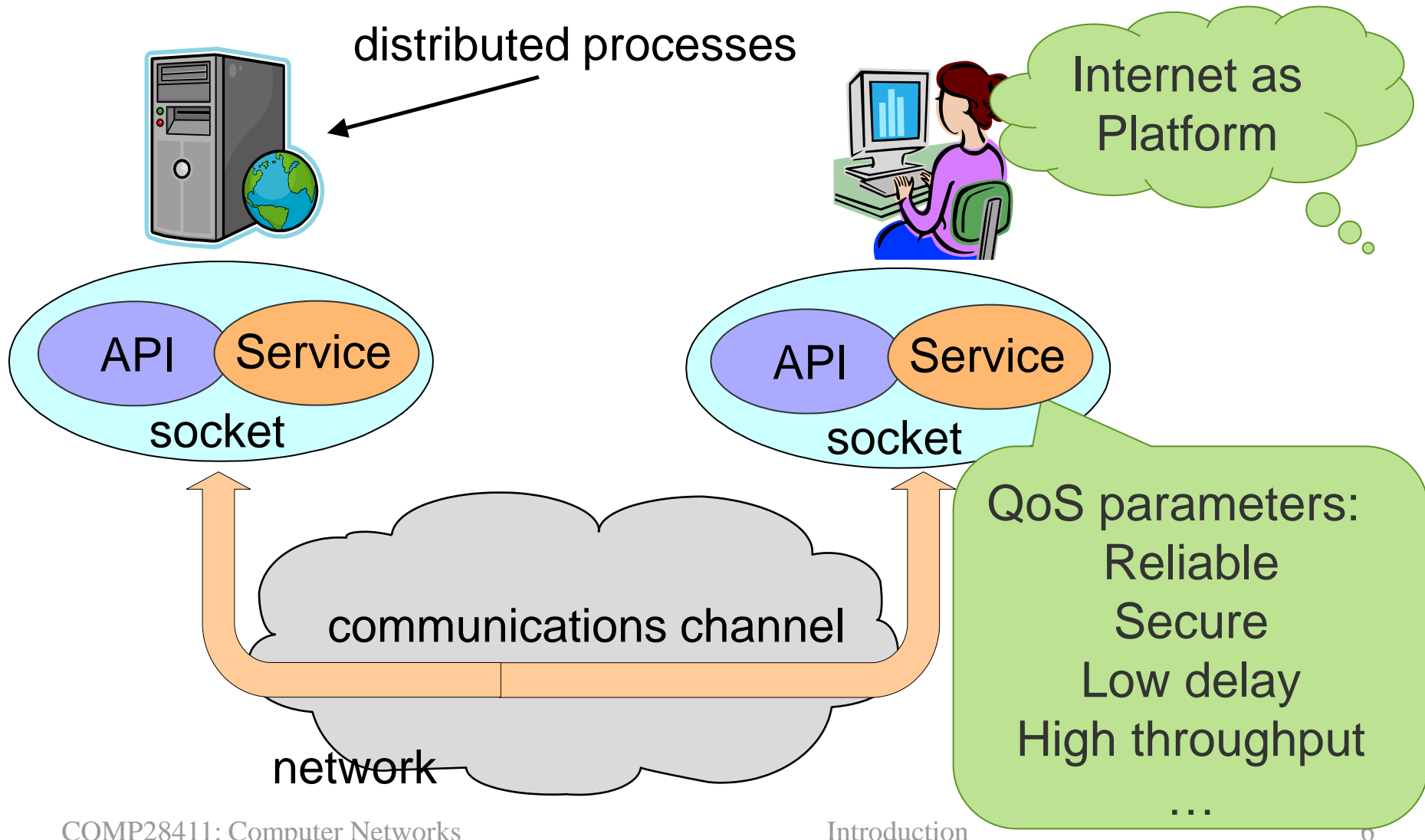
Protocols, Layers and Service Models K&R: 1.5

Layer N+1

End 1

interaction

Defines form and meaning of messages

Service — Service interaction — Service

Layer N

End 1

interaction

Peer interface

End 2

Service

Possible service features depend on layer

interaction
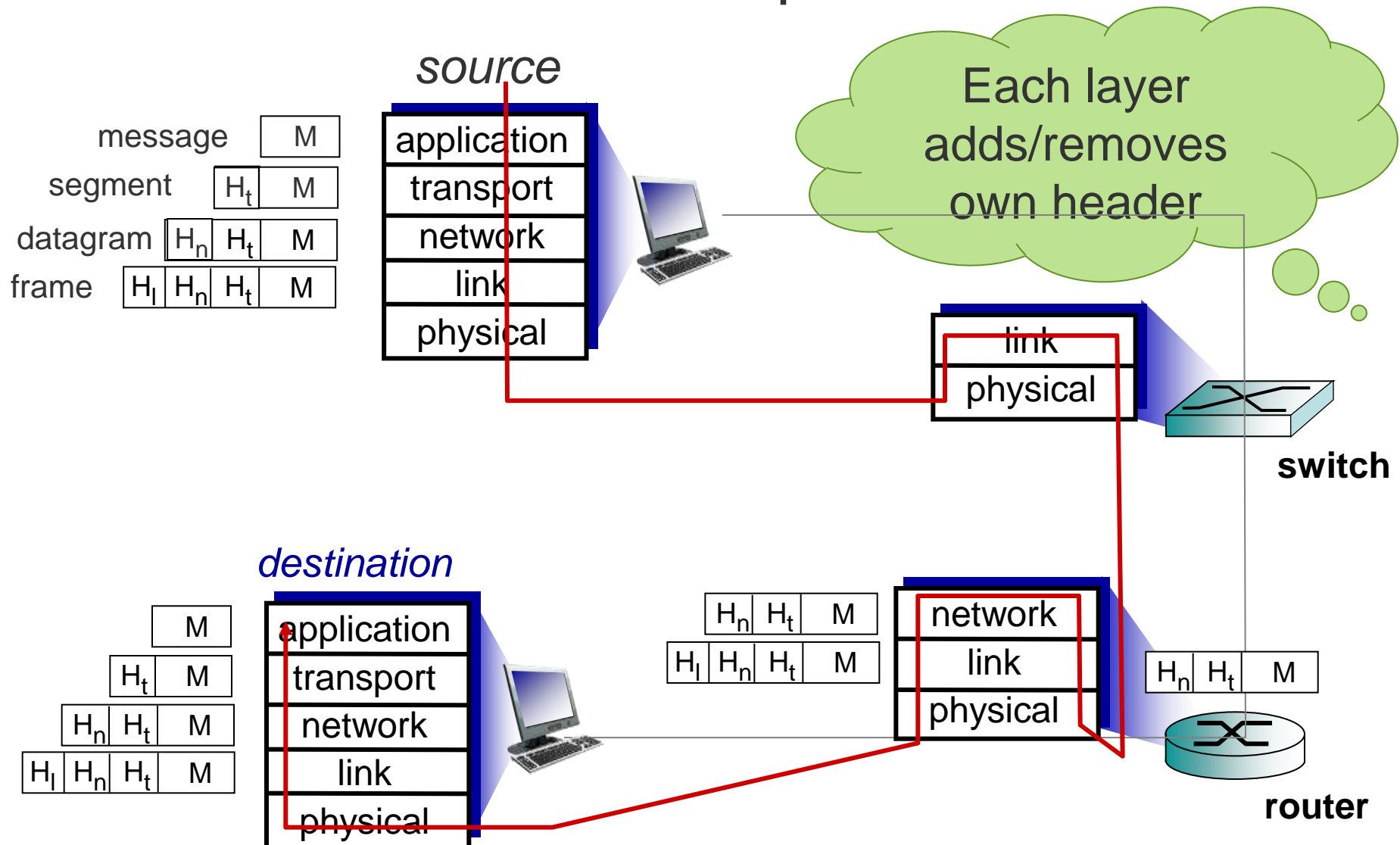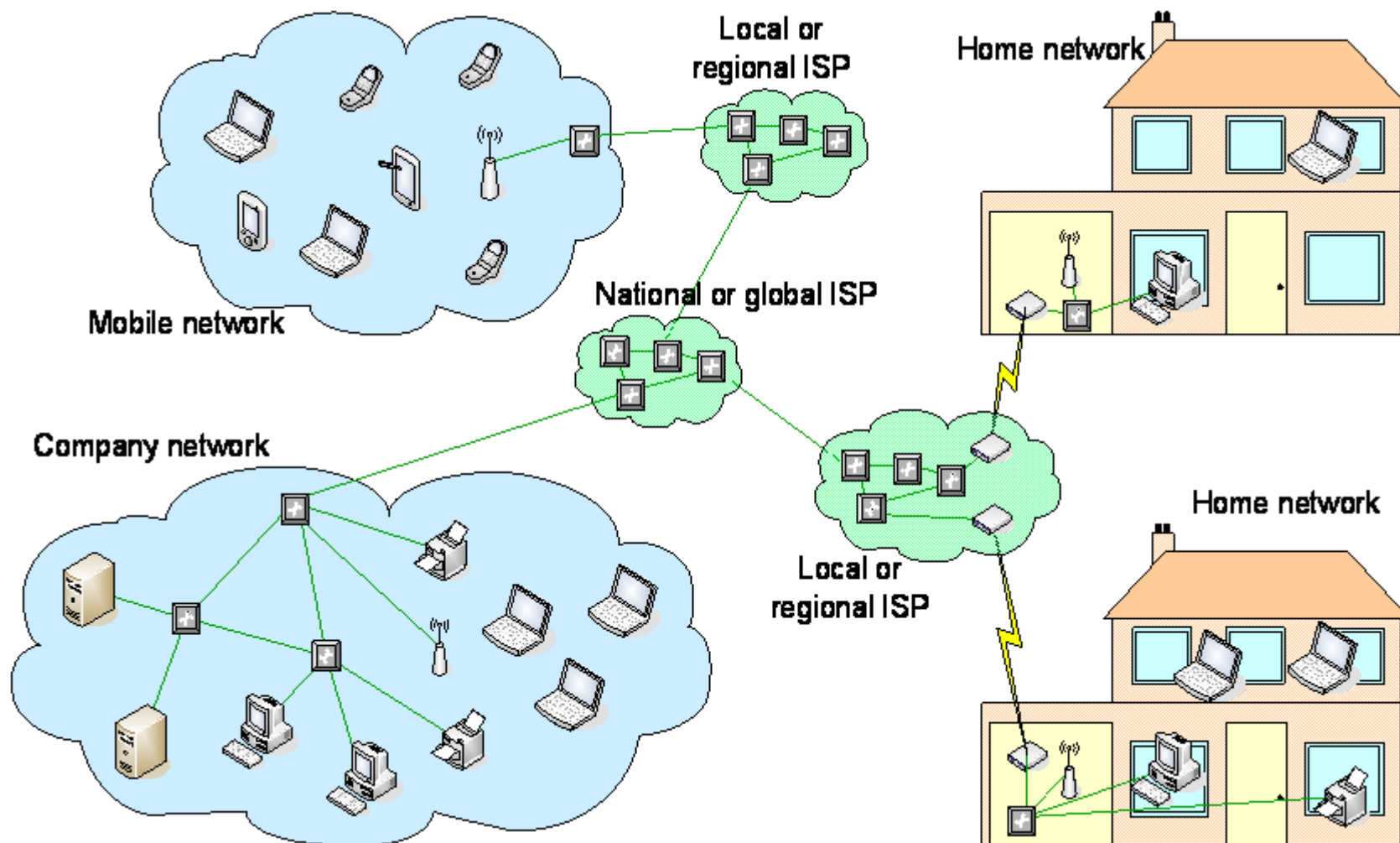
End 2
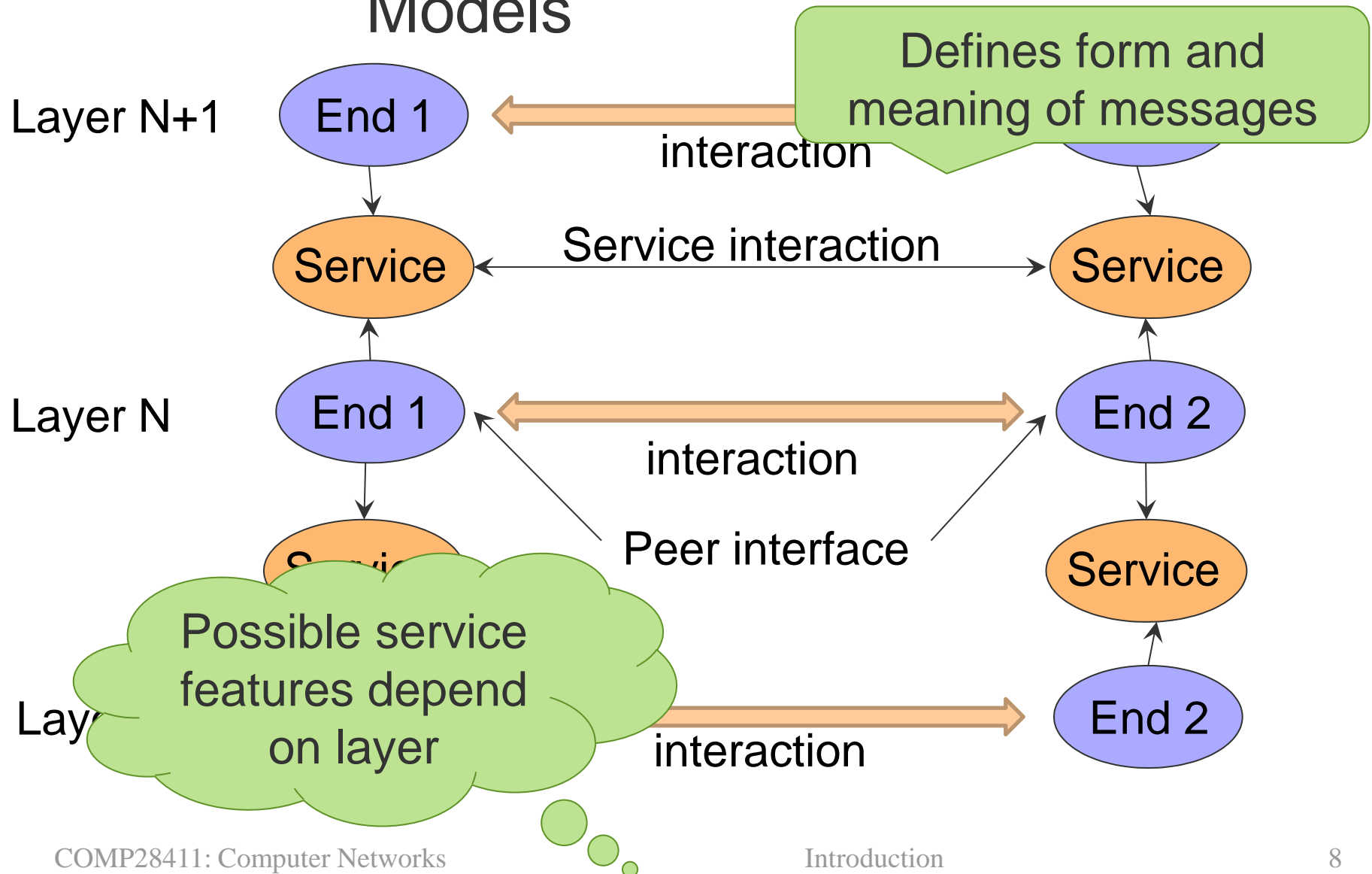
Reference Model: OSI 7 Layer

- **Application**: ultimate source and destination of data
- **Presentation**: meaning of data, e.g.:
  - encryption, compression, size of integers
  - machine specific conversions (e.g. endian)
- **Session**: links aspects of an application together e.g.
  - synchronising video and audio streams
  - check pointing, recovery of data
- **Transport**: sends data process-to-process
- **Network**: routes data (packets) to destination node
- **Data link**: forms structures (frames) from bits
- **Physical**: transmission of bits over link

Protocol Encapsulation

source

Each layer adds/removes own header

message			M
segment		H_t	M
datagram	H_n	H_t	M
frame	H_l H_n	H_t	M

source

| application |
| transport |
| network |
| link |
| physical |

| link |
| physical |

switch

destination

| M |
H_t	M
H_n	H_t	M
H_l	H_n	H_t	M

| application |
| transport |
| network |
| link |
| physical |

| H_n | H_t | M |
| H_l | H_n | H_t | M |

| network |
| link |
| physical |

| H_n | H_t | M |

router

Structural View

Network Area Terminology

- **Personal Area Network**
  - Bluetooth phone, PDA.
- **System Area Network (SAN)**
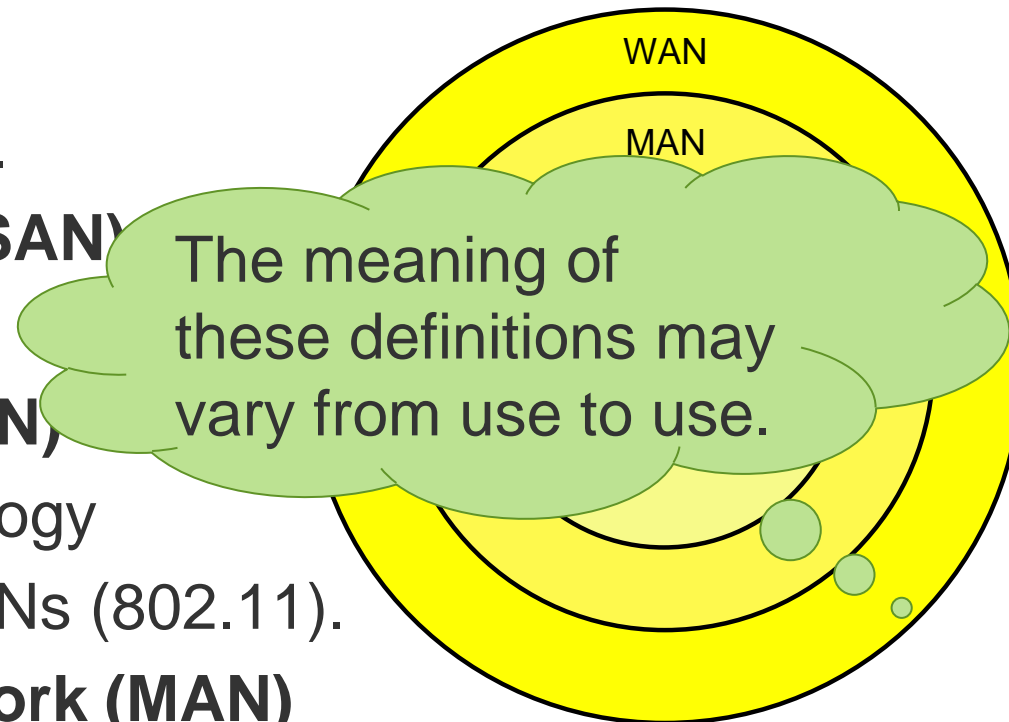 - printer, disk …
- **Local Area Network (LAN)**
  - typically single technology
  - Ethernet (802.3), WLANs (802.11).
- **Metropolitan Area Network (MAN)**
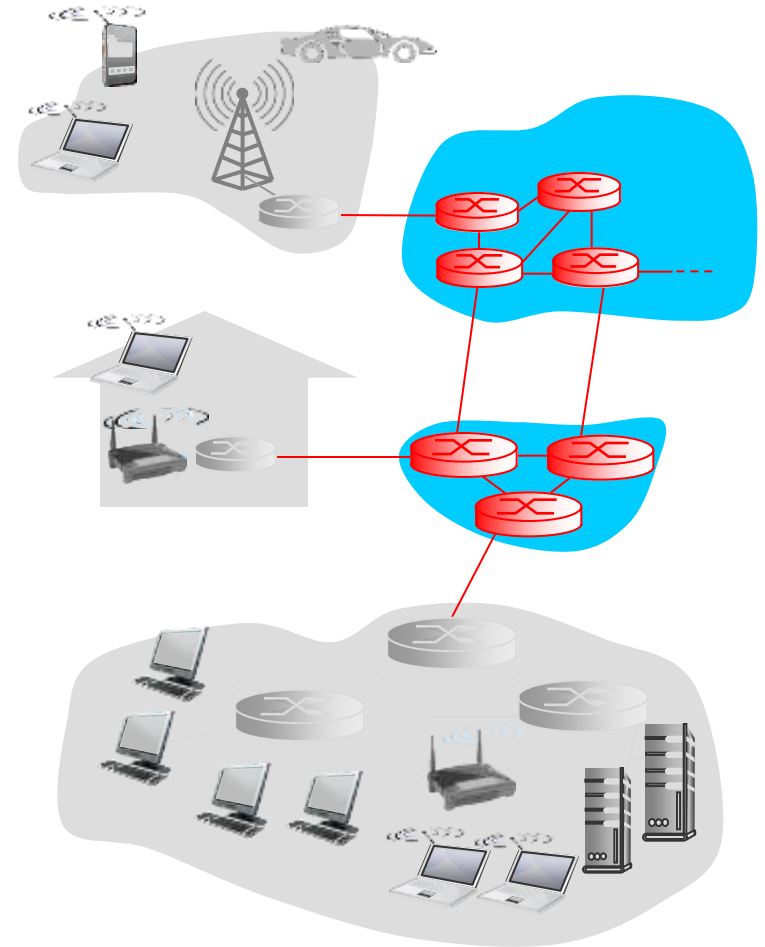 - complete city, or an internetwork of LANs
- **Wide Area network (WAN)**
  - multiple technologies, large geographical areas

The meaning of these definitions may vary from use to use.
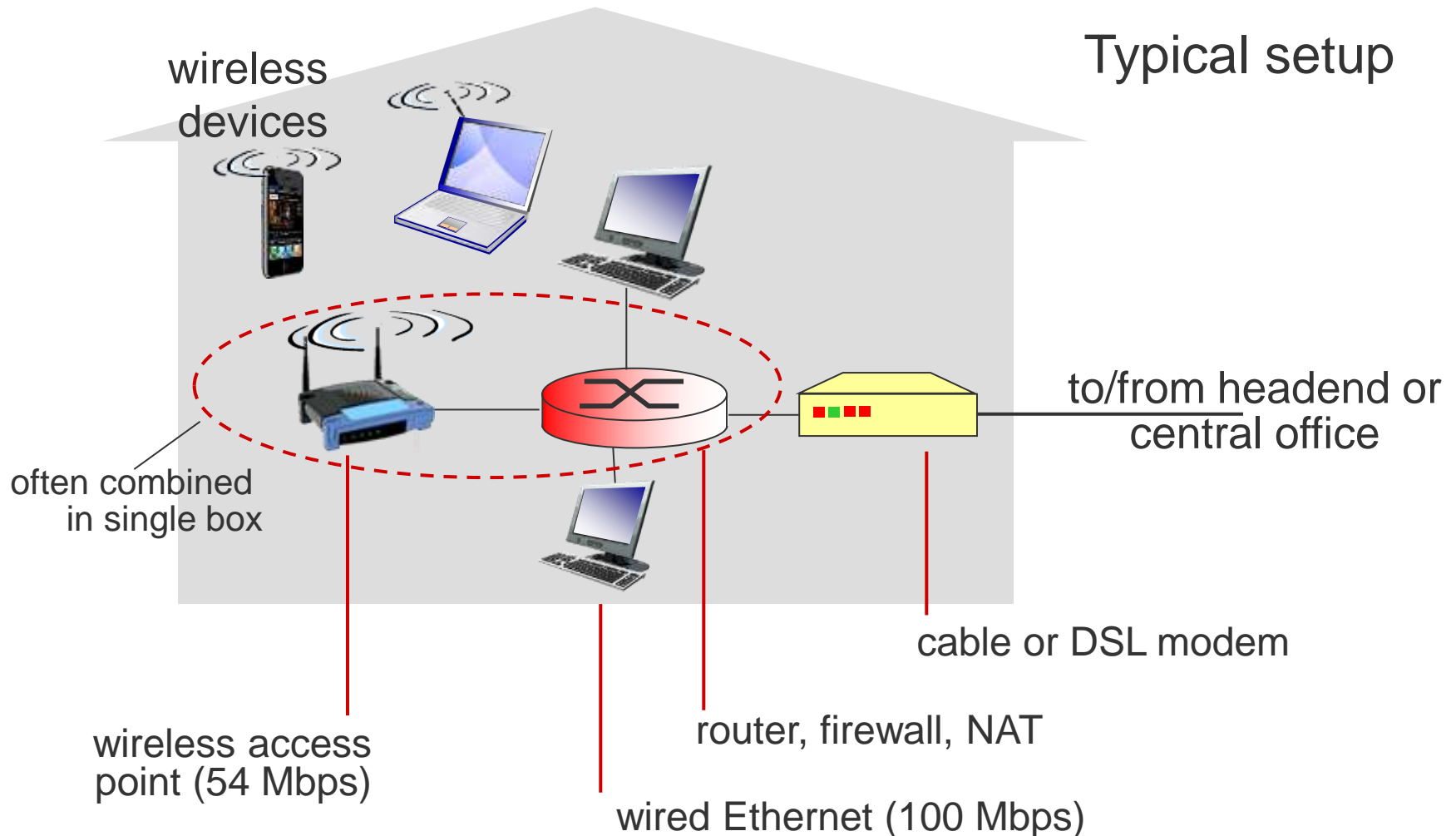
WAN

MAN

Network Connectivity

- Edge
  - applications and hosts
  - home networks
  - wireless networks
  - corporate networks
- Core
  - interconnected routers
  - network of networks
- Physical media
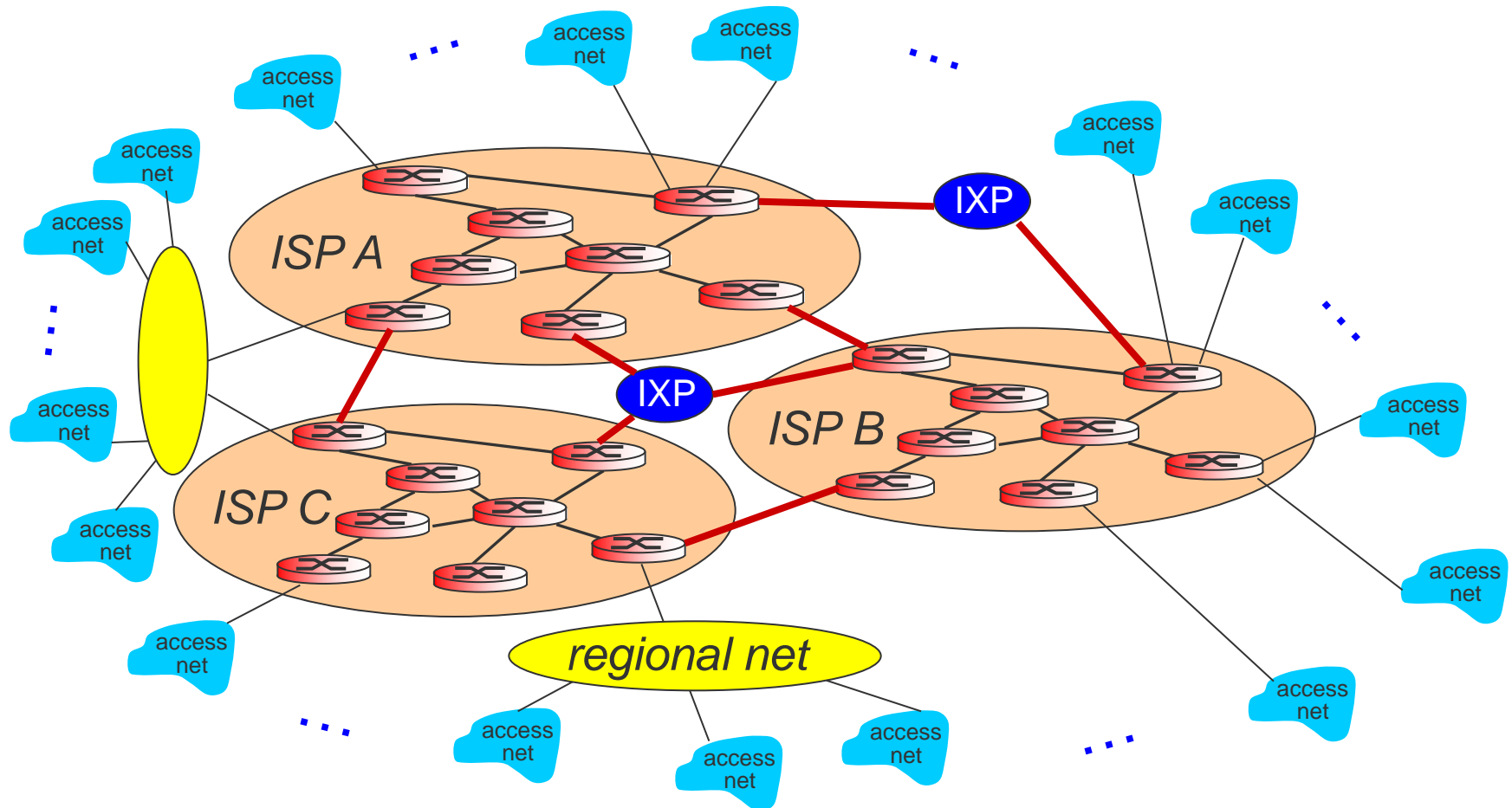 - bandwidth
  - shared or dedicated
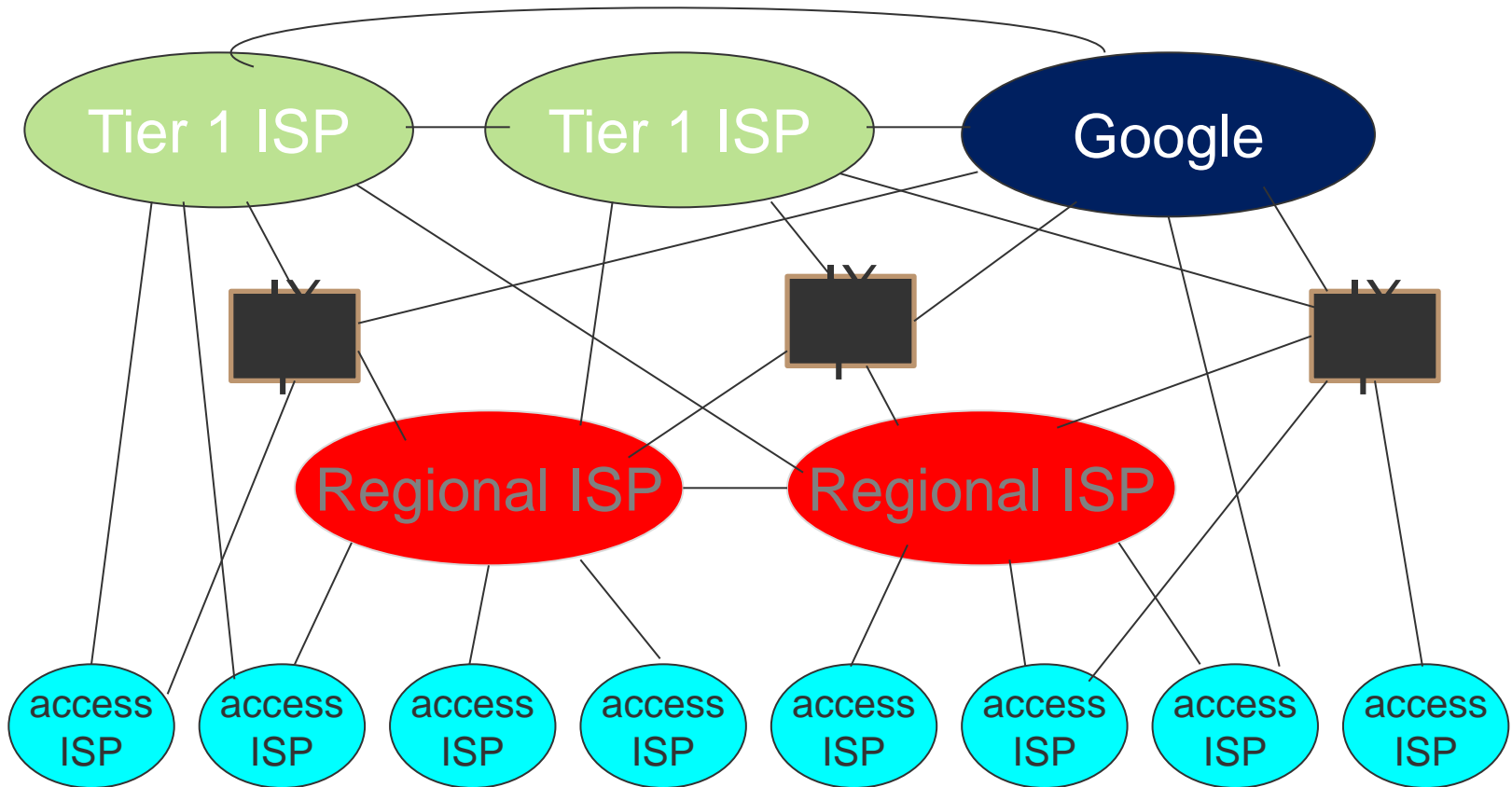
Edge Connectivity: Home

Typical setup

wireless devices

to/from headend or central office

often combined in single box

cable or DSL modem

router, firewall, NAT

wireless access point (54 Mbps)

wired Ethernet (100 Mbps)

Core Connectivity

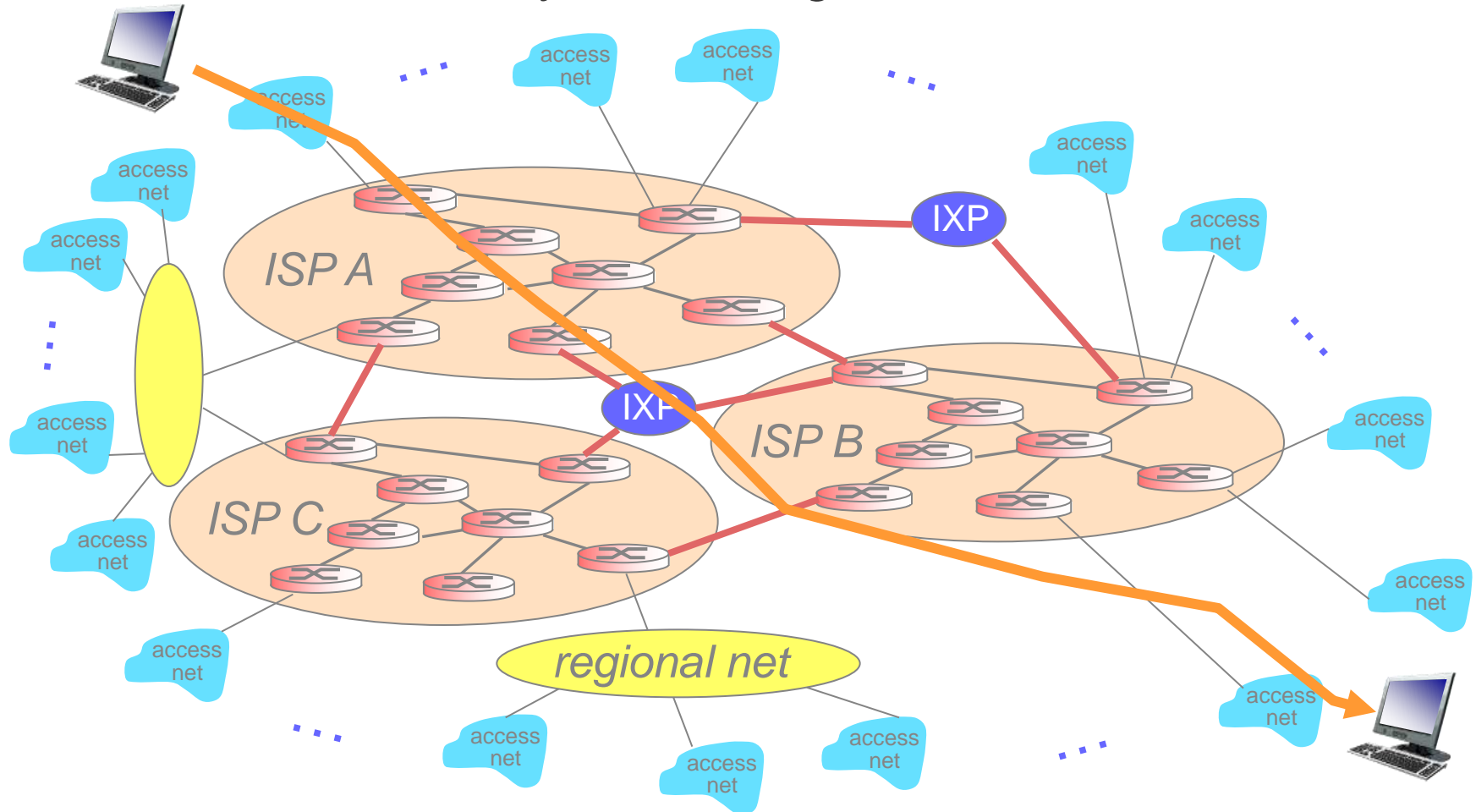- Network of networks, theoretically hierarchical

Core Connectivity

- Network of networks, theoretically hierarchical
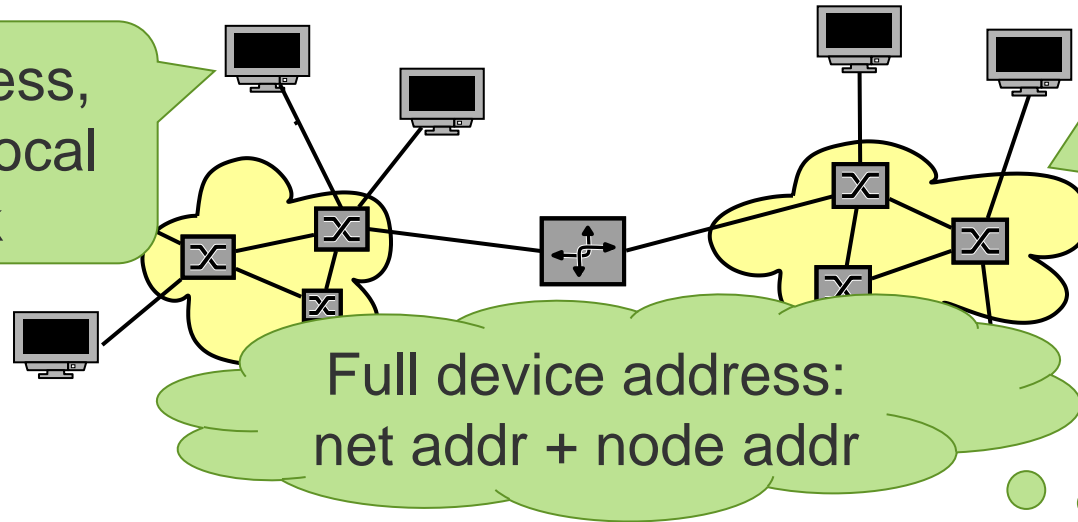
Core Connectivity: Forwarding

- Reach destination by forwarding to closer location

Connectivity: Addressing

- Intended destination indicated by unique address
 – IPv4 uses 32-bit numeric address for device

Node address, unique on local network

Network address shared by all devices on network

Full device address: net addr + node addr

- Need to identify destinations (process) within nodes
  – TCP/UDP use numeric **port** numbers (16-bit)
- Internet addresses are independent from:
  – physical network technology, operating system

Connectivity: Transmissions

- Types of destinations:
  - single (**unicast**), all nodes (**broadcast**)
  - multiple nodes, but subset of all nodes (**multicast**)
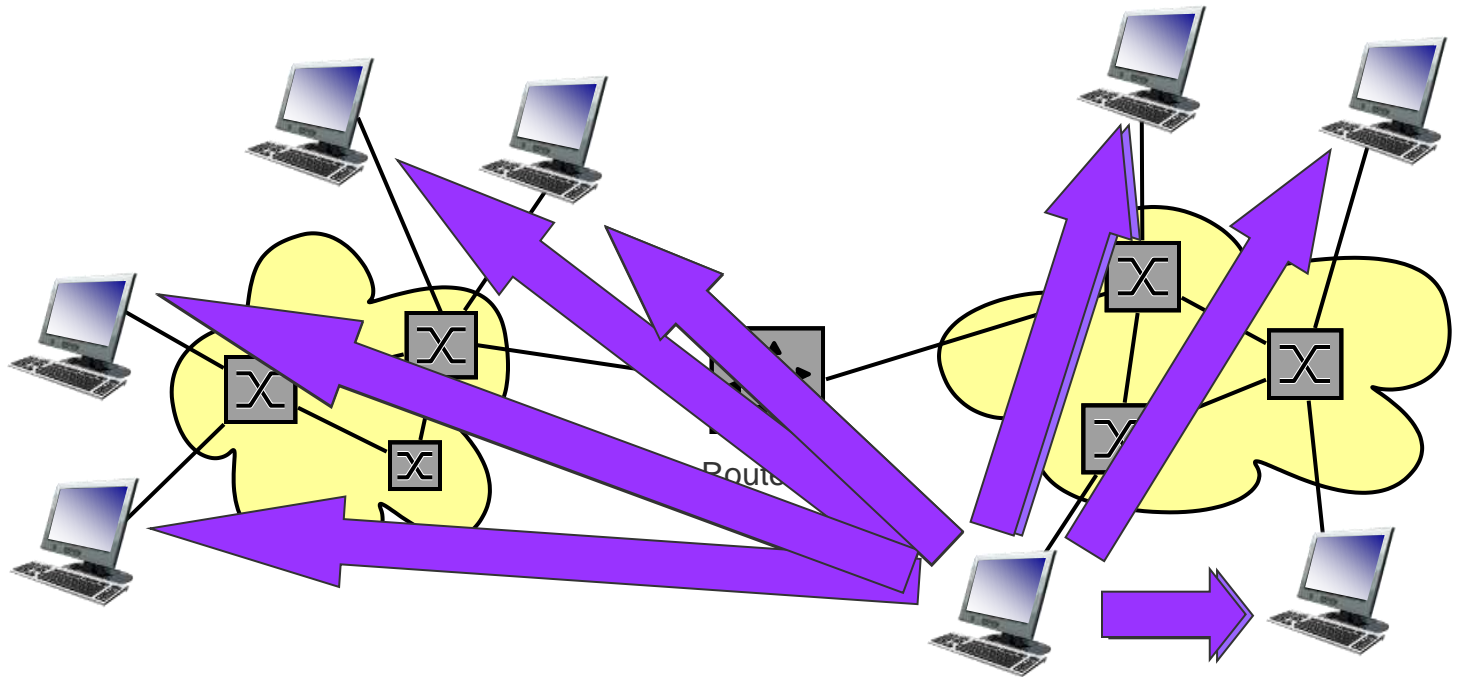
Network Reliability

- Possible failures within a network include:
  - machines crash, fibres cut, electrical interference
  - switches run out of buffer space, routing problems
- Checking codes inserted into data can detect errors
- Acknowledgements confirm delivery
- Negative acknowledgements request retransmission
- Timeouts detect missing expected data
- By using these can:
  - mask (hide) some kinds of network failure
  - make network appear more reliable than is

Good Network Design

- Service model
- Global coordination; universal understanding
- Minimise manual setup
- Minimise volume of information at any point
- Distribute information capture and management
- Extensibility
- Integration/interoperation of heterogeneous systems
- Error detection
- Error recovery (reliability)
- Scalability

Summary

- Review of basic networking
- View: applications vs physical structure
- Fundaments of way connectivity is achieved
- Protocols
  - purpose, service models
  - interactions, messages
- Layering and reference models
- Application place QoS needs on infrastructure