DT228/2 Web Development
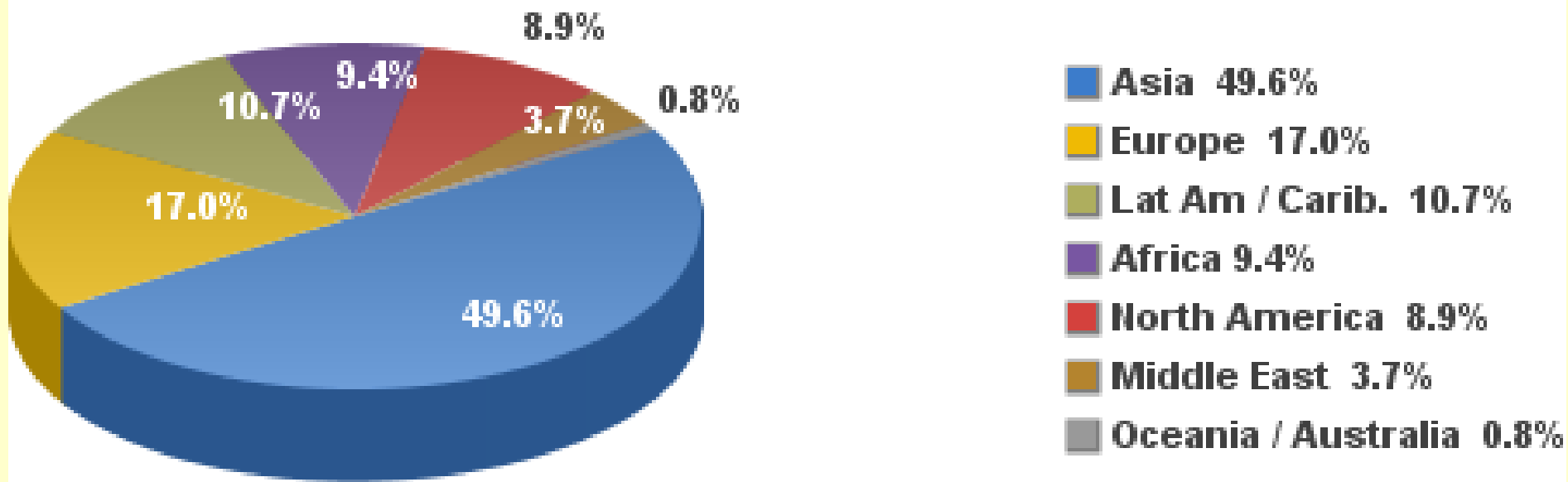
Internet:
Architecture and The Internet Protocol Suite

Some Facts

Internet Users in the World by Regions June 2016

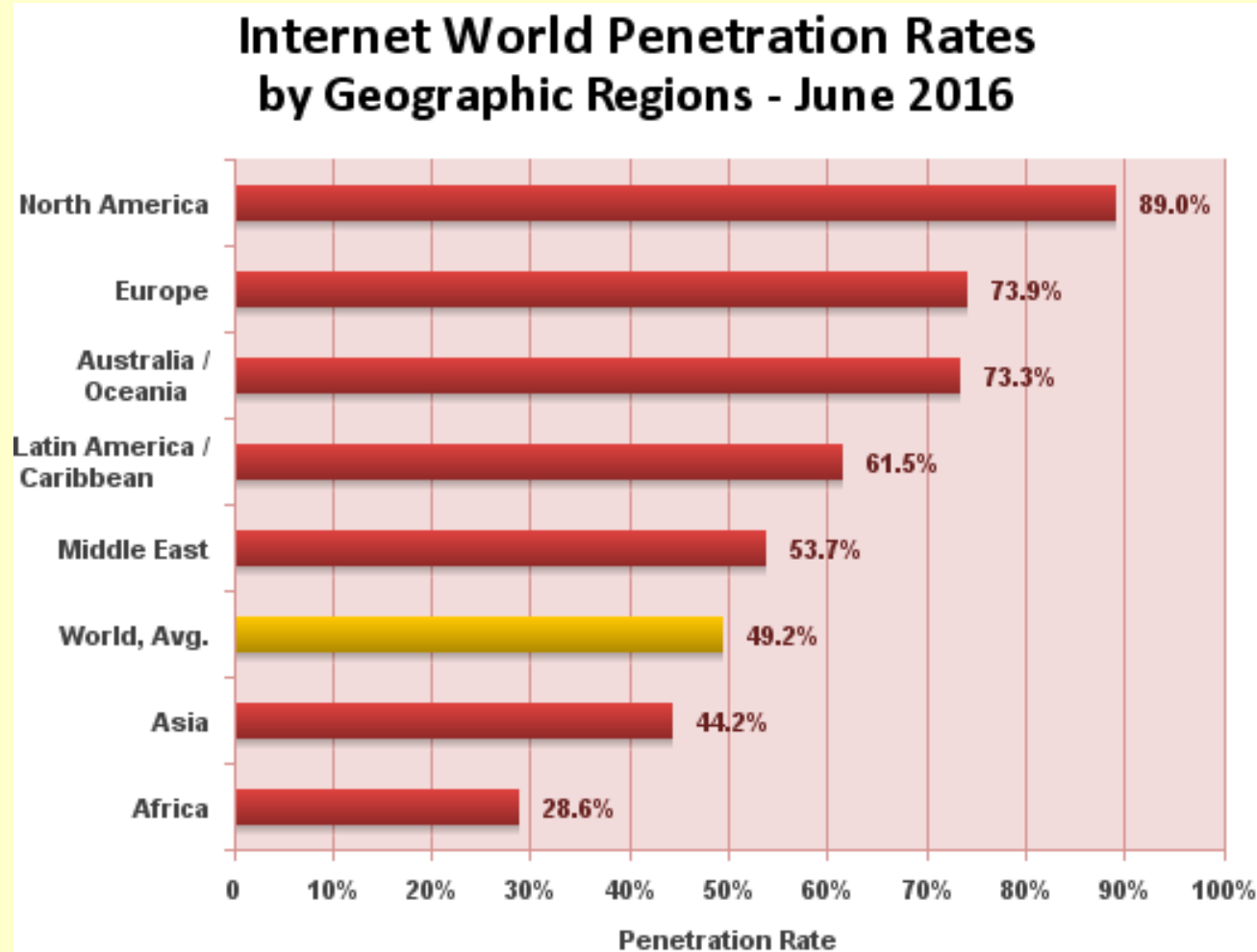| Region	Percentage
Asia	49.6%
Europe	17.0%
Lat Am / Carib.	10.7%
Africa	9.4%
North America	8.9%
Middle East	3.7%
Oceania / Australia	0.8%

Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 3,611,375,813 Internet users on June 30, 2016
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Some Facts

Internet World Penetration Rates by Geographic Regions - June 2016

Region	Penetration Rate
North America	89.0%
Europe	73.9%
Australia / Oceania	73.3%
Latin America / Caribbean	61.5%
Middle East	53.7%
World, Avg.	49.2%
Asia	44.2%
Africa	28.6%

Source: Internet World Stats - www.internetworldstats.com/stats.htm
Penetration Rates are based on a world population of 7,340,093,980
and 3,611,375,813 estimated Internet users on June 30, 2016.
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Web Concepts

Internet

‣ Physical structure is very detailed- Transmission media includes fibre-optic, satellites, phone-lines etc. ‣ Internet grown to connect many devices: computers, cells, TVs etc.

Web Concepts

Networks
‣ Group of nodes throughout the world that are linked together by some media
‣ Most common structure is client/server- Server gives/offers something: service

- Client requests services‣ Types of networks: LANs and WANs- Restricted to geographical area, but too subjective: what defines that area?- Historically LAN is: Faster, Reliable- Historically WAN: Slow, Prone to errors- Today LANs & WANs have same characteristics: High speed, Low error rate- Internet is world's largest WAN

The Internet

‣ A global interconnection of networks and independent computers using a universal language/protocol (TCP/IP) to communicate
- TCP/IP is the underlying difference between the Internet and other global networks(i.e. the telephone network)
- If you want to connect to the net, you must speak/use TCP/IP

‣ Offers services: WWW, SMTP, FTP, Telnet*, Gopher*, NNTP* (*not greatly used today)

The World Wide Web (WWW)

‣ A collaboration of computers that allow for the transmission of documents across the Internet

‣ Uses browser and server software to provide collection of documents in hypertext structure across the internet

Internet

How the Internet Works

Client: Send me a document
Server: Which one?
Client: Server\Docs\document.pdf
Server: Where do I send it to?
Client: Me
Server: No I can't: 1-you don't have permission and 2-that file doesn't exist

Outline

- The Internet: Structure & Service Views
- What is a Protocol?
- The Internet Protocol (IP)
- Protocol Layers & the OSI Model
- The Internet Protocol Stack
- TCP & UDP
- Application Protocols
- Summary

Internet

- Wikipedia:
  http://en.wikipedia.org/wiki/Internet

- a connection of computer networks using the Internet Protocol (IP)

- layers of communication protocols: IP → TCP/UDP → HTTP/FTP/POP/SMTP/SSH...

- What's the difference between the Internet and the World Wide Web (WWW)?

What's the Internet: "nuts and bolts" view

- *protocols* control sending, receiving of msgs
  - e.g., TCP, IP, HTTP, FTP, PPP
- *Internet:* "network of networks"
  - loosely hierarchical
  - public Internet versus private intranet
- Internet standards
  - RFC: Request for comments
  - IETF: Internet Engineering Task Force

router

workstation

server

mobile

local ISP

regional ISP

company network

3
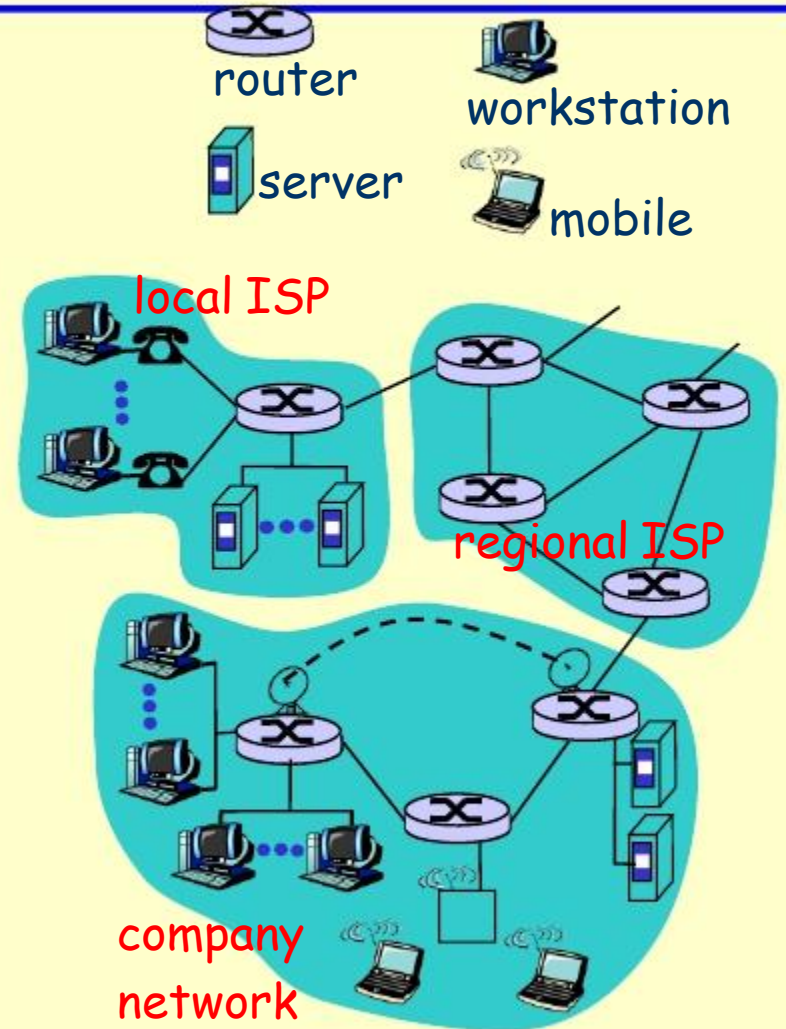
What's the Internet: a service view

- communication *infrastructure* enables distributed applications:
  - Web, email, games, e-commerce, file sharing
- communication services provided to apps:
  - Connectionless unreliable
  - connection-oriented reliable
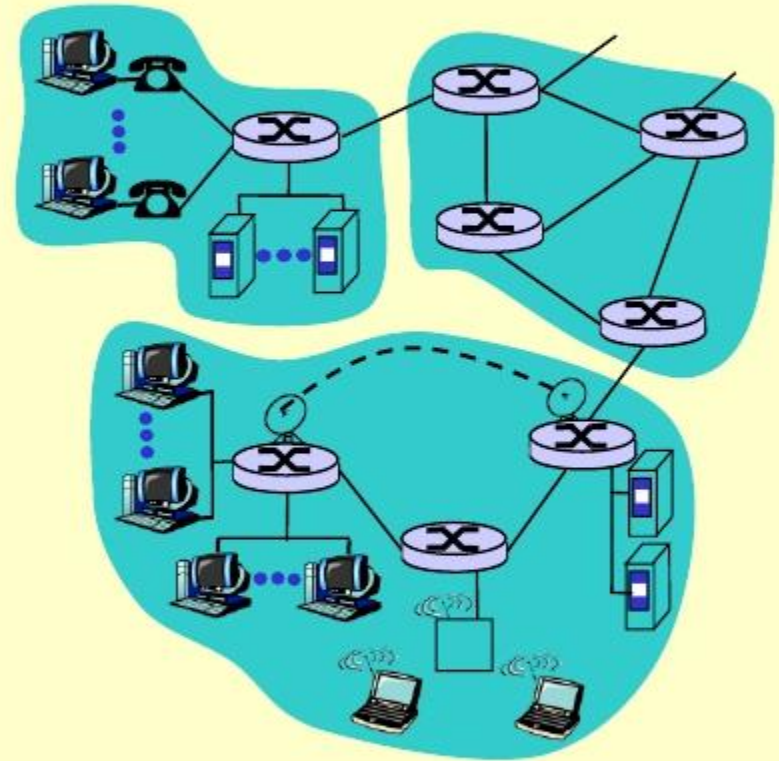
What's a protocol?

human protocols:

- "what's the time?"
- "I have a question"
- introductions

… specific msgs sent

… specific actions taken when msgs received, or other events

network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt
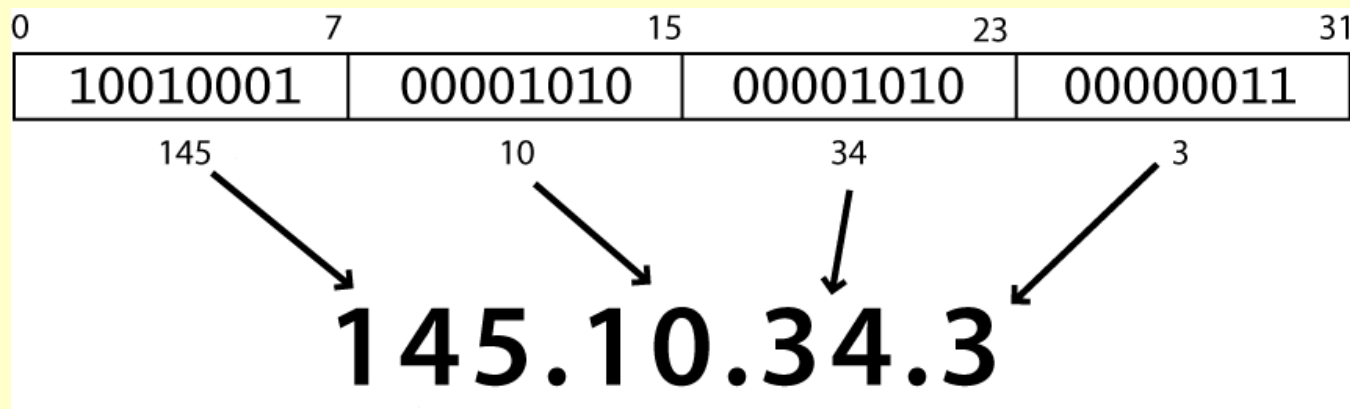
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What's a protocol?

a human protocol and a computer network protocol:
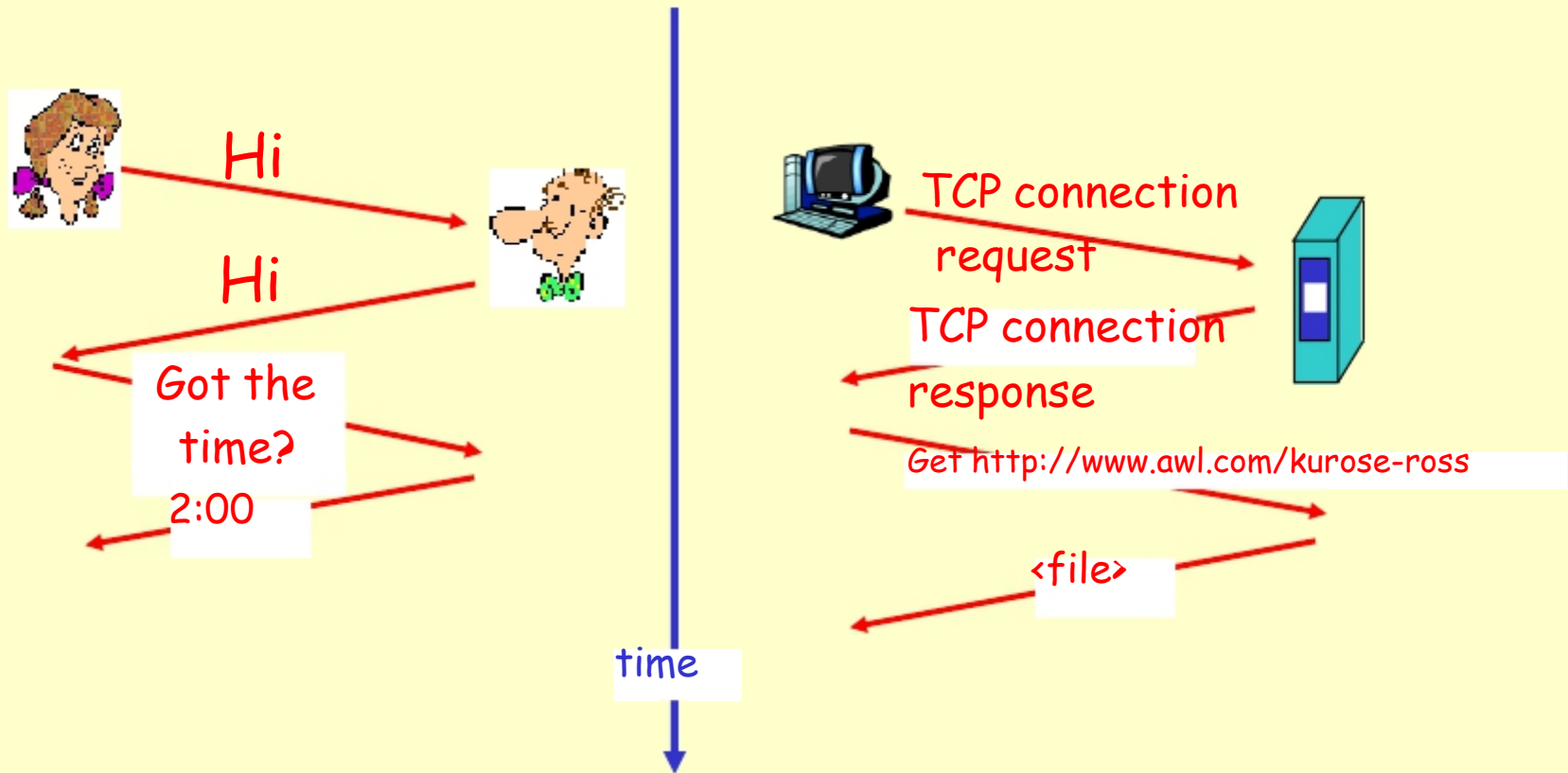
Q: Other human protocols?

Internet Protocol (IP)

- a simple protocol for attempting to send data between two computers
- each device has a 32-bit IP address written as four 8-bit numbers (0-255)

- find out your internet IP address: whatismyip.com
- find out your local IP address:
  - in a terminal, type: ipconfig (Windows) or ifconfig (Mac/Linux)

Transmission Control Protocol

- adds multiplexing, guaranteed message delivery on top of IP
- **multiplexing**: multiple programs using the same IP address
  - **port**: a number given to each program or service
  - port 80: web browser (port 443 for secure browsing)
  - port 25: email
  - port 22: ssh
  - port 5190: AOL Instant Messenger
  - more common ports
- IP + TCP = TCP/IP
- some programs (games, streaming media programs) use simpler UDP protocol instead of TCP

Protocol "Layers"

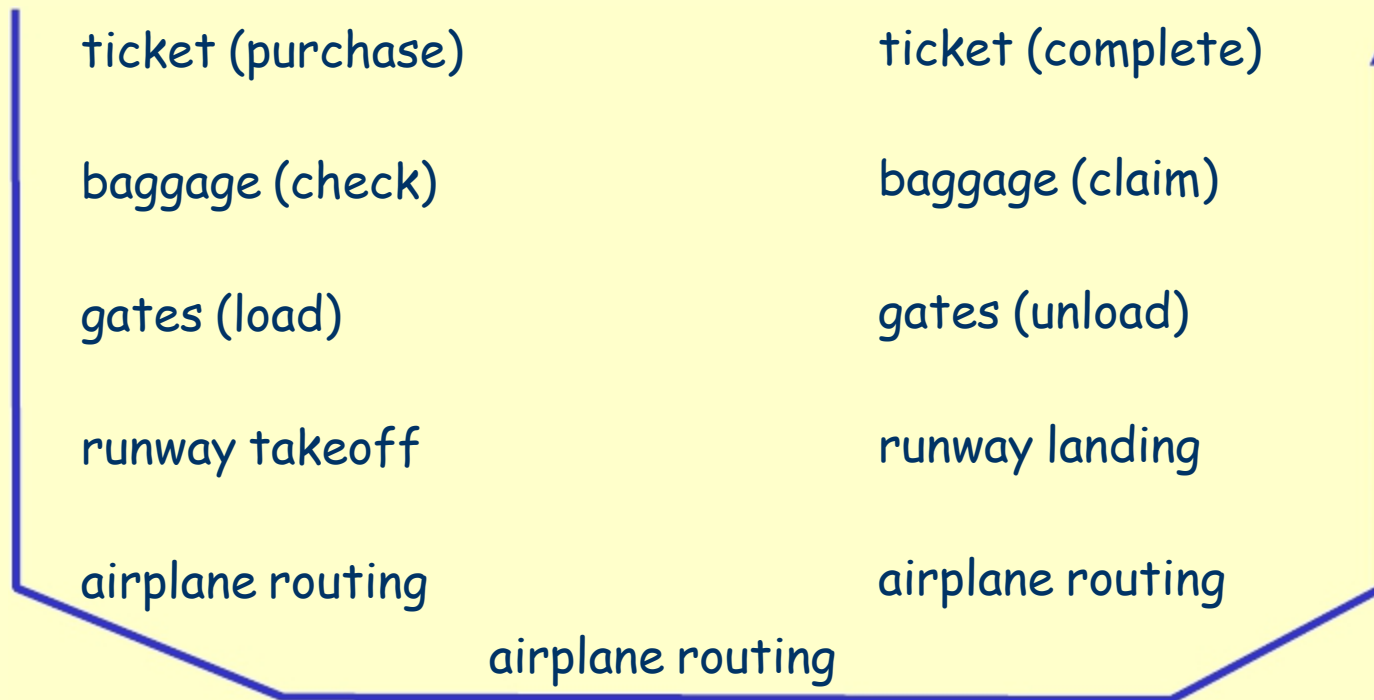Networks are complex!

- many "pieces":
  - hosts
  - routers
  - links of various media
  - applications
  - protocols
  - hardware, software

Question:

Is there any hope of *organizing* structure of network?

Or at least our discussion of networks?

Organization of air travel

ticket (purchase)   ticket (complete)

baggage (check)   baggage (claim)

gates (load)   gates (unload)

runway takeoff   runway landing

airplane routing   airplane routing

airplane routing

• a series of steps

Layering of airline functionality

ticket (purchase)		ticket (complete)	ticket
baggage (check)		baggage (claim)	baggage
gates (load)		gates (unload)	gate
runway (takeoff)		runway (land)	takeoff/landing
airplane routing	airplane routing · airplane routing	airplane routing	airplane routing

departure airport · intermediate air-traffic control centers · arrival airport
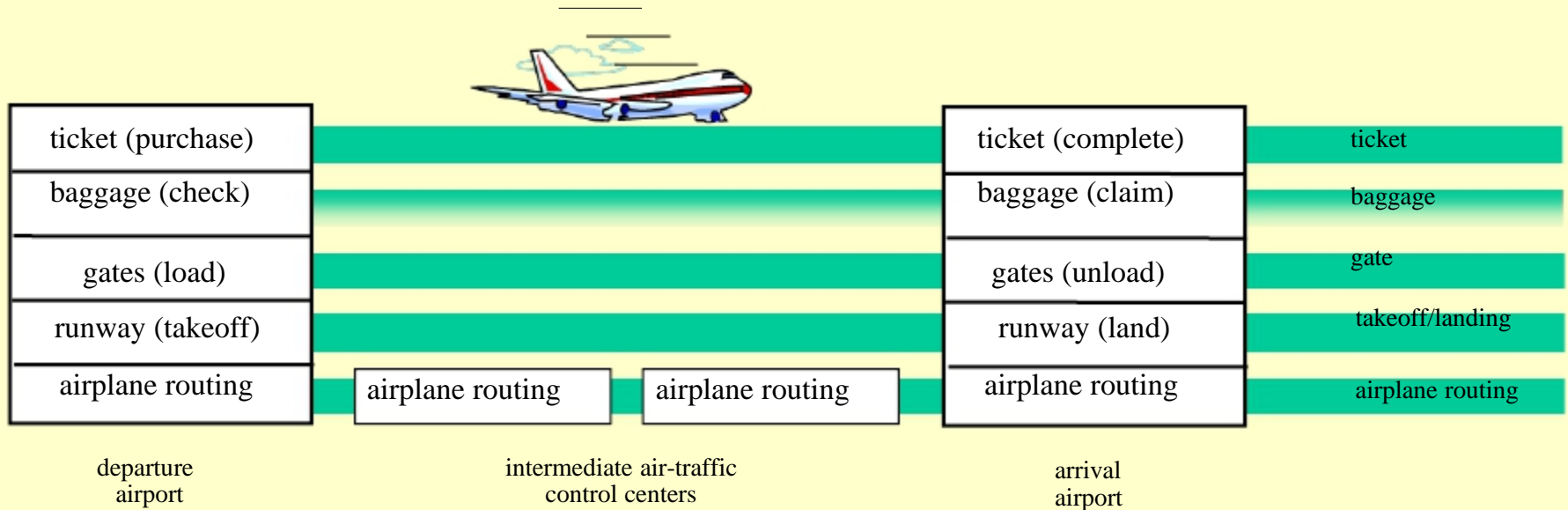
Layers: each layer implements a service
- via its own internal-layer actions
- relying on services provided by layer below

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Why layering?

Dealing with complex systems:

- explicit structure allows identification, relationship of complex system's pieces

  – layered reference model for discussion

- modularization eases maintenance, updating of system

  – change of implementation of layer's service transparent to rest of system
  – e.g., change in gate procedure doesn't affect rest of system

- layering considered harmful?

OSI Model for Networking Protocols
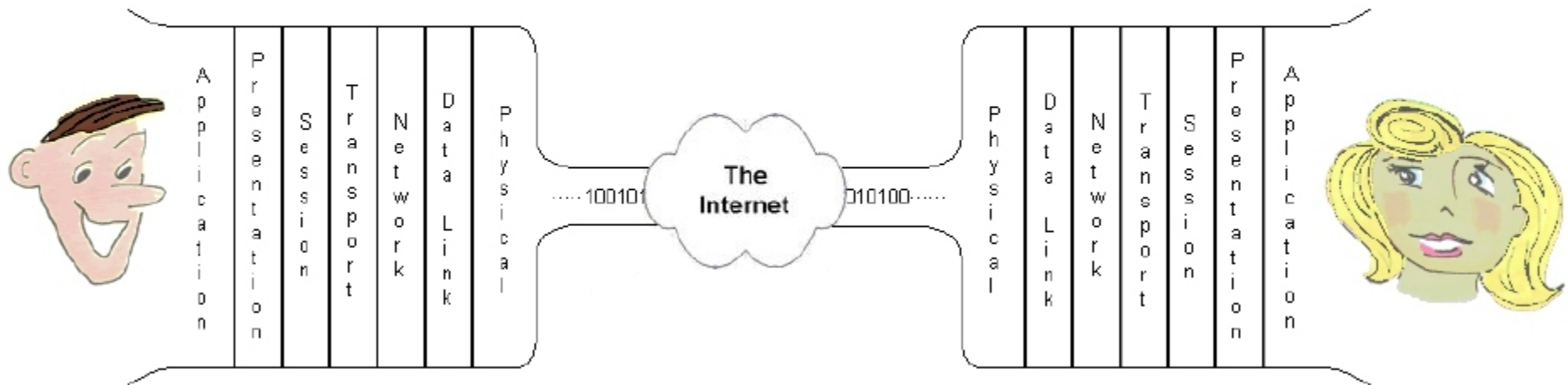
Internet Protocol Stack

- designed to be independent of the underlying physical medium,

- Any communications network, wired or wireless, that can carry two-way digital data can carry Internet traffic.

- Internet packets flow through wired networks like copper wire, coaxial cable, and fibre optic, and through wireless networks like Wi-Fi.

- Networks, sharing the same protocols,

Internet protocol stack

- **application:** supporting network applications
  - FTP, SMTP, HTTP
- **transport:** host-host data transfer
  - TCP, UDP
- **network:** routing of datagrams from source to destination
  - IP, routing protocols
- **link:** data transfer between neighboring   network elements
  - PPP, Ethernet
- **physical:** bits "on the wire"

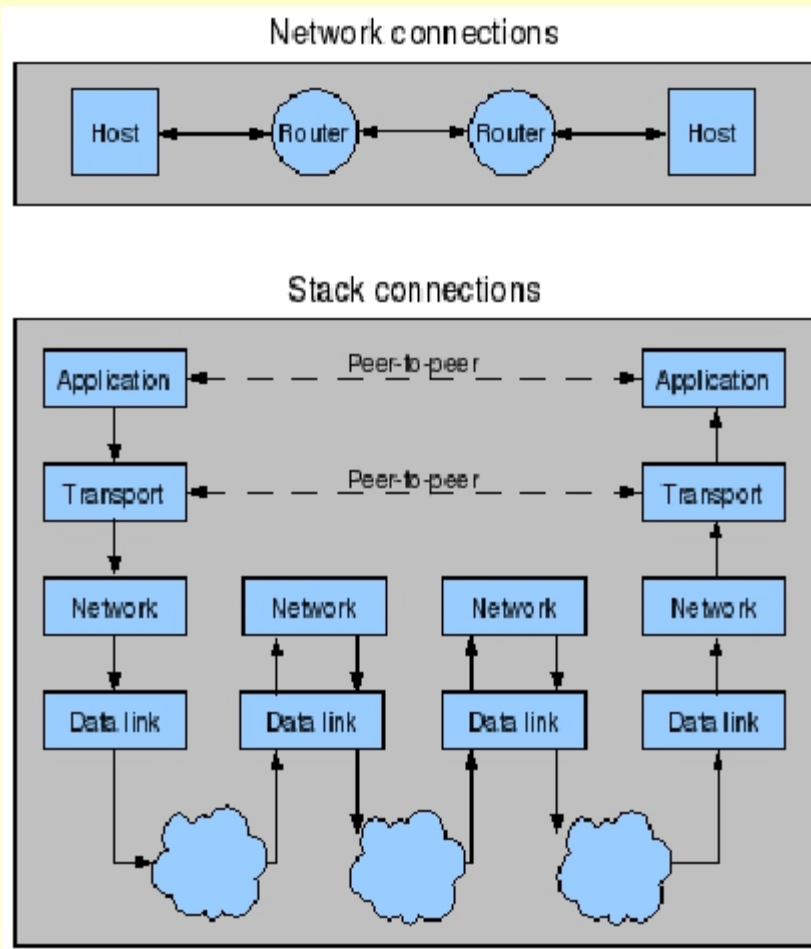| application |
|---|
| transport |
| network |
| link |
| physical |
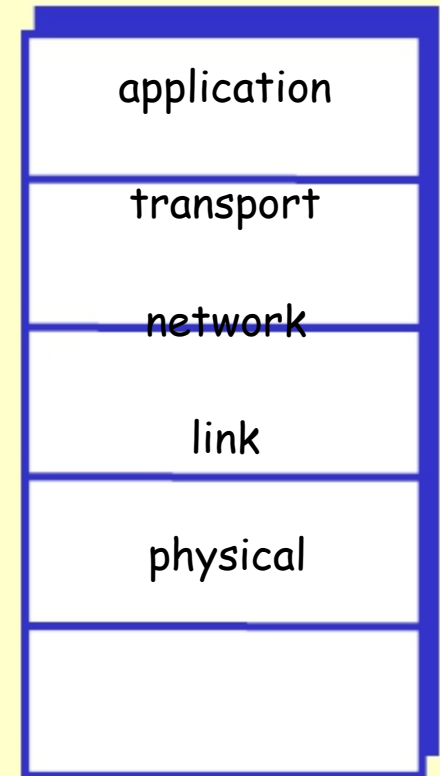
Internet Protocol Stack – 3 Layers

Reduced to 3 layers:

- Layer 1 – network protocols:

    IP (Internet Protocol)

- Layer 2 – transport protocols:

    TCP (Transmission Control Protocol), and UDP (User Datagram Protocol)

- Layer 3 - Application protocols

    – DNS, POP3, IMAP, SMTP, HTTP, HTTPS and FTP.

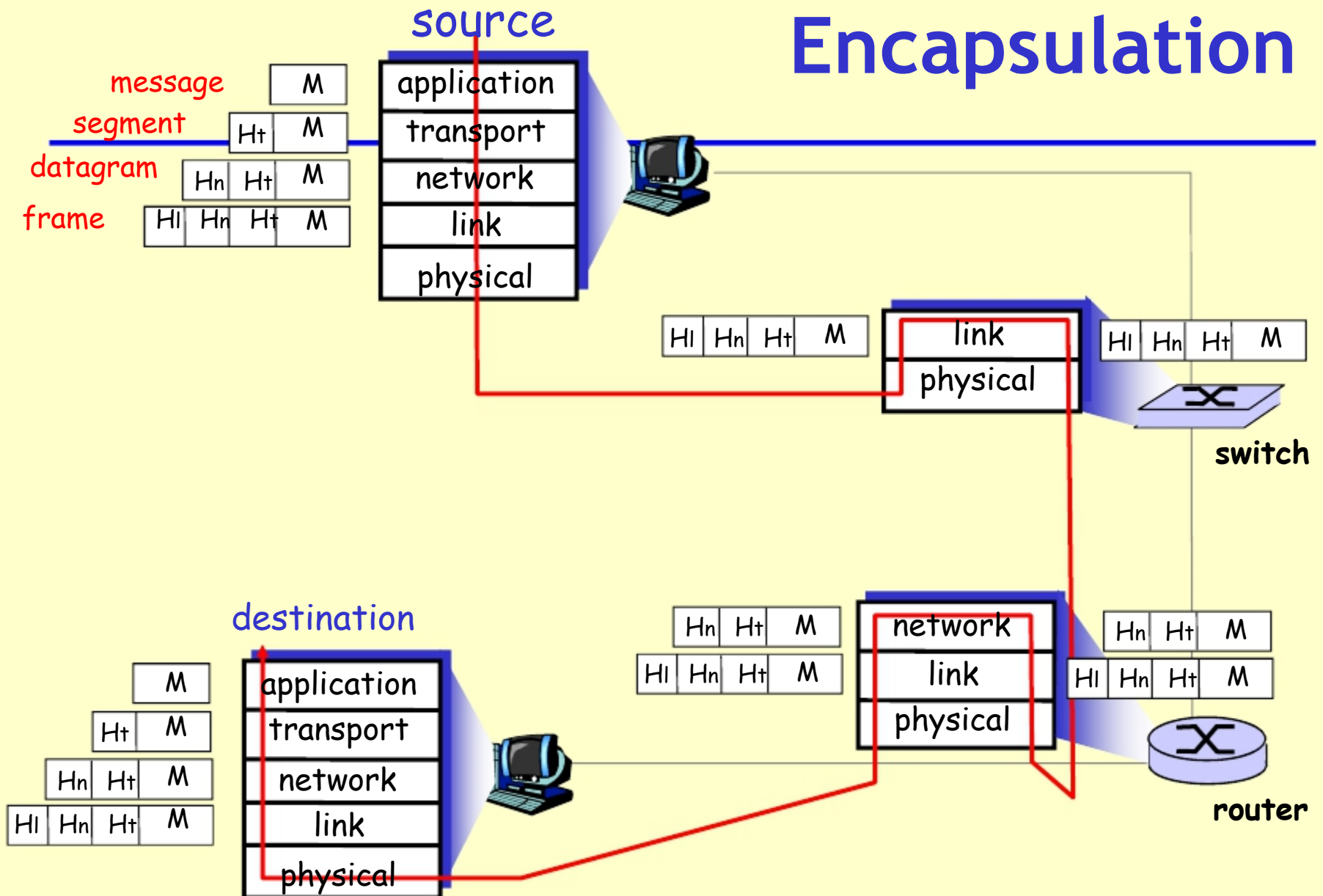# Internet Protocol Stack - TCP and UDP

- The protocols by which one host sends data to another;

- TCP makes a virtual 'connection', which gives some level of guarantee of reliability; and

- UDP is a best-effort, connectionless transport, in which data packets that are lost in transit will not be re-sent.

Internet Protocol Stack - Structure

- **Layer 4 - Application** - DNS, TFTP, TLS/SSL, FTP, HTTP, IMAP, IRC, NNTP, POP3, SIP, SMTP, SNMP, SSH, TELNET, ECHO, BitTorrent, RTP, PNRP, rlogin, ENRP, ...
- **Layer 3 - Transport** - TCP, UDP, DCCP, SCTP, IL, RUDP, ...
- **Layer 2 - Network** - IP (IPv4, IPv6)
- **Layer 1 – Data Link** - Ethernet, Wi-Fi, Token ring, PPP, SLIP, FDDI, ATM, Frame Relay, SMDS, ...

Encapsulation

source

message M

segment Ht M

datagram Hn Ht M

frame Hl Hn Ht M

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

Hl Hn Ht M

| link |
| physical |

Hl Hn Ht M

switch

destination

M

Ht M

Hn Ht M

Hl Hn Ht M

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

Hn Ht M

Hl Hn Ht M

| network |
| link |
| physical |

Hn Ht M

Hl Hn Ht M

router

Application Protocols

- This defines the specific messages and data formats sent and understood by the applications running at each end of the communication.

- Internet protocol suite:
  - most-used application protocols are: DNS, POP3, IMAP, SMTP, HTTP, HTTPS and FTP.

Common Internet Protocols: HTTP

- *Most widely used internet protocols:*
  - *DNS,*
  - *POP3,*
  - *IMAP,*
  - *SMTP,*
  - *HTTP,*
  - *HTTPS and*
  - *FTP.*

Summary

- Internet Protocols:

    - IP – internet protocol
    - Application Protocols
    - TCP and UDP
    - Internet Protocol Suite/Stack
    - The OSI Model

- Widely Used Internet Protocols:
    - HTTP, FTP, POP, SMTP, IMAP, SSH, VoIP