DT228/2 Web Development

Internet:
Architecture and The Internet Protocol Suite

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
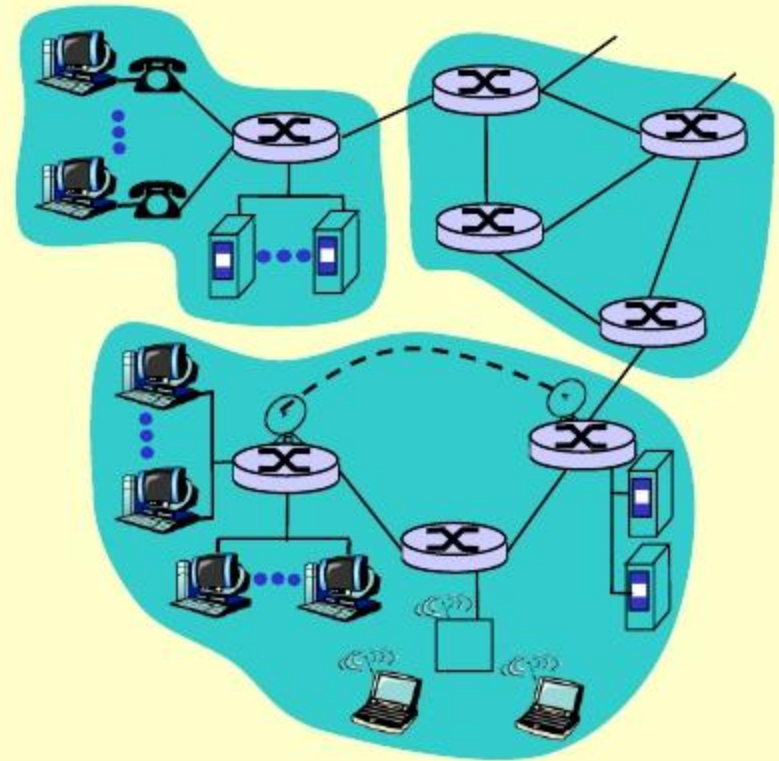- Application Protocols
- Summary

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
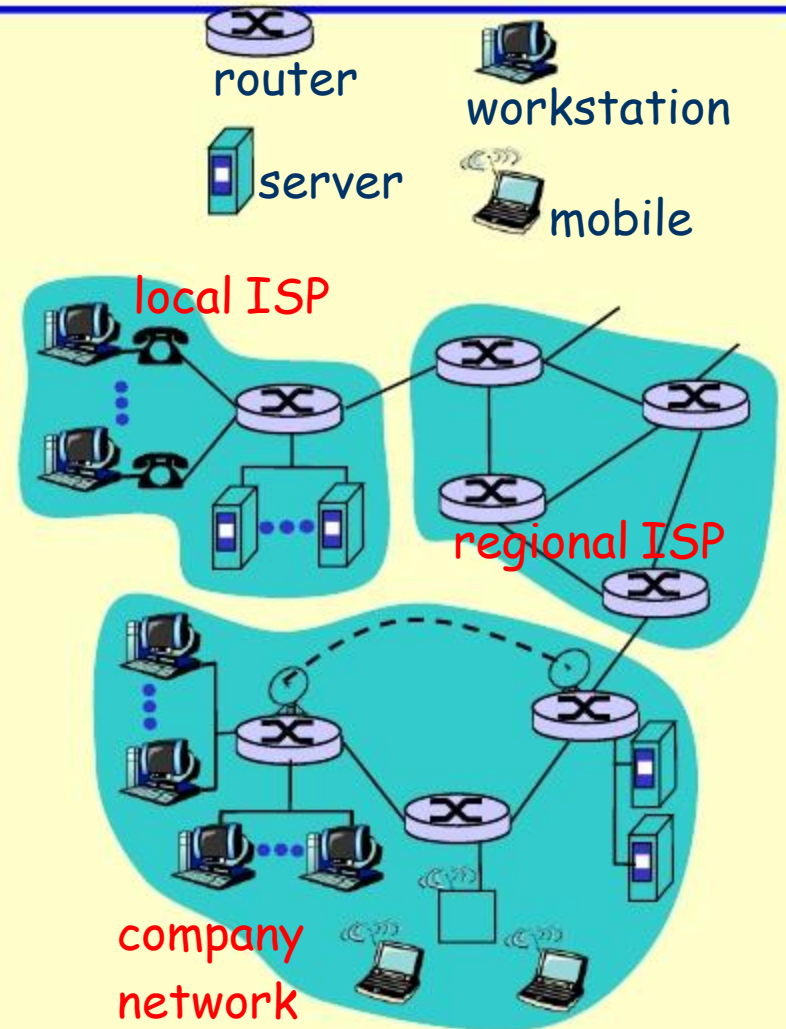
What's the Internet: a service view

- 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:
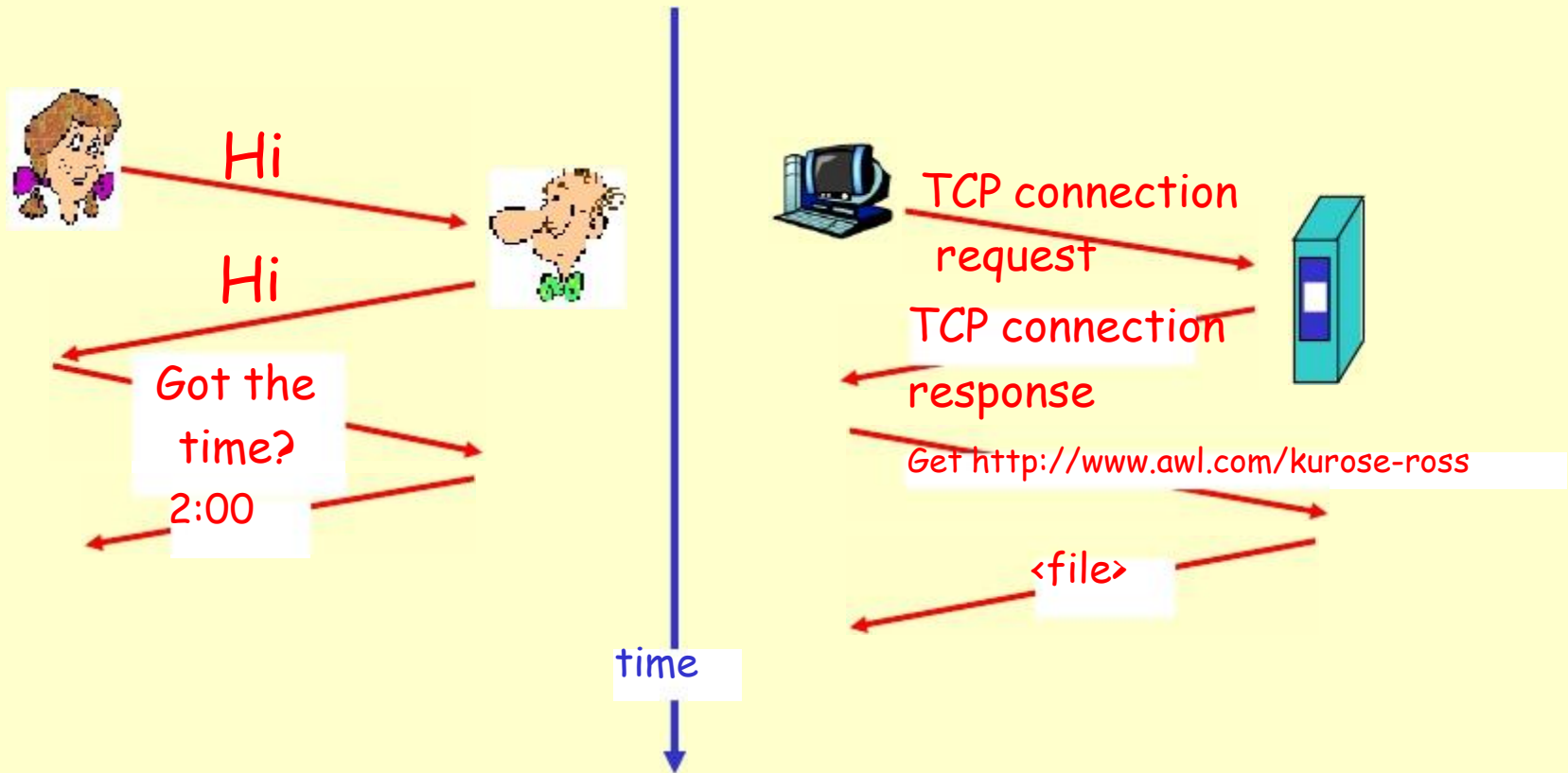
Q: Other human protocols?

Internet Protocol (IP)

- Defines the datagrams or packets that carry blocks of data from one node to another.

- Majority of today's Internet uses version four of the IP protocol (i.e. IPv4), and

- IPv6 is standardised, it exists only as "islands" of connectivity,

- Many ISPs don't have any IPv6 connectivity at all.

Protocol "Layers"

Networks are complex!

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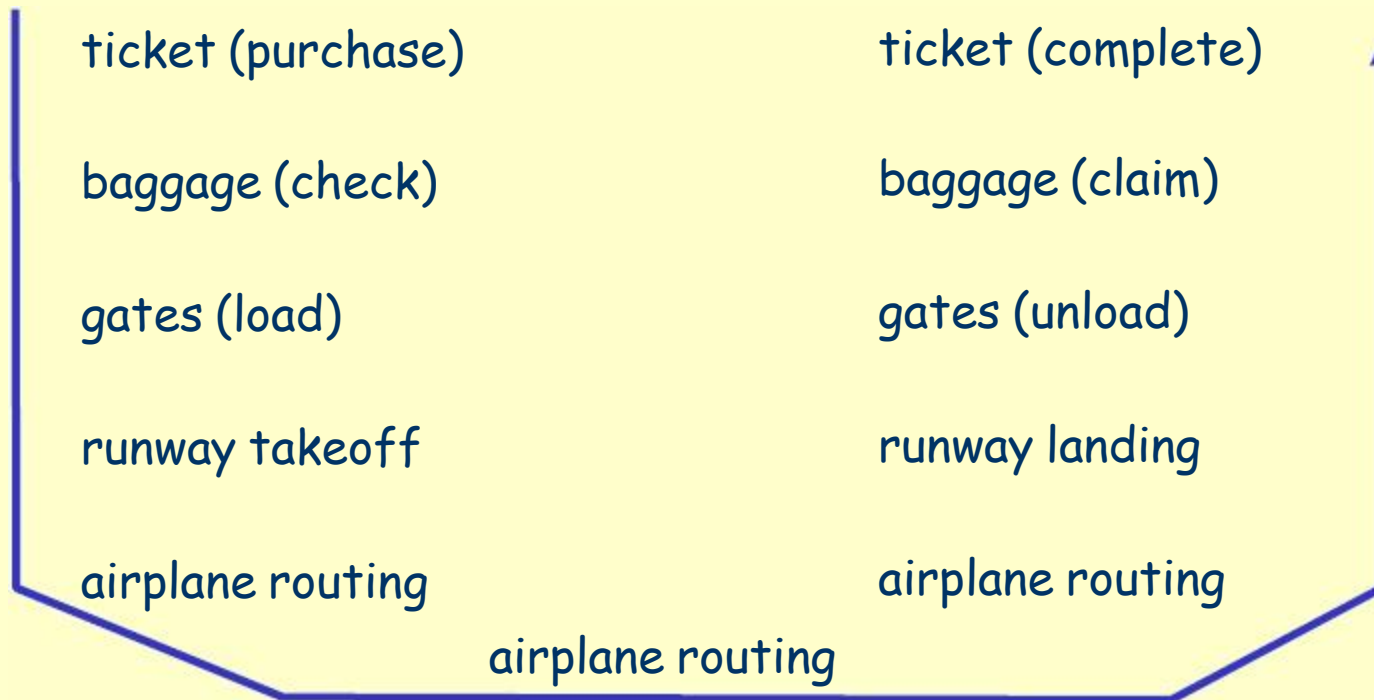 - applications
  - protocols
  - hardware, software

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
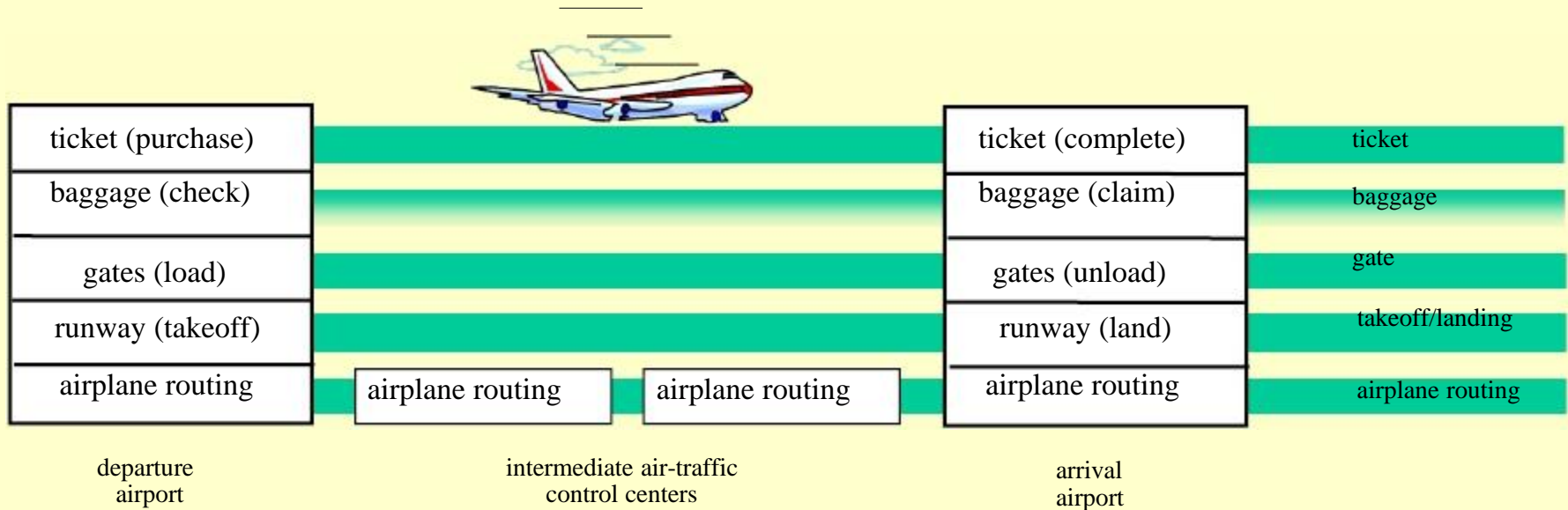
Layers: each layer implements a service
- via its own internal-layer actions
- relying on services provided by layer below

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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
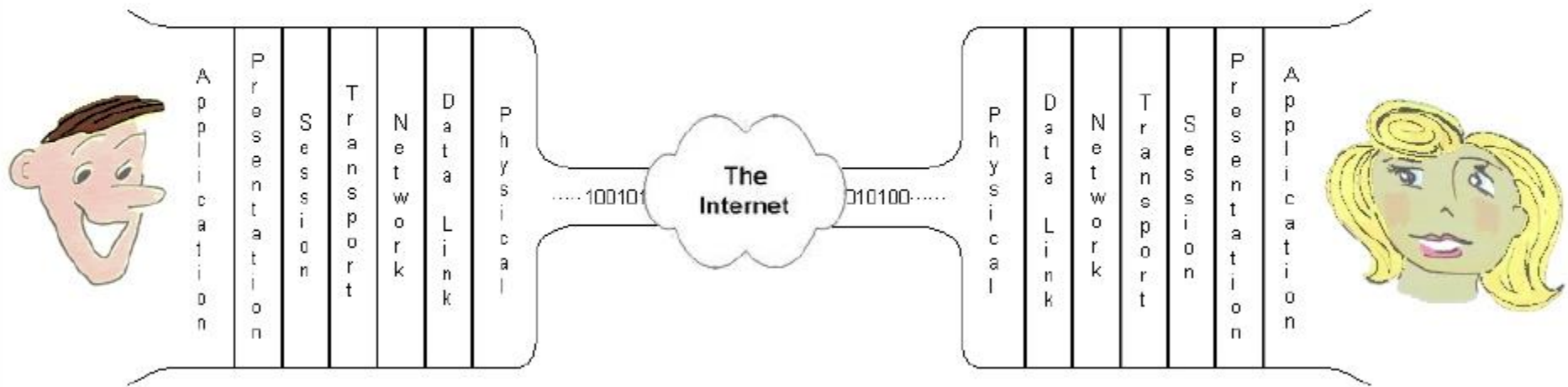
Internet Protocol Stack

- 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
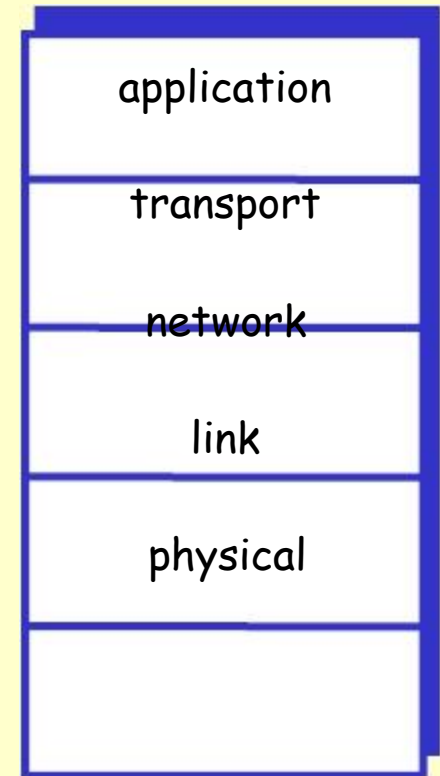
Internet Protocol Stack – 3 Layers

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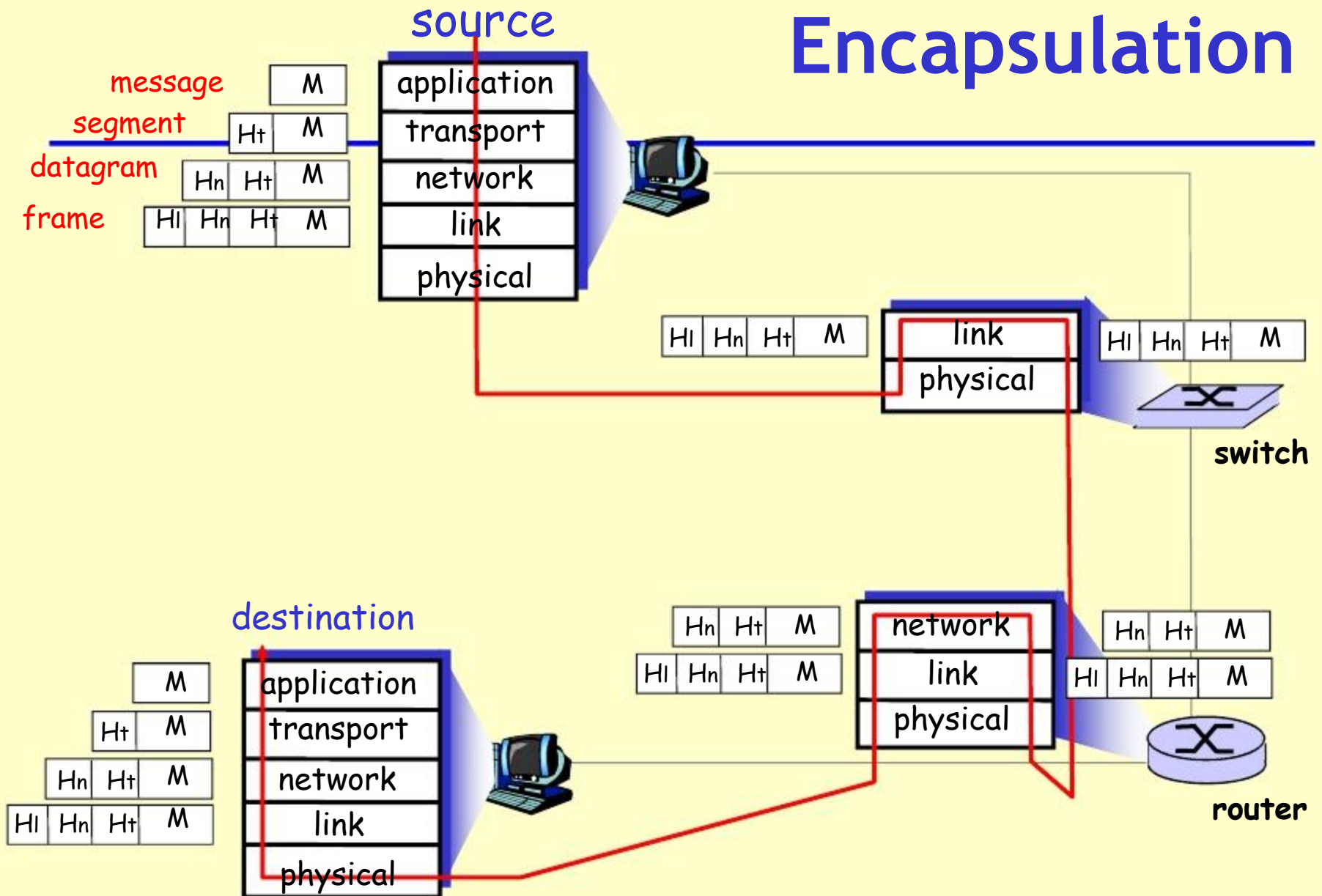
Internet Protocol Stack - Structure
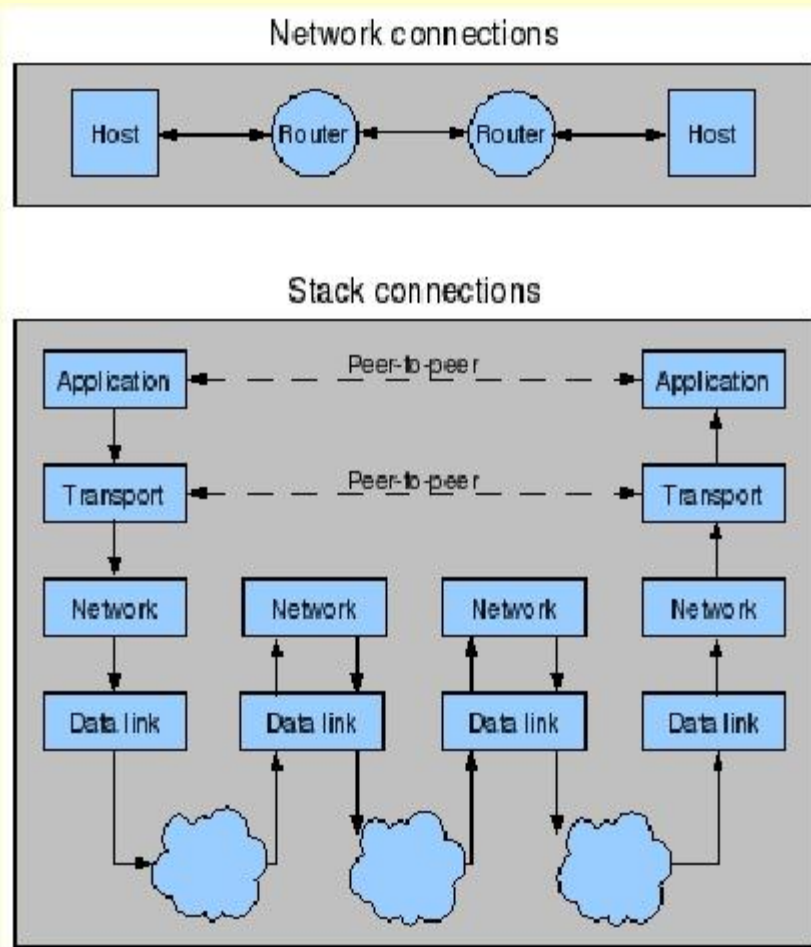
- **Layer 4 - Application** - DNS, TFTP, TLS/SSL, FTP, HTTP, IMAP, IRC, NNTP, POP3, SIP, SMTP, SNMP, SSH, TELNET, ECHO, BitTorrent, RTP, PNRP, rlogin, ENRP, ...
- **Layer 3 - Transport** - TCP, UDP, DCCP, SCTP, IL, RUDP, ...
- **Layer 2 - Network** - IP (IPv4, IPv6)
- **Layer 1 – Data Link** - Ethernet,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

Encapsulation

message   M

segment   Ht M

datagram   Hn Ht M

frame   Hl Hn Ht M

source

| 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

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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