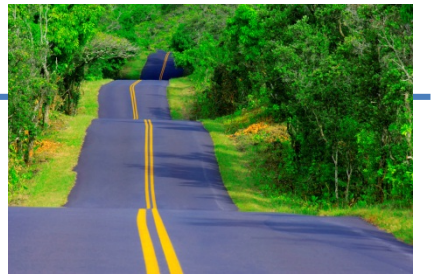
Course on Computer Communication and Networks

Lecture 1
Chapter 1: Introduction
Part A: Internet, Protocol Layering and Data

CTH EDA344/ GU DIT 420

Based on the book Computer Networking: A Top Down Approach, Jim Kurose, Keith Ross, Addison-Wesley.

Roadmap



- What's the Internet
  - Nuts&bolts view
  - Service view
  - Distinction between network edge and network core
- Layers of abstraction, protocols
- ISO/OSI & Internet layer structure
- Data communication through layers: physical and logical view

the Internet: "nuts and bolts" view (1)

PC

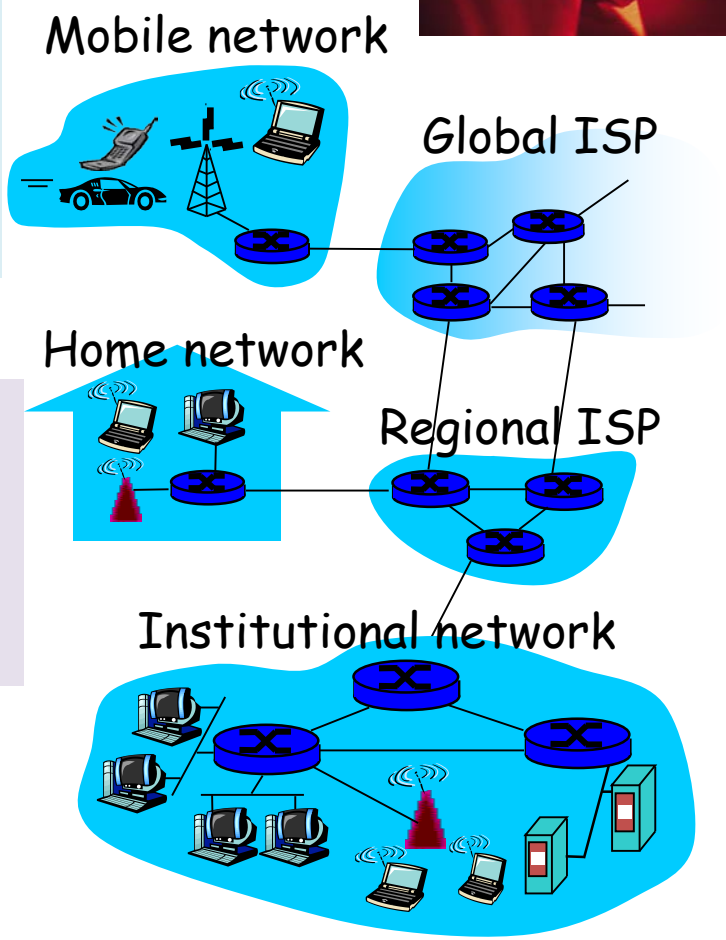
server

wireless laptop

cellular handheld

millions of connected (computing) devices: *hosts = end systems*

running *network apps*



communication links

- fiber, copper, radio, satellite
- transmission rate = *bandwidth*

access points

wired links

router

Connecting devices, eg routers: forward packets (chunks of data)

”Fun” internet appliances in “Internet of things”

IP picture frame
http://www.ceiva.com/

Web-enabled toaster +
weather forecaster

Tweet-a-watt:
monitor energy use

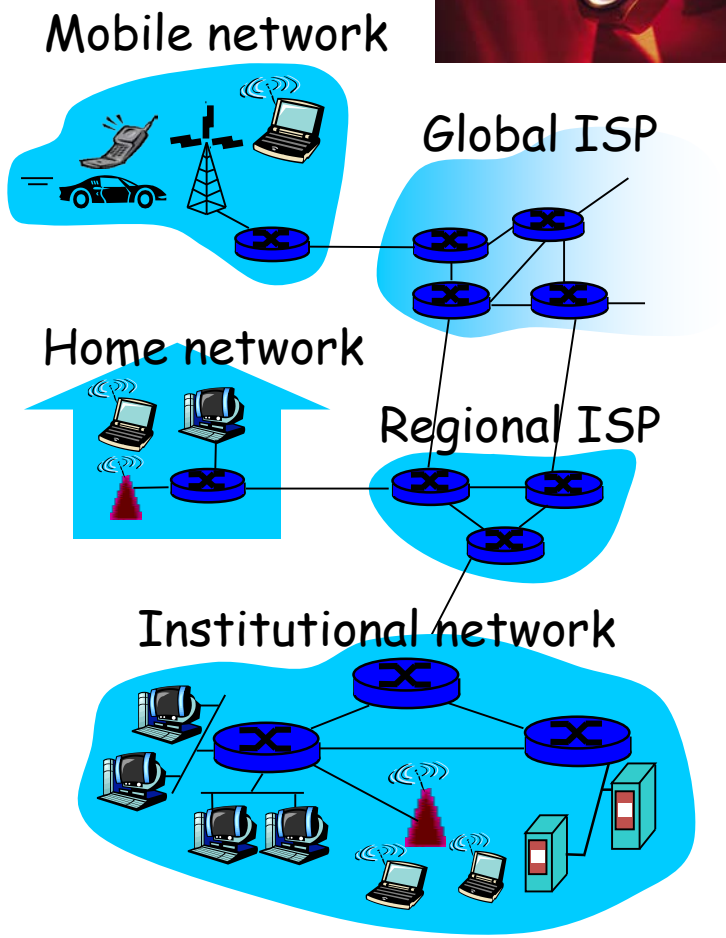
Internet
refrigerator

Slingbox: watch,
control cable TV remotely

Internet phones

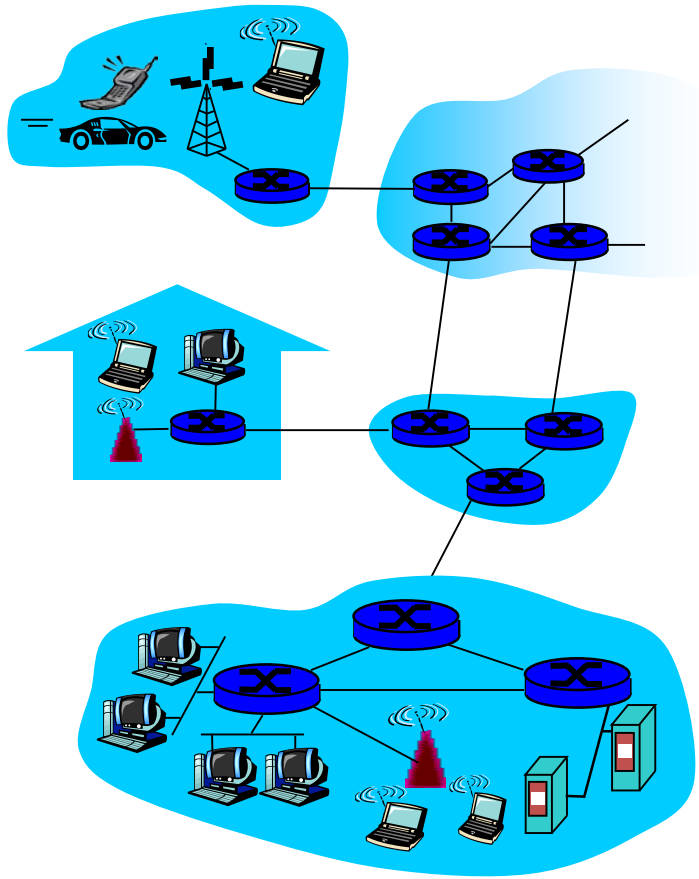
the Internet: "nuts and bolts" view (2)

- *protocols* control sending, receiving of msgs
  - e.g., TCP, IP, HTTP, Skype, Ethernet
- *Internet:* "network of networks"
  - loosely hierarchical



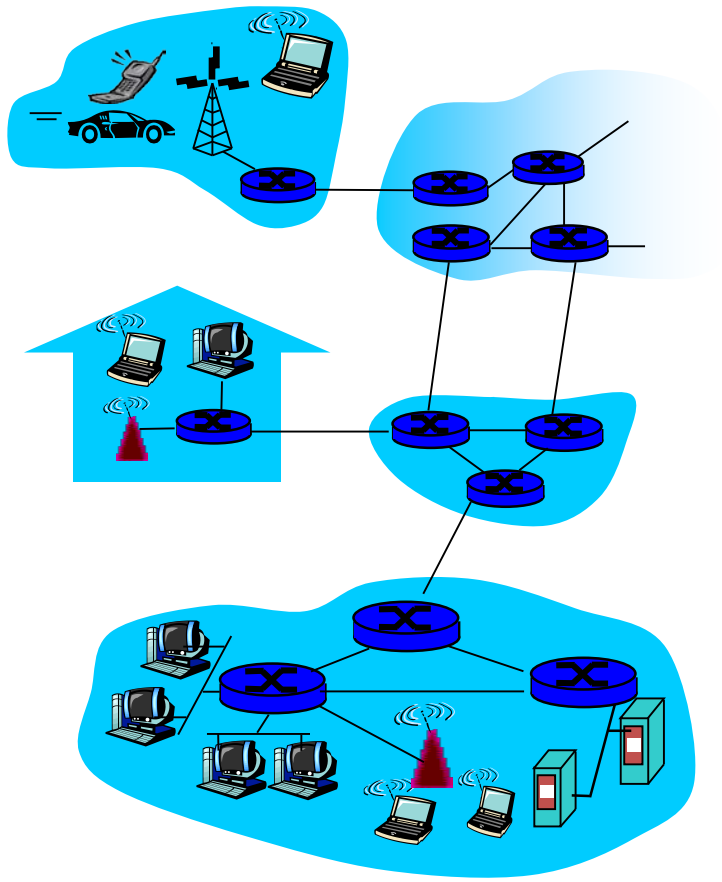
the Internet: *service* view

- communication *infrastructure* enables distributed applications:
  - Web, VoIP, email, games, e-commerce, file sharing
- communication *services* provided to apps:
  - Reliable, in-order data delivery from source to destination
  - "best effort" (unreliable) data delivery



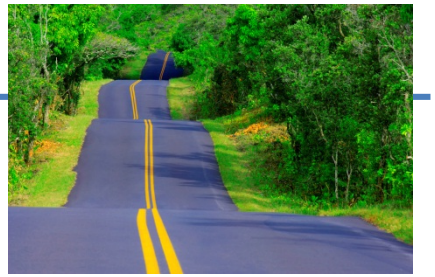
A closer look at (any big) network's structure:

- network edge: applications and hosts
- access networks, physical media: wired, wireless communication links



- network core:
  - interconnected routers
  - network of networks

Roadmap



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Networks are complex and evolving….

- Hosts, routers, links
- Services, applications
- Hardware, software
- Networks of Networks
- ….

Question:

Is there any hope of *organizing* structure, study, development of networks?

Terminology:

Layers, Protocols, Interfaces

Each layer implements **services**

- via its own internal-layer actions
- relying on services by layer below

It provides services to the upper layer (shielding from implementation details)

- **service interface**: across layers in same host

Layer *n* on a host carries a conversation with layer *n* on another host

host-to-host interface: defines messages exchanged with peer entity

Logical communication, protocol

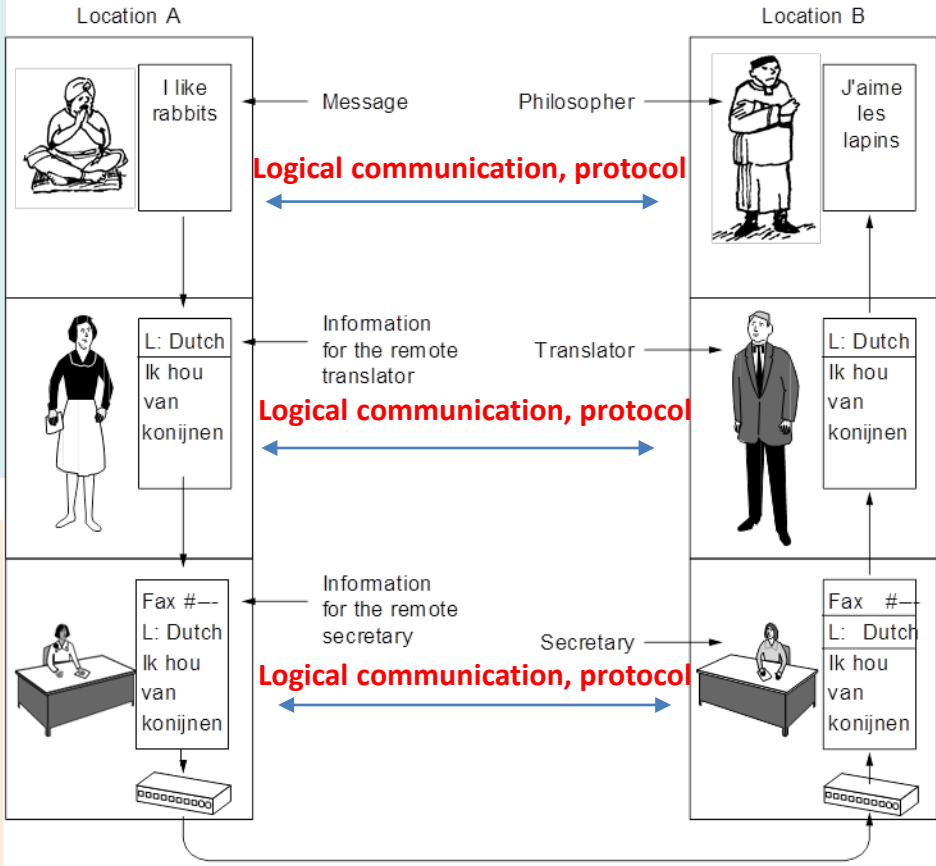
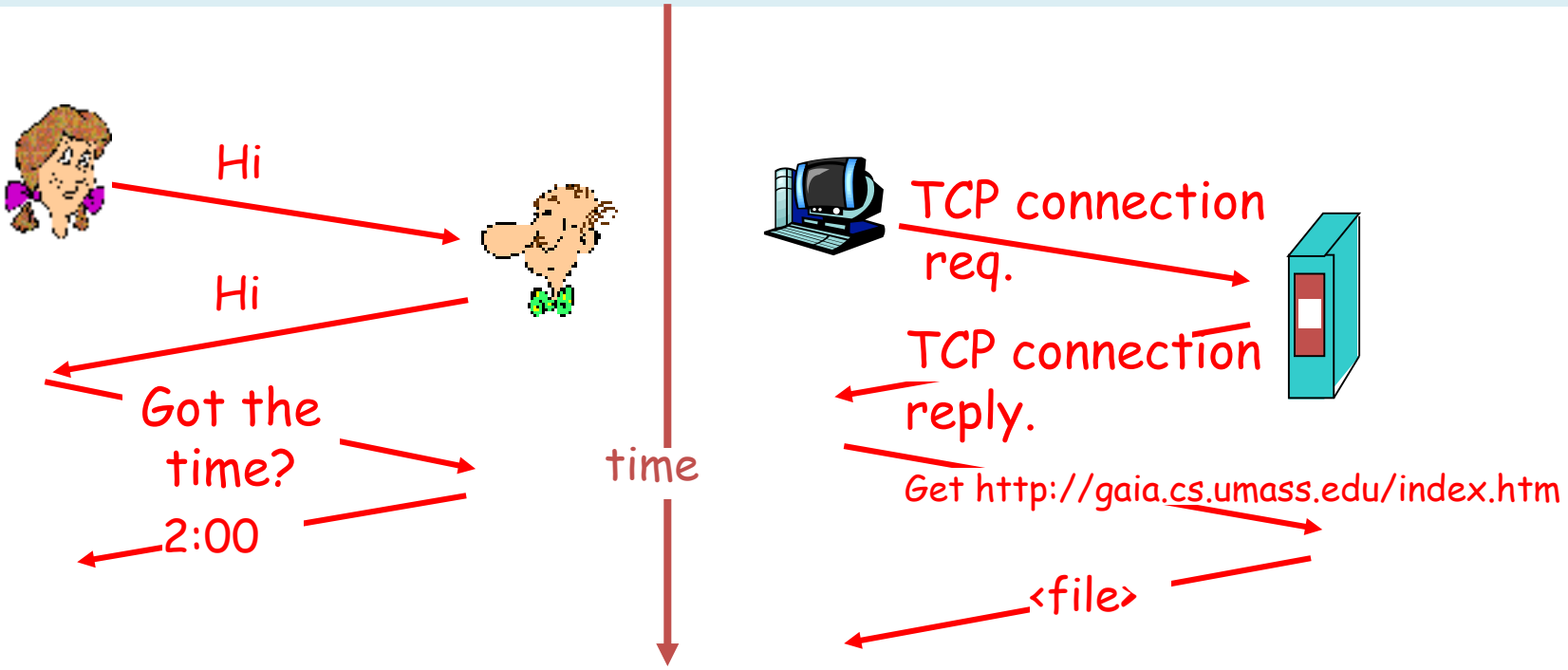


Fig. 1-10. The philosopher-translator-secretary architecture.

Fig. A. Tanenbaum Computer Networks

What's a protocol?

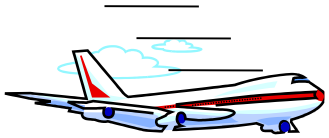
Examples: a human protocol and a computer network protocol:

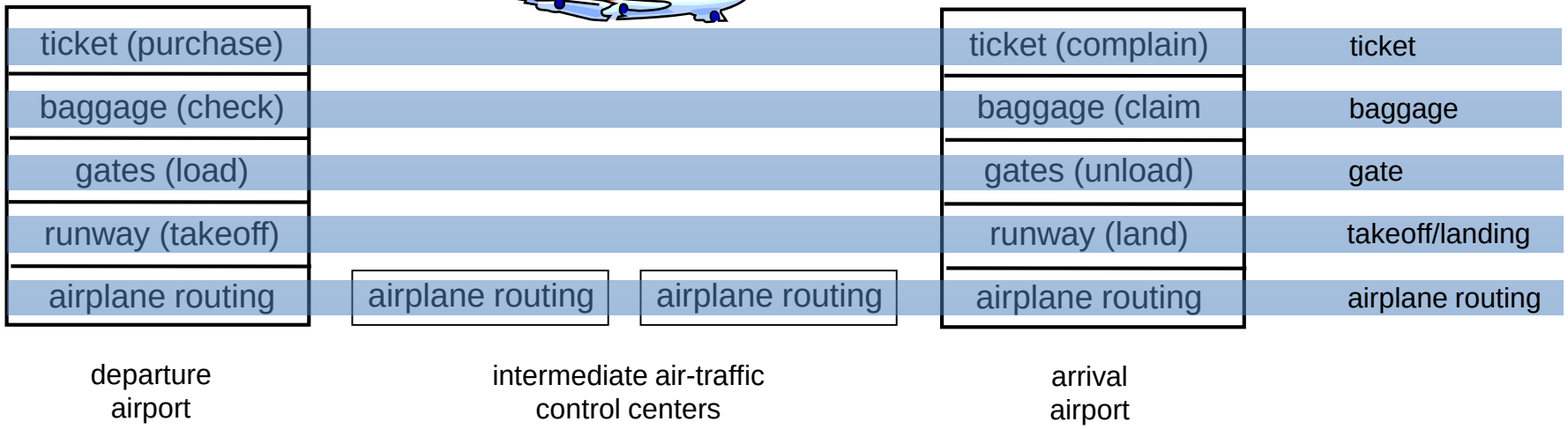


host-to-host interface: defines

- messages exchanges with peer entity: *format, order of msgs*
- *actions todo on msg transmission, receipt*

Another example:
Layering of airline functionality





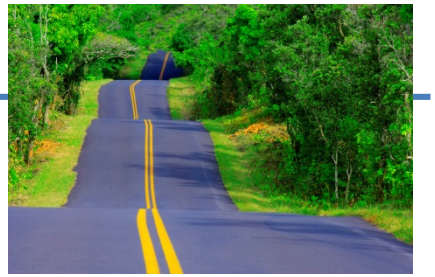
System architecture: set of layers, interfaces
Protocol stack: protocol implementation

Why layering?

Dealing with complex systems:

- structure allows to identificaty & relate of complex system's pieces
  - layered reference model for discussion
- modularization eases maintenance/es
  - change of implementation of layer's service transparent to rest of system
  - e.g., change in gate procedure doesn't affect rest of system

Roadmap



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Layering – Some "history":
The OSI Reference Model

ISO (International Standards Organization) defined the OSI (Open Systems Interconnect) model to help vendors create interoperable network implementation

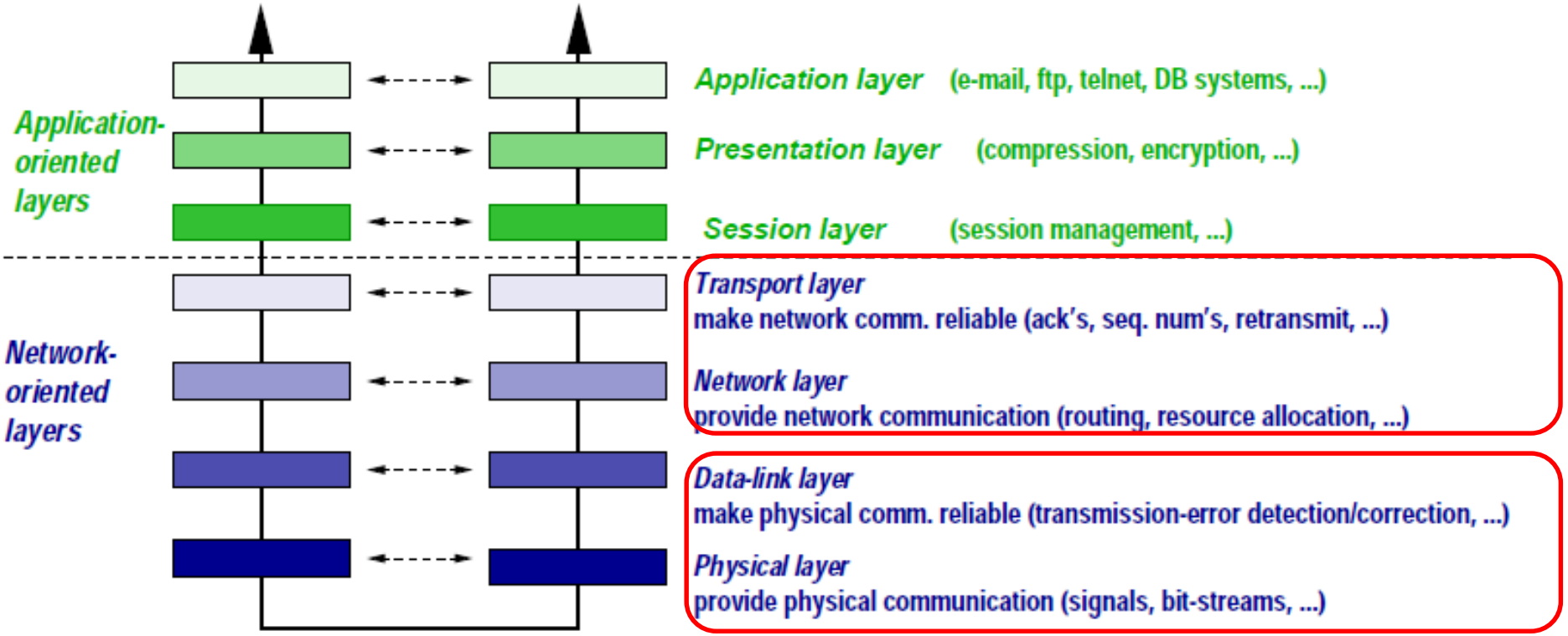


Fig. Steen, Sips : Computer and Network organization

``X dot" series (X.25, X. 400, X.500) OSI model implementation (protocol stack)

Internet protocol stack layers&protocols

Application: protocols supporting *network applications*

http (*web*), smtp (*email*), p2p, streaming…

transport: process2process (end2end) data transfer protocols

UDP, TCP

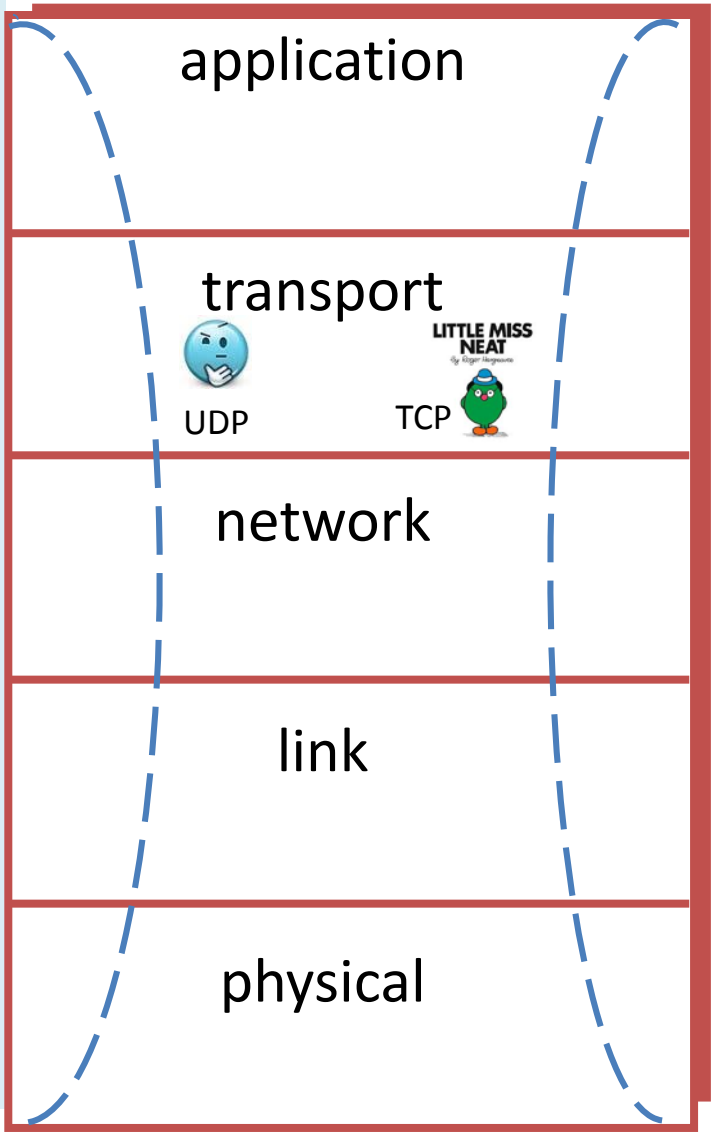
network: routing of datagrams (independent data-packets), connecting different physical networks

IP addressing, routing protocols, virtualization, virtualization, virtualization……

link: protocols for data transfer between neighboring (ie physically connected) network nodes

Ethernet, WiFi, …

physical: protocols for bit-transmission/receipt on the physical medium between neighboring network nodes



Internet protocol stack

- Architecture simple but not as thoroughly thought as OSI's
  - no clear distinction between interface-design and implementations;

ning of data, e.g., encryption,

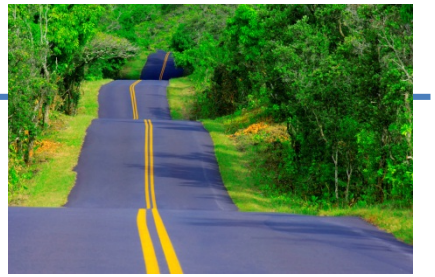
eckpointing, …
uarantees
e implemented in application

standard)
plementations were too complicated)

aist though…

- IETF: Internet Engineering Task Force

Roadmap



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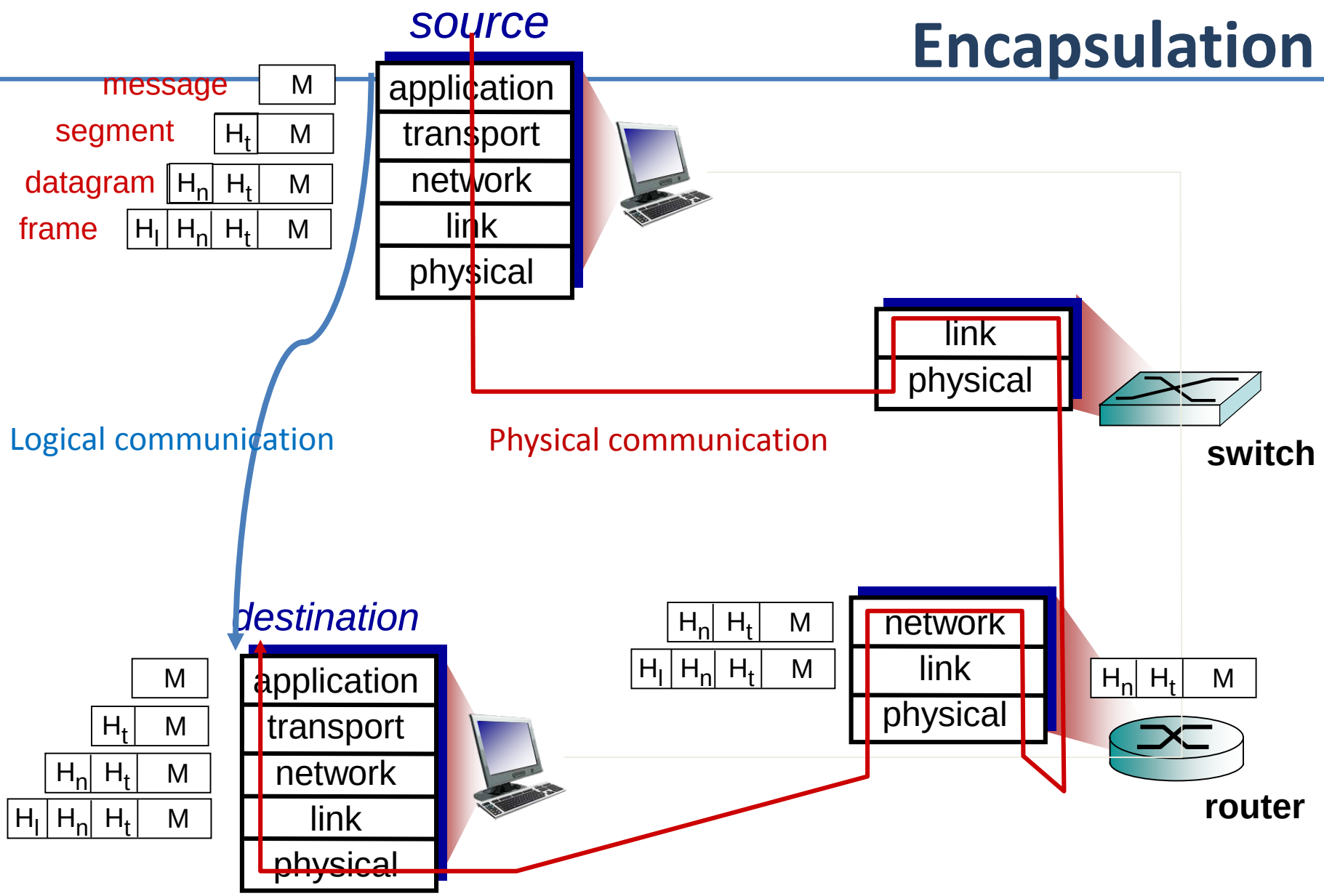
Layered communication: Encapsulation



Chapter 1a: Summary

We discussed

- what's the Internet
- what's a protocol?
- protocol layers, service models

We will continue (next lecture) with

- Network edge & network core services & functionality overview
- More on Internet structure overview
  - access nets, physical media
  - backbones, NAPs, ISPs
- Performance concerns: delays, loss
- Security concerns

To provide :

- context, overview, "feel" of networking
- A point of reference for context in the "zoom-in" discussions to come

Reading instructions (incl.next lecture)

1. Kurose Ross book

Careful	**Quick**
6/e, 7/e: 1.3, 1.4, 1.5	the rest

Extra Reading (optional)
Computer and Network Organization: An Introduction,
by Maarten van Steen and Henk Sips, Prentice Hall
(very good introductory book for non-CSE students)

Review questions

Review questions from Kurose-Ross book, chapter 1 (for basic study)

- 6/e, 7/e: R11, R12, R13, R16, 17, R18, R19, R20, R21, R22, R23, R24, R25, R28.

Extra questions, for further study: delay analysis in packet switched networks:

http://www.comm.utoronto.ca/~jorg/teaching/ece466/material/466-SimpleAnalysis.pdf