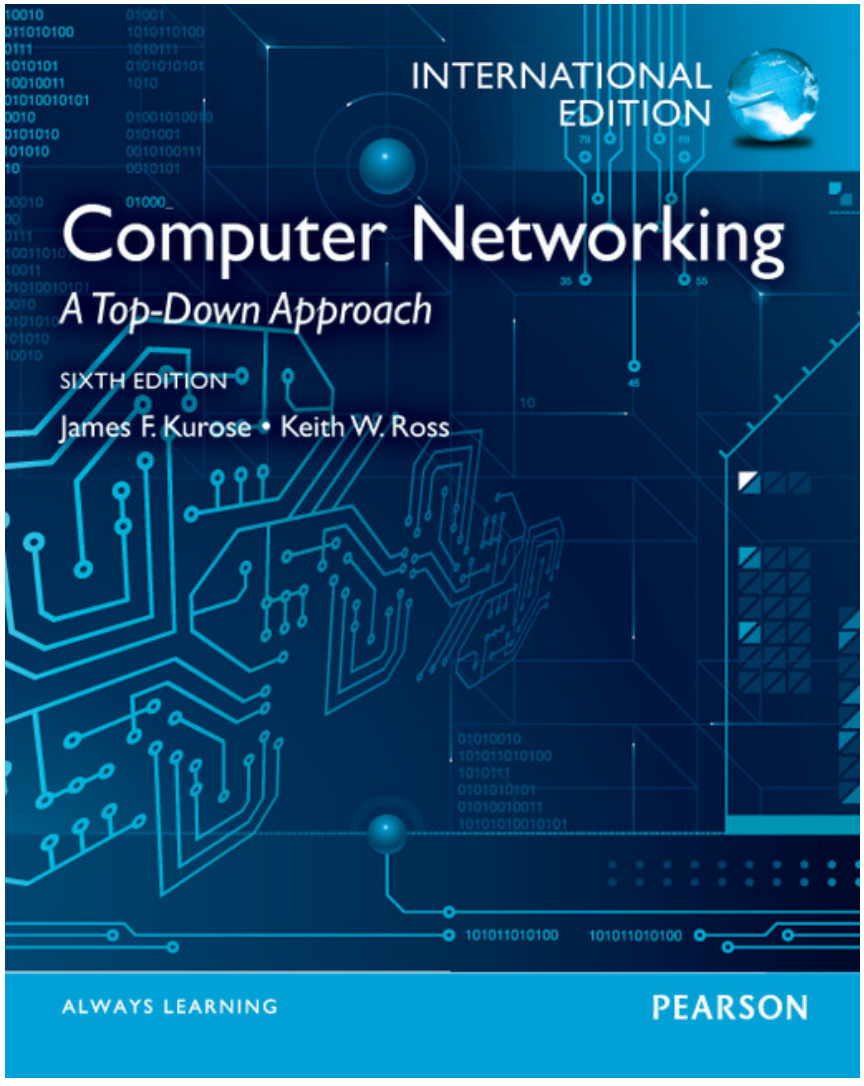
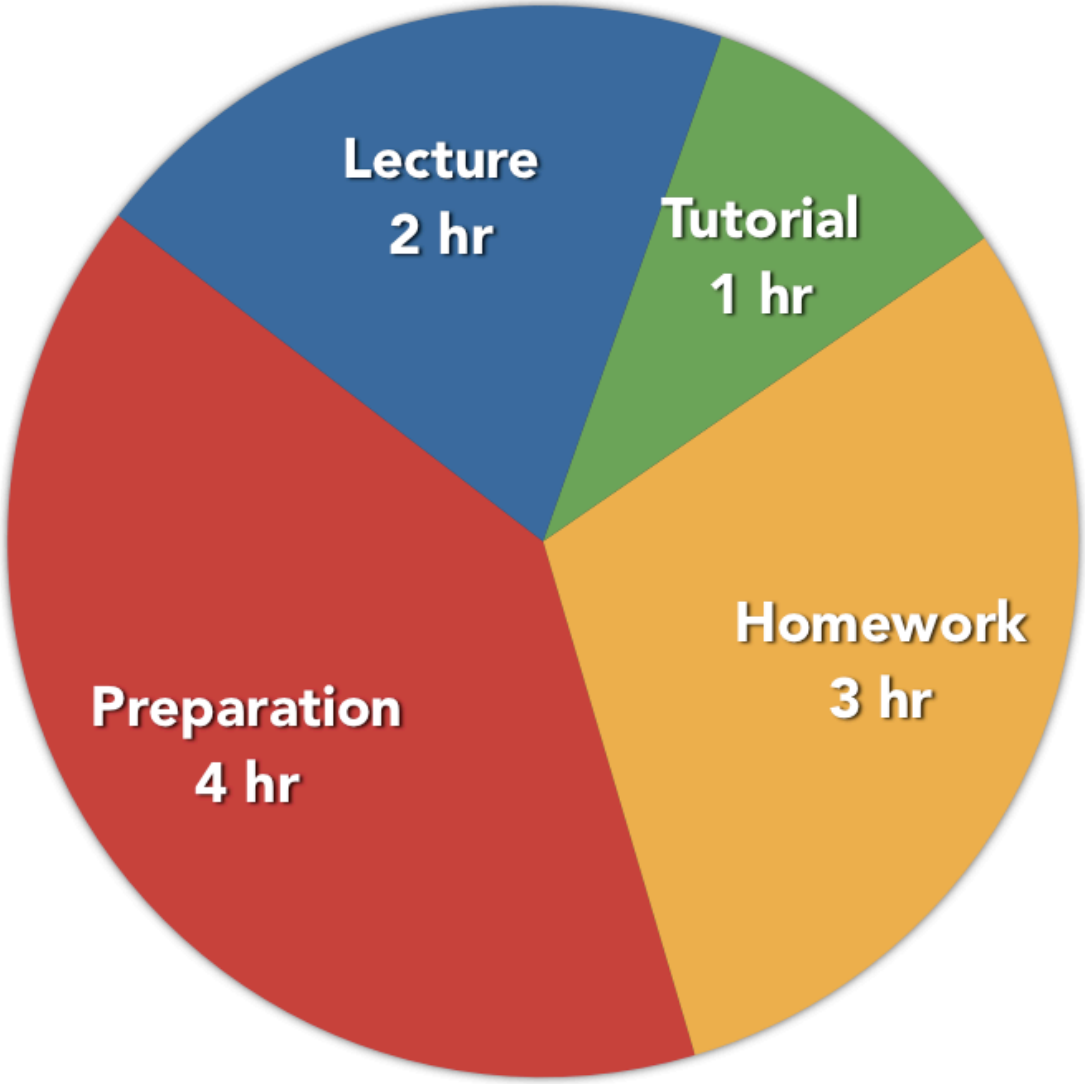
CS2105

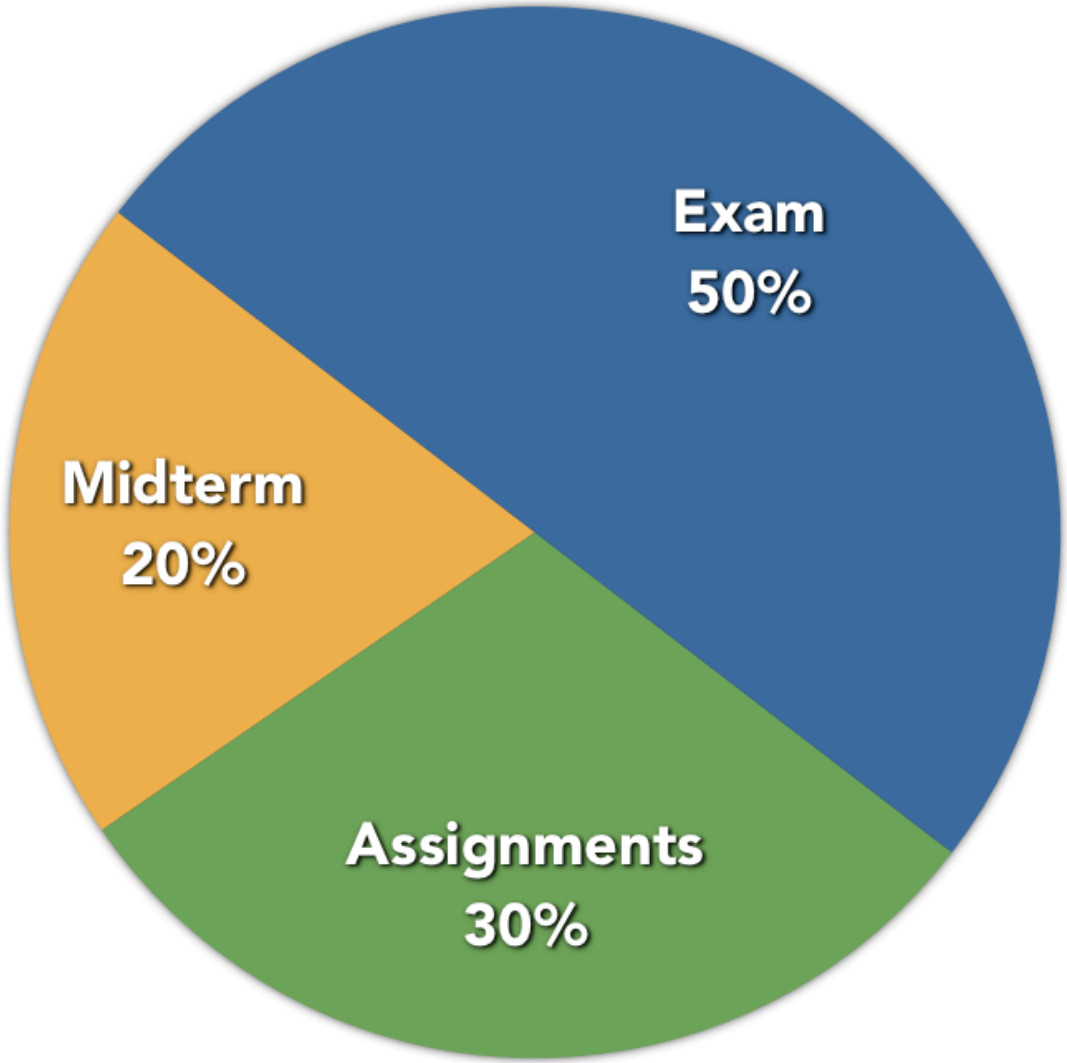
An Awesome Introduction to Computer Networking

Ooi Wei Tsang
AS6 05-14
ooiwt@comp.nus.edu.sg

Office Hour
Monday 4-6pm


INTERNATIONAL EDITION
Computer Networking
A Top-Down Approach
SIXTH EDITION
James F. Kurose • Keith W. Ross
ALWAYS LEARNING
PEARSON


Lecture
2 hr
Tutorial
1 hr
Homework
3 hr
Preparation
4 hr


Exam
50%
Midterm
20%
Assignments
30%

2 programming assignments
1 written assignment
9 problem sets
4 practical exercises

Important Dates

Midterm: **10 March 2014**

Final Exam: **30 April 2014**

Midterm & Final are

Semi-Open Book

(one double-sided A4 crib sheet allowed)

Slides to be posted 1-2 days before the lecture

Slides $\neq$ Notes

You are expected to **take notes** during lecture

You are expected to **read** the assigned readings

No model answer will be posted

Light a Fire

``**No mercy**'' policy against **plagiarism**

``**No mercy"** policy against voilation of **naming convention**

http://blog.nus.edu.sg/cs2105

Check for updates frequently
and
subscribe via email or RSS

Use your real name when commenting online

Screencast will be posted

You need an SoC UNIX account.

Get one here:

`https://mysoc.nus.edu.sg/~newacct/`

Questions?

CS2105 Lecture 1

Introduction

14 January, 2014

CS2105 Lecture 1

Introduction

14 January, 2014

After this class, you are expected to:

- understand the basic terms, including host, packet, protocol, throughput, bottleneck link, store-and-forward, and autonomous system.
- know about the logical (the five layers) and physical architecture (as a network of ASes) of the Internet.
- know about the pros and cons of packet switching versus circuit switching.
- understand the different components of end-to-end delay and their relations to bandwidth, packet size, distance, propagation speed, and queue size.

The complexity involved in engineering the Internet will make your head explode, but this one incredibly simple trick keeps the complexity manageable.

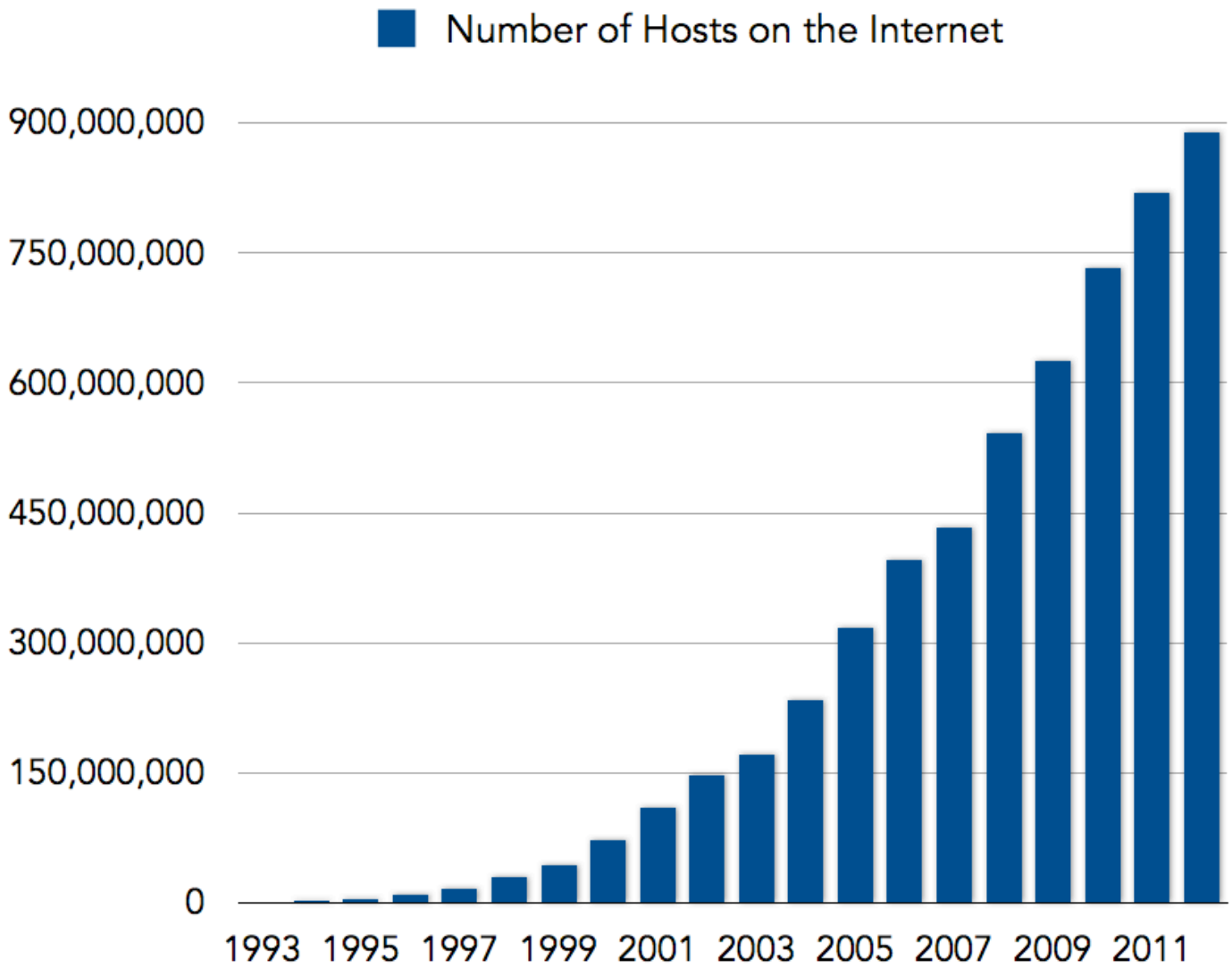
What is CS2105 about?

Concepts and **principles** behind computer networking

Introduction to networked application programming

The Internet is a network of connected computing devices.

Hosts or end systems


Number of Hosts on the Internet
900,000,000
750,000,000
600,000,000
450,000,000
300,000,000
150,000,000
0
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

996,230,757

as of July 2013

996,230,757
as of July 2013

Data obtained from Internet Systems Consortium: `http://www.isc.org/solutions/survey/history`

The hosts run **distributed applications**

Web: browsers, Web servers
WoW: clients, game servers
Skype: clients, supernodes
BitTorrent: peers, trackers

Applications
exchange messages and
communicate according to
protocols

Protocol: the **type** and **order** of messages exchanged and the **actions** taken after messages are sent or received

Examples:
HTTP, SMTP, FTP, TCP

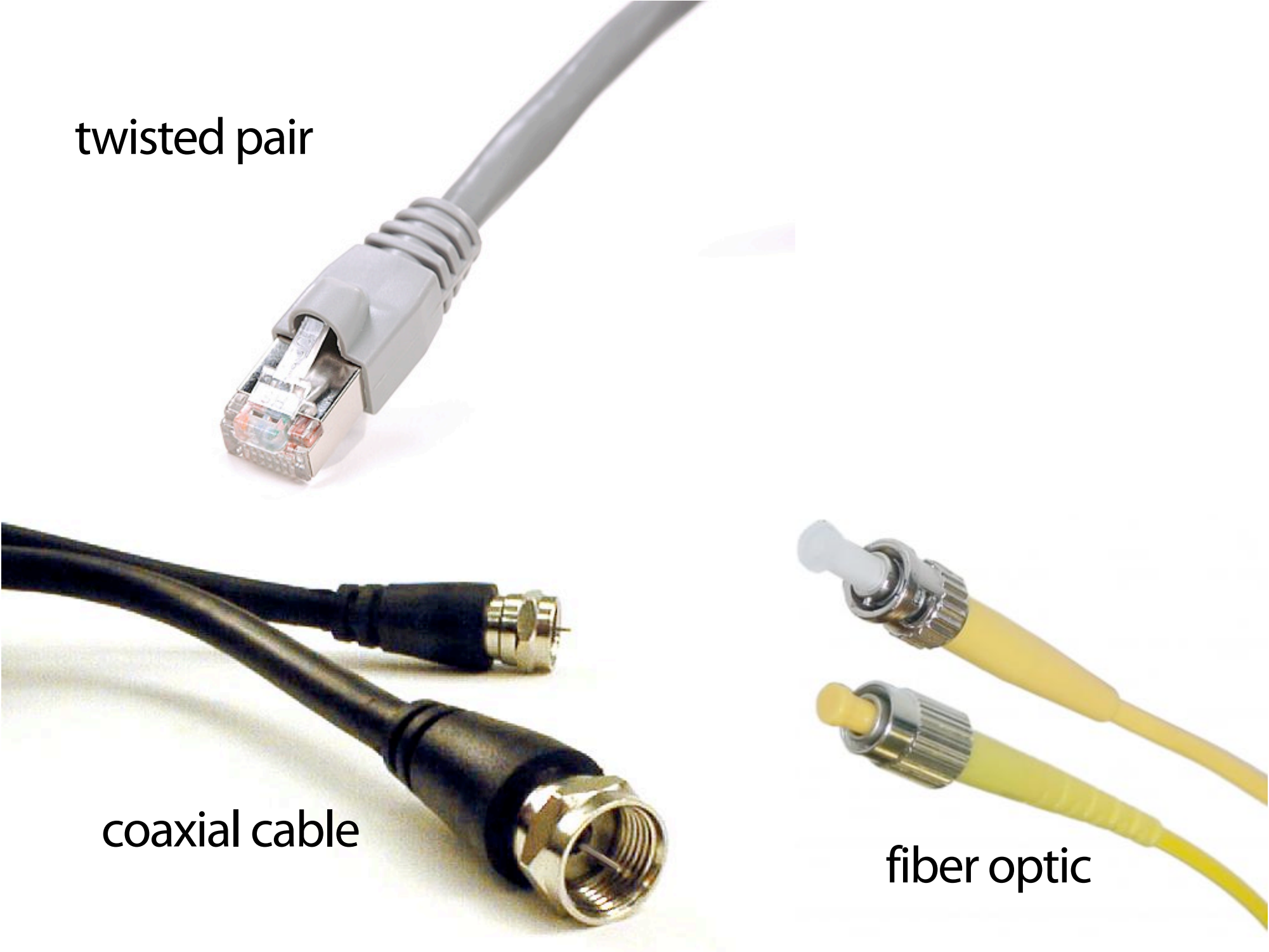
The hosts access the Internet through **access network**

WiFi, Ethernet, 3G, LTE, DSL, Cable, Fiber, Dial-Up, Satellite

WiFi, Ethernet, 3G, LTE, DSL,
Cable, Fiber, Dial-Up, Satellite

You can read up more about these different access network technologies in Section 1.2.1. We will cover Ethernet and WiFi in more details in CS2105.

Hosts can communicate over different **physical media**


twisted pair
coaxial cable
fiber optic

Consider two hosts connected directly through a physical medium

The hosts communicate by sending information to each other.

Information can be represented by a sequence of bits -- 0 or 1.

Modulation/Demodulation: Conversion between bits and signals

Error Detection/Correction: Ensuring that bits are received correctly

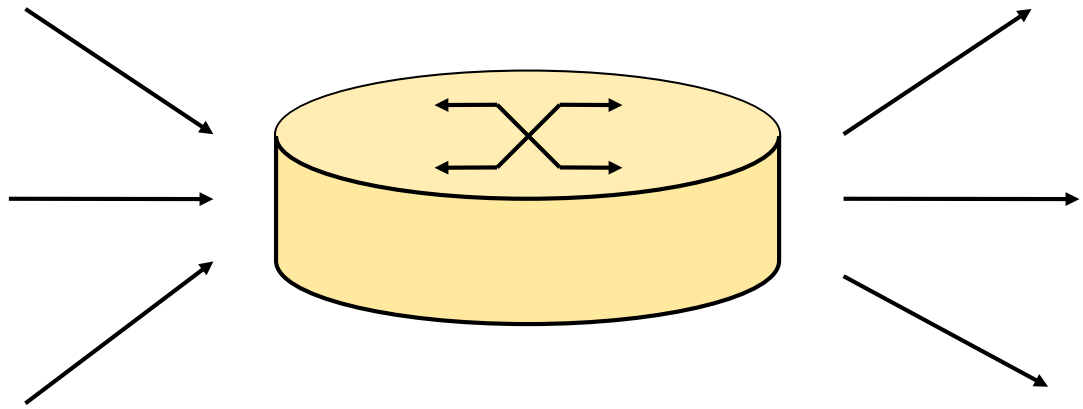
Packetization/Segmentation: Dividing data into chunks (called *packets*) so that only errornous packets need to be retransmitted.

Consider multiple hosts connected through a shared physical medium

Addressing:
Identify the source and destination

Medium access control:
Regulate who sends

Consider multiple hosts connected through **intermediate packet switches**, which **store and forward** the packets.



The Internet is a **packet switching** network

Packet switching:
Resources used on demand;
best effort services

Circuit switching:
Resources are reserved, guaranteeing services

Packet vs. Circuit Switching: Which is more efficient?

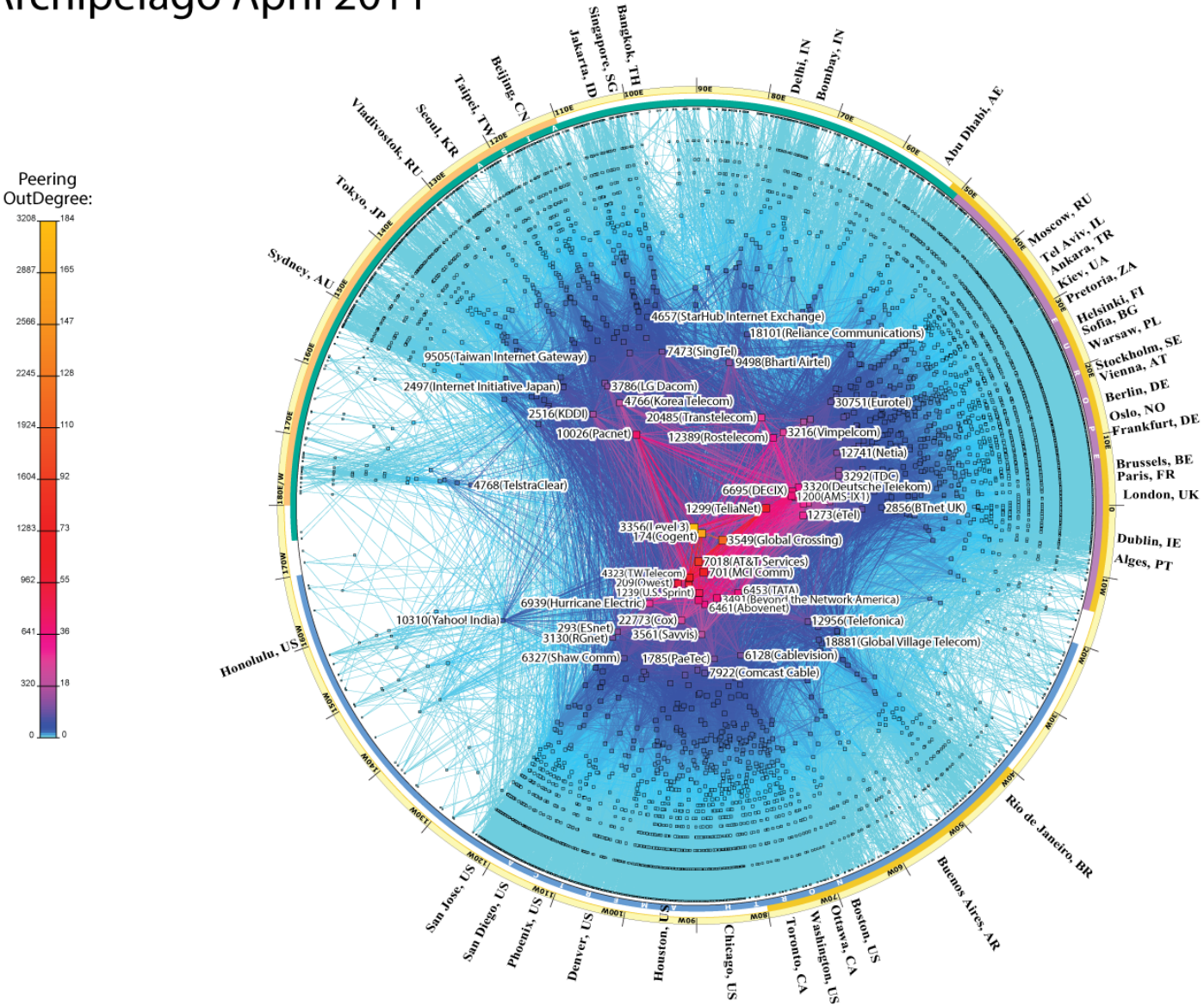
Packet vs. Circuit Switching:
Which is more efficient?

Details about packet switching and circuit switching is explained in Sections 1.3.1 and 1.3.2

Who owns the intermediate packet switches on the Internet?

CAIDA'S IPv4 AS Core
AS-level INTERNET GRAPH

Archipelago April 2011



The Internet is a ``network-of-networks", organized into autonomous systems (AS), each is owned by an organization.

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To learn more about the architecture of the Internet, read Section 1.3.3. The Internet topology figure is taken from `http://www.caida.org/research/topology/as_core_network/`

traceroute

You can also try to traceroute from other locations on the Internet at

`http://www.traceroute.org`

Routing: Decide which path/route to take

Reliability: Recover from packet losses

Link Rate/Bandwidth:
How many bits can be ``pushed'' onto a link per unit time.

Delay:
Time between send and receive

To send a packet in a packet switch network, for each link in the path

1. transmit packet onto the link as bits
2. propagate bits to next node
3. store and process the packet
4. wait to be transmitted

End-to-end packet delay consists of:

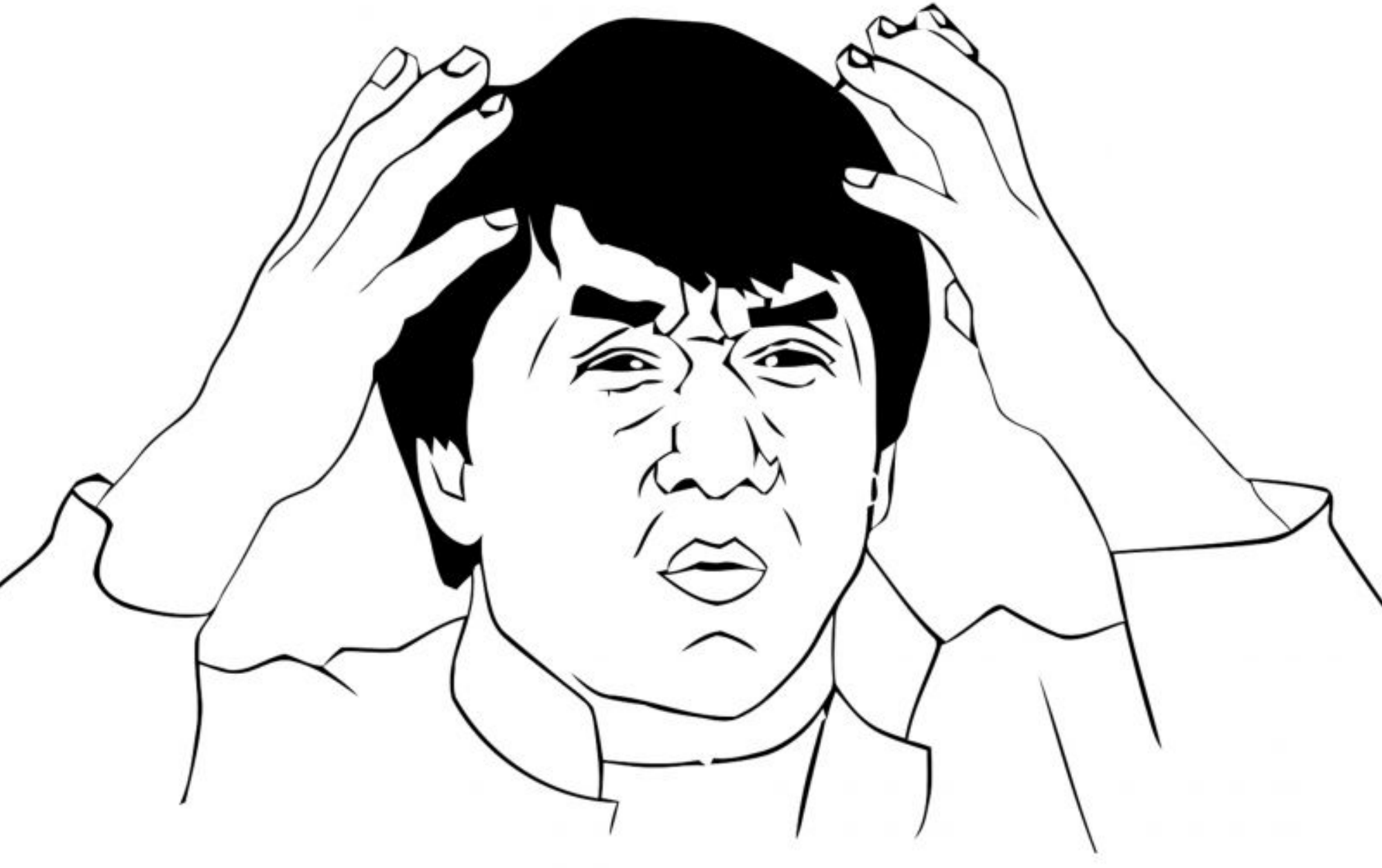
1. transmission delay
2. propagation delay
3. processing delay
4. queueing delay

Throughput:
How many bits can be communicated per unit time.

Multiple applications can run on each host

Demultiplexing: Determine which packet belongs to which application

Many issues to consider, to support different applications running on large number of hosts through different access technology and physical media.



Layering:
Common CS trick to deal with large and complex systems

Each layer provides a service;
Simple interfaces btwn layers;
Hide details from each other.

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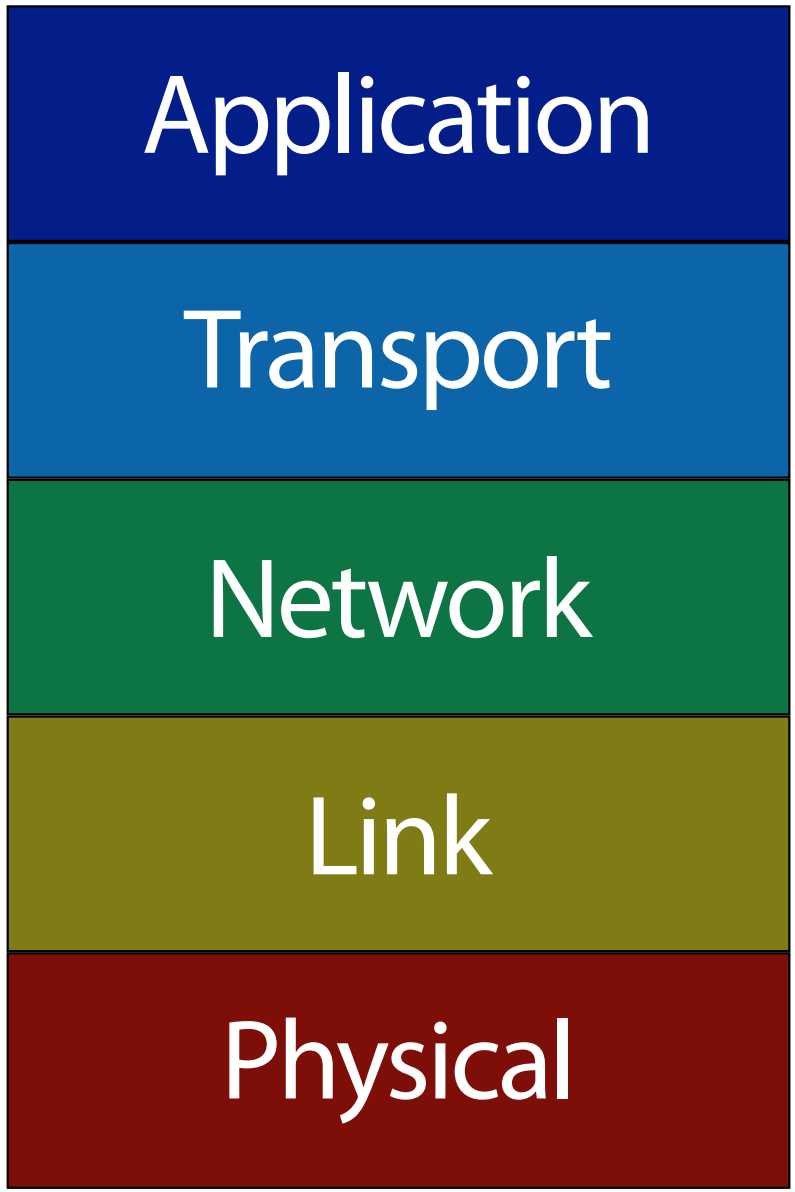
The five layers of the Internet are described in Section 1.5.


Application
Transport
Network
Link
Physical

Applications (or processes) treat the Internet as a **black box**, sending and receiving messages through a **socket**.

Transport layer
provides process-to-process message delivery services.

TCP

reliable, in-order delivery, with congestion and flow control

UDP
best-effort delivery

Network layer
host-to-host delivery

Link layer
node-to-node delivery

Physical layer

``bits over physical media"