

Computer Networks

CS3001

(Section BDS-7A)

Instructor: Dr. Syed Mohammad Irteza

Assistant Professor, Department of Computer Science

22 August, 2023

Administrative Information

- Office: L-109, 1st Floor, Library Building
- Email-01: m.irteza@nu.edu.pk
- Email-02: mohammad.irteza@lhr.nu.edu.pk
- Office Hours:
 - Possibly Tues/Thursday after 10:30 am.

Office Hours

You are welcome to visit and discuss things related to the course, or general academic and/or research interests!

If this slot does not suit you, try to arrange for a separate slot through email, preferably one day before.

Wednesdays are less suitable due to a busier schedule on those days.

Administrative Information

- Course Website (Google Classroom):
 - BDS-7A → <https://classroom.google.com/u/1/c/NjE4OTM2ODgzMDk1>
 - Invite Link: <https://classroom.google.com/c/NjE4OTM2ODgzMDk1?cjc=6mep63p>
- Class Schedule:
 - BDS-7A -- Tuesdays & Thursdays 08:30 – 10:00 (Venue: CS-2)

My Research/Academic Background

- BS, MS and PhD in Computer Science from LUMS
 - 2002, 2005, 2018
- PhD Thesis: *Resilient Network Load Balancing for Datacenters*
 - Advisor – Dr. Ihsan Ayyub Qazi
- Google Scholar Page:
 - <https://scholar.google.com/citations?hl=en&user=wHazKsgAAAAJ>
- Main Interests:
 - Datacenter Networking: network layer and transport layer protocols

Classroom Etiquette

- Please come on time within the first 5 minutes
- I am bothered by students talking among each other while I am delivering the course content
- I am bothered by students leaving class to attend phone calls
- Cases of plagiarism (copying of other people's work) may lead to marks and/or grade reductions
- Recommendation: try to write notes, this will improve your retention

Grading Policy – Tentative (May be changed)

- Quizzes → 15%
 - Quizzes will be unannounced, they can be held at the start or end of class
 - If we have 7 or more quizzes, we will drop the worst two quizzes
- Assignments → 10%
 - All assignments will count to your grade
- Midterm I & II → $15 + 15 = 30\%$
- Final Exam → 45%
 - Comprehensive exam (all course contents included)

Textbook

- “*Computer Networking: A Top Down approach*” by James F. Kurose and Keith W. Ross, **8th Edition**
- We may discuss some research papers during the semester
 - Mostly related to Datacenter Networking, Software Defined Networks, etc.

Course Objectives

- Discuss *basic* & *advanced* topics in the field of *computer networking*
- Talk about things like:
 - Different layers within the network
 - Wireless and mobile networking
 - Security and management
 - Datacenter networking
 - Software defined networking
- Discuss current *trends* and future *paths* within *modern computer networking*

Course Outline (some changes may happen)

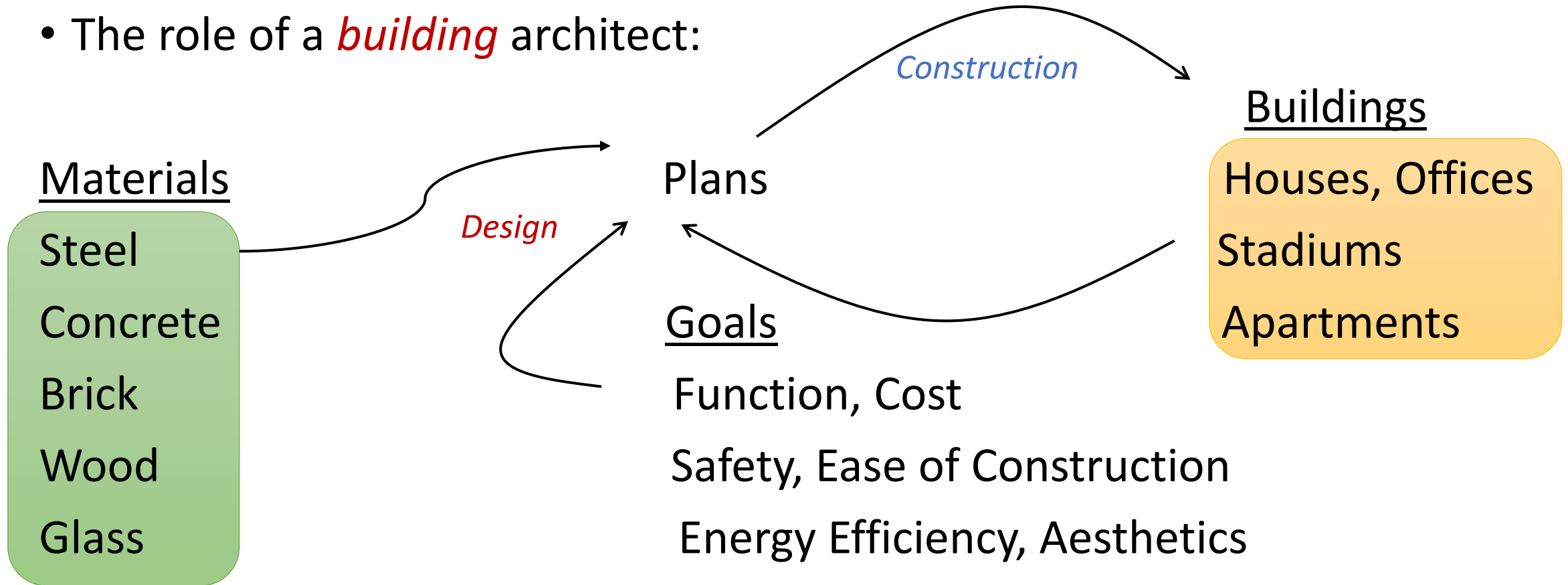
- Introduction and Overview of Computer Networking (**Module 1**)
- Application Layer (**Module 2**)
- Transport Layer (**Module 3**)
- Network Layer: Data Plane, Control Plane (**Module 4**)
- Physical and Link Layer Functionality (**Module 5**)
- Advanced Topics (**Module 6**)
- Review Session
- Final Exam

Lets move on to our first topic!

- Advanced in computer architecture have enabled many developments in computer networks

Analogy: Architects & Computer Architects

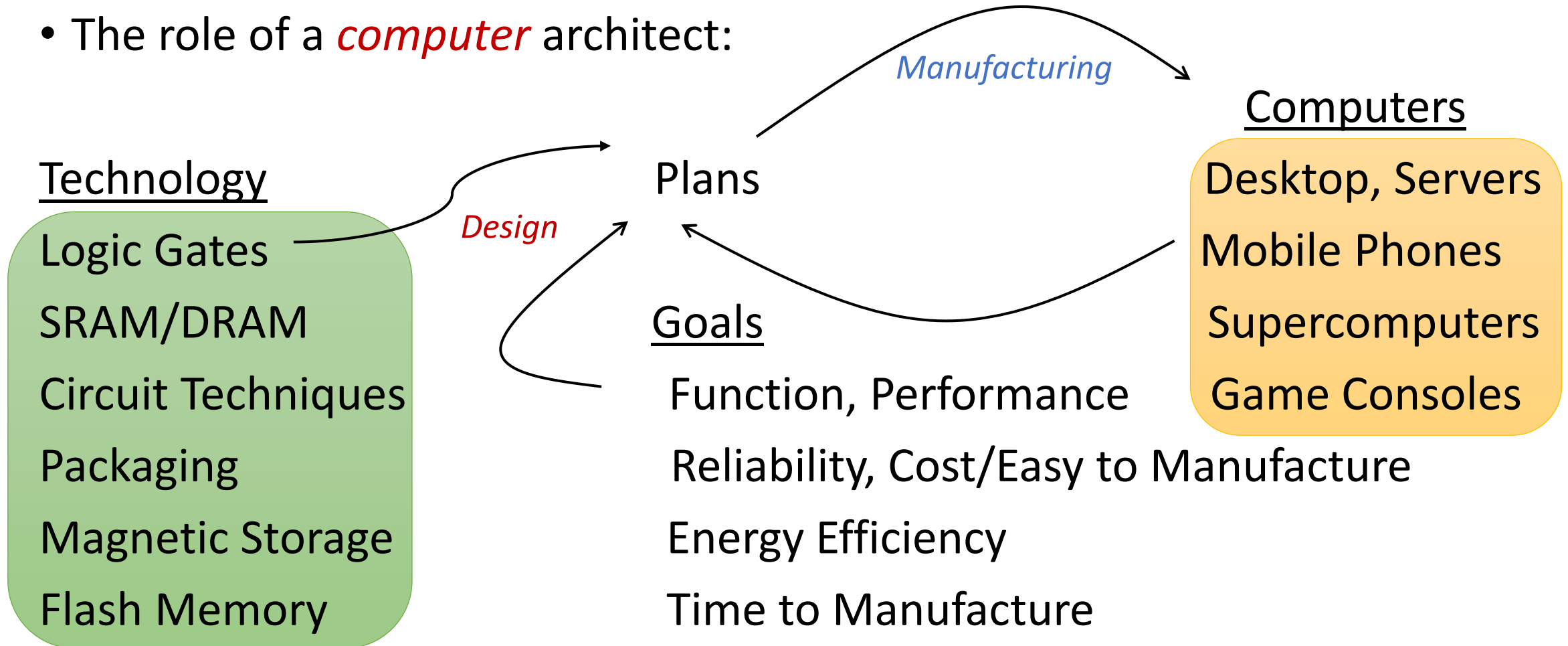
- The role of a *building* architect:



*ref. Prof. Milo Martin, UPenn

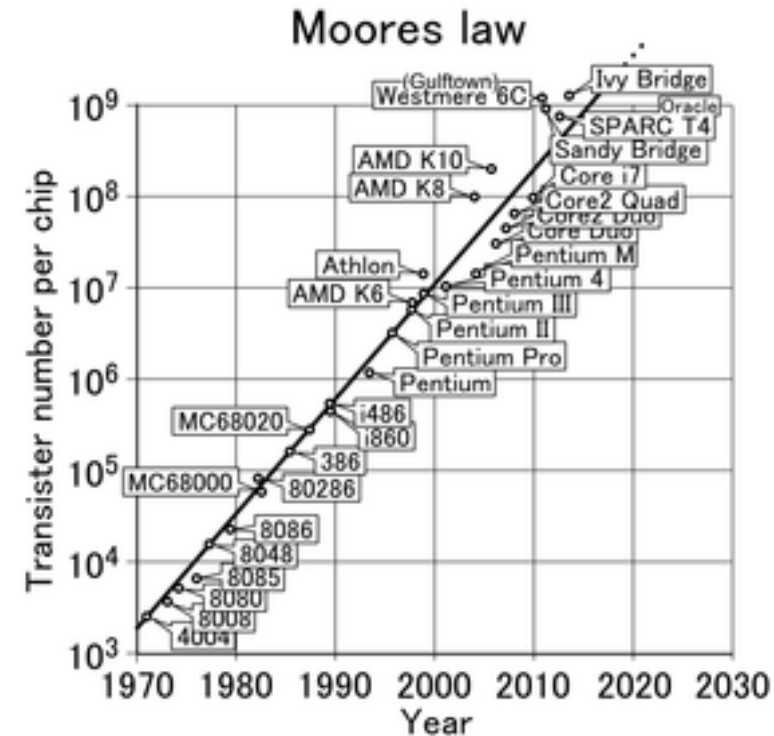
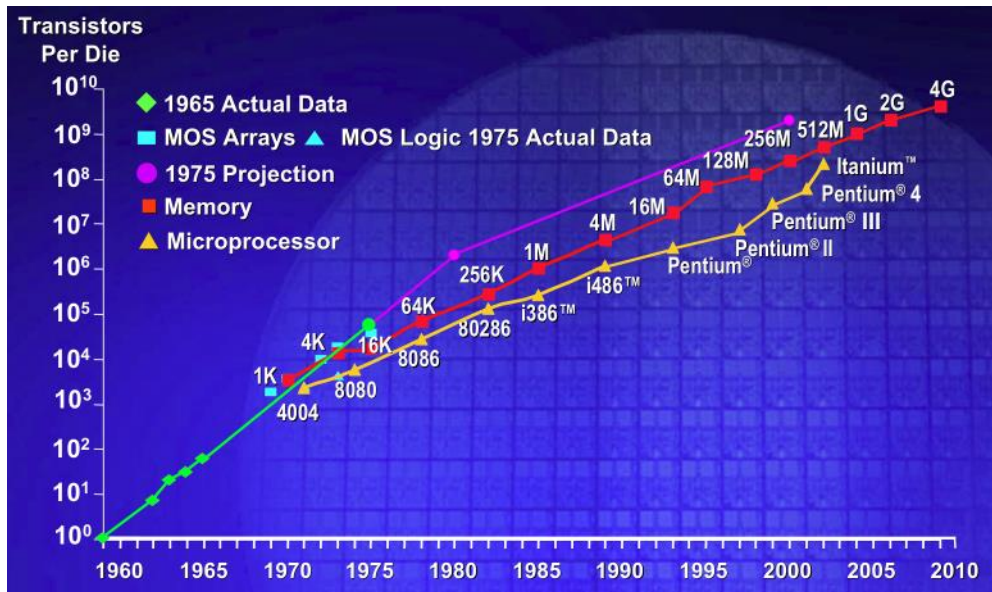
Analogy: Architects & Computer Architects

- The role of a *computer* architect:



Moore's Law

- Number of transistors on cost-effective integrated circuits (ICs) doubles every 18 months



Why study networking?

1. Printing press, 1430s
2. Electricity, late 19th century
3. Penicillin, 1928
4. Semiconductor electronics, 1950s
5. Optical lenses, 13th century
6. Paper, second century
7. Internal combustion engine, ~1860
8. Vaccination, 1796
- 9. The Internet, 1960s**
10. Steam engine, 1712

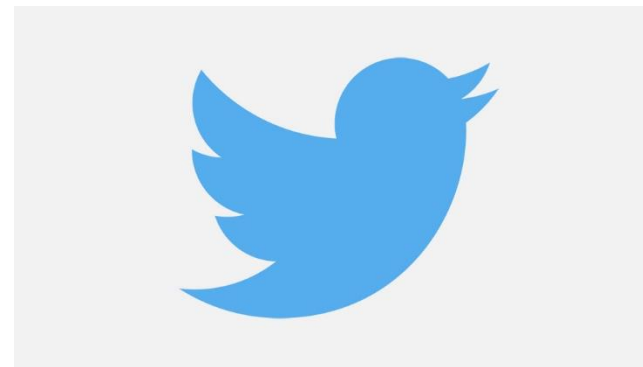
The 50 Greatest Breakthroughs Since the Wheel

Why did it take so long to invent the wheelbarrow? Have we hit peak innovation? What our list reveals about imagination, optimism, and the nature of progress.



Huge Impact on Society

- Social Media Applications supported by the Internet are used by millions of users everyday
 - Facebook – 1.66 billion users log on daily
 - Source: <https://zephoria.com/top-15-valuable-facebook-statistics/>
 - Twitter averaged 330 million DAU (daily active users) in first quarter of 2019
 - Source: <https://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users/>



Chapter 1

Introduction

A note on the use of these PowerPoint slides:

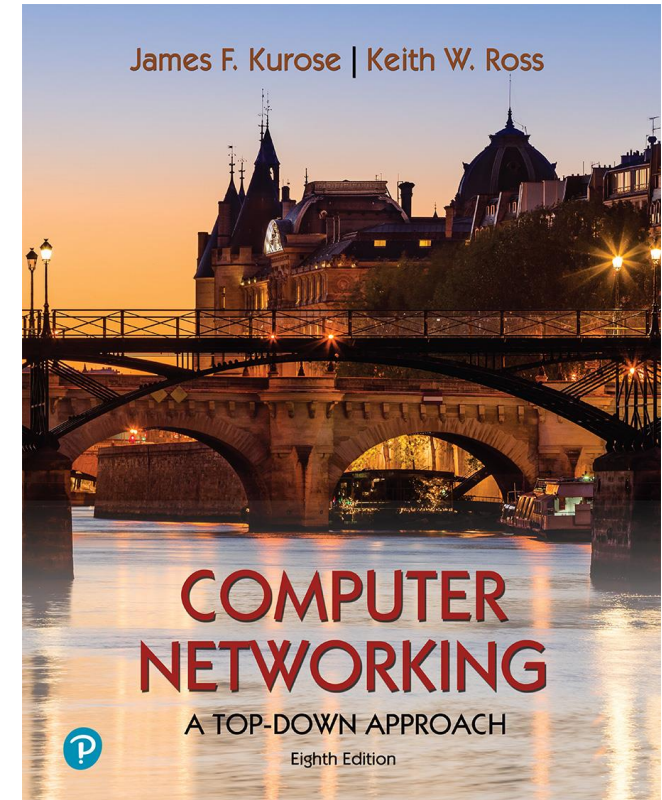
We're making these slides freely available to all (faculty, students, readers). They're in PowerPoint form so you see the animations; and can add, modify, and delete slides (including this one) and slide content to suit your needs. They obviously represent a *lot* of work on our part. In return for use, we only ask the following:

- If you use these slides (e.g., in a class) that you mention their source (after all, we'd like people to use our book!)
- If you post any slides on a www site, that you note that they are adapted from (or perhaps identical to) our slides, and note our copyright of this material.

For a revision history, see the slide note for this page.

Thanks and enjoy! JFK/KWR

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Computer Networking: A Top-Down Approach

8th edition

Jim Kurose, Keith Ross
Pearson, 2020

Chapter 1: introduction

Chapter goal:

- Get “feel,” “big picture,” introduction to terminology
 - more depth, detail *later* in course



Overview/roadmap:

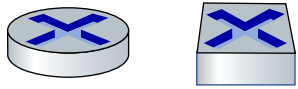
- What *is* the Internet? What *is* a protocol?
- **Network edge:** hosts, access network, physical media
- **Network core:** packet/circuit switching, internet structure
- **Performance:** loss, delay, throughput
- Protocol layers, service models
- Security (*might be excluded*)
- History (*might be excluded*)

The Internet: a “nuts and bolts” view



Billions of connected computing *devices*:

- *hosts* = end systems
- running *network apps* at Internet's “edge”



Packet switches: forward packets (chunks of data)

- *routers, switches*

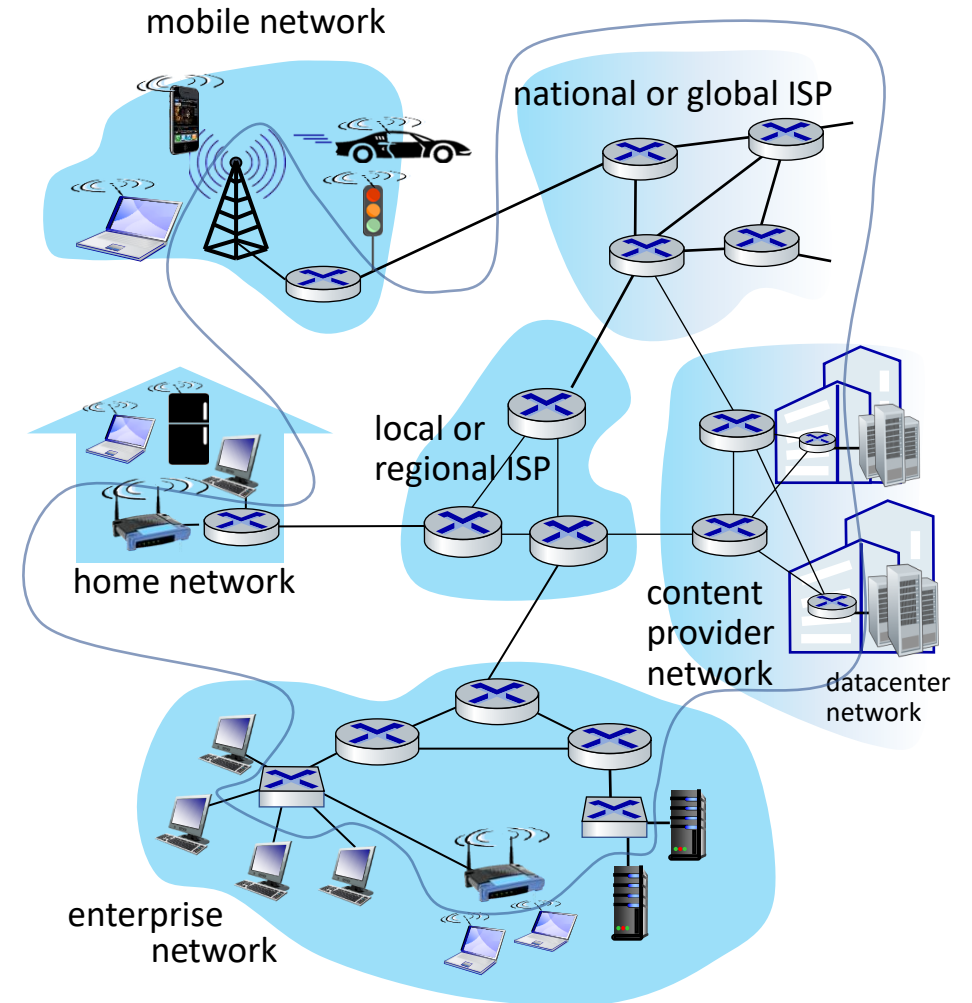


Communication links

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

Networks

- collection of devices, routers, links: managed by an organization



“Fun” Internet-connected devices



Amazon Echo



Internet refrigerator



IP picture frame



Pacemaker & Monitor



Tweet-a-watt:
monitor energy use



Security Camera



Slingbox: remote control cable TV



Web-enabled toaster +
weather forecaster



AR devices



Fitbit



diapers



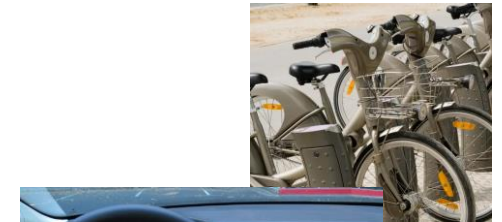
Internet phones



Gaming devices



sensorized,
bed
mattress



bikes



cars

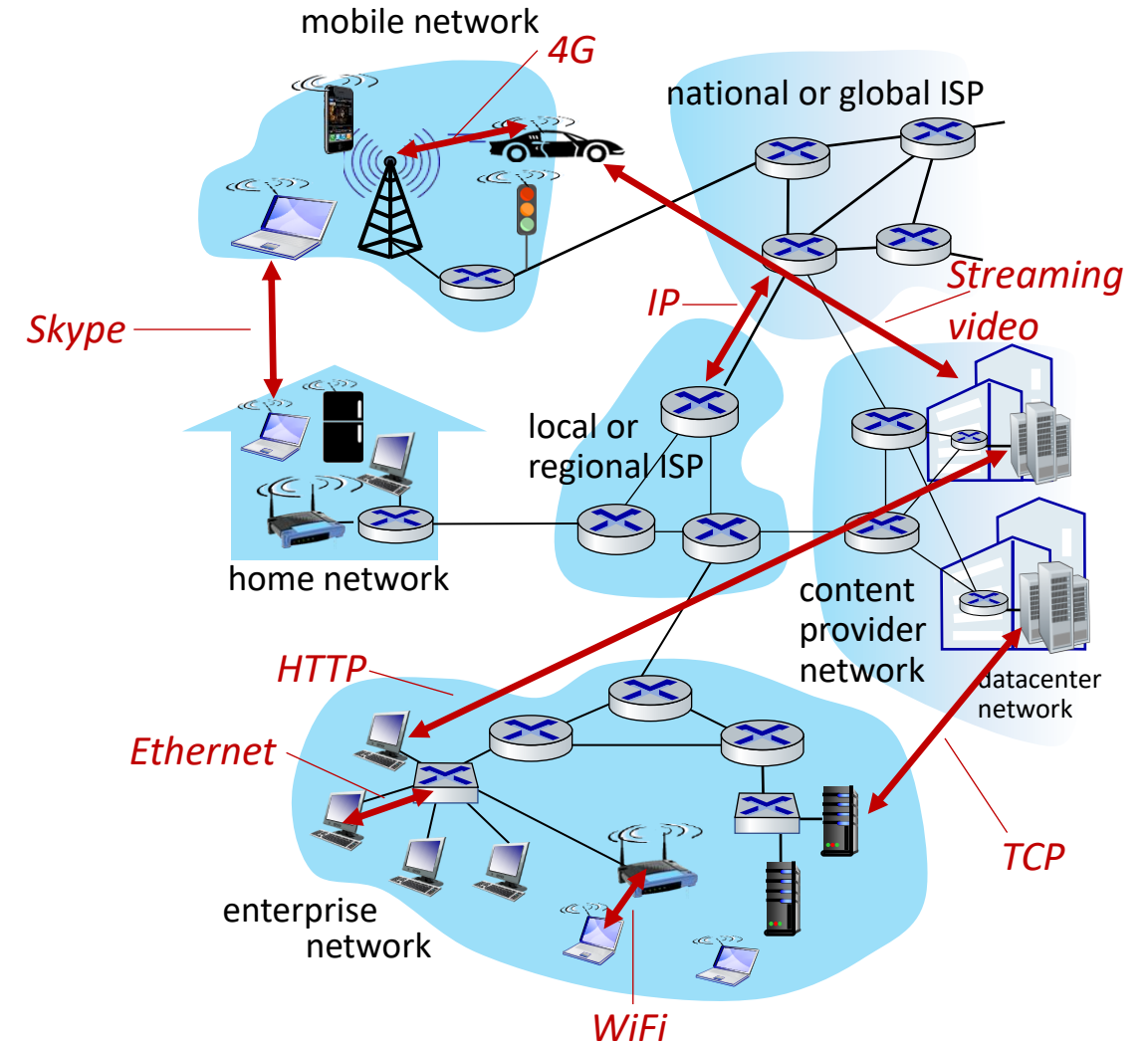


scooters

Others?

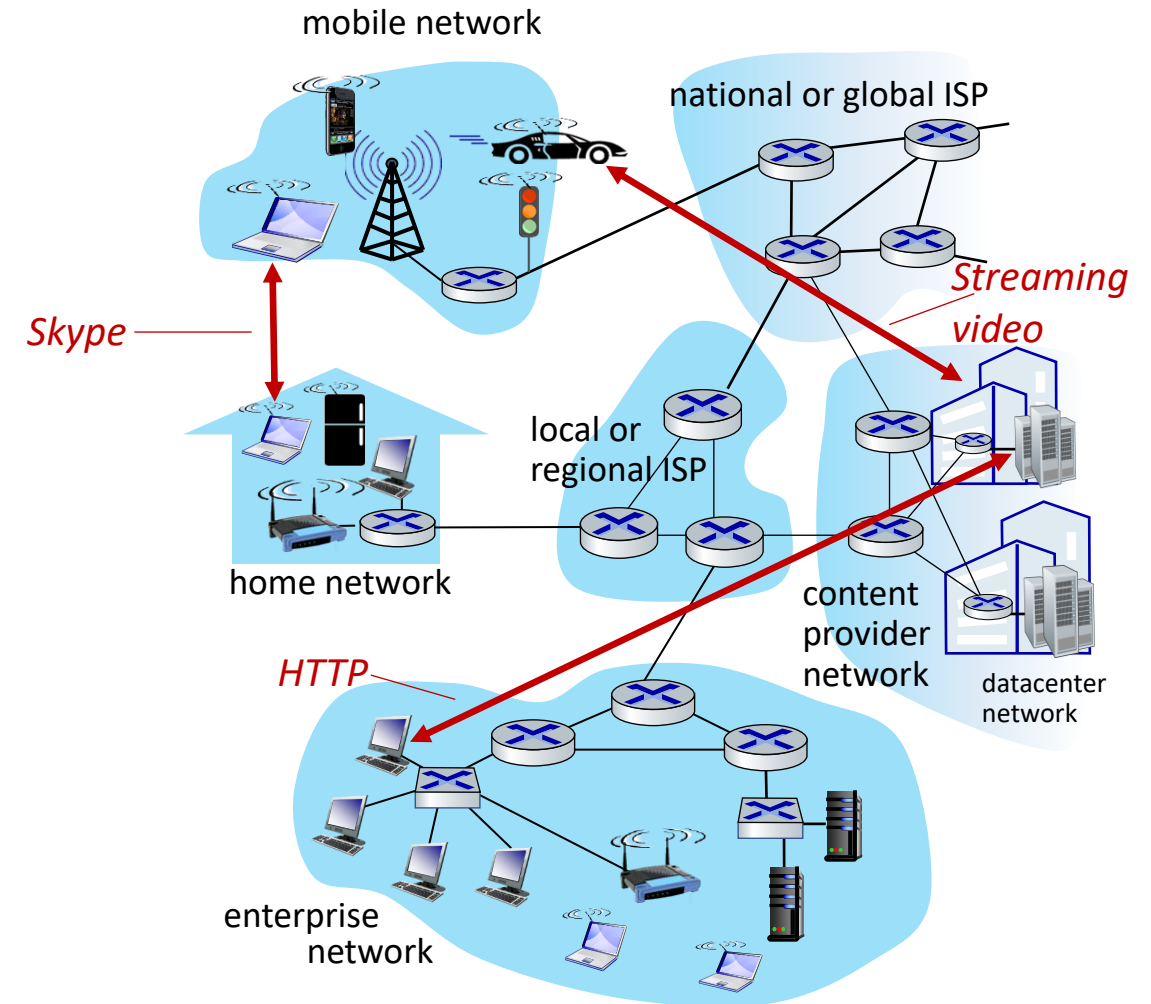
The Internet: a “nuts and bolts” view

- *Internet: “network of networks”*
 - Interconnected ISPs
- *protocols are everywhere*
 - control sending, receiving of messages
 - e.g., HTTP (Web), streaming video, Skype, TCP, IP, WiFi, 4/5G, Ethernet
- *Internet standards*
 - RFC: Request for Comments
 - IETF: Internet Engineering Task Force



The Internet: a “services” view

- *Infrastructure* that provides services to applications:
 - Web, streaming video, multimedia teleconferencing, email, games, e-commerce, social media, inter-connected appliances, ...
- provides *programming interface* to distributed applications:
 - “hooks” allowing sending/receiving apps to “connect” to, use Internet transport service
 - provides service options, analogous to postal service



What's a protocol?

Human protocols:

- “what’s the time?”
- “I have a question”
- introductions

Rules for:

- ... specific messages sent
- ... specific actions taken
when message received,
or other events

Network protocols:

- computers (devices) rather than humans
- all communication activity in Internet
governed by protocols

*Protocols define the **format, order** of
messages sent and received among
network entities, and **actions taken**
on message transmission, receipt*

Acknowledgement

- I have taken help for these slides from the work of:
 - Dr. Ankit Singla (ETH Zurich)
 - Dr Sami Rollins (Mount Holyoke College)