EECS 333: Introduction to Communication Networks

Professor Dongning Guo

Department of Electrical Engineering & Computer Science
Northwestern University

Spring 2007

Course Information

Lecturer: Prof. Dongning Guo
Teaching Assistant: Jun Luo

Prerequisite (important)

Basic probability theory (EECS302, IEMS302, Math330, or equivalent).
Handout: A brief note of probability.

Textbook

A. Leon-Garcia and I. Widjaja, Communication Networks: Fundamental Concepts and Key Architectures, 2nd edition, McGrawHill, 2004.
The book provides principles and a lot of details. Focus on the principles.

Course website

https://courses.northwestern.edu/

Problem sets

Quasi-weekly, usually due on Friday in class. (A one-time delay of 48 hours is allowed. Late homework not accepted otherwise.)
Working in groups of 2 or 3 is encouraged if enhances learning.
Each student should write own solution to hand in.

Office hours

Prof. Guo: Wednesday 3–4 pm or by appointment.
Jun Luo: 4–5 pm, Tue/Thu (subject to change).

Exams

Midterm: Friday, April 27, in class.
Final: Monday, June 4, 9-11 am.

Course grade

Midterm 25% Final 45% Problem Sets 30%.
Undergraduate and graduate students on separate scales.

Chapter 1: Introduction

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March 26, 2007

Outline

This course provides an introduction to communication networks, such as the Internet and the public telephone network.

Primary goals

1. To help you develop a conceptual framework for understanding the key issues that must be addressed in communication networks;
2. To introduce some of the technologies in modern networks;
3. To help you learn some basic methods for performance analysis for networks;
4. **Not** to learn detailed specifications of particular standards - rather, the emphasis is on basic principles.

Elements of Networks

Definition

A *communication network* is an infrastructure that allows users to exchange information.

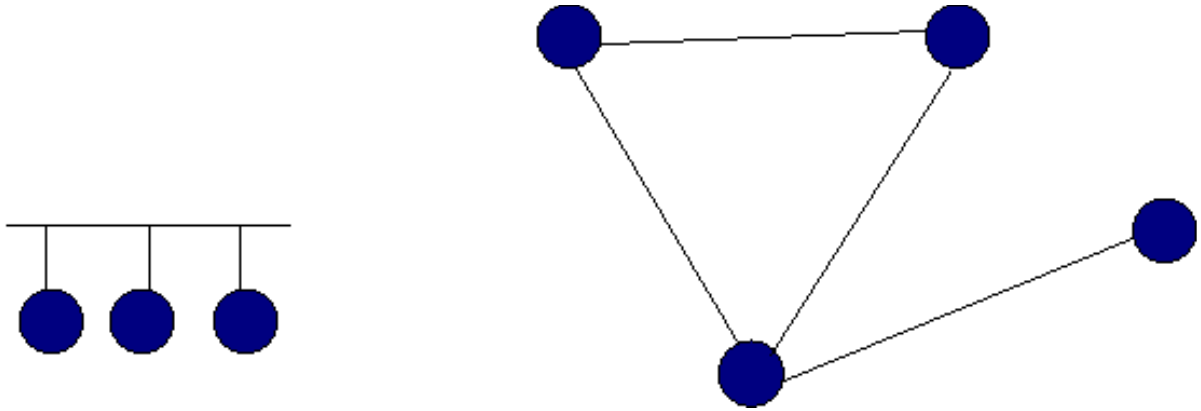
Key elements

- User — a person, a computer program, a sensor, and etc;
- Information — a text, a computer file, a webpage, a video, and etc. Digital representation of information. Analog-to-digital conversion.

Examples

Postal service, public telephone network (including cellular telephony), cable TV, wireless local area network (wifi), Internet (a “network of networks”).

Network components



Nodes

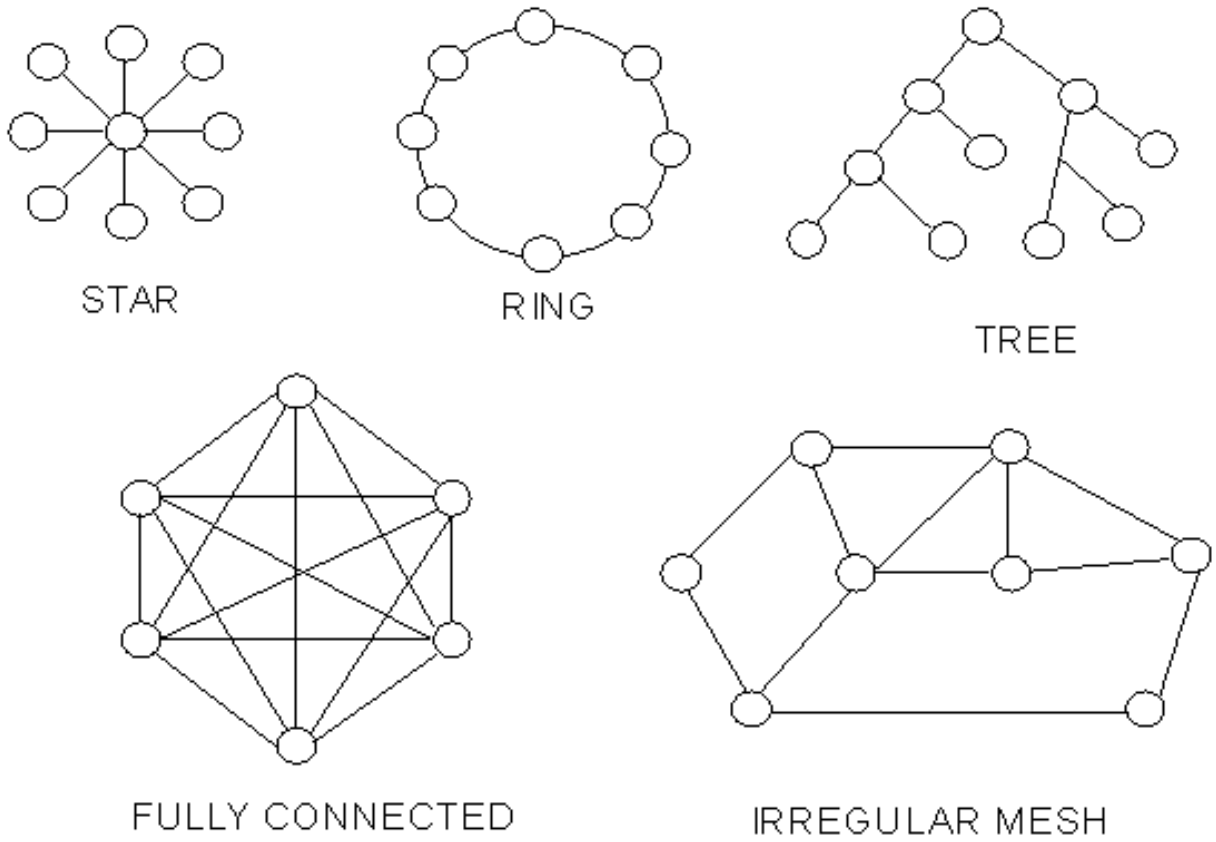
Devices that produces or process information. E.g., computers, switches, routers, servers.

Links

Physical channel over which information is sent. Point-to-point vs. broadcast. E.g., optical fiber, twisted-pair copper wire, radio link. Point-to-point: Transmitter $\longrightarrow$ channel $\longrightarrow$ receiver.

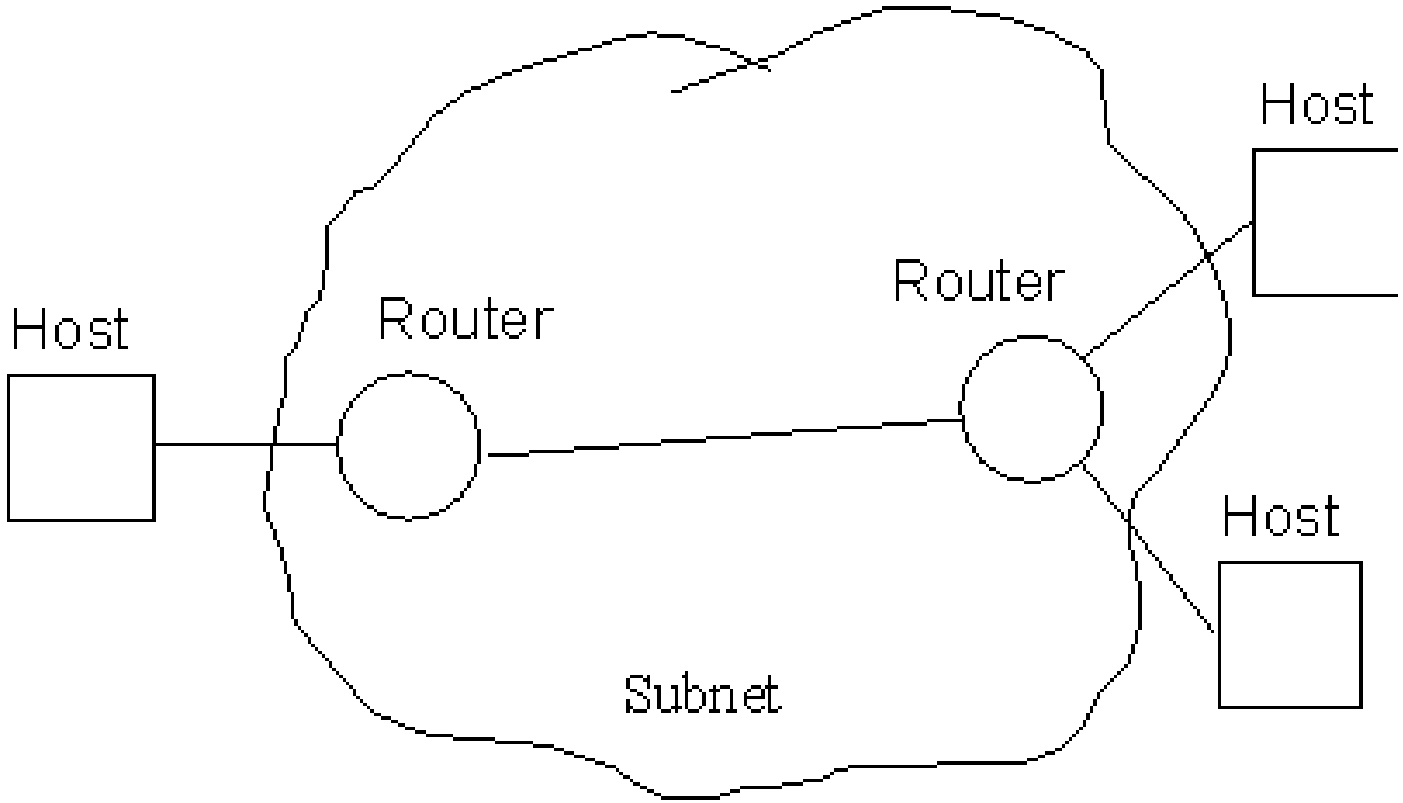
Some common network topologies

Topology: The arrangement of links and nodes.



Subnet

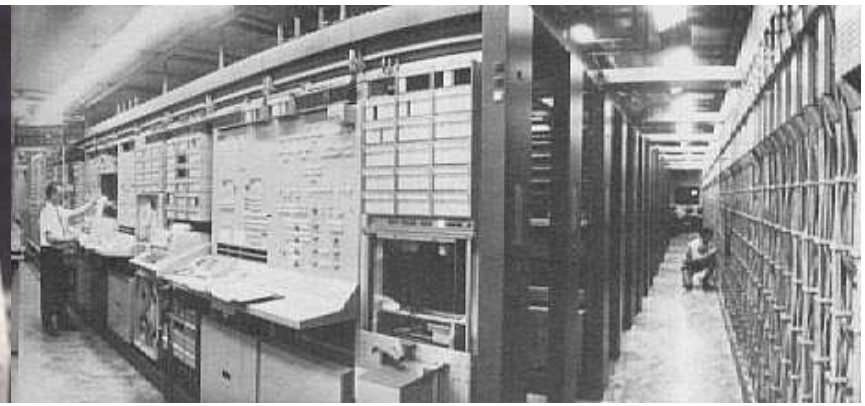
Sometimes non-terminal nodes and links are grouped together and called the “subnet” (this term has a different meaning in IP routing).



Some History: Telephone Network

- Before telephone: Telegraph.
- 1876 Bell invented telephone.
- 1880s Manual switching.
- 1890s Electromechanical switches.
- 1970s Computerized switches.





History: Mobile Telephony

- Predecessor: Mobile rigs (two-way radios in vehicles).
- 1946 Swedish police, (possibly) the first ones connected to the telephone network.
- 1973 Modern mobile phone, Motorola (Dr. Martin Cooper).
- 1978 Trial of commercial cellular network (Bell Labs, in Chicago).
- 1980s First generation (analog).
- 1990s Second generation (digital voice).
- 2000s Third generation (digital voice/data).

History: Computer Networks

- 1946 First electronic digital computer invented.
- 1957 Soviet Union launched the first artificial satellite, Sputnik I.
- 1958 ARPA (Advanced Research Projects Agency).
- 1968 ARPANET: computers connected via dial-up telephone lines.
- 1970 ALOHAnet: first wireless packet network.
- 1972 Email.
- 1974 TCP: Bob Kahn and Vinton Cerf (2005 Turing Awardees).
- 1986 NSFNET.
- 1991 World Wide Web (HTML due to Tim Berner-Lee).
- 1993 Mosaic (first web browser).

Convergence

Single-purpose vs. integrated service

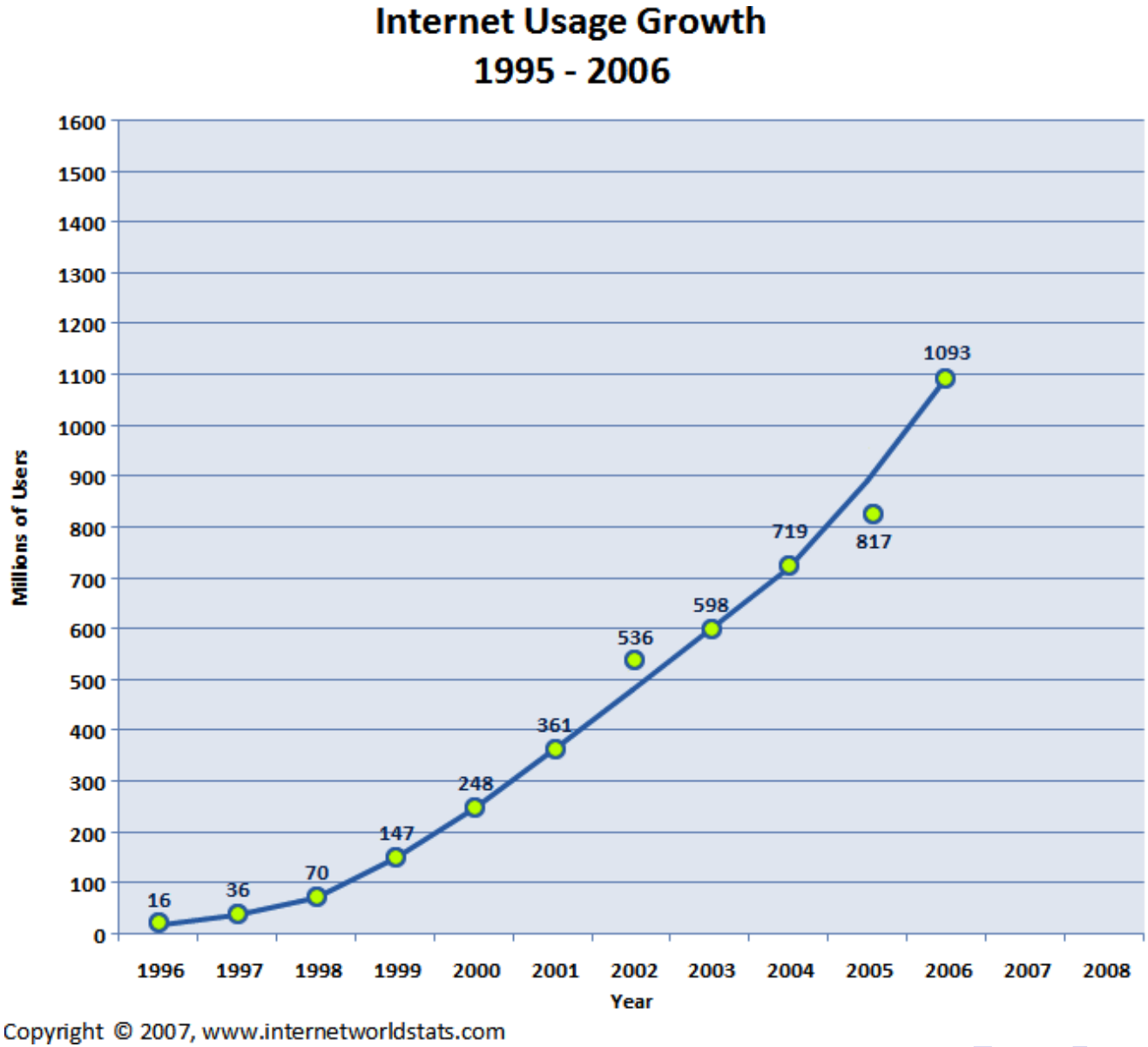
Early networks were designed for a single purpose.
The trend is towards networks that satisfy a variety of different users.

- cost effective;
- made possible by digital revolution.

Examples

IP phone. 3G and 4G telephony.

Growth of the Internet (Number of Hosts)



Some reasons for growth

- Economic benefits.
- Critical mass of users - economies of scale, increased user value.
- Advances in VLSI - faster, cheaper, smaller computers.
- Fiber optic communication - high speed, huge bandwidth, reliable links.
- Applications - web browsers, and etc.

Classifying Networks

By size or distance between nodes

- PAN Personal Area Network
- LAN Local Area Network
- MAN Metropolitan Area Network
- WAN Wide Area Network

Different economics. Different technologies.

Modeling Uncertainty

Sources of uncertainty

- Arrival times of packets, sessions, ...
- Lengths of packets, sessions, ...
- Destination of packets.
- Whether errors occur in packets.
- When a link or node fails.

Probability theory

is the key for modeling uncertainty and analyzing networks.

Related (undergraduate) courses:

Computer science

- EECS 340 - Introduction to Computer Networking

Communication systems & networking

- ECE 307 Communication Systems
- ECE 378 Digital Communications
- ECE 380 Wireless Communications

Photonics

- ECE 383 fiber optic communication

Computer engineering

- ECE 358 Introduction to Parallel Computing
- ECE 362 Computer Architecture Projects