

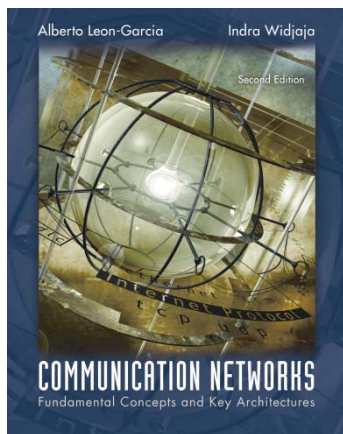
CSE 3213: Communication Networks

Winter 2010



Course Web-Page: https://wiki.cse.yorku.ca/course_archive/2009-10/W/3213/

Instructor: Foroohar Foroozan (foroozan@cse.yorku.ca)



Office Hours: TR 14:00-15:00 (CSE 2052)

Prerequisite: General Prerequisite.

Textbook: "Communication Networks:
Fundamental Concepts and Key Architectures",

A. Leon-Garcia and I. Widjaja, McGraw Hill, 2004, 2nd edition.

Other Material:

"Data Communications and Networking", B. A. Forouzan, McGraw Hill, 2007, 4th edition.

"Computer Networks: A Systems Approach – Network Simulation Experiments Manual",
E. Aboelela, Morgan Kaufmann, 2008, 2nd edition.



Grading Scheme:

Quiz 1, 2, 3, 4:	4 x 3 % =	12 %
Lab Report 1, 2 ,3:	2 x 6 % =	18 %
Midterm (Feb 24):		30%
Final:		40%

Missed Midterm/ Quizes:

Missing a test will result in a score of zero – unless the official York [attending physician's statement](#) is filled out. (with the official physician's statement, the weight of the exam/quiz will be added to that of the final exam.)

Exact time of each Quiz will be announced on the course Web site, in advance.

Lab Software:

OPNET IT Guru (Academic Edition)

- 'free' **network simulation** software
- 6-month renewable licence
- lab-manual will be available after reading week
- labs to take place in March

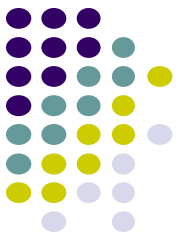


Course Objective and Schedule:

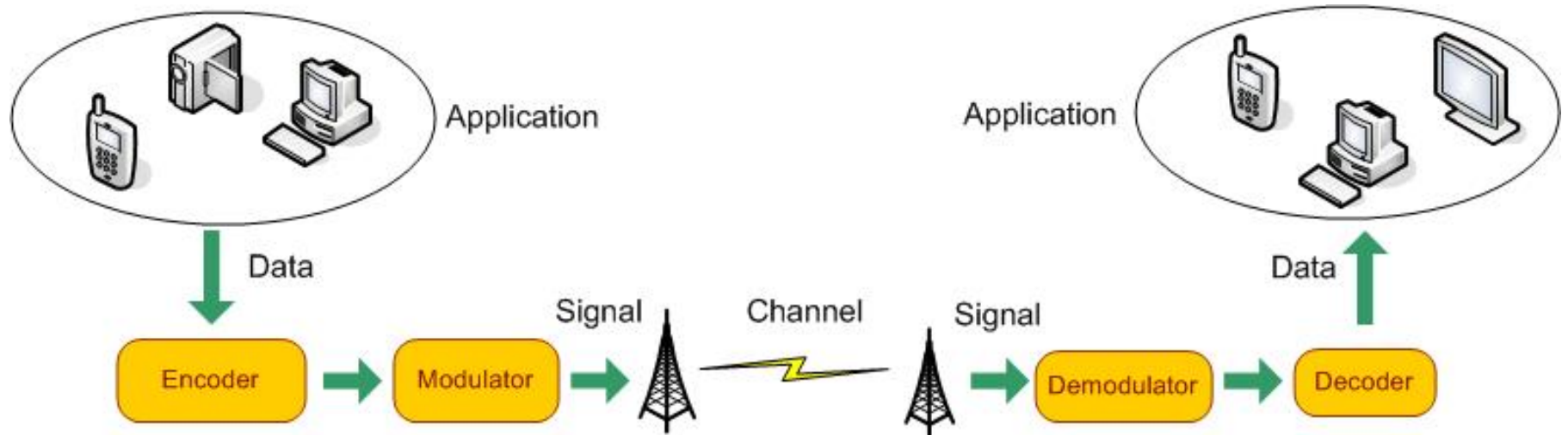
The course is an introduction to communications and networking. Topics covered include:

- **Message, Circuit, Packet Switching LANs, WANs**
- **Applications and Layered Architectures**
- **Digital vs. Analog Communications**
- **Characterization of Communication Channels**
- **Channel Capacity, Nyquist and Shannon Theorems**
- **Line Coding (RZ, NRZ, Bipolar, Manchester)**
- **Digital Modulation (ASK, PSK, FSK)**
- **Properties of Media and Digital Transmission Systems**
- **Error Detection and Correction**
- **Flow and Error Control**
- **Medium Access Control (Aloha, CSMA, Scheduling)**
- **LAN Protocols (Ethernet, Token Ring, Wireless LANs)**
- **Connecting LANs**
- **Network Layer and IP Protocol**





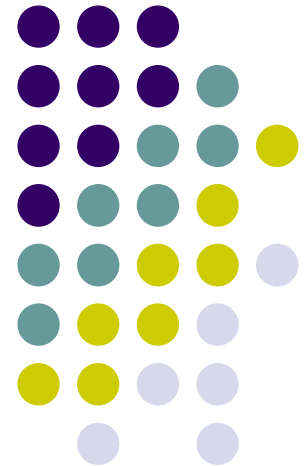
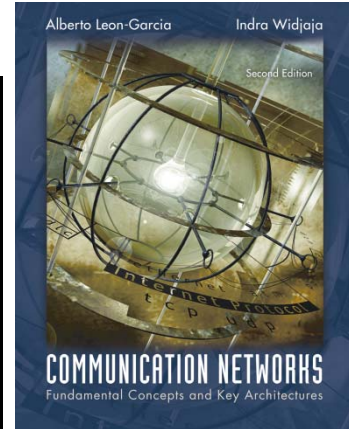
Telecommunication = communication over distance



Chapter 1

Communication Networks and Services

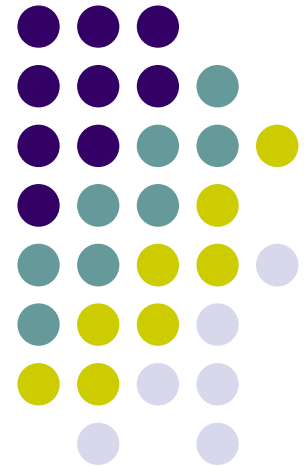
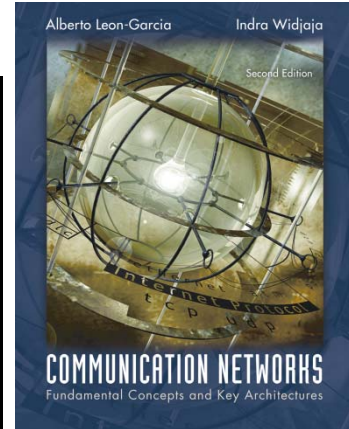
Network Architecture and Services
Telegraph Networks & Message Switching
Telephone Networks and Circuit Switching
Computer Networks & Packet Switching



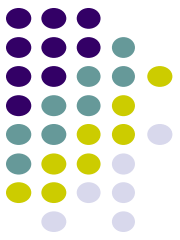
Chapter 1

Communication Networks and Services

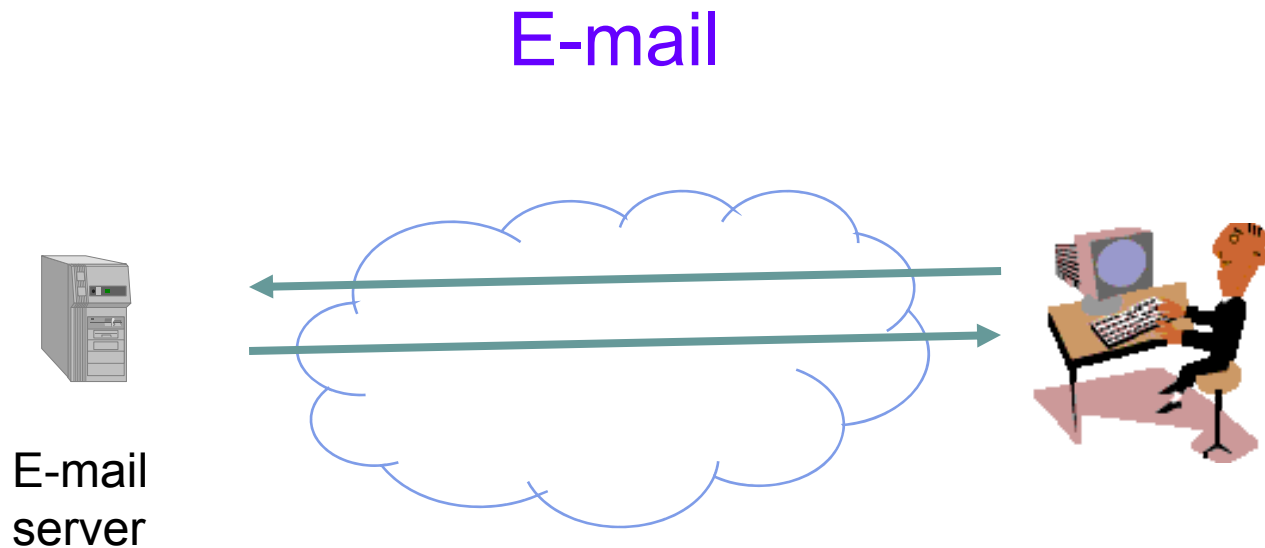
Network Architecture and Services



Communication Services & Applications

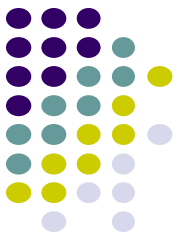


- A communication service enables the exchange of information between users at different locations.
- Communication services & applications are everywhere.



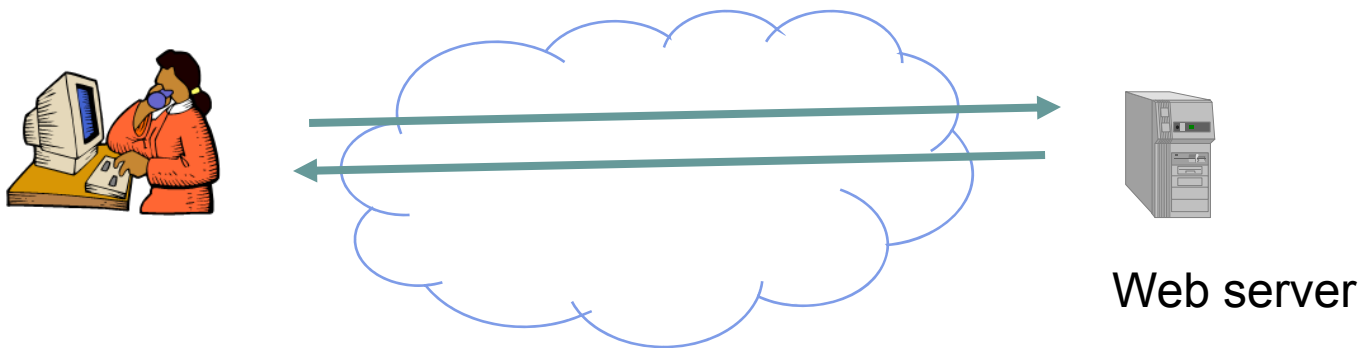
Exchange of text messages via servers

Communication Services & Applications



- A communication service enables the exchange of information between users at different locations.
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Web Browsing



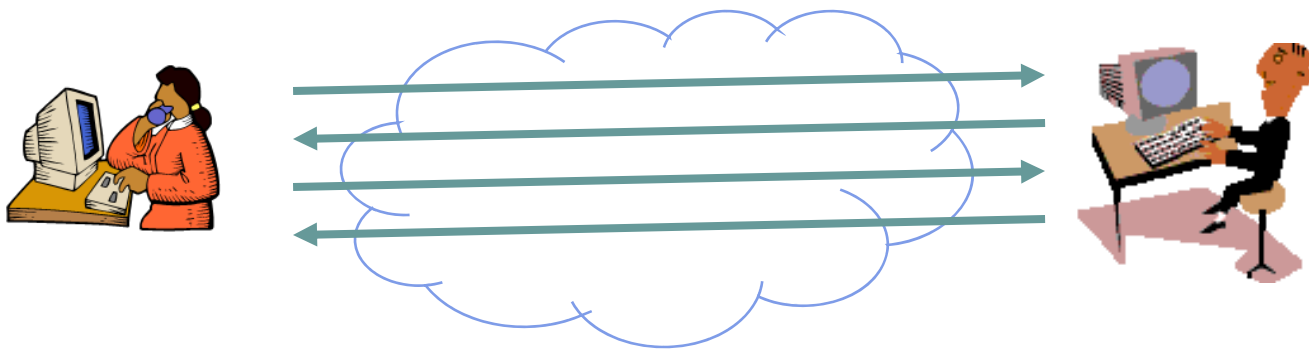
Retrieval of information from web servers

Communication Services & Applications



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Instant Messaging



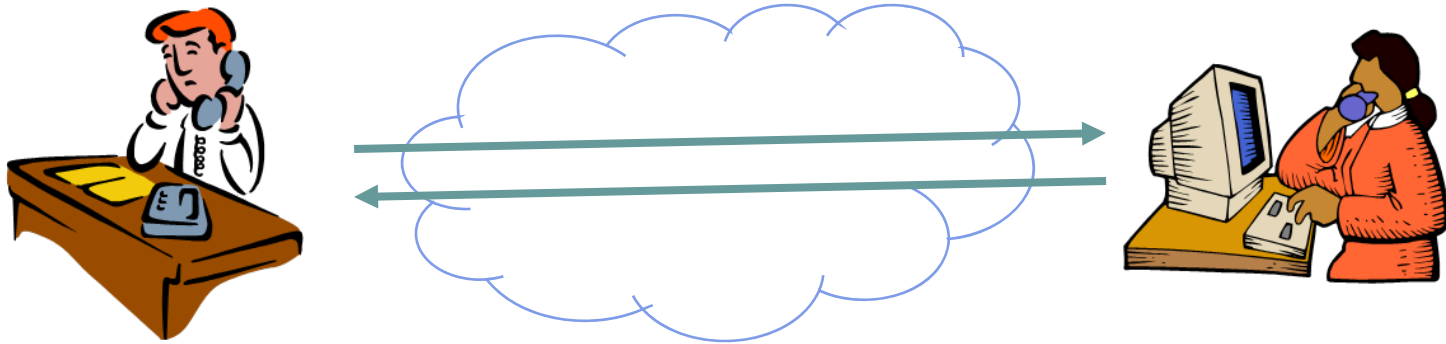
Direct exchange of text messages

Communication Services & Applications



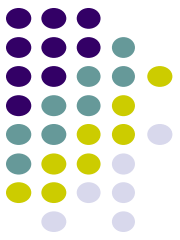
- A communication service enables the exchange of information between users at different locations.
- Communication services & applications are everywhere.

Telephone

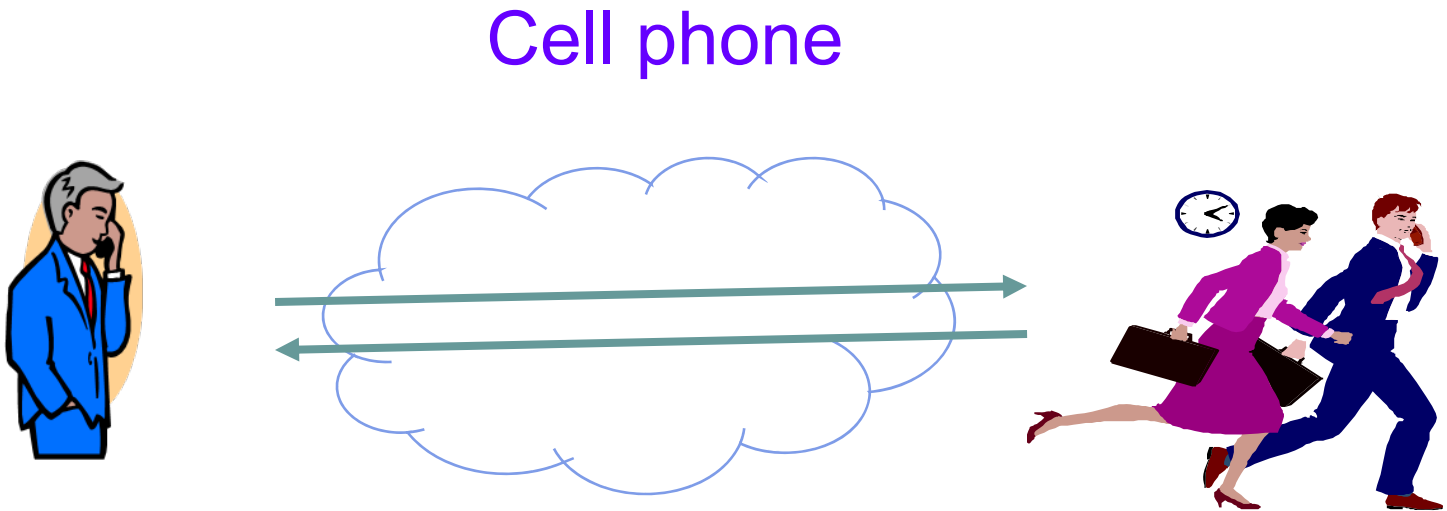


Real-time bidirectional voice exchange

Communication Services & Applications



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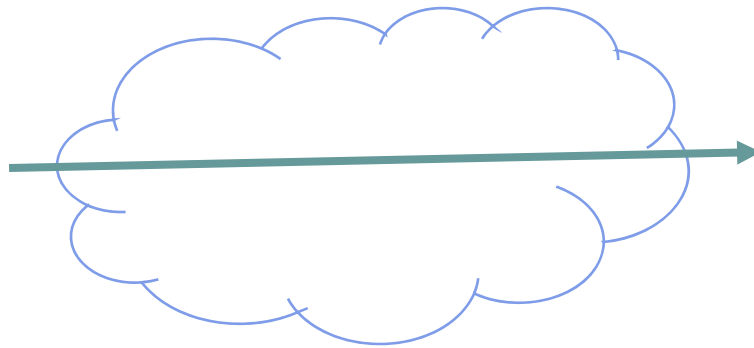
Real-time voice exchange with mobile users

Communication Services & Applications



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Short Message Service



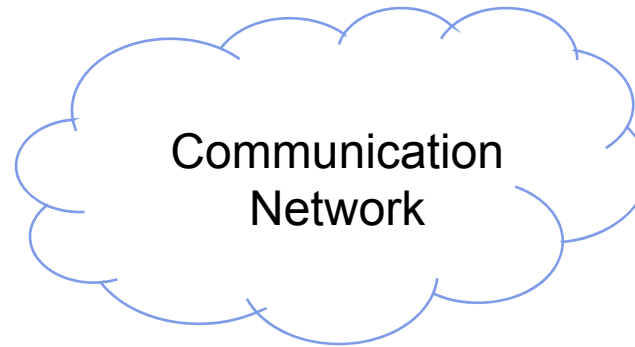
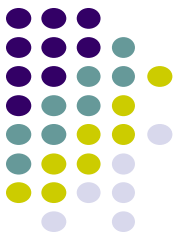
Fast delivery of short text messages

Services & Applications



- Service: Basic information transfer capability
 - Internet transfer of individual block of information
 - Internet reliable transfer of a stream of bytes
 - Real-time transfer of a voice signal
- Applications build on communication services
 - E-mail & web build on reliable stream service
 - Fax and modems build on basic telephone service
- New applications build on multiple networks
 - SMS builds on Internet reliable stream service and cellular telephone text messaging

What is a communication network?



- The equipment (hardware & software) and facilities that provide the basic communication service
- Virtually invisible to the user; Usually represented by a cloud
- Equipment
 - Routers, servers, switches, multiplexers, hubs, modems, ...
- Facilities
 - Copper wires, coaxial cables, optical fiber
 - Ducts, conduits, telephone poles ...

How are communication networks designed and operated?

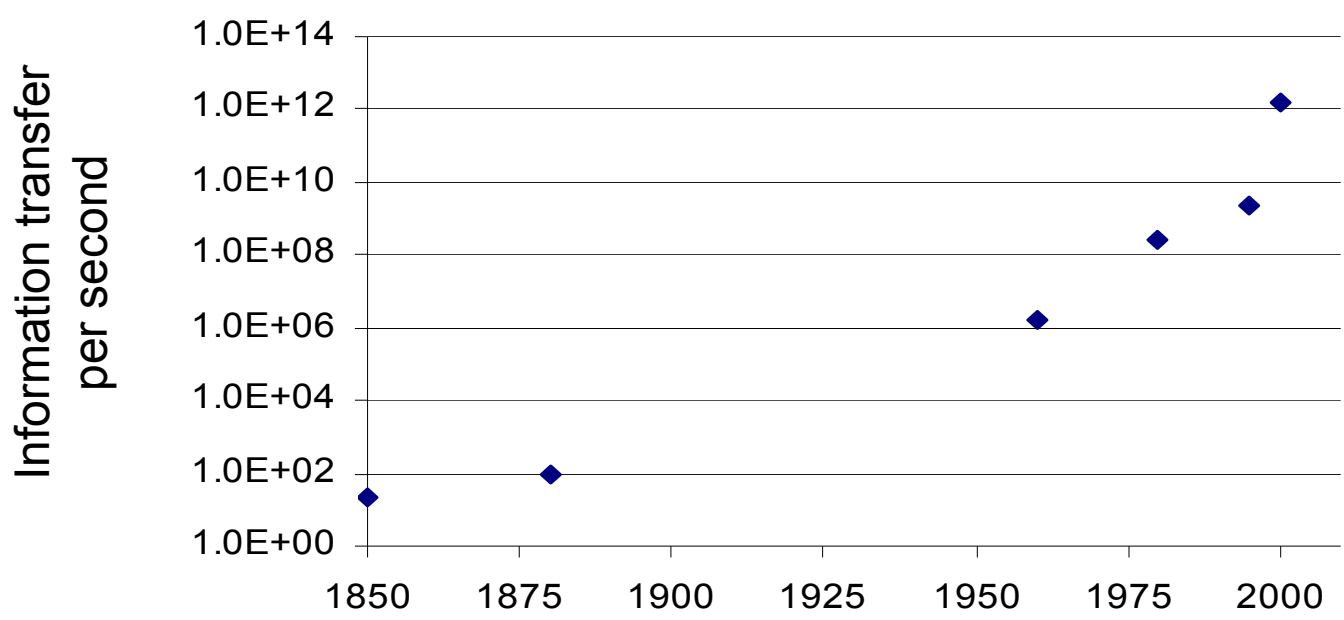
Communication Network Architecture



- *Network architecture*: the plan that specifies how the network is built and operated
- Architecture is driven by the network services
- Overall communication process is complex
- Network architecture partitions overall communication process into separate functional areas called *layers*

Next we will trace evolution of three network architectures: telegraph, telephone, and computer networks

Network Architecture Evolution



?

Telegraph networks

Telephone networks

Internet, Optical & Wireless networks

Next Generation Internet

Network Architecture Evolution

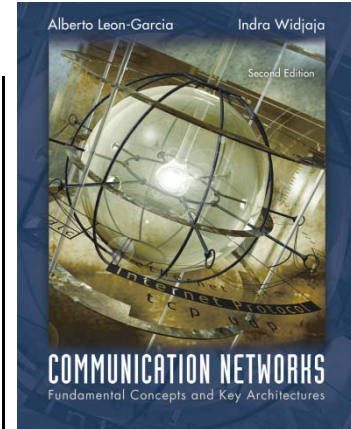


an indicator of the progress in comm. technology is the speed at which data can be transmitted measured in [bps]

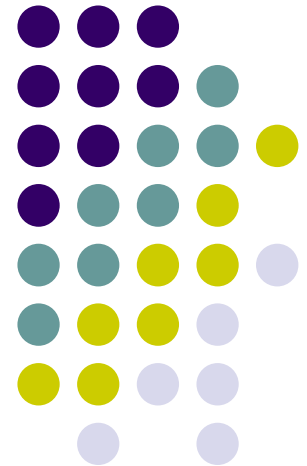
- Telegraph Networks [**20 bps**]
 - Message switching & digital transmission
- Telephone Networks [**64 kbps**]
 - Circuit Switching
 - Analog transmission → digital transmission
 - Mobile communications
- Internet [**n*Gbps**]
 - Packet switching & computer applications
- Next-Generation Internet
 - Multiservice packet switching network

Chapter 1

Communication Networks and Services



Telegraph Networks & Message Switching



Telegraphs & Long-Distance Communications



Approaches to long-distance communications

- Courier: physical transport of the message
 - Messenger pigeons, pony express, FedEx
- Telegraph: message is transmitted across a network using signals
 - Drums, beacons, mirrors, smoke, flags, semaphores...
 - Electricity, light
- Telegraph delivers message much sooner

Telegraphs Networks : Message Switching



Electric Telegraph wires were stretched from one point to another; electric current is either allowed to flow through the wires or is broken by switch called **telegraph key**

electric current is used to activate a **sounder** which makes clicking sounds – short / long times between clicks are decoded into letters from the alphabet

Morse Telegraph text message is encoded into a sequence of dots and dashes [1837]

- dots and dashes are converted into short and long pulses of electric current
- **digital transmission system** – relies only on 2 signal-levels

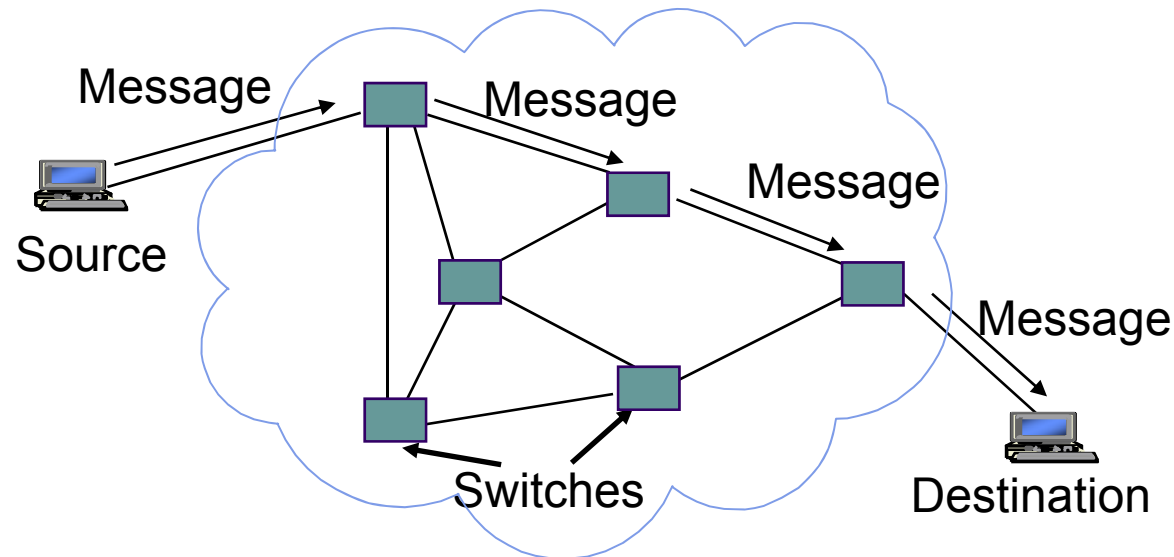


	Morse Code		Morse Code		Morse Code		Morse Code
A	- · -	J	- · - - -	S	- · - · -	2	- · - - - -
B	- · - - -	K	- · - -	T	- -	3	- · - - - -
C	- · - - -	L	- · - - ·	U	- · - -	4	- · - - -
D	- · - -	M	- - -	V	- · - - -	5	- · - - -
E	-	N	- - -	W	- · - - -	6	- · - - -
F	- · - - -	O	- - - - -	X	- · - - -	7	- · - - -
G	- · - -	P	- · - - -	Y	- - - - -	8	- · - - -
H	- · - -	Q	- · - - -	Z	- - - - -	9	- · - - -
I	- · -	R	- · - -	1	- - - - -	0	- - - - -

Electric Telegraph Networks



- Electric telegraph networks exploded
 - Message switching & Store-and-Forward operation
 - Key elements: Addressing, Routing, Forwarding



Elements of Telegraph Network Architecture

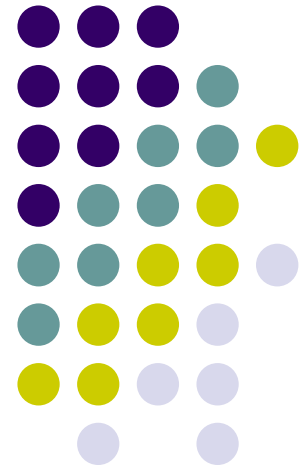
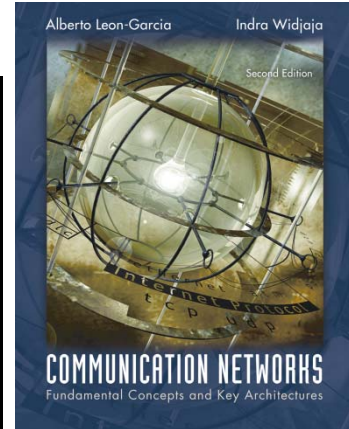


- Digital transmission
 - Text messages converted into symbols (dots/dashes, zeros/ones)
 - Transmission system designed to convey symbols
- Multiplexing
 - *Framing* needed to recover text characters
- Message Switching
 - Messages contain source & destination *addresses*
 - *Store-and-Forward*: Messages forwarded hop-by-hop across network
 - *Routing* according to destination address

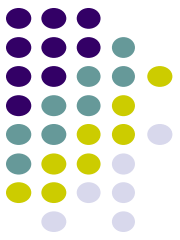
Chapter 1

Communication Networks and Services

Telephone Networks and Circuit Switching



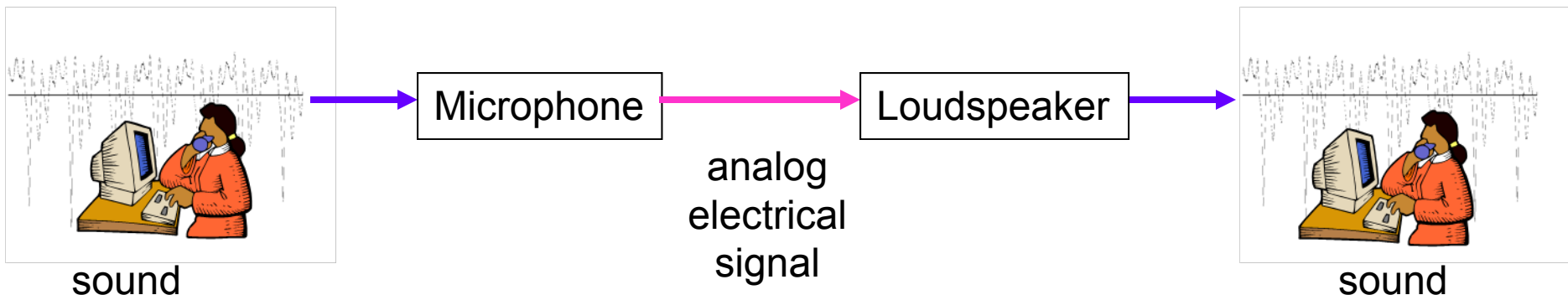
Bell's Telephone



- Alexander Graham Bell (1875) working on harmonic telegraph to multiplex telegraph signals
- Discovered voice signals can be transmitted directly
 - Microphone converts voice pressure variation (sound) into *analogous* electrical signal
 - Loudspeaker converts electrical signal back into sound

Telegraph vs. Telephone

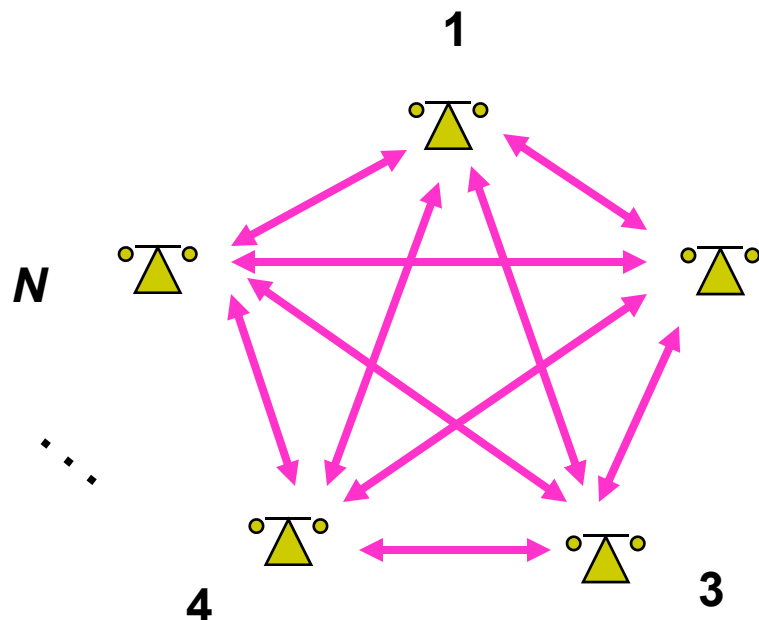
- telegraph was rather slow and (in some cases) required an expert operator with knowledge of Morse code and
- telephone terminal was very simple and did not require any expertise - targeted as a direct service to end users





The N^2 Problem

- For N users to be fully connected *directly*
- Requires $N(N-1)/2$ connections
- Requires too much space for cables
- Inefficient & costly since connections not always on

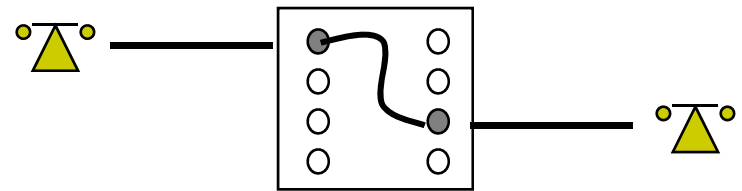
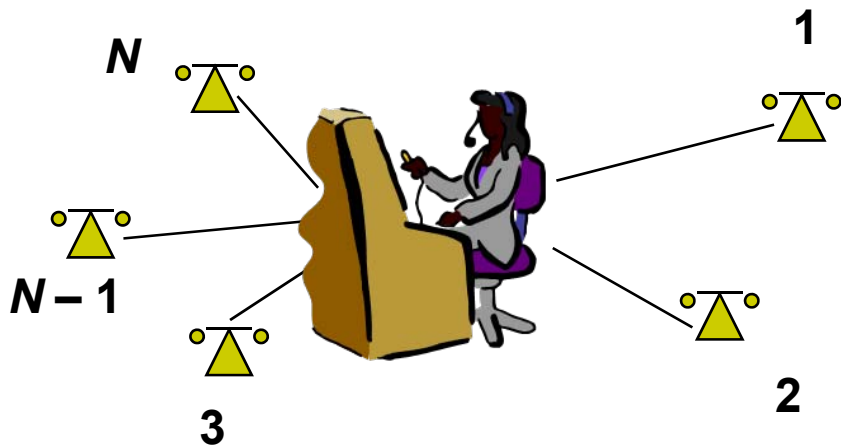


$$N = 1000$$
$$N(N-1)/2 = 499500$$

Circuit Switching



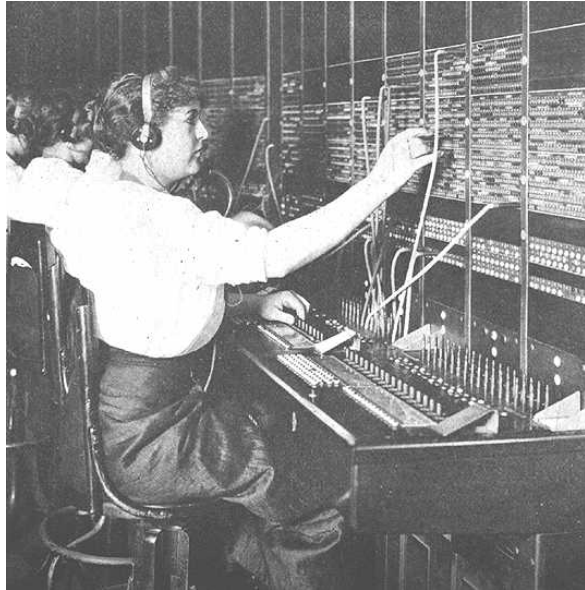
- Patchcord panel switch invented in 1877
- Operators connect users on demand
 - Establish *circuit* to allow electrical current to flow from inlet to outlet
- Only N connections required to central office



Telephone Networks



Connection-Oriented Service! – connection has to be set up before the actual transfer of information can take place

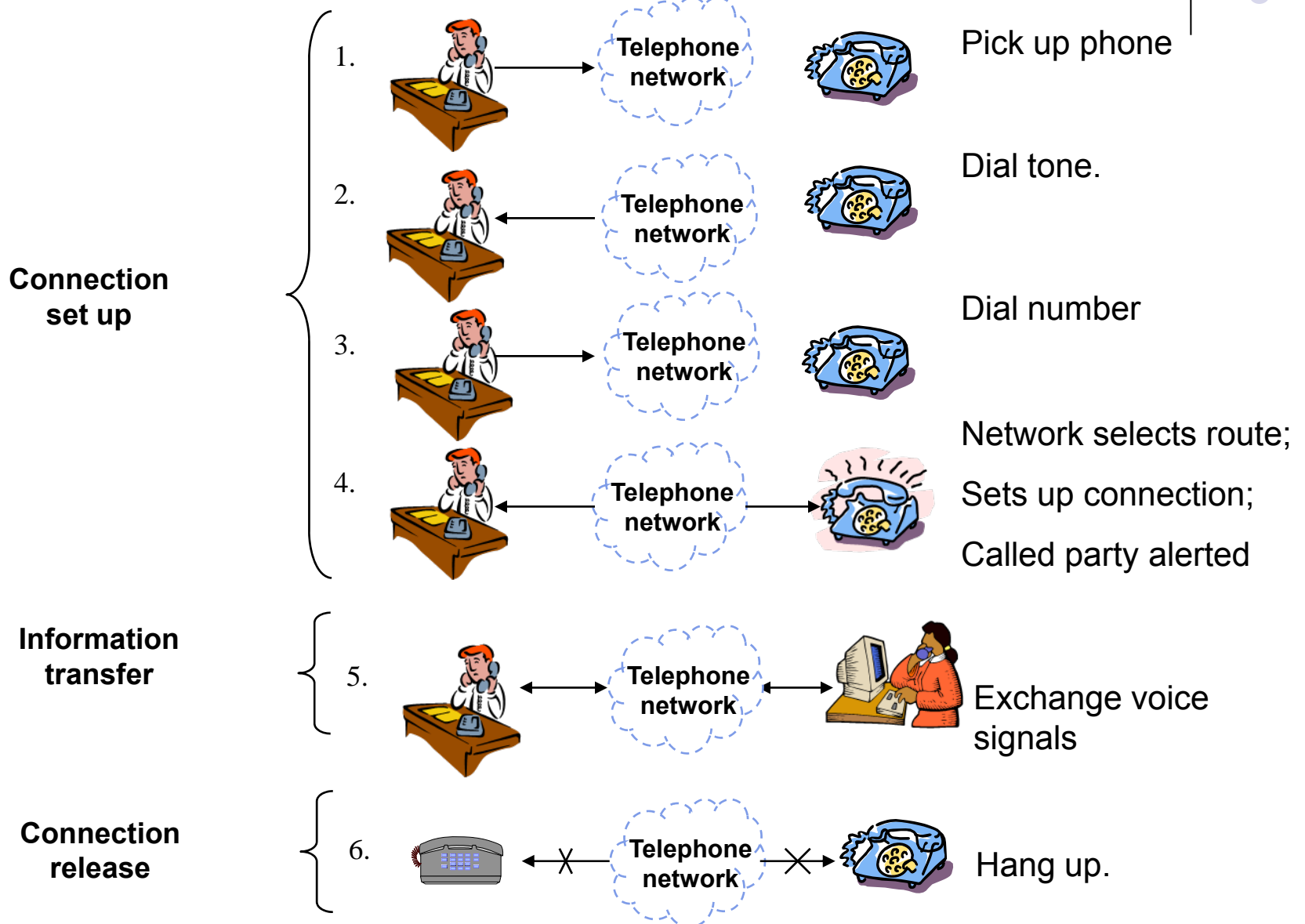


“intelligence” inside the network

Digital Telephone Systems: evolution began with the invention of the transistor and integrated circuits

- (1) analog voice is converted into digital signal \Rightarrow better transmission
- (2) digital switches \Rightarrow faster switching and advanced reservation of resources

Three Phases of a Connection



Elements of Telephone Network Architecture



- Digital transmission & switching
 - Digital voice; Time Division Multiplexing
- Circuit switching
 - User signals for call setup and tear-down
 - Route selected during connection setup
 - End-to-end connection across network
 - Signaling coordinates connection setup
- Hierarchical Network
 - Decimal numbering system
 - Hierarchical structure; simplified routing; scalability
- Signaling Network
 - Intelligence inside the network