EEE 432
Introduction to Data Communications

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DATA COMMUNICATIONS AND NETWORKS

Course Information

Reference Books & Grading

1. Data Communications and Networking, Behrouz A. Forouzan, Fourth Edition.

2. Data and Computer Communications, William Stallings, Eighth Edition

3. Computer Networking A Top- Down Approach, James F. Kurose, Keith W. Ross, Sixth Edition

Score = 1st Midterm Exam 30% + 2nd Midterm Exam 30% + Final Exam 40%

What Is Data Communications?

- When we communicate we are sharing information

➤ Local sharing, e.g. face-to-face

➤ Remote sharing, e.g. over some distance (telecommunication)

- **Data:** Information being shared, e.g. text, numbers, images, audio, video

- **Data Communications:** Exchange of data between two (or more) devices via some transmission medium such as a wire cable or air

What Is Data Communications?

• A data communications system has five components;

1. **Message.** The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

2. **Sender.** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

3. **Receiver.** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

4. **Transmission Medium.** The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.

5. **Protocol.** A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.

Analog and Digital Data

- **Data:** Entities that convey meaning or information

➢ **Analog Data**
  - Continuous varying over time
  - Voice, music, video, sensor data, photos . . .

➢ **Digital Data**
  - Discrete values over time
  - Text, integers, digitized analog data
  - Digitizing involves taking samples of analog data (discretization) and mapping those samples to numbers (quantization)

Example of Analog Data: Audio

- Acoustic Spectrum of Speech and Music
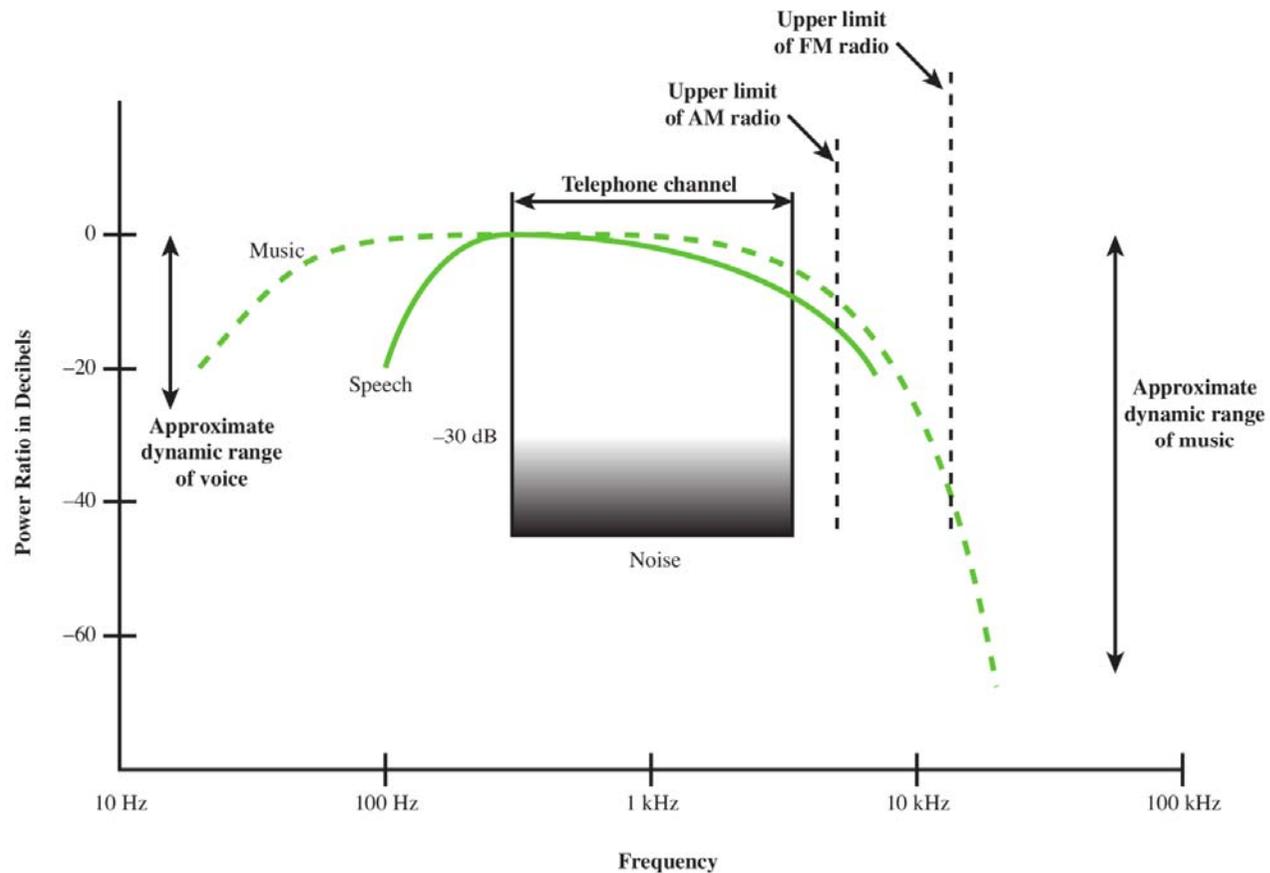
Example of Digital Data: Text

	First 3 bits							
Last 4 bits	000	001	010	011	100	101	110	111
0000	NUL	DLE	SP	0	@	P	`	p
0001	SOH	DC1	!	1	A	Q	a	q
0010	STX	DC2	"	2	B	R	b	r
0011	ETX	DC3	#	3	C	S	c	s
0100	EOT	DC4	$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	'	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
1001	HT	EM	)	9	I	Y	i	y
1010	LF	SUB	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	l		
1101	CR	GS	–	=	M	]	m	}
1110	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	–	o	DEL

A Model of Communication Systems
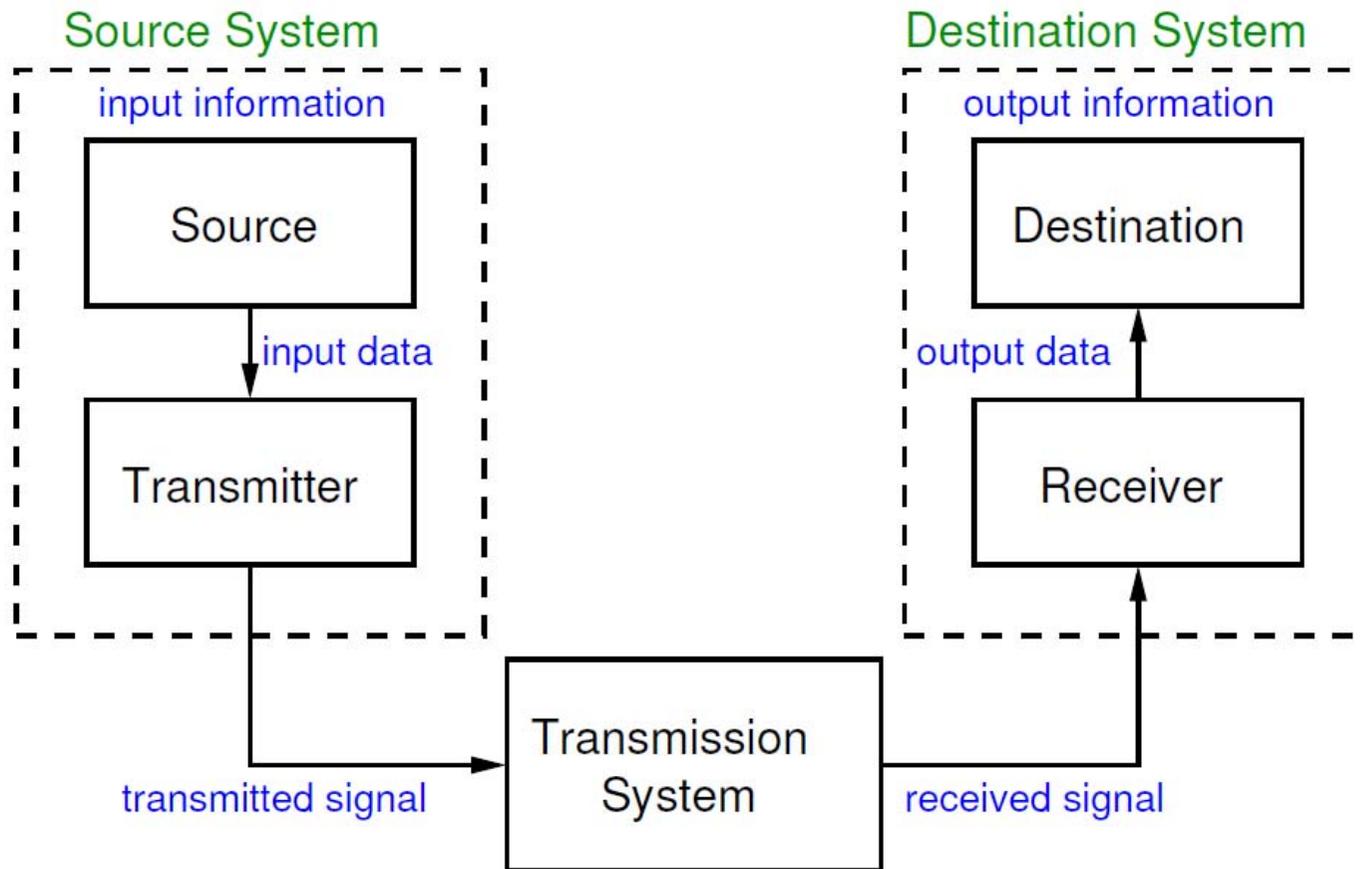
A Model of Communication Systems

Aim: Transfer information from source to destination

Source: Device that generates data to be transmitted

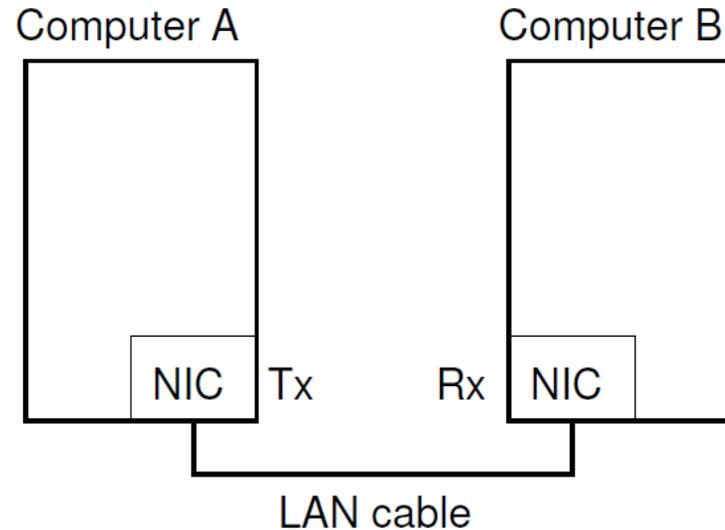**Transmitter:** Converts data from source into transmittable signals

Transmission System: Carries data from source to destination

➢ Maybe simple as a single link/cable

➢ Or a complex network, e.g. the Internet

Receiver: Converts received signal into data
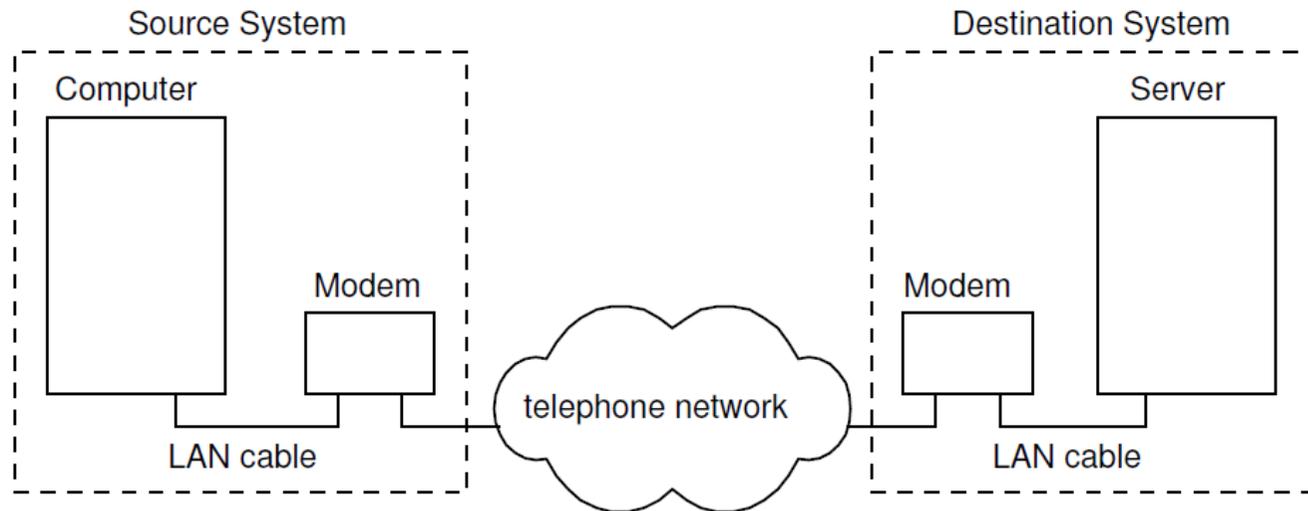
Destination: Takes and uses incoming data

Example: Computer to Computer

NIC: Network Interface Card
NIC can be such as Ethernet or
Wi-fi card.

➢ **Transmitter (Tx)** is built into source computer

➢ **Receiver (Rx)** is built into destination computer

➢ **Transmission System** is single link between two computers
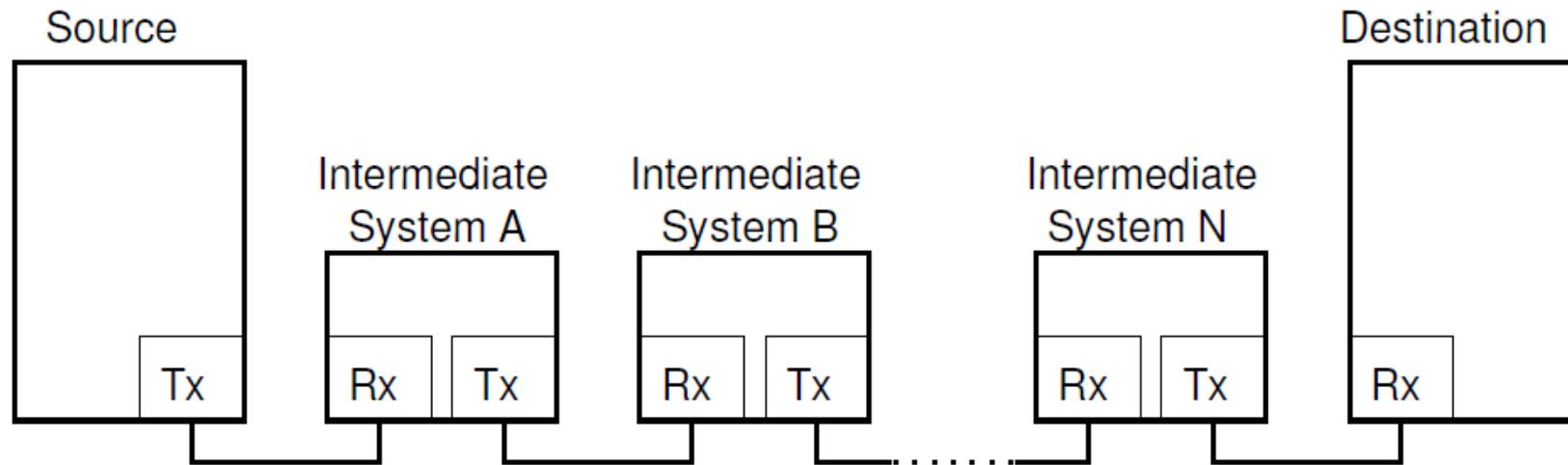
Example: Old Dialup Connection

➤ Source and transmitter are separate devices (similar at destination)

➤ Transmission system is telephone network

Example: Communications via the Internet
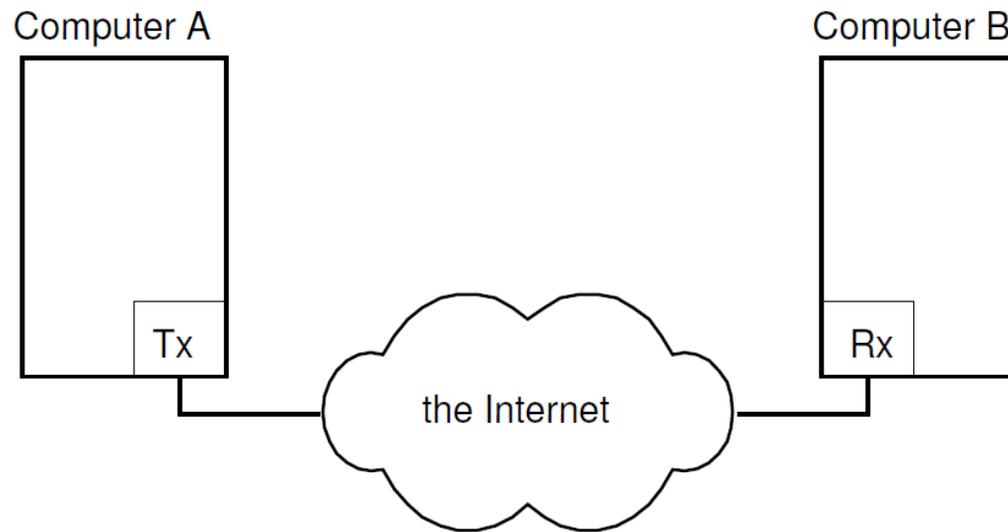
- ➢ Source and transmitter may support different technologies
- ➢ Transmission system is the Internet

General Model for Communications via a Network

- ➤ Source system generates data
- ➤ Intermediate systems receive signal from previous system and then transmit to next system
- ➤ Destination system receives and processes the data
- ➤ Source and destination are connected via multiple transmission systems (or links) to form a network

Challenges with Link Communications
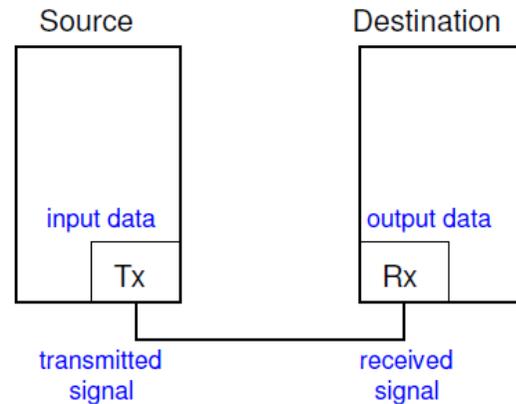
- ➢ How to convert information into transmittable signals?
- ➢ What are the characteristics of signals?
- ➢ What transmission media to use?
- ➢ How to efficiently encode data as signals?
- ➢ How to know who is at other end?
- ➢ How to deal with errors?
- ➢ How to share media amongst two or more transmitters?

Challenges with Networked Communications
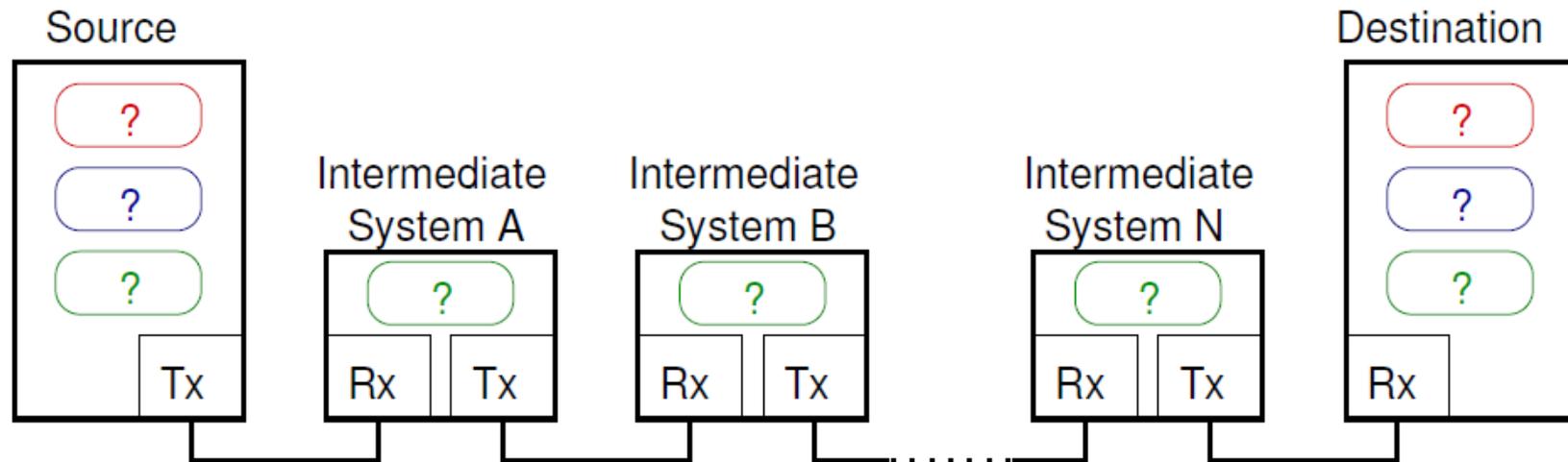
- ➤ How do intermediate systems receive/send data?
- ➤ How to select which intermediate systems to send via?
- ➤ What happens if failures within intermediate systems?
- ➤ How to create applications without knowing the details of underlying network and technologies?

How big is a ...

➢ Web page?

➢ Email?

➢ Photo?

➢ Song?

➢ Audio CD?

➢ TV show?

➢ Movie?

Classify Types of Information

Information may be in analog or (more commonly) digital form

➢ **Audio:** Voice calls, radio, music

➢ **Video:** Video conference, video streams

➢ **Data:**

➢   **Early:** Signalling, fax, SMS, . . .

➢   **Internet:** Messaging (email, instant), web browsing, remote login, database, business-specific apps, monitoring and control systems, . . .

Effective Data Communications

➢ **Delivery:** The data must be delivered to the correct destination

➢ **Accuracy:** The data received must be accurate representation of the data sent.

➢ **Timeliness:** The data should be delivered within a reasonable time

➢**Jitter:** The variation in the packet arrival time. For example; If some of the packets arrive with 3ms delay and others with 4ms delay, an uneven quality in the video is the result.

Types of Internet Applications

Traditional Internet-Based Applications

➢ File transfer, email, web browsing, remote login, database

➢ Accuracy is most important

Multimedia or Real-Time Applications

➢ Audio/video streaming, voice/video calls, gaming, collaborations

➢ Timeliness is most important