EEE 432 Introduction to Data Communications

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DATA COMMUNICATIONS AND NETWORKS

Course Information

1. **Data Communications and Networks**
2. Data Transmission
3. Transmission Media
4. Signal Encoding Techniques
5. Digital Data Communication Techniques
6. Multiplexing
7. Networking and Protocol Architectures
8. Switching
9. Routing in Switched Networks
10. LANs and WANs
11. Ethernet
12. The Internet

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**

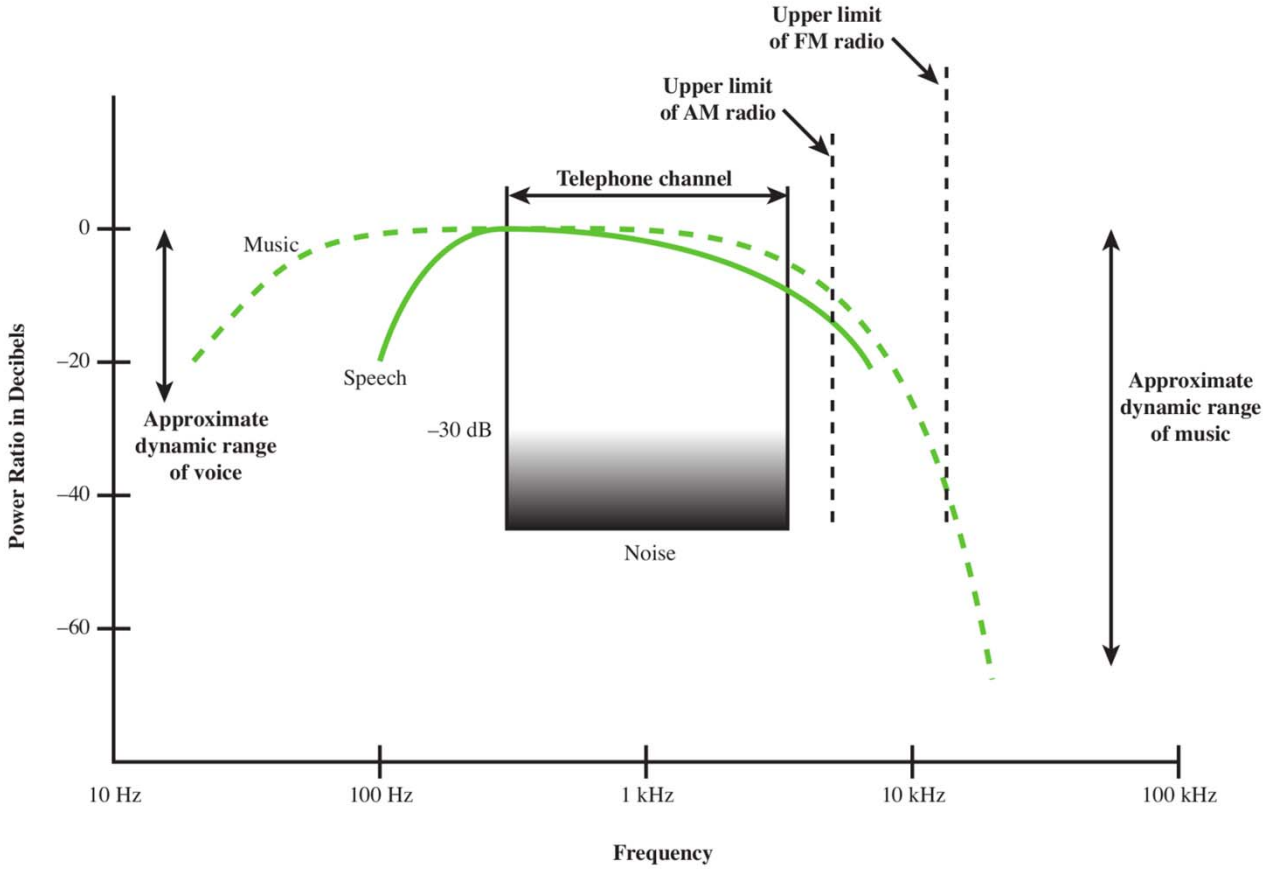
- Continuous varying over time
- Voice, music, video, sensor data, photos . . .

➢ **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

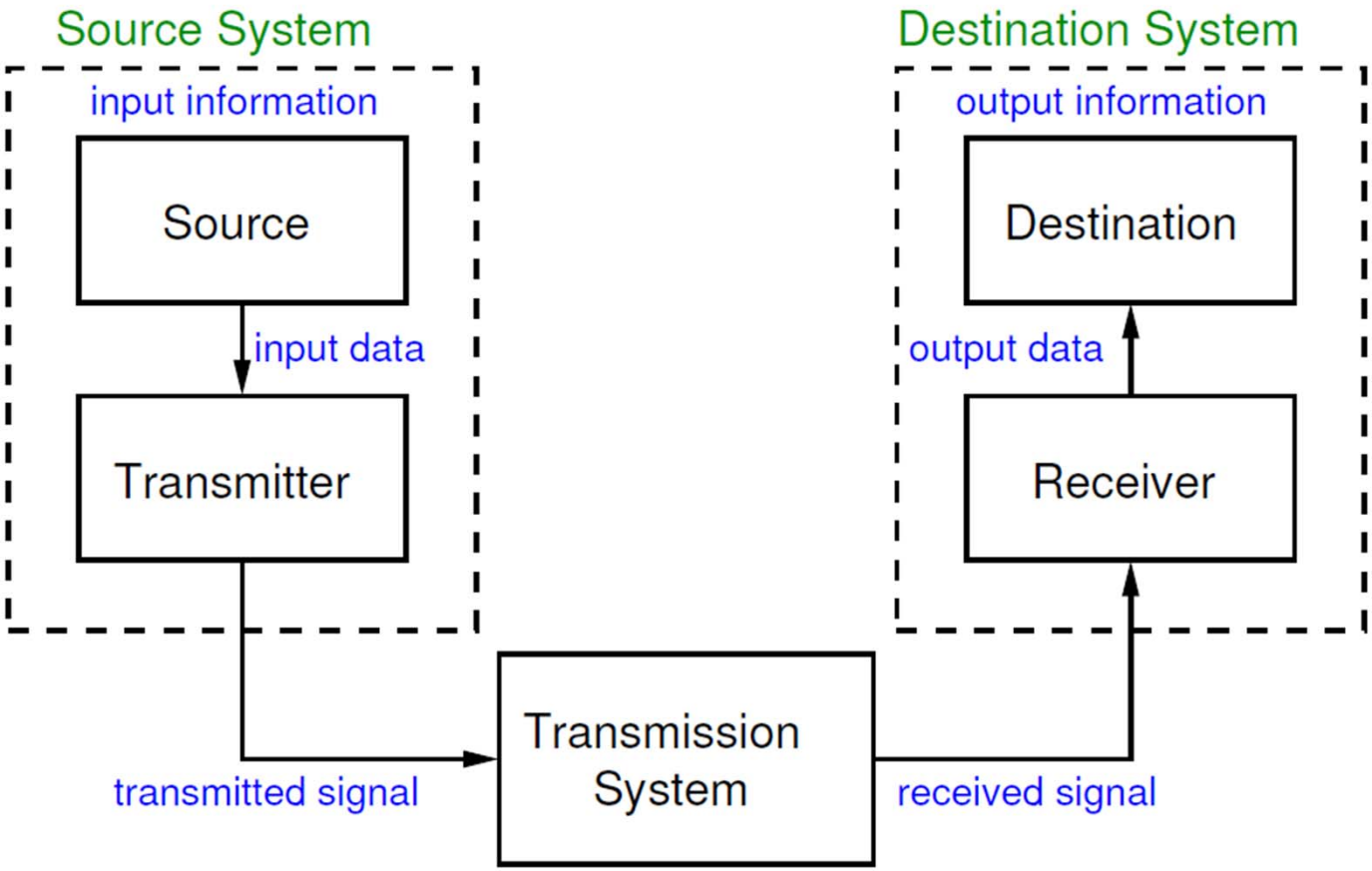
- Acoustic Spectrum of Speech and Music



Example of Digital Data: Text

Last 4 bits \ First 3 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

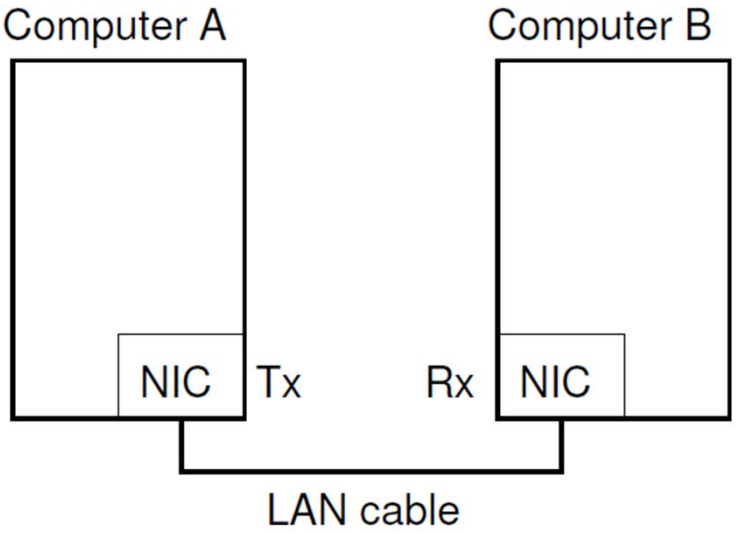
Transmission System: Carries data from source to destination

- 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

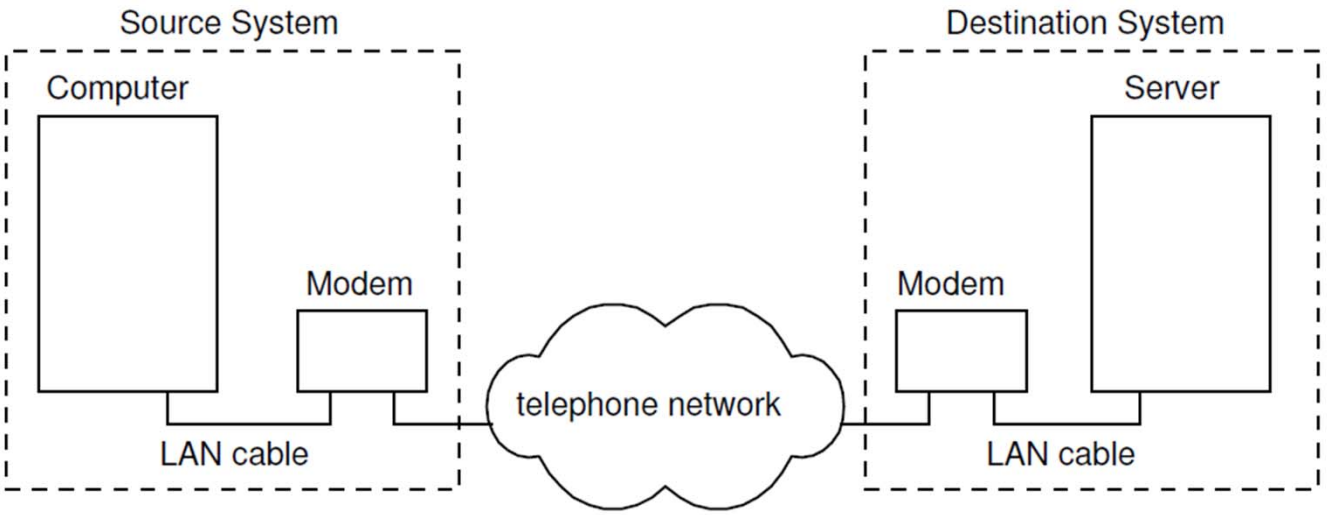
Example: Computer to Computer



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

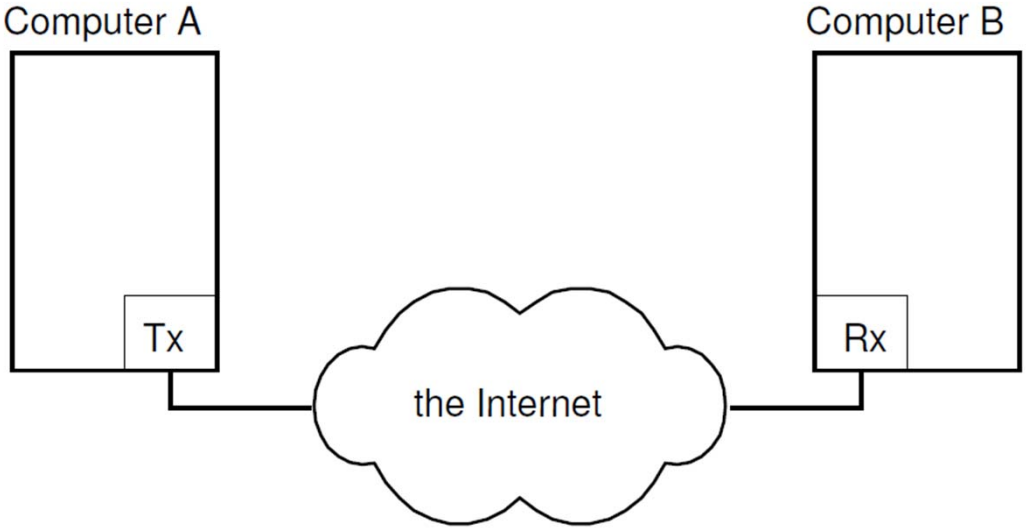
- **Transmitter (Tx)** is built into source computer
- **Receiver (Rx)** is built into destination computer
- **Transmission System** is single link between two computers

Example: Old Dialup Connection



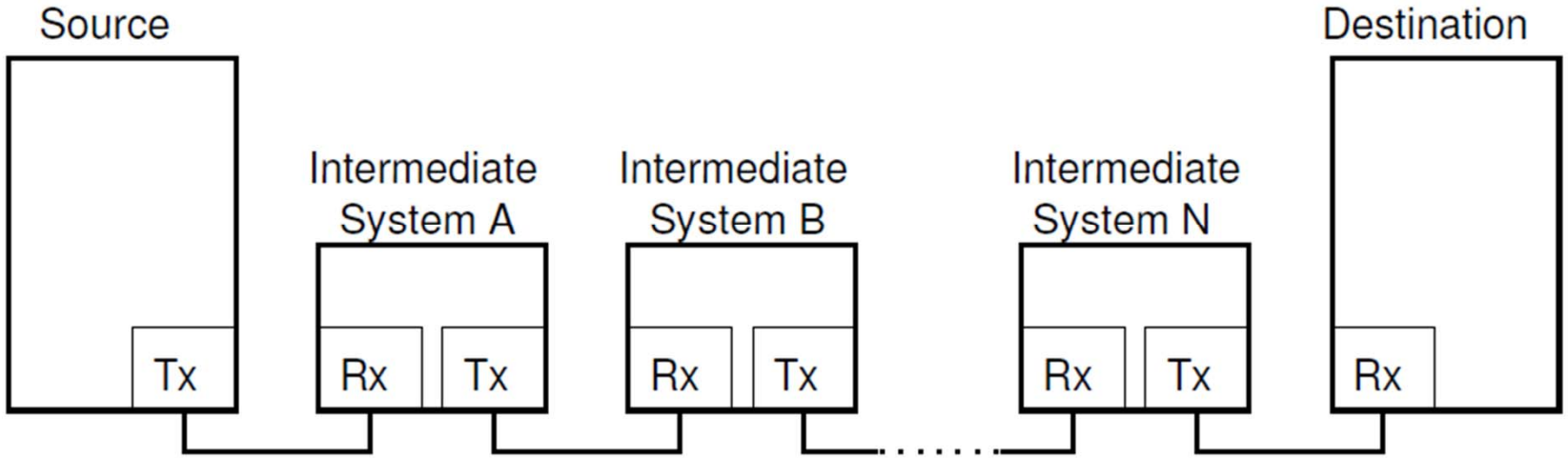
- Source and transmitter are separate devices (similar at destination)
- Transmission system is telephone network

Example: Communications via the Internet



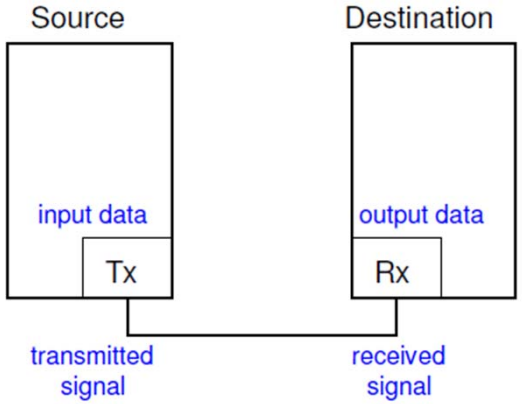
- Source and transmitter may support different technologies
- Transmission system is the Internet

General Model for Communications via a Network



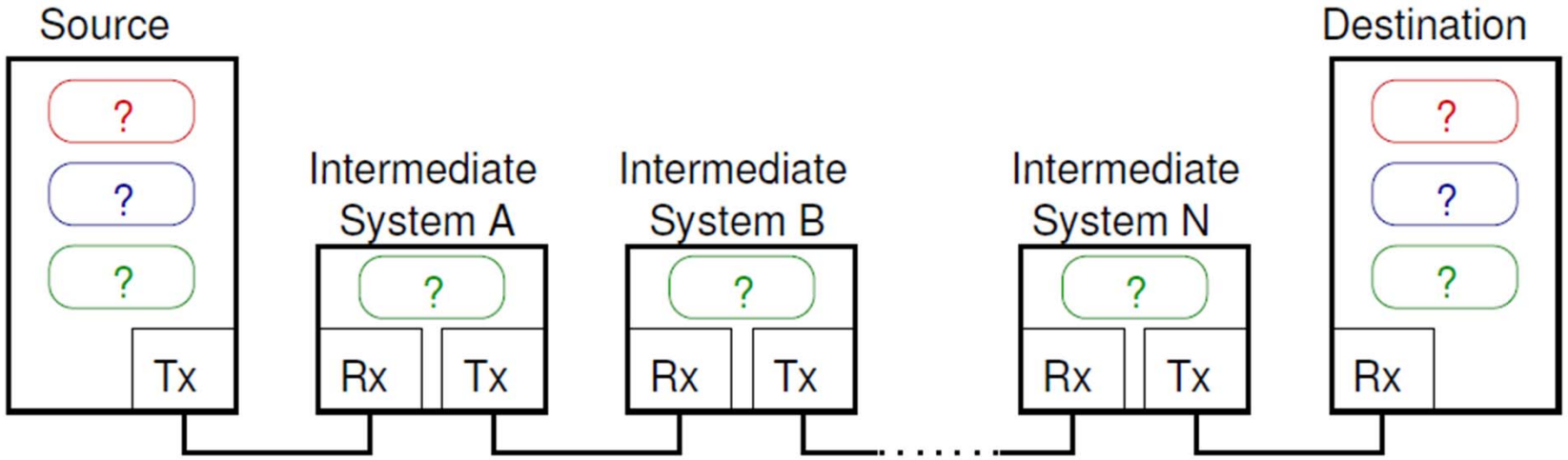
- Source system generates data
- Intermediate systems receive signal from previous system and then transmit to next system
- Destination system receives and processes the data
- Source and destination are connected via multiple transmission systems (or links) to form a network

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