ADVANCED ELECTRONIC COMM. SYSTEMS

LECTURE 2

FACSIMILE & TELEPHONE IP

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Telecommunication Systems

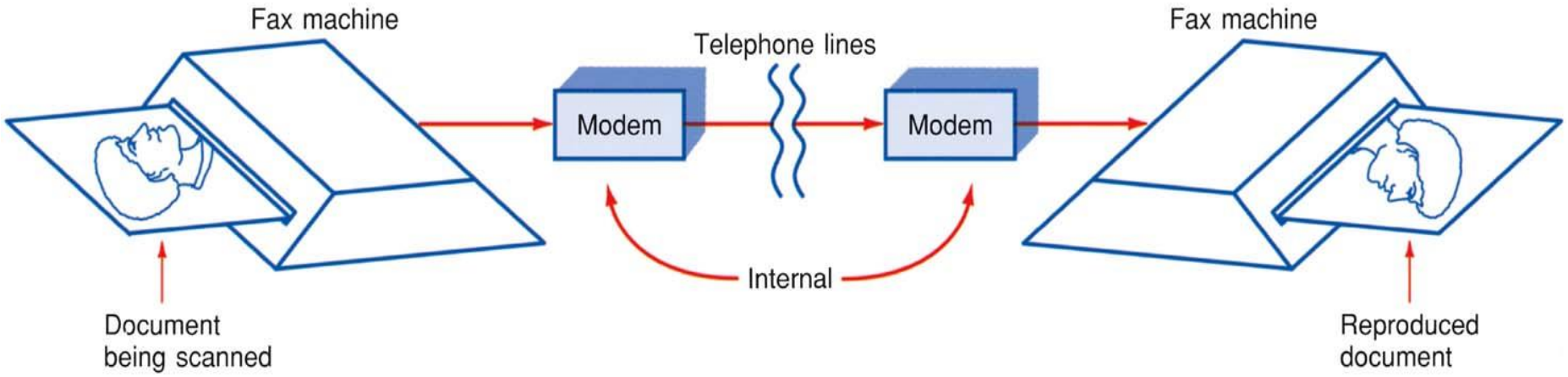
Ref: L.Frenzel - Principles of electronic communication systems

Topics: Ch. 18

- Telephone System ✓
- **Facsimile**
- Telephone IP

Facsimile

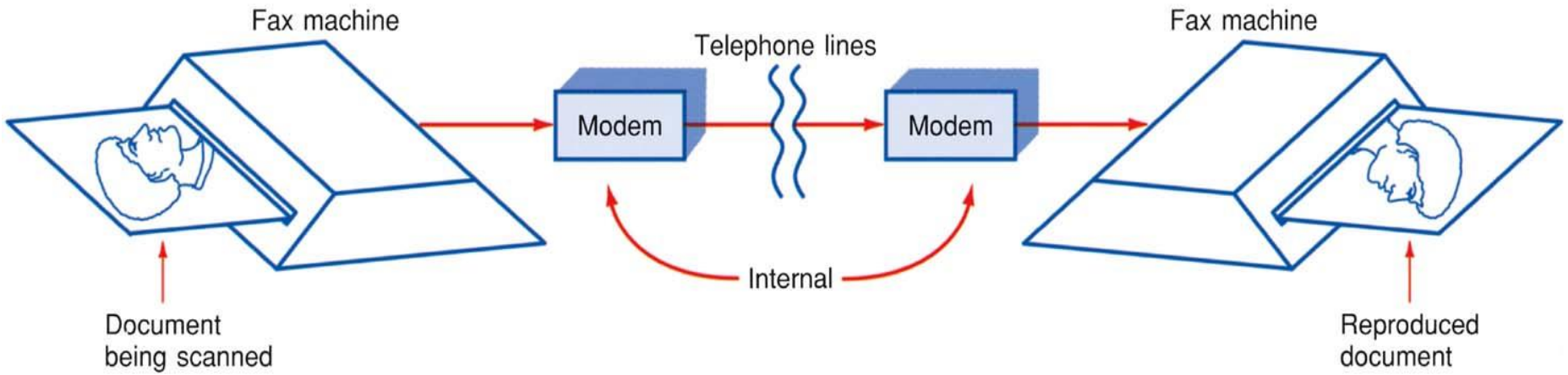
- **Facsimile,** or **fax,** is an electronic system for transmitting graphic information by wire or radio.
- **Facsimile** is used to send printed material by scanning it and converting it into electronic signals that modulate a carrier to be transmitted over the **telephone lines.**



Components of a facsimile system.

Facsimile

- With facsimile, documents such as letters, photographs, line drawings, or any printed information can be converted into an electrical signal and transmitted.
- **Facsimile** uses scanning techniques that are similar to those used in TV.
- **Scanning process** is used to break a printed document up into many horizontal scan lines which can be transmitted and reproduced serially.



How Facsimile Works

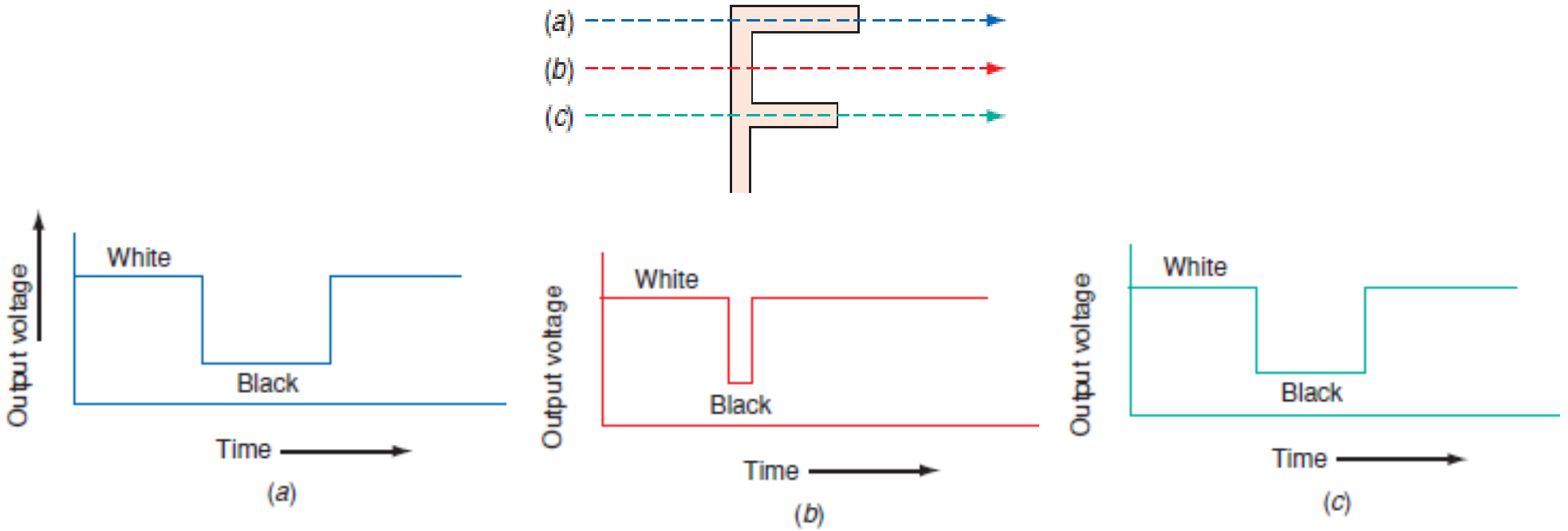
- **Modern fax machine is a high-tech electrooptical machine. Scanning is done electronically, and the scanned signal is converted to a binary signal.**
- **Then digital transmission with standard modem techniques is used.**

1. The transmission process begins with an image scanner that converts the document into hundreds of horizontal scan lines.
2. It incorporates a photo- (light-) sensitive device to convert light variations along one scanned line into an electric voltage.
3. The resulting signal is then processed (e.g. compressed) to make the data smaller and faster to transmit.

How Facsimile Works

The scanning process basically involves exposing the document to a light source and gathering the reflected light on a photo-sensitive device to convert light variation into electrical voltage (output amplitude) proportional to the intensity of reflected light.

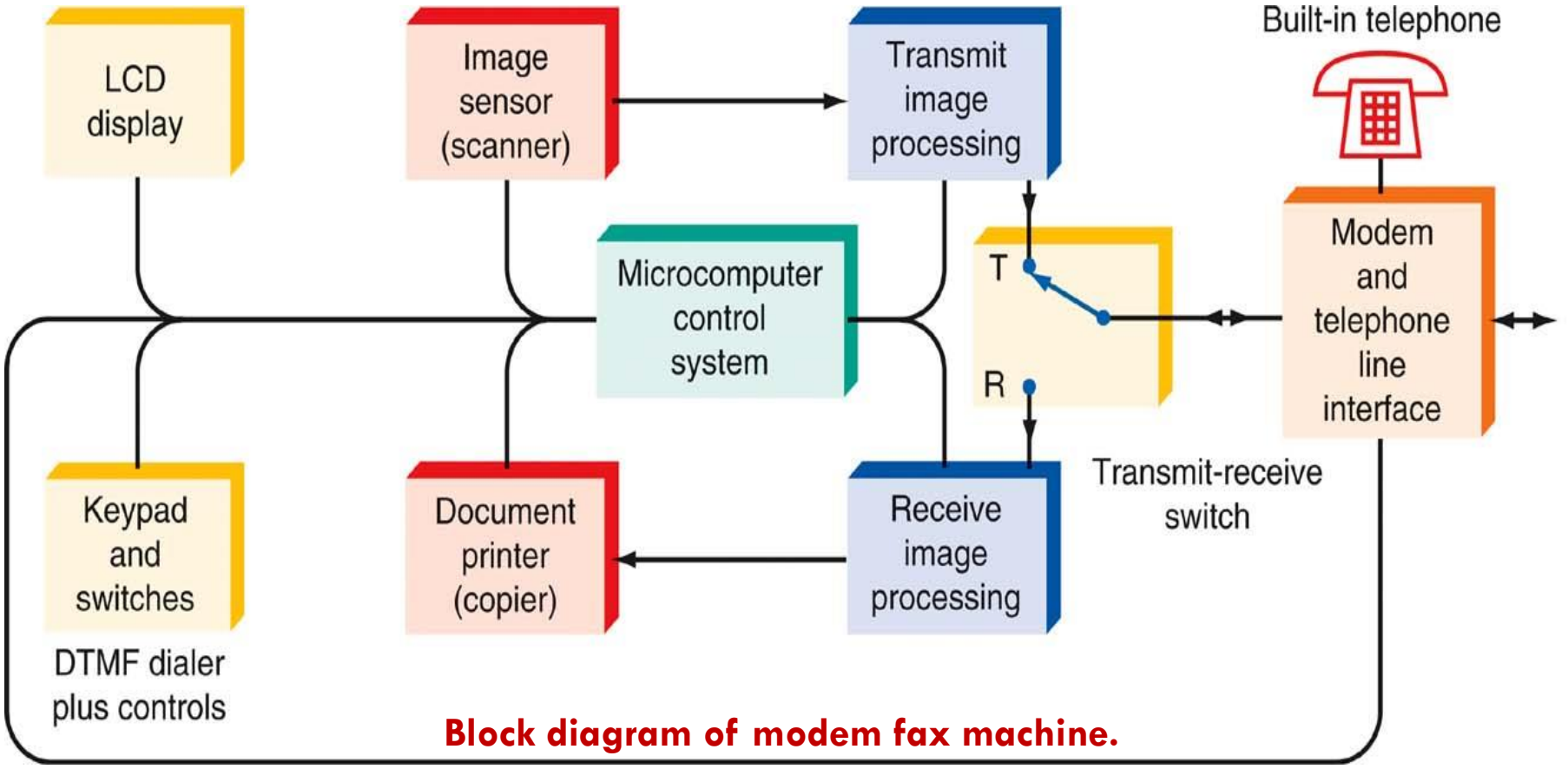
- Number of scan lines per vertical inch governs the resolution of the reproduced document. Older systems had a resolution of 96 lines per inch (LPI), and the new systems have 200 LPI.



Output of a photosensitive detector during different scans.

How Facsimile Works

- The signal is sent to a modem where it modulates a carrier set to the middle of the telephone voice spectrum bandwidth [the audio frequency range].
- The receiving machine's modem demodulates the signal, which was then applied to a stylus to redraw the original information on a blank sheet of paper.
- The data is decompressed and printed out.



Block diagram of modem fax machine.

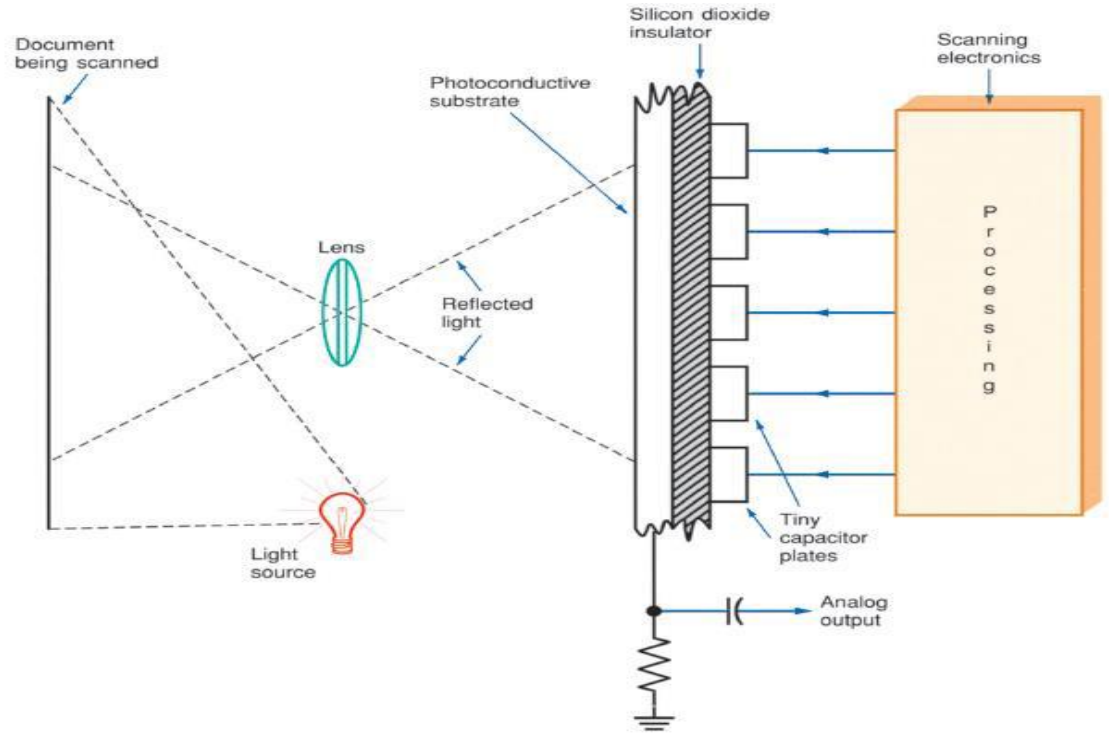
How Facsimile Works

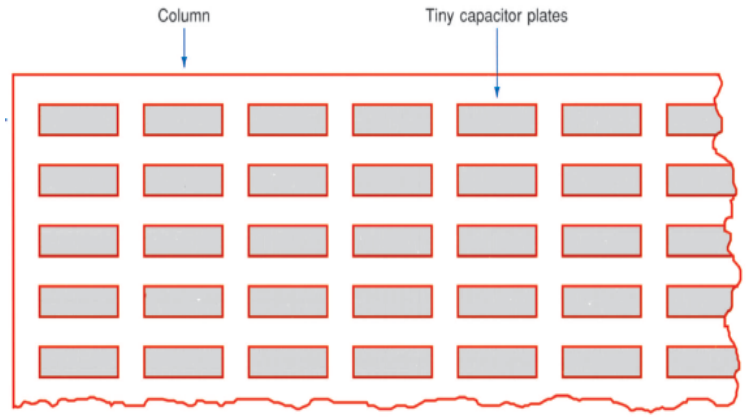
- Because all fax machines can transmit as well as receive, they are referred to as transceivers.
- The transmission is half duplex because only one machine may transmit or receive at a time.

How Facsimile Works

The scanning process

- Most fax machines use charge-coupled devices (CCDs) for scanning.
- **A CCD** is a light sensitive semiconductor device that converts varying light amplitudes to an electric signal.





Capacitors matrix

A charge-coupled device is used to scan documents in modern fax machines.

How Facsimile Works

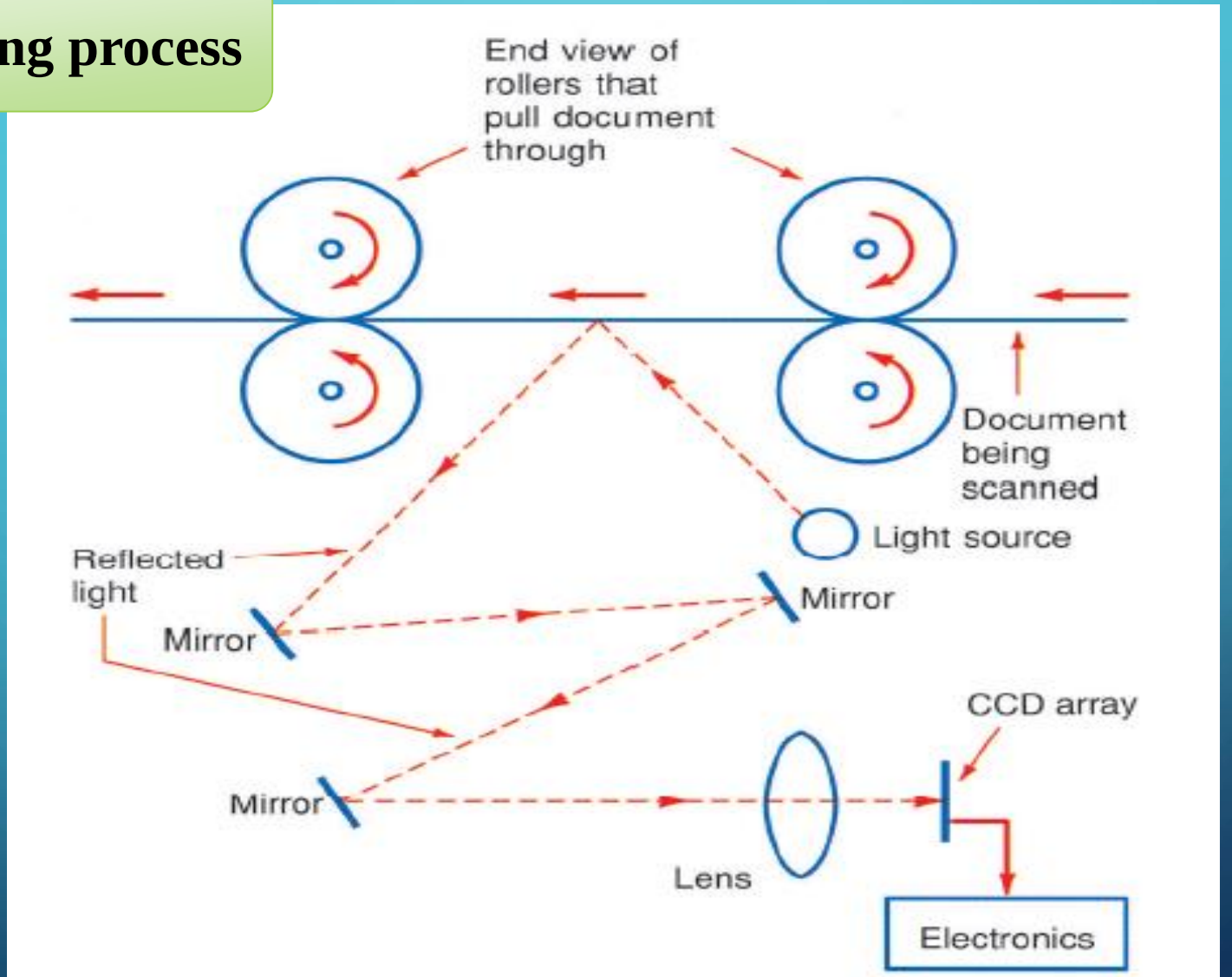
The scanning process

- The CCD is made up of many tiny capacitors, which are manufactured in a matrix on a silicon chip.
- When the CCD is exposed to light, the CCD capacitors charge to a value proportional to the light intensity.
- The capacitors are then sampled electronically to determine their charge. This creates an analog output signal that accurately depicts the image focused on the CCD.

A CCD breaks up any scene or picture into individual picture elements, or pixels. The **greater** the number of CCD capacitors, or pixels, the **higher** the resolution.

How Facsimile Works

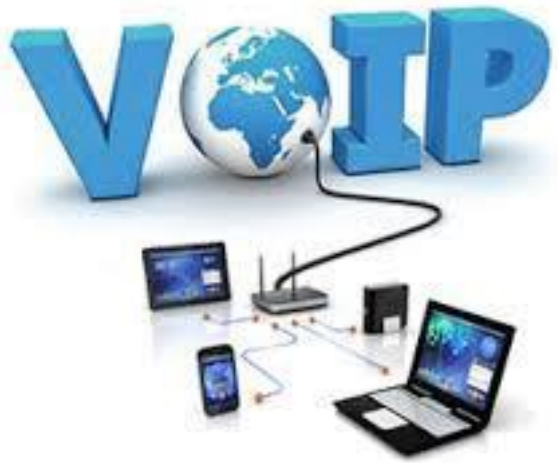
The scanning process



Scanning mechanism in a fax machine.

CHAPTER 18

Internet Telephony



Internet Telephony

Internet telephony, also called **Internet Protocol (IP)** telephony or **Voice over Internet Protocol (VoIP),** uses the Internet to carry digital voice telephone calls and/or image messaging applications rather than the PSTN.

VoIP is a highly complex digital voice system that relies on high-speed Internet connections from phone companies supplying DSL, and other broadband systems including wireless.

VoIP uses the Internet's vast fiber-optic cabling network to carry phone calls without phone company charges using existing Internet resources.

Why → Internet Telephony

In large companies, VoIP is replacing traditional telephone service because:

- It offers the benefits of lower long-distance calling charges
- It reduces the amount of new equipment needed, since phone service is provided over the same LAN that interconnects the PCs.

The Internet telephony has packetized nature:

The main concept is converting the analog voice/image signal to digital format and compress/translate the signal to IP packets for transmission over the Internet. The process is reversed at the receiving end.

Internet Telephony

VoIP Fundamentals

There are two basic parts to an IP phone call:

1. The “dialing” process which establishes an initial connection
2. The voice signal flow.

Internet Telephony

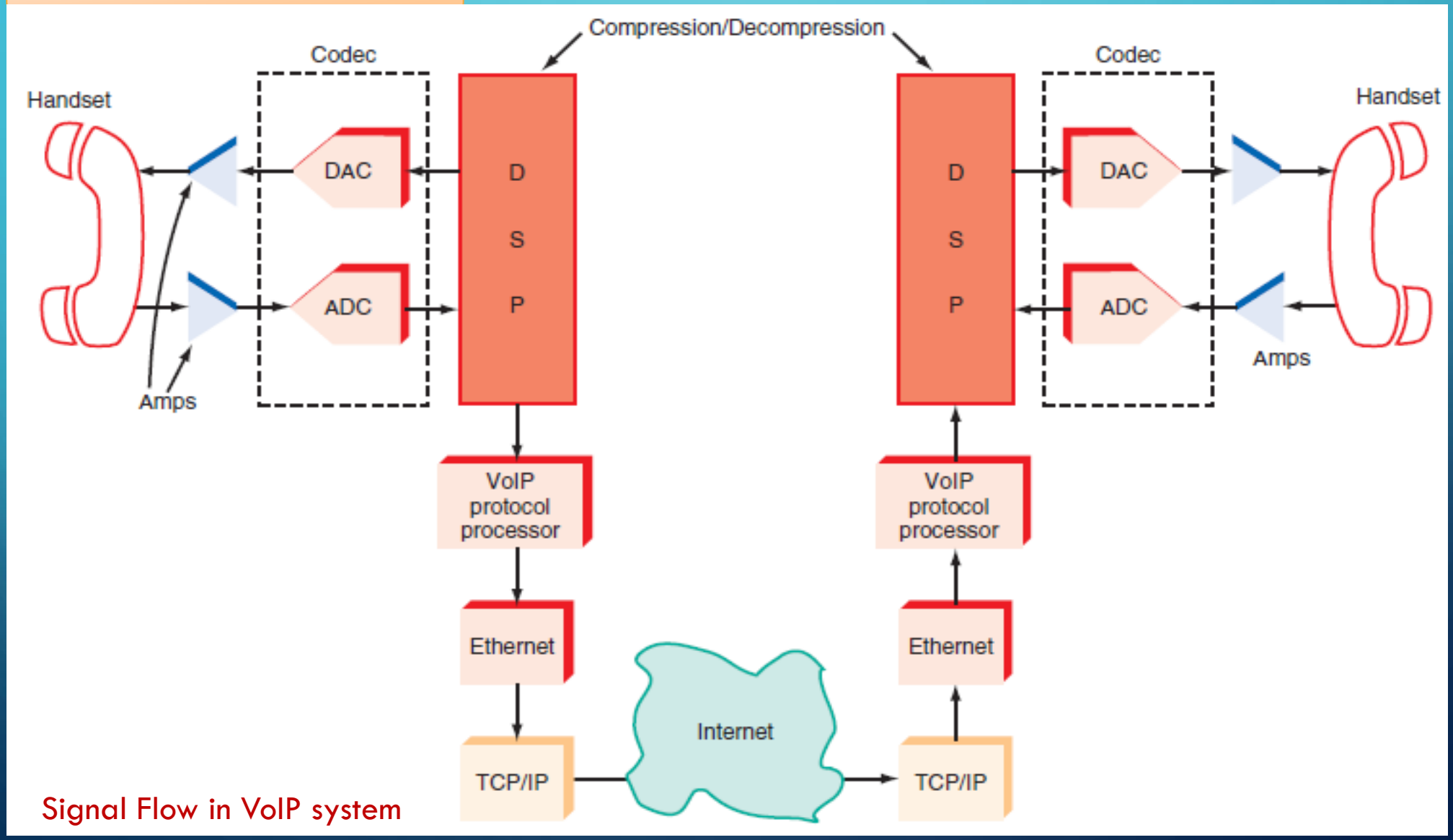
1. Dialing(link establishment)

- **In the PSTN**, the dialing process initiates multiple levels of switching that literally connects the calling phone to the called phone.
  - That **link** is maintained for the duration of the call because the switches stay in place and the electronic paths stay dedicated to the call.
- **In Internet telephony**, **no such temporary** dedicated link is established because of the packetized nature of the system.

- Special protocols developed for this purpose e.g., **session initiation protocol (SIP)** developed by Internet Engineering Task Force (IETF).
- The protocol sets up the call and then makes sure that the voice packets produced by the calling phone get sent to the receiving phone in a timely manner.

Internet Telephony

2. Voice Signal Flow



Signal Flow in VoIP system

Internet Telephony

2. Voice Signal Flow

- The voice signal is first amplified and digitized by an analog-to-digital converter (ADC), which is part of a coder-decoder (codec) circuit that also includes a digital-to-analog converter (DAC).

- **The ADC usually samples the voice signal at 8 kHz and produces an 8-bit word for each sample (i.e., 64-kbps digital signal)**

- The bit stream is processed by a voice encoder that compresses the voice signal **To reduce the data rate and the need for bandwidth via DSP processor chip. [G711 , G.729a , G.723]**

  8-kbps → 5.3-kbps

- The resulting serial digital signal is put into a special packet by a microcomputer processor running a VoIP protocol and then transmitted by Ethernet over a LAN or via a high-speed Internet connection such as is available on DSL.

Internet Telephony

→ One of the main problems with VoIP is that it takes a relatively long time to transmit the voice data over the Internet.

- The signal travels over standard available Internet connections using TCP/IP through multiple servers and routers each adding transit time or latency until it comes to the desired location.

- Hence, the packets arrives out of sequence at the final destination which must put them back in the correct sequence.

- The compressed data is extracted, decompressed by a DSP, and sent to the DAC in the codec where the original voice is heard.

Latency is the delay between the time the signal is transmitted and the time it is received. **(the maximum acceptable latency is about 150 ms. Any longer time is noticeable by the user).**


Thank you
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