PSTN
(PUBLIC SWITCH TELEPHONE NETWORK)

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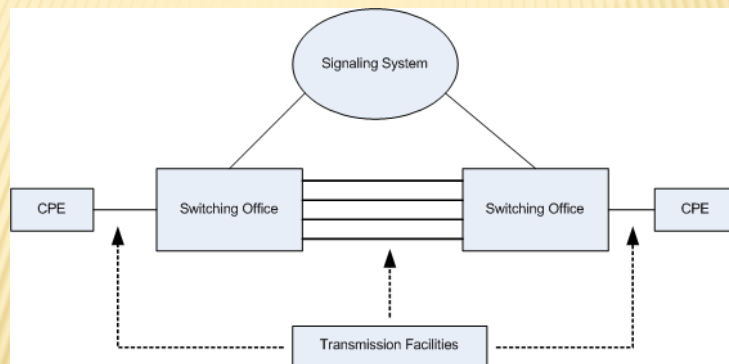
CPE: Customer Premise Equipment that includes:
        Hand Set, PBX (Private Branch Exchange), Fax machine
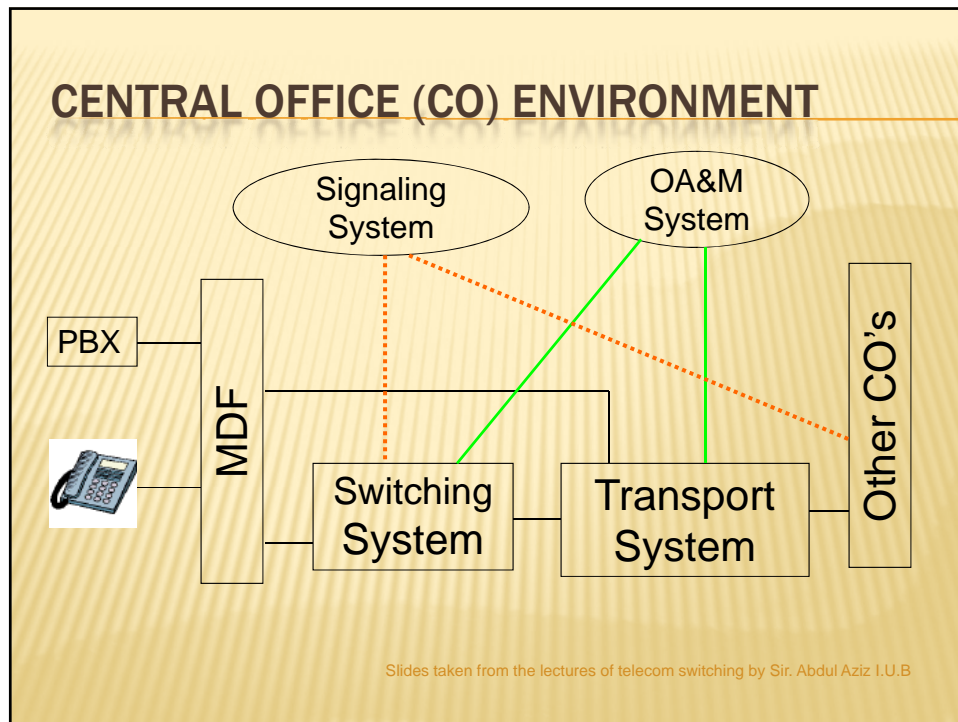
CENTRAL OFFICE (CO) ENVIRONMENT

- × MDF: Main Distribution Frame
- × OA&M: Operation, Administration, and Maintenance
- × PBX: Private Branch Exchange

MDF

CABINET

PSTN

- The telephone network is also referred to as the Public Switched Telephone Network (PSTN

- The network terminals are telephones, fax machines and modems while the network consists of access switches (or exchanges) and back-bone or core network switches.

- A Circuit from the calling to called party is set-up, with guaranteed resources allocated by the network at set-up time (circuit switching).

- Two-way (full-duplex) communication takes place simultaneously

- A single basic service is offered: two-way, switched voice service

TELEPHONE NETWORK ASPECTS

× The key aspects of the telephone network are:

- End-systems or terminals;
- Transmission;
- Switching; and
- Call control or signaling.

END-SYSTEMS OR TERMINALS

Customer Premise Equipment (CPE) is any piece of equipment supplied by the customer to interface with the PSTN. Examples are:

- Telephone Set
- Fax Machine
- Private Branch Exchange (PBX)

- ✖ The telephone network supports wired telephones, fax machines, answering machines, mobile phones and modems.
- ✖ The interface between the network and these end-systems (or terminals) has been standardized:

  • The network expects either an analog signal band-limited to 3.4 KHz or a digital signal of 64 Kbps.

- ✖ This interface has allowed terminals to evolve over time (from analog telephones to digital handsets and mobile phones) without any change to the underlying network architecture

TRANSMISSION ASPECTS

- The link bandwidth measures its information carrying capacity, i.e. it is the width of the "information pipe"
- As the length of a link increases, the quality of the carried signal degrades and should be regenerated after some distance. This is expensive and undesirable (need to maintain regenerators).

     • Recent advances in optical fiber technology has made it

  possible to build links that need regeneration only for very long distances.

SWITCHING

- For every call, a physical path (a "circuit") needs to be established from the caller to the called party's terminal through signaling.
- Switches along that path connect temporarily the two parts of the circuit (a "cross-connection") in the incoming and outgoing link.
- This technique where a circuit is established with resources granted (i.e. 64 Kbps) for the duration of the call is called Circuit Switching
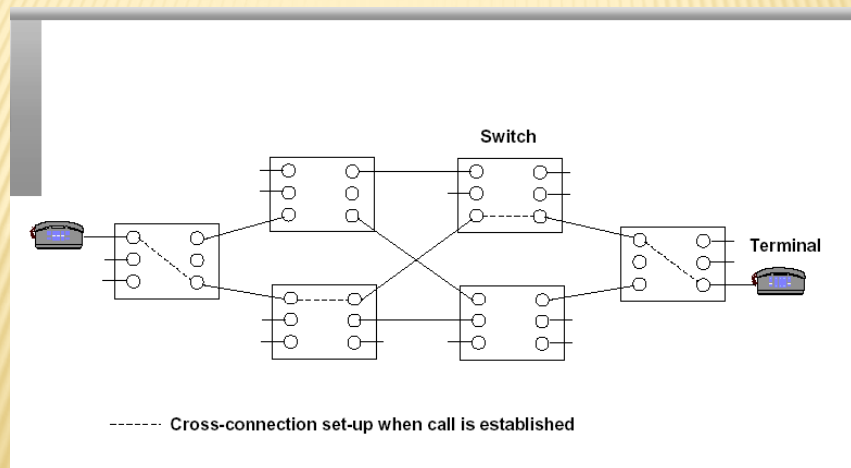
CONT'D

× Switches "switch" information from inputs to outputs

CONT'D

Cross-connection set-up when call is established

VOICE TELEPHONY

- A channel that is suitable for transmission of speech or analog data and has the maximum usable frequency range of 300 to 3400 Hz
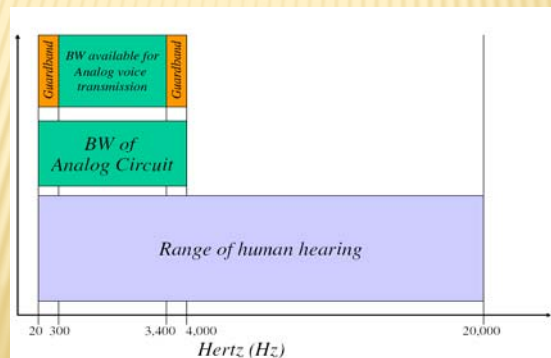
TELEPHONE HANDSET

- It is a device which converts human speech in the form of sound waves produced by the vocal cord to electrical signals. These signals are then transmitted over telephone wires and then converted back to sound waves for human ears.
- Microphone
- Earphone
- Signaling functions

MICROPHONE

- Microphone (mouthpiece) consists of a movable speaker diaphragm that is sensitive to both amplitude and frequency
- The diaphragm contains carbon particles that can conduct electricity.
- As the human voice spoken into the transmitter varies, the amount of carbon granules that strike the electrical contacts in the mouthpiece also varies—thereby sending varying analog electrical signals out into the voice network

EARPHONE

- Earphone (earpiece)
- Acts in an opposite direction to the mouthpiece.
- The electrical signal/waves produced by the transmitter are received at an electromagnet in the receiver.
- Varying levels of electricity produce varying levels of magnetism—that, in turn, cause the diaphragm to move in direct proportion to the magnetic variance.
- The moving diaphragm produces varying sound that corresponds to the sound waves that were input at the transmitter.

TELEPHONE SYSTEM

WHAT IS A PHONE CALL?

Telecommunications System
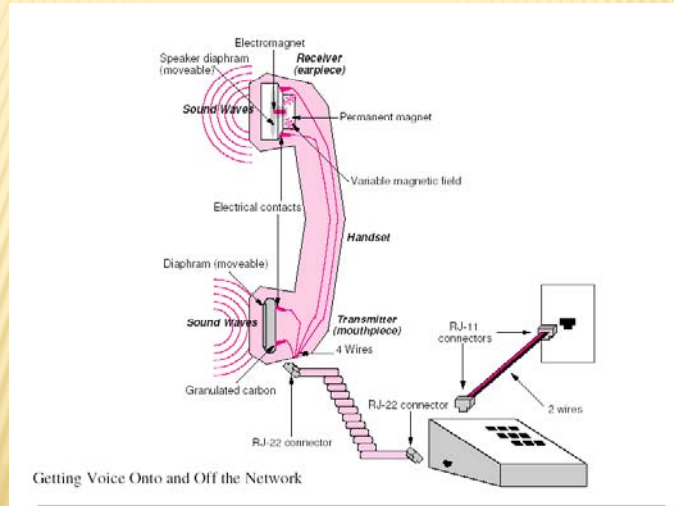
Off hook
Dialing
Ring-back ←————————————————→ Ringing
Off hook

Talking ←————————————————→ Talking
On hook   On hook

CONT'D
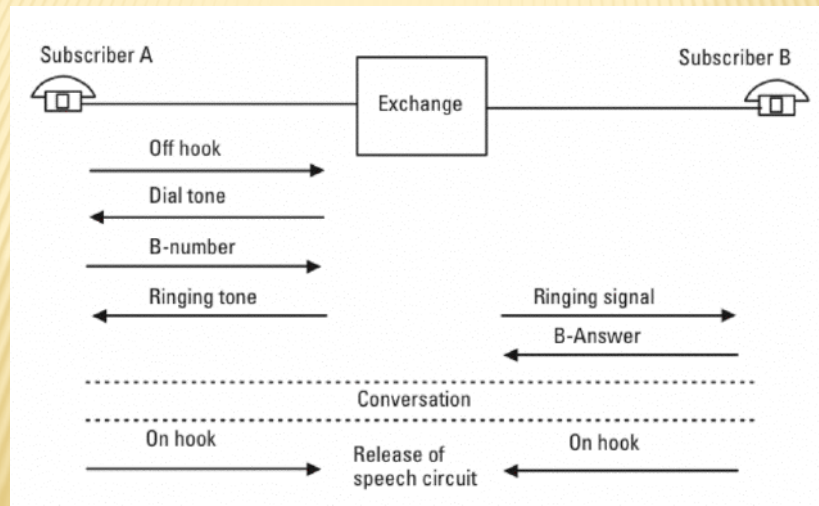
PLACING A CALL

- Calling customer takes phone off hook which closes the circuit to the C.O. ("looping the circuit").
- C.O. detects the "loop" and indicates readiness with dial tone.
- Calling customer hears dial tone and dials number.
- Exchange network sets up connection.
- If connection possible, called party alerted.
    – Large alternating current is applied to line achieving ringing.
- "Ring tone" is returned to caller.
- Called party picks up handset and closes his/her loop.
- Exchange detects second loop and "trips" or stops ringing, then establishes call.
- One party opens loop by hanging up, and exchange clears connection.
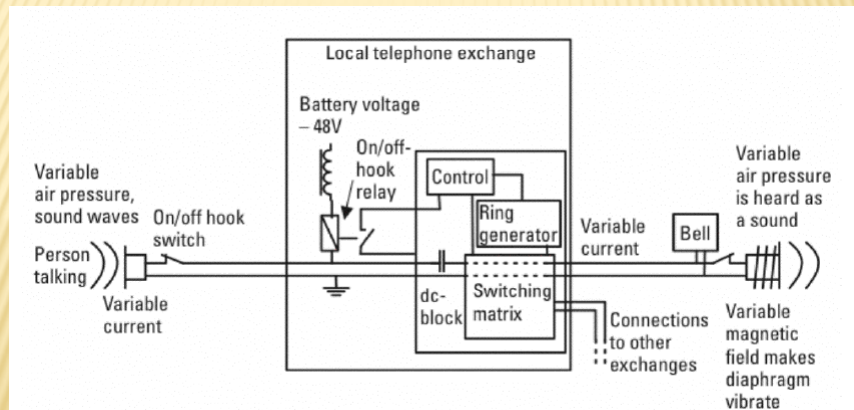
DIALING

- A combination of 350 Hz and 440 Hz sine waves sent to the Telephone from the central office (CO) indicating that the network is ready to receive calling instructions
- Dialing Modes: Pulse Tone and Touch Tone or Dual-Tone-Multi Frequency

LOOP AND DISCONNECT SIGNALING

* Also known as 'pulse dialing' or LD signaling
* Line is rapidly disconnected and reconnected in sequence with one pulse for digit value "1", two pulses for digit value "2", etc.
* Each pulse lasts 0.1 second.
* Inter-digit pause (IDP) must be >0.5 second.
  – If not, current digit may combine with previous digit.
* Ten digit phone number typically takes 6-15 seconds total.

Rotary or pulse dialing
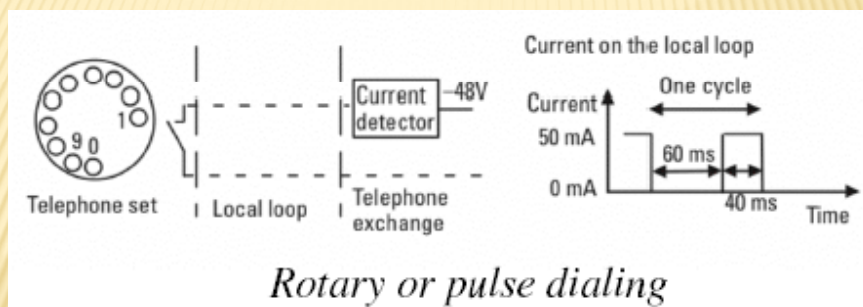
DUAL TONE MULTI-FREQUENCY SIGNALING

- Also "**MF signaling**" or "**tone signaling**".
- Faster than pulse dialing (1-2 seconds for ten digit number).
  - Reduces call set-up time.
- Each digit produced by combination of 2 pure frequency tones.
  - Reduces chances of error or interference

		High Frequency Tone			
		1208 Hz	1336 Hz	1477 Hz	1633 Hz
Low Frequency Tone	697 Hz	1	2	3	spare
	770 Hz	4	5	6	spare
	852 Hz	7	8	9	spare
	941 Hz	*	0	#	spare

BASIC SWITCHING FUNCTIONS

- Eight basic functions for a conventional switch:
    - Attending
    - Information receiving
    - Control
    - Busy testing
    - Alerting
    - Interconnection
    - Supervising
    - Information transmitting

CONT'D

- Attending
  The system continually monitoring all the lines to detect call requests
- Information receiving
  Receiving call and information from the caller as to the called line required
- Control
  Control function includes following :
  - Determining call destination

CONT'D

- Busy testing

  Making a busy test whether the required outgoing circuit is free or already engaged on another call
- Alerting

  Sending a signal to alert the called customer to the call
- Interconnection

  For a call between two customers, three connections are made in the following sequence:
  (a) A connection to the calling terminal
  (b) A connection to the called terminal
  (a) A connection between the two terminals

CONT'D

- Supervising

  Monitoring the connection in order to be able to clear it down when the call has ended
- Information transmitting

  If the called customer's line is located on another exchange the additional function of information sending is required. The origination exchange must signal the required address to the terminating exchange through intermediate exchanges.

CONCEPTS OF TELEPHONE NUMBERING

- **Numbering Area (Local Numbering Area)**
  - This is the area in which any two subscribers use the same dialing procedure to reach another subscriber in the telephone network.
- **Subscriber Number**
  - This is the number to be dialed or called to reach a subscriber in the same local network or numbering area.
- **Trunk Prefix (Toll-Access Code)**
  - This is a digit or combination of digits to be dialed by a calling subscriber making a call to a subscriber in his own country but outside his own numbering area.
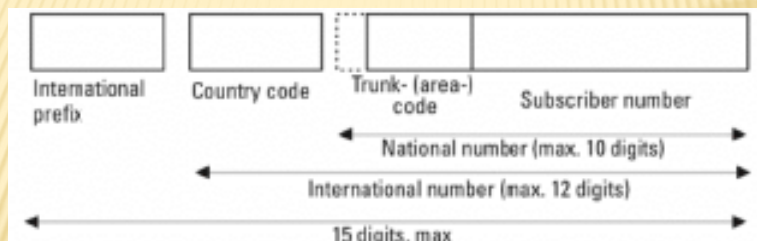
CONCEPTS OF TELEPHONE NUMBERING

- **Trunk Code (Area Code)**
  - This is a digit or combination of digits (not including the trunk prefix) characterizing the called numbering area within a country.
- **Country Code**
  - This is the combination of one, two, or three digits characterizing the called country.
- **Local Code (Exchange Code)**
  - This is a digit or combination of digits for obtaining access to an adjacent numbering area or to an individual exchange (or exchanges) in that area

TELEPHONE NUMBERING

- The numbering is hierarchical, and it has an internationally standardized country code at the highest level.
- An international prefix or international access number is used for international calls.
- The country code contains **one to four numbers** that define the country of subscriber B. Their purpose is to make the subscriber identification unique in the world. A telephone number that includes the country code is called an international number and it has a maximum length of 12 digits.

International prefix | Country code | Trunk- (area-) code | Subscriber number

National number (max. 10 digits)

International number (max. 12 digits)

15 digits, max

TELEPHONE NUMBER PLANS

- ✖ 4 Basic parts of National calls:
  - ✚ Trunk Prefix---(0)
  - ✚ 2 or 3-digit area code---(51)
  - ✚ 3-digit exchange---(486)
  - ✚ 4-digit subscriber number---(3650)
- ✖ 4 Basic parts of an International call:
  - ✚ International Prefix
  - ✚ Country code
  - ✚ City code
  - ✚ City number

TELEPHONE NUMBER

- ✖ A telephone number performs two important functions:
  - ✚ It routes the call
  - ✚ It activates the necessary equipment for proper call charging.
- ✖ Each area code can support:
  - ✚ 1000 exchanges
- ✖ Each exchange can support:
  - ✚ 10,000 telephone numbers
- ✖ Each area code can support:
  - ✚ 103 X 104 = 107 = 10 million phone numbers