Telephony Fundamentals
Basic Telephony – general terms

- **Central Office (CO)** - the telephone facility where telephone users’ lines are joined together to switching equipment that connects telephone users to each other.
- **Common Carrier** - a company that must offer its services to all customers at the prices and conditions outlined in a public tariff.
- **LEC – Local Exchange Carrier** - a company that makes telephone connections to subscribers’ homes and businesses, and provides telephone services. The terms LEC and RBOC (Regional Bell Operating Company) are equivalent.
- **Local Loop** - the pair of copper wires that connects a customer’s telephone (system) to the LEC’s Central Office.
- **Bandwidth** - The total information-carrying capacity of a network of transmission channel. For analog networks this is measured in Hz and for digital networks in bps.
- **Technology Convergence** - The same transmission lines and computer switching systems carry voice, video, Internet traffic, and other data communications.
Basic Telephony – local exchange functions

- **Analog**: A signal transmitted as a pattern of continually changing electromagnetic waves is referred to as an analog signal.

- **Digital**: Refers to a signal transmitted as a pattern of binary bits. Information is represented as a series of 1’s and 0’s, high or low electrical voltages.

- **Channel**: A portion of the total bandwidth of a transmission path, used to carry a single signal.

- **Demarcation Point (Demarc)**: The connection between the private telephone system and the PSTN (Public Switched Telephone Network). It’s the physical point where the Telco’s responsibility ends and the customer’s begins.

- **DTMF**: Dual Tone Multifrequency – Touch Tone

- **PSTN**: Public Switched Telephone Network
Basic Telephony – telephone system hierarchy

- Class 1: Regional Center
- Class 2: Sectional Centers
- Class 3: Primary Centers
- Class 4: Toll Offices
- Class 5: CO – Local Exchanges

![Telephone System Hierarchy Diagram]
Customer Premises Equipment (CPE)

- **Key Telephone Systems** – Provides multiple telephone extensions access to a group of single telephone lines
  - Lines are represented by LEDs on the phone
  - “Red” LED means the line is in use; “green” LED means the line is free to use

- **Hybrid Systems** – A more advanced Key telephone system, incorporating many features previously found only on PBXs

- **Central Office Exchange** – Centrex – CTX – A telephone company network service that provides sophisticated office telephone switching features through a CO switch
  - Customer purchases a block of numbers
  - Allows for interoffice calling, outside calling, and direct inward dialing (DID)

- **PBX – Private Branch Exchange** –
  - Telephones are extensions off the PBX
  - Trunks are pooled for incoming and outgoing service
  - Equipment cabinet made up a main processor, network interface circuit card, and telephone station circuit cards
  - Calls typically answered at a central answering position (Attendant Console)
Basic Telephony – signaling

- In Band vs. Out-of-Band Signaling
  - In Band signaling shares a single transmission channel with the voice conversation
    - Analog (POTS) lines – i.e. Call Waiting Tone
  - Out-of-Band Signaling is carried over a separate channel from voice
    - ISDN-BRI: Uses 16 Kbps channel for signaling & 2 64 Kbps channels for voice or data
    - ISDN-PRI: Uses a 64 Kbps channel for signaling & 23 64 Kbps channels for voice or data
Basic Telephony – signaling

Lines & Trunks are classified according to the type of supervisory signaling the use. There are 4 main ways in which supervisor signals are transmitted

- **Loop Start**: The CO switch detects electrical current that flows through a local loop when the user lifts the telephone handset
- **Ground Start**: The CO switch detects electrical current that flows through a trunk when a PBX system grounds one side of a wire pair
- **Wink Start**: The CO switch and the PBX signal to each other by briefly changing the electrical polarity of the trunk
- **Digital Signaling**: On digital trunks and lines, digital signals travel on one channel set aside for out-of-band signaling
Basic Telephony – trunks, lines and loops

- A *loop*, or local loop is the physical connection that links the Demarc at the customer premises, to the telco CO switch.

- A *line* is generally understood as the transmission path that connects a CO to an individual customer.

- A *trunk* specifically describes the connection between switching systems. For example a trunk connects 2 COs, a CO and a PBX (Private Branch Exchange), or 2 PBXs.
  - Trunks are classified according to 3 major characteristics:
    - Direction – Incoming, Outgoing, or Two-way
    - Capacity – Quantity of information the trunk can carry
    - Transmission Type – Analog or Digital
Basic Telephony – transmission methods

- **Analog** – The signal is carried as a pattern of continually changing waves. Example of an analog line is a POTS line

  ![Waveform](image)

- **Frequency** refers to the number of times the wave swings back and forth in a cycle. High frequency (closed spaced) creates high-pitched sound. Low frequency (loosely spaced) creates a low-pitched sound

- **Amplitude** refers to the height of the wave. This describes the loudness of the signal
Basic Telephony – transmission methods

Digital

- Newer technology
- Signals are transmitted in the form of binary bits
  - Information is represented in the form of 1s and 0s.
- Bits have two values: On or Off
- The information carrying capacity of a digital line or trunk is expressed in the number of bits it can transmit in a second.
  - i.e. – A DS1 channel transmits at 64 Kbps.
Basic Telephony – special access trunks

- **Tie Lines** - A TL is a dedicated circuit, connected through a CO, that links two PBXs, without having to dial a telephone number. A 4-wire circuit (1 pair to transmit and a second pair to receive)

- **Private Lines** - Private lines creates and end-to-end, on-all-the-time connection between two locations

- **Foreign Exchange Lines** - By foreign this means the line originates in a non-local CO. It gives companies the appearance of having a local telephone number in an area that is not local to their office

- **Ring Down Circuits (manual or automatic)** - Is a special telephone line that rings a particular destination telephone as soon as the caller picks up the handset. It’s a type of dedicated line that permanently connects two telephones. (i.e. Courtesy phones, Brokerage houses, hotline phones)

- **Direct Inward Dial (DID)** - A type of trunk, along with DID lines, that give the end user the appearance of having a direct dial number, when in fact they don’t have a dedicated line. Works on PBXs
Basic Telephony – digital line services

- Digital transmission makes it possible to combine or multiplex different types of signals on a single local loop between the user’s location and the telephone network. This can be voice, data, and video

- **T1 Lines**
  - Was developed to carry 24 digitized voice conversations over 2 pairs of copper wires
  - A bandwidth of 64 Kbps is needed to digitize one voice conversation
  - For 24 conversations you need $24 \times 64 = 1,536$ Kbps of bandwidth
  - Additional 8 Kbps required for call control
  - A full T1 provides a total bandwidth of 1.544 Mbps
  - T1s can be ordered as full or fractional
  - Voice Services available on a T1 include two-way calling, DID, TL, and data services
Basic Telephony – digital line services

- **ISDN – Integrated Services Digital Network**
  - A switched service that offers all the capabilities of a voice telephone line as well as data services. International standard
  - ISDN uses 2 types of channels
    - B (Bearer) Channel carries the voice & data signals. Each B channel carries 64 Kbps of bandwidth. An ISDN line may have either 2 B channels (BRI) or 23 (PRI).
    - D Channel carries the control information. Each ISDN line has 1 D channel.
    - Two types of lines:
      - PRI (Primary Rate Interface) – 23 B Channels, 1 D Channel
      - BRI (Basic Rate Interface) – 2 B Channels, 1 D Channel
Basic Telephony – Voice over Internet Protocol (VoIP)

- Voice transmitted over a digital network (Corporate, Private, Public, Cable, and wireless)
- Runs over Ethernet LANs.
- Converts voice communications into data packets.
- Utilizes packet switched technology for communications
  - IP devices have IP or network addresses
  - VoIP packets include sender’s & receiver’s IP addresses
  - Packets traverse the LAN
Simply Put...

- VoIP is ‘converging’ voice and data into one ‘pipe’
- Your voice call is carried over the same connection as your internet

Why have 2 sources when you can have one?
The Benefits of “Convergence”

- Combine Internet AND Voice calls
  - Cut down call charges
  - Reduce monthly recurring charges

- Easy to manage Multiple sites
  - Drive down operating cost.

- Your customers can progress to new technology easily whenever they are ready...
Definitions

- **Convergence**
  - The delivery of multiple media (voice, fax, video, data) over a single network. Typically this network is considered IP-based as in the Internet or a company’s Intranet

- **Voice Over IP (VoIP)**
  - The ability to “packetize” voice into data that can be recognized and routed over a data network

- **IP Telephony**
  - The ability to provide full business telephony features and functionality in a converged environment with all the scalability and reliability that business end users have come to expect from legacy telephony networks
LAN (Local Area Network) Telephony

LAN Telephony - describes the networking infrastructure and wiring on a single site
LAN (Local Area Network) Telephony

WAN Telephony - describes the networking required to connect multiple sites together anywhere - even around the globe.
WAN Telephony

Definition: connecting multiple sites using service provider data services to carry video, data, voice and voice networking traffic.

Typical applications:
- Toll bypass for intra-company calling
- Centralized administration & management
- Networked applications between sites:
  - Uniform dial plan (4-digit dialing)
  - Centralized Operator and voice mail
  - Hot desking and Remote access for home workers
Benefits of VoIP - operational efficiency

► Employee Productivity:
  – Better collaboration through conferencing, IM, webinars, etc.
  – Consistent telephony capabilities minimize re-training
  – Ability to leave or forward voicemails between remote locations
  – Business continuity through remote worker support and hot standby system

► Increased Customer Responsiveness:
  – Customer driven call handling
  – Various ways (fax, email, calls) to communicate with customers
Benefits of VoIP - operational efficiency

- **Lower Costs:**
  - Reduce long distance expense through toll bypass
  - Consolidates voice & data networks
  - Self service options automate customer transactions at peak times
  - Reduce capital costs through centralized applications
  - Eliminate duplicate wiring in greenfield locations

- **Simpler Network Management:**
  - Reduced staff
  - Central management for MAC (Moves Adds and Changes)

- **Easily Scaleable and Ready for Growth:**
  - Distributed network capabilities
  - Reuse existing communications hardware (analog, digital, IP sets)
Benefits of VoIP – investment protection

► Widespread Interoperability of IP-Enabled Equipment & Services
  – The **ubiquitous** presence of IP makes it the protocol of choice for network and application service consolidation
  – **Every PC** produced includes support for IP
  – **Hand-held computers** and **wireless devices** support IP
  – **IP expertise** is widespread and application development companies are numerous
  – IP is the standard for **data transactions** – everything from e-mail to Web browsing to e-commerce

► Contrast This With Circuit Switched (Voice) Technology
  – Based on **proprietary** designs
  – **Limited integration** choices with other vendor equipment
Reduce Calling Costs - SIP services

- Cut calling costs by half!
  - Implementing VoIP or SIP reduces the monthly recurring cost of separate PSTN & data circuits

- Number portability and virtual numbers
  - Move premise and still appear local!

Half the Price
24-channel T1: ~$600-$700
24 SIP Trunks: ~$350
Sample cost savings

**Small Business 30 Employees**

**POTS and DSL**
- 14 Analog lines
- 12,500 local
- 12,500 LD minutes
- DSL For Internet

**MONTHLY**
$2145

**2 x T1 (24 lines)**
- T1 for Local and LD
  - 12,500 local
- 12,500 LD minutes
- 1 x T1 for Internet

**MONTHLY**
$2414

**VoIP or SIP**
- Shared T1 for Voice (14 channels) and Data (Internet)
  - 12,500 local
  - 12,500 LD minutes

**MONTHLY**
$1120
IP Telephony – real world example

Teleworker
Avaya 4610 Phone via VPN Home Network

Optional PC Local Web based Management

Avaya Quick Edition on 4610SW and/or 4621SW IP telephones

Avaya A10 Analog Telephone Adapter

Analog phone/device

PSTN

Avaya G11 PSTN Gateway

NETGEAR Firewall/VPN FVS338

NETGEAR PoE Switch FS728TP

Internet

SIP Trunk WAN

Avaya Quick Edition VoIP phones and gateways

NETGEAR VPN Firewalls: FVS338

POE switch: Smart Switch (FS728TP)
Challenges of VoIP

Issues Affecting Broad Use of VoIP - Voice communications have different requirements than data, for successfully getting through a network. Issues affecting broad utilization of VoIP have included:

- Latency or delay
- Jitter
- Packet Loss
- Features
- Scalability
Challenges of VoIP

Many businesses have significant investments and functionality in circuit-switched (traditional equipment), in which many traditional telephony systems are “closed” or proprietary

- **Cost of Implementing VoIP**
  - Re-wiring
  - LAN/WAN equipment Upgrades
  - Power issues
- **Investments in circuit-switched equipment**
- **Interoperability with Multi-Vendor Equipment**
What does this mean for your customer?

Customers decide what they need to do without worrying about the technology behind it

Does your business need to reduce its infrastructure costs?
Do you need to share information between offices?
Do you need to provide internet access to your staff?
Do you need to reduce the cost of calls between sites?
Does it make more sense for you to manage things centrally?

Then moving toward voice and data convergence could help!!
Reduce the challenge of managing separate voice and data networks

- Single point of configuration across the network
- Simple moves and changes
- Easy to use management interface
- Operators can work across multi sites
- Improved resource management
- Centralized voicemail

Using the same lines to carry your voice and data calls can reduce variable costs

Using the same equipment to route your voice and data traffic can reduce fixed costs
Understand the underlying challenges for small businesses

- Selling into Small Businesses in today’s environment has become an art
- More than 85% of Small Businesses plan to either increase or maintain their IT spending level
- Small Businesses make purchasing decisions for new technology solutions differently because they:
  - Likely are unaware of new technology solutions
  - Must immediately discern the value of a new technology
  - Often need assistance developing Return On Investment (ROI) and Total Cost of Ownership (TCO) for new solutions
Winning in the small business market

You need a basic understanding of:
- IP Telephony
- Business Enhancing Applications
- Mobile Solutions

Why do sales people fail during the sales process?
- Because they talk about the virtues of technology rather than listen to the issues their customers are struggling with

Small businesses buy solutions from vendors that demonstrate how their solutions solve challenges.
## Typical solutions for key small business needs

<table>
<thead>
<tr>
<th>Business Need</th>
<th>IP Telephony Application</th>
<th>Customer Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Monthly Costs</td>
<td>IP Telephony Networking</td>
<td>One wire run for voice and data</td>
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<td></td>
<td></td>
<td>Easy moves, adds and changes (MACs)</td>
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<tr>
<td></td>
<td></td>
<td>Improve inter-site communication to simplify information exchange and enhance customer service</td>
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<td></td>
<td>Centralize services (e.g. operator, voicemail) as well as management and administration to reduce costs</td>
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<tr>
<td></td>
<td>Conferencing</td>
<td>Speed deployment of remote offices—respond more quickly to market demands</td>
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<td>Reduce costs of collaboration by bringing conferencing and webinars in house</td>
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<td>Improve Productivity</td>
<td>Remote Worker</td>
<td>Enhance productivity with applications like single number reach, one mailbox for all message types, sending message alerts to your cell phone, and email read over voice mail</td>
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<td>Work anywhere - Give your employees all the communications capabilities they have at the office whether they are working from home, a hotel or a remote office</td>
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<td>Increase Revenues; Improve Service</td>
<td>Contact Center</td>
<td>Improve customer relationships—get the call to the right person as quickly as possible</td>
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Solutions must be tied to business needs

“How can solutions vendors make (voice-data) convergence more relevant to your business?” (% Respondents)

- Develop better understanding of our unique business requirements (52%)
- Develop more applications that meet a real business need (49%)
- Improve Security for IP Networks (48%)
- Reduce the cost of the underlying technology (47%)
- Provide more information on the value of convergence (45%)
- Improve voice quality on IP networks (42%)
- Simplify implementation for IP networks (38%)
- Improve the reliability of IP networks (36%)

Small Businesses expect you to:
- Understand their business-specific requirements
- Deliver solutions that meet business needs

Source: EIU, June 2004