

TSN: Lecture 26

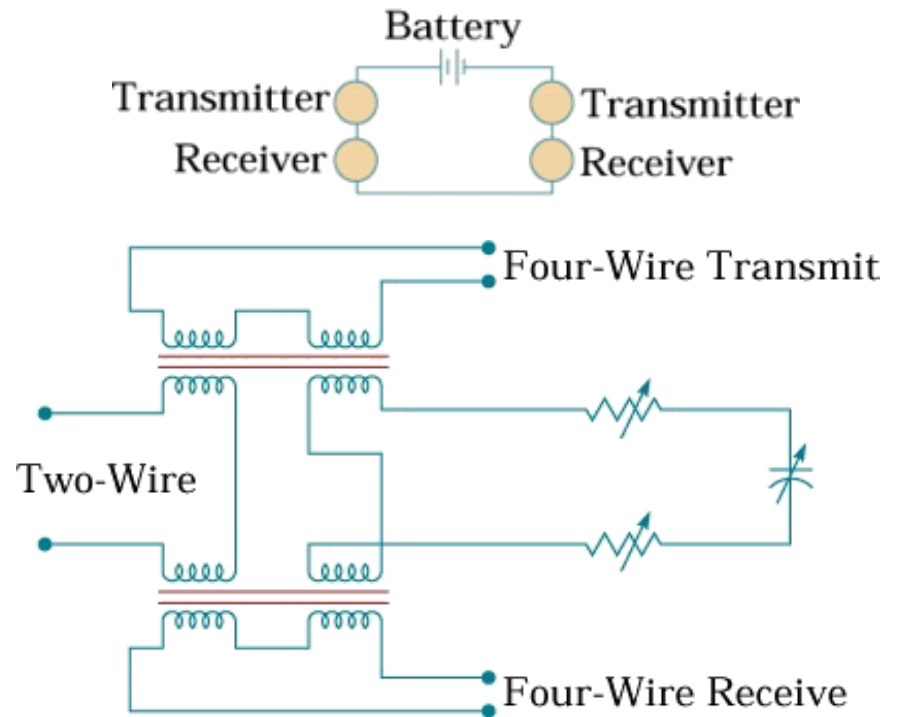
Simple Telephone System

Topics Covered

- Simple Telephone System
- Signals and Noise in the Telephone System
- Frequency-Division Multiplexing
- FDM Hierarchy

Simple Telephone System

- A single twisted-pair line is required to carry both sides of the conversation, thus providing *full-duplex* communication



Signals and Noise in the Telephone System

- Again, two of the most important characteristics of any communication system are bandwidth and signal-to-noise ratio
- The bandwidth of a voice-grade telephone system is about 3.2 kHz
- Noise in a system increases in relation to the distance from the source
- **Repeaters** are used to increase the signal level and improve the signal-to-noise ratio

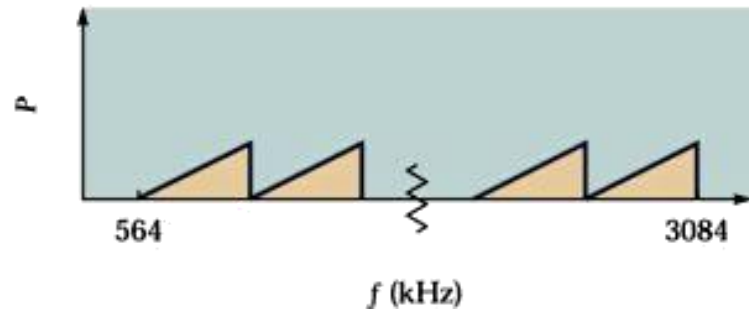
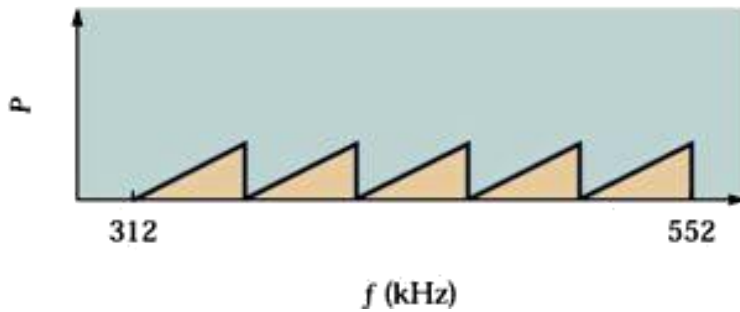
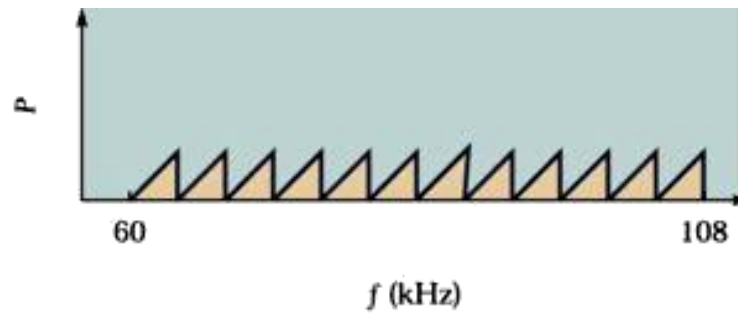
Frequency-Division Multiplexing

- Analog telephone signals can be combined (multiplexed) using FDM
- The channel can be a twisted-pair, a coaxial cable, a microwave radio link, or satellite
- In FDM, the spectrum is divided among a number of information signals
- In FDM telephony, the modulation is typically SSB or SSBSC, and 4 kHz of spectrum is allocated to each conversation

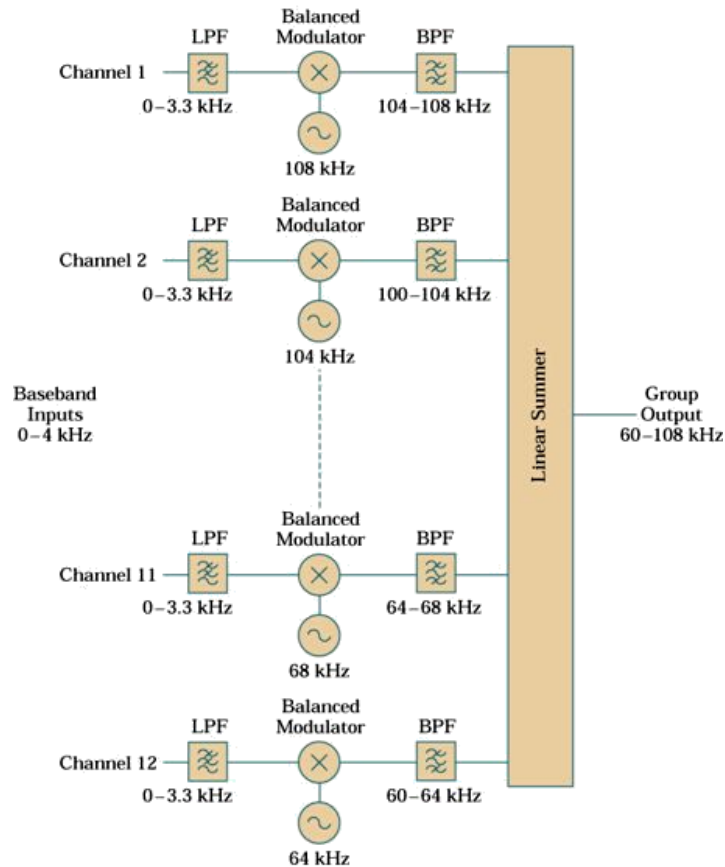
FDM Hierarchy

- The number of conversations transmitted using FDM depends upon the total bandwidth available
- The channels are grouped according to a hierarchical structure:
 - Group - lowest level
 - Supergroup - 5 groups
 - Mastergroup - 10 supergroups
 - Jumbogroup - 6 mastergroups
 - Superjumbogroup - 3 jumbogroups

FDM Hierarchy



Generation of a Group

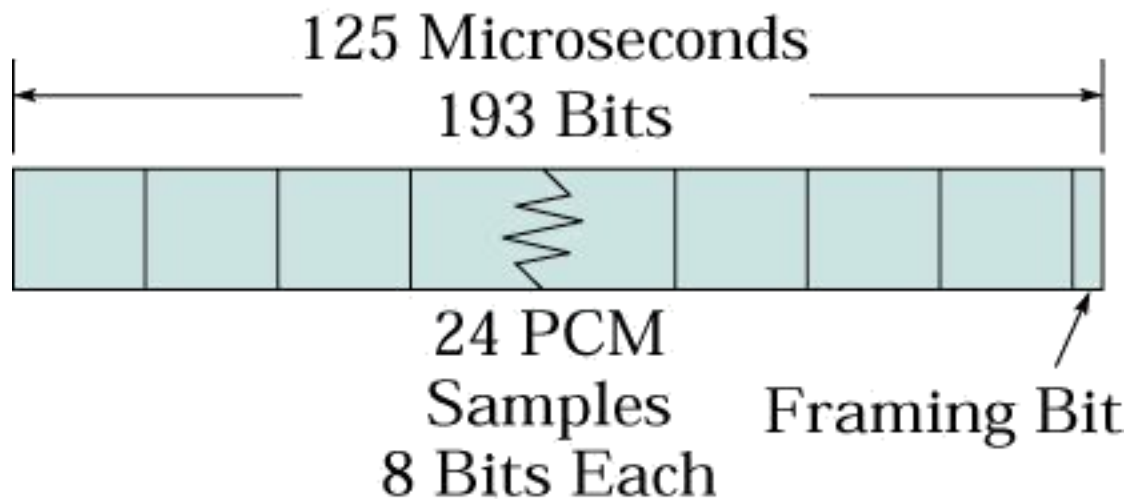


Digital Transmission

- Over the past 30 years, telephone systems have gradually been converted to digital technology
- PCM is a typical scheme for digital transmission along telephone lines

Time-Division Multiplexing

- DS-1 lines can be used for voice or data transmission using TDM techniques



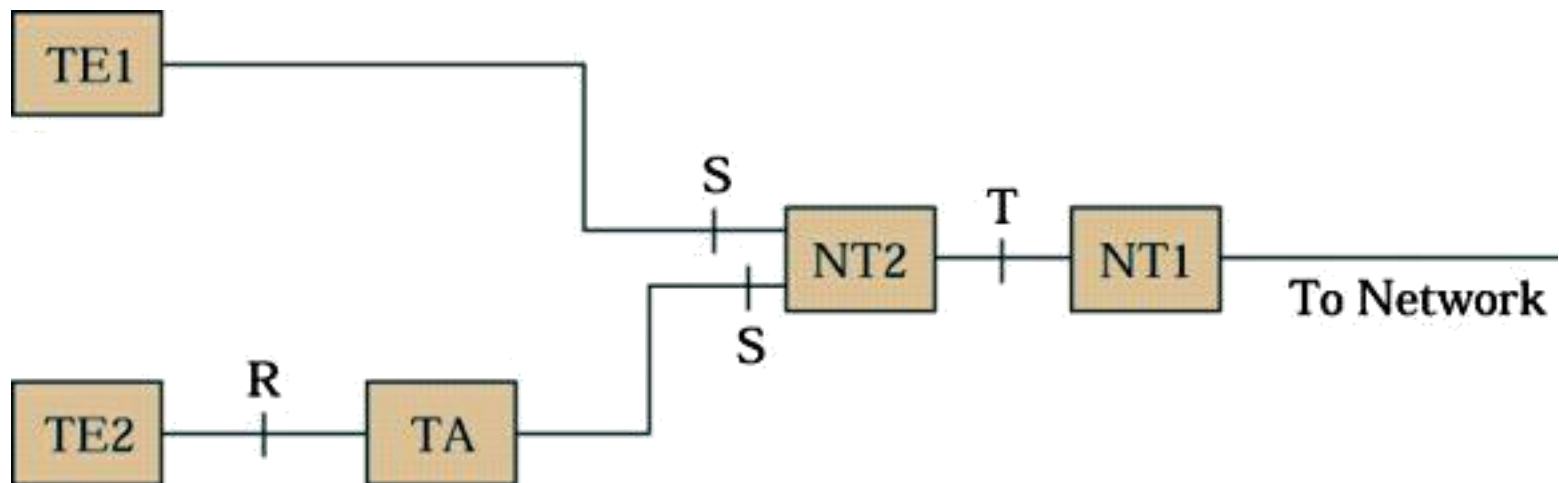
Telephone-Network Signaling

- Local-loop signals such as DTMF tones, dial tones, busy signals, and ringback signals are called *in-channel* signals because they use the same channel as the voice, only at different times
- These signals are AC and in the same range as voice signals and are also referred to as *in-band* signals
- DC signals and currents such as on/off-hook signals are referred to as *out-of-band* because DC is not part of the same frequency range as a voice signal

Integrated Services Digital Network (ISDN)

- ISDN is designed to allow voice and data to be transmitted along the same lines
- ISDN provides a way to standardize data and voice communications without resorting to modems
- ISDN connects at a primary access point with a data rate of 1.544 Mb/s
- One of these channels is the D (data) channel and is used for setting up and monitoring calls
- The other 23 channels are called B (bearer) channels and can be used for voice or data

ISDN Access



Asymmetrical Digital Subscriber Line (ADSL)

- ADSL lines use the frequencies above the voice range for high-speed data while leaving the use of the local loop for analog telephony intact
- Typical ADSL uses include Internet access and interactive television

