

# THE PHYSICAL LAYER

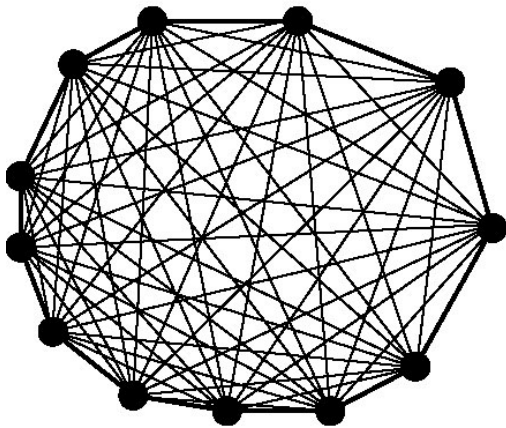
Data Communication – Lets Talk

# Public Switched Telephone System

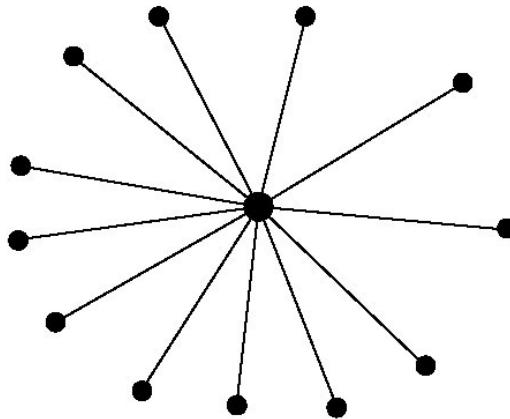


- Structure of the Telephone System
- Trunks and Multiplexing
- Switching

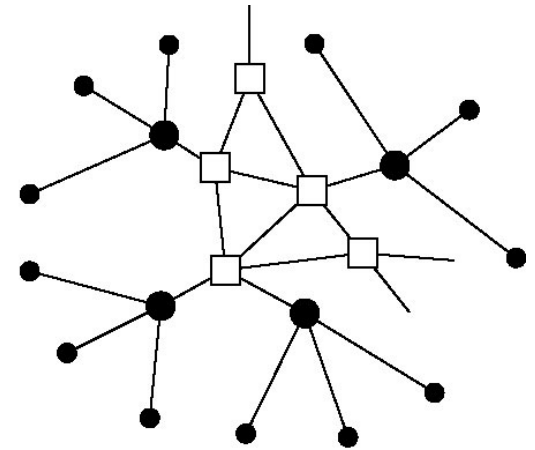
# Analysis of Infrastructure



(a)



(b)

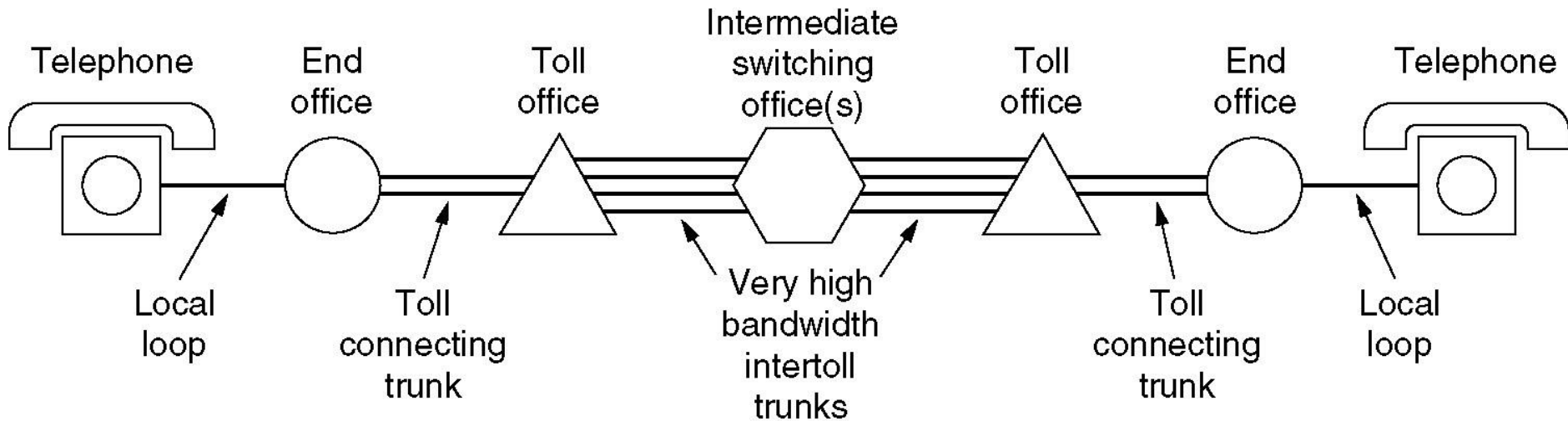


(c)

- (a) Fully-interconnected network.
- (b) Centralized switch.
- (c) Two-level hierarchy.

# End to End Structure

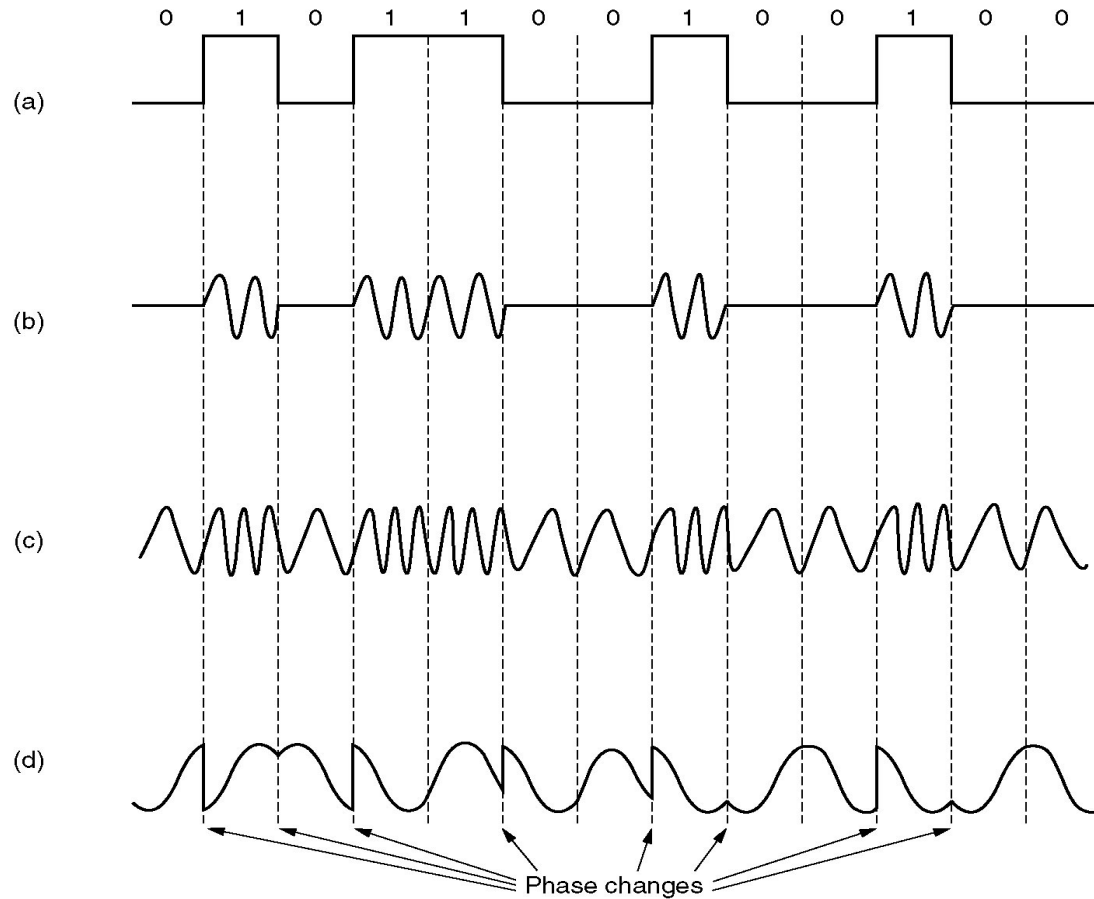
A typical circuit route for a medium-distance call.



# Major Components of the Telephone System

- Local loops
  - ▣ Analog twisted pairs going to houses and businesses
- Trunks
  - ▣ Digital fiber optics connecting the switching offices
- Switching offices
  - ▣ Where calls are moved from one trunk to another

# Modems



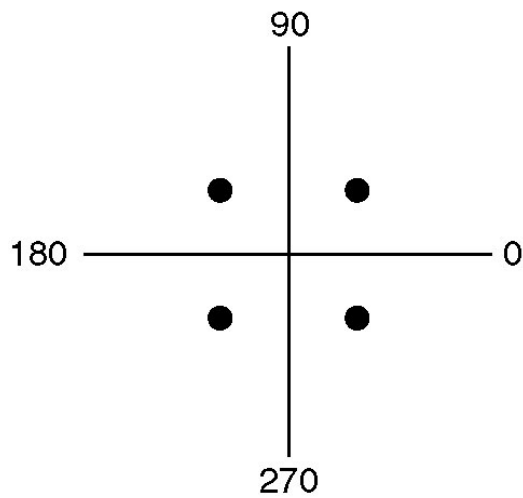
(a) A binary signal

(b) Amplitude modulation

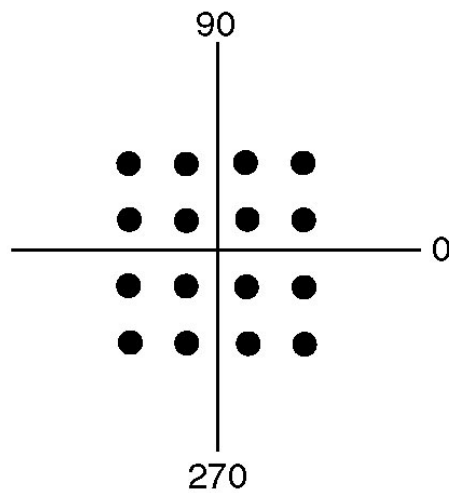
(c) Frequency modulation

(d) Phase modulation

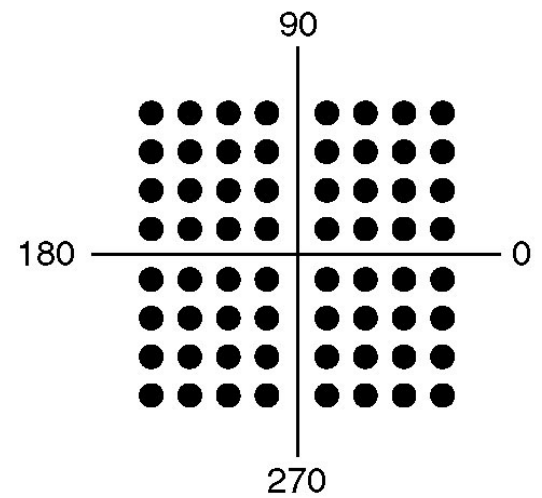
# Modems (2)



(a)



(b)



(c)

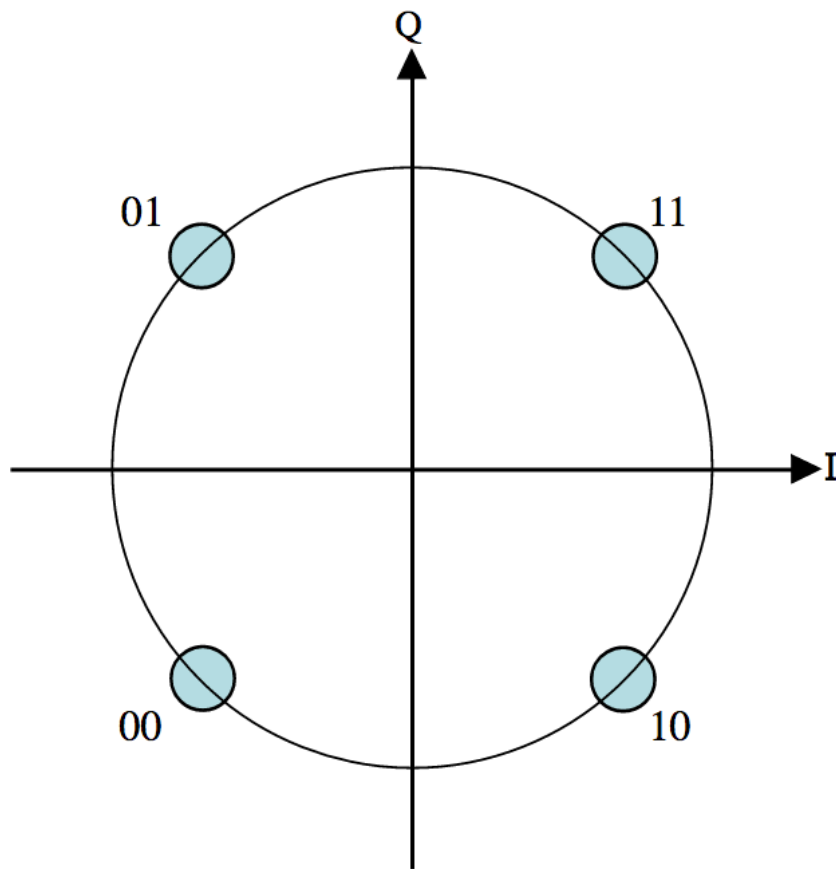
(a) QPSK.

(b) QAM-16.

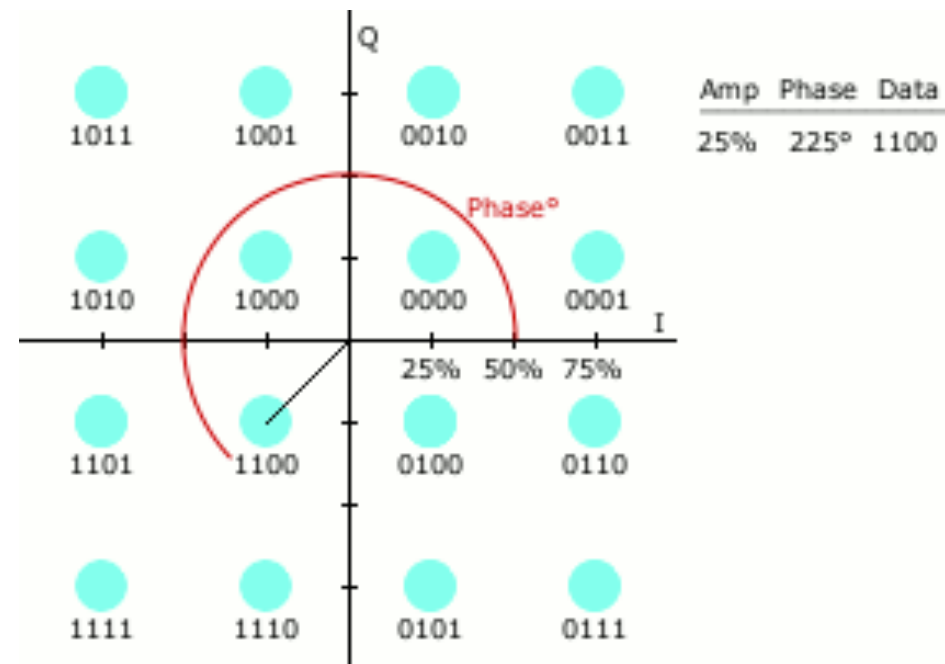
(c) QAM-64.

# QPSK vs QAM

## □ QPSK

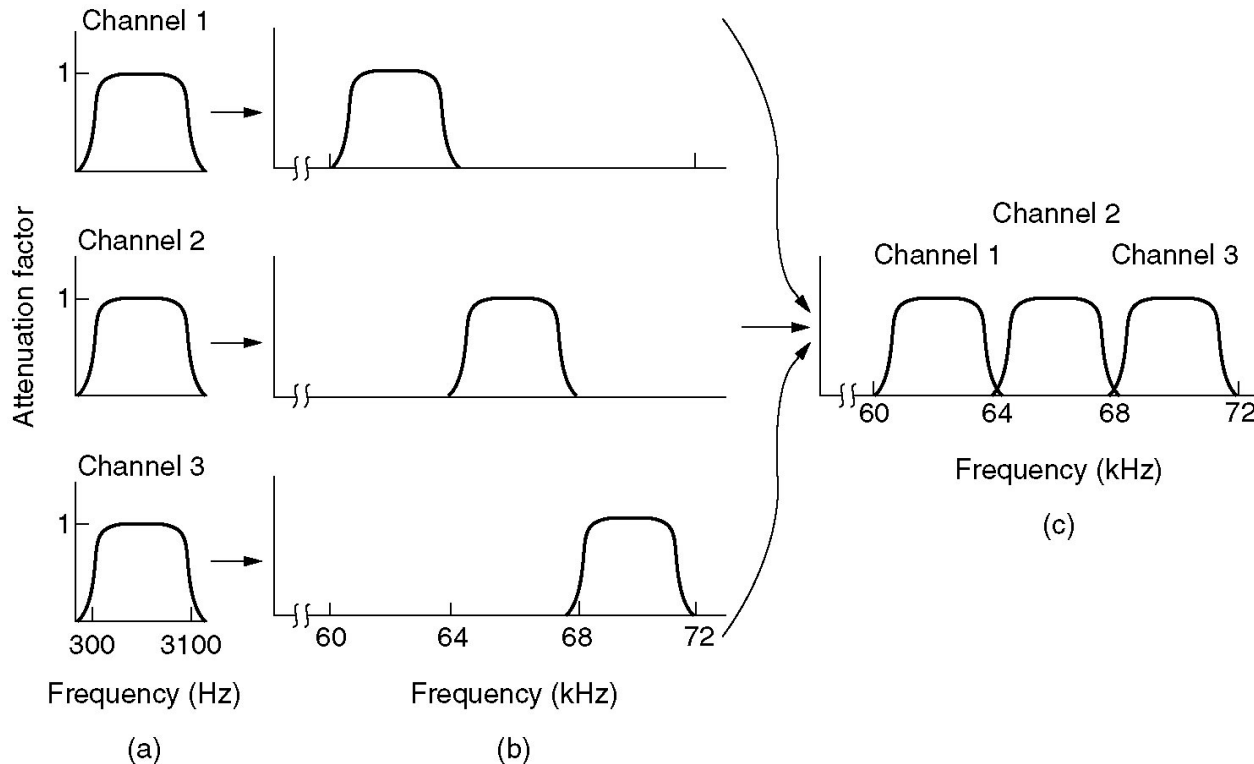


## □ QAM





# Frequency Division Multiplexing



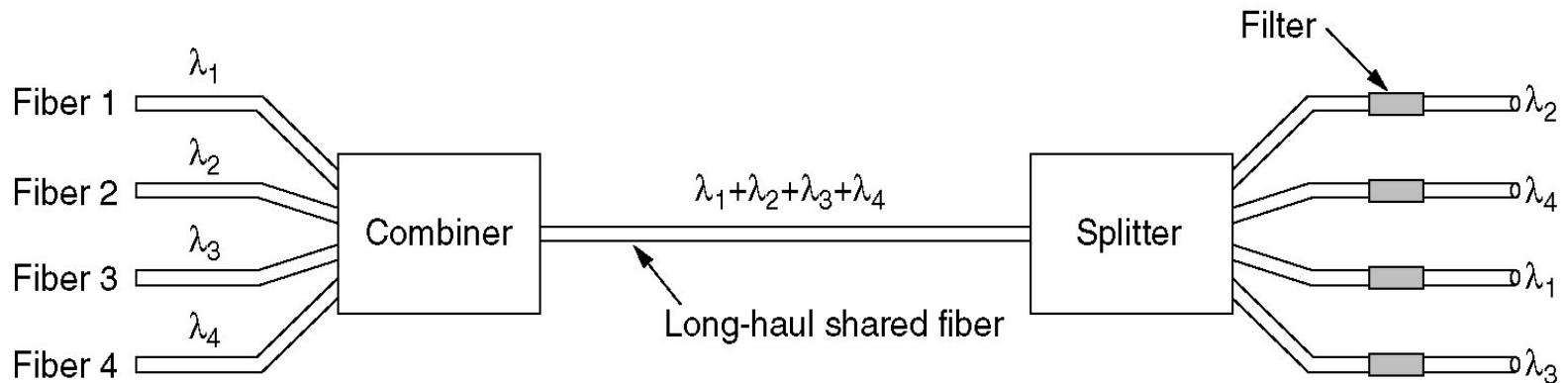
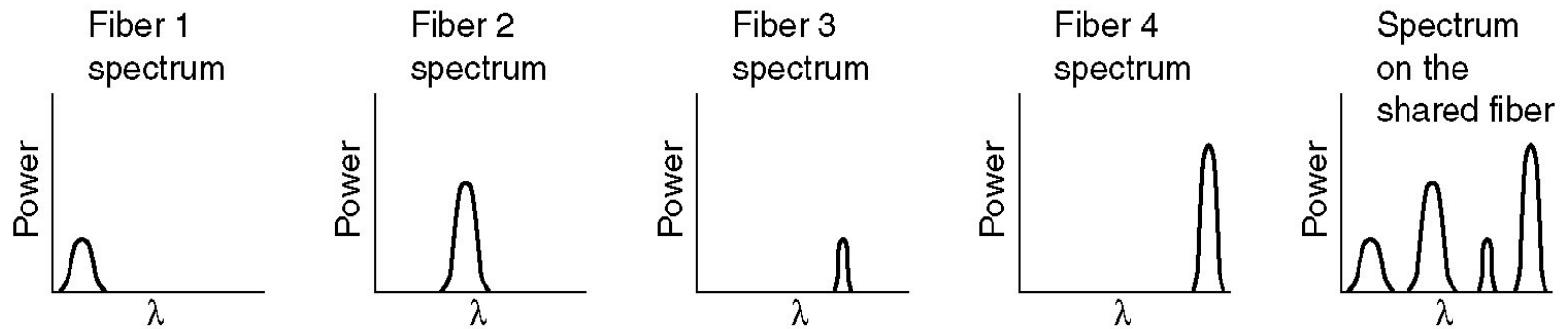
**(a)** The original bandwidths.

**(b)** The bandwidths raised in frequency.

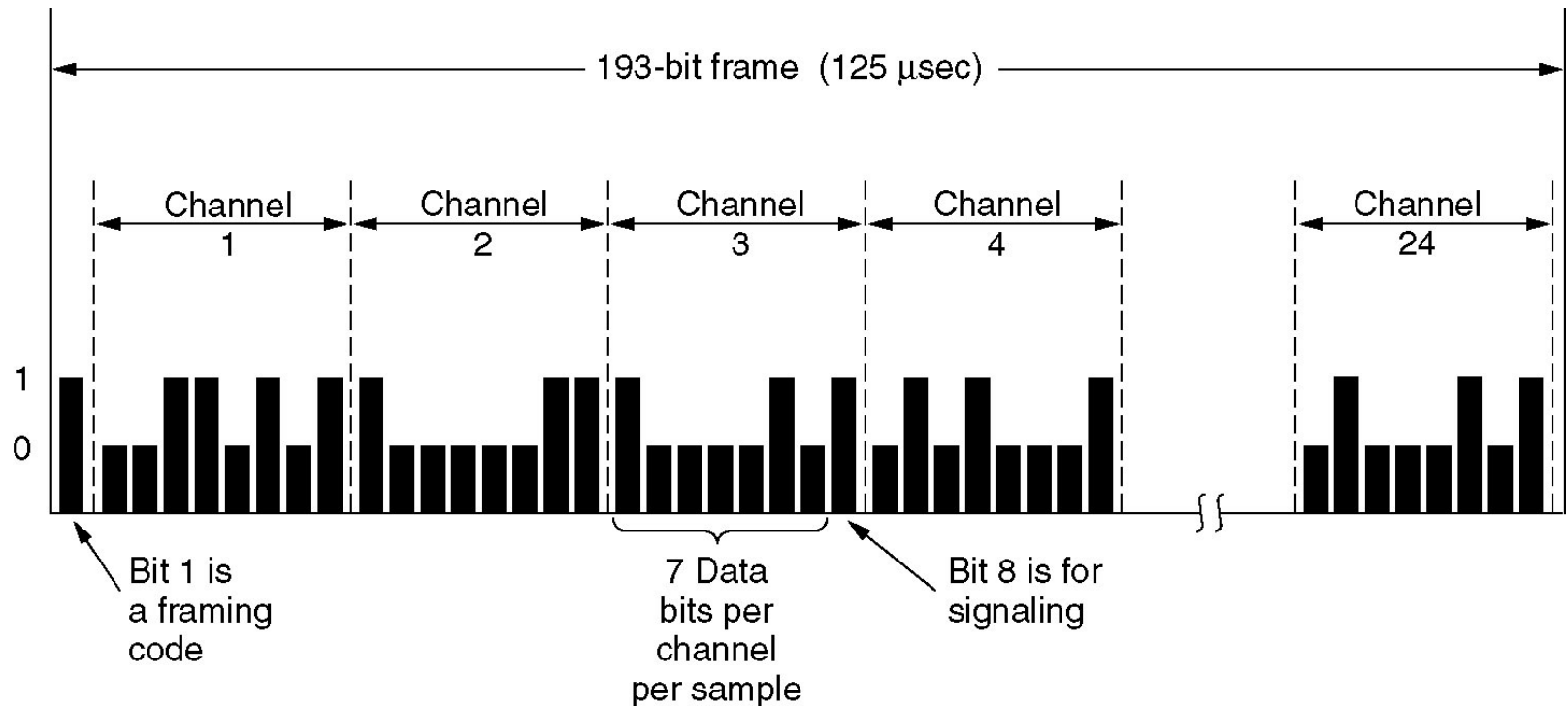
**(b)** The multiplexed channel.

# Wavelength Division Multiplexing

## Wavelength division multiplexing.



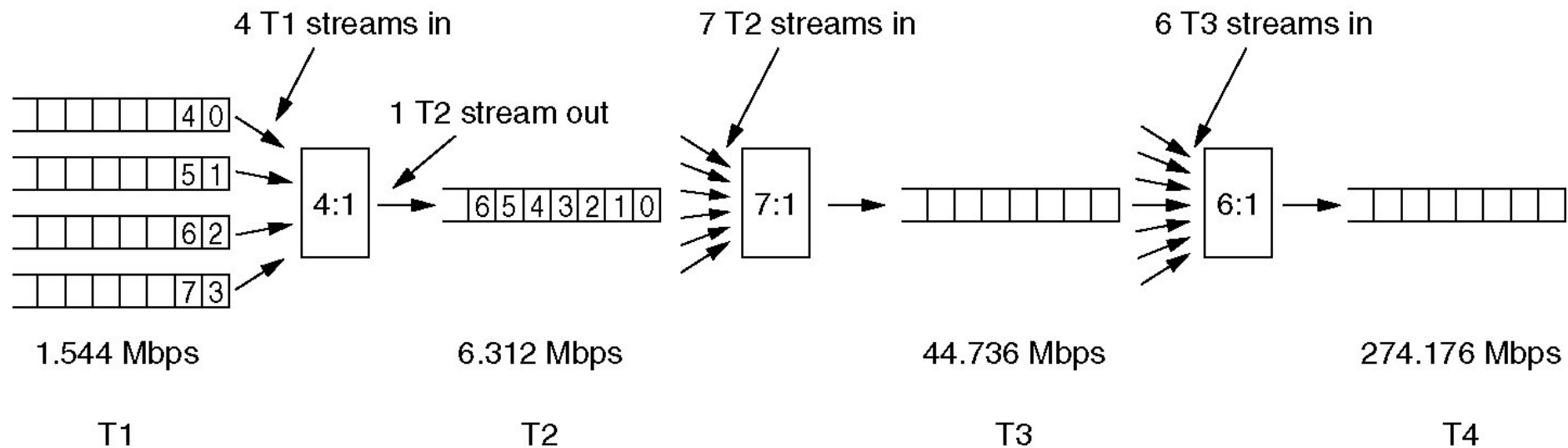
# Time Division Multiplexing



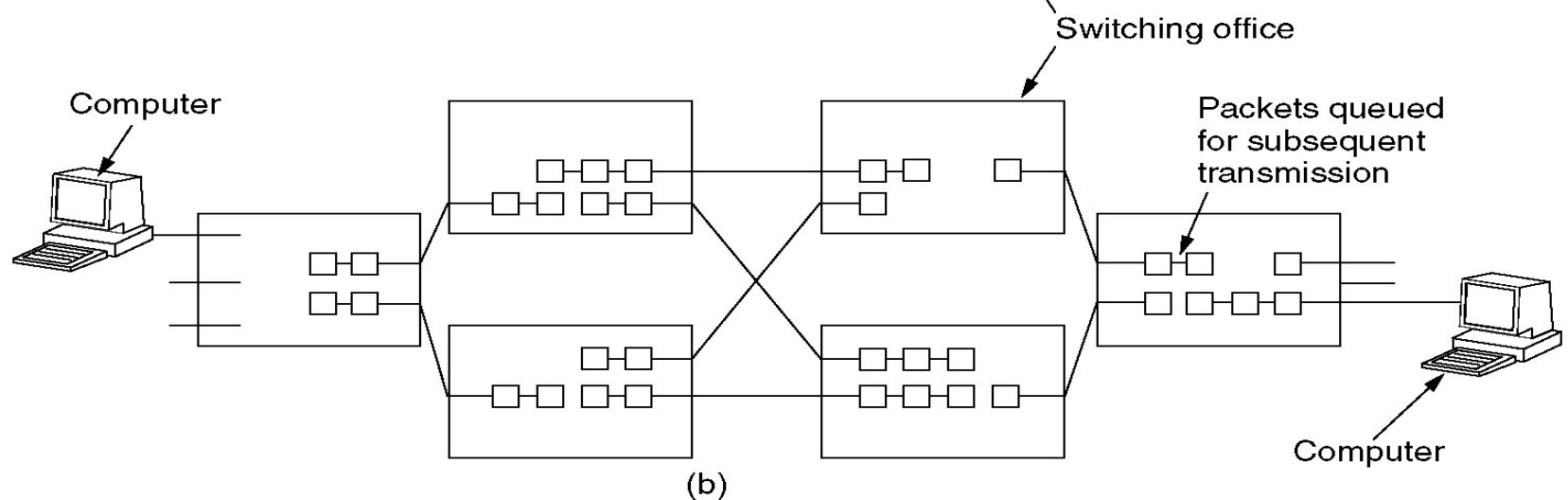
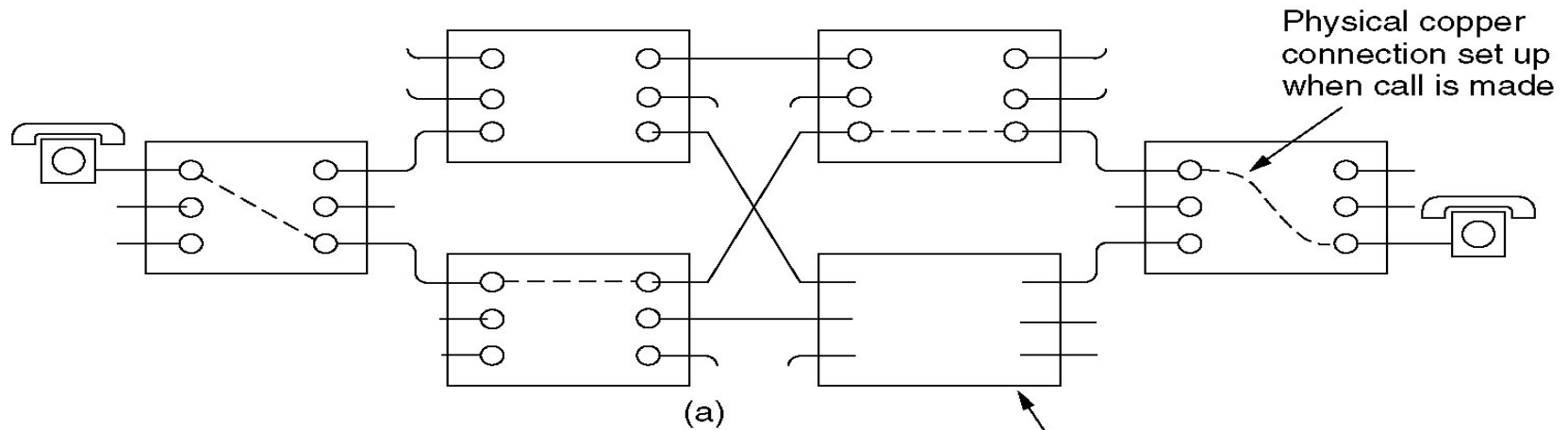
The T1 carrier (1.544 Mbps).

# Scaling TDM

Multiplexing T1 streams into higher carriers.



# Circuit Switching



(a) Circuit switching.

(b) Packet switching.

# Packet Switching

Item	Circuit-switched	Packet-switched
Call setup	Required	Not needed
Dedicated physical path	Yes	No
Each packet follows the same route	Yes	No
Packets arrive in order	Yes	No
Is a switch crash fatal	Yes	No
Bandwidth available	Fixed	Dynamic
When can congestion occur	At setup time	On every packet
Potentially wasted bandwidth	Yes	No
Store-and-forward transmission	No	Yes
Transparency	Yes	No
Charging	Per minute	Per packet

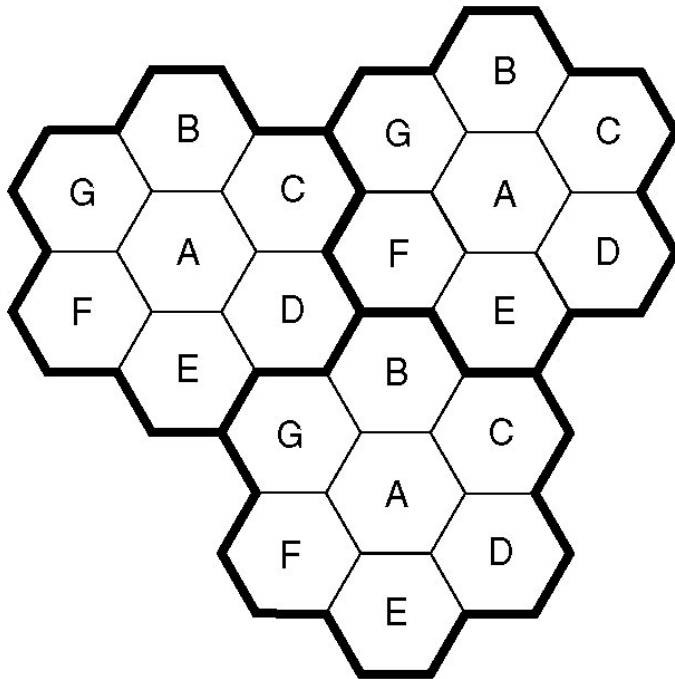
A comparison of circuit switched and packet-switched networks.

# The Mobile Telephone Systems

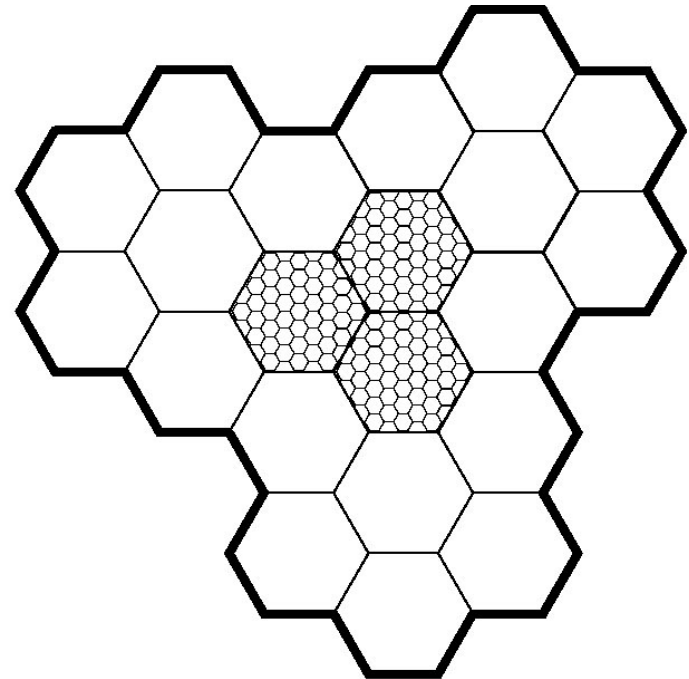
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- First-Generation (1G) Mobile Phones:  
Analog Voice
- Second-Generation (2G) Mobile Phones:  
Digital Voice
- Third-Generation (3G) Mobile Phones:  
Digital Voice and Data

# Advanced Mobile Phone System



(a)



(b)

- (a) Frequencies are not reused in adjacent cells.
- (b) To add more users, smaller cells can be used.



# Channel Categories

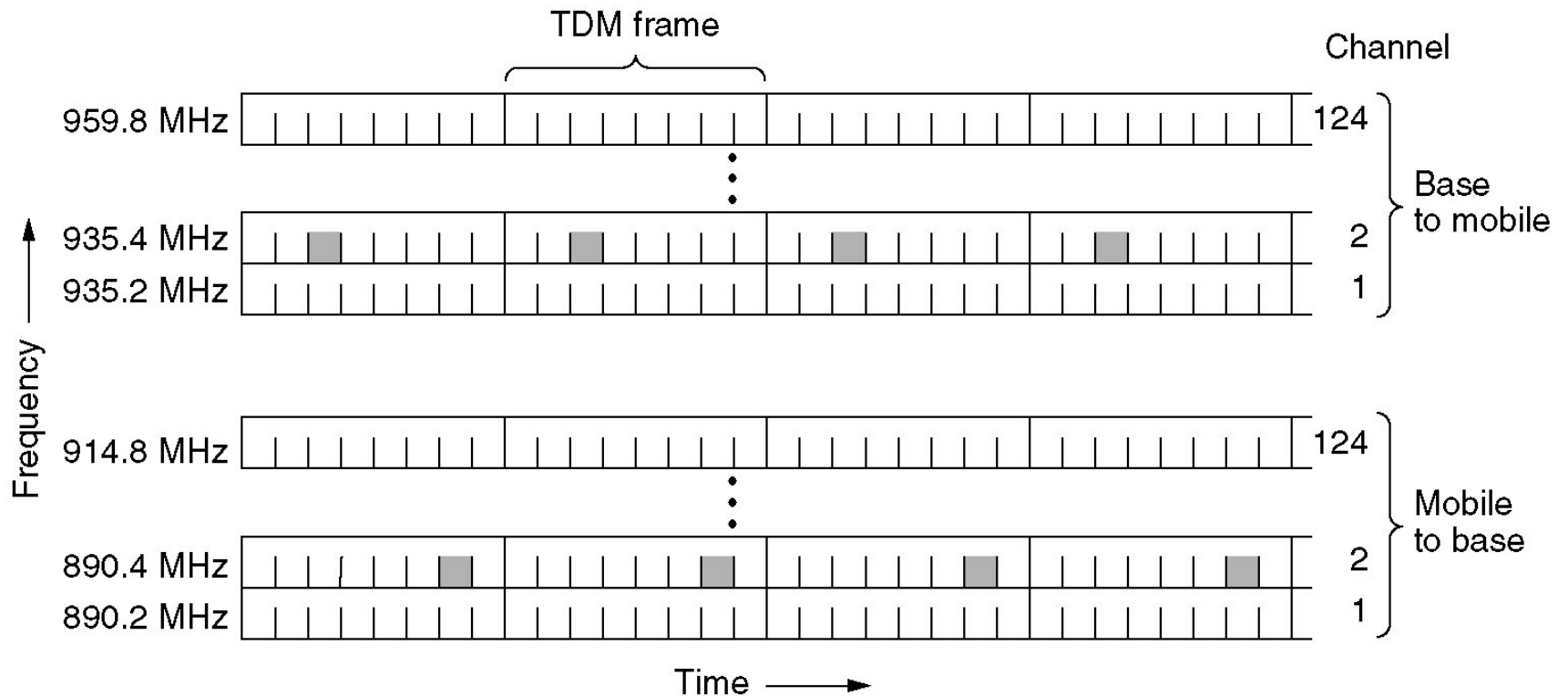
The 832 channels are divided into four categories:

- Control (base to mobile) to manage the system
- Paging (base to mobile) to alert users to calls for them
- Access (bidirectional) for call setup and channel assignment
- Data (bidirectional) for voice, fax, or data

# 1G - Examples



# GSM - 2G



GSM uses 124 frequency channels, each of which uses an eight-slot TDM system

# 3G Mobile Phones: Digital Voice and Data



Basic services an IMT-2000 network should provide

- High-quality voice transmission
- Messaging (replace e-mail, fax, SMS, chat, etc.)
- Multimedia (music, videos, films, TV, etc.)
- Internet access (web surfing, w/multimedia.)

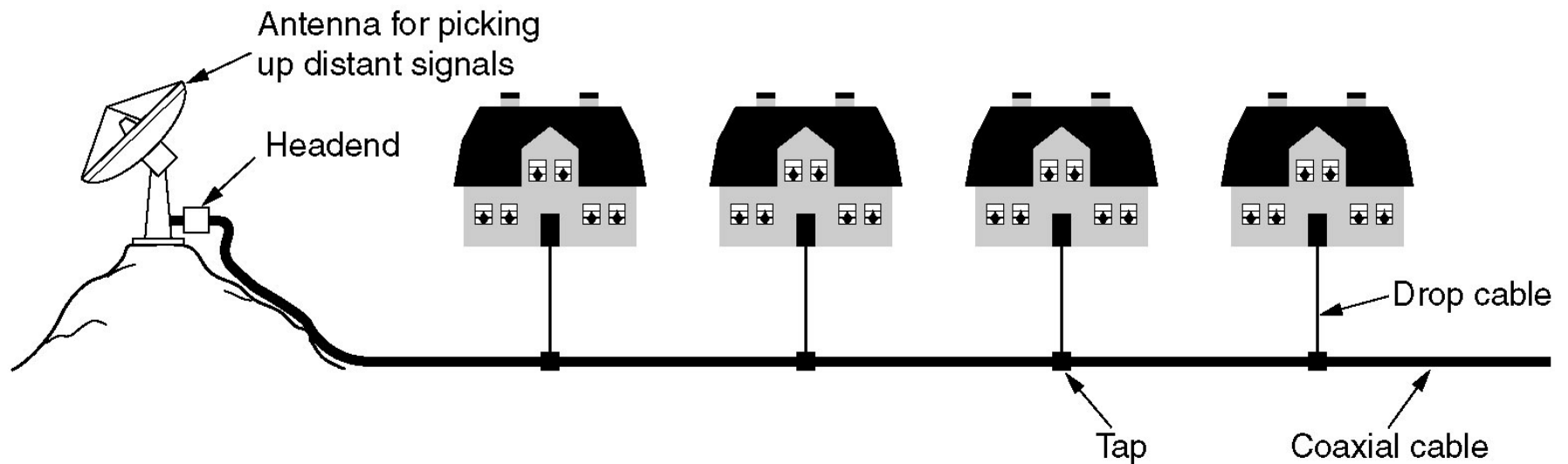
# Domestic Internet Provision

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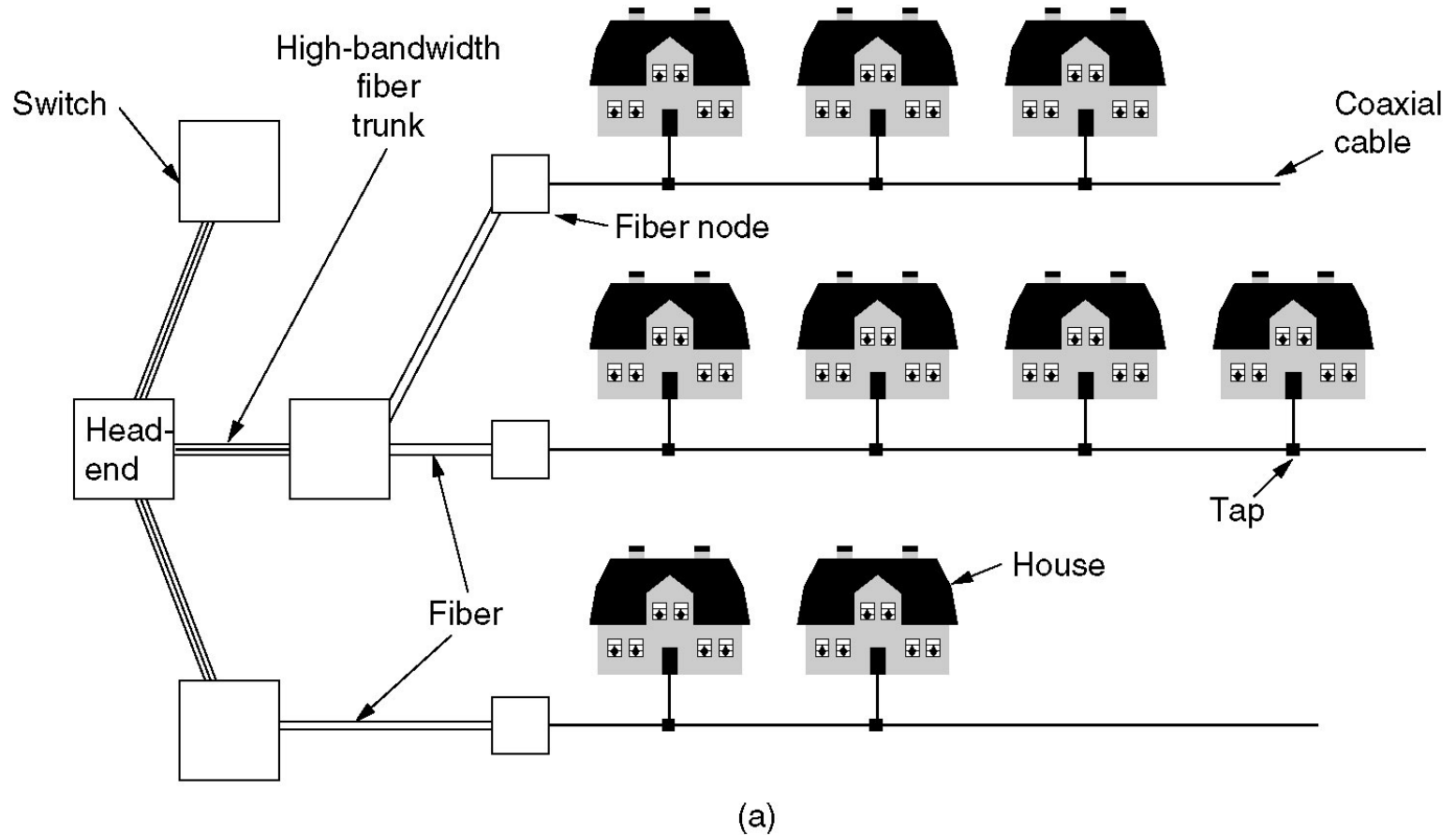
- Community Antenna Television
- Internet over Cable
- Cable Modems
- ADSL versus Cable

# Community Antenna Television

An early cable television system.

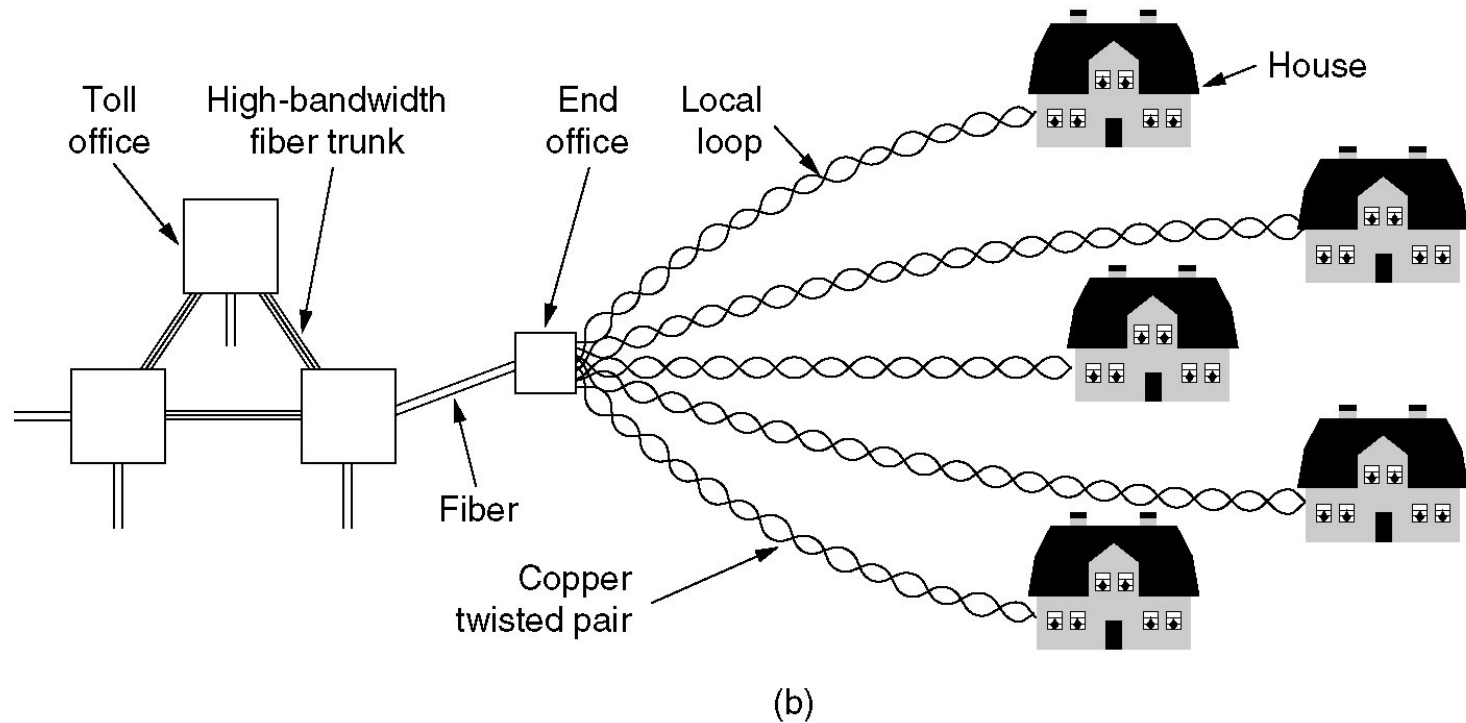


# Internet over Cable - TV



Cable television

# Internet over Cable - Data

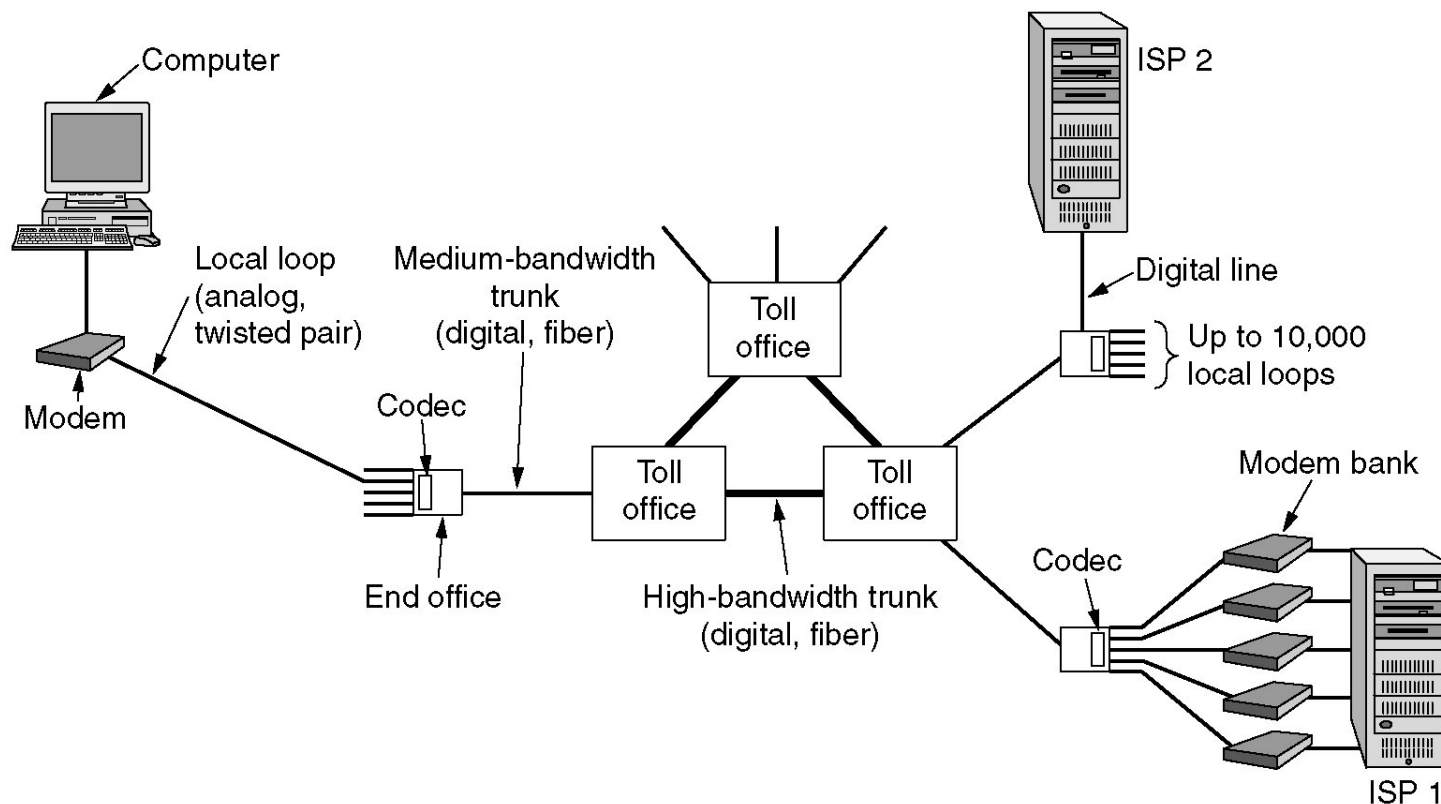


The fixed telephone system.



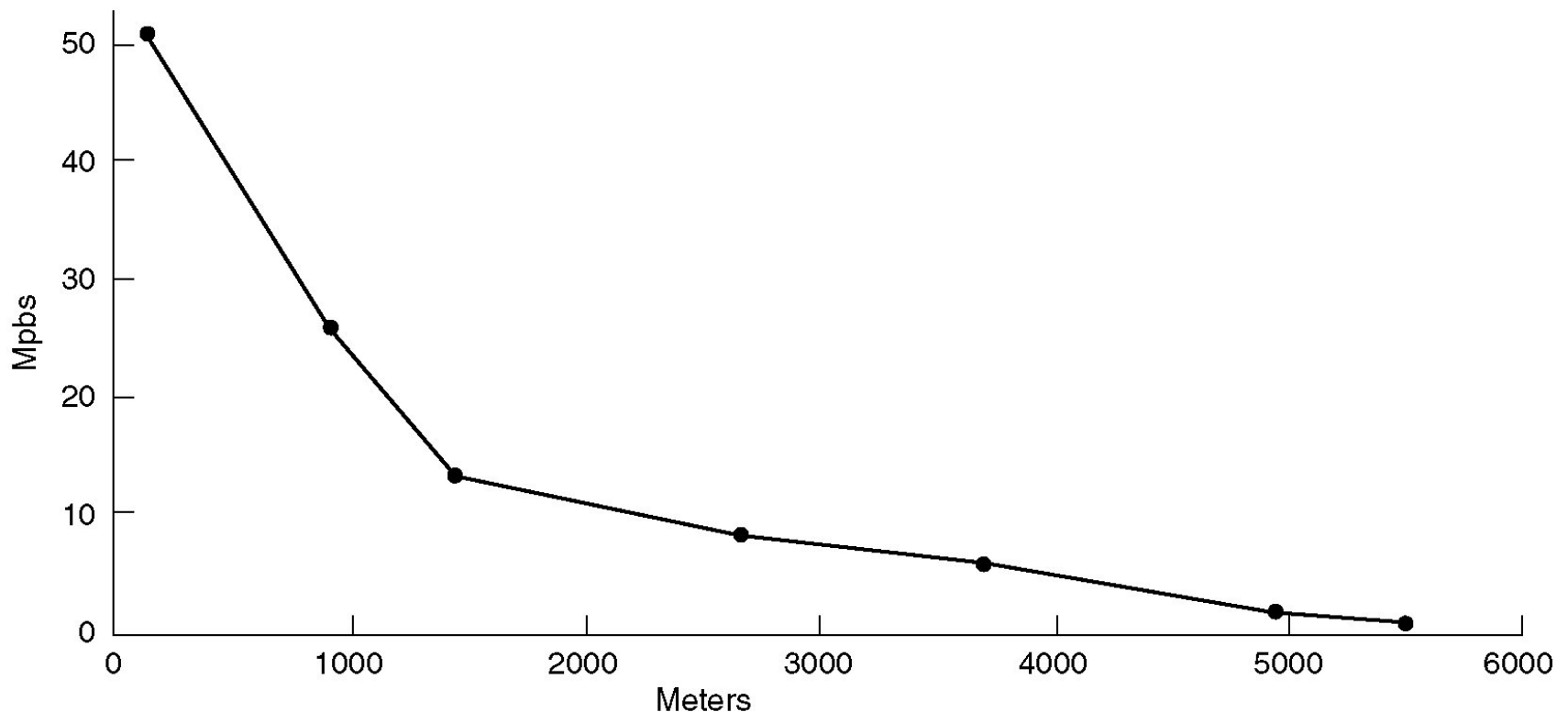
# The Local Loop: Modems, ADSL, and Wireless

The use of both analog and digital transmissions for a computer to computer call. Conversion is done by the modems and codecs.



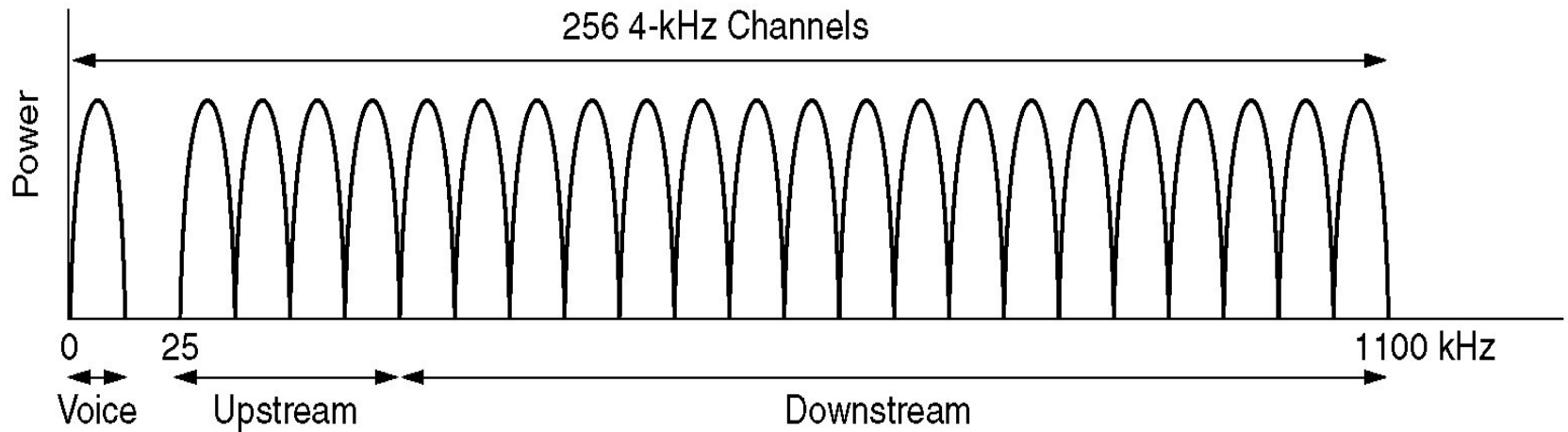
# Digital Subscriber Lines - DSL

Bandwidth vs distanced over category 3 UTP for DSL.



# DSL - Modulation

Operation of ADSL using discrete multitone modulation.



# DSL - Structure

A typical ADSL equipment configuration.

