



Long-Distance Communication

รศ.ดร. อนันต์ พลเพิ่ม

Asso. Prof. Anan Phonphoem, Ph.D.

anan.p@ku.ac.th

<http://www.cpe.ku.ac.th/~anan>

Computer Engineering Department

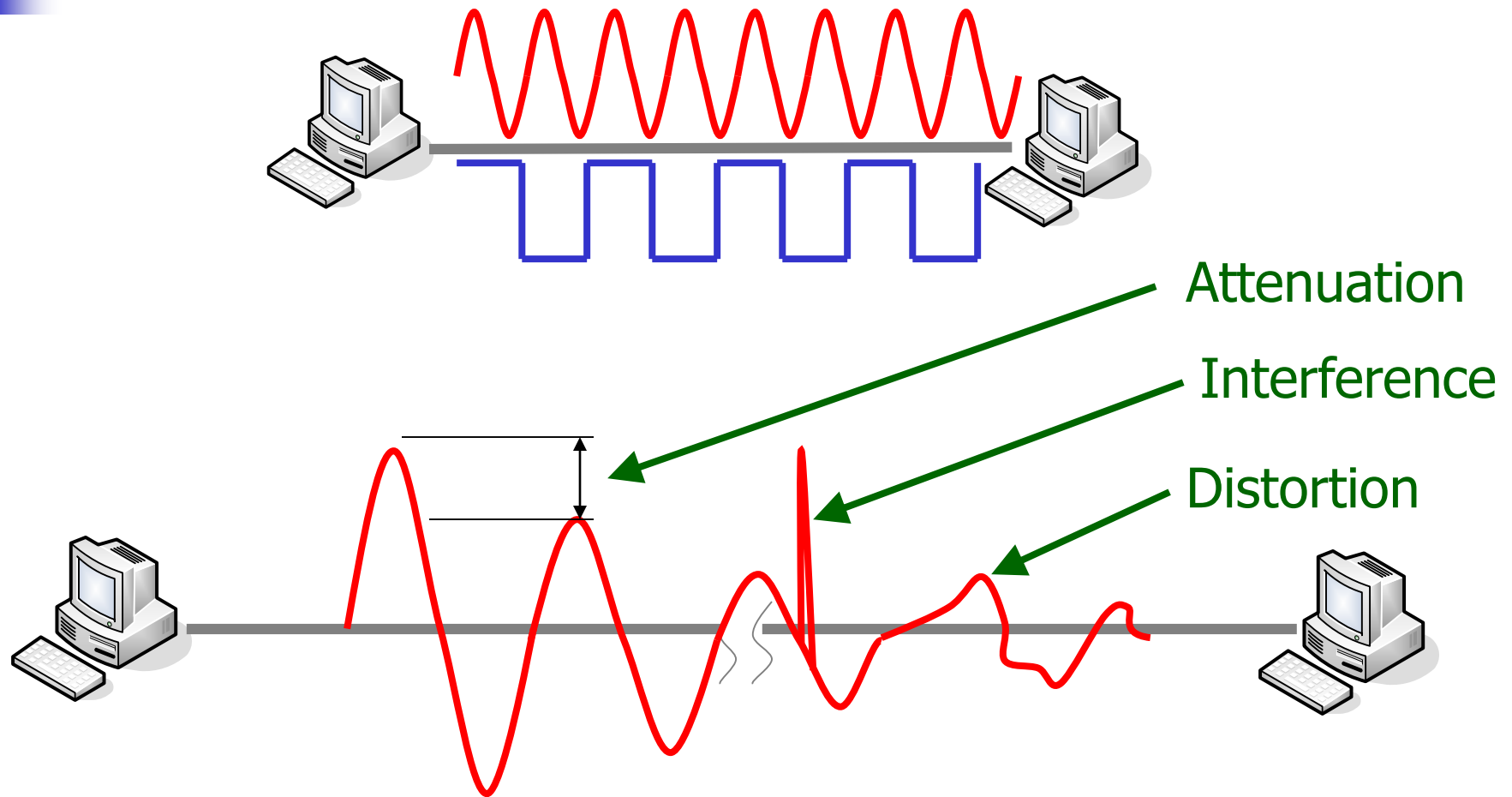
Kasetsart University, Bangkok, Thailand



Outline

- Long-distance problem
- Carrier
- Modem
- Multiplexing
- Spread Spectrum

Long-Distance Communication



Basic concepts

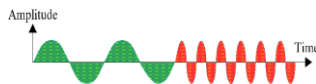
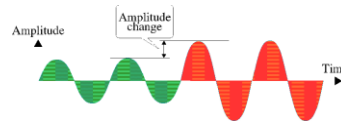


- **Carrier signal (carrier frequency)**

- High frequency
- Sender and receiver agree on the frequency
- Digital data is modulated (shift keying) on the carrier by modifying carrier characteristics

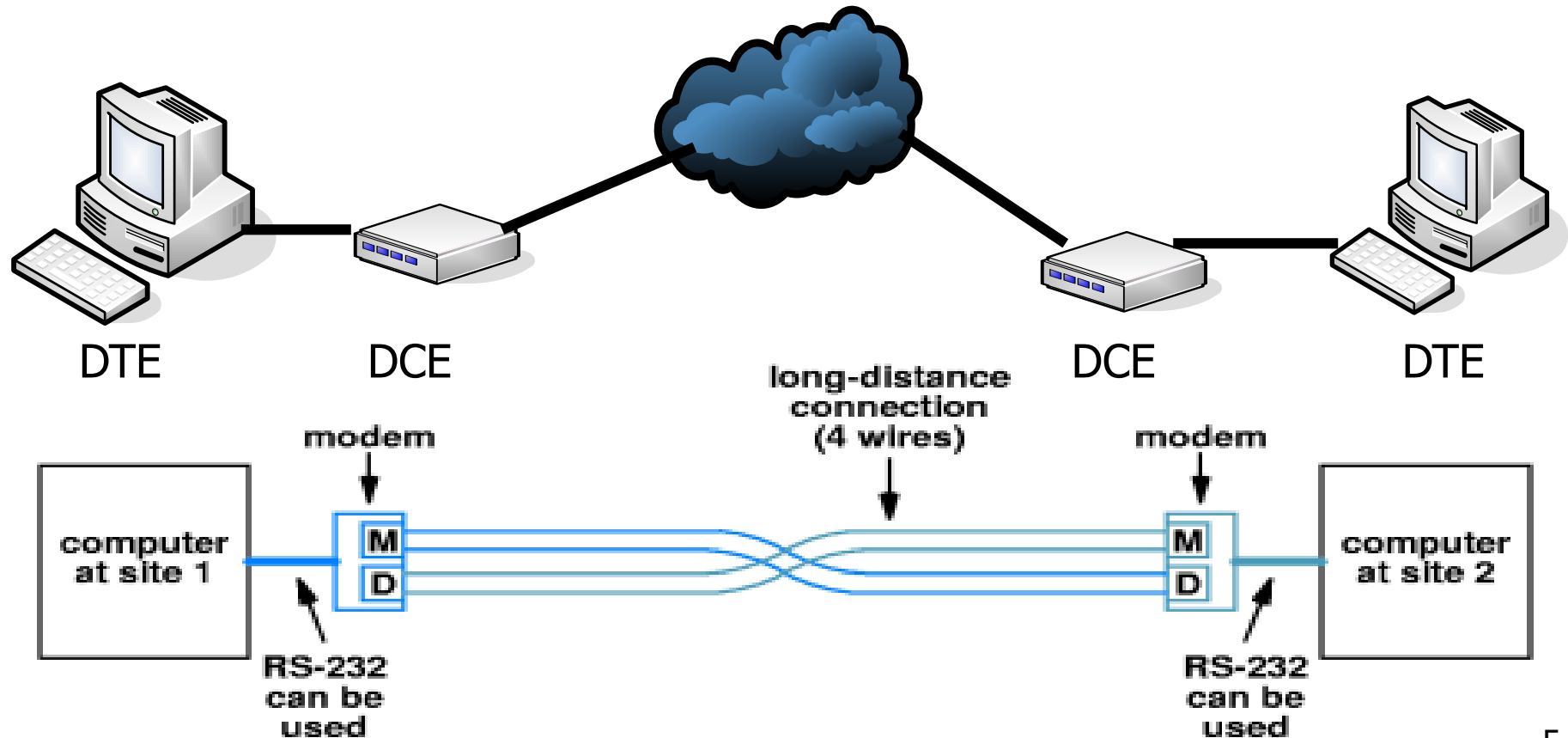
- **3 characteristics of carrier signal**

- Amplitude
- Frequency
- Phase

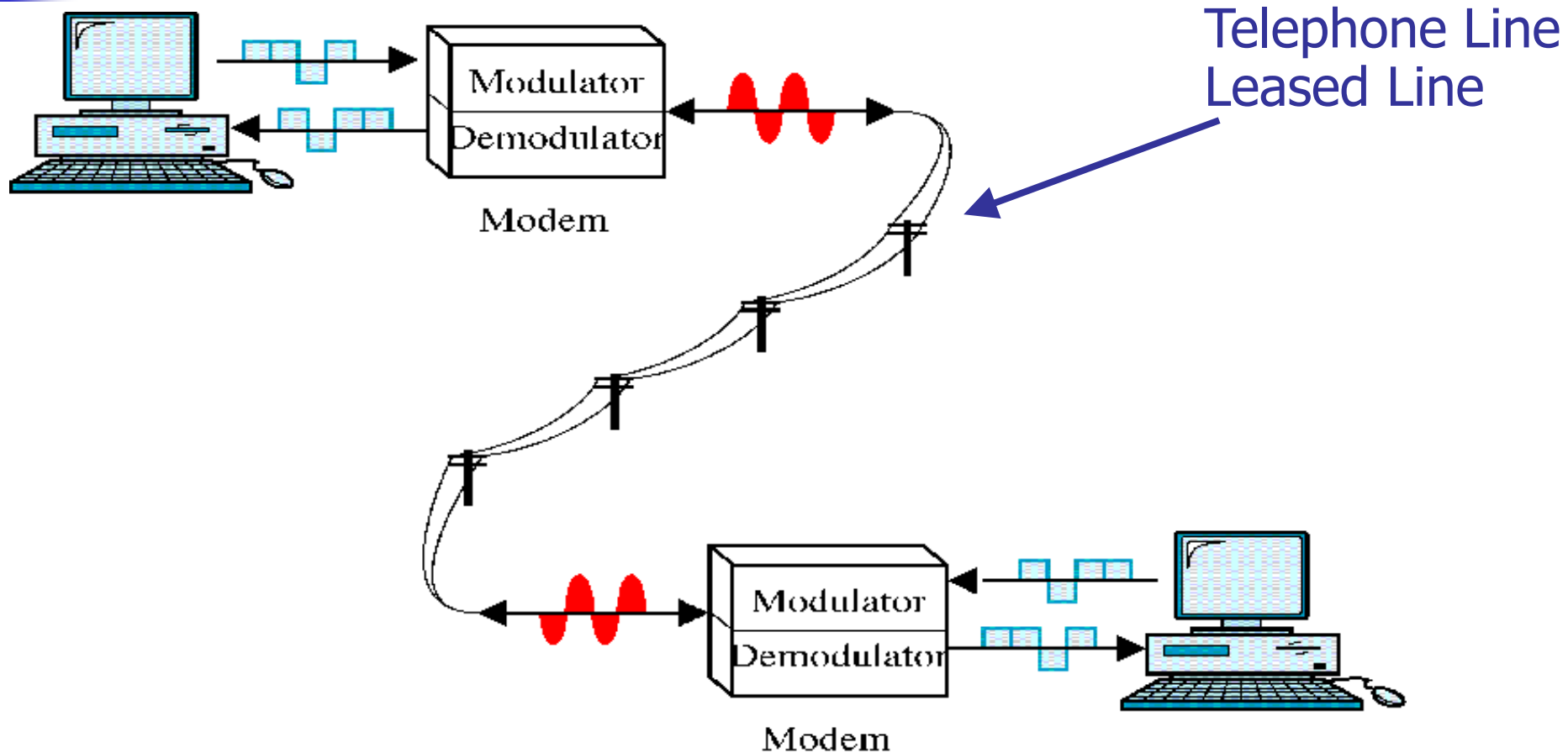


Modem: Modulation and demodulation

Convert digital signal \leftrightarrow analog signal



Modem concept





Modem concept

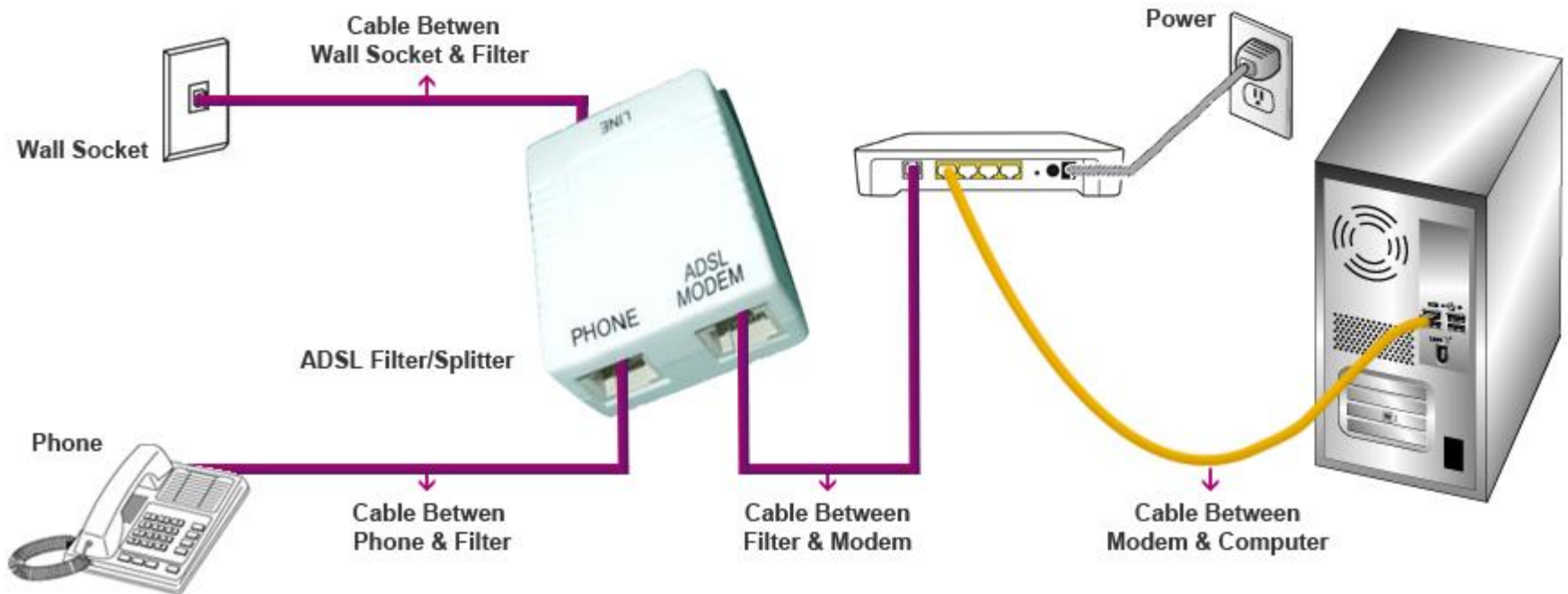
- Modulator
 - Convert digital signal → analog signal
 - Modulation technique (ASK,FSK,PSK,QAM)
- Demodulator
 - A reverse process of modulation → not a converter
 - No signal sampling



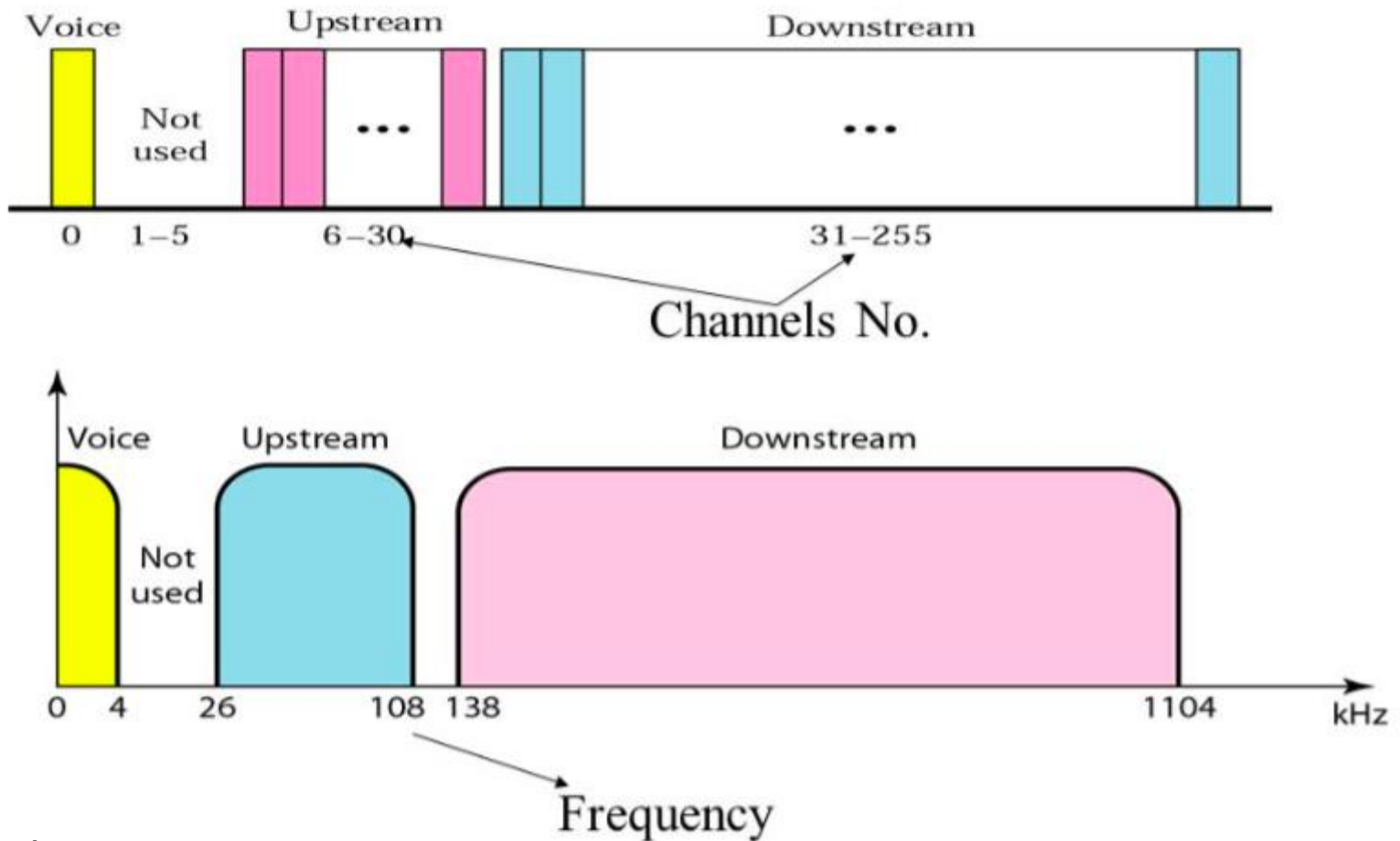
Modem data rate (bit rate)

- 14.4 Kbps, 33.6 Kbps, 56 Kbps
- Depends upon
 1. Medium bandwidth
 2. Data encoding

ADSL (Asymmetric Digital Subscribers Line)



ADSL Bandwidth





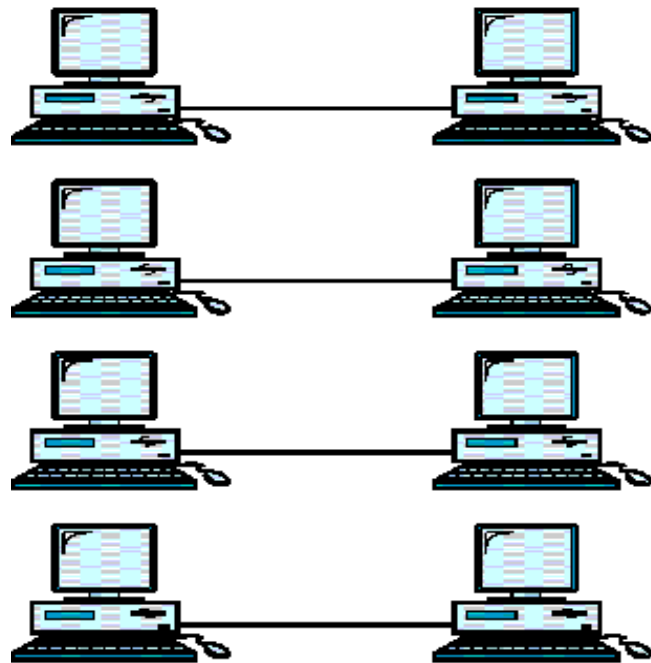
Multiplexing

- Media Sharing
 - Medium Transmission Capacity
 - High bandwidth media (coax, optical fiber)
- Cost-effective
- Medium Transmission Cap $>$ data rate required

Terms:

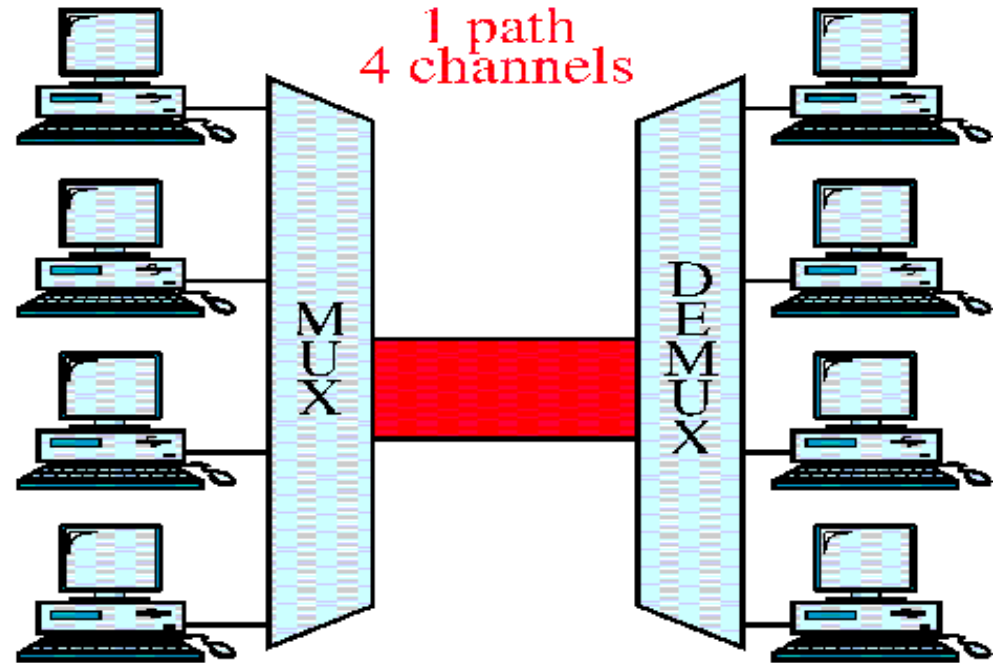
- Path
- Channel

Multiplexing vs. No Multiplexing

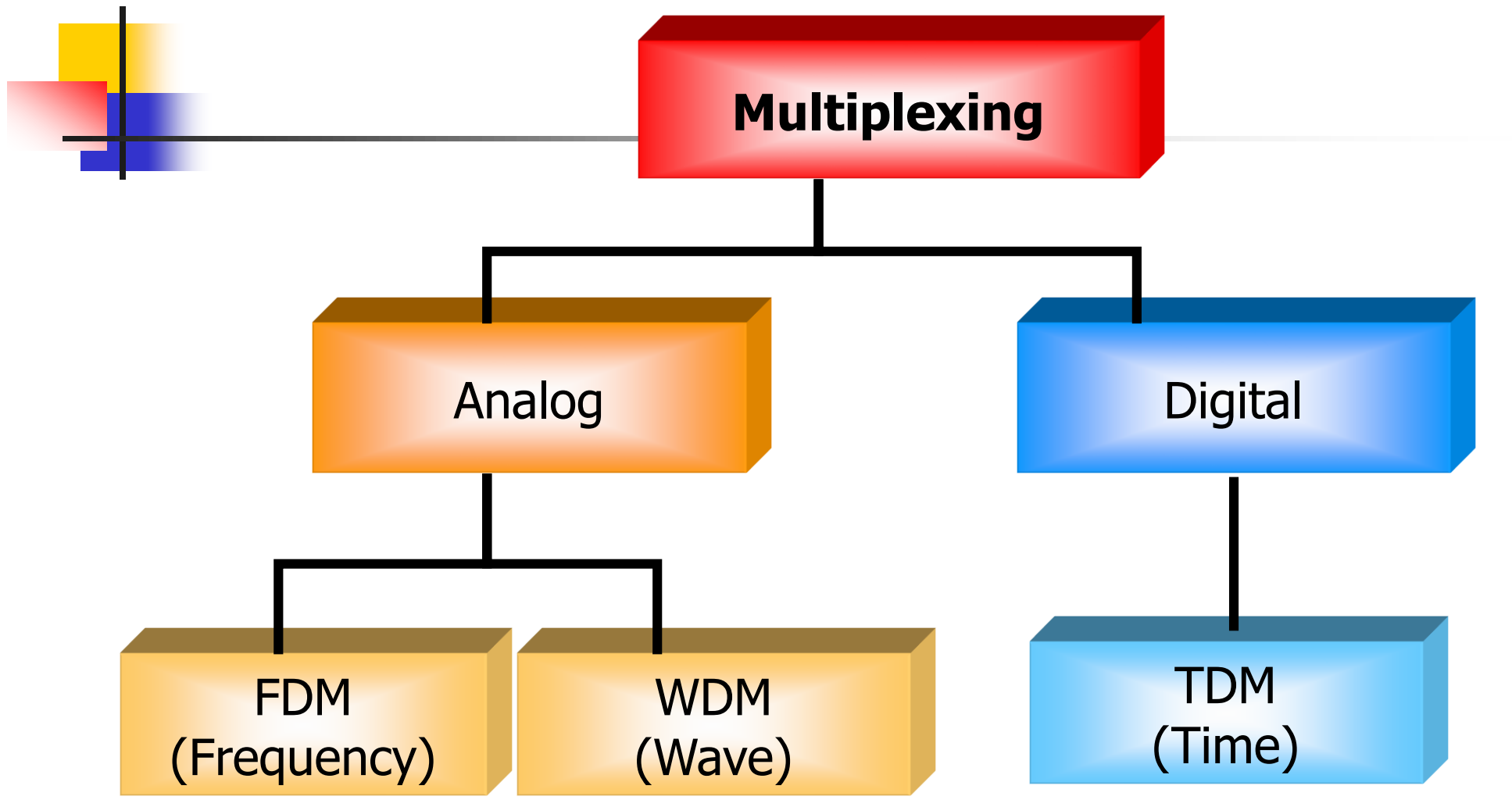


a. No multiplexing

Many to One



b. Multiplexing

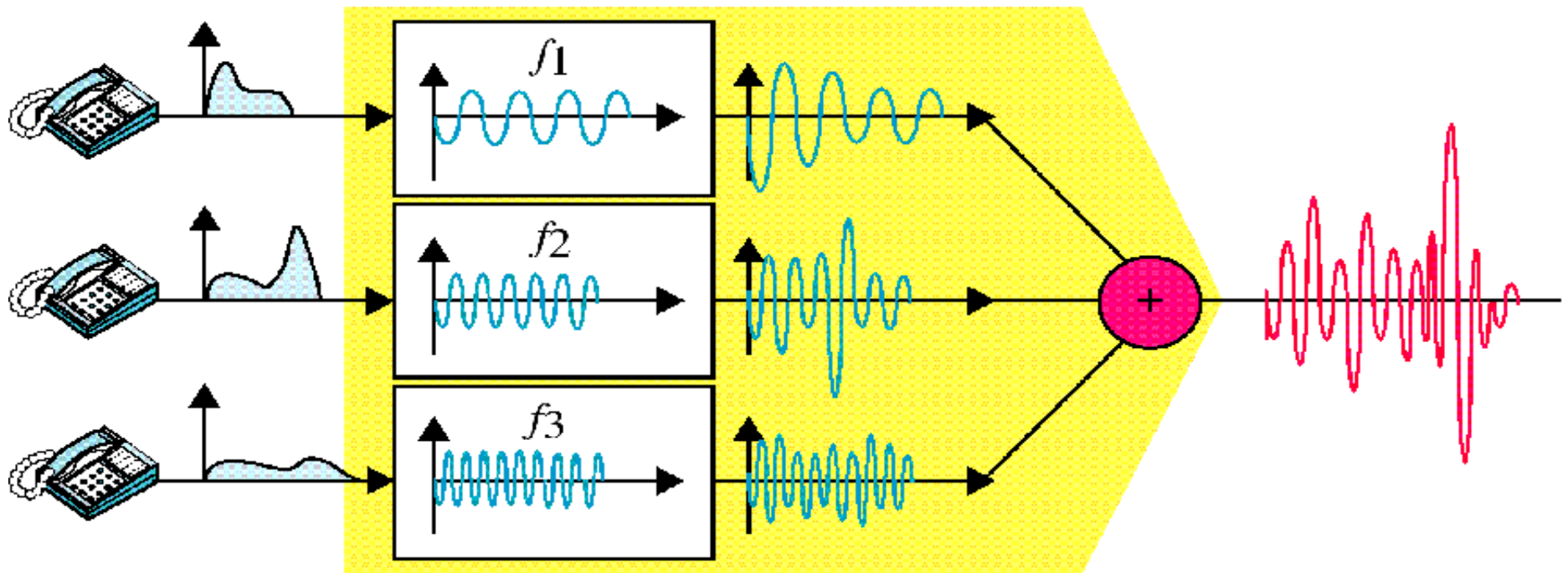


FDM, Time Domain

Sender

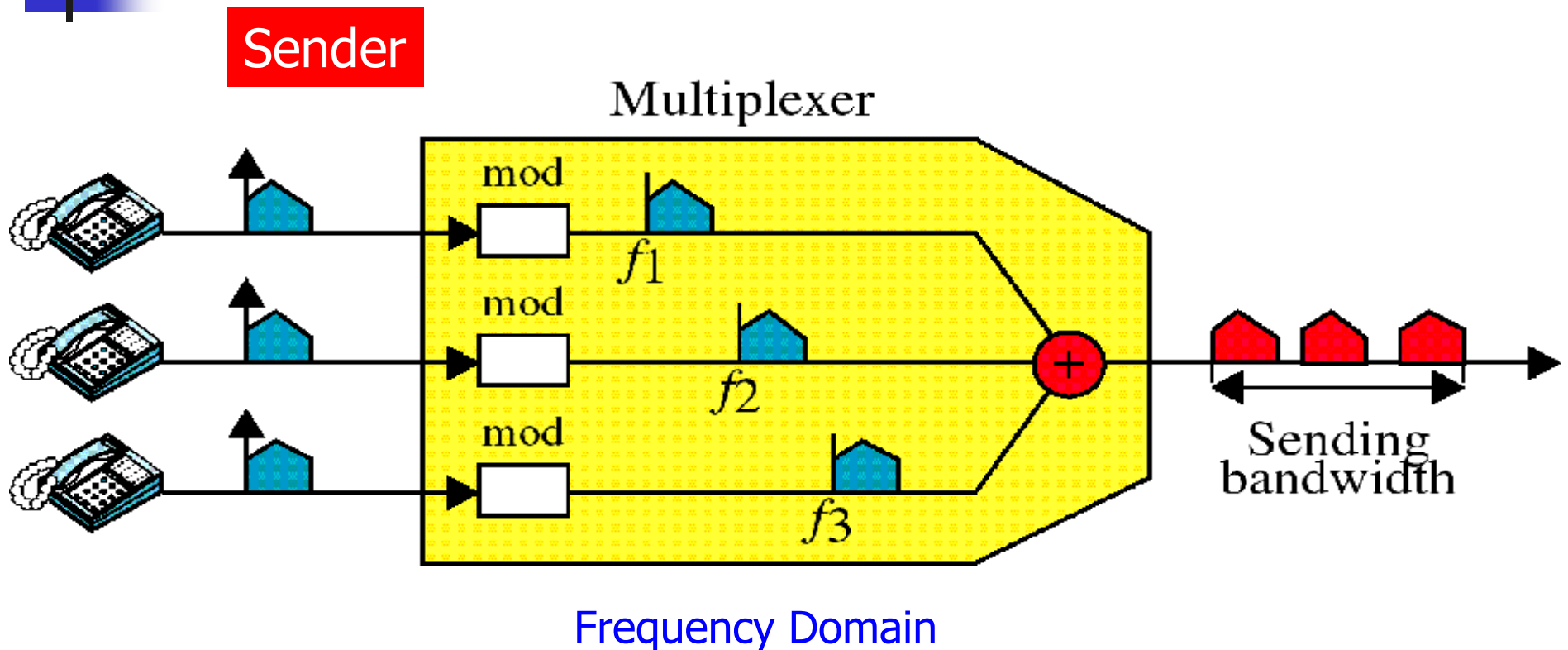
Using AM or FM

Multiplexer



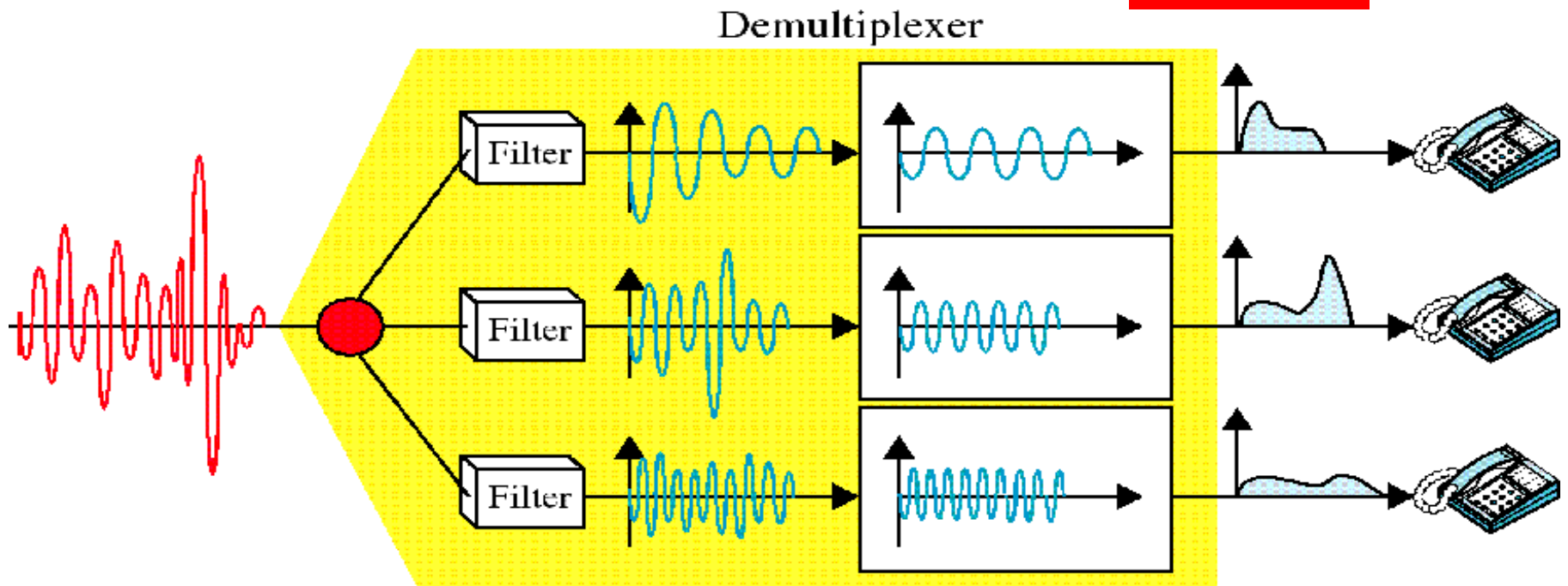
Time Domain

Multiplexing, Frequency Domain



Demultiplexing, Time Domain

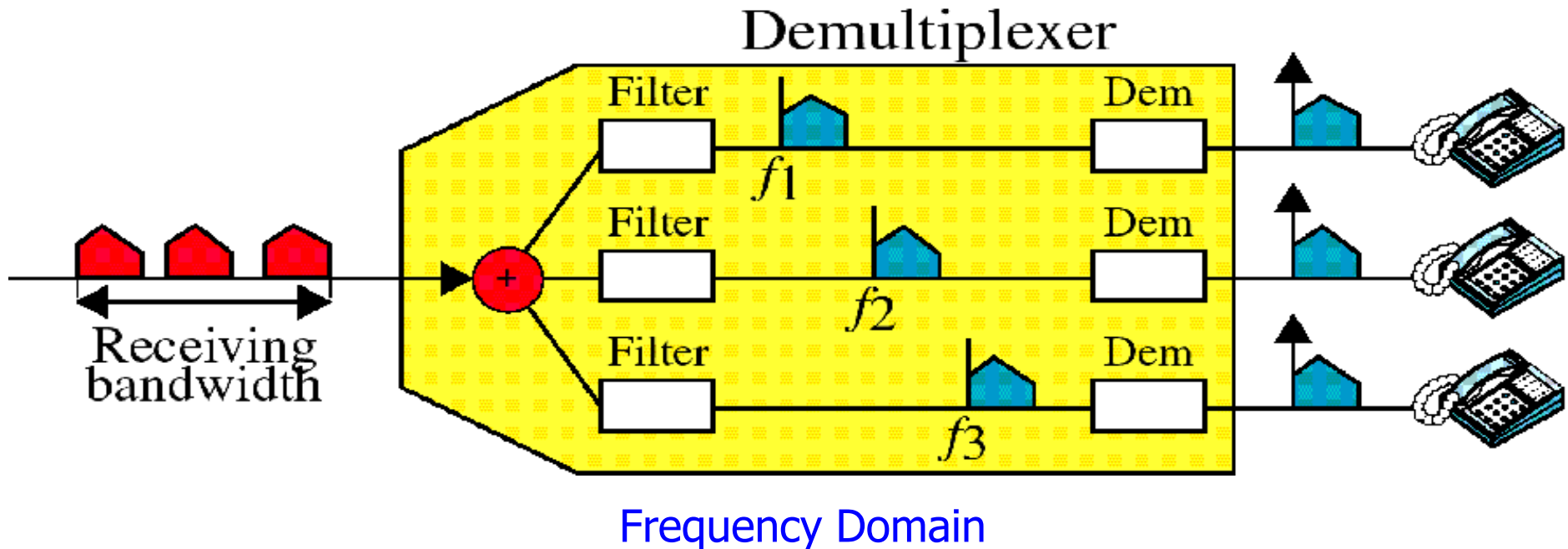
Receiver



Time Domain

Demultiplexing, Freq. Domain

Receiver



Multiplexing

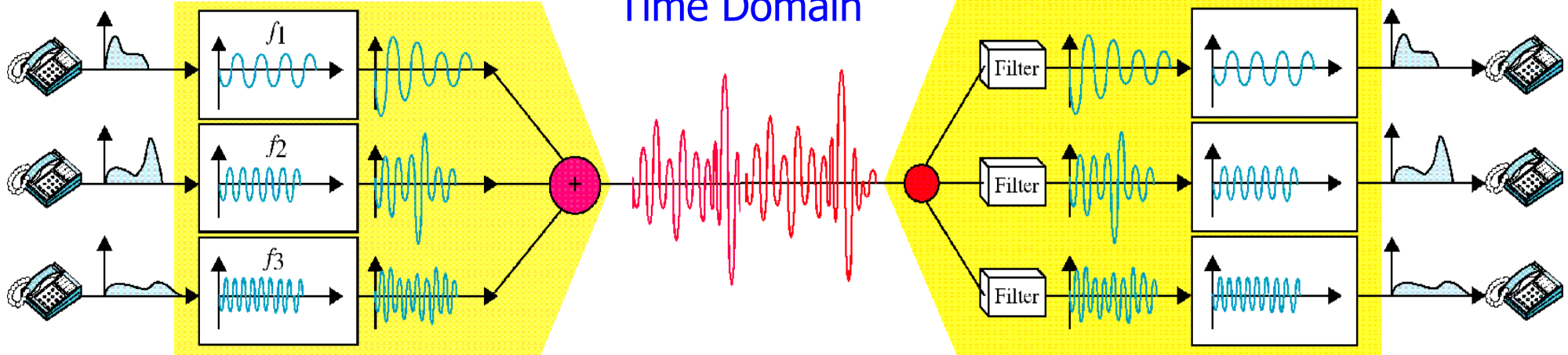
Sender

Receiver

Multiplexer

Demultiplexer

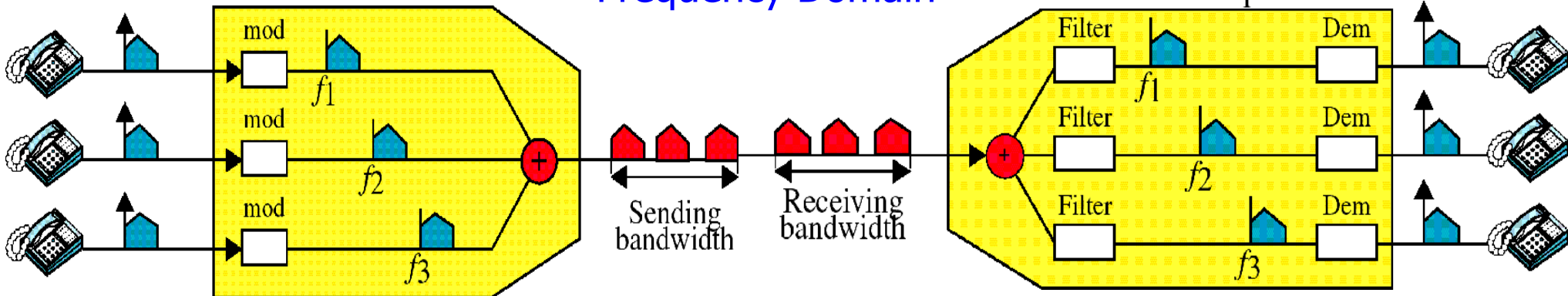
Time Domain



Multiplexer

Frequency Domain

Demultiplexer

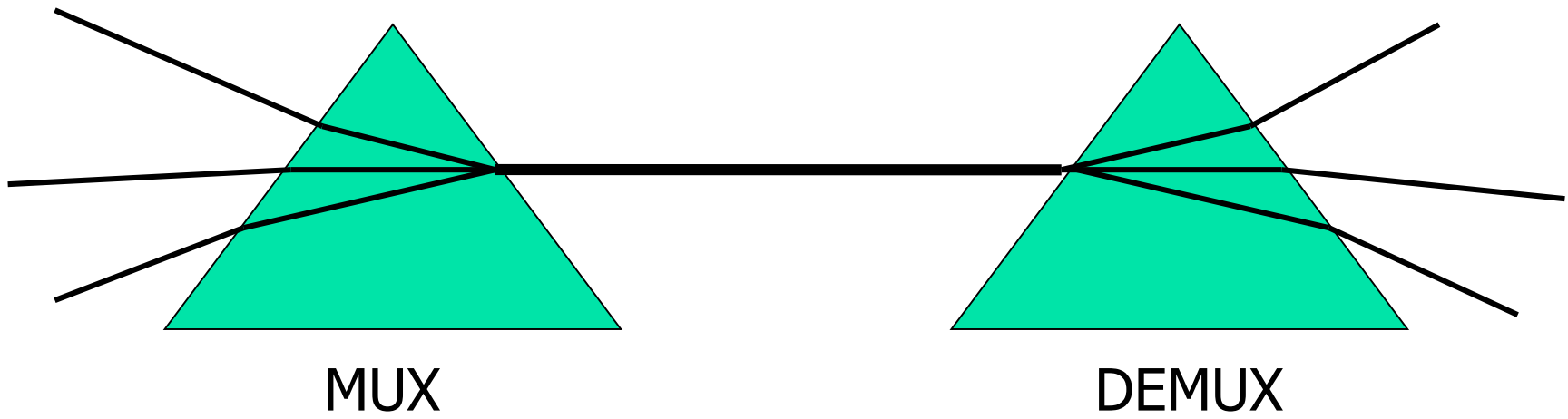
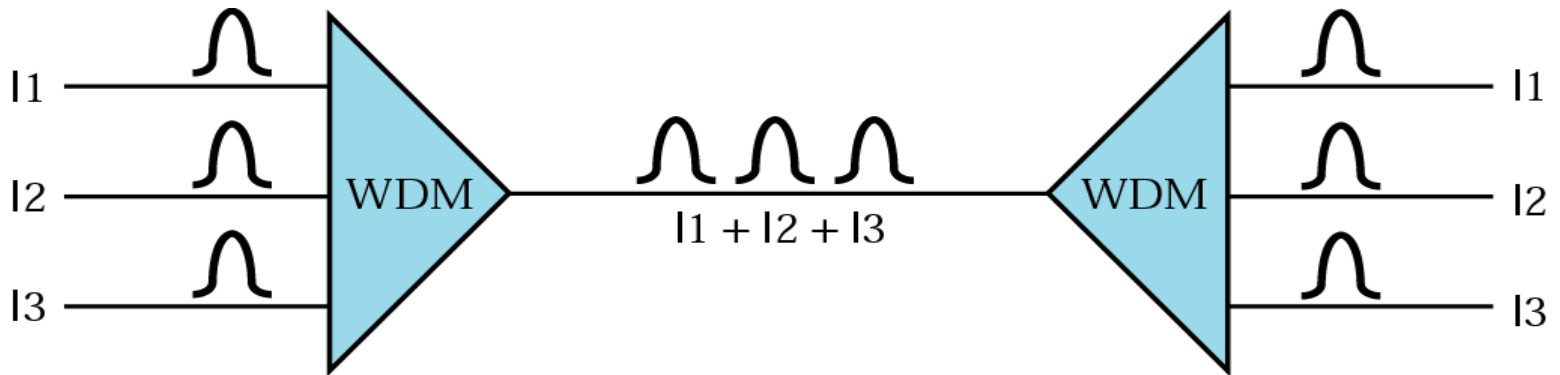




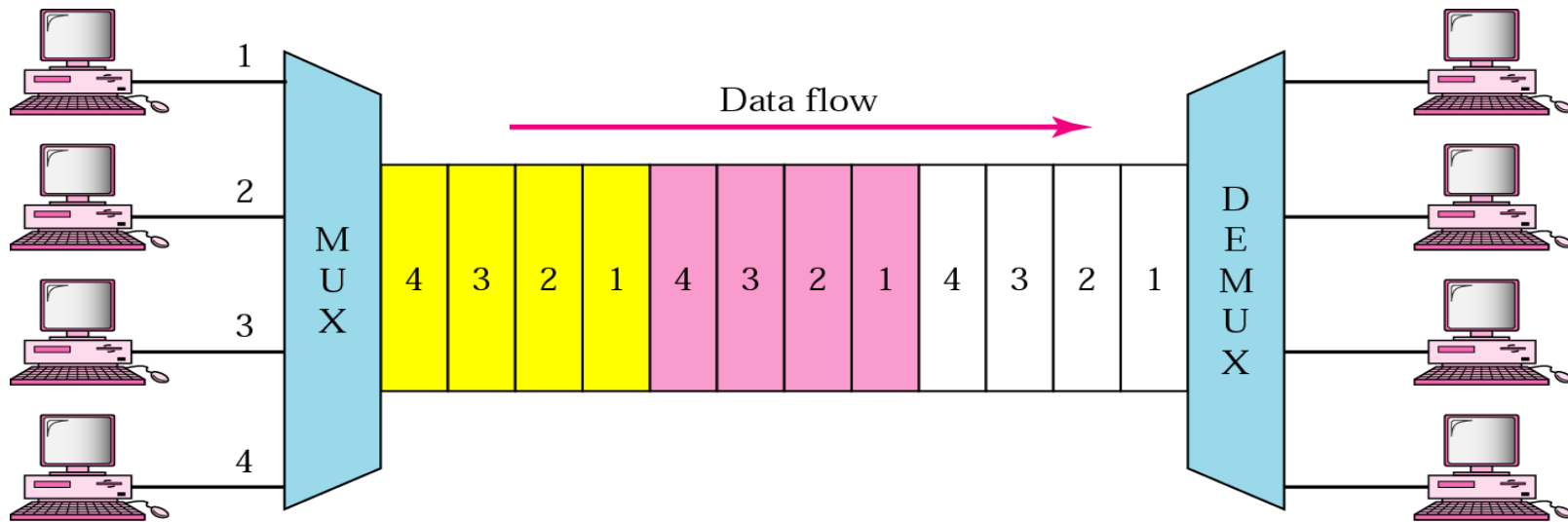
WDM

- Same as FDM but very higher frequency
- Light signal
- Optical fiber

WDM



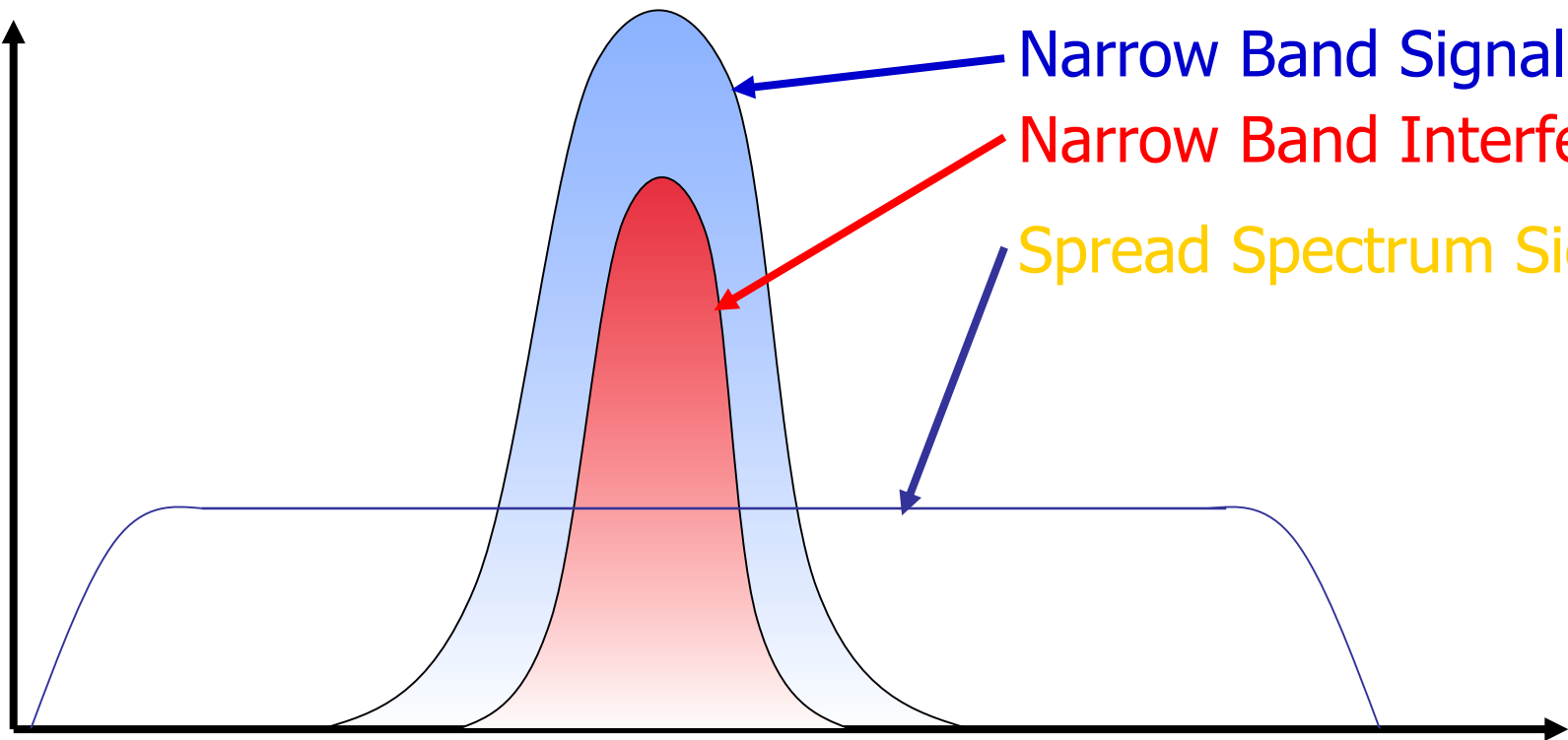
TDM



- Synchronous TDM
- Asynchronous TDM

Spread Spectrum Modulation

Amplitude



Narrow Band Signal

Narrow Band Interference

Spread Spectrum Signal

Frequency



Spread Spectrum Modulation

- Frequency Hopping Spread Spectrum (FHSS)
- Direct Sequence Spread Spectrum (DSSS)
- Orthogonal Frequency Division Multiplexing (OFDM)



Broadband VS. Baseband

- **Broadband**

- Independent communication over a single medium
- FDM

- **Baseband**

- One communication over a single medium (at a time)
- Ethernet



Summary

- Long-distance problem
- Carrier
- Modulation
- Modem
- Multiplexing
- Spread Spectrum



HW

- Fiber to Home (FTTH)
 - Technology concept
 - Components
 - Data Rate (?? Mbps)
- Due
 - Print out and submit on the exam date
 - Not more than 2 pages of A4