

TRANSMISSION

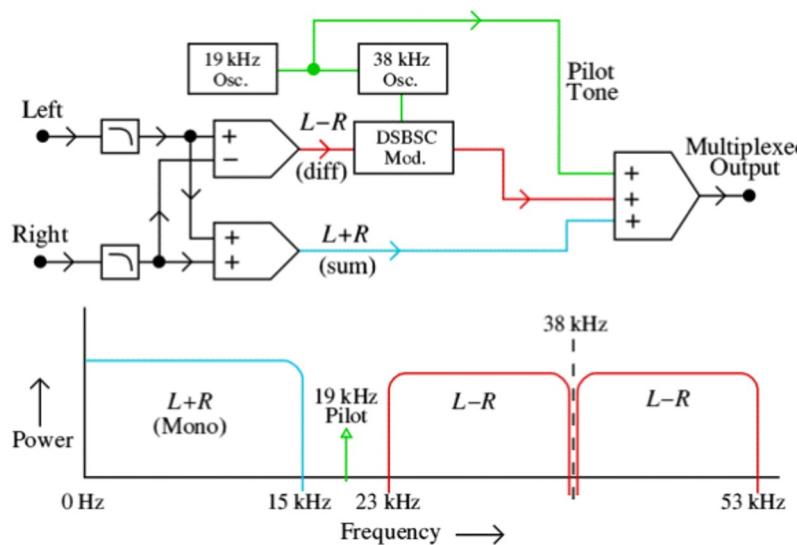
Digital and ***Analog*** conversion

Bandwidth Utilization

MULTIPLEXING & SPREAD SPECTRUM

Learning Outcome

MULTIPLEXING & SPREAD SPECTRUM



DIGITAL to DIGITAL CONVERSION

Analog to **DIGITAL CONVERSION**

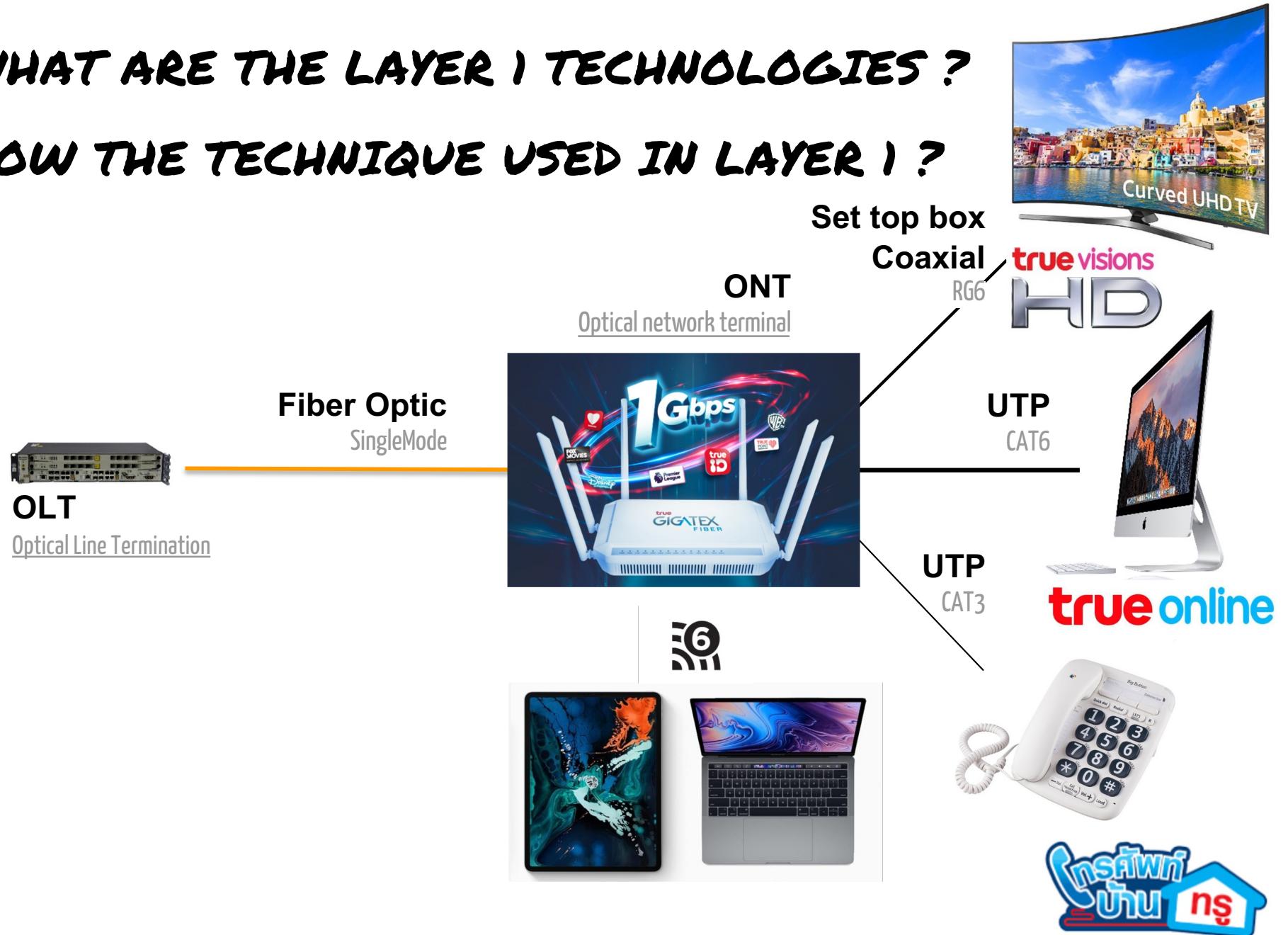
DIGITAL to *Analog* CONVERSION

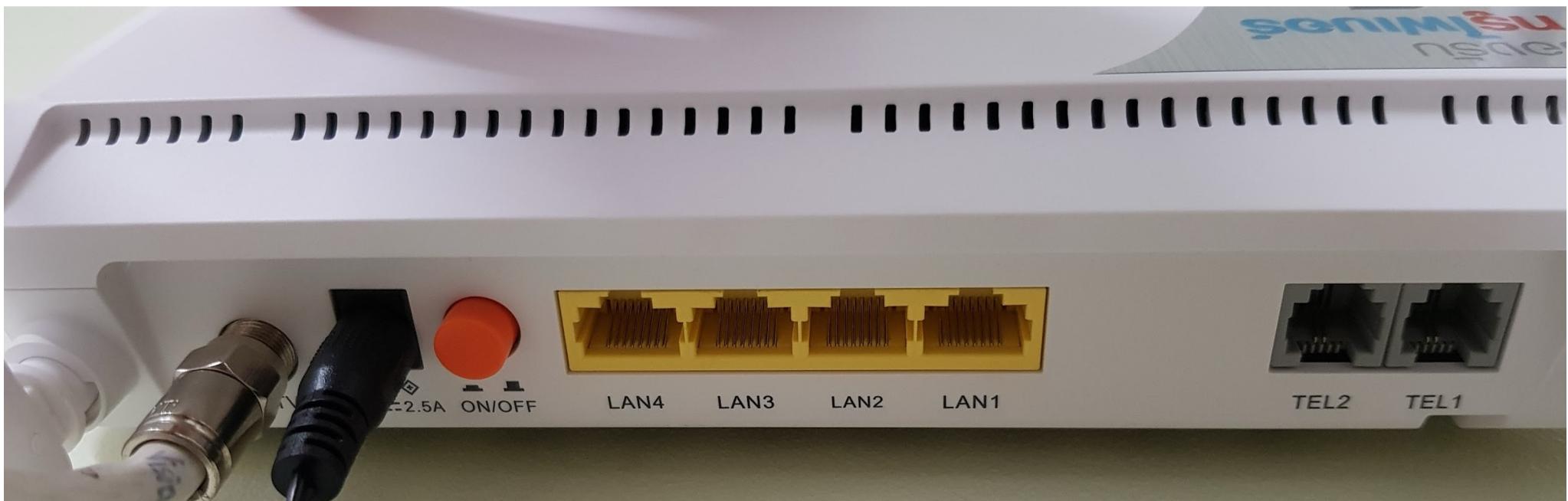
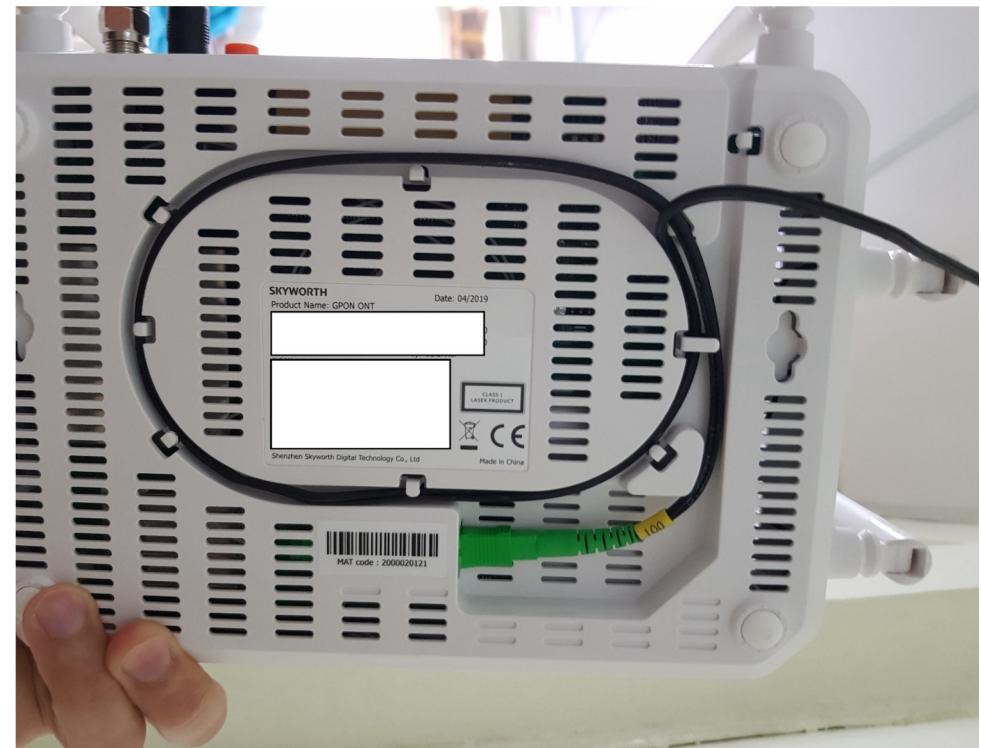
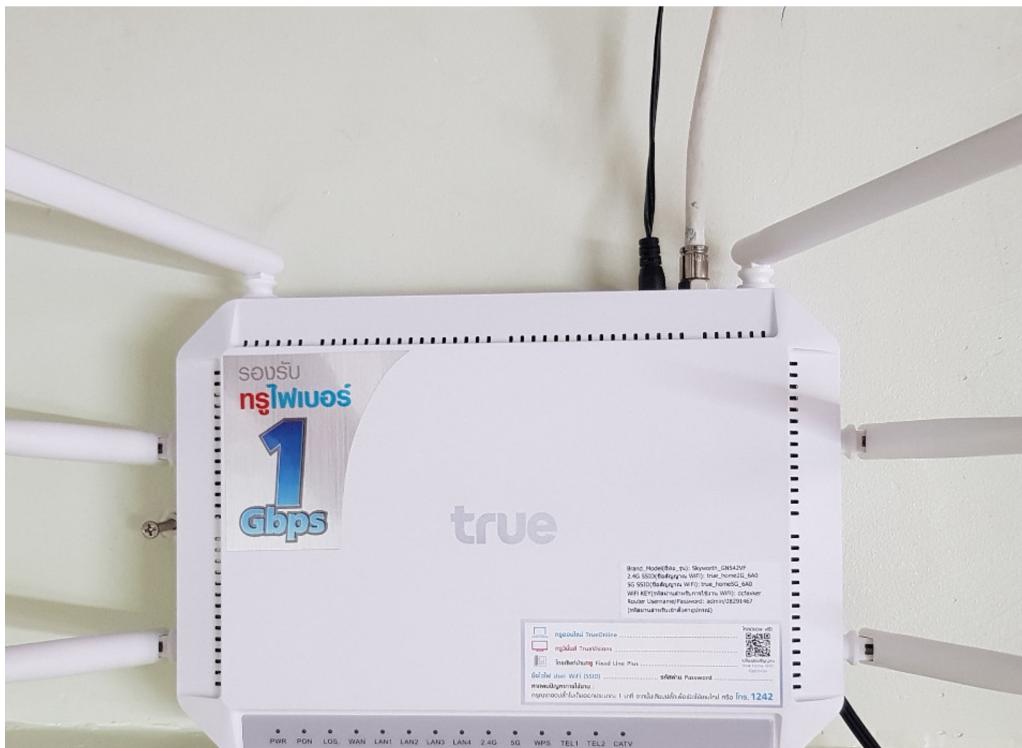
Analog to **Analog CONVERSION**



WHAT ARE THE LAYER 1 TECHNOLOGIES ?

HOW THE TECHNIQUE USED IN LAYER 1 ?







 MacThai

ALL-TIME TOP SCORER

true visions 676
BeIN SPORTS 1



Frank Lampard
211 goals

BeIN 1 362MHz/6952Kbps/QAM256 (85%)

10 17/09 17:52

◀ true visions

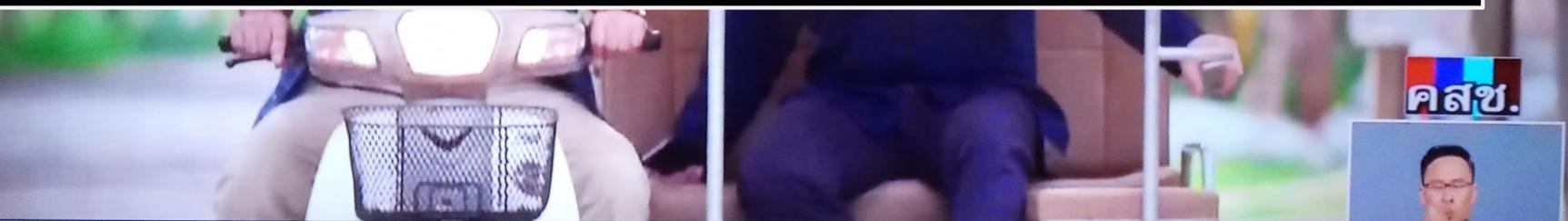
17:35 MLS - The Movement 2017

17:55 UEFA Champions League MS 2017/18

((•))

16:9 1080i

▶ 82%
100%



◀ true 3 HD 658MHz/8Mhz/DVB-T2 (18%)
18:00 เดินหน้าประเทศไทย
18:20 ก.เรื่องยา...การกิจอิต...เมียนมรက
((•)) 16:9 1080i

10 17/09 18:03

▶ 28%
78%

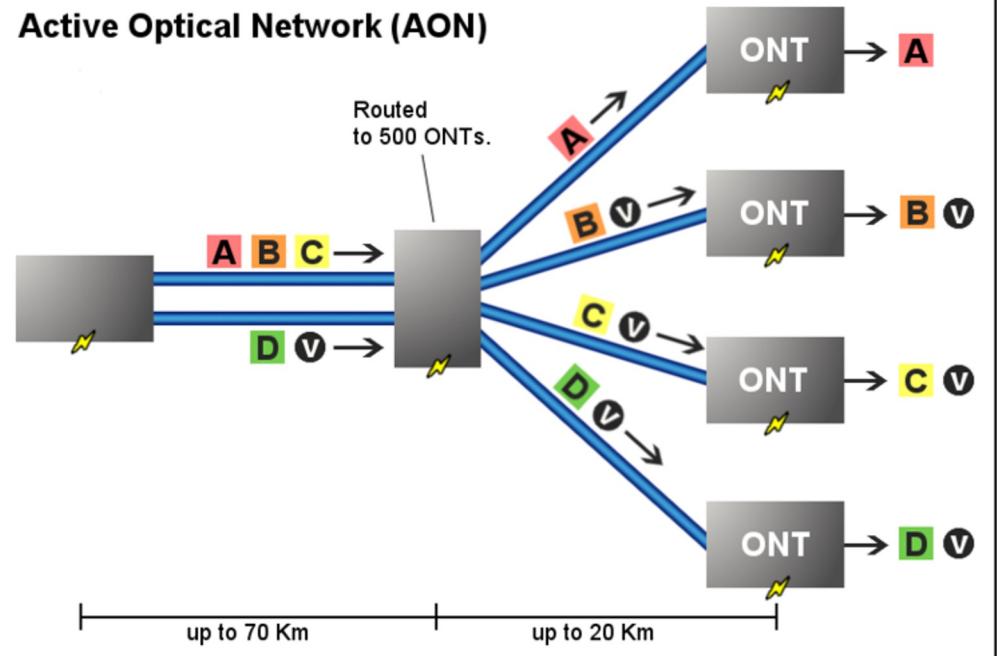


OLT

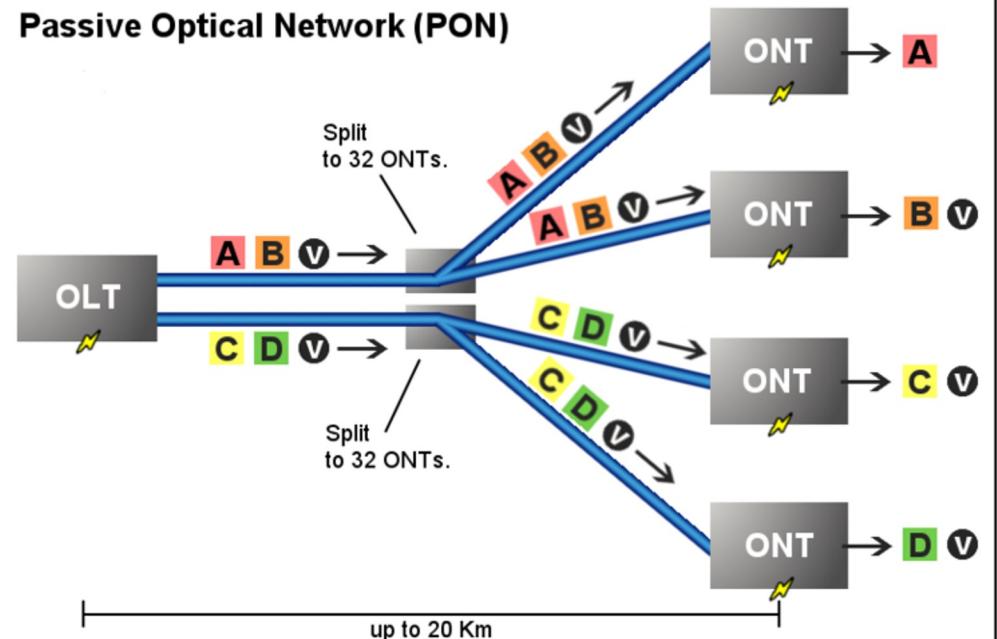
Optical Line Termination



Active Optical Network (AON)

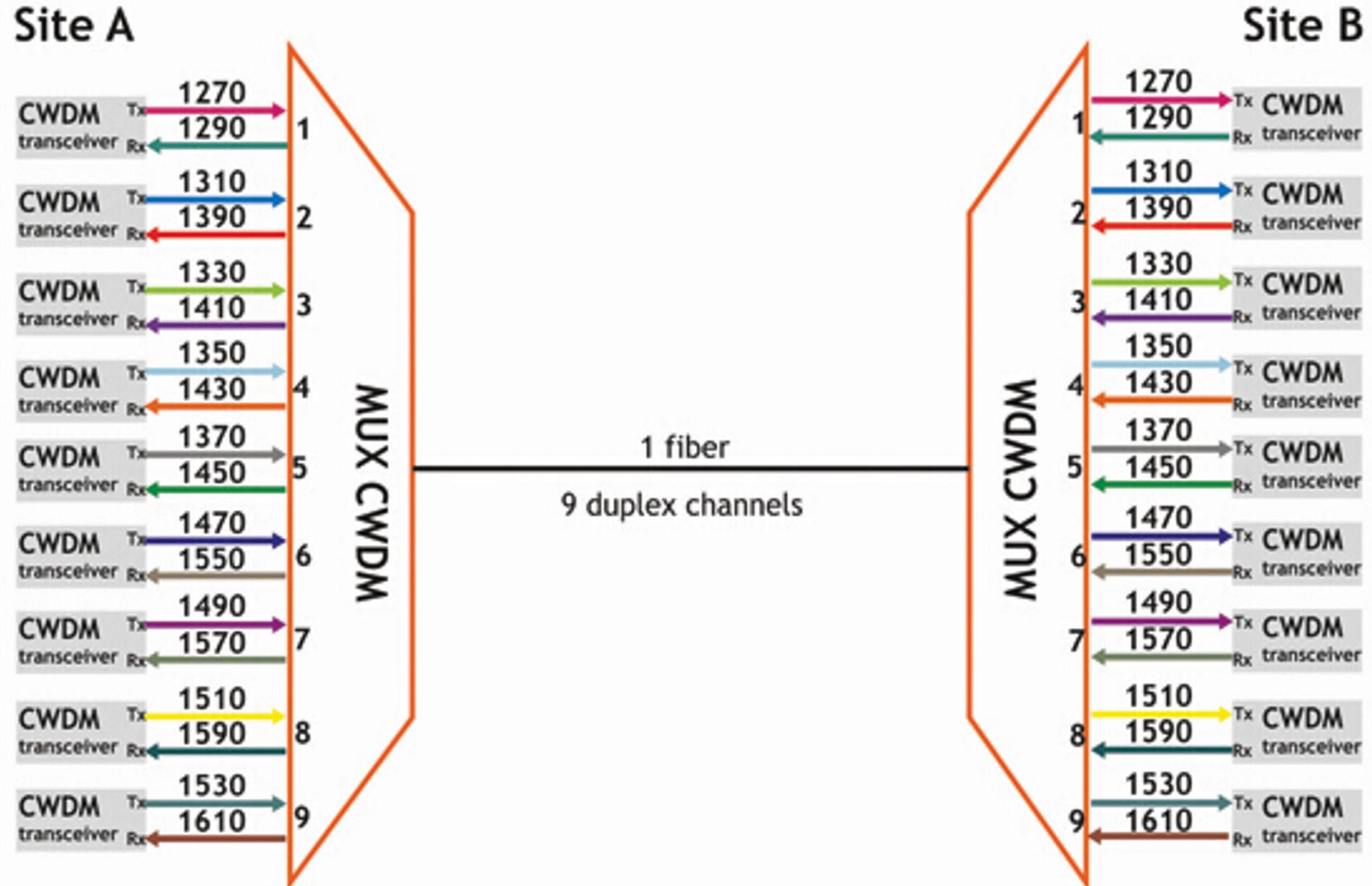


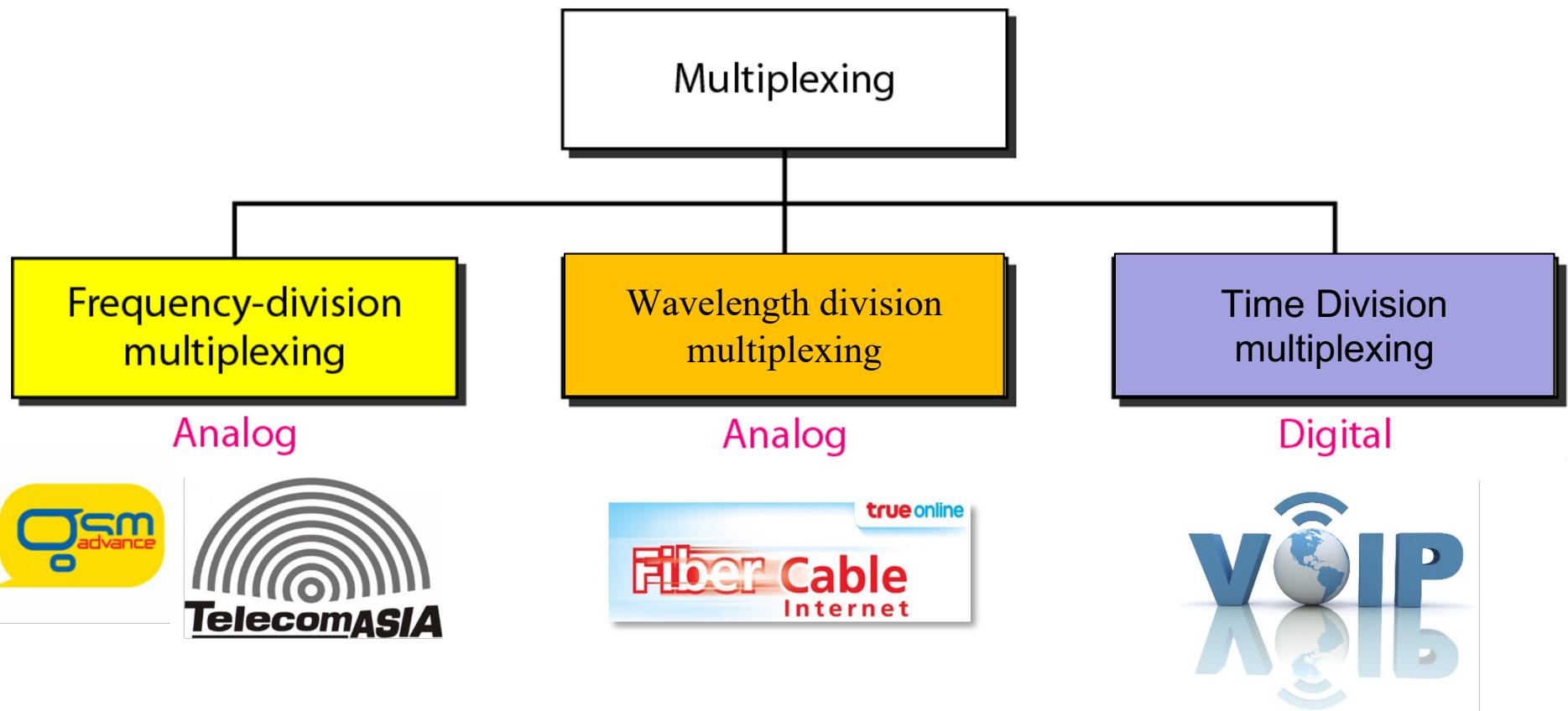
Passive Optical Network (PON)



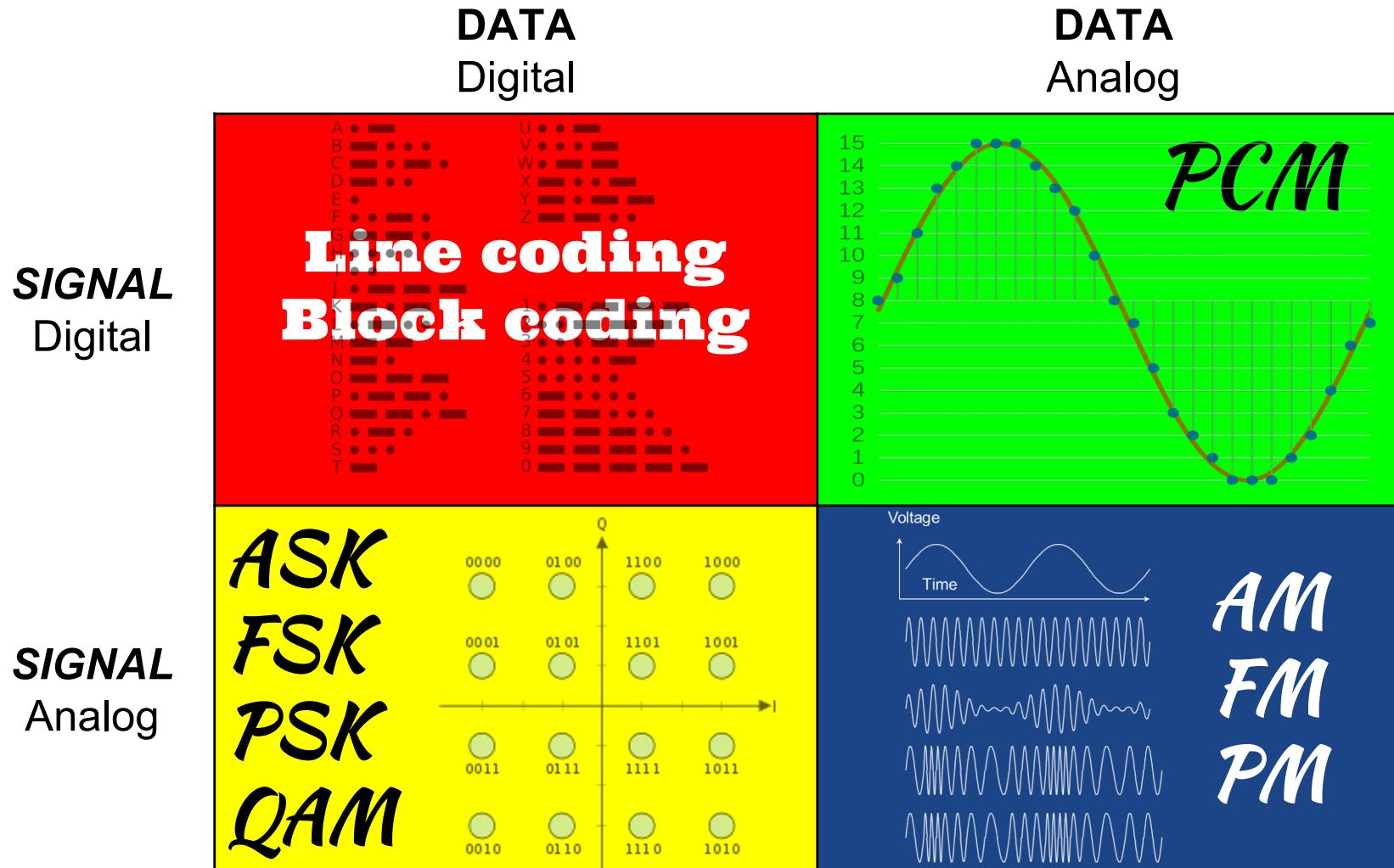
Key: **A** - Data or voice for a single customer. **V** - Video for multiple customers.

Prisms in wavelength division multiplexing

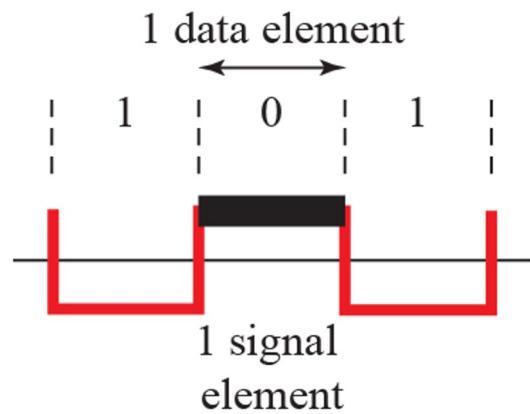




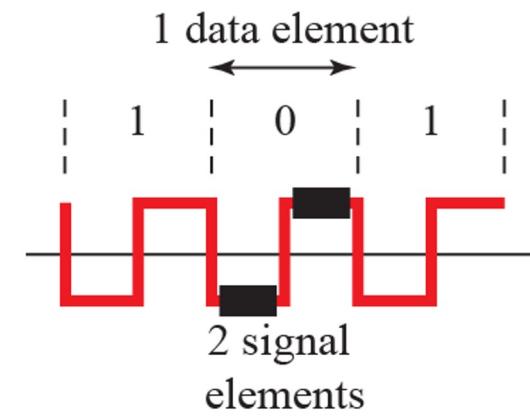
Digital and *Analog* conversion



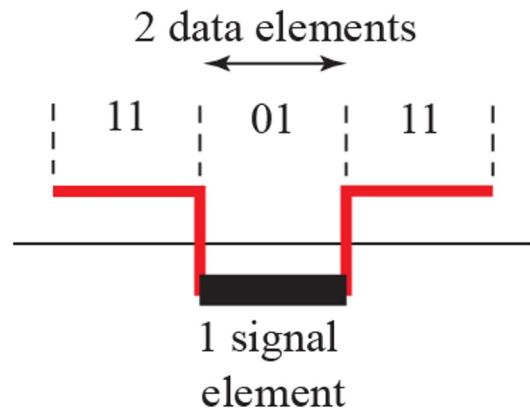
SIGNAL elements vs DATA elements



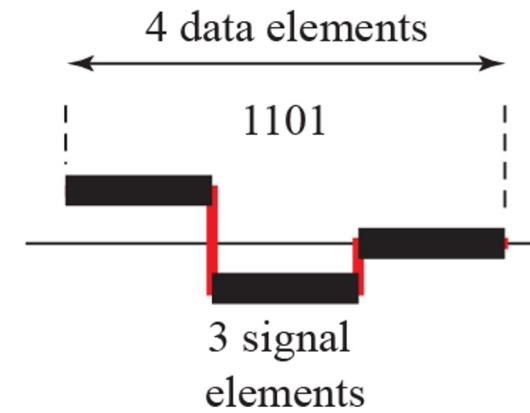
a. One data element per one signal element ($r = 1$)



b. One data element per two signal elements ($r = \frac{1}{2}$)



c. Two data elements per one signal element ($r = 2$)



d. Four data elements per three signal elements ($r = \frac{4}{3}$)

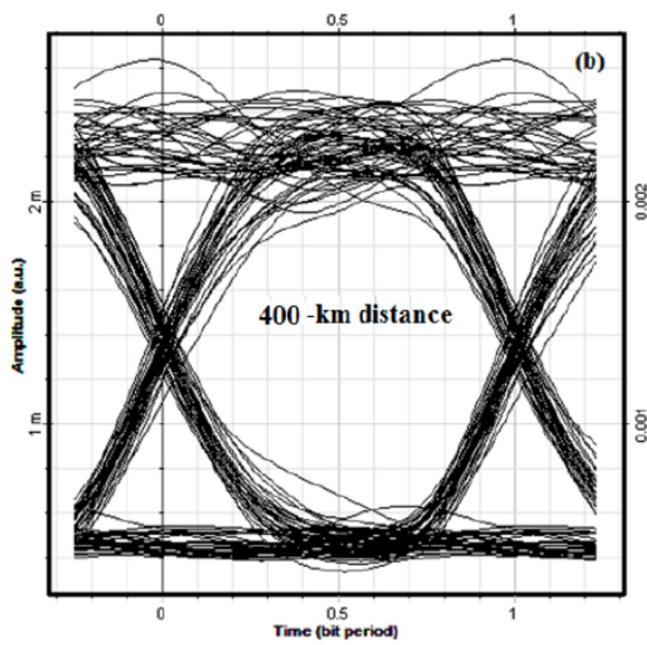
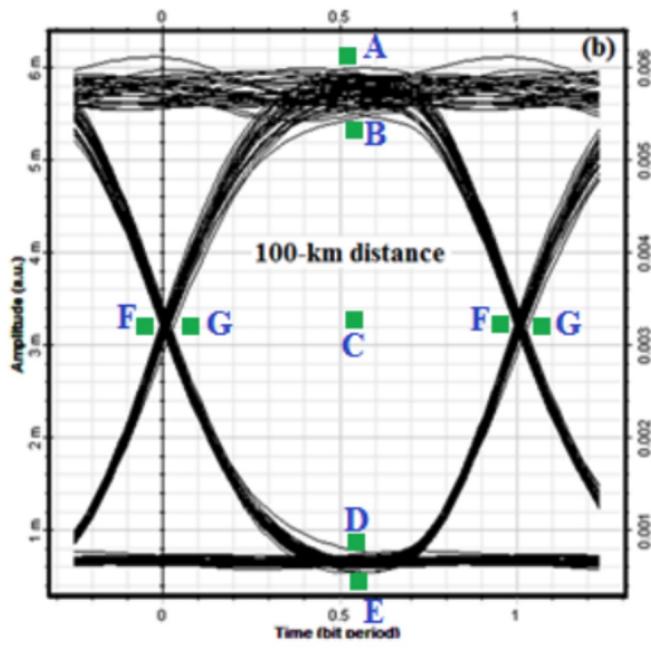
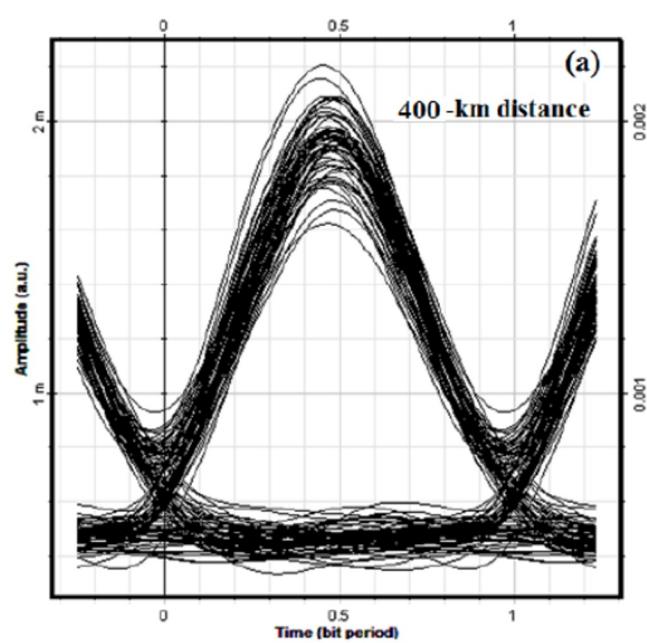
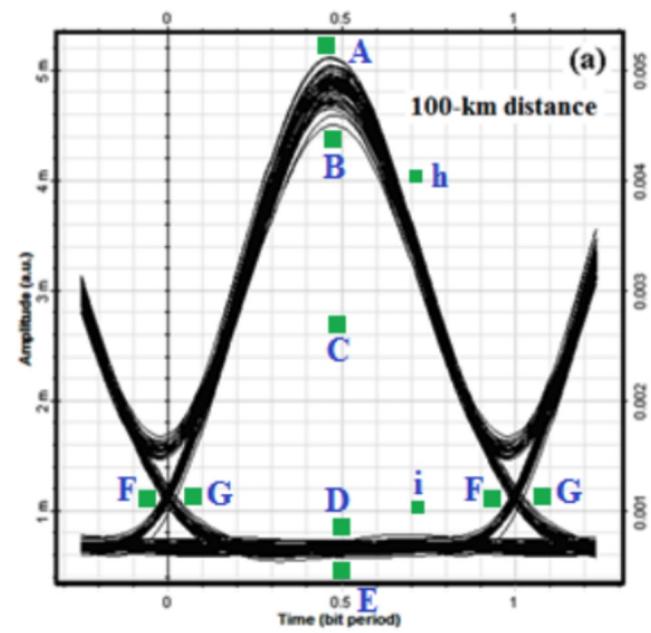


Figure 3.21: Baseband transmission using a dedicated medium

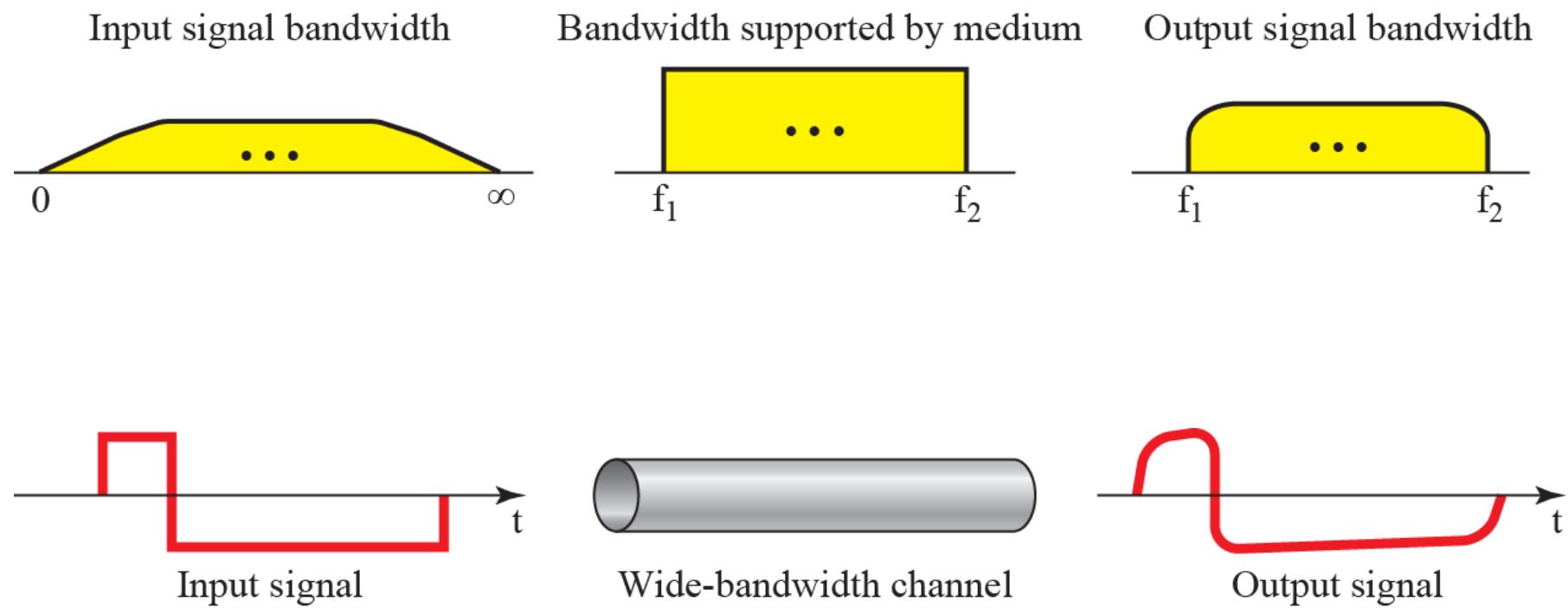


Figure 3.26: Causes of impairment

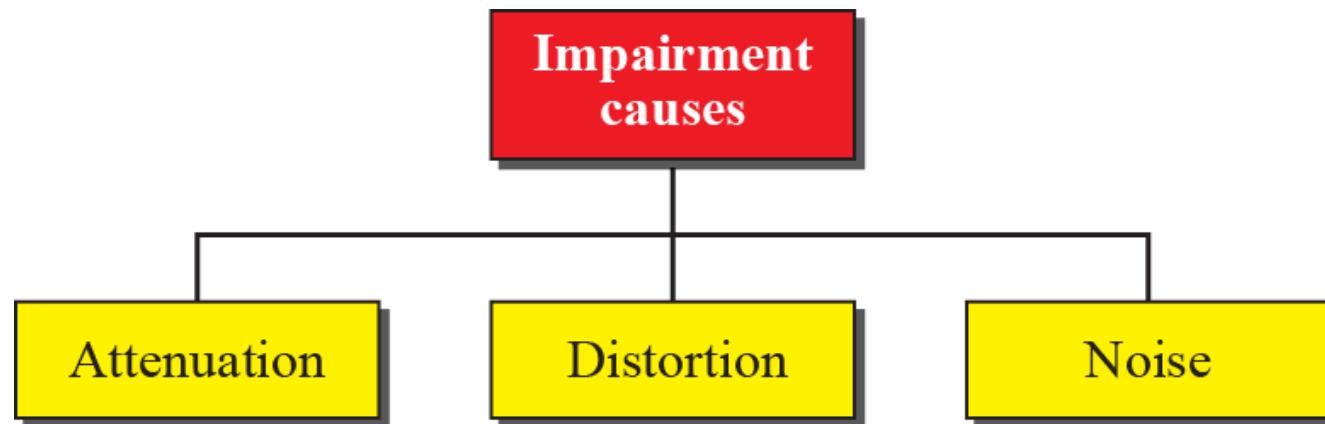


Figure 3.27: Attenuation and amplification

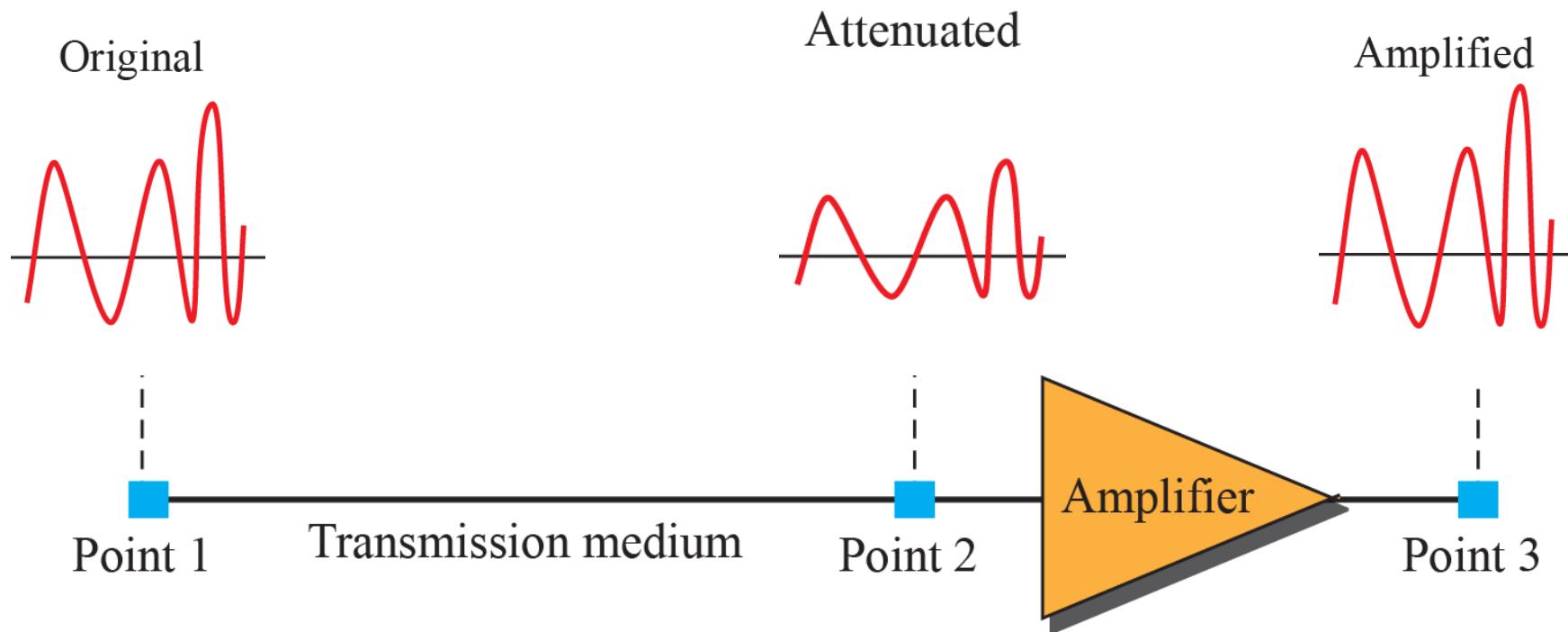


Figure 3.29: Distortion

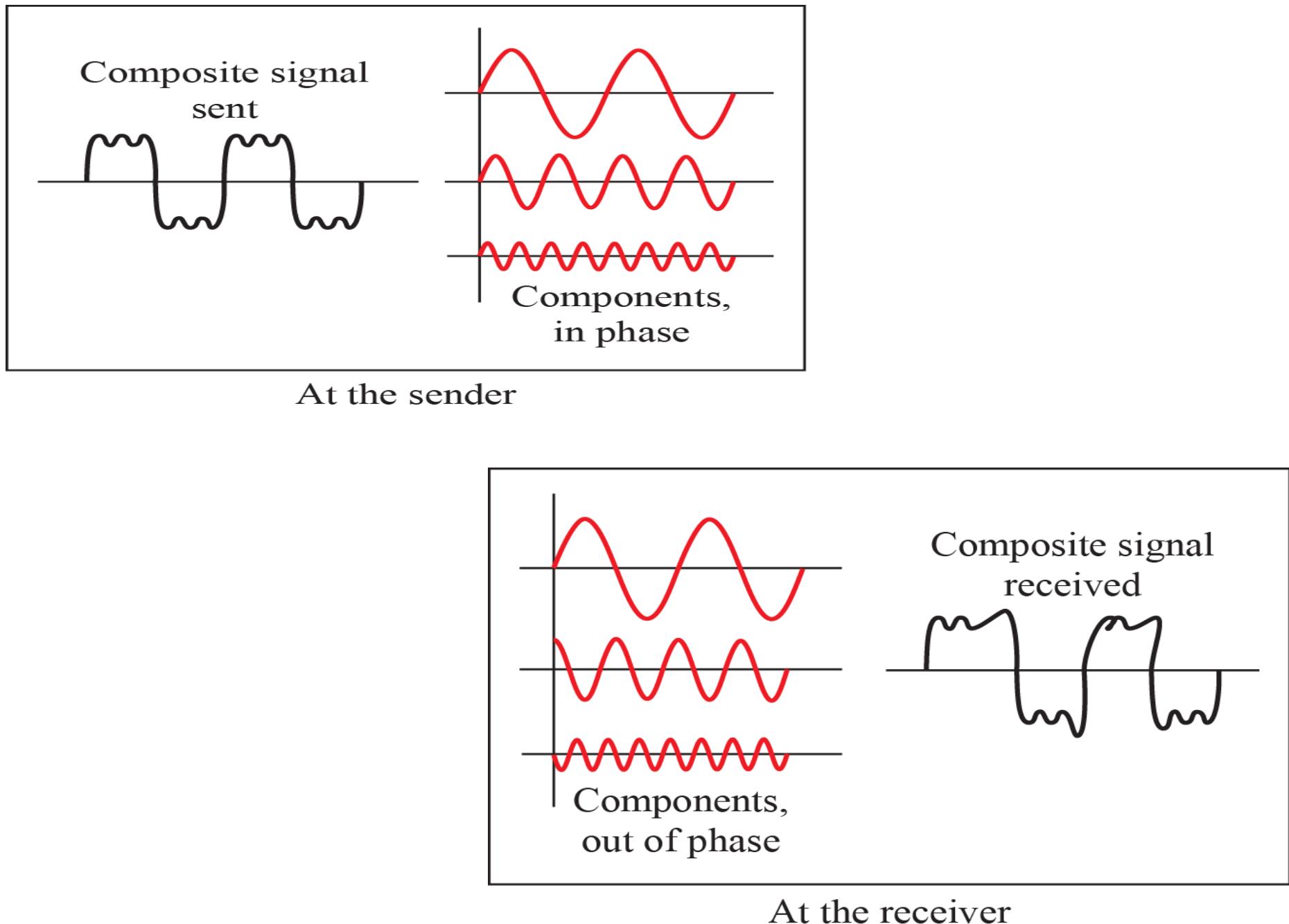


Figure 3.30: Noise

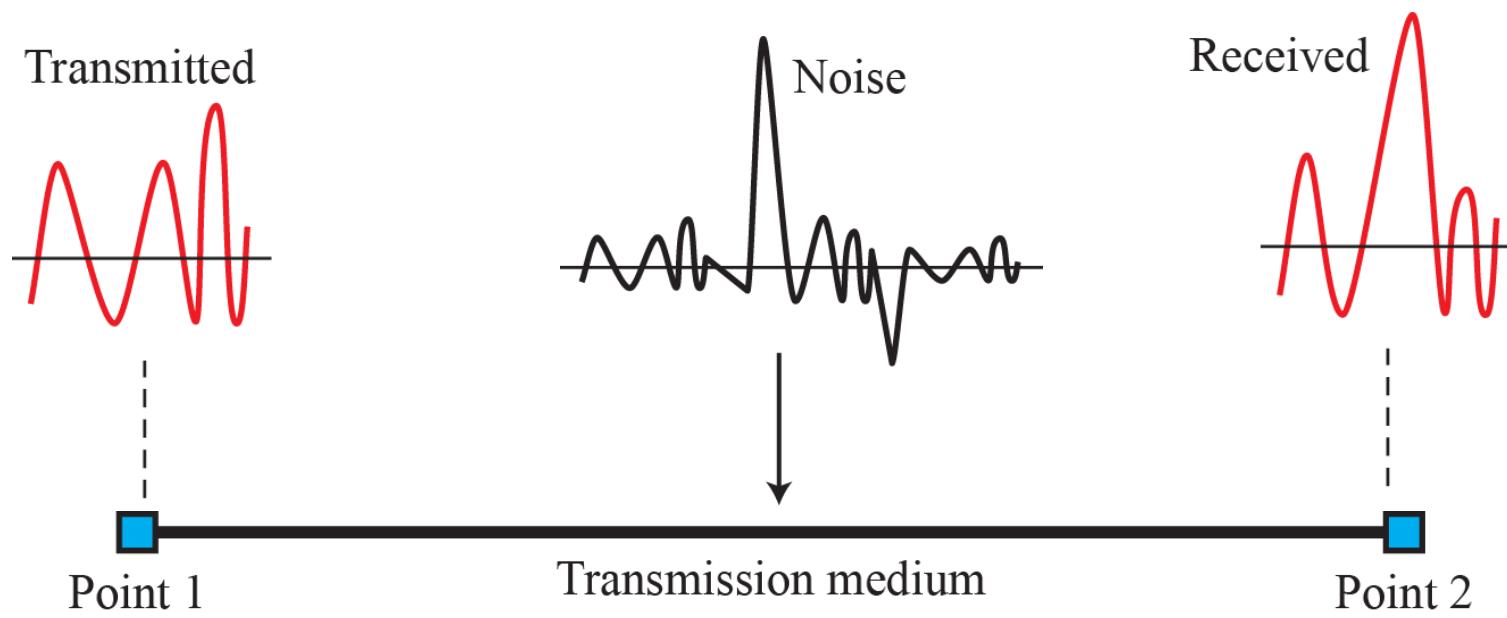
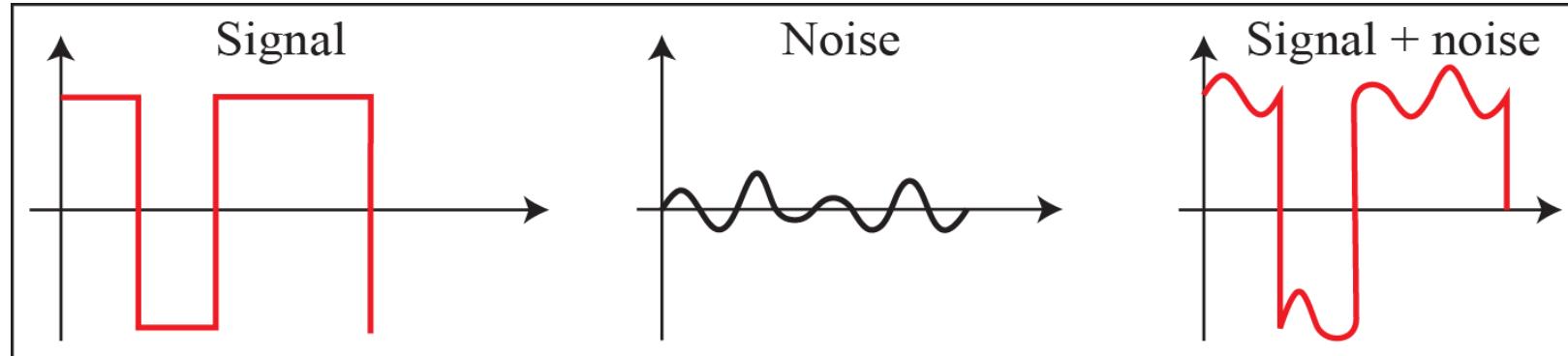
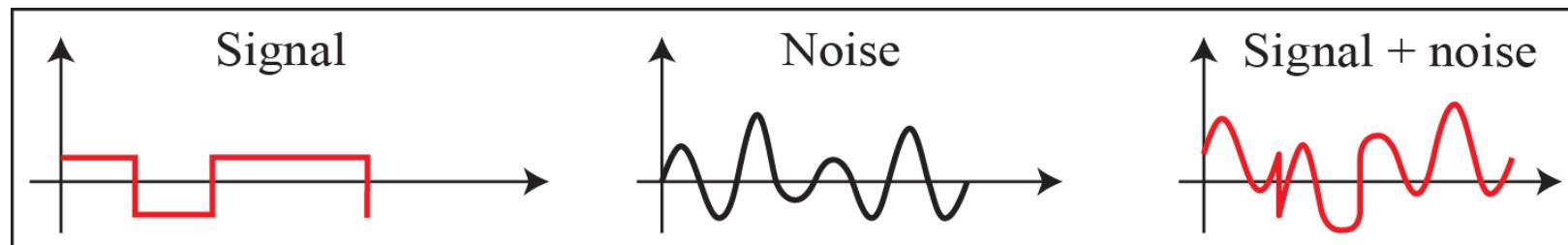


Figure 3.31: Two cases of SNR: a high SNR and a low SNR

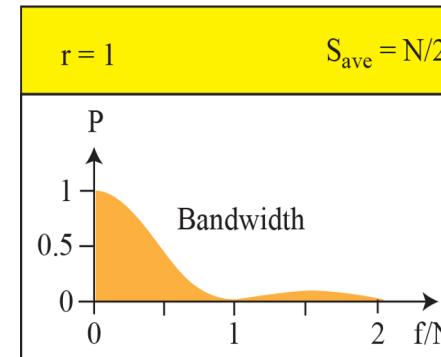
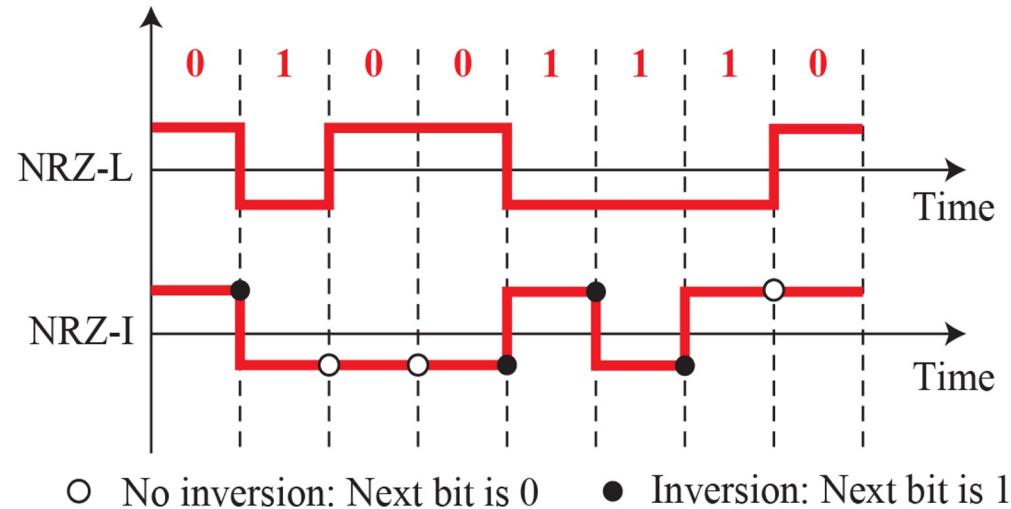


a. High SNR

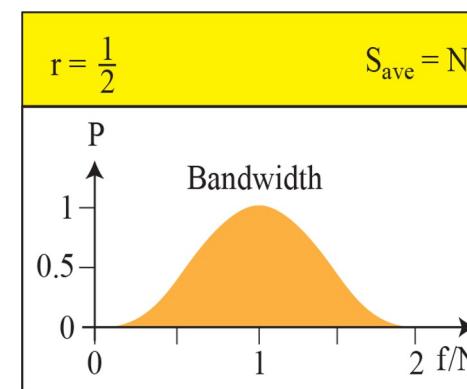
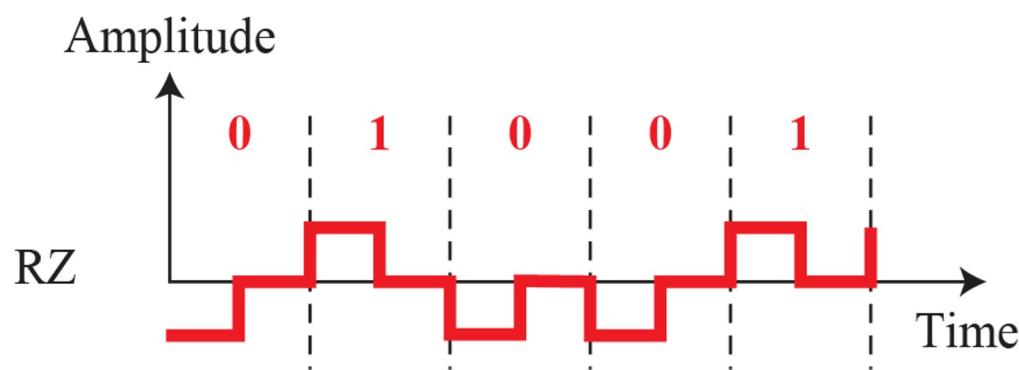


b. Low SNR

Polar schemes

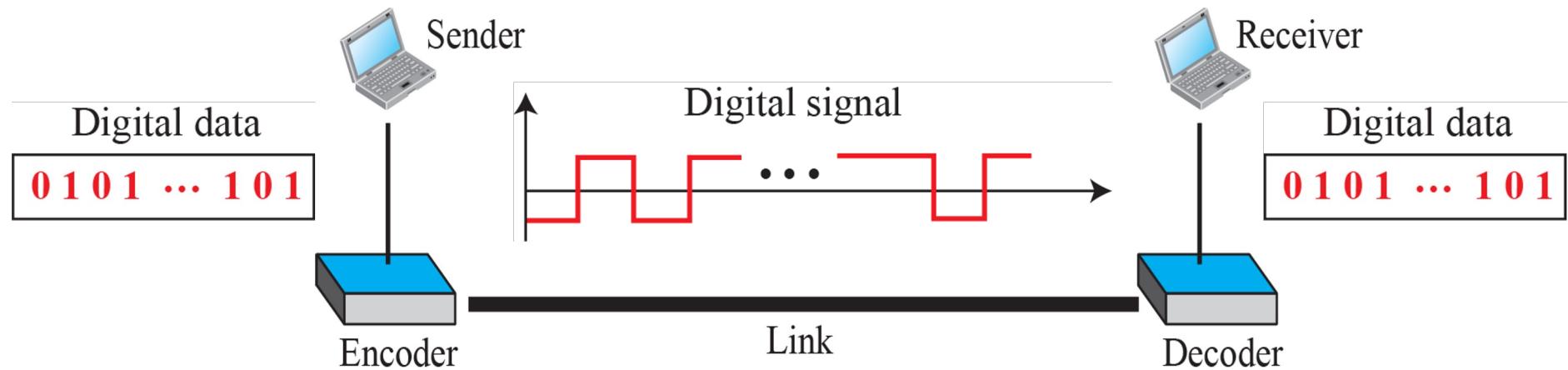


NRZ-L and NRZ-I



RZ

Digital to Digital conversion



Line coding and decoding

Multilevel schemes cont.

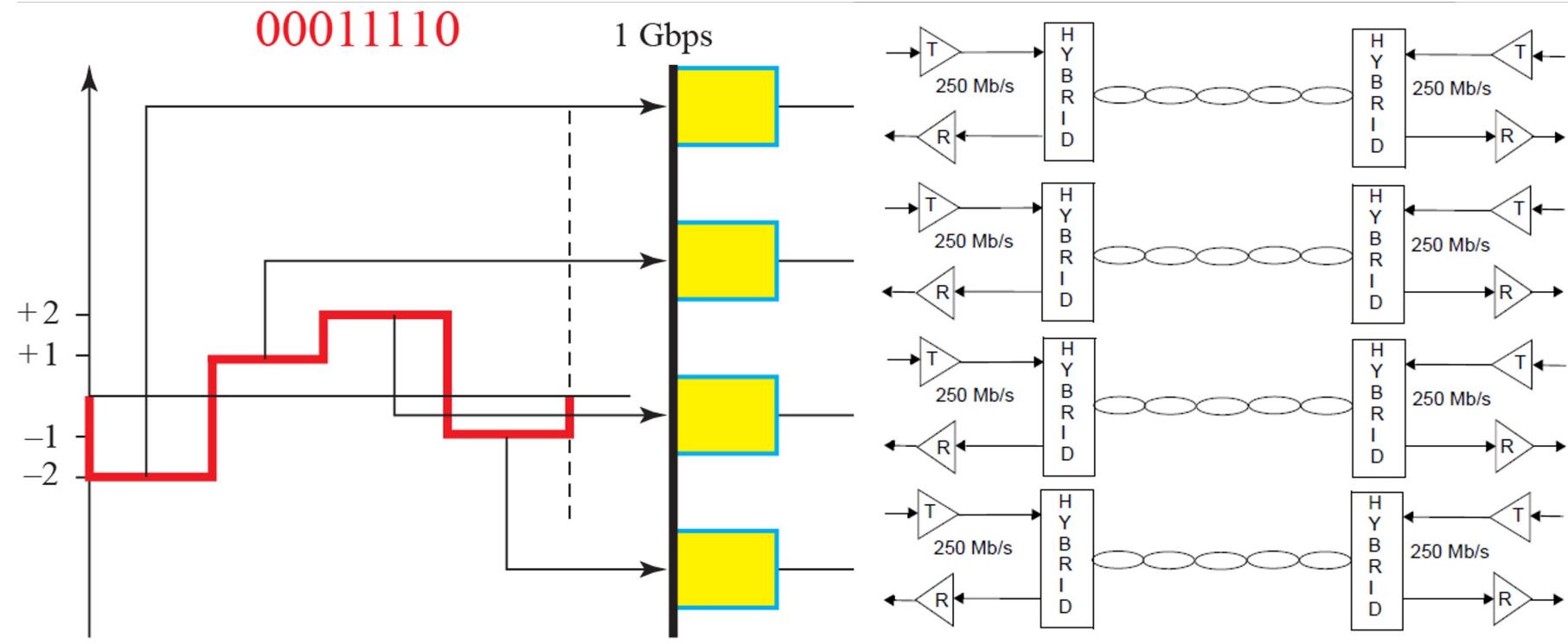
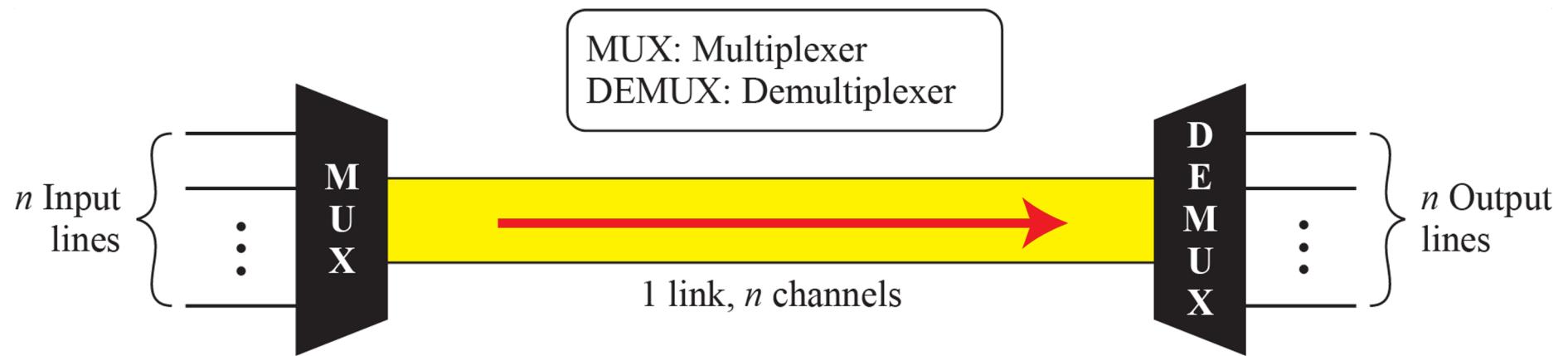


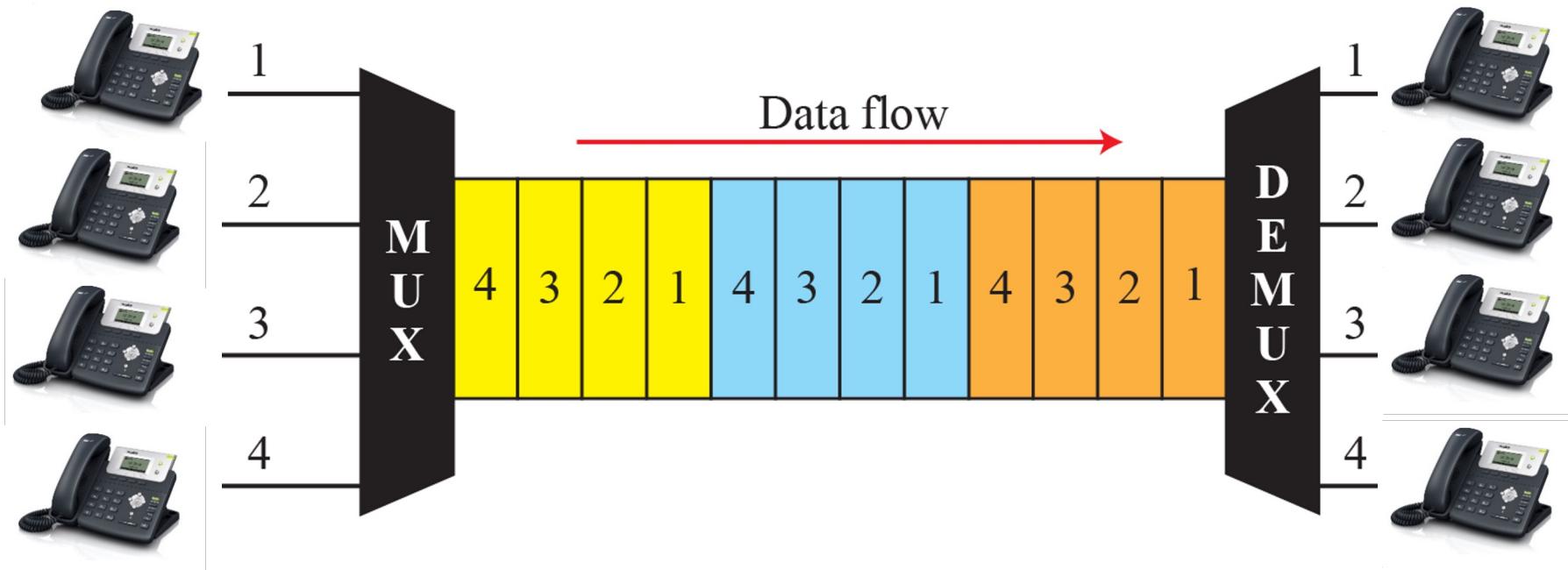
Figure 40-2—1000BASE-T topology

Multilevel: 4D-PAMS

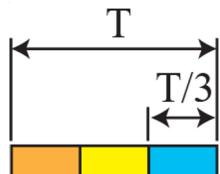
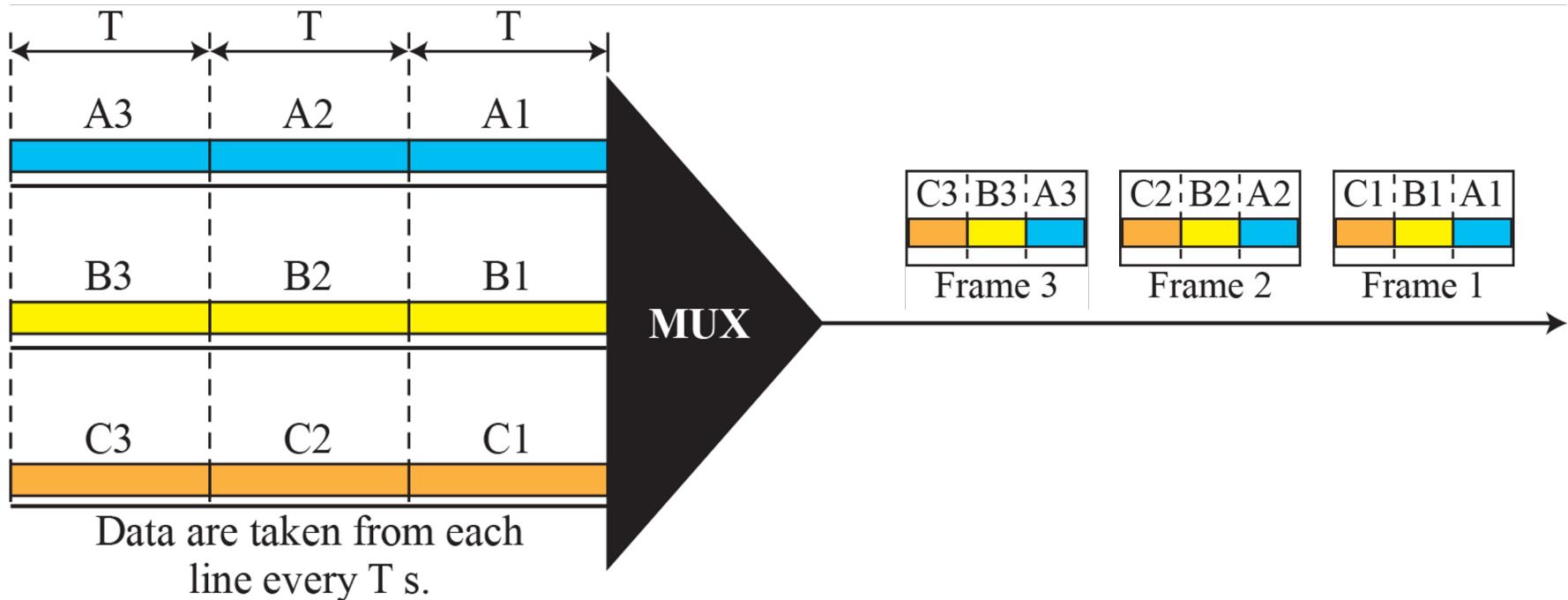
Dividing a link into channels



Time-Division Multiplexing

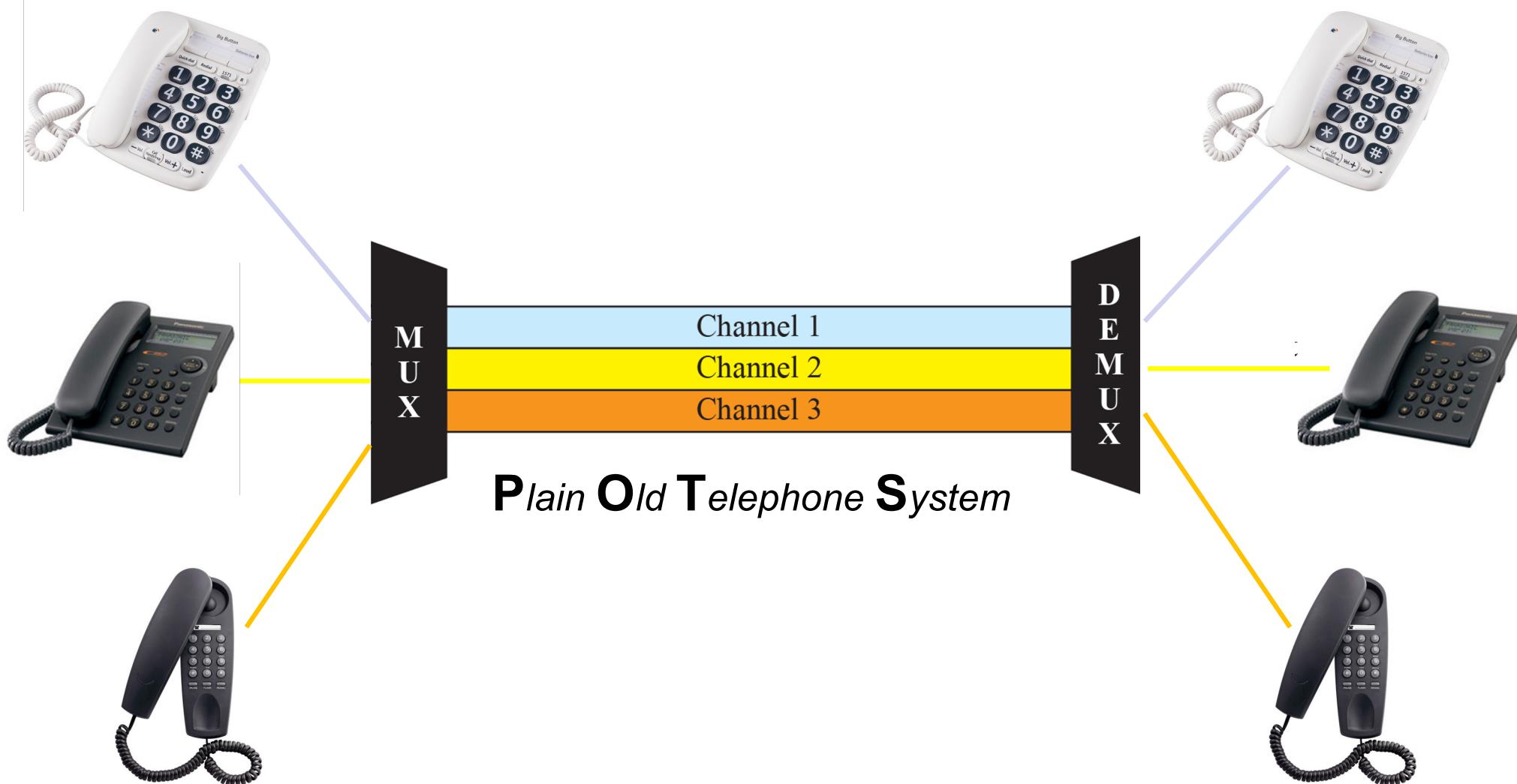


Synchronous time-division multiplexing

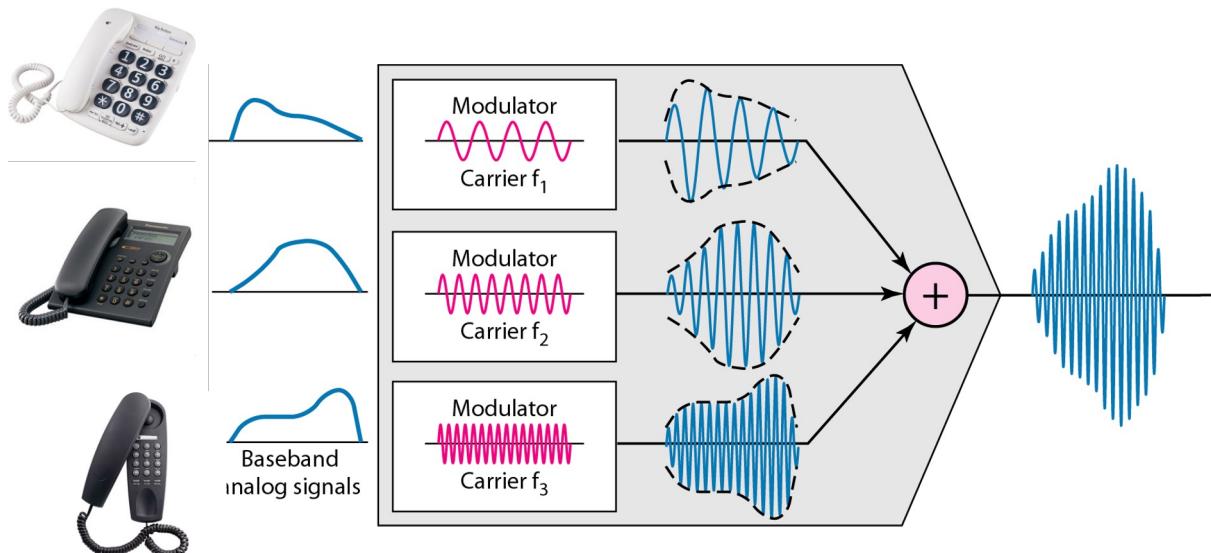


Each frame is 3 time slots.
Each time slot duration is $T/3$ s.

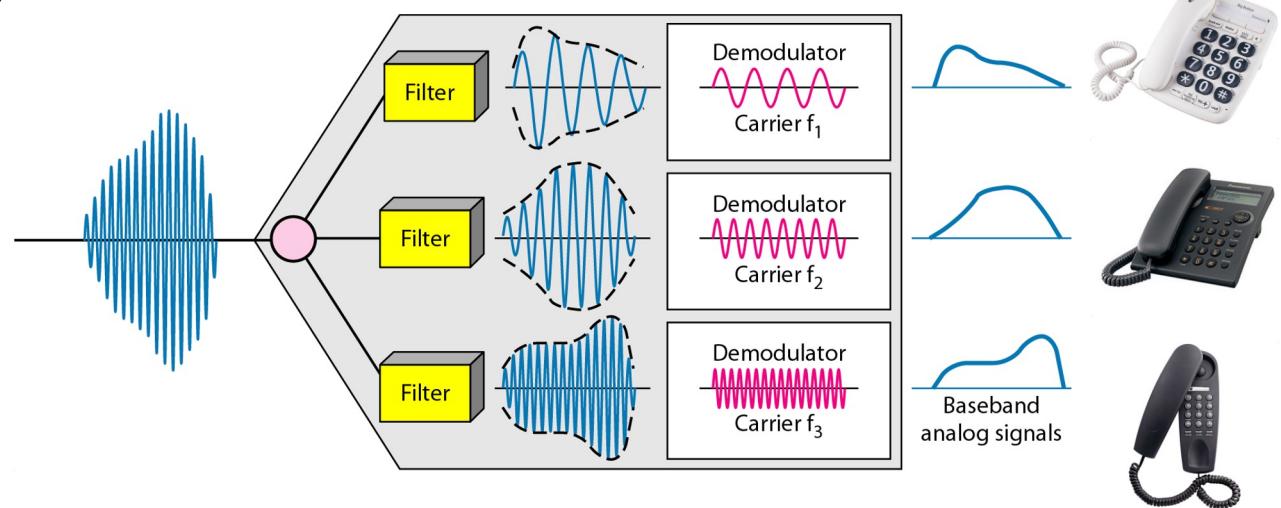
Frequency-division multiplexing



FDM Process

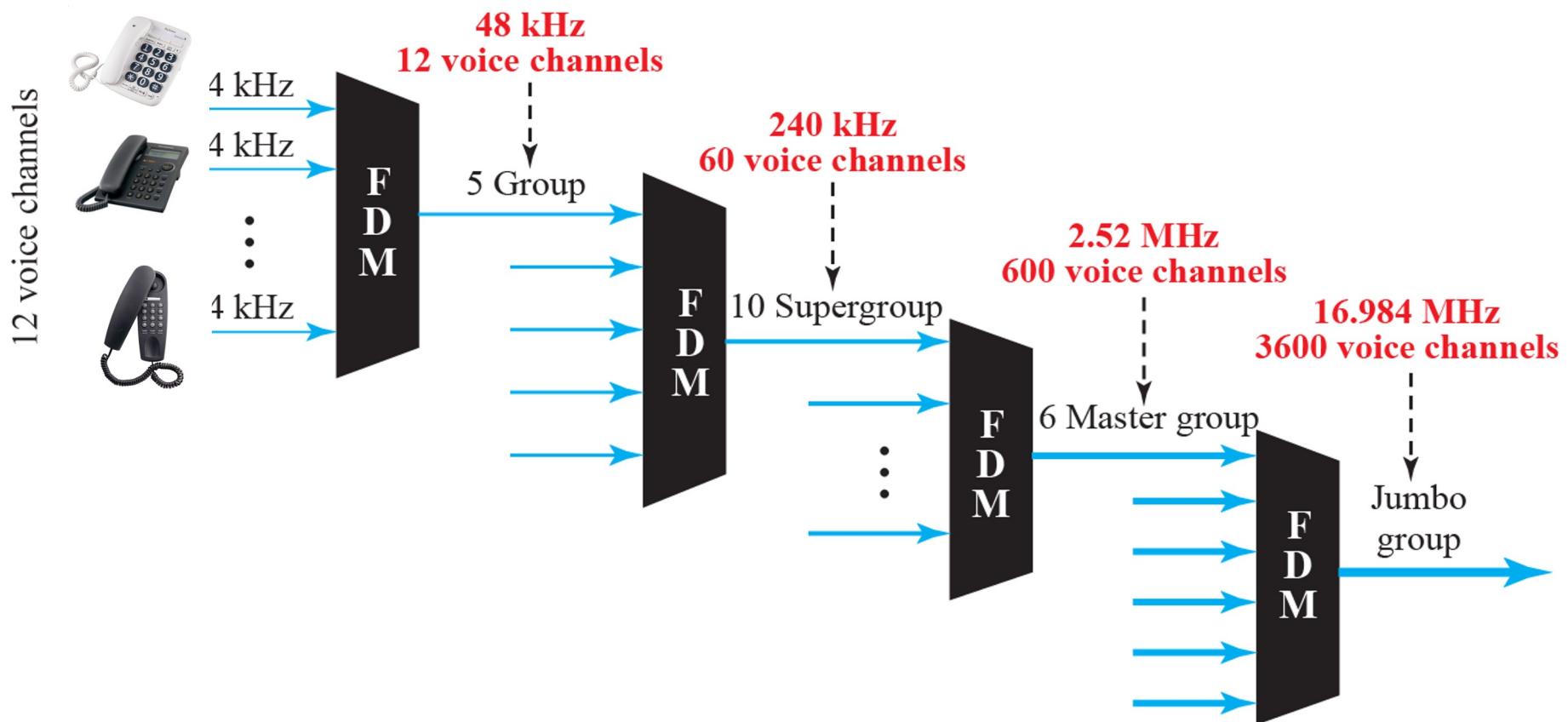


FDM multiplexing

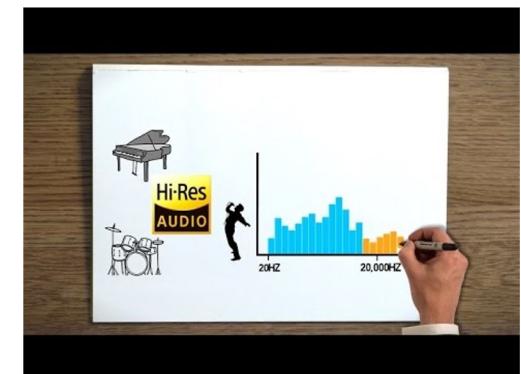
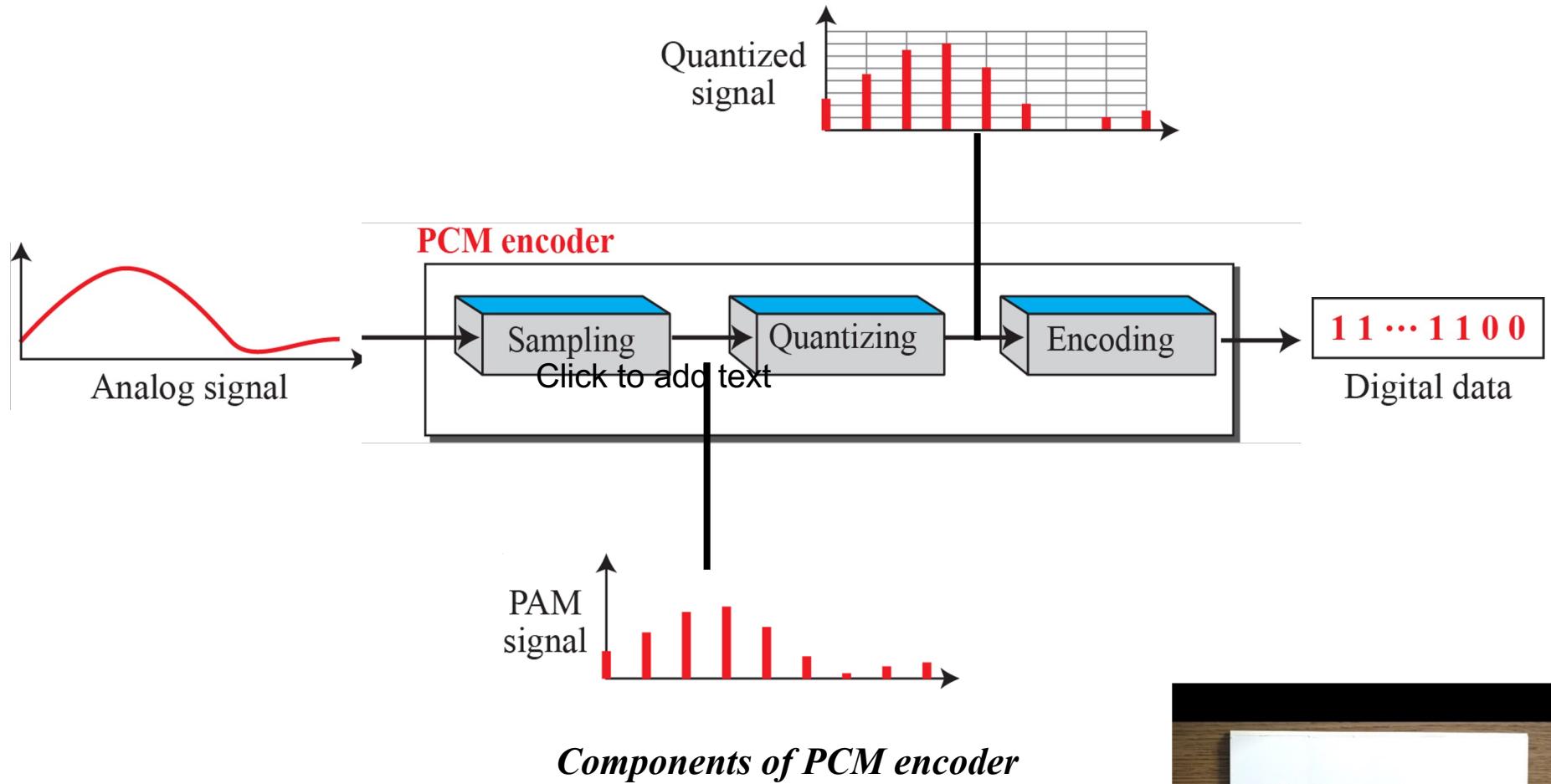


FDM demultiplexing

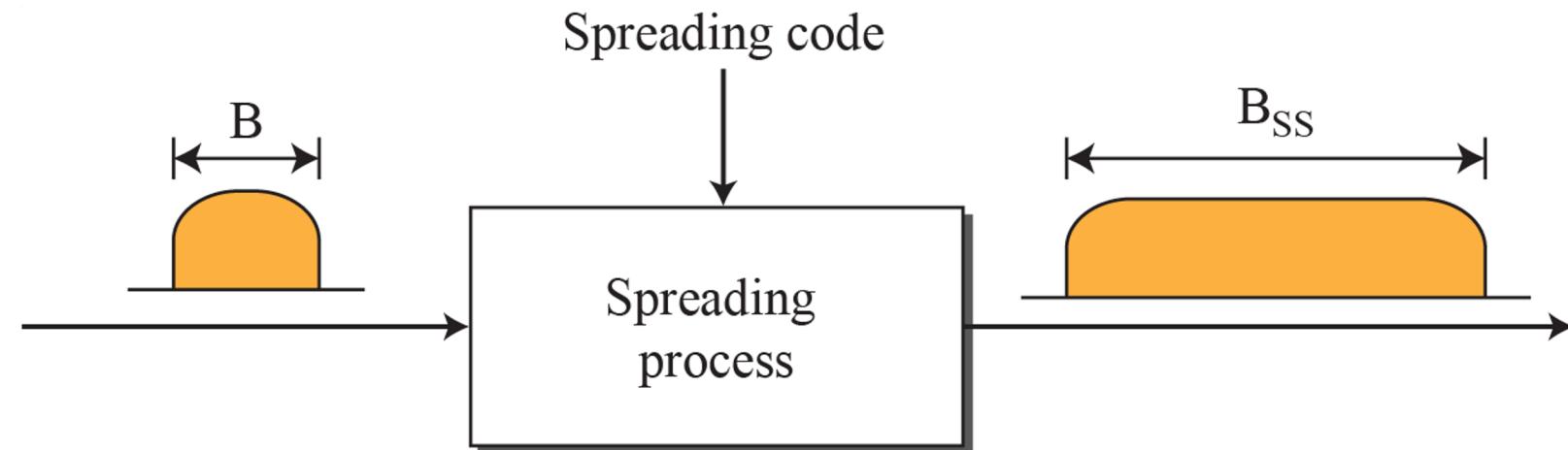
Analog hierarchy



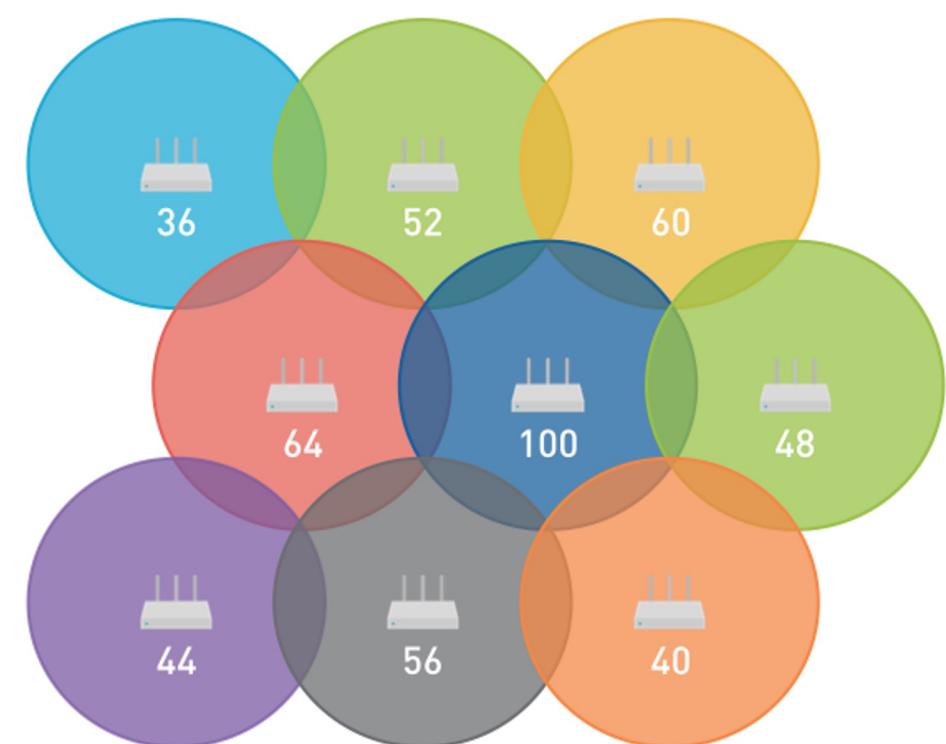
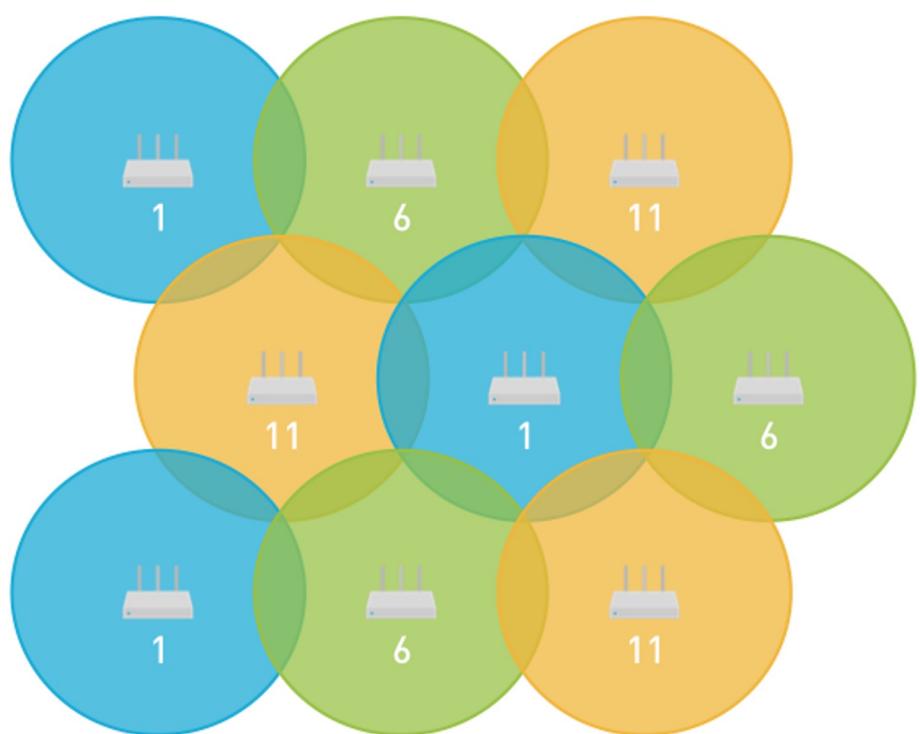
Analog to **DIGITAL** CONVERSION



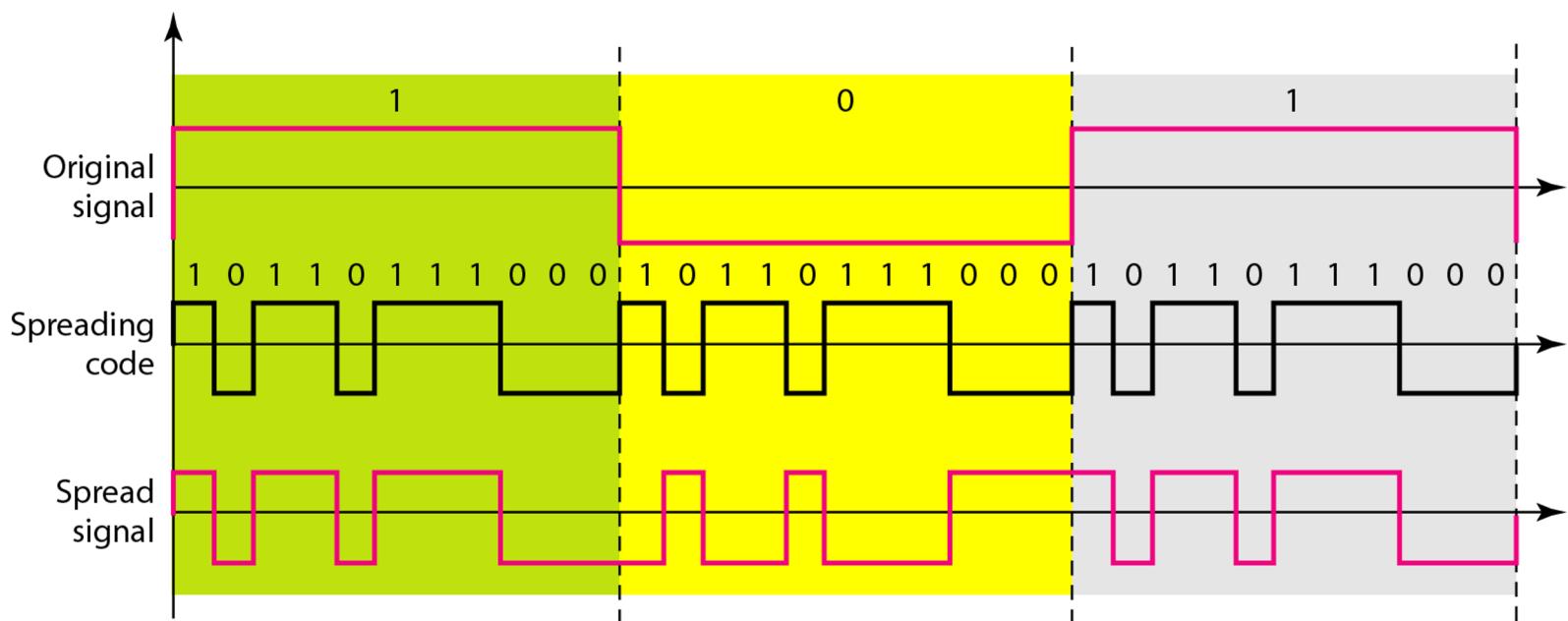
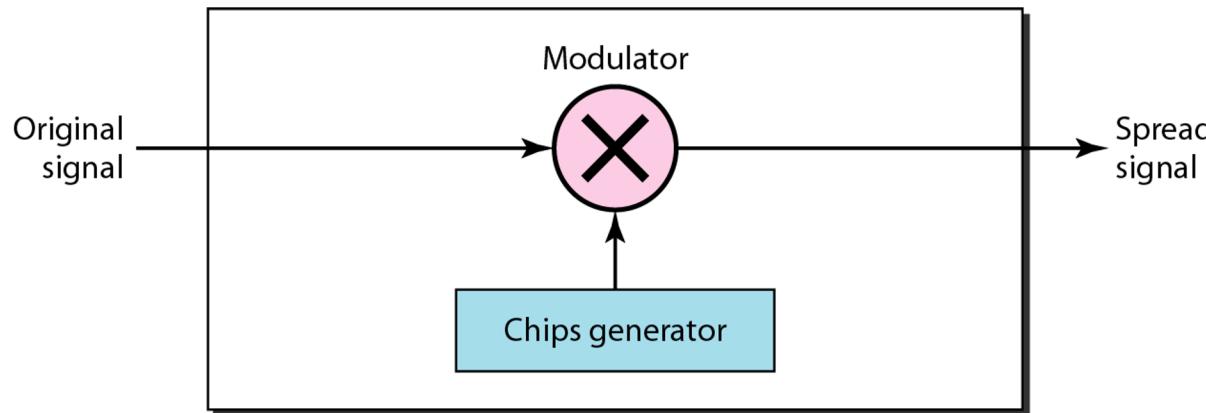
Spread spectrum



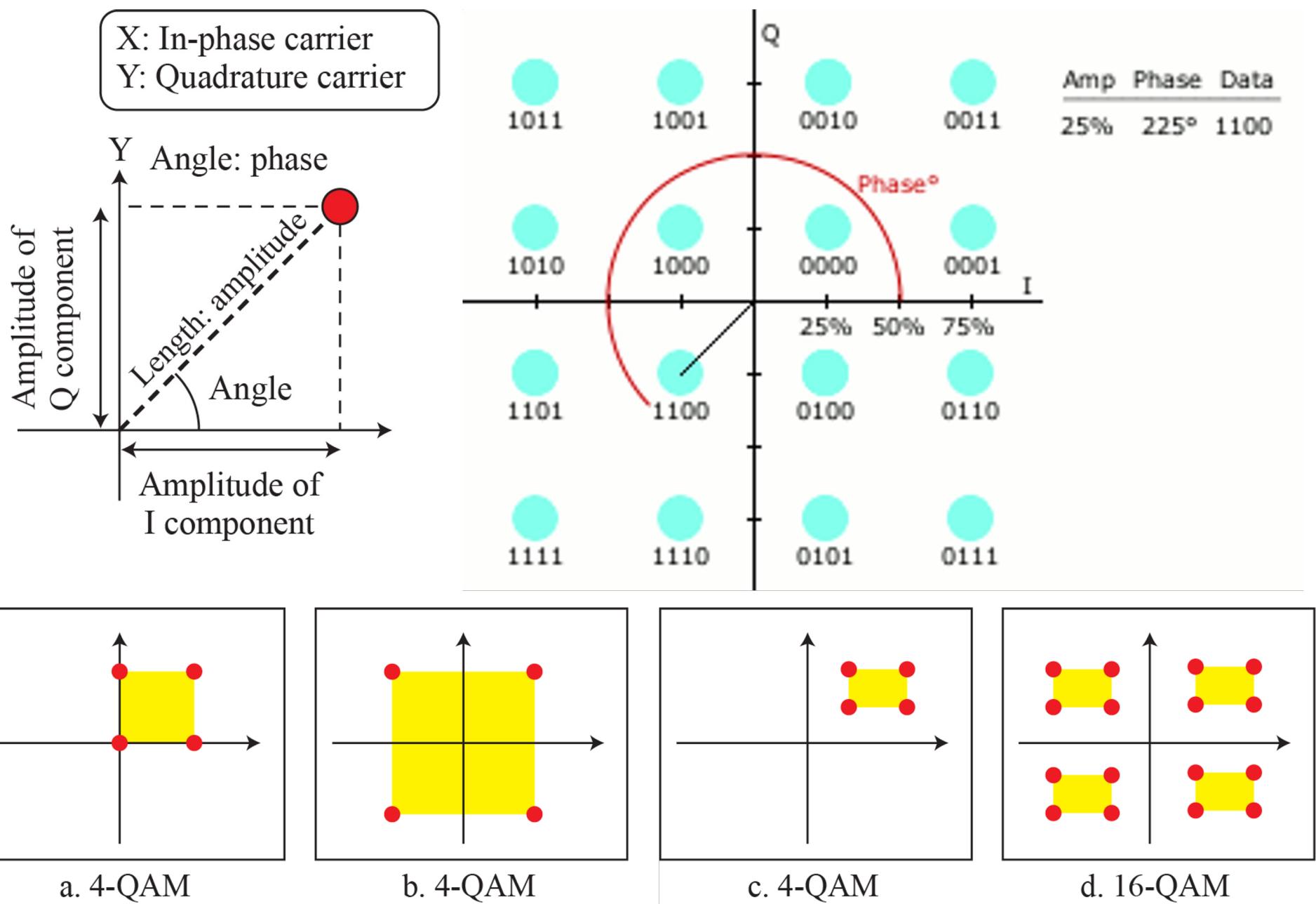
FHSS or DSSS



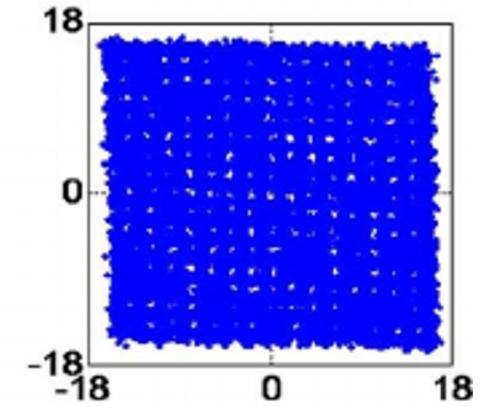
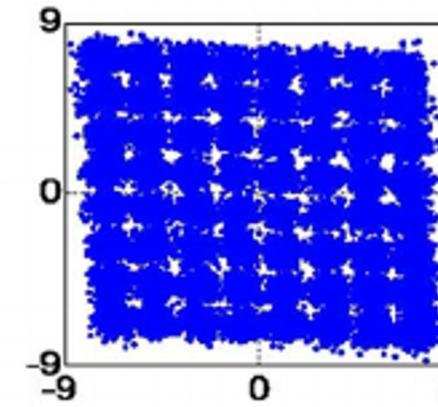
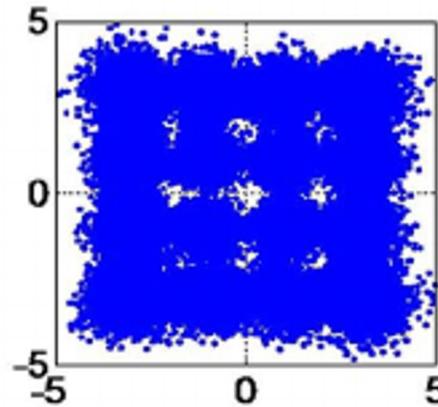
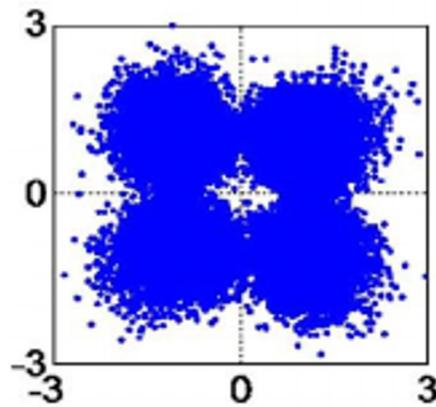
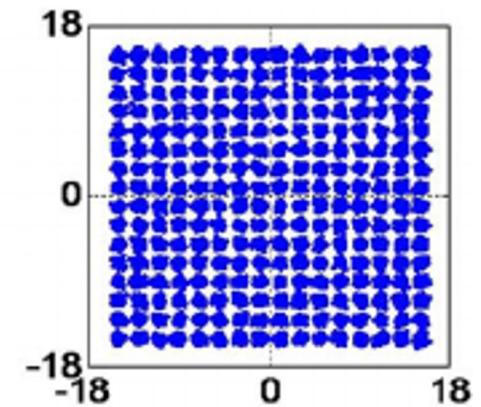
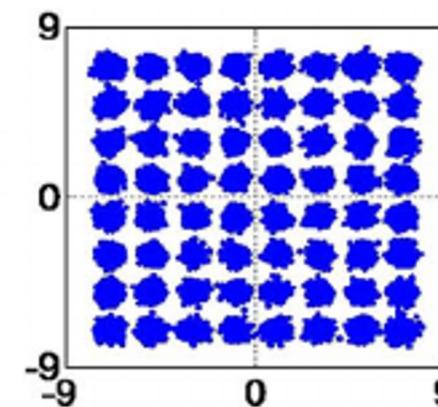
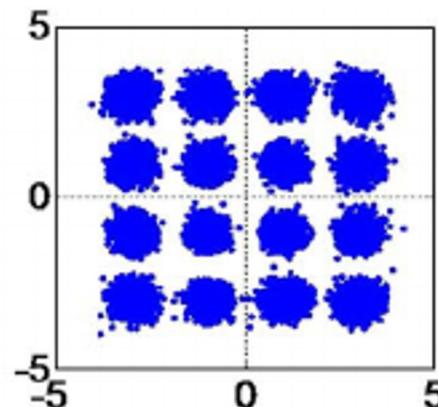
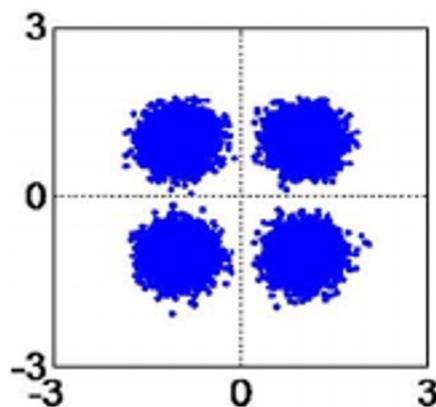
Direct Sequence Spread Spectrum (DSSS)



Concept of a constellation diagram



Quadrature Amplitude Modulation (QAM)

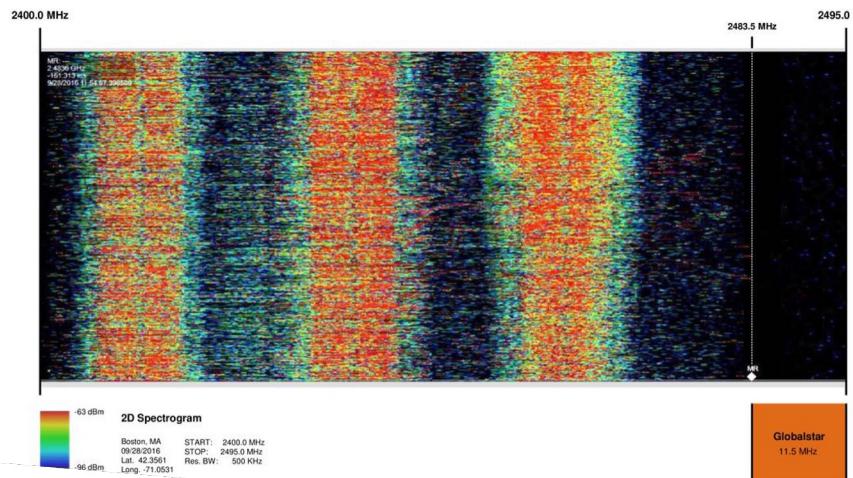


(a)

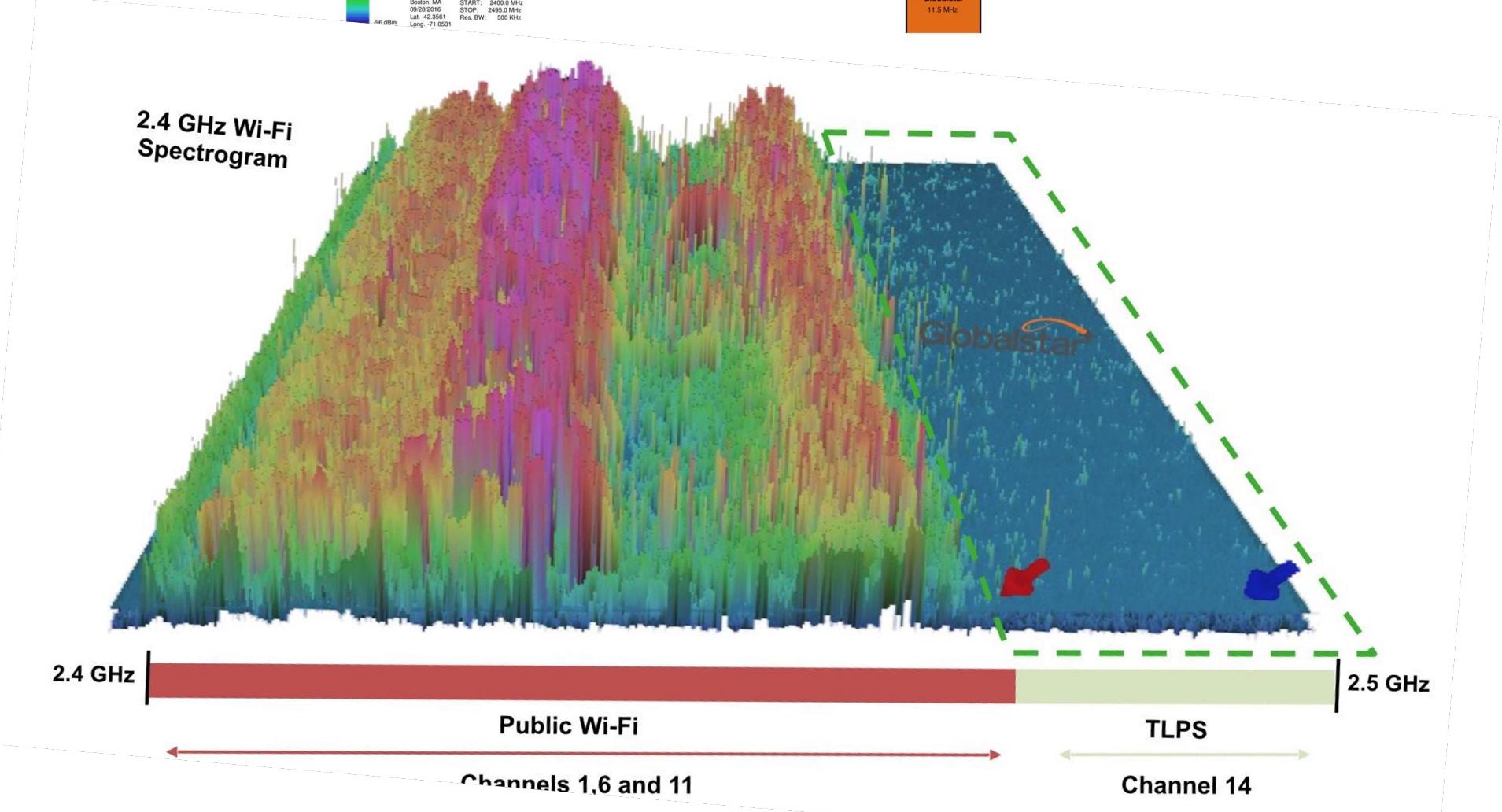
(b)

(c)

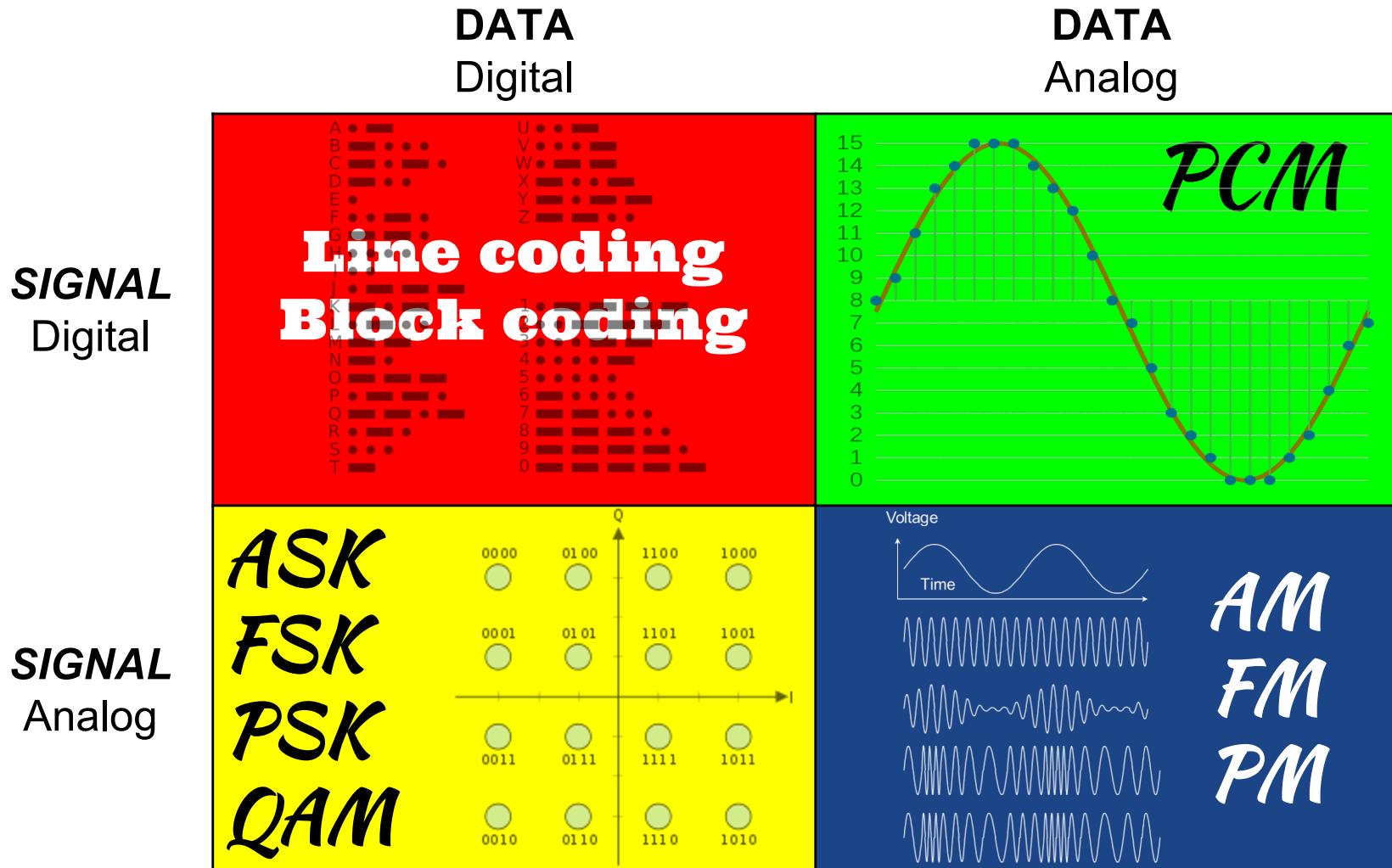
(d)



**2.4 GHz Wi-Fi
Spectrogram**



Digital and *Analog* conversion





Digital
Source

Digital
Data



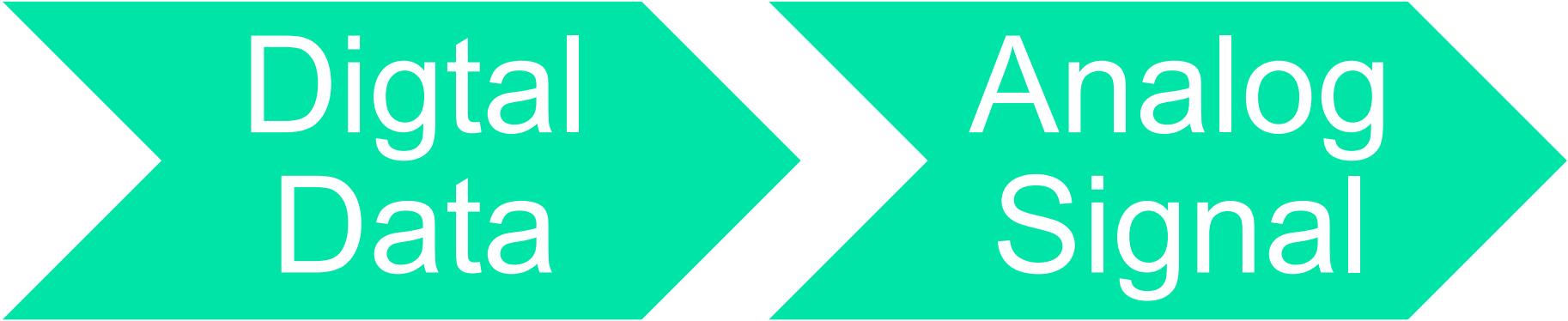
- Sampling
- Quantization
- Encoding

```
graph LR; A[Digital Data] --> B[Digital Signal]; B --- C["•NRZ,  
Bipolar,  
etc."]
```

Digital
Data

Digital
Signal

- NRZ,
Bipolar,
etc.



Digital
Data

Analog
Signal

- Spread spectrum
- QAM