School of Computer Science

Winter Term 2000

CS 308-435
Basics of Computer Networks

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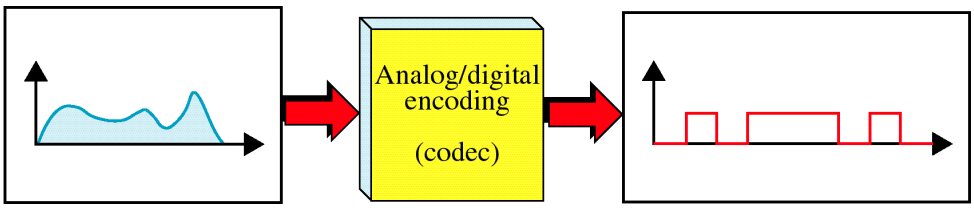
Data to Signal Conversion

- digital to digital
- analog to digital (codec)
- digital to analog
- analog to analog

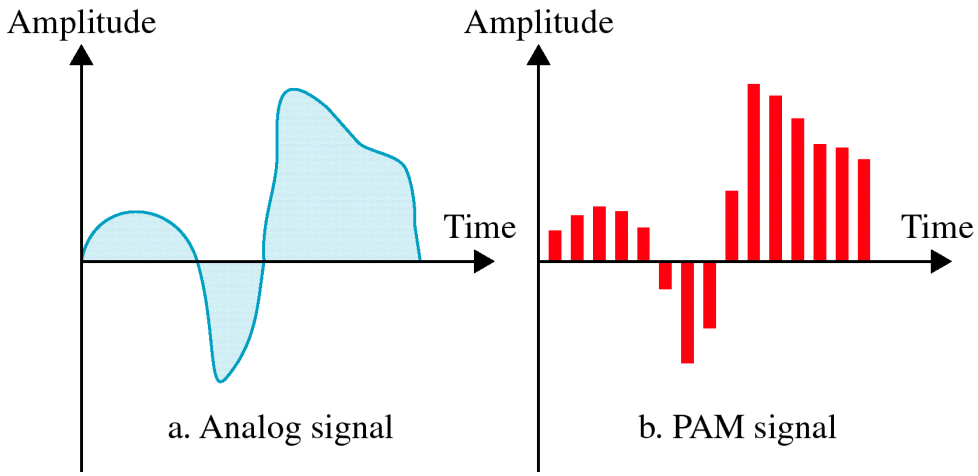
Digital to Digital

class notes

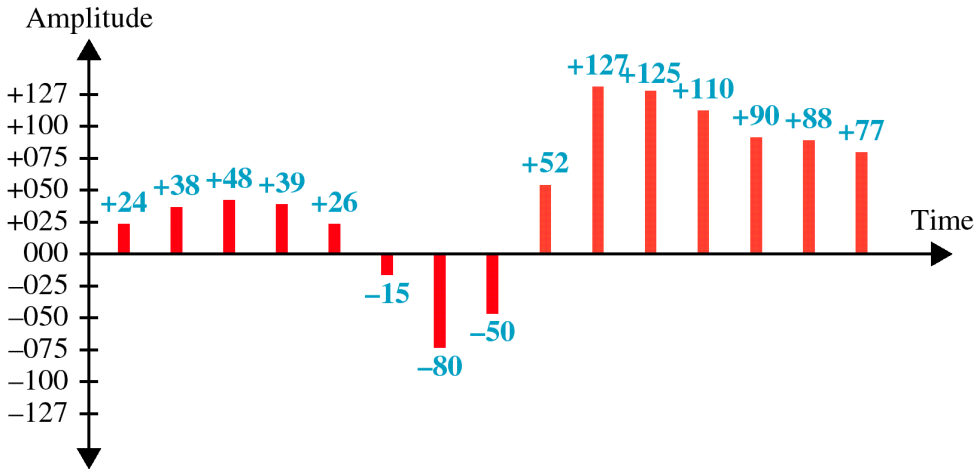
Analog to Digital (codec)



Pulse Amplitude Modulation (sample and hold)



Quantized PAM

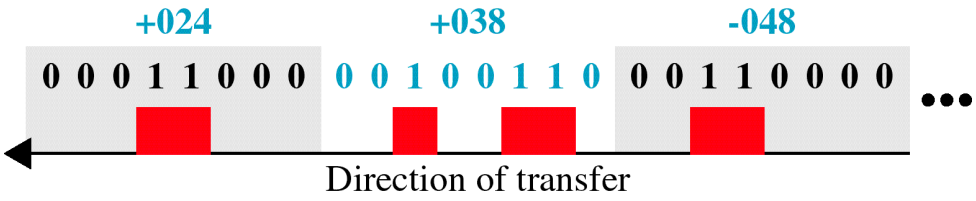


Quantized with sign and magnitude

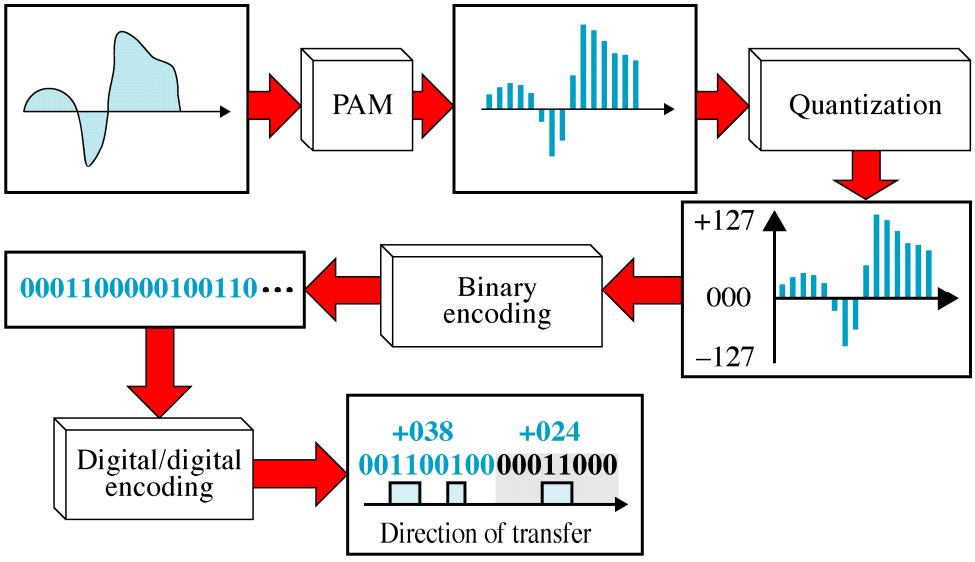
+024	00011000	–015	10001111	+125	01111101
+038	00100110	–080	11010000	+110	01101110
+048	00110000	–050	10110010	+090	01011010
+039	00100111	+052	00110110	+088	01011000
+026	00011010	+127	01111111	+077	01001101

Sign bit
+ is 0 – is 1

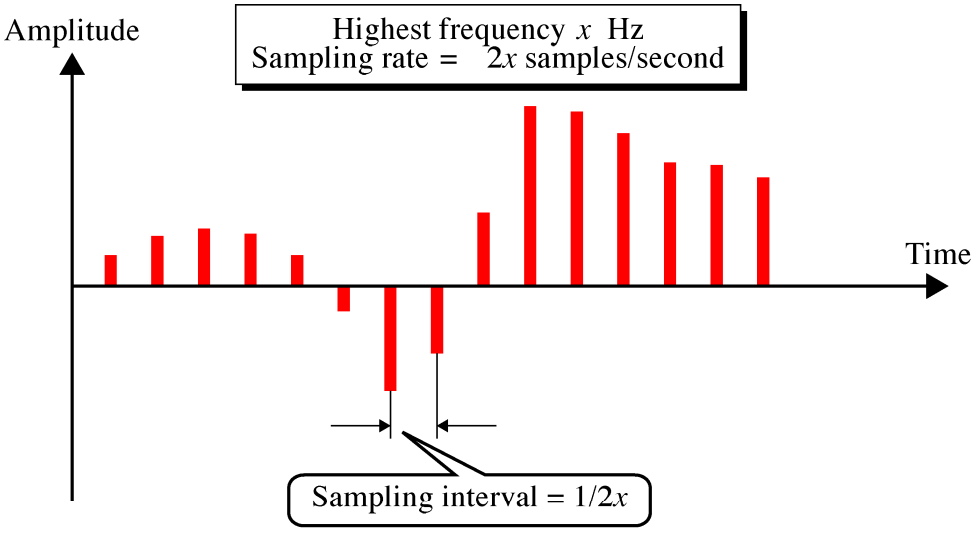
Pulse Code Modulation (PCM)



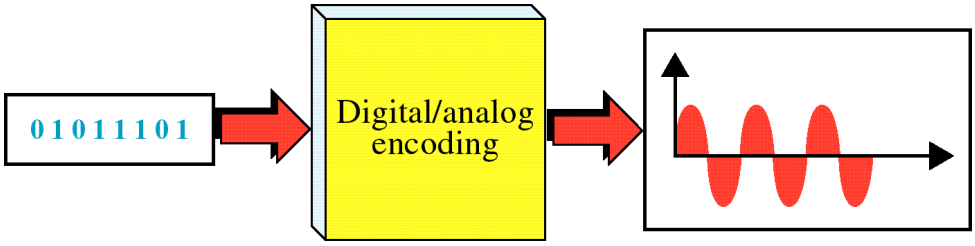
From analog to PCM



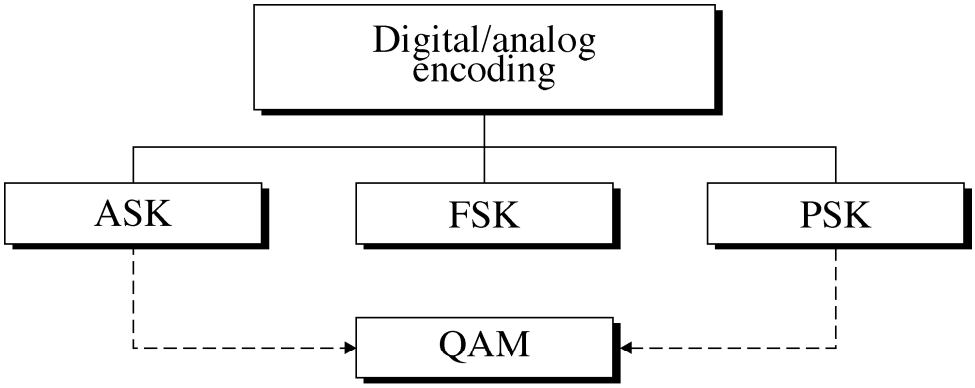
Nyquist Theorem (sampling)



Digital to Analog



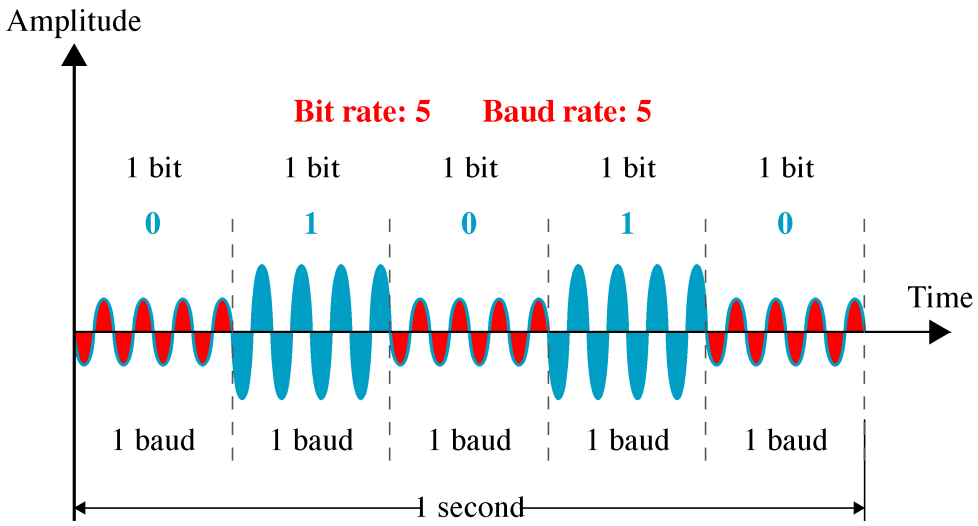
Types of Digital to Analog



Bit Rate vs. Baud Rate

- bit rate: bits transmitted per second
- baud rate: signal units per second (bandwidth)

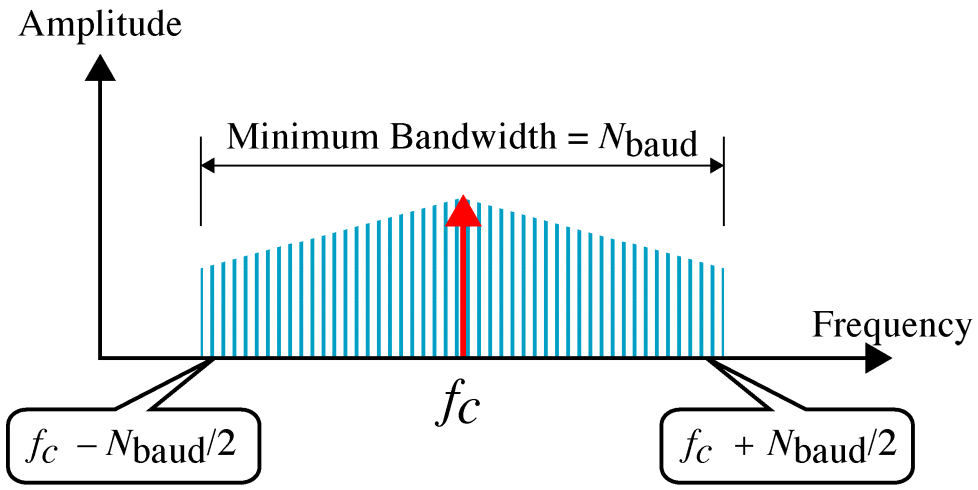
Amplitude Shift Keying (ASK)



Amplitude Shift Keying (ASK)

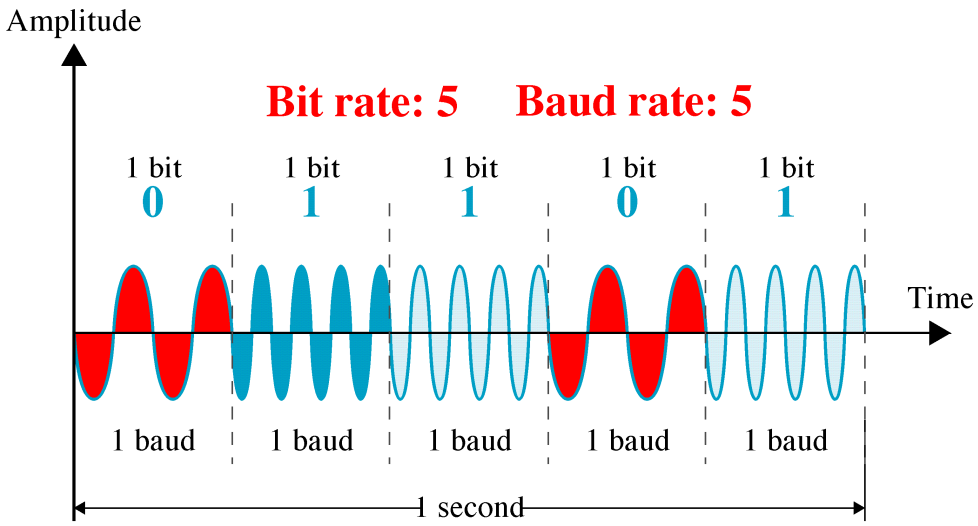
- Sensitive to noise
- on-off-keying (OOK): 1 or 0 represented by no voltage

Bandwidth for ASK (most significant frequencies)

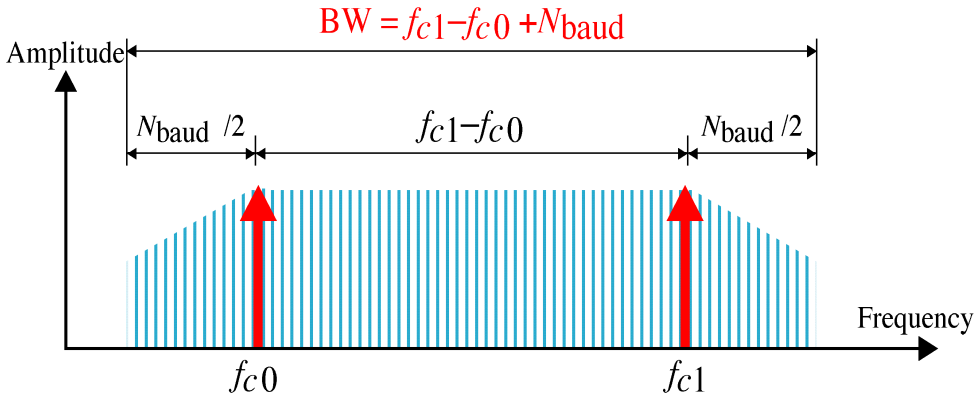


Full Duplex communication

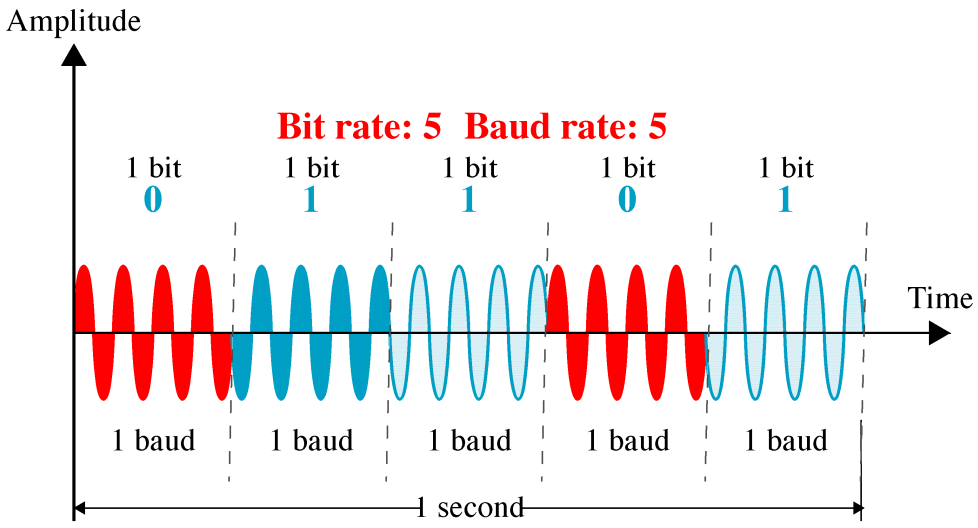
Frequency Shift Keying (FSK)



Bandwidth for FSK



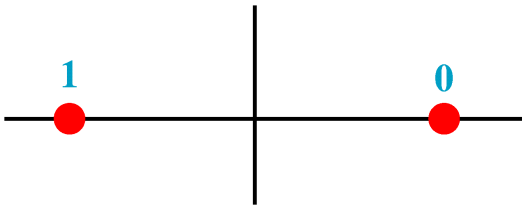
Phase Shift Keying (PSK)



PSK Constellation

Bit	Phase
0	0
1	180

Bits

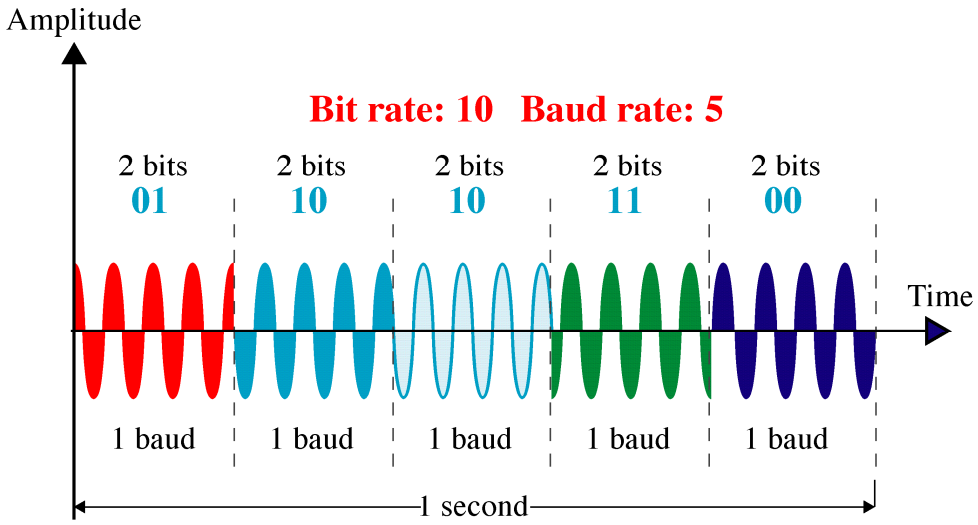


Constellation diagram

PSK Constellation

- Noise insensitive
- no bandwidth limitations

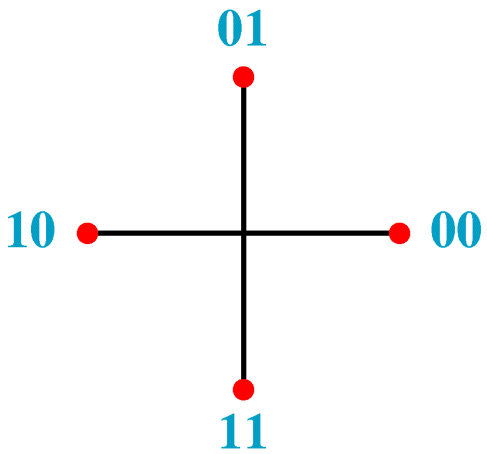
4-PSK



4-PSK constellation

Dibit	Phase
00	0
01	90
10	180
11	270

Dibit
(2 bits)

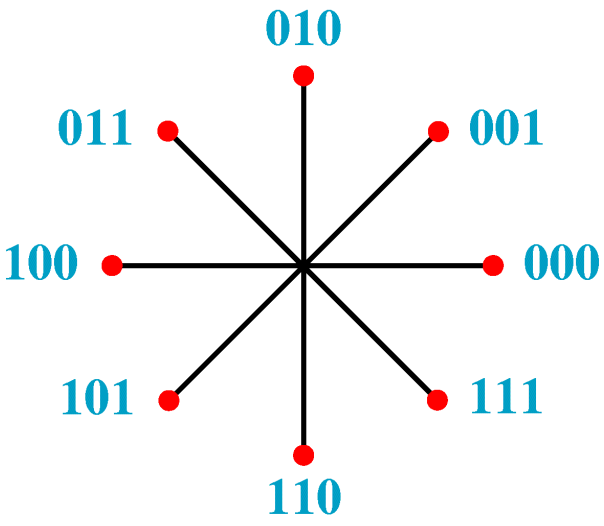


Constellation diagram

8-PSK

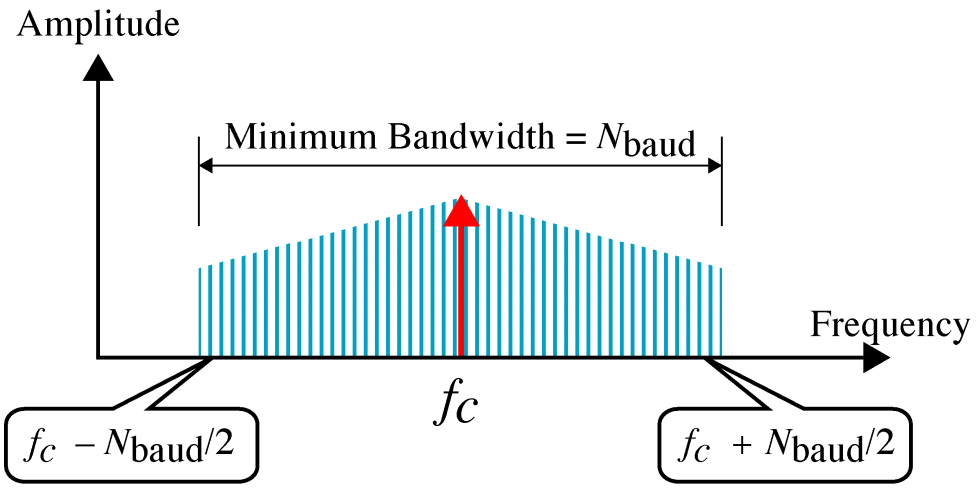
Tribit	Phase
000	0
001	45
010	90
011	135
100	180
101	225
110	270
111	315

Tribits
(3 bits)

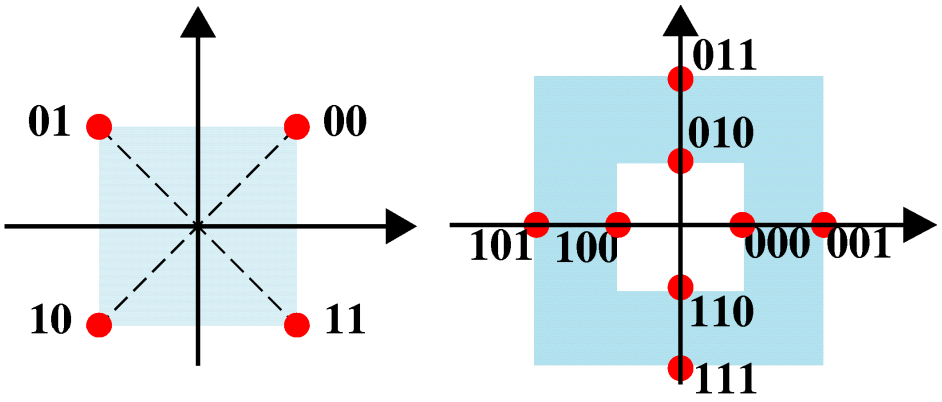


Constellation diagram

Bandwidth PSK = Bandwidth ASK



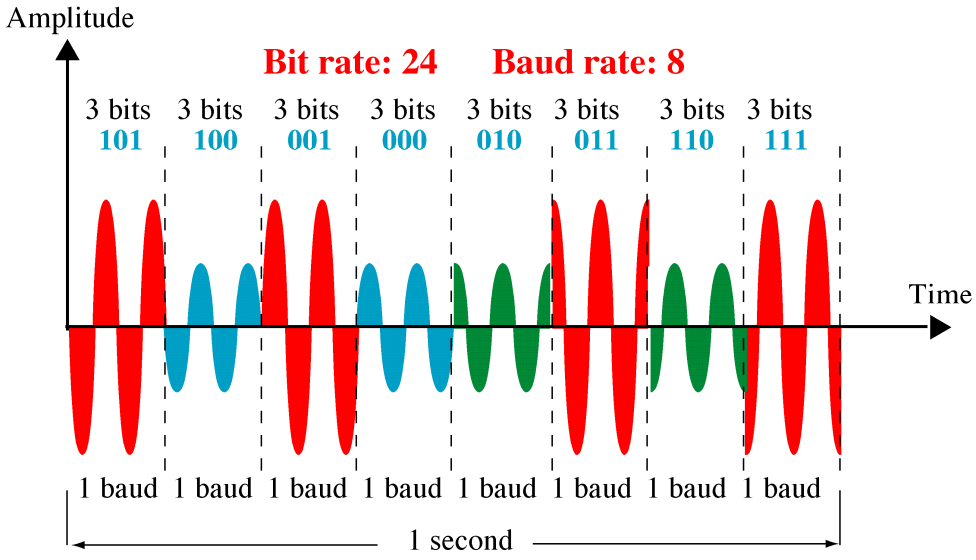
Quadrature Amplitude Modulation (QAM)



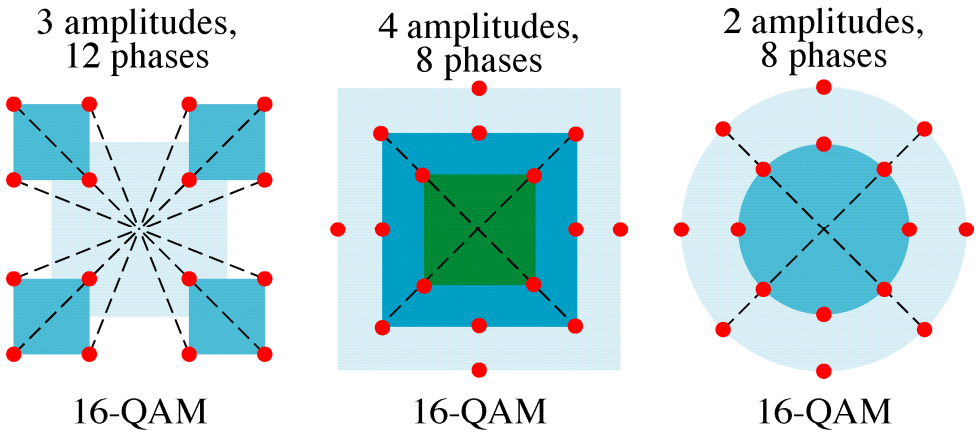
4-QAM
1 amplitude, 4 phases

8-QAM
2 amplitudes, 4 phases

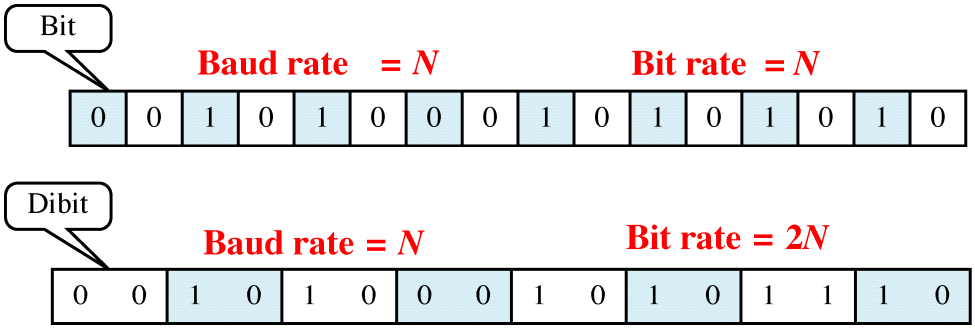
Time Domain for 8-QAM



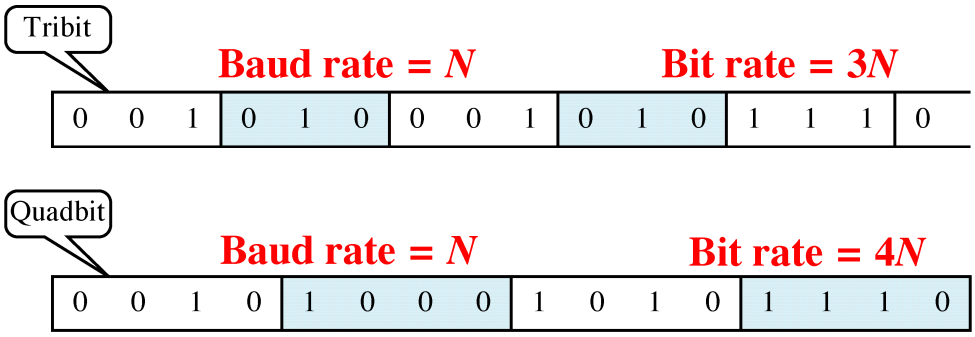
16-QAM Constellations



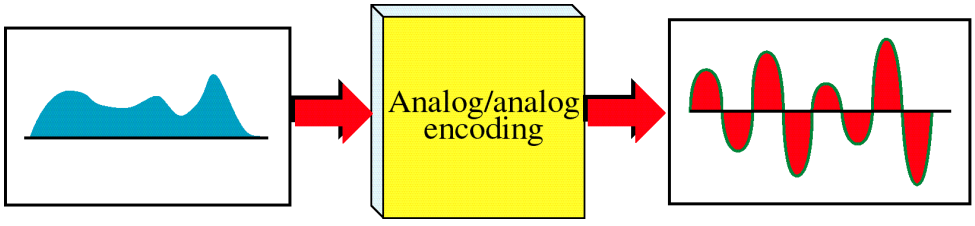
Bit and Baud



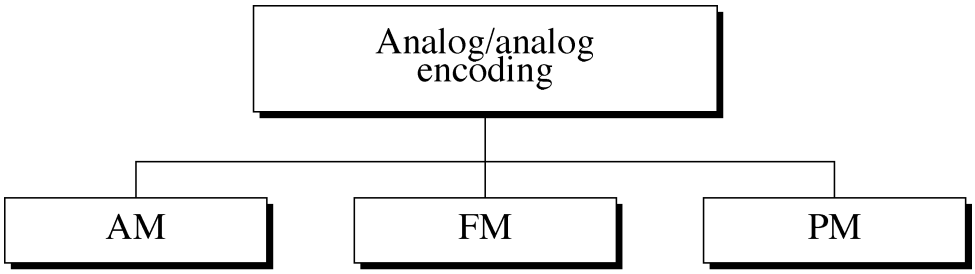
Bit and Baud



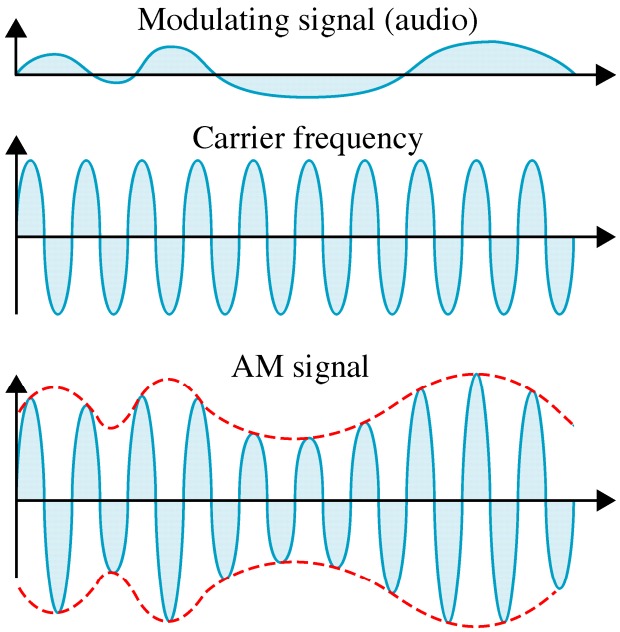
Analog to Analog



Types of Analog to Analog Modulation

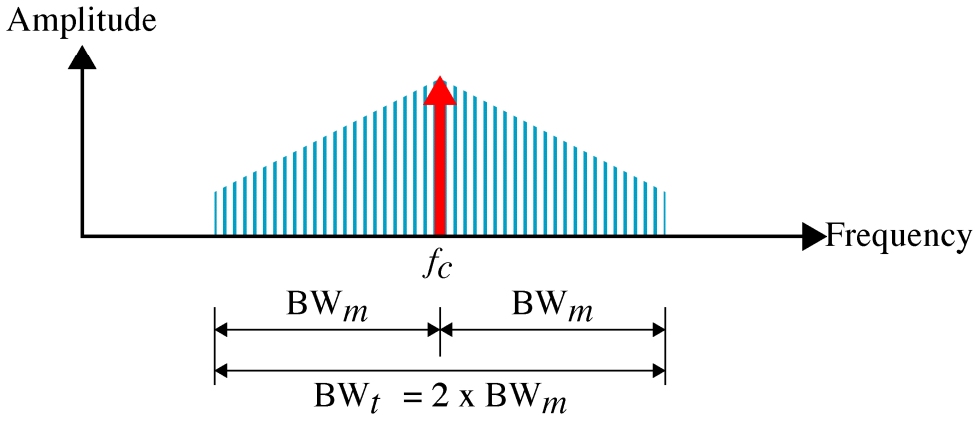


Amplitude Modulation (AM)



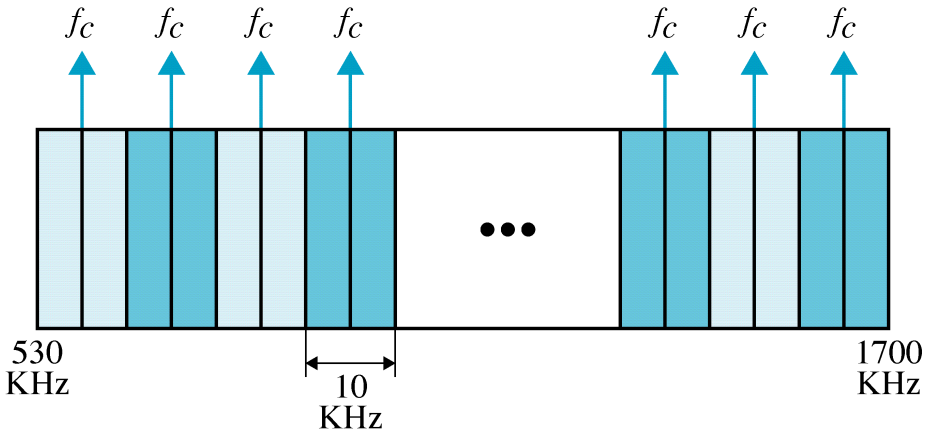
AM Bandwidth

BW_m =Bandwidth of the modulating signal (audio)
BW_t = Total bandwidth (radio)
f_c = Frequency of the carrier

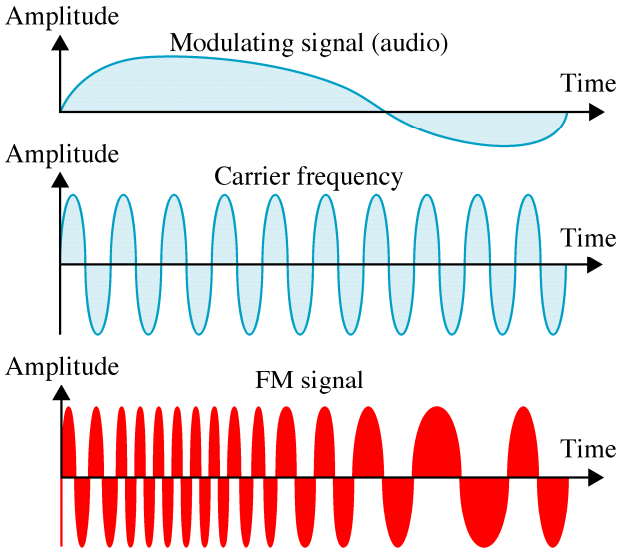


AM Band Allocation
(Federal Communications Commission)

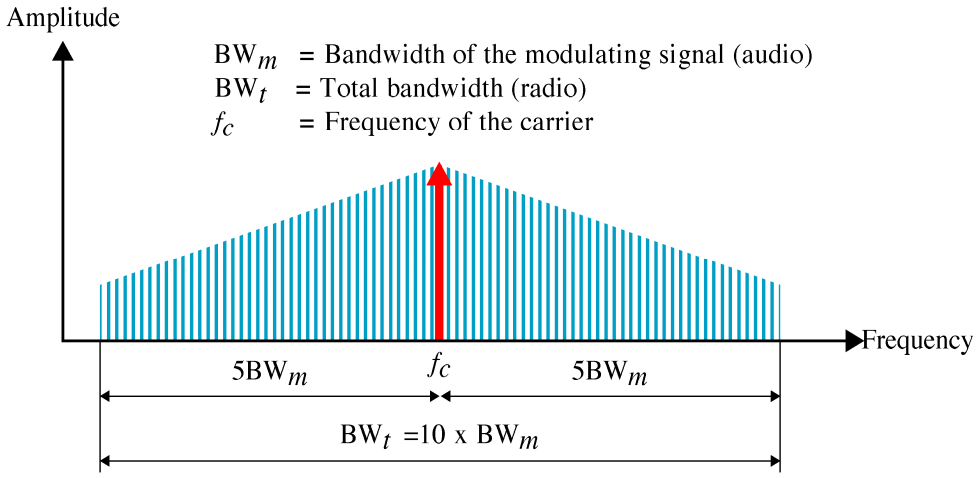
f_c = Carrier frequency of the station



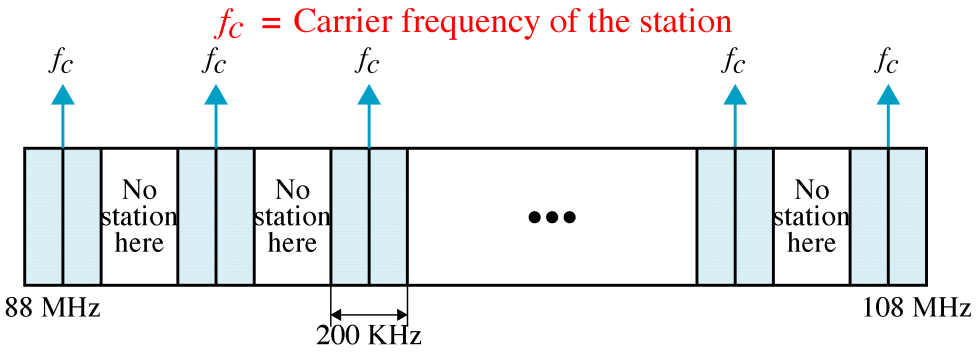
Frequency Modulation (FM)



FM Bandwidth



FM Band Allocation (stereo: 15KHz)



Phase Modulation (PM)

Similar to FM