HY-330

fall semester 2021

Introduction to telecommunication systems theory

University of Crete
Computer Science Department

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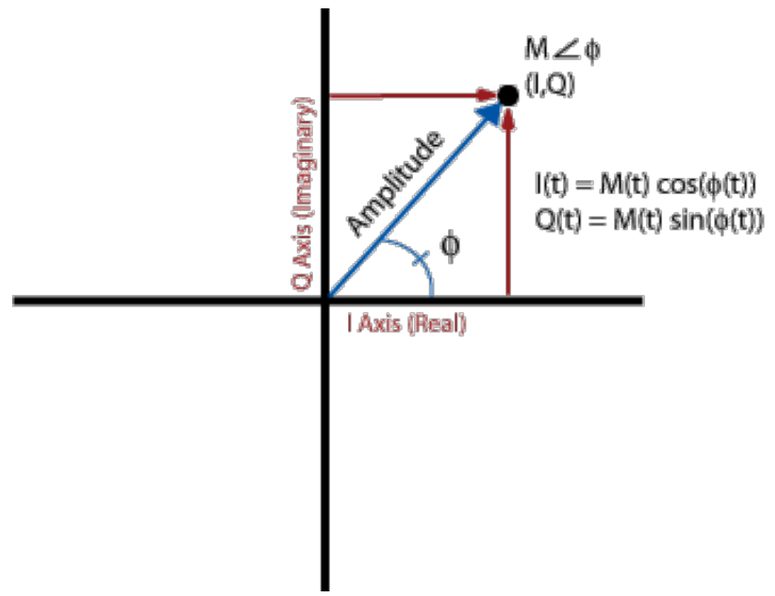
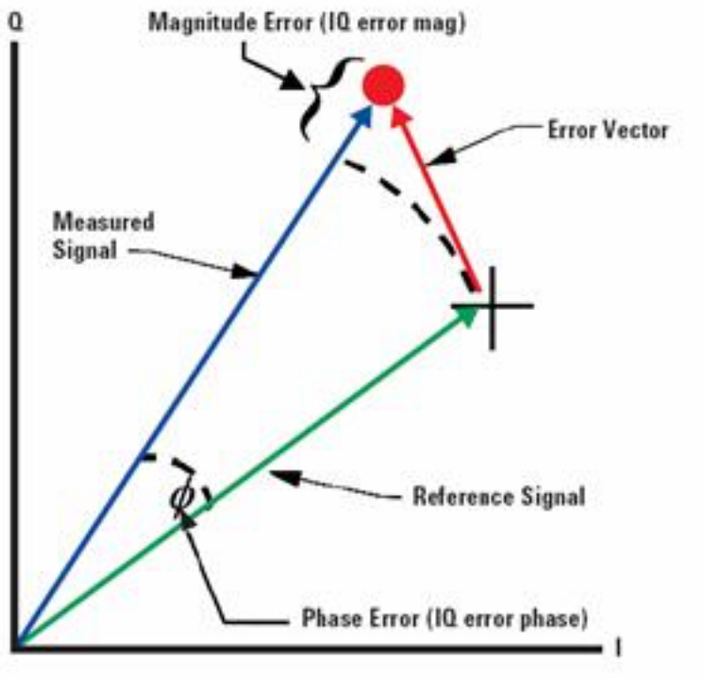
Digital Modulations

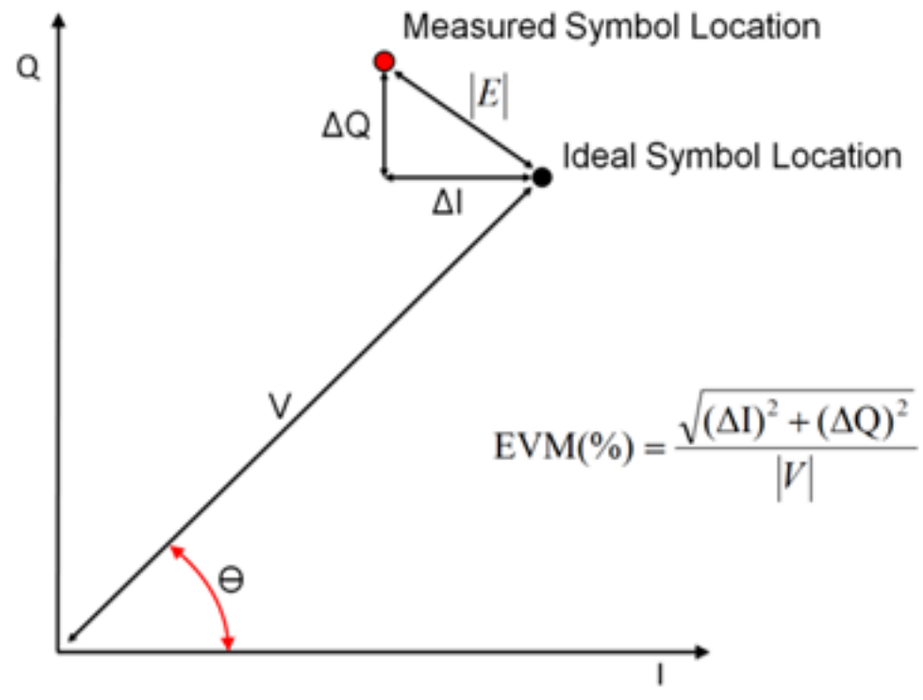
- EVM
- Efficiency

Quadrature Amplitude Modulation



Error Vector Magnitude





Error Vector Magnitude

- EVM

$$EVM(\%) = \sqrt{\frac{P_{error}}{P_{reference}}} \cdot 100\%$$

$$EVM(dB) = 10 \log_{10} \frac{P_{error}}{P_{reference}}$$

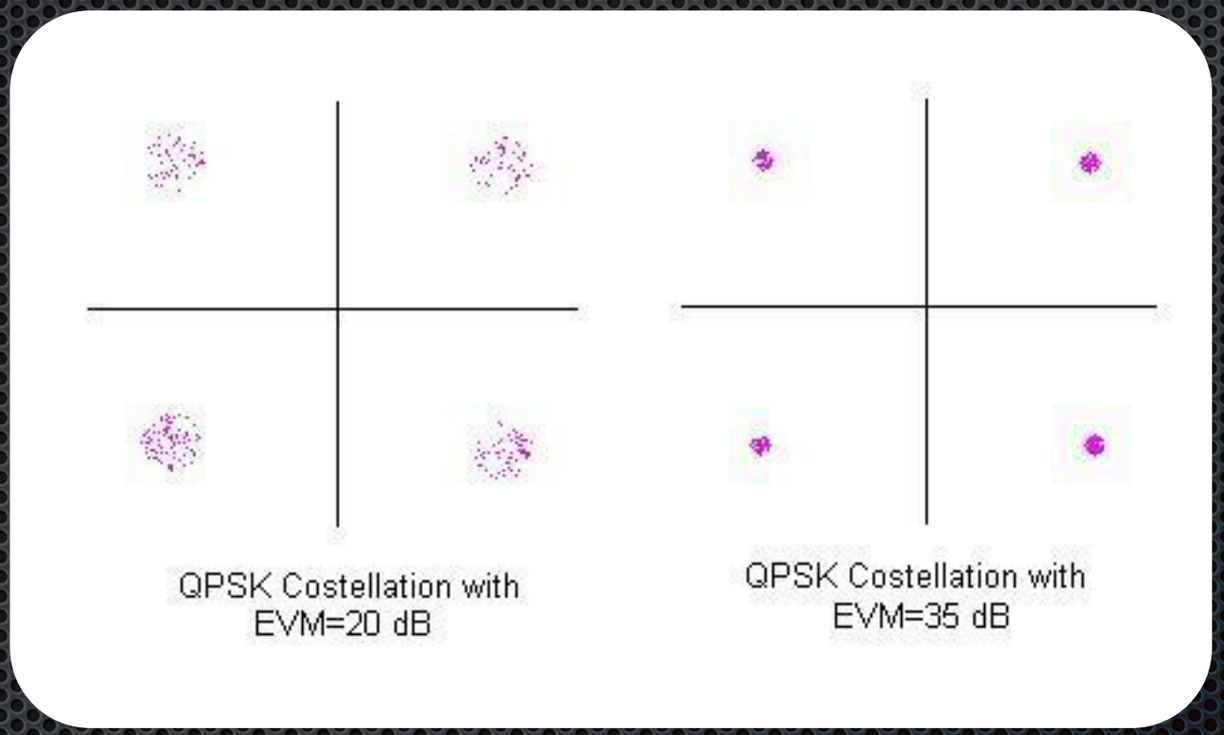
Error Vector Magnitude

- EVM vs SNR

$$EVM_{RMS} \approx \sqrt{\frac{1}{SNR}}$$

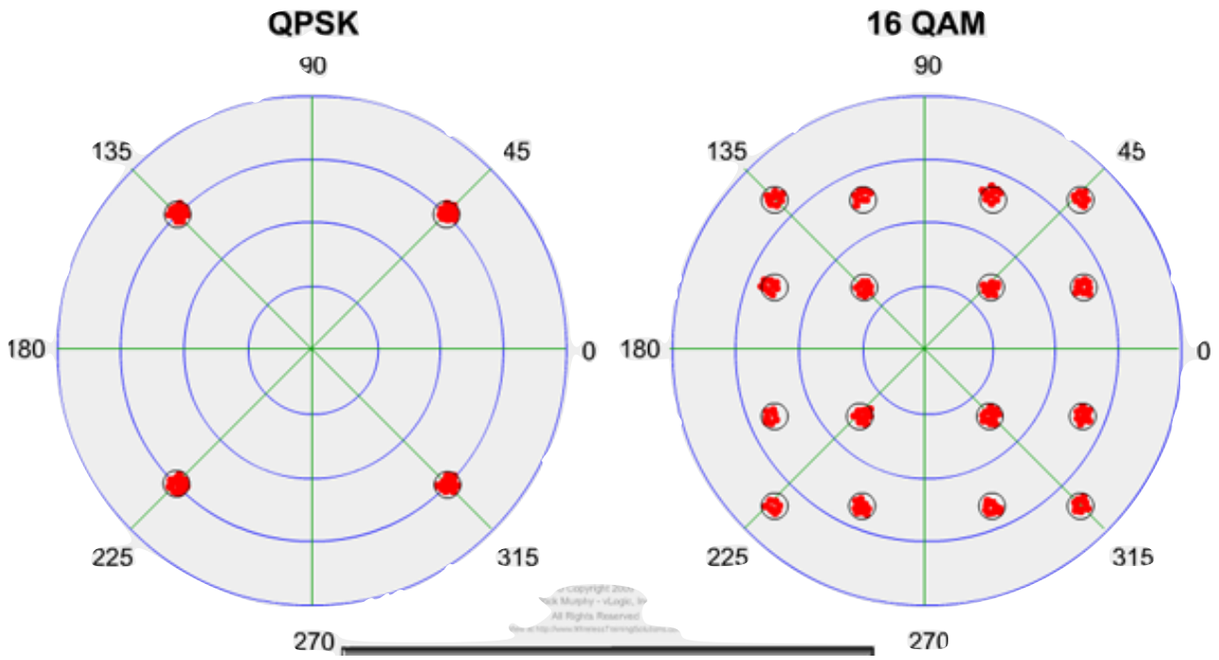
$$SNR[dB] = -20 \cdot \log(EVM/100\%)$$

Error Vector Magnitude

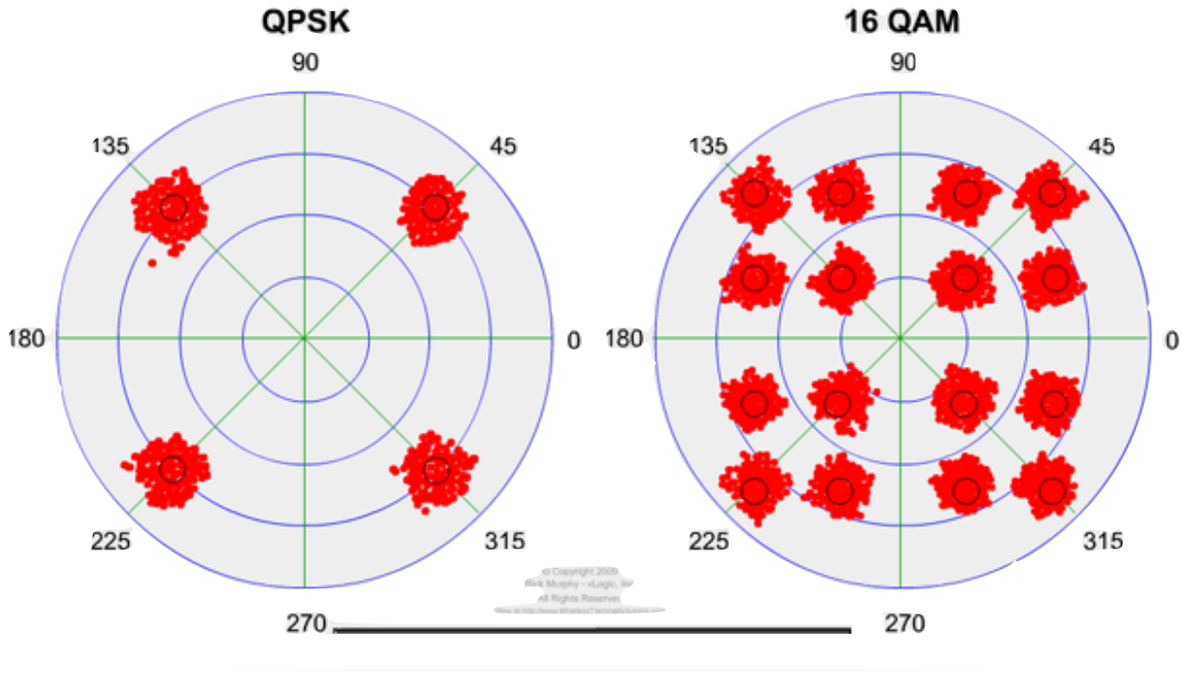


SNR~EVM

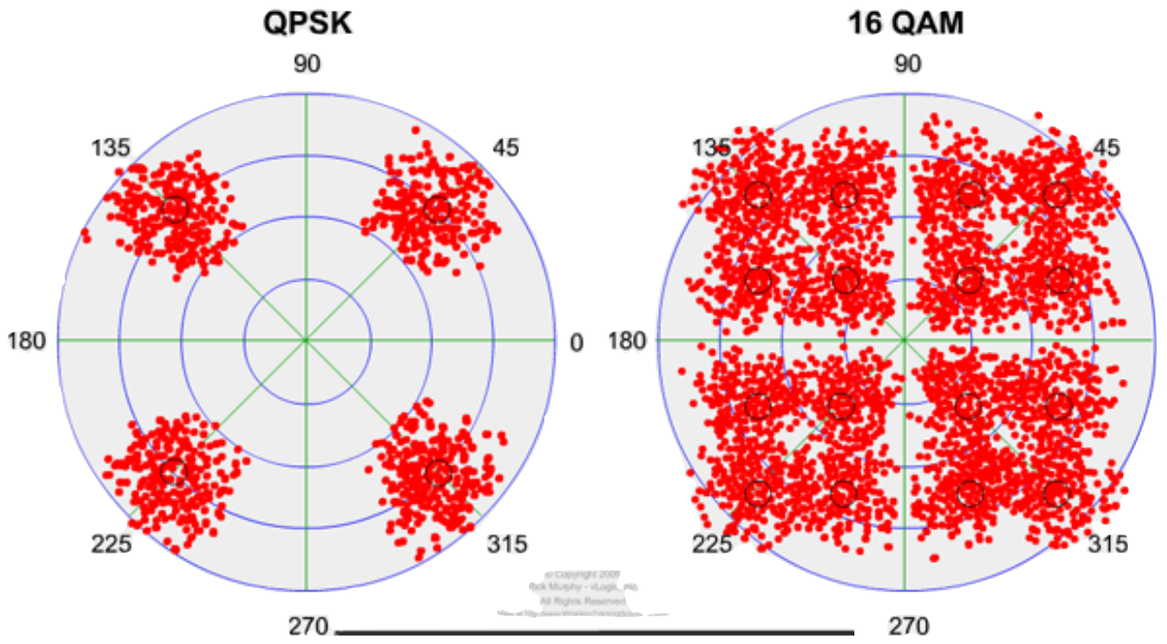
SNR ≈ 30 dB



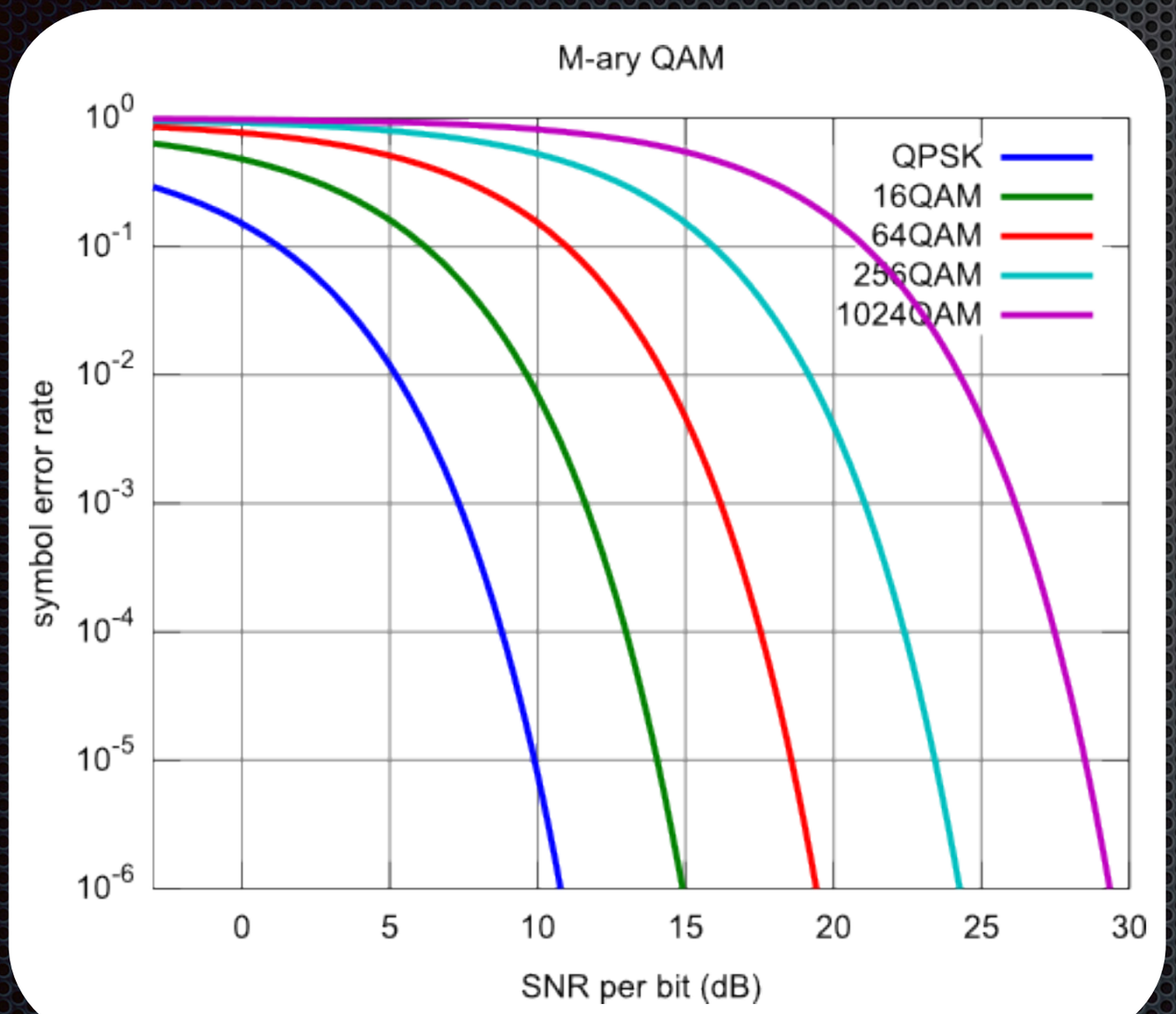
SNR ≈ 15 dB

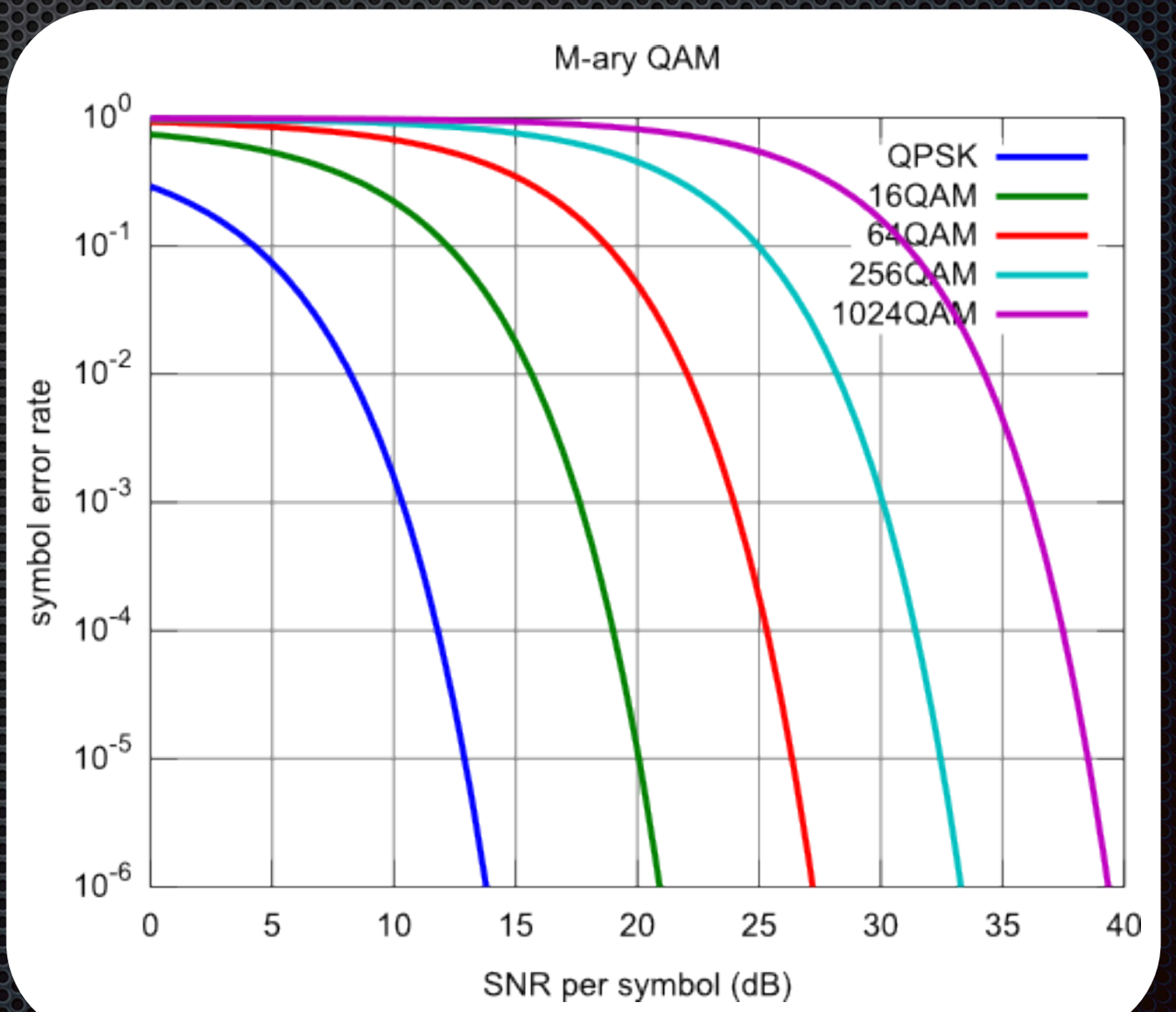


SNR ≈ 10 dB

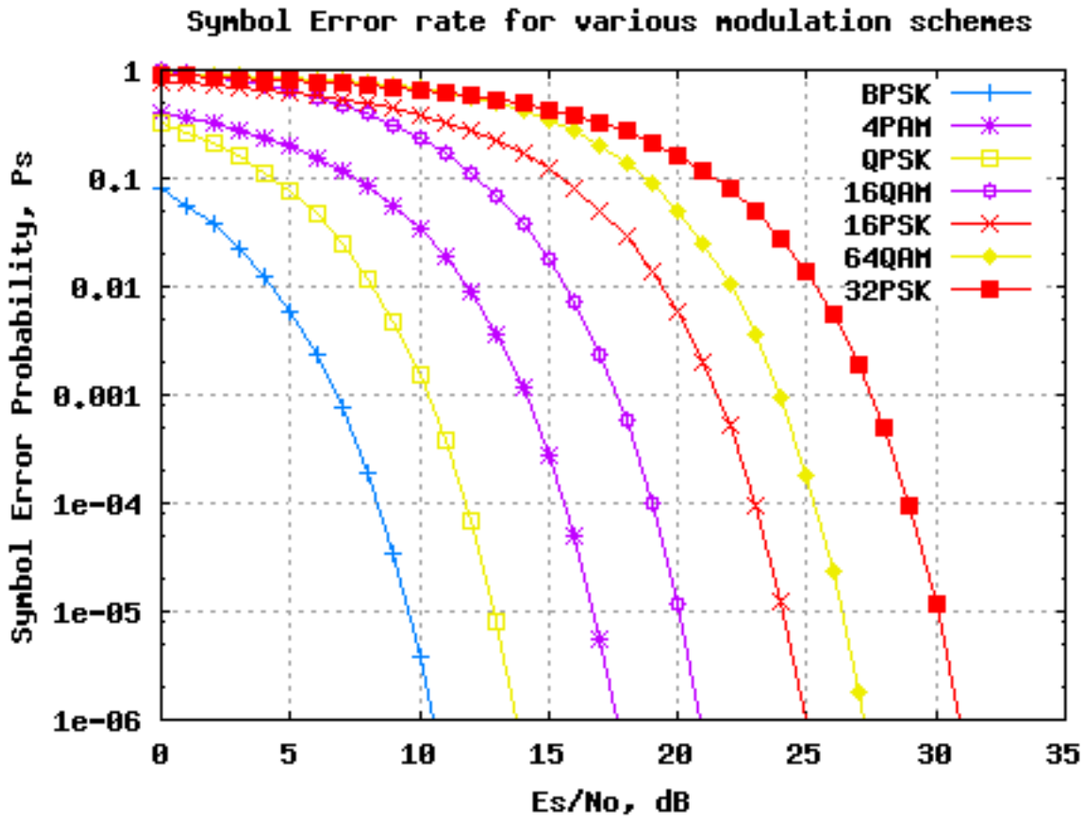


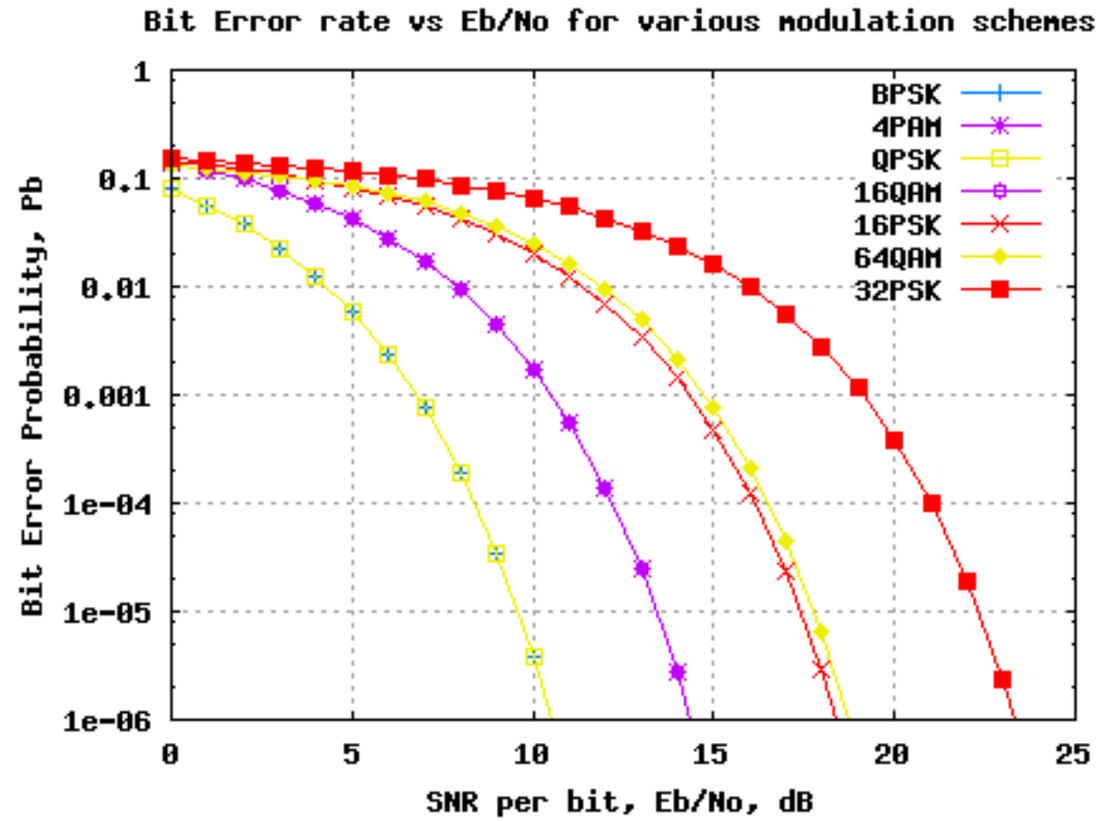
Performance of QAM



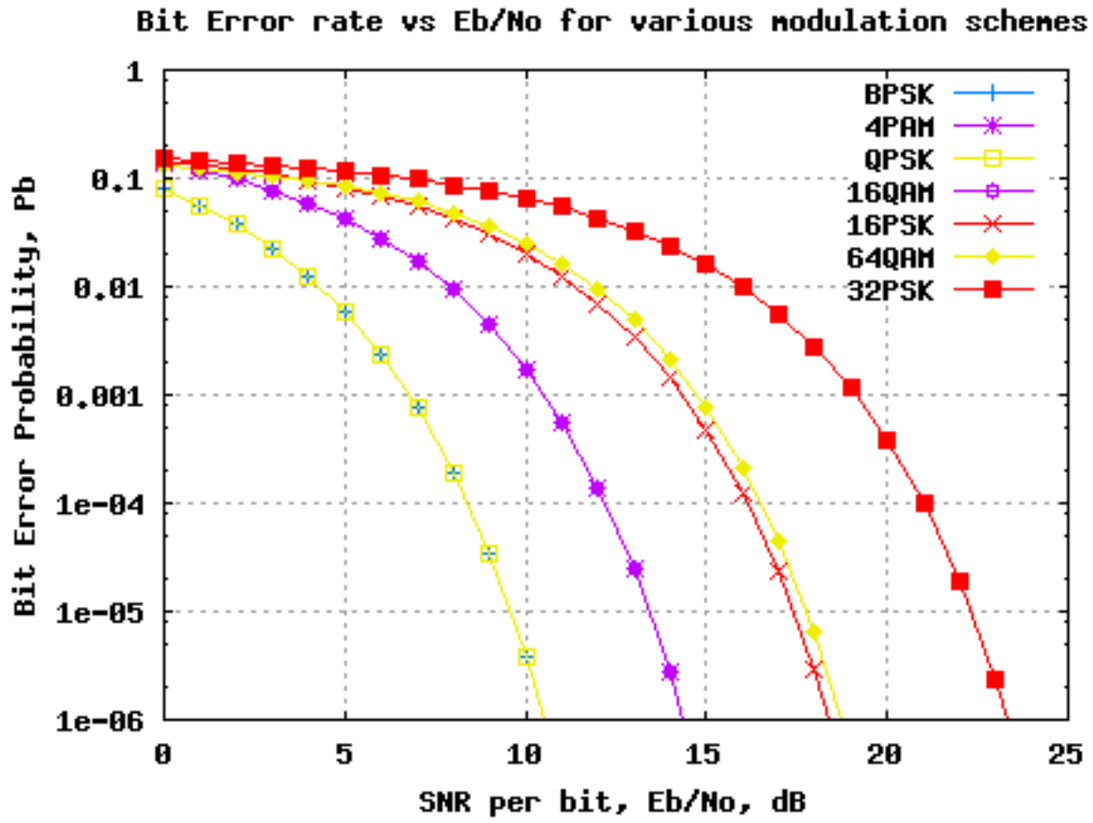


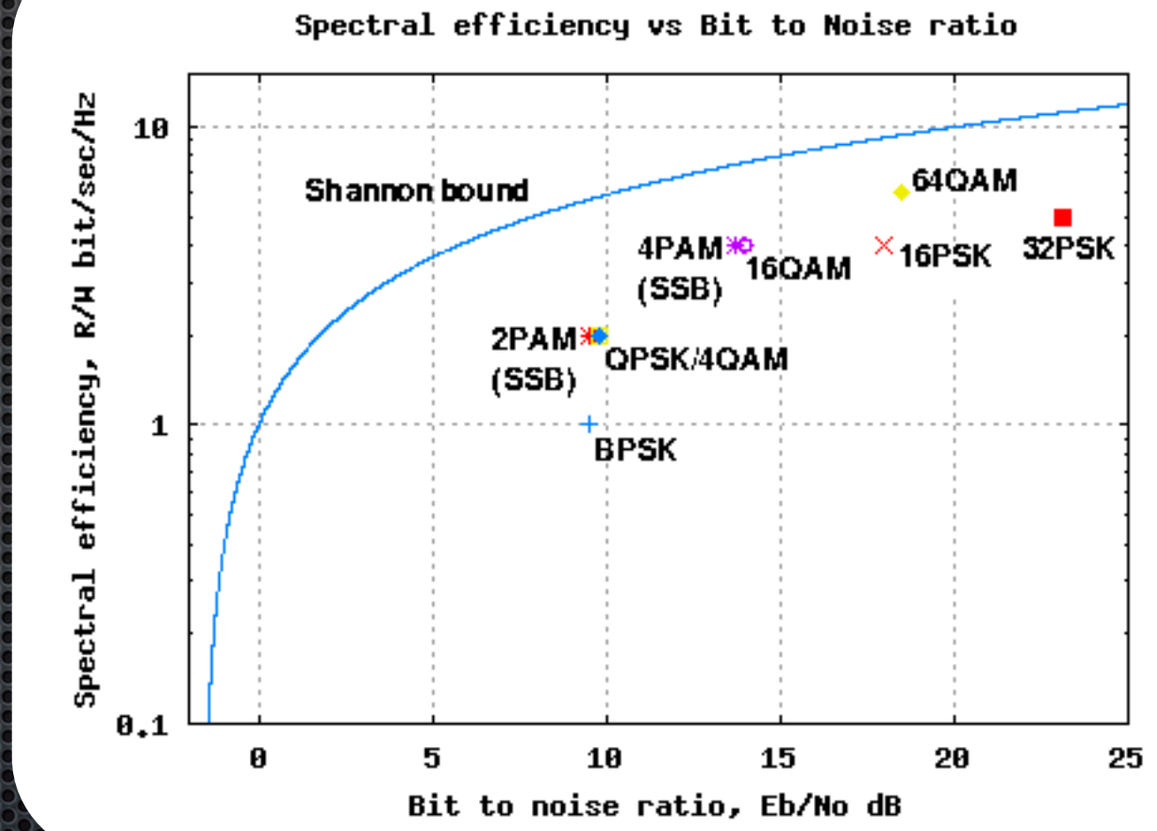
Performance of Modulations





Performance of Modulations





Performance of Modulations

Digital Modulation scheme	Symbol time, second	Bit Rate, bits/second	Bandwidth, Hz	Capacity, (bits/ second/ Hz)	Eb/No, dB required for Ps = 10^-5
BPSK	T	1/T	1/T	1	9.5
2-PAM (SSB BPSK)	T	1/T	1/2T	2	9.5
QPSK	T	2/T	1/T	2	9.8
4-QAM	T	2/T	1/T	2	9.8
4-PAM (SSB)	T	2/T	1/2T	4	13.7
16-QAM	T	4/T	1/T	4	14
16-PSK	T	4/T	1/T	4	18
32-PSK	T	5/T	1/T	5	23.1
64-QAM	T	6/T	1/T	6	18.5