Lecture 21

Nov. 25, 2016

Binary → M-ary

Efficient Manner

- TX design
- RX design
- Performance

$\{m_i\}_{i=1}^{M} \rightarrow \{s_i(t)\}_{i=1}^{M}$

$\{\phi_j\}_{j=1}^{k}$: basis functions

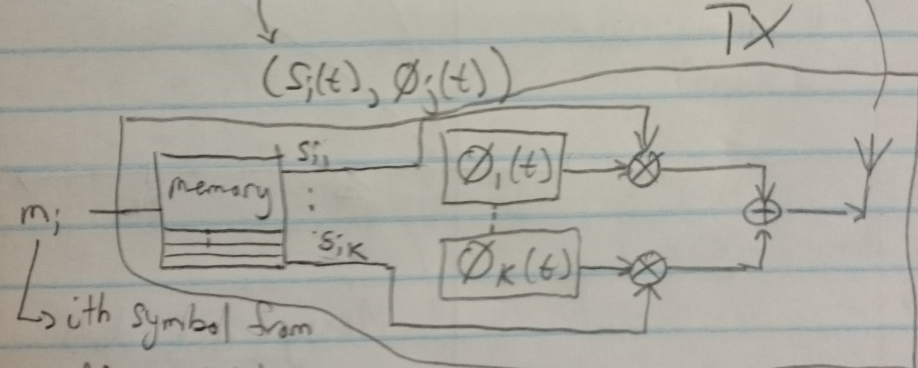
$k \leq M$ often $k \ll M$.

Ex: m-QAM $k=2$

$$S_i(t) = \sum_{j=1}^{k} S_{ij}\phi_j(t)$$

$i = 1, \ldots M$

$j = 1 \ldots k$



m_i → ith symbol from M possibilities → ($\log_2 M$ bits of info)

Size of memory $M \times K$

Ex: 1024 QAM

$$S_i(t) = A_i \cos(2\pi f_c t + \theta_i), \quad i = 1, \dots, 1024$$

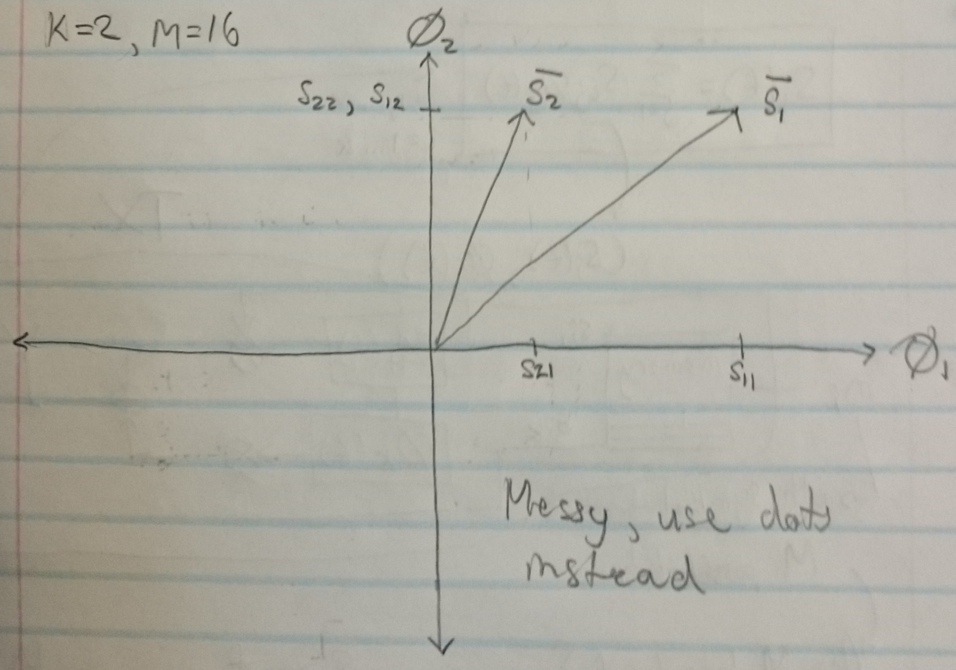
$$\phi_1(t) = \sqrt{\tfrac{2}{T}} \cos 2\pi f_c t$$
$$\phi_2(t) = \sqrt{\tfrac{2}{T}} \sin 2\pi f_c t$$

$$M = 2$$

$$S_i(t) = S_{i1}\phi_1(t) + S_{i2}\phi_2(t) \quad i = 1, \dots, 1024$$

$$1024 \times 2 = 2048$$
$$M \times K$$

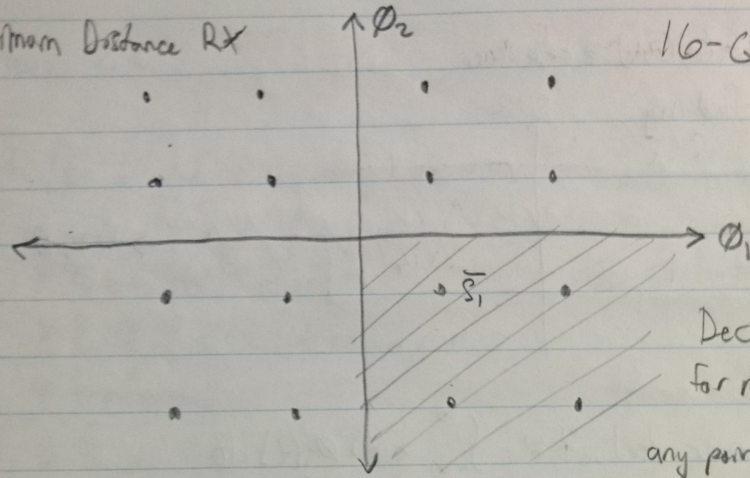
Ex:
$K=2$, $M=16$



Messy, use dots instead

Minimum Distance RX

16-QAM



Decision region for m_1

any point in that region is closer to $\bar{s}_1$ than $\bar{s}_\ell$, $\ell \neq 1$

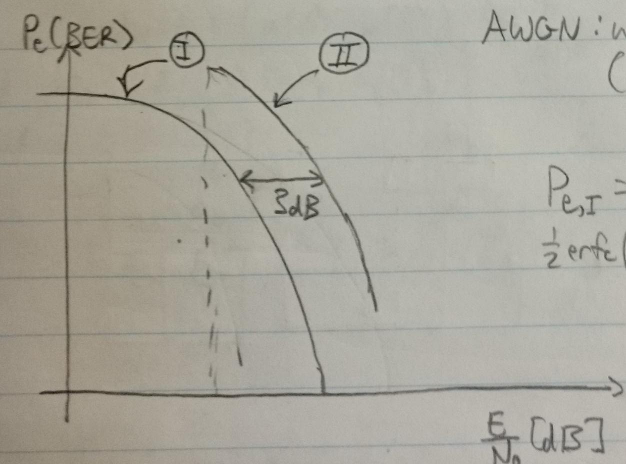
Signal Constellation

set of all the possible signal points (vectors)

Antipodal

(I) $P_{e,I} = \frac{1}{2}\,\mathrm{erfc}\left(\sqrt{\frac{E}{N_0}}\right)$

(II) $P_{e,II} = \frac{1}{2}\,\mathrm{erfc}\left(\sqrt{\frac{E}{2N_0}}\right)$



AWGN: waterfall (exponential decrease)

$P_{e,I} = P_{e,II}$

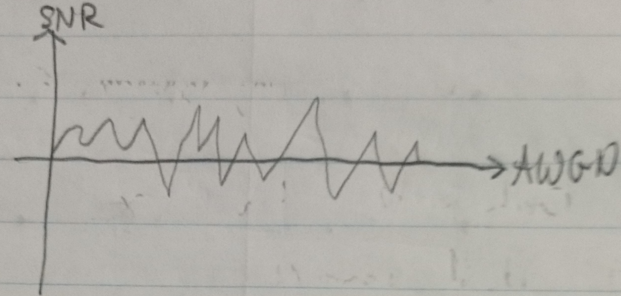
$\frac{1}{2}\,\mathrm{erfc}\left(\sqrt{\frac{E}{N_0}}\right)_I = \frac{1}{2}\,\mathrm{erfc}\left(\sqrt{\frac{E}{2N_0}}\right)_{II}$

$\left(\sqrt{\frac{E}{N_0}}\right)_I = \left(\sqrt{\frac{E}{2N_0}}\right)_{II}$

$2\left(\frac{E}{N_0}\right)_I = \left(\frac{E}{N_0}\right)_{II}$

AWGN → exp dec

fading



Inner Product = $\int_{-\infty}^{\infty} x(t)\, \phi_j(t)\, dt$

$= \int_0^T x(t)\, \phi_j(t)\, dt$