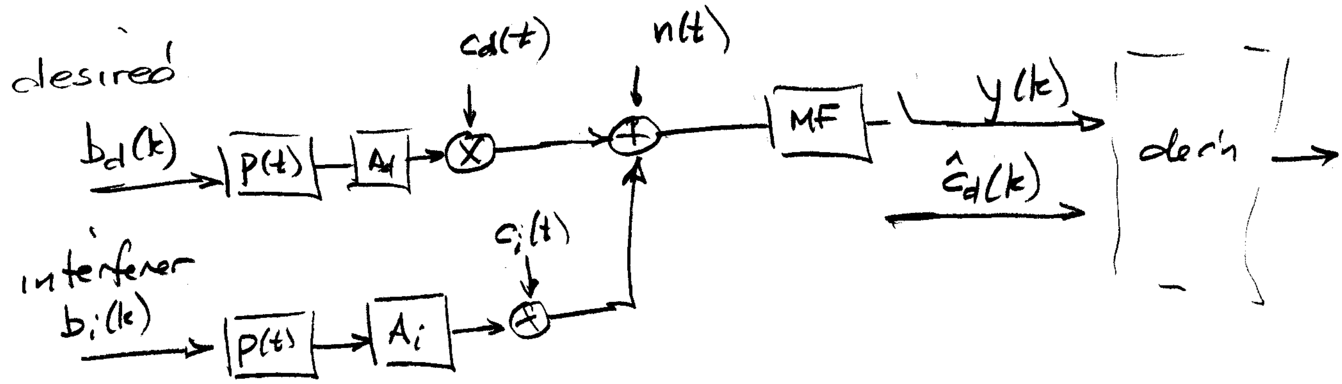
4.6 Interference

- Interference among users is one of the primary themes of this course. Here we will take a first look at it, to see what happens if we don't take preventive measures.
- Model – flat fading for simplicity, synch symbols



$$y = c_d A_d b_d + c_i A_i b_i + n$$

$$A_d = \sqrt{2E_s} \qquad A_i = \sqrt{2E_s/\Lambda}$$

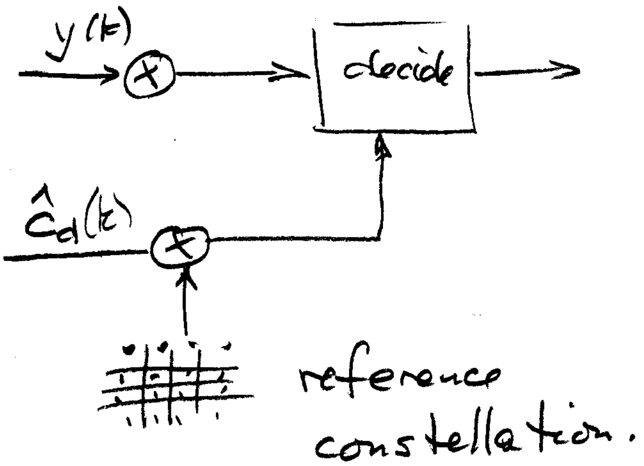
b_d, b_i not necess $|b| = 1$

$\sigma_{c_d}^2 = \sigma_{c_i}^2 = 1/2$

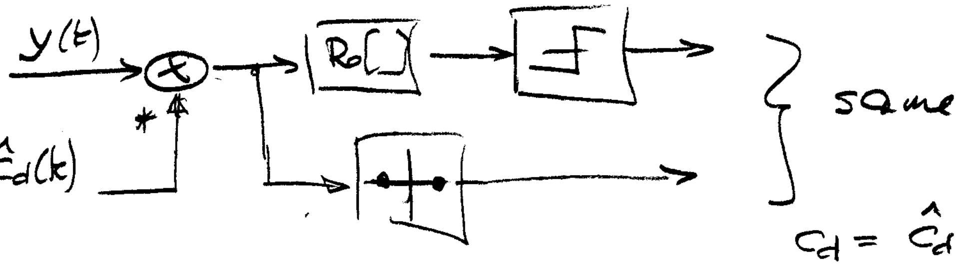
Λ is SIR

$\sigma_n^2 = N_0$

- Detection, if interferer is ignored



- For simplicity, assume that desired user is BPSK, so that metric in Section 4.1 is the usual $\mathrm{Re}[y\, \hat{c}_d^*]$.



$$c_d = \hat{c}_d + e_d$$

$$y = c_d A_d b_d + c_i A_i b_i + n_i$$

is conditionally Gaussian, conditioned on b_d, b_i.

More precisely, conditioned on $|b_d|$, $|b_i|$, since phase of b_d, b_i is absorbed in random phase of c_d, c_i. Implication: if interferer is PSK, then interference is unconditionally Gaussian, and you can treat it as noise.

- Get the conditional corr'n coeff.

$$\sigma_y^2 = A_d^2 |b_d|^2 \sigma_{c_d}^2 + A_i^2 |b_i|^2 \sigma_{c_i}^2 + \sigma_n^2$$

$$\sigma_{yc_d}^2 = \frac{1}{2}\overline{\left((\hat{c}_d + e_d) A_d b_d + c_i A_i b_i + n_i\right) \hat{c}_d^*}$$

$$= \sigma_{\hat{c}_d}^2 A_d b_d$$

$$\rho = \frac{\sigma_{\hat{c}_d}^2 A_d b_d}{\sqrt{\left(A_d^2 \underbrace{|b_d|^2}_{1} \sigma_{c_d}^2 + A_i^2 |b_i|^2 \sigma_{c_i}^2 + \sigma_n^2\right) \sigma_{\hat{c}_d}^2}}$$

and conditional BER

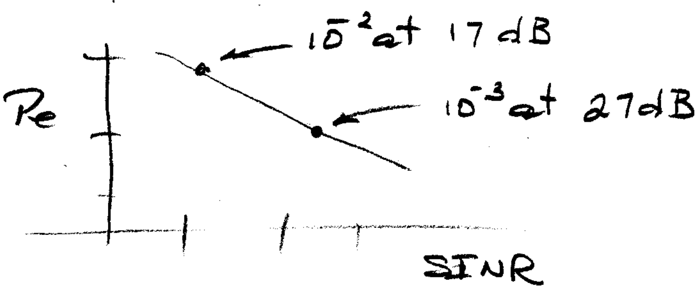
$$P_{e\,cond} = \frac{1}{2}(1-\rho)$$

We see:

- Larger $|b_i|^2$ values reduce ρ, increase BER. Another way of saying the interference is stronger with high-amplitude symbols.
- If $|b_i|^2 = \text{const}$, for PSK, then it's like Gaussian noise.
- The total noise-like disturbance is

$$\underbrace{A_i^2\,|b_i|^2\sigma_{c_i}^2}_{\text{interference power}} + \underbrace{\sigma_n^2}_{\text{noise power}}$$

so interference must be low. Recall BER curves



The total interference and noise must be <u>very</u> low.

space cochannel cells enough to ensure

$$\frac{A_i^2}{A_d^2} + \frac{\sigma_n^2}{A_d^2} = \Lambda^{-1} + \Gamma^{-1} \text{ is small.}$$