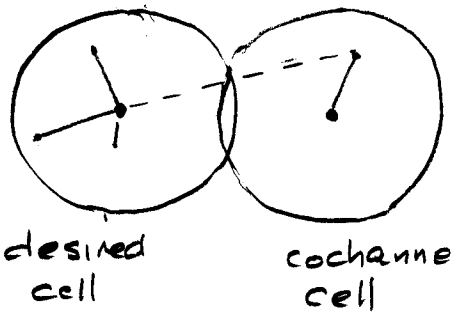
APPENDIX A : MUD AND CDMA CAPACITY

- Consider a simple CDMA system as described in [Gilh91], and focus on the uplink



Model:

- Each path experiences path loss, shadowing (from occlusions) and fading (interference among scattered components).
- Each mobile connected to the closest base.
- Perfect power control compensates for path loss, shadowing between mobile and own base
- Dual diversity at base
- Rate 1/2 convolutional code
- Speech activity factor reduces contributions to interference.
- Sectorization

- Central result: the E_b/N_0 for reception of any user signal is a random variable, given by

$$\gamma_b = \frac{W/R}{\sum_{i=1}^{N_s-1} \chi_i + \frac{I}{S} + \frac{\eta}{S}}$$

W bandwidth R bit rate W/R processing gain

$\chi_i = 1$ if user i transmitting (prob α) else 0, N_s users/sector

I total other cell interference

S ideal power each user seen at own base

I/S Gaussian, mean $0.247 N_s$, var $0.078 N_s$

η thermal noise power in bandwidth W

η/S design parameter, about 1.25

- What is the probability that $\gamma_b \le \gamma_t$, a threshold?

Define $\delta = \frac{W/R}{\gamma_t} - \frac{\eta}{S}$

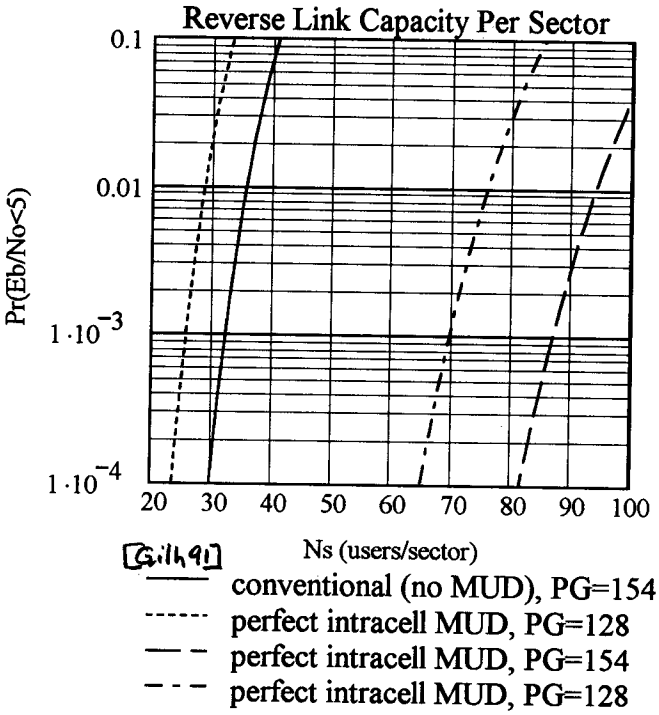
Use binomial $\sum_{\delta} \chi_i$, Gaussian I/S:

$$Pr[\gamma_b \le \gamma_t] = \sum_{k=0}^{N_s-1} \binom{N_s-1}{k} \alpha^k (1-\alpha)^{N_s-1-k} Q\left(\frac{\delta - k - 0.247 N_s}{\sqrt{0.078 N_s}}\right)$$

- Modify for use of own-cell perfect MUD:

$$\gamma_b = \frac{W/R}{\frac{I}{S} + \frac{\eta}{S}} \qquad \text{(no intracell MAI)}$$

$$\Pr[\gamma_b \le \gamma_t] = Q\left(\frac{\delta - 0.247 N_s}{\sqrt{0.078 N_s}}\right)$$



processing gains:

$\frac{W}{R_1} = 153.75$

$\frac{W}{R_2} = 128.125$

speech activity factor:

$\alpha = 0.375$

noise power/user power:

$\frac{\eta}{S} = 1.25$

$W = 1.23$ MHz

$R_1 = 8$ ksym/s

$R_2 = 9.6$ ksym/s

Capacity increases by factor of 2.5 to 2.7

- Note N_s in typical systems is about half the value shown, because of
  - imperfect power control
  - multiple connections in soft handoff
  - etc

but the argument remains.