Example 9.7

Evaluate four different cellular radio standards, and choose the one with the maximum radio capacity. Assume $n = 4$ propagation path loss.

System A: B_c = 30 kHz, $(C/I)_{min}$ = 18 dB
System B: B_c = 25 kHz, $(C/I)_{min}$ = 14 dB
System C: B_c = 12.5 kHz, $(C/I)_{min}$ = 2 dB
System D: B_c = 6.25 kHz, $(C/I)_{min}$ = 9 dB

Solution

Consider each system for 6.25 kHz bandwidth, and use Equation (9.23)

System A; B_c = 6.25 kHz, $(C/I)_{eq}$ = 18 – 20 log (6.25/30) = 31.680 dB
System B; B_c = 6.25 kHz, $(C/I)_{eq}$ = 14 – 20 log (6.25/25) = 26.00 dB
System C; B_c = 6.25 kHz, $(C/I)_{eq}$ = 2 – 20 log (6.25/12.5) = –4 dB
System D; B_c = 6.25 kHz, $(C/I)_{eq}$ = 9 – 20 log (6.25/6.25) = 9 dB

Based on comparison, the smallest value of $(C/I)_{eq}$ should be selected for maximum capacity in Equation (9.22). System C offers the best capacity.

In a digital cellular system, C/I can be expressed as

$$\frac{C}{I} = \frac{E_b R_b}{I} = \frac{E_c R_c}{I} \tag{9.24}$$

where R_b is channel bit rate, E_b is the energy per bit, R_c is the rate of the channel code, and E_c is the energy per code symbol. From Equations (9.23) and (9.24) $n = 4$, the ratio of C/I to $(C/I)_{eq}$ of a different system is given as

$$\frac{\left(\frac{C}{I}\right)}{\left(\frac{C}{I}\right)_{eq}} = \frac{\frac{E_c R_c}{I}}{\frac{E_c' R_c'}{I'}} = \left(\frac{B_c'}{B_c}\right)^2 \tag{9.25}$$

The relationship between R_c and B_c is always linear, and if the interference level I is the same in the mobile environment for two different digital systems, then Equation (9.25) can be rewritten as

$$\frac{E_c}{E_c'} = \left(\frac{B_c'}{B_c}\right)^3 \tag{9.26}$$

Equation (9.26) shows that if B_c is reduced by half, then the energy code symbol increases eight times. This gives the relationship between E_b/N_0 and B_c in a digital cellular system.