Solution

Quiz 3 Mobile Communication

a) Suppose that a non-line-of-sight wireless channel at 1.9 GHz has an rms delay spread of 100 ns. Further, suppose the mobile terminal is moving with a speed of 70miles/hr. If a BPSK signal is transmitted with a bit rate of 22 Mbps, then give a complete description of the small-scale fading that this signal will undergo. (Flat or frequency selective and slow or fast)?

b) If the speed of the mobile is increased to 100km/hr, whether the channel will be frequency selective or flat? Explain.

$f_c = 1.9 \times 10^9$ Hz ; $\sigma_\tau = 100$ns ; $V = 70$ miles/hr

$V = 31.29$ m/s

$R_b = 22$ Mbps

(a) $R_b = R_s \Rightarrow T_s = 1/R_s$

$T_s = 1/22 \times 10^6 = \boxed{45\text{ns}}$

$\therefore \sigma_\tau > 0.2 T_s$ } Frequency Selective.

$100\text{ns} > 0.2(45\text{ns})$

$\lambda = c/f \Rightarrow \lambda = 3 \times 10^8 / 1.9 \times 10^9 = \boxed{0.1579\text{ m}}$

$f_m = V/\lambda = 31.29 / 0.1579 = \boxed{198.661\text{ Hz}}$

$T_c = \frac{0.423}{f_m} = \frac{0.423}{198.661} = \boxed{2.12\text{ ms}}$

$\therefore T_c >> T_s$ } Slow fading.

$2.12\text{ms} >> 45\text{ns}$

b) increasing speed doesn't effect the doppler ~~frequency~~ Coherance bandwidth $\}$ T_c, Channel will remain freq selective.

Quiz 4 Mobile Communication

Consider the following digital wireless systems,

System	Data Rate (kbps)	Modulation
USDC	48.6	π/4 DQPSK
GSM	270.833	GMSK
DECT	1152	GMSK

a) Estimate the maximum rms delay spread for each system for which no equalizer is required at the receiver (neglect channel coding). Note that GMSK has one bit per symbol and DQPSK has 2 two bits per symbol.

b) If GSM at 900MHz has a non line-of-sight communication with a level crossing rate of 3 crossing per second at a threshold ρ=-20dB, what can be predicted about the time-varying nature of the channel (fast or slow)?

part a:

(a) USDC: $K=2$, $T_s = \frac{2}{48.6} \Rightarrow \boxed{T_s = 41.15\mu s}$

$\frac{\sigma_\tau}{T_s} \leq 0.1 \Rightarrow \boxed{\sigma_{\tau max} = 4.1\mu s}$

(b) GSM: $K=1$, $T_s = \frac{1}{270.833} \Rightarrow \boxed{T_s = 3.69\mu s}$

$\frac{\sigma_\tau}{T_s} \leq 0.1 \Rightarrow \boxed{\sigma_{\tau max} = 369\,ns}$

(c) DECT: $K=1$, $T_s = \frac{1}{1152} \Rightarrow \boxed{T_s = 868ns}$

$\frac{\sigma_\tau}{T_s} \leq 0.1 \Rightarrow \boxed{\sigma_{\tau max} = 86.8ns}$

part b: $f_c = 900MHz$, $N_R = 3/sec$, $\rho = -20dB = 0.1$

$N_R = \sqrt{2\pi} f_m (0.1) e^{-(0.1)^2}$

$\boxed{f_m = 12.08Hz}$

$T_s = 1/R_b$

$T_s = 1/270.833$

$\boxed{T_s = 3.69\mu s}$

$T_c = \frac{0.423}{f_m}$

$T_c = \frac{0.423}{12.08}$

$\boxed{T_c = 0.035s}$

$T_c \gg T_s$ (slow fading)