Diversity Combining Techniques for Wireless Communication Systems

Robert Morelos-Zaragoza

San Jose State University

John G. Proakis | Masoud Salehi, *Fundamentals of Communication Systems*, Second Edition.

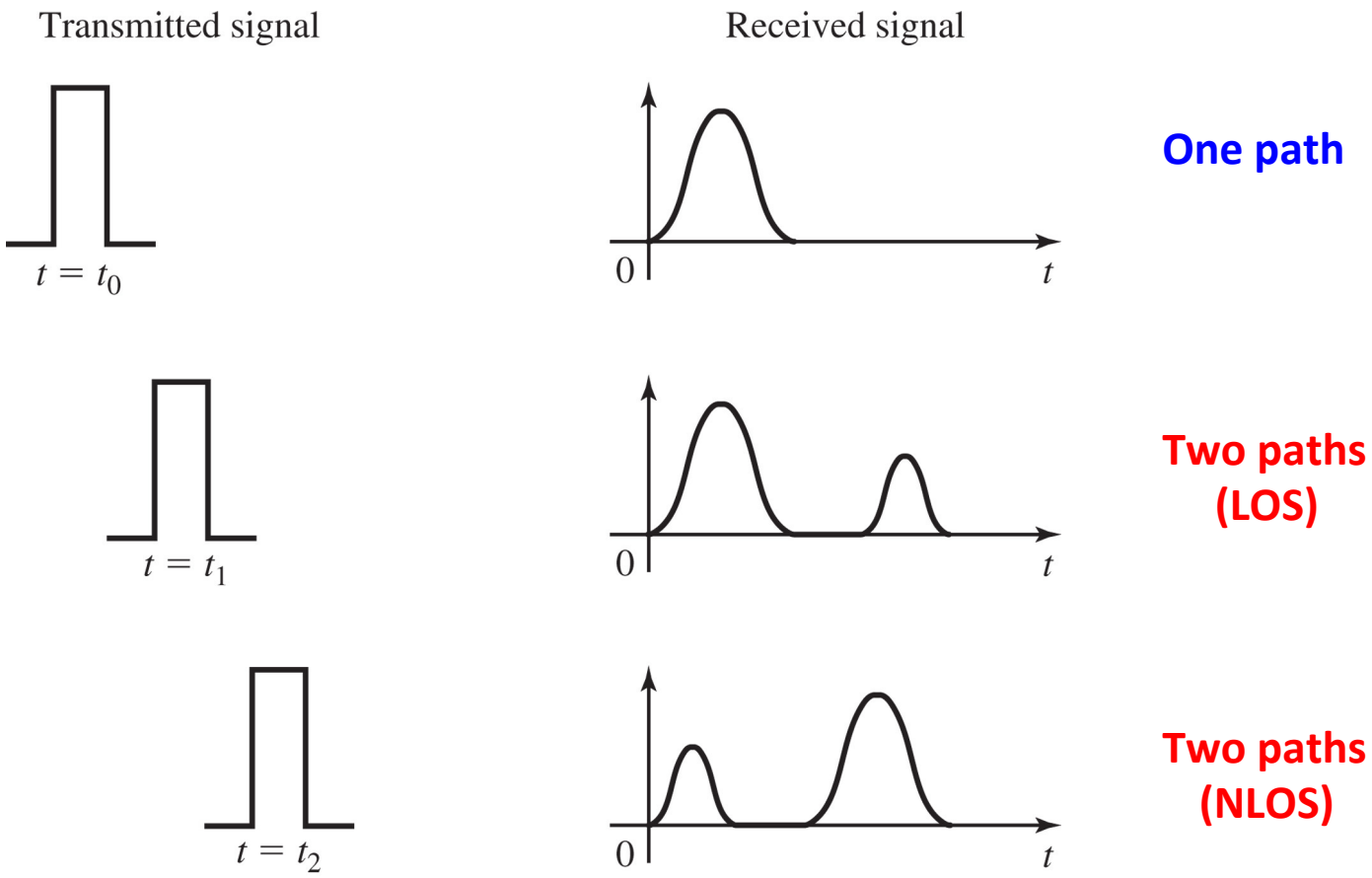


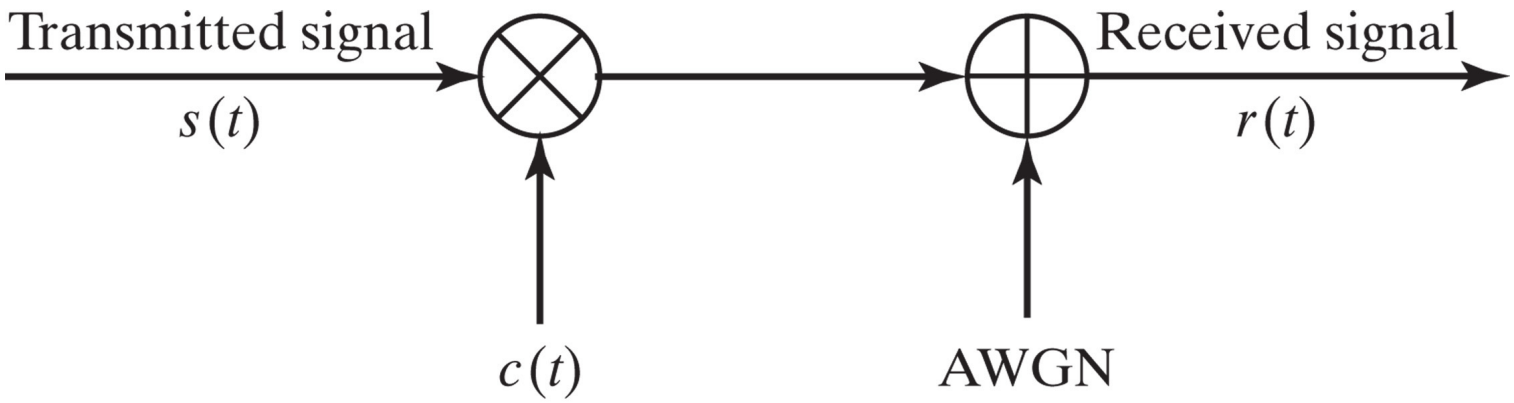
Figure 14.3 Illustration of ***time-variant channel-response*** characteristics.

Delay spread and Doppler spread

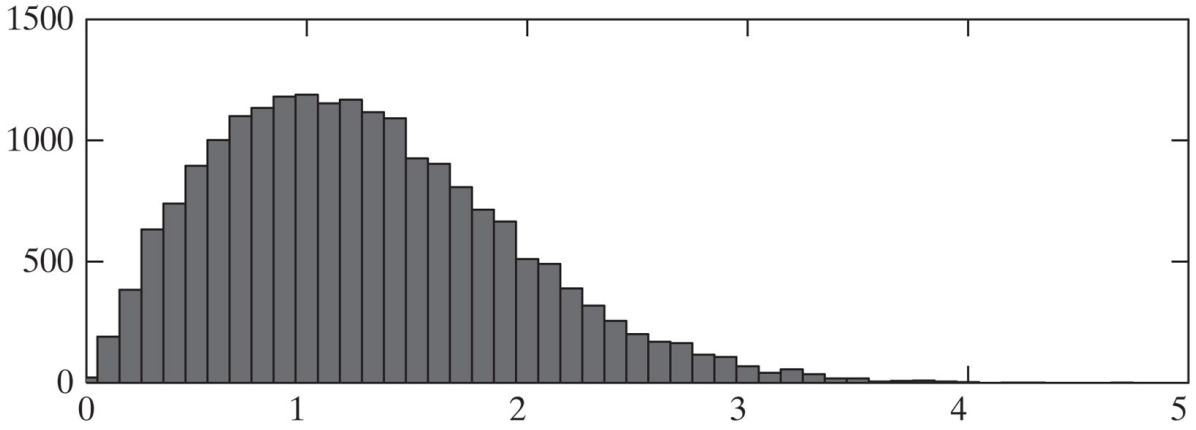
TABLE 14.1 MULTIPATH SPREAD, DOPPLER SPREAD, AND SPREAD FACTOR FOR SEVERAL TIME-VARIANT MULTIPATH CHANNELS

Type of Channel	Multipath Duration (sec)	Doppler Spread (Hz)	Spread Factor
Shortwave ionospheric propagation (HF)	$10^{-3} - 10^{-2}$	$10^{-1} - 1$	$10^{-4} - 10^{-2}$
Ionospheric propagation under disturbed auroral conditions	$10^{-3} - 10^{-2}$	$10 - 100$	$10^{-2} - 1$
Ionospheric forward scatter (VHF)	10^{-4}	10	10^{-3}
Tropospheric scatter	10^{-6}	10	10^{-5}
Mobile cellular (UHF)	10^{-5}	100	10^{-3}
Wireless indoor LANs at 5 GHz	10^{-7}	10^{2}	10^{-5}

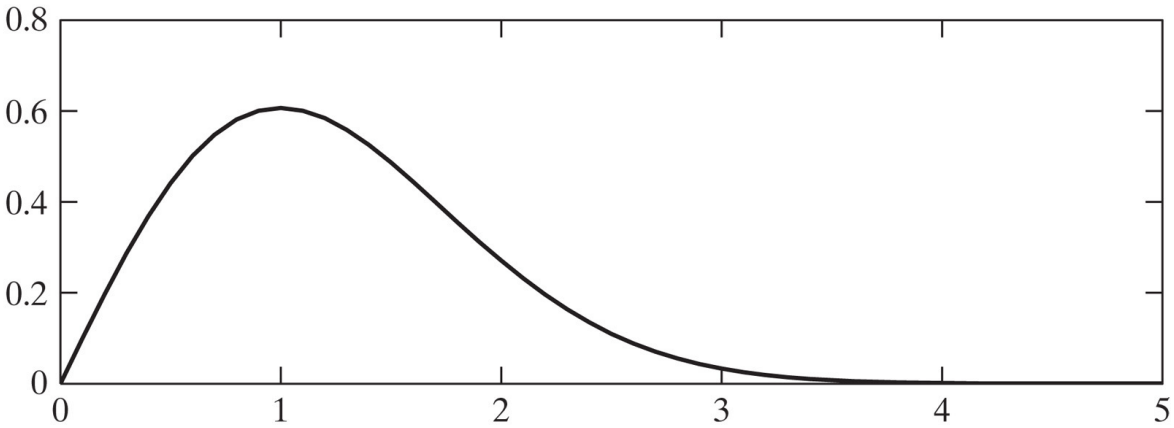
Flat time-varying fading channel



Rayleigh fading amplitude

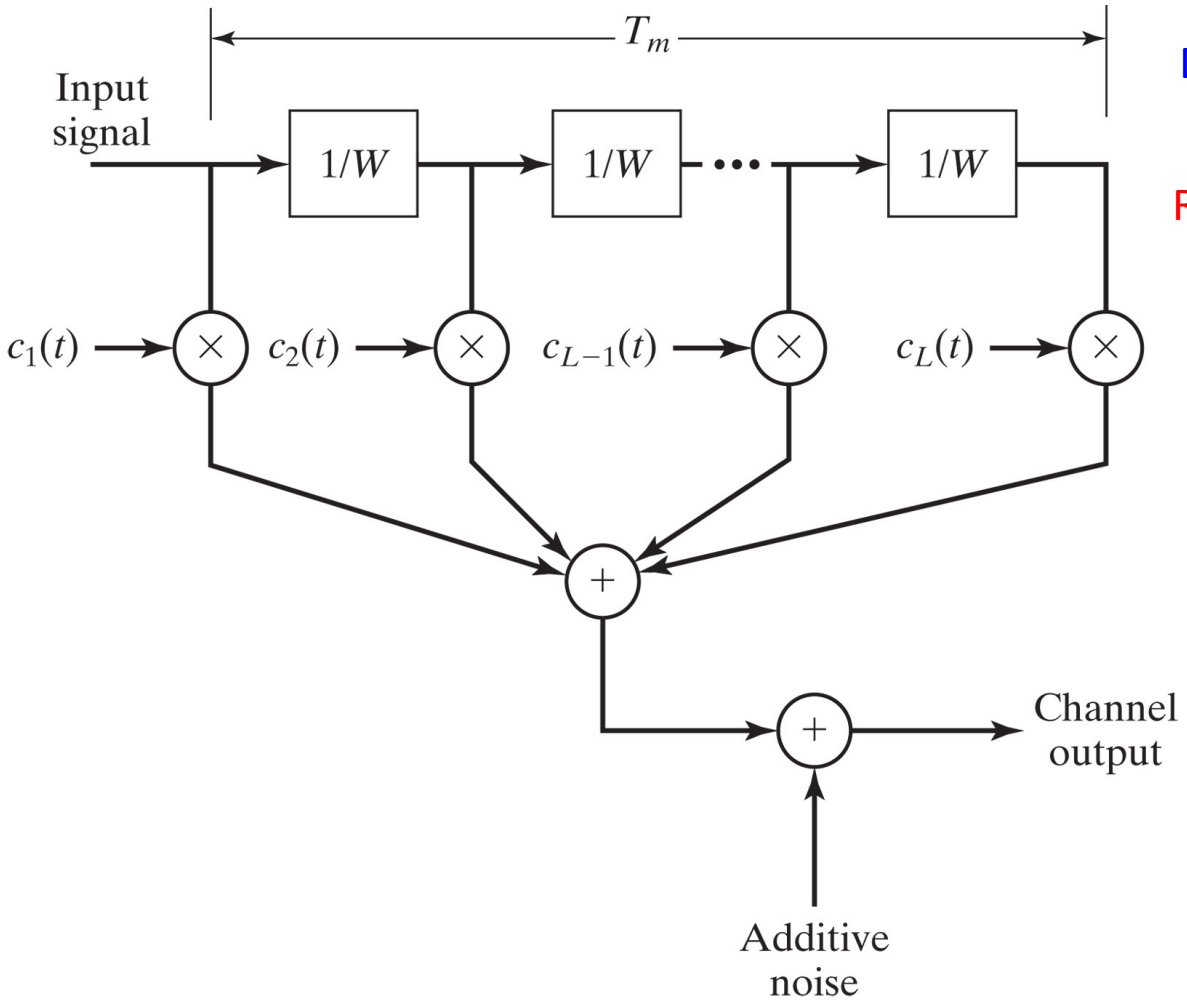


(a) Histogram for N=20,000 samples



(b) Rayleigh PDF

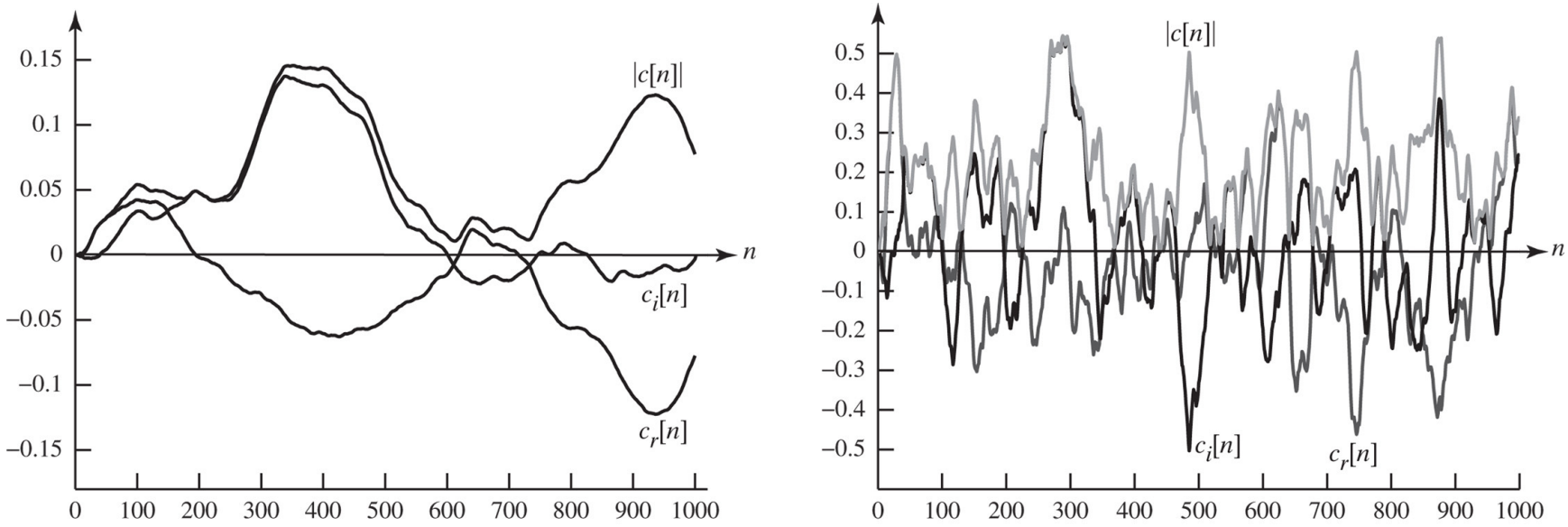
Multipath fading channel model



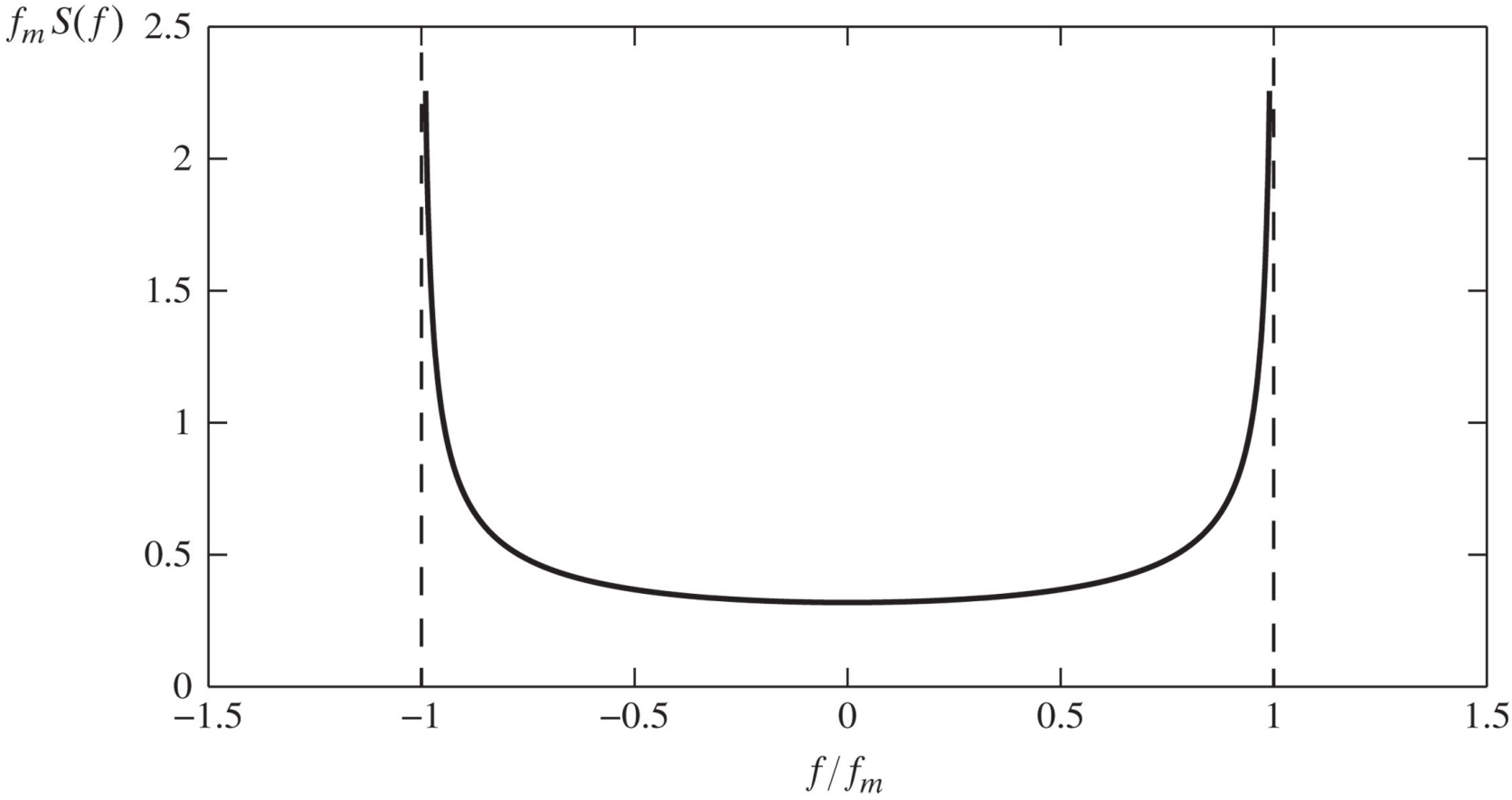
$T_m = (L\text{-}1)\,\tau$
Delay spread

$\tau = 1/W$
Resolution time

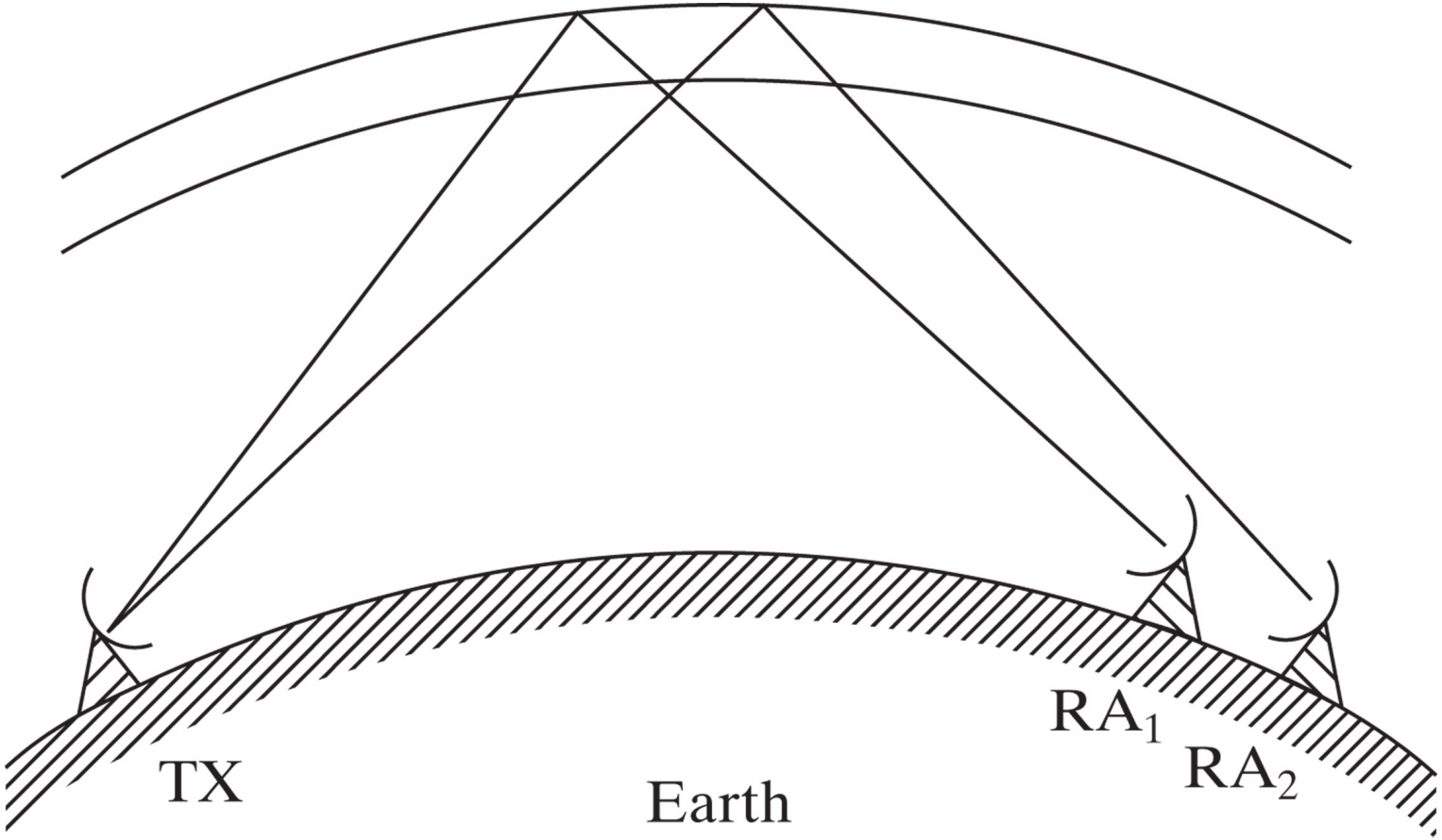
Path gains time variation



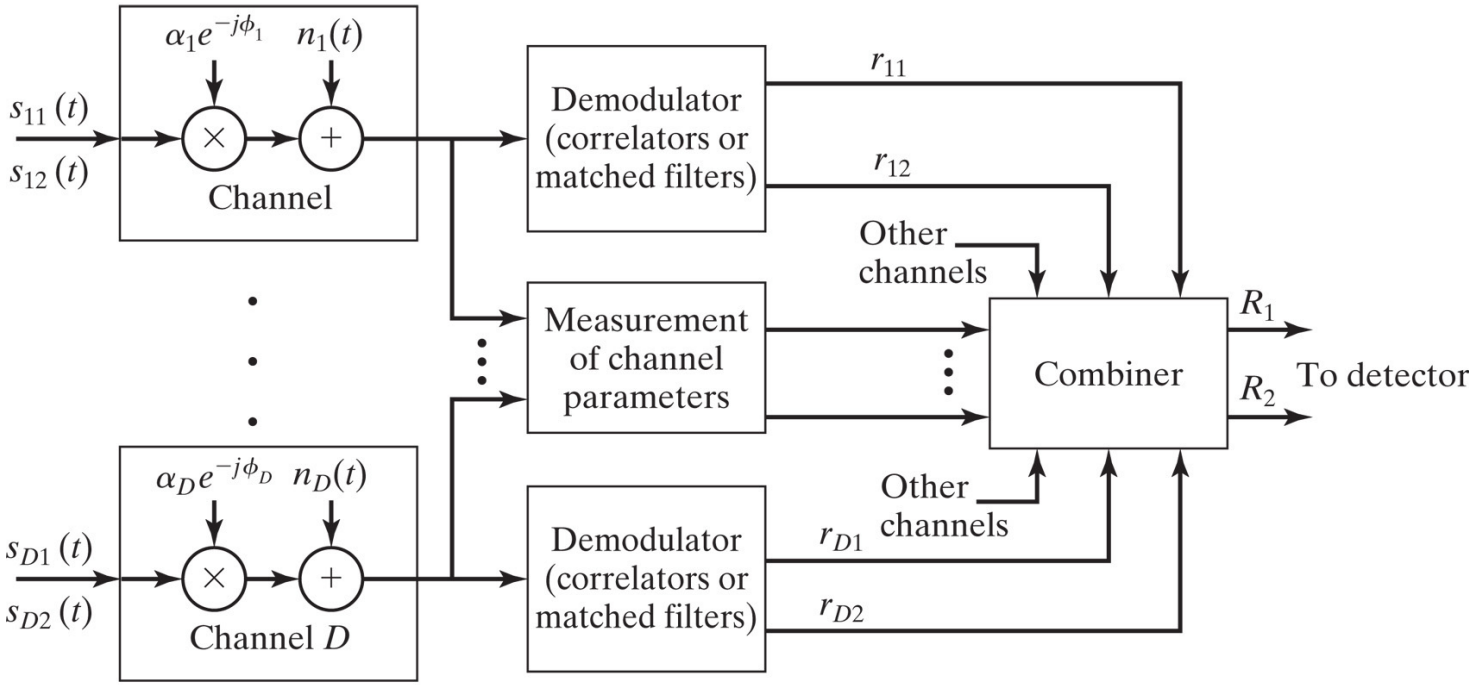
Doppler spectrum



Example with D=2 diversity branches



Diversity Combining

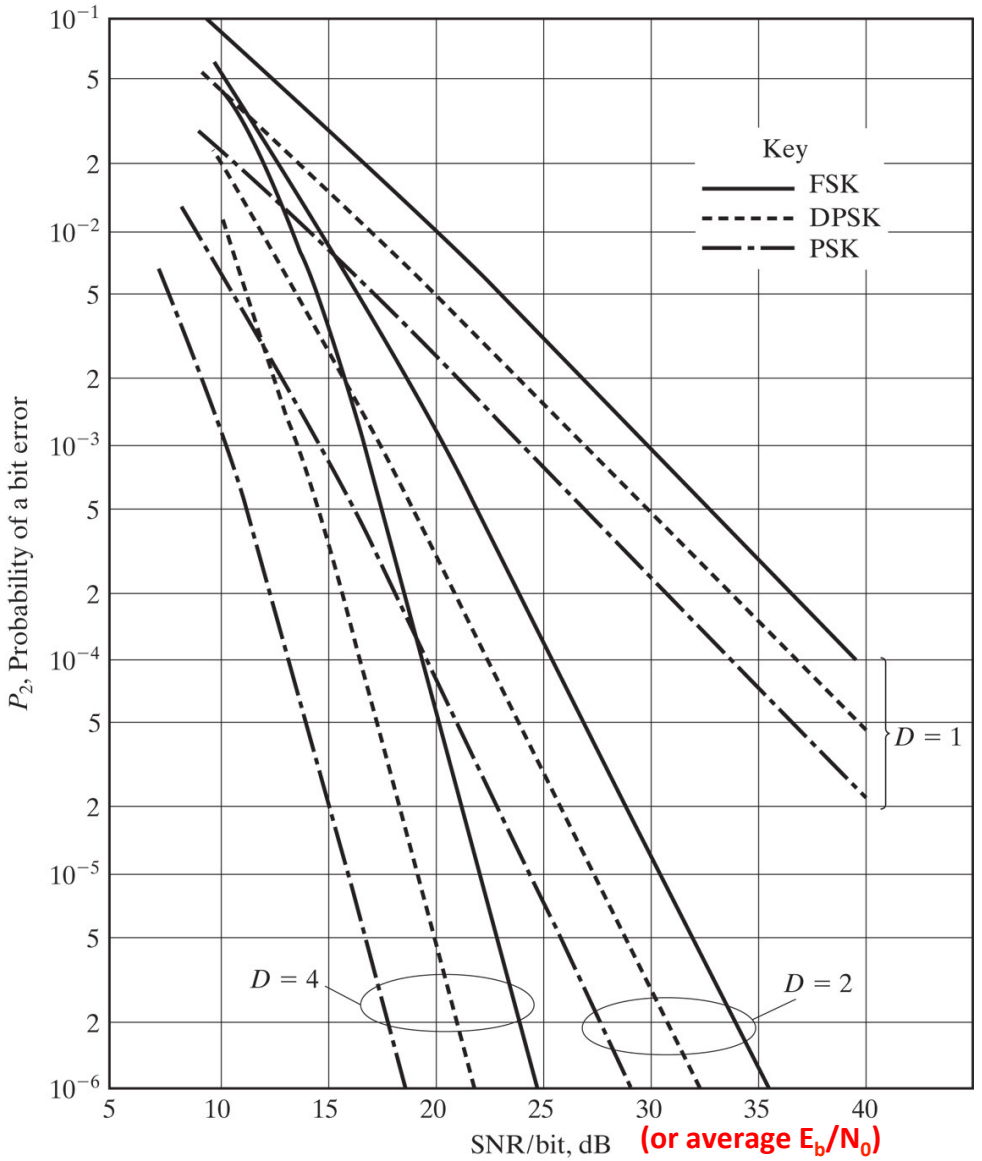


Equal gain combiner: $$R_m = \sum_{k=1}^{D} r_{km} e^{j\phi_k}, m = 1, 2$$

Maximal ratio combiner: $$R_m = \sum_{k=1}^{D} \alpha_k r_{km} e^{j\phi_k}, m = 1, 2$$

Square law combiner: $$R_m = \sum_{k=1}^{D} |r_{km}|^2, m = 1, 2$$

Figure 14.14 Performance of binary signaling with diversity.



Time diversity with ECC

Figure 14.15 Comparison of performance of repetition code with Golay (24, 12) code.