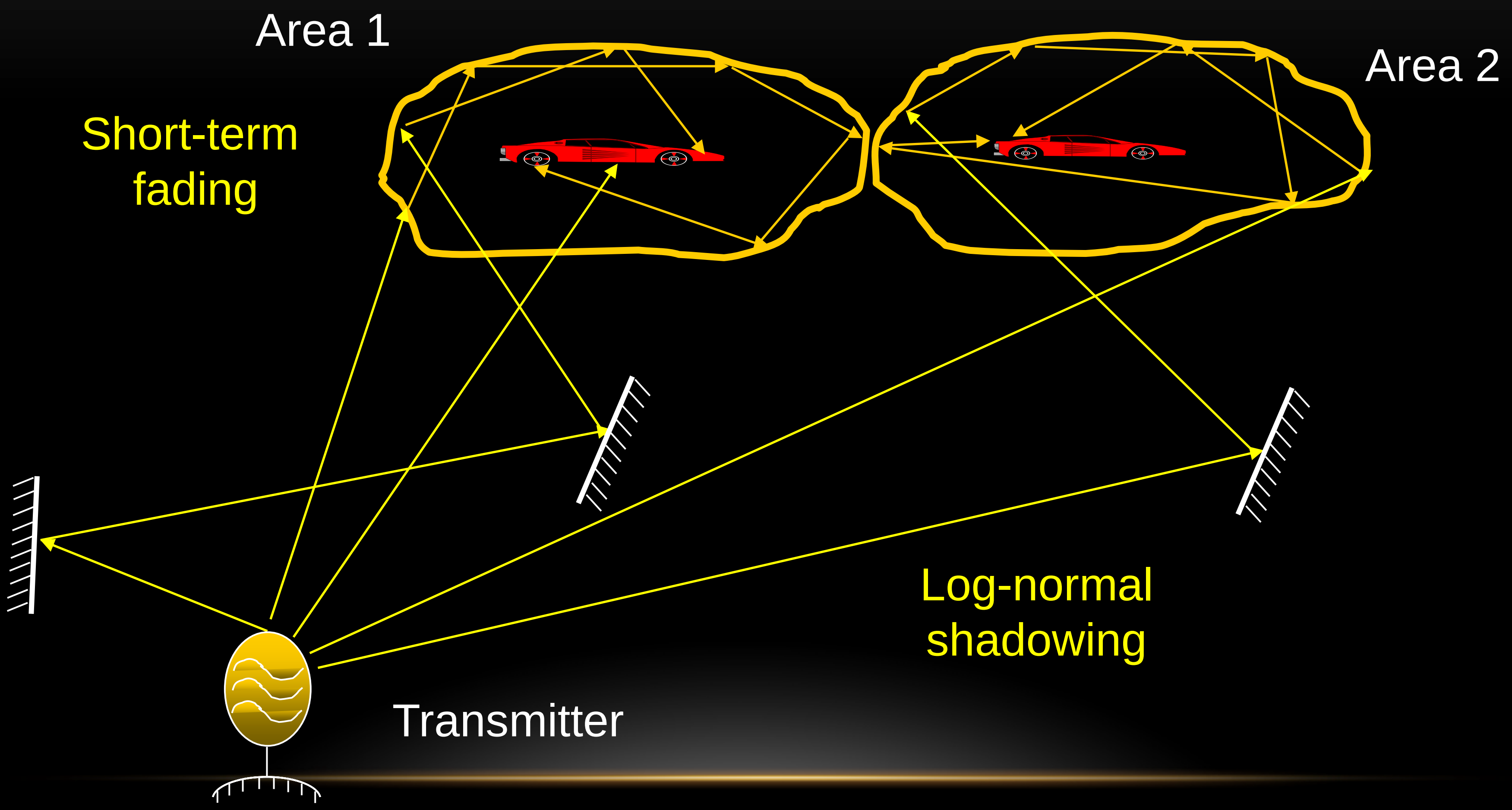
SHADOWING AND OUTAGE PROBABILITY

By: Vaibhav B. Joshi

WC – LAB 3

SHADOWING


Area 1
Area 2
Short-term
fading
Log-normal
shadowing
Transmitter

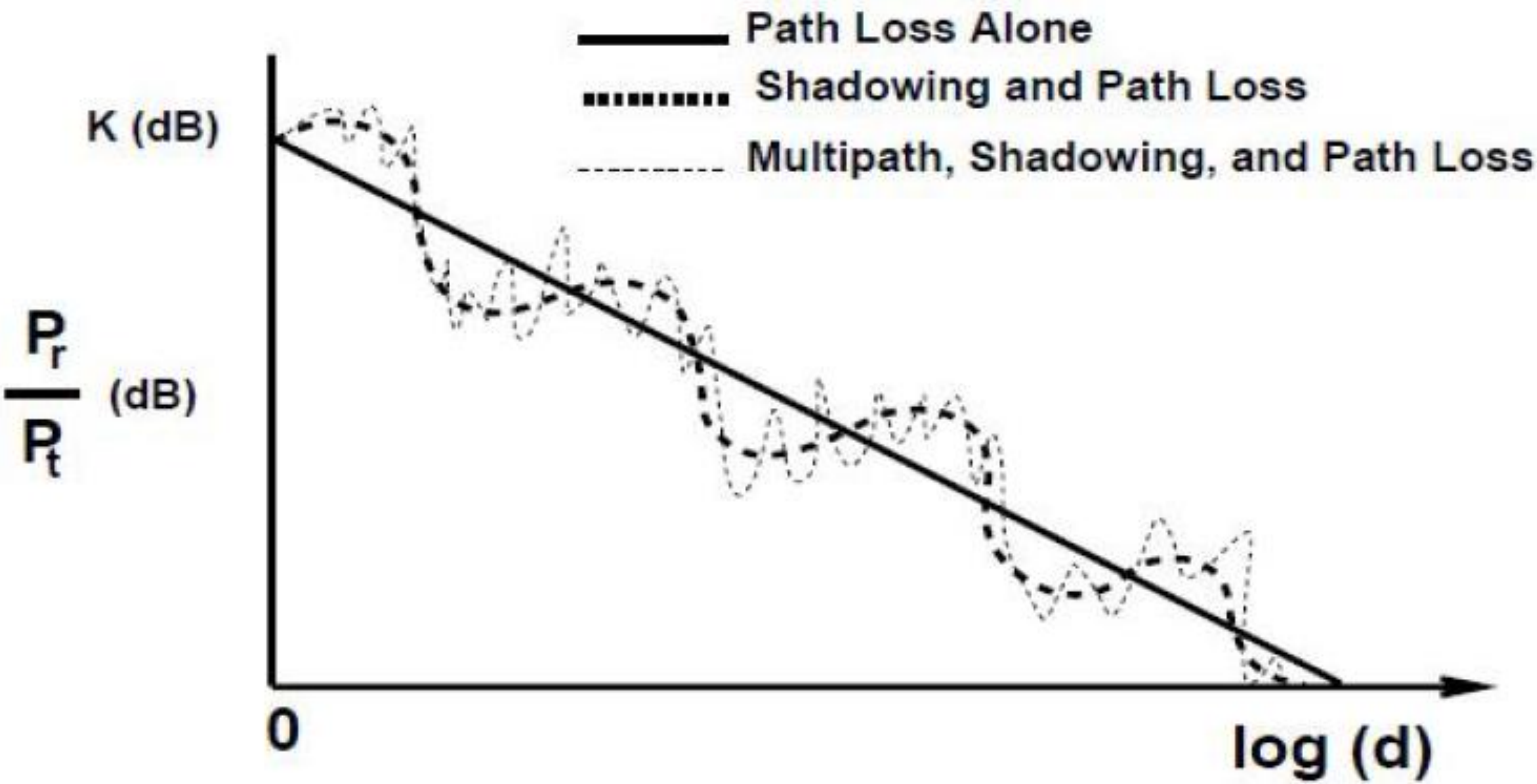


Fig.1.1 Path loss, shadowing and multipath versus distance

COMBINED PATH LOSS WITH SHADOWING

- $p_r dB = p_t dB + \ 10 \log_{10} K \ - 10\gamma \log_{10} \frac{d}{d_0} \ - \ \psi dB$
  - Here, ψdB is a Gaussian distribution with zero mean and σ^2 as variance.
  - γ is a path loss exponent.

$$\gamma = \frac{dF(\gamma)}{d\gamma}$$

$$F(\gamma) = \ \sum_{i=1}^{n} \left[M_{\{measured\}} \ - M_{\{model\}}\right]^2$$

$$M_{\{model\}} = K \ - 10\gamma \log_{10} d$$

$$K \ = 20 \log_{10} \frac{\lambda}{4\pi d_0}$$

$$\sigma^2 = \frac{1}{5} \sum_{i=1}^{n} \left[M_{\{measured\}} \ - M_{\{model\}}\right]^2$$

OUTAGE PROBABILITY

- To know at what minimum power below which the performance will become worse.
- We can dene outage probability for the minimum transmitted power and the distance, which is given as below.

$$p(P_r(d) \leq P_{min}) = 1 - Q(\frac{P_{min} - (P_t + 10log_{10}(K) - 10\gamma log_{10}(\frac{d}{d_0}))}{\sigma_{\psi_{dB}}})$$

$$Q(x) = p(x > z) = \int_z \frac{1}{\sqrt{2\pi}} e^{\frac{-y_2}{2}} dy$$

DATA FOR CALCULATION

- Consider an indoor scenario
  - $d_0 = 1m, \lambda = 0.3333$
  - Simplified path loss:

$$p_r dBm = p_t dBm + K \ - 10\gamma \log_{10} \frac{d}{d_0}$$

  - Combined path loss with shadowing

$$p_r dBm = p_t dBm + \ 10 \log_{10} K \ - 10\gamma \log_{10} \frac{d}{d_0} - \ \psi dB$$

DATA FOR CALCULATION

Distance from Transmitter	$M = \frac{P_r}{P_t}$
10	-70 dB
20	-75 dB
50	-90 dB
100	-110 dB
300	-125 dB

DATA FOR CALCULATION

- Outage probability: $p_t = 10mW, P_{\{min\}} = -110.5\ dBm$

$$p(P_r(d) \le P_{min}) = 1 - Q(\frac{P_{min} - (P_t + 10log_{10}(K) - 10\gamma log_{10}(\frac{d}{d_0}))}{\sigma_{\psi_{dB}}})$$

- Plot simplified path loss vs. Distance
- Plot combined path loss with shadowing vs. Distance
- Plot Outage probability vs. Distance

Thank you