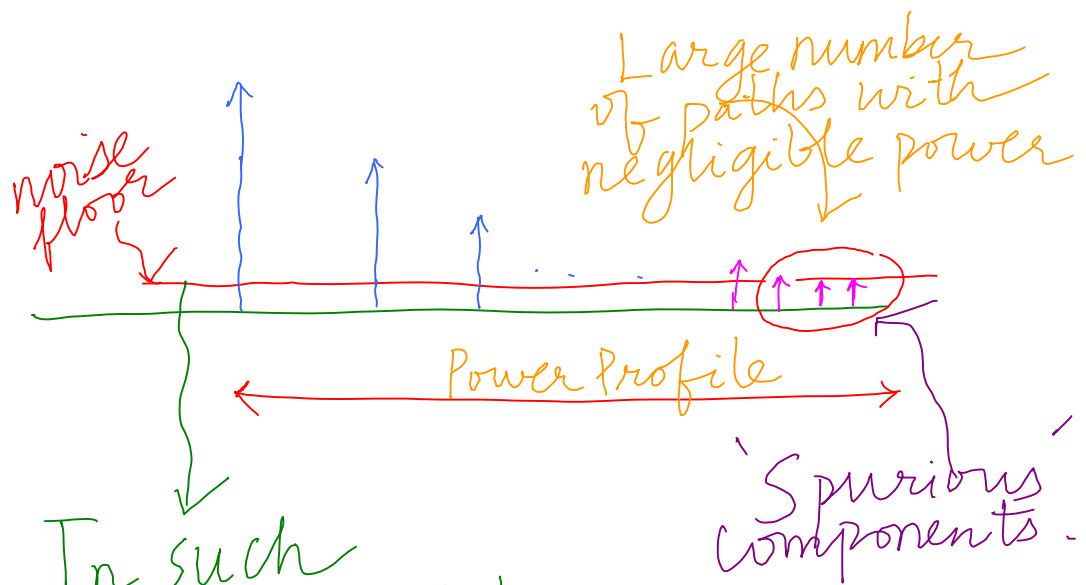




In such scenarios, max delay spread might not be an appropriate metric.

RMS Delay Spread .

↓ Root Mean Square (RMS)
Delay spread.

L multipath
components

$$\begin{array}{lcl} g_0 & - & \tau_0 \\ g_1 & - & \tau_1 \\ & \vdots & \\ g_{L-1} & - & \tau_{L-1} \end{array}$$

g_i = gain of i^{th} path
 τ_i = Delay of i^{th} path

Average Delay - $\bar{\tau}$

$$b_i = \frac{g_i}{\sum_{j=0}^{L-1} g_j}$$

Fraction of power in i^{th} path.

$$= \frac{\text{Power of } i^{\text{th}} \text{ path}}{\text{Total Power}}$$

average delay $\bar{\tau}$

$$= \frac{b_0 \tau_0 + b_1 \tau_1 + \dots + b_{L-1} \tau_{L-1}}{1}$$

weighing each delay τ_i by fraction of power b_i in i th path.

$$= \sum_{i=0}^{L-1} b_i \tau_i$$

$$= \frac{\sum_{i=0}^{L-1} g_i \tau_i}{\sum_{j=0}^{L-1} g_j}$$

$$\bar{\tau} = \frac{\sum_{i=0}^{L-1} g_i \tau_i}{\sum_{i=0}^{L-1} g_i}$$

average delay $\bar{\tau}$

$$\sigma_z^2 = b_0(z_0 - \bar{z})^2 + b_1(z_1 - \bar{z})^2 + \dots + \dots + b_{L-1}(z_{L-1} - \bar{z})^2$$

$$\sigma_z = \left(\sum_{i=0}^{L-1} b_i (z_i - \bar{z})^2 \right)^{1/2}$$

RMS Delay Spread

$$\sigma_z = \left(\frac{\sum_{i=0}^{L-1} g_i (z_i - \bar{z})^2}{\sum_{i=0}^{L-1} g_i} \right)^{1/2}$$

$$g_i = |a_i|^2$$

$$\sigma_z = \left(\frac{\sum_{i=0}^{L-1} |a_i|^2 (z_i - \bar{z})^2}{\sum_{i=0}^{L-1} |a_i|^2} \right)^{1/2}$$

RMS Delay Spread.

Example:

Consider Scenario with $L = 4$
multipath components.

$$\tau_0 = 0 \mu s$$

$$\tau_1 = 1 \mu s$$

$$\tau_2 = 3 \mu s$$

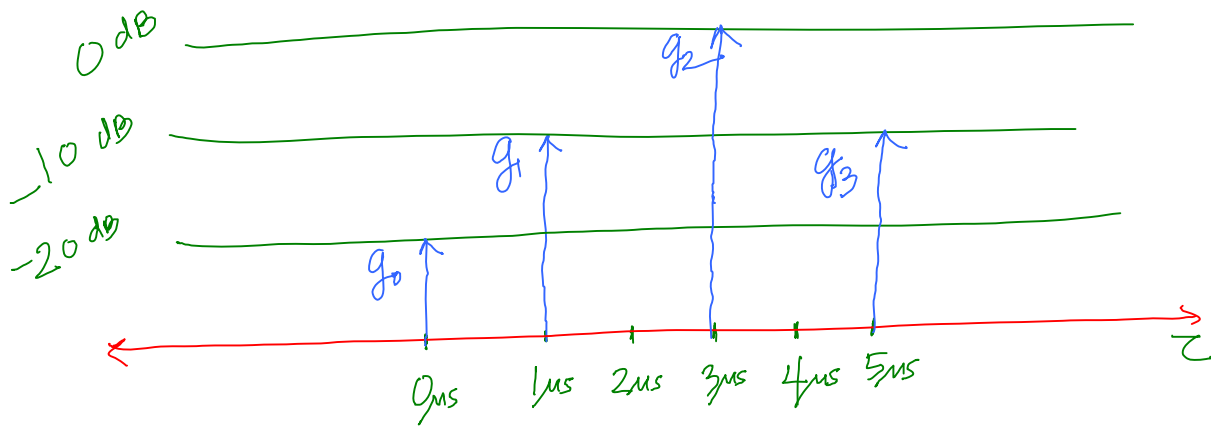
$$\tau_3 = 5 \mu s$$

$$g_0 = 0.01 = -20 \text{ dB}$$

$$g_1 = 0.1 = -10 \text{ dB}$$

$$g_2 = 1 = 0 \text{ dB}$$

$$g_3 = 0.1 = -10 \text{ dB}$$



← Multipath Power Profile. →

Tabular Representation

τ	dB Gain	g	$a = \sqrt{g}$
$0\mu s$	-20 dB	0.01	0.1
$1\mu s$	-10 dB	0.1	0.3162
$3\mu s$	0 dB	1	1
$5\mu s$	-10	0.1	0.3162

$$\bar{z} = \frac{\sum_{i=0}^{L-1} g_i z_i}{\sum_{i=0}^{L-1} g_i}$$

$$= \frac{0.01 \times 0 + 0.1 \times 1 + 1 \times 3 + 0.1 \times 5}{0.01 + 0.1 + 1 + 0.1}$$

$$\bar{z} = 2.9752 \mu s$$

↖ average delay.

$$\sigma_z = \left(\frac{\sum_{i=0}^{L-1} g_i (z_i - \bar{z})^2}{\sum_{i=0}^{L-1} g_i} \right)^{1/2}$$

$\sigma_z =$
RMS
 Delay
 Spread.

$$= \left(\frac{0.01 \times (0 - 2.9752)^2 + 0.1 (1 - 2.9752)^2 + 1 \times (3 - 2.9752)^2 + 0.1 (5 - 2.9752)^2}{0.9 + 0.1 + 1 + 0.1} \right)^{1/2}$$

$$= 0.8573 \mu s$$

$$\sigma_z = 0.8573 \mu s.$$

$$\sigma_z^{\max} = \tau_3 - \tau_1 = 5 \mu s.$$

RMS Delay Spread is much smaller than max Delay Spread.