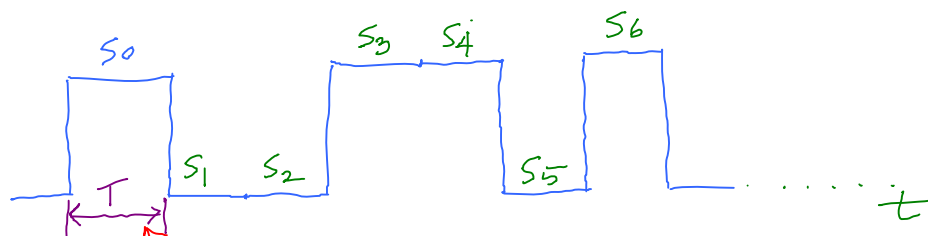


Two metrics for
Delay Spread.

- Max Delay spread
- RMS Delay spread.

What is the 'impact' or
'significance' of delay
spread on wireless comm?

$s_0, s_1, s_2, \dots \leftarrow$ various symbols.



symbol Time = T

Transmitted Signal
Tx signal.

Consider of wireless
multipath channel, $L = 2$

$$h(t) = \frac{a_0 s(t - \tau_0) + a_1 s(t - \tau_1)}{2 \text{ Multipath components}}$$

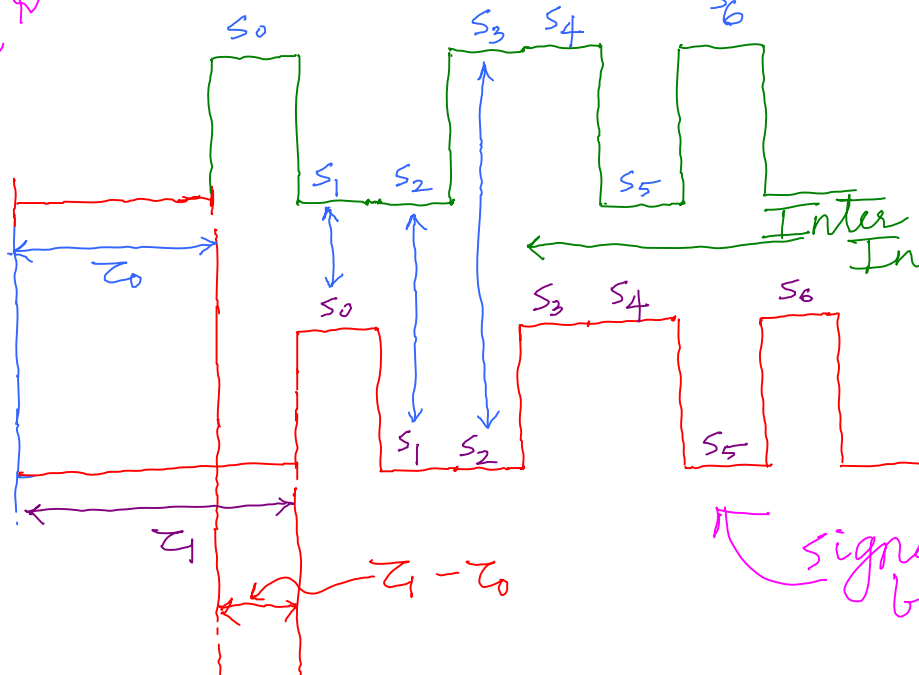
$$a_0 = a_1 = 1$$

$$\rightarrow s(t - \tau_0) + s(t - \tau_1)$$

Rx Signal:

These 2 signat copies
add at receive

signal delayed
by τ_0 .



Inter Symbol Interference (ISI)

signal delayed by τ_1

When $\tau_1 - \tau_0 > T$

$\downarrow$
 $\sigma_z > T$

Then different symbols
interfere with each other

⇓
Inter Symbol Interference
(ISI)

IF $\boxed{\sigma_z > T}$

ISI

ISI is undesirable
since it leads to 'distortion'
of the original Tx signal.

To avoid $|S|$, we need

$$T > \sigma_z$$

If $\text{symbol time} > \text{Delay spread}$

$\Downarrow$
No ISI

If $\text{symbol time} < \text{Delay spread}$

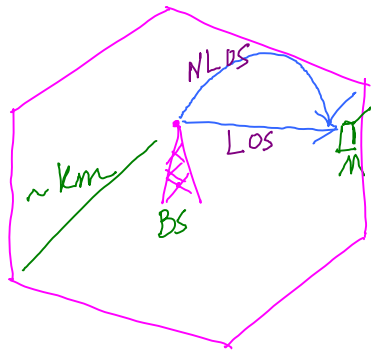
$\Downarrow$
ISI

What is Typical Delay spread
in a wireless channel?

Cell Radius $\sim$ km

Therefore,

LOS, NLOS $\sim$ km



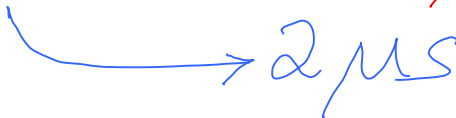
$\Delta d =$ Difference in
Distance

Therefore $\Delta d \sim \text{km}$

Delay spread = $\frac{\text{Difference in}}{\text{Time of arrival}}$

$$= \frac{\Delta d}{c} \sim \frac{1 \text{ km}}{3 \times 10^8 \text{ m/s}}$$

$$= 3.33 \mu\text{s}$$

Delay Spread $\sim 1-3 \mu\text{s}$


Typical outdoor delay spread
of wireless channel

$$= 2 \mu s.$$

If $T < \sigma_z = 2\mu s$
 $\Rightarrow$ ISI

If $T > \sigma_z = 2\mu s$
 $\Rightarrow$ No ISI