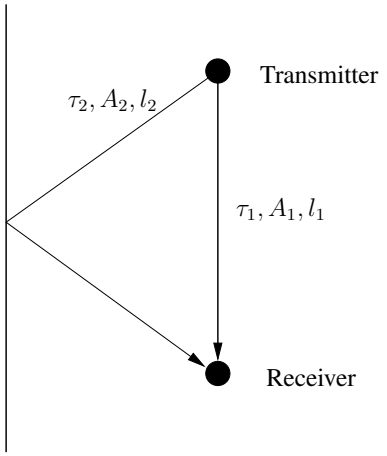
# Advanced Digital Communications (EQ2410)

Lecture 7, Period 3, 2016

**Task 1** Consider the simple propagation model with 2 transmission paths as shown in the Figure below. Assume that the speed of light is given as $c = 3 \cdot 10^8$ m/s, and the bandwidth of the transmitted signal is $W = 10$ MHz. Assume that the length of the second path is $l_2 = 2l_1$.




(a) For which value of $l_1$ will we have ISI?

(b) What can you say about the power received via the second path relative to the power received via the first path (e.g., by assuming free-space propagation)?

(c) Discuss (again assuming free-space propagation) how a typical power delay profile may look like.

**Task 2** The maximum Doppler shift for a carrier with frequency $f_c$ is given by $f_D = f_c v/c$. The speed of light is given as $c = 3 \cdot 10^8$ m/s, and the sound speed in water is given by $c_w = 1500$ m/s.

(a) Give (in good approximation) the Doppler shift $f_D$ and the coherence time $T_D$ for mobile communications systems with carrier frequencies $f_{c1} = 0.9$ GHz and $f_{c2} = 1.9$ GHz for moving receivers with speed v and a bandwidth of 5 MHz.

| $v$ | $f_{c1} = 0.9$ GHz | $f_{c2} = 1.9$ GHz |
|---|---|---|
| 5 km/h (1.4 m/s) | | |
| 50 km/h (14 m/s) | | |
| 100 km/h (28 m/s) | | |
| 250 km/h (70 m/s) | | |

(b) Which frequency band would you allocate to slow users and which to fast users?

(c) What happens in underwater communications when we choose $f_c = 10$ kHz?