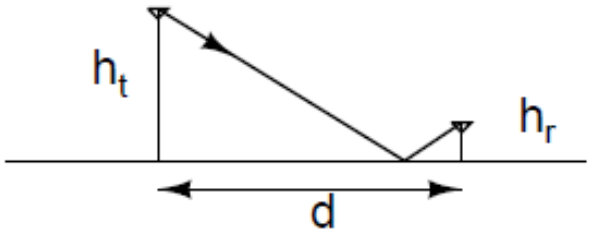
Ground Reflection (2-ray) Model

This is a simple model for propagation over ground.



Assume two components arrive at receiver: one LOS and one reflected from the ground. For small angles of incidence assume the reflection coefficient $\Gamma = -1$.

At large distances compared to the antenna heights the two components will have approximately equal amplitude and a small phase difference:

$$\theta_\delta = \frac{2\pi\delta}{\lambda}$$

where δ is the path length difference which can be approximated as:

$$\delta \approx \frac{2h_t h_r}{d}$$

For large d ($\gg \sqrt{h_t h_r}$) it can be shown (see Rappaport for derivation) that:

$$P_r \approx P_t G_t G_r \frac{h_t^2 h_r^2}{d^4}$$

For this model the path loss varies as d^4, the square of the antenna heights and is independent of frequency.

This approximation does not apply for distances that are short relative to the antenna heights.

Exercise 1: You want to set up an over-water link to provide data service to a ferry. The maximum distance from the terminal to the ferry is 10km. The antenna heights are 20m at the terminal and 10m at the ferry. You can use 20dBi antennas at each end and 1W transmit power. What will be the received power in Watts and dBm?