The Two Towers

Graduate Project 2: Outdoor Bridge

Eliora Horst

COMP 449: Wireless Network Security

Prof. Corby Schmitz

Loyola University Chicago

Hardware

As the My-Co primary facility and remote facility need only to communicate with each other, and this wireless set up is not intended for other usage, a yagi directional antenna would be well suited, with a 5GHz power – as the facilities are 12.9 miles apart, high power amplifiers placed near the antennae will help bridge the gap to connect the two facilities. With consideration for the height of these towers, guy wire anchors should be used for sway protection. A lightning arrester should be fixed 6.5' above the tops of the towers, with the coax cables run along a leg of the tower. Entry to the facilities should be standard, with drip loops and weather resistant sealant used in the entry into the concrete. The main facility tower resides on top of the concrete structure, with no steel/conductive materials. As such, grounding should be routed through a earth down conductor to reach the ground. The grounding plates at each facility should be property buried at 2' feet and fixed with rods.

Calculations

The dense forest between the My-Co primary facility and remote facility contains Scots Pines, Rowans, and Silver Birches.[1]

Tree	**Growth Rate**	**Maximum Height**
Scots Pine	<1' – 2'	60'
Rowan	1' – 2'	20' – 40'
Silver Birch	1.6'	30' – 60'

This being the case, for these calculations the obstruction height of the trees will be set as 60', thereby eliminating the chance of trees growing to impact the LOS.

[1] The trees listed as living on the western slopes of Fangorn Forest are birches, rowans, and pinewoods, from this source. The specific trees listed here were chosen as being possible real-world examples from J.R.R. Tolkien's life in England.

PRIMARY CALCULATION

H1 = 0.6*72.1*√6.8*6.1/(6.8+6.1)*5 = 43.26*√41.48/64.6 = 34.66

H2 = $(6.8*2)^2/6$ = 30.82

H3 = 60

H4 

Total = 34.66 + 30.82 + 60 = **125.48'**

This would mean that the primary facility tower would need to be raised from 30' to at least 75.48'.

SECONDARY CALCULATION

If My-Co would prefer to save relative resources and not extend the height of either of the towers, they could tilt the antenna on the remote facility tower to accommodate the LOS, using the following equation: the first one gives the tilt angle, the second gives the inner cell radius, and the third gives the outer cell radius.

$$A_{DT} = tan^{-1}\left(\frac{h_T - h_R}{D}\right)$$

$$R_{outer} = \frac{h_T - h_R}{tan\left(A_{DT} - \frac{\theta_{BW})}{2}\right.}$$

$$R_{inner} = \frac{h_T - h_R}{tan\left(A_{DT} + \frac{\theta_{BW})}{2}\right.}$$

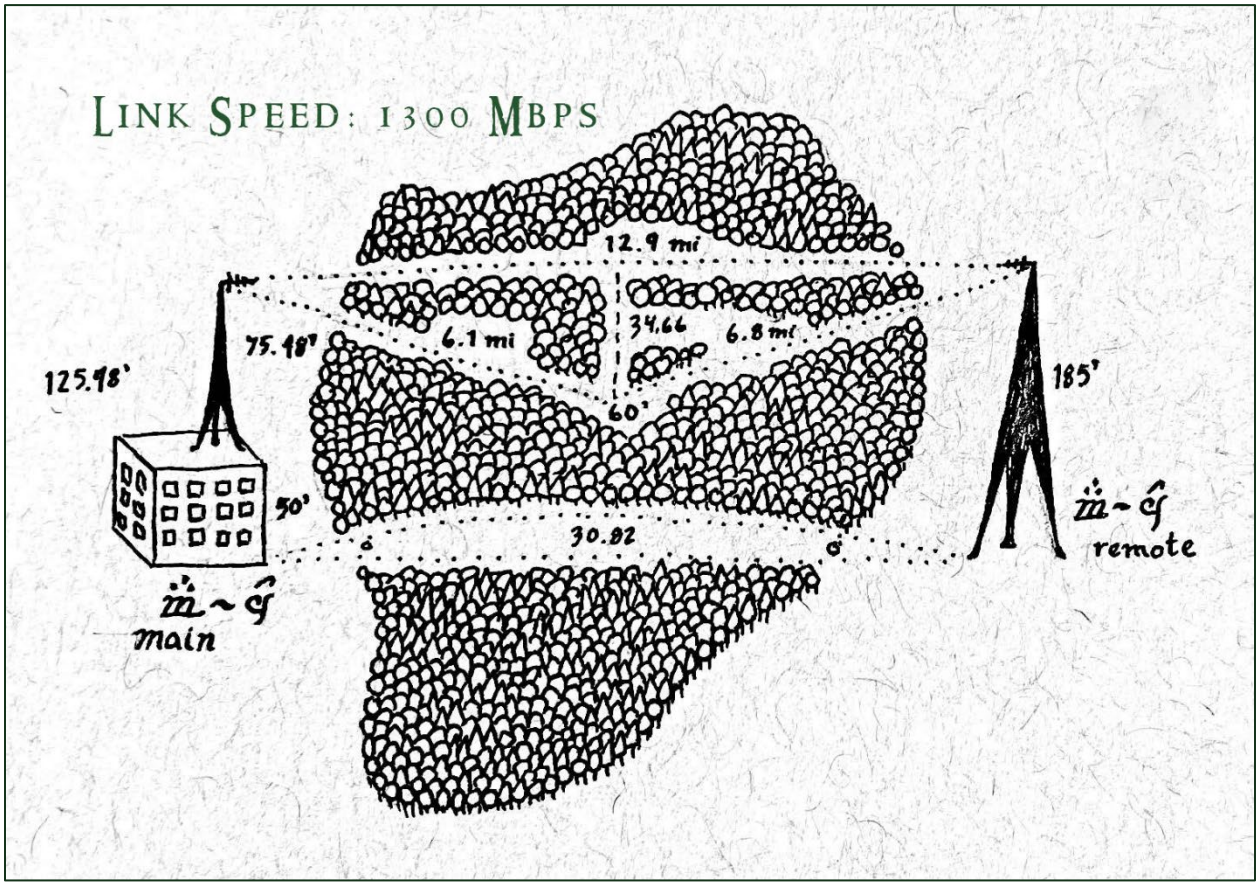
h_T = Height of transmitter

h_R = Height of receiver

$A_{DT} = \tan^{-1}(80\text{-}185/12.9)$ = **-82.99°**

This means the antenna on the primary facility will need to be tilted up at a 82.99 degree angle to achieve ideal LOS.

Drawing


Link Speed: 1300 Mbps
12.9 mi
6.1 mi
34.66
6.8 mi
75.18'
125.98'
60°
185'
50'
30.82
main
remote