# Link Calculation example

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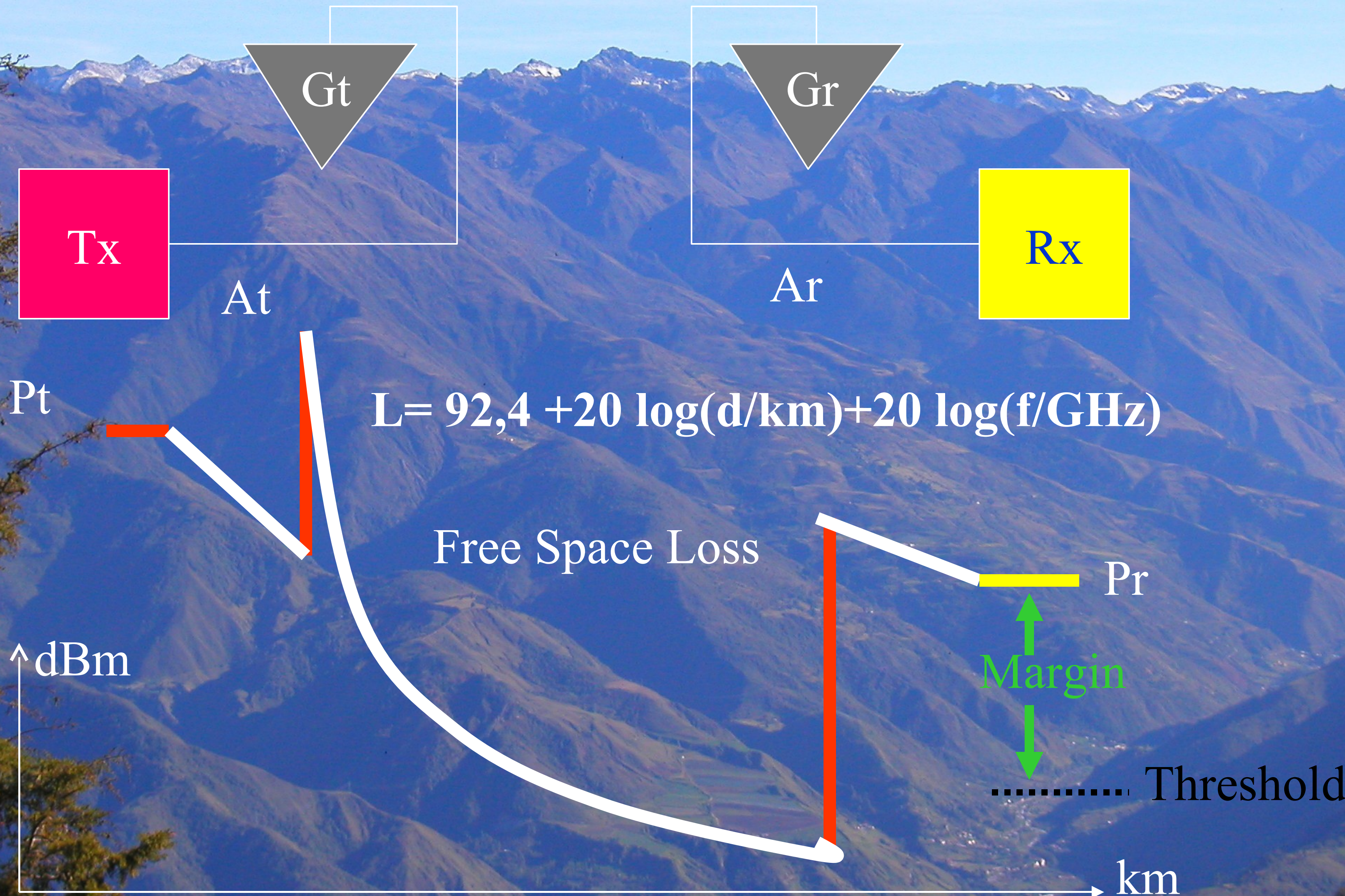
Abdus Salam ICTP

Ermanno Pietrosemoli
Latin American Networking School
(Fundación EsLaRed) – ULA
Mérida Venezuela www.eslared.org.ve

# Power over distance



# Example 1

- Find the FSL between two sites 20 km apart at 2, 4GHz operating frequency
- Repeat for the 5,7 GHz frequency

# Exercise

Find the received signal level at 10 degrees from the boresight of a 24 dBi Hyperlink HG2424 antenna fed from a Linksys WRT54G Router with 12 meters of LMR400 cable. The receiving antenna is omnidirectional, located at 13  km and with a gain of 8 dBi at 2, 4GHz operating frequency. The receiving antenna cable is LMR 200 and 7 meters long. Both antennas are protected by cabling arrestors that introduce 0,5 dB of additional loss each.

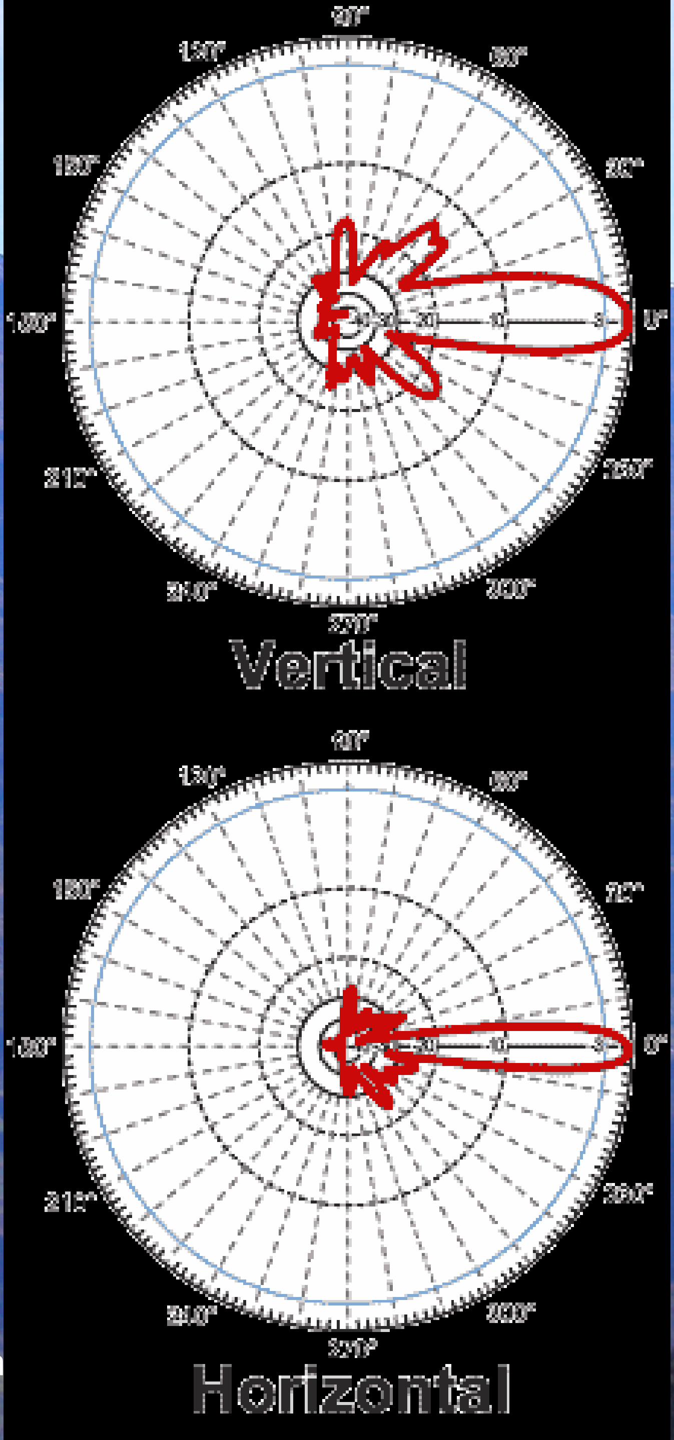
The link is meant to attain 11 Mbit/s nominal speed.

# Transmitter Cable loss

- From www.linksys.com we find the specs for the router, the TX power at 11 Mbit/s is 18 dBm.
- From www.hyperlinktech.com we find the loss for the LMR 400 cable which is 0,22 dB/m, so for 12 m we will have 2,64 dB loss. But we must have 2 connectors at each end, with an estimated loss of 0,2 dB each, plus one adapter from the RPTN connector of the linksys to the N male connector of the cable, which has a  loss of 0,15 dB, so adding the o,5 dB loss of the lightning arrestor, the total loss of the cabling will be: 2,64+2*0,2+0,15+0,5=3,69 dB, so the input power at the antenna will be: 18- 3,69= 14,3 dBm

# Antenna Gain

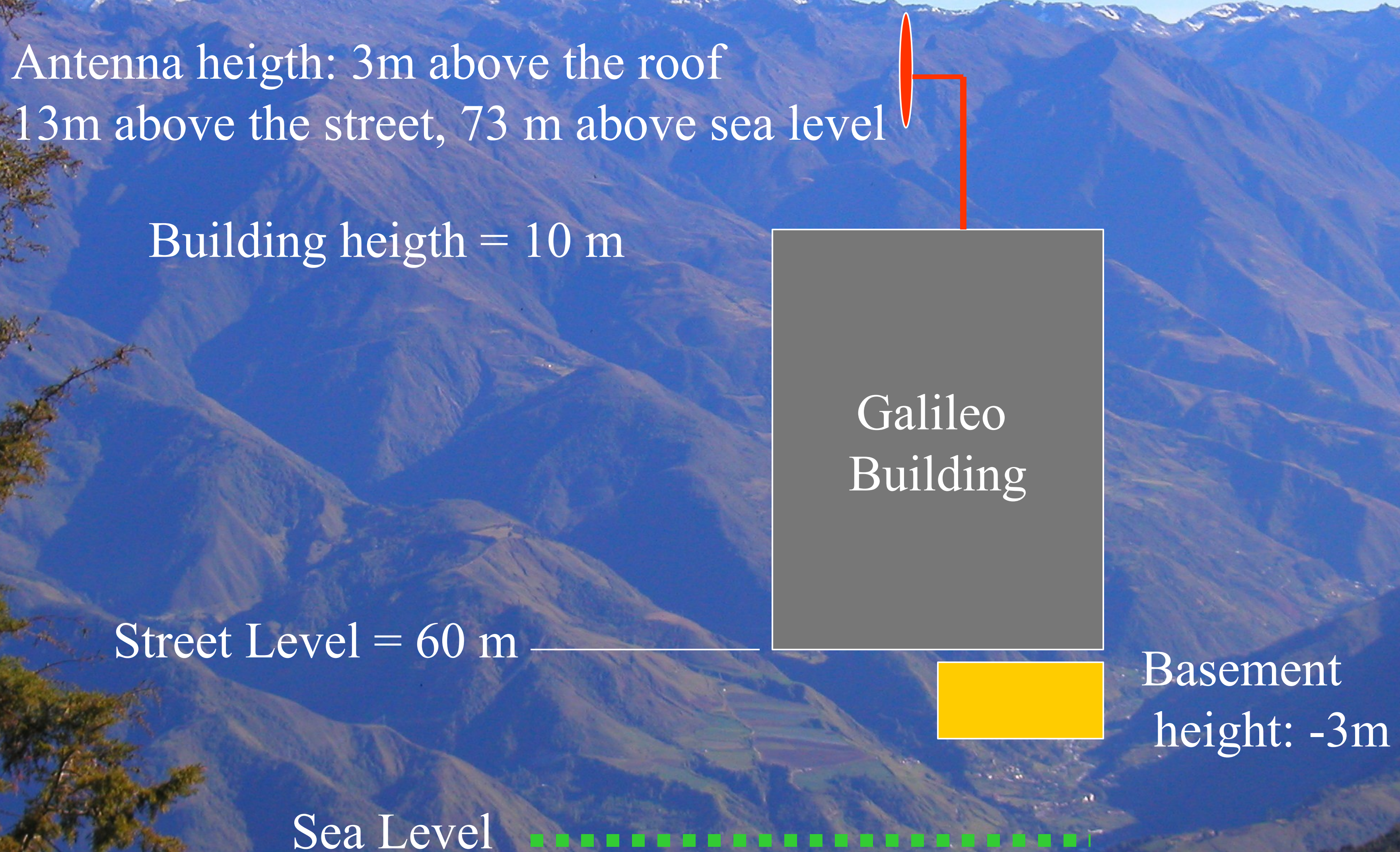
From www.hyperlinktech.com
we find the radiation pattern of
The antenna. But there are two.
Which one do we choose?
Since the receiving antenna is
Omnidirectional, we will assume
that it is vertically polarised, and
therefore we must use vertical
polarisation at both ends.
For vertical polarisation, we have
about 8 dB signal drop at 10°
Offset, so the effective antenna
gain in this direction is 24-8=16 dBi



# EIRP

- Adding 16 dBi to the 14,3 dBm of intentional radiator output power we have an Equivalent Isotropic Radiated Power of 30,3 dBm, slightly above of 1 Watt.
- Notice that we have been happily adding dBm with dBi and dB. Why are we allowed to do this?

# Relative and absolute height



# FSL

- L= 100 +20Log(13km/km) = 122.28 dB
- The power reaching the receiving antenna will be 30,3 dBm -122,3 dB = -92 dBm
- Adding the receiving antenna gain, the power at the antenna terminal will be: -92 + 8 = -84 dBm

# Receiver Cable loss

- From www.hyperlinktech.com we find the loss for the LMR 200 cable which is 0,55 dB/m, so for 7 m we will have 3,85 dB loss. But we must have 2 connectors at each end, with an estimated loss of 0,2 dB each, plus one adapter from the RPTN connector of the linksys to the N male connector of the cable, which has a  loss of 0,15 dB, so adding the o,5 dB loss of the lightning arrestor, the total loss of the cabling will be: 3,85+2*0,2+0,15+0,5=4,9 dB, so the input power at the receiver will be: -84 dBm – 4,9 dB = -88,9 dBm

# We can now build a graph of power over distance: