Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Why/when is AWGN a suitable channel model for wireless front-/backhaul?
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Abstract: This presentation gives reason that an Additive White Gaussian Noise Chanel is a suitable model for wireless front- and backhaul. In addition some clues on the necessary future coordination for such links is given..

Purpose: Input to provide a channel model for wireless front-/backhaul to TG3 d.

Why/when is AWGN a suitable channel model for wireless front-/backhaul?

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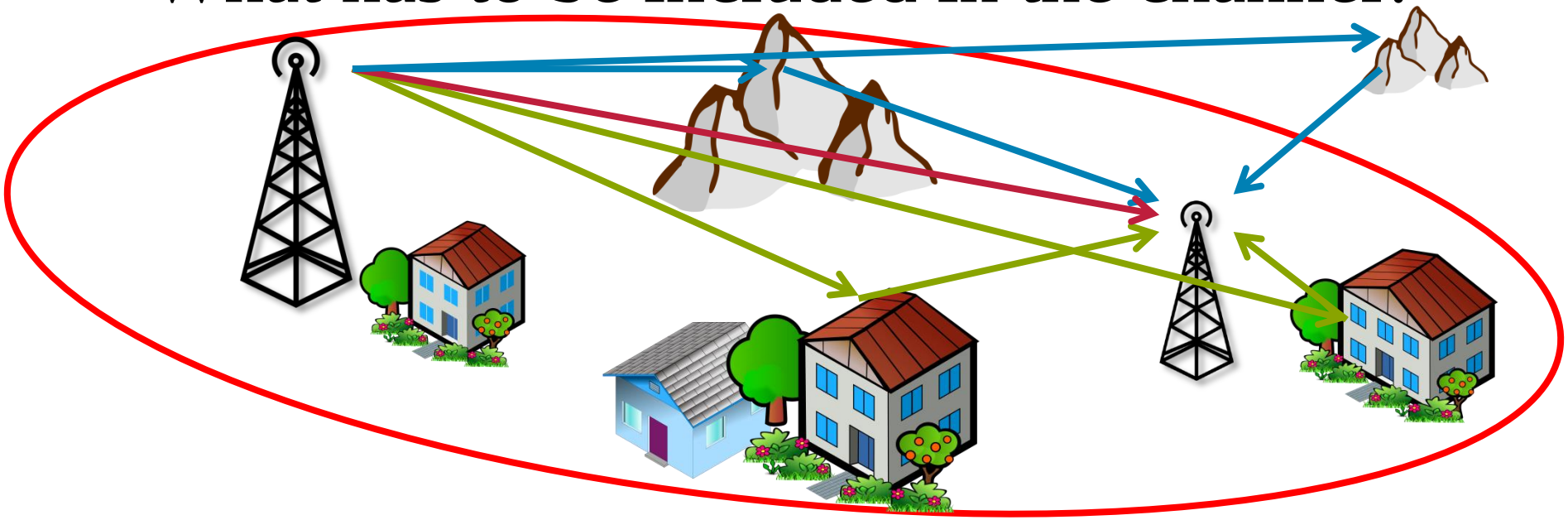
Outline

1. What has to be included in the channel model?
2. Simple Link Budget
3. Directive Antennas
   - Simple Link Budget
   - Impact of Directive Antennas on the Channel
   - Real World Antennas
4. Conclusion

What has to be included in the channel?



- At first glance: every reflection/refraction/diffraction and scattering
- At second glance: everything less than 30 dB weaker than the direct path
- Typical distances
  - Backhaul few 100m to several km (TRD, ARD)
  - Fronthaul few 100m (TRD)
- Additional 30 dB correspond to a factor of ~31.5 in distance: 3.5 km – 35.5+ km

(Simple) Link budget for the direct path

SNR =	0	dBm	transmitter power (baseband)
+	G_{tx}	dBi	antenna gain (transmitter)
-	L_{FSL}	dB	free space loss
+	G_{rx}	dBi	antenna gain (receiver)
-	7.6	dB	noise figure
-	P_n	dBm	thermal noise

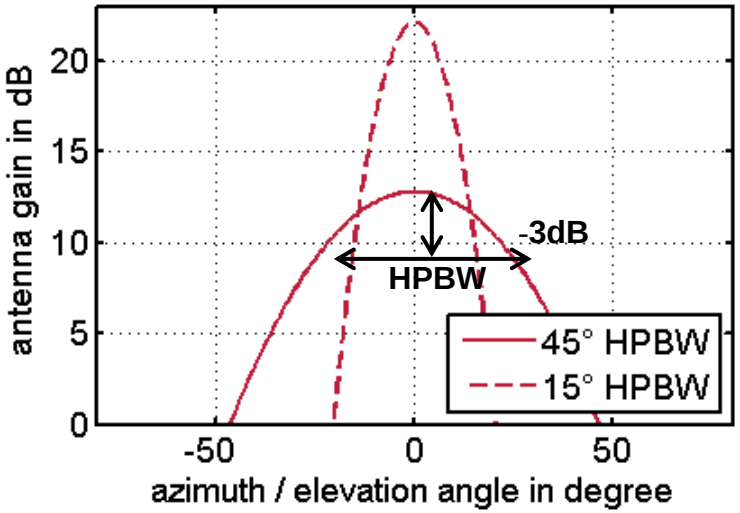
Required Antenna gain:
- 2x 26 dBi @ 100m
- 2x 36 dBi @ 1km

for SNR = ~10 dB

- free space path loss at 300 GHz: 122 dB @100m 142 dB @1km
- required BER of 10^-12 after FEC (TRD, ARD)
- reasonable SNR = ~10 dB for a QPSK (see Doc. IEEE 802.15-15-13-0406-00-0thz)
- carrier frequency: 300 GHz bandwidth: 50 GHz

What kind of antenna?

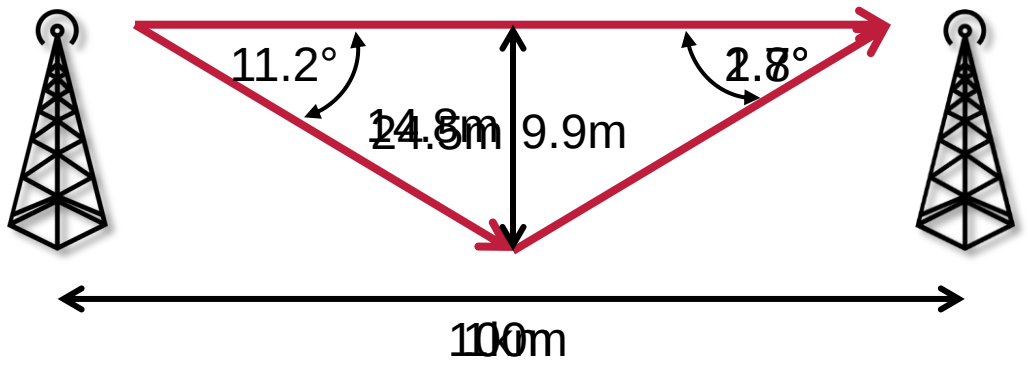
- Suitable antennas are e.g.:
  - dish antennas
  - cassegrain antennas
  - may include lenses
- Common properties:
  - High antenna gain
  - No grating lobes, usually no side lobes
  - dimensions scale with gain and wave lengt
- Assuming a Gaussian antenna pattern in elevation and azimuth:



HPBW	gain	gain-30 dB reached at (one antenna!)
1.5°	42.1 dBi	2.4°
2.5°	37.7 dBi	4.0°
5.0°	31.6 dBi	7.9°
10°	25.6 dBi	15.8°
15°	22.1 dBi	23.7°

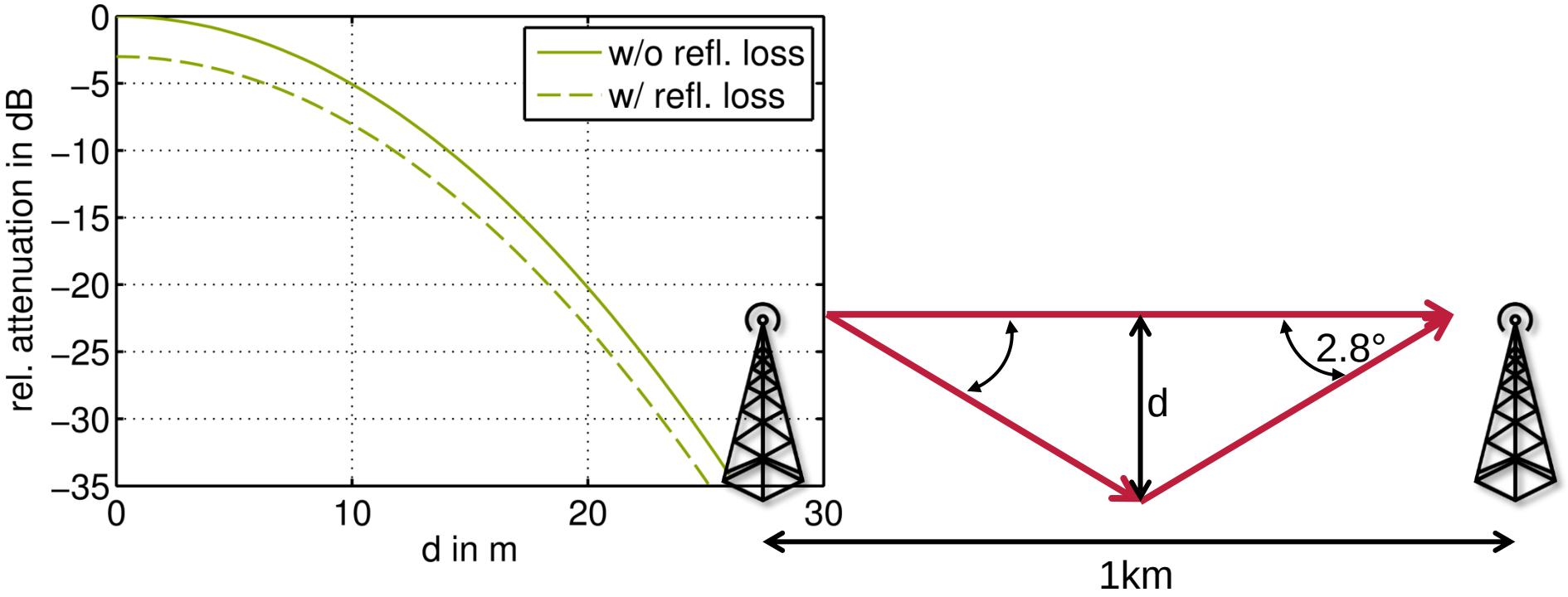
A simple worst case evaluation

HPBW	gain	gain-30 dB	2x gain-30 dB
1.5°	42.1 dBi	2.4°	1.7°
2.5°	37.7 dBi	4.0°	2.8°
5.0°	31.6 dBi	7.9°	5.6°
10°	25.6 dBi	15.8°	11.2°
15°	22.1 dBi°	23.7°	16.8°



A slightly more sophisticated evaluation

HPBW	gain	gain-30 dB	2x gain-30 dB
2.5°	37.7 dBi	4.0°	2.8°

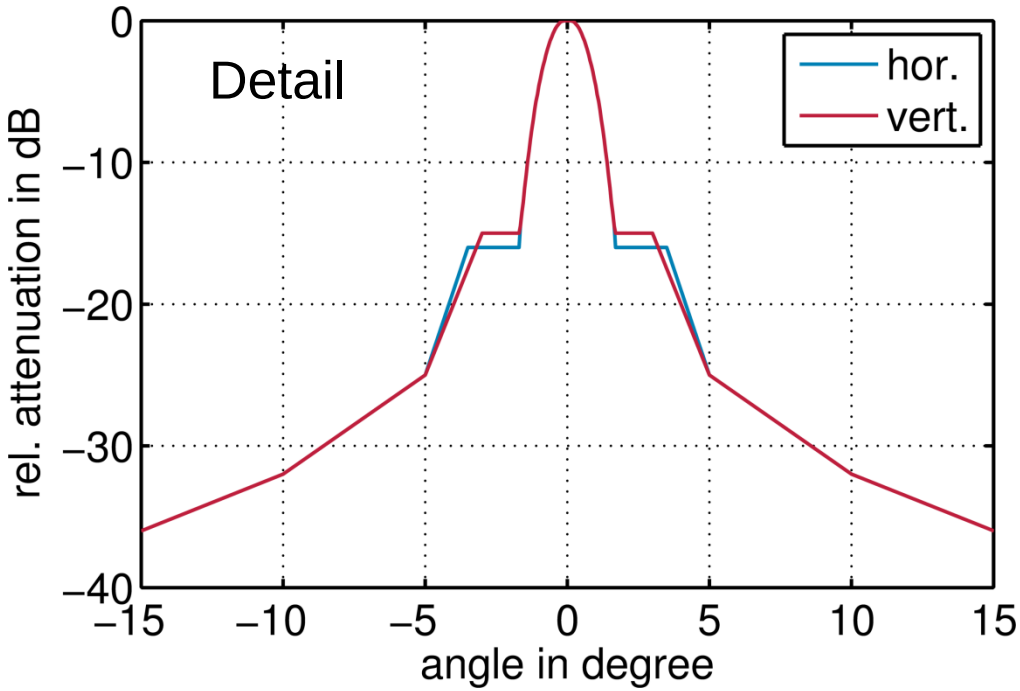


And in the real world? (1)

- Dish antennas for 71-86 GHz are available, e.g. Commscope VHLP200-80

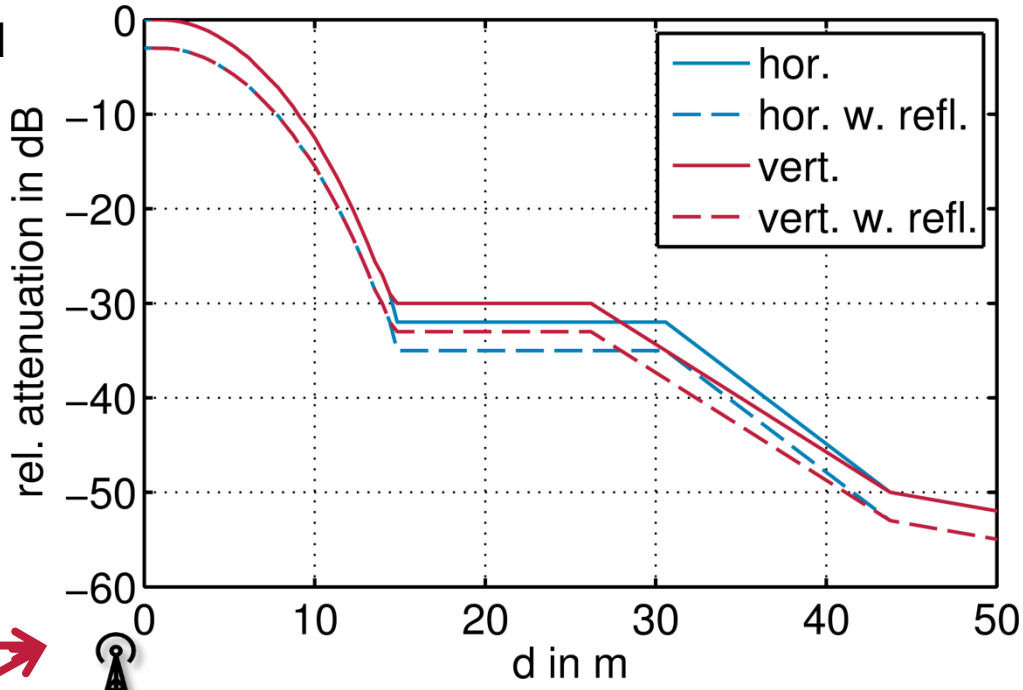
  Gain 41 dBi
  HPBW 1,5°

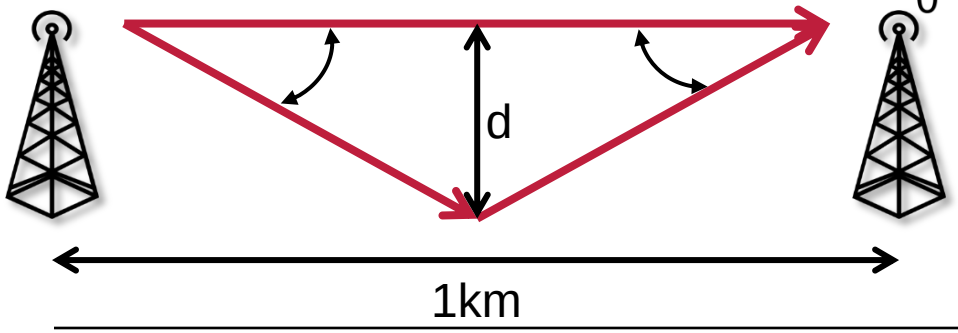
- Antennas with only 0.5° HPBW are also available at 80 GHz



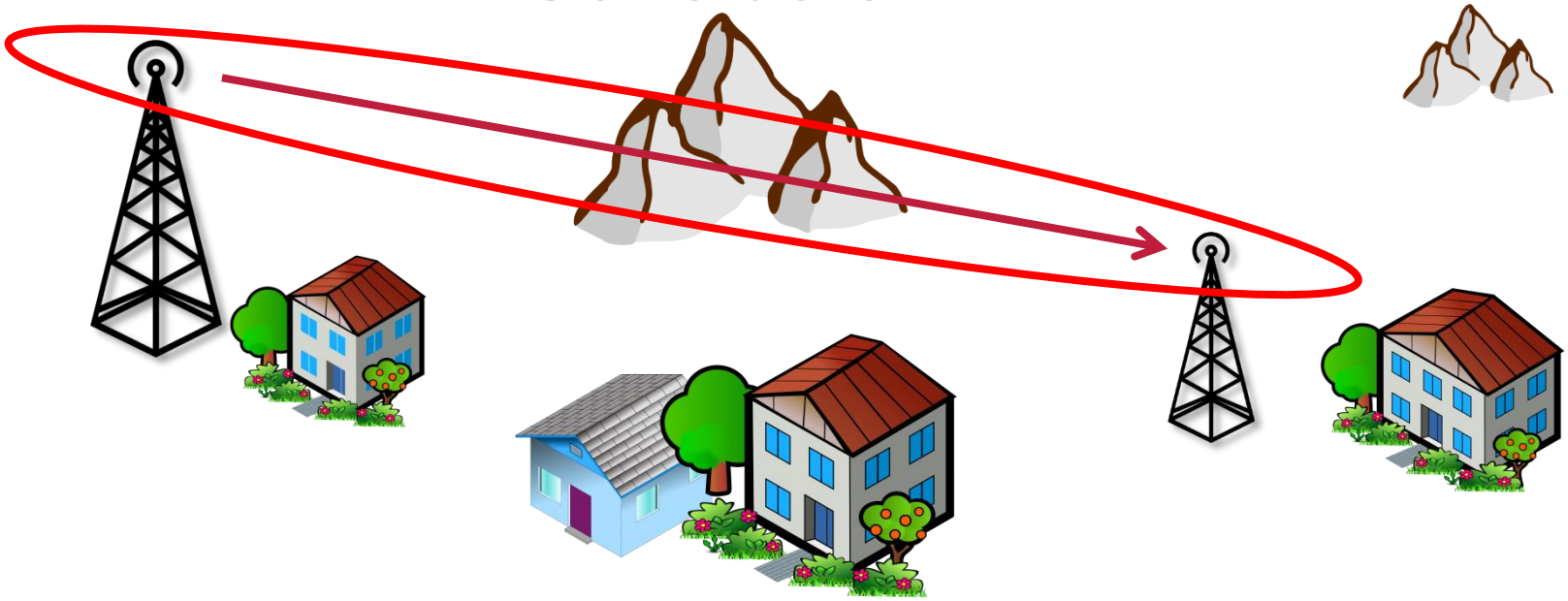
And in the real world? (2)

- At les than 15m -30dB is reached
  - Gain 41 dBi
  - HPBW 1,5°
- With the Gaussian Antennas 25m are required
- SNR increased by 2x 5 dB





Conclusion



- Multipath propagation is irrelevant (regarding the necessary planning process)
- AWGN sufficient for propagation aspects
- BUT still super wide band channels (more than ultra wide band)

Danke für Ihre Aufmerksamkeit!

(Thank you for paying attention!)

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