Wireless Fundamentals

University of Southern Queensland

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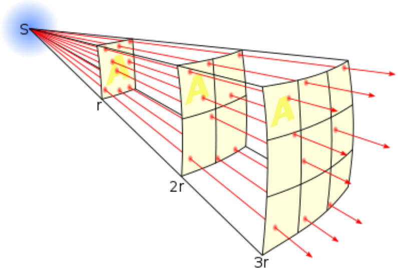
RF Fundamentals

- Wireless Signal Characteristics
- Antenna Design and Choice
- The Shannon-Hartley law
- System Gain
- Reflection and Refraction

Wireless Signal Characteristics

- Power vs distance
- Power vs Frequency
- Noise and interference

Power vs distance



The power of an electromagnetic signal reduces over distance.

$$P_d = \frac{1}{d^2} P_1, \qquad (1)$$

Power vs Frequency

The atmosphere is not transparent. Some frequencies are absorbed more than others.

Higher frequencies are more likely to be absorbed.

This introduces additional loss.

This additional "gain" will be d^{-a} for some $a > 0$ (a gain less than 1 is really a loss), where d is the distance through the atmosphere.

Noise and interference

Supposing the noise has power level N, and the signal has power S. The formula of Hartley and Shannon gives the maximum capacity, C, as:

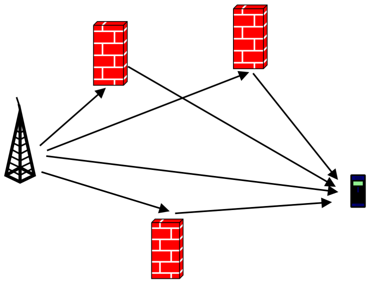
$$multipathproblem.png C = B \log_2(1 + S/N).$$

where B is the bandwidth, in Hz.

Antenna Design and Choice

System Gain

Reflection and Refraction



Wireless signals pass along multiple paths of different gain, and delay. Some paths can also be refracted.

This is the multipath problem.

OFDM

- OFDM solves the multipath problem.
  - Divide spectrum up into bands
  - Relative to a frame, bands are *orthogonal*
  - Estimate the complex gain of each frequency
  - This overcomes multipath interference
  - Transmit over all frequencies at once
  - Each frame must include a cyclic continuation

The OFDM concept was fully proved by Australia's CSIRO and introduced from 802.11a. 802.11b was the last non-OFDM wifi.