# Pulse Modulation and Signal Prop.

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- Encode PAM signal digitally
- Each analog PAM sample is assigned a binary code
- The digital signal consists of block of *n* bits, where each *n*-bit number is the amplitude of a PAM sample pulse
- Basically Analog to Digital (A/D) conversion















































# Path Loss Models Commonly used to estimate link budgets, cell sizes and shapes, capacity, handoff criteria etc. "Macroscopic" or "large scale" variation of RSS Path loss = loss in signal strength as a function of distance Terrain dependent (urban, rural, mountainous), ground reflection, diffraction, etc. Site dependent (antenna heights for example) Frequency dependent Line of site or not Simple characterization: PL = L<sub>0</sub> + 10α log<sub>10</sub>(d) L<sub>0</sub> is termed the frequency dependent component The parameter α is called the "path loss gradient" or exponent













### Antennas

- An antenna is a way of converting guided signals into electromagnetic radiation as efficiently as possible in the direction required
- An antenna has a near field and a far field
  - The near field is called the Fresnel region (close to the antenna)
  - The far field is called the Fraunhofer region (far away from the antenna)
- The radiation pattern of an antenna is the way in which energy propagates in the far field of an antenna as a function of direction











## Cellular Antennas



Cells are typically sectored into 3 parts each having 120<sup>0</sup> sector of the cell to cover

1 transmit antenna in middle of each sector face

2 receive antenna at edge of sector face on the tower.

This is done to provide antenna diversity – it combats fast fading – as only 1 antenna will likely be in fade at any point in time. Can get 3-5 dB gain in the system









### Link Budget

| Link                   | Up     | Down   |
|------------------------|--------|--------|
| TX Power               | 30dbm  | 30dbm  |
| Antenna Gain           | 3      | 5      |
| Antenna Diversity Gain | 5      | Х      |
| Shadow Margin          | 10     | 10     |
| Body Attenuation       | 2      | 2      |
| Vehicle Penetration    | 5      | 5      |
| Receiver Sensitivity   | -105   | -90    |
| Path Loss Budget       | 126 db | 108 db |

### Typical Cellular System Downlink Limited!





