EEE 6109 Wireless Communication.

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Today's Lecture

1. Multiple Access

Introduction

- Spectrum is a precious resource
- It is important to allow as many users within a particular band
- Multiple Access (MA) methods allow multiple users to communicate with a base station (BS) simultaneously.
- MA methods include
  - Frequency Division Multiple Access
  - Time Division Multiple Access
  - Packet Radio
- Code Division Multiple Access is another scheme

Frequency Division Multiple Access

- Each user assigned a frequency sub-band
- Frequency assignment done during call set up
- Combined with frequency domain duplexing - different frequencies for uplink and downlink

Frequency Division Multiple Acces

- Advantages
  - Minimal DSP at TX and RX
  - Time synchronisation is simple
- Disadvantages
  - Difficult frequency synchronisation - narrow band
  - Sensitive to fading

Frequency Division Multiple Acces - Trunking Gain

- How many subscribers can be covered with an FDMA system by one BS
- Assume the system is purely for speech communication
- Worst case assumes all callers want to call simultaneously
- Best case design
- Using statistical properties of user habits we design a system with a given probability that a user will make a successful call $1 - P_{rblock}$

Erlang-B system

We make the following assumptions

- Times when calls are placed are statistically independent
- The duration of calls is an exponentially distributed random variable
- If the call attempt is rejected the next attempt is statistically independent from the previous one
- In this case we have the probability of call blocking

$$P_{r_{block}} = \frac{T_{tr}^{N_c}/N_c!}{\sum_{k=0}^{N_c} T_{tr}^{k}/k!} \tag{1}$$

- Offered traffic is measured in Erlang (call arrival rate times call holding time)

Figure 17.2 in Molisch, Example 17.2

Time Division Multiple Acces

- Users transmit at different times
- A time unit is divided into N timeslots of fixed duration
- During assigned time slot user occupies larger bandwidth
- Temporal guard intervals are required
- Time slot duration must be optimized - it is used for synchronisation and channel estimation for equalisation

Cellular Networks

- Coverage area divided into small "cells" with one BS
- Frequency channels reused in multiple cells a minimum distance from each other
- Assuming path loss that depends on distance, the ideal cell shape would be a disk
- Disks cannot fill the space without gaps or overlaps
- Hexagons satisfy these properties

Example 17.3

Spread Spectrum Methods

- Information spread over a large bandwidth much larger than the inverse of the data rate
- Frequency Hopping Multiple Access - change carrier frequency of a narrowband transmission
- The spreading factor - ratio between the bandwidth over which the frequency is hopped and the narrowband transmission bandwidth

Figure 18.1

Code Division Multiple Access

- Direct Sequence- Spread Spectrum multiplys the transmit signal by second signal of large bandwidth
- The PSD of transmitted signal is very small

Figure 18.3

Readings

- Molisch - Chapter 17, 18