Project

- Default project:
  - SSTV tranciever does not necessarily requires an SDR -- Should work with just the radio. SDR as well is a plus.
  - SSTV project is individual! Unless you are proposing significant extensions.
  - SSTV is analog communications. Analog is not digital!!!

Lab 3 Part III - afsk, AX.25 and APRS

- The lab implements a packet based tranciever
- You will be able to send/receive packet to other classmates
- You will be able to send/receive APRS packets that users and stations with APRS equipped radios can decode.

AFSK1200 / Bell 202 modem

- Audio FSK
  - Encodes digital data at 1200b/s
  - Use audio frequencies 1200/2200Hz
  - Within the bandwidth of the audio input BP filter of your radios
  - Still(!) popular for ham packet networks
  - Phase is not the same for each bit -- must use non coherent detection.

\[
s(t) = \cos \left(2\pi f_c t + 2\pi \Delta f \int_{\infty}^{t} m(\tau)d\tau \right)
\]

- \( f_c = 1700 \), \( \Delta f = 500 \), \( m(t) = \pm 1 \)
AFSK1200

- Write a function to generate AFSK1200
  - Take care: sampling rate (44.1KHz) does not divide with bit-rate
  - Look at Spectrum

Non-Coherent Demodulator

- Complex BP filters around frequencies

FM Demodulator

- Complex bandpass filter
- Compute Phase derivative to get frequency
- Low-pass filter again with a BW of 1200hz corresponding to bit rate

Bit Error Rate

- When adding noise, things are not so nice

- Compute % or bits incorrectly decoded with respect to total bit sent.
  - 'BER of non-coherent:', 0.0021 in this case
Bit Error Rate Curves

- Compute BER vs SNR

![Bit Error Rate Curve Graph](image)

- Compare between parameters and methods.

AX.25

- Link Layer packet based protocol
- Used by ham radio, based on X.25

<table>
<thead>
<tr>
<th>Flag</th>
<th>Dest. Addr.</th>
<th>Src. Addr.</th>
<th>Digipeter Addresses</th>
<th>Control field</th>
<th>ID</th>
<th>Information Field</th>
<th>FCS</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>7</td>
<td>56</td>
<td>1</td>
<td>1</td>
<td>266</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

- NRZI: 0 is encoded in change, 1 is no change
11011000 is converted to 11000101
- Bit stuffing: include a ‘0’ every 5 ‘1’s to guarantee signal change -- help synchronization
- Flag: 01111110 at beginning an end. The only sequence with 6 ‘1’s.
- FCS field for checksum error detection

Automatic Positioning and Reporting System

- Ham packet system for real-time tactical digital communication
- Based on AX.25
- Many commercial products implementing APRS
- National frequency 144.39MHz (ch-117)
- ISS packet: 145.825 (ch-50)

APRS Packet

<table>
<thead>
<tr>
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- Dest address: APDSP (software version)
- Source address: Your call sign
- Digipeter addresses - Wide2-2/ Wide1-1
- Control field (UI X.25 packet) : \x03
- ID: \xF0
APRS Information Field

- 256 Bytes
- Messages:
  - :ALL-----:Everyone will capture this 64 byte message tex
  - :KK6MRI---:This message will only show on Miki's APRS enabled Yaesu VX-8dr radio screen
  - :EMAIL----:mlustig@eecs.berkeley.edu I sent you an email Miki through an OpenAPRS node!
- Position:

<table>
<thead>
<tr>
<th>or = symbol</th>
<th>Latitude 6 chars</th>
<th>Longitude 9 chars</th>
<th>Icon 1 char</th>
<th>Comment max 43 chars</th>
</tr>
</thead>
<tbody>
<tr>
<td>=</td>
<td>3752.50N</td>
<td>12215.43W</td>
<td>K</td>
<td>Shows a school symbol on Cory Hall position</td>
</tr>
<tr>
<td>=</td>
<td>3752.45N</td>
<td>12215.69W</td>
<td>I</td>
<td>Shows a person walking on Oxford and Hearst</td>
</tr>
<tr>
<td>=</td>
<td>2768.16N</td>
<td>08655.30E</td>
<td>I</td>
<td>I'm on the top of the world (Mt. Everest)</td>
</tr>
<tr>
<td>=</td>
<td>3752.50N/12215.43W</td>
<td></td>
<td></td>
<td>Shows a school symbol on Cory Hall position</td>
</tr>
</tbody>
</table>

- Status (starts with a ‘>’)
  - >I like radios

Generate APRS packet

- import ax25
- callsign = "KK6MRI"
- Digis =b'WIDE1-1,WIDE2-1'
- dest = "APDSP"
- # Uncomment to send Email
  - info = ":EMAIL mlustig@eecs.berkeley.edu What a great lab!"
- # Uncomment to report position
  - info = ":3752.50N/12215.43W This is Cory Hall"
- # Uncomment to send a status message
  - # info = ">I like radios"
- packet = ax25.UI(destination=dest,
  - source=callsign,
  - info=info,
  - digipeaters=Digi.split(b','),
  - )
- print(packet.unparse())

Decode APRS packets

- From: Sivan Toledo, 4X6IZ
- Look at zero-crossing
Packet from ISS

- Dest: CQ | Source: RS0ISS | Digis: | ▶ARISS - International Space Station ▶ |

Implement Stream Processing

- Data comes in
- Process in chunks
- Make sure overlaps are taken care of

- Write an application:
  - Decode in real time
  - Interactive text messaging