Very High Frequency (VHF) Meteor Scatter
Team Members

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- **Supervisor**
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- **Academic Advisors:**
  - Professor Ali Pezeshki
  - Professor Rocky Luo
Introduction

- COMET: NATO’s Military use.
  (C)ommunication by (M)eteor Trail)
- Meteor Scatter:
  Uses the ionized Trails of Meteors.
  When Meteor enters the upper atmosphere ....
  Relatively low cost reliable form of radio communication.
Our Motivation

- SNOTEL

- Operated by:
  Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture

-(SNowpack TELemetry):
  To measure snow from inaccessible remote site.
Approach and Goals

- Transmit signal from a remote site to Fort Collins
- Measure the Propagation.
- Measure the noise.
- Measure the SNR for the Modems.
TEST BENCH

• Automated beacon station
  - 4-element Yagi antenna
  - Repeatedly transmit WB9DUN/B.

• Receiver Station
  - Loop antenna connected to a transceiver.
Signal Strength

- Received Signal strength → -107dbm → Very low

- Need to confirm this result by a simulator
Signal Strength

- Received Signal strength $\rightarrow -107\text{dbm}$
- Simulation Result. $\rightarrow -103\text{dbm}$

- No Variation on signal strength
  - No Meteor Scatter
  - Dominated by Tropospheric scatter.
  - Similar experiment in UK provided similar result.

- Measured Noise is high
Signal Strength Analysis

Radiation Pattern of antennas above ground

4-element Yagi antenna

loop antenna

Ground Reflection because of antenna height

<table>
<thead>
<tr>
<th>Antenna Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power radiated (Watts)</td>
<td>0.00144237</td>
</tr>
<tr>
<td>Effective angle (Steradians)</td>
<td>0.399816</td>
</tr>
<tr>
<td>Directivity (dB)</td>
<td>14.9735</td>
</tr>
<tr>
<td>Gain (dB)</td>
<td>13.0318</td>
</tr>
</tbody>
</table>
• Tropospheric scattering:
  ➢ Scatter angle must be small
  ➢ Each degree costs 9-12 dB
Signal Strength Analysis
Signal Strength Analysis

No low angle radiation
Noise Analysis

- SNR is 1.5
- Need at least 20dB SNR to use AFSK modems

Noise = -105 dBm
Options:

- (1) continue with meteor scattering at 50 MHz:
  - Increase the radiation angle of the antenna.
  - Increase the transmitted power.
  - Change the modems to work with lower SNR.
Options:

- (2) build a tropospheric scattering link at higher frequency:
  - Operating at 440 MHz.
  - Use corner antenna instead of yagi antenna.
The New Approach

- Use tropospheric scattering.

Benefits:
- higher frequency, so lower man made noise.
- higher gain antenna.
- lower radiation angle.
AFSK modem

- Bits 1 and 0 are represented with two different frequencies.

- BER vs. SNR.
Next semester’s Plans

- Building the new antenna.
- Measuring BER and SNR.
- Establish the link between the two ends.
- Study the propagation and build the mathematical model.
- Establish a communication link using the modified modems.
### Budget

<table>
<thead>
<tr>
<th>Part / Hardware</th>
<th>Expenses in $</th>
</tr>
</thead>
<tbody>
<tr>
<td>24V Divider</td>
<td>3</td>
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<tr>
<td>Key Switch</td>
<td>2</td>
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<tr>
<td>Relay Board</td>
<td>10</td>
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<td>USB Supply</td>
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<tr>
<td>Misc. HW</td>
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<tr>
<td>Transmitter</td>
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<td>Power Distribution</td>
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<td>DC/DC Converter</td>
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<tr>
<td>Power Amplifier</td>
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<td>Antenna, 4 element yagi</td>
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<tr>
<td>Lightening arrester</td>
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<tr>
<td>Coax</td>
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<td>Mast bracket</td>
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<tr>
<td>Connectors</td>
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<td>3 modems</td>
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<tr>
<td>3 soldering irons</td>
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**Total:** 1244
Acknowledgment
Questions?