Advantages of TV over GPS:

- **High Power**
  
  1MW ERP typical (1000x GPS)

- **Low Frequency**
  
  54-800 MHz
  (stronger indoor signals)

- **Horizontal Signals**
  
  Less attenuation from walls than roofs

- **Frequency Diversity**
  
  Clear 6MHz channels, multiple channels per tower

- **Vertical Signals**
  
  Greater attenuation from roofs and floors

- **Low Power**
  
  500W ERP

- **High Frequency**
  
  1.575GHz

- **Limited Spectrum**
  
  Single shared frequency

Technology Background

- **~40 dB (10,000X)**
  
  Indoor power advantage
TV+GPS Hybrid Positioning Module

- Available as of October 2006
- Integrates TV-positioning with A-GPS at ranging level
- Rosum assists A-GPS
- Delivers 30-50m indoor accuracy
- Focus on safety-of-life applications
- Product trials, evaluation under way
- 58 million people under coverage
Wide-Area Testing: FCC Compliance Testing

E 9-1-1 requirements for handset-based location technologies
- **67%** of all fixes must be less than **50m** from ground truth
- **95%** of all fixes must be less than **150m** from ground truth

Why use the FCC Guidelines?
- Widely accepted and understood accuracy metrics
- Challenging in environments where GPS is unreliable

Why exceed testing requirements?
- **No indoor testing required** (5% recommended by other org.)
- Recent FCC statements (NPRM) address poor performance of E9-1-1 location technologies
- People spend much of their time indoors
- New communications technologies (VoIP, Femtocells) require reliable in-building location and timing
Wide-Area Testing: FCC Compliance Testing

Our Test:

- Conducted by 4G communications, an independent 3rd-party
- Testing was done according to OET-71 guidelines (FCC doc)
- 30 sites/metro area
- At least 1200 total fixes/metro area
  - 50% of all test sites (and about 50% of the fixes) done outdoors,
  - 50% of all test sites (and about 50% of the fixes) done indoors
- Indoor locations were chosen to meet the ATIS0500011 guidelines
  (which force you to test in meaningful, sometimes nasty, indoor locations)
<table>
<thead>
<tr>
<th>Metro Area</th>
<th>Overall</th>
<th>Indoor</th>
<th>Outdoor</th>
<th>Compliant?</th>
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<tbody>
<tr>
<td>Santa Clara, CA</td>
<td>36 65</td>
<td>37 66</td>
<td>36 65</td>
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<tr>
<td>Nashua, NH</td>
<td>31 66</td>
<td>39 71</td>
<td>22 35</td>
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<td>Needham, MA</td>
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<td>34 59</td>
<td>33 66</td>
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<tr>
<td>Edison, NJ</td>
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<td>54 97</td>
<td>45 72</td>
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<tr>
<td>Washington, DC</td>
<td>49 86</td>
<td>46 80</td>
<td>49 94</td>
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</table>
Pseudo-Television Transmitter Design

- TV-UHF band (470-800 MHz)
- 10 Watts EIRP
- TV-like signal
  - 6 MHz Bandwidth
  - 8-VSB modulation
  - PN511 M-code (ATSC)
- Coax-tethered prototype with single source of base-band signal generation
- 8 RF-channels of transmission
What's on TV? Never lose the best with the PN511 show!

ATSC has 0.2% Duty Factor

PTT signal is repeating PN511 sequence with 100% Duty Factor
Frequency Diversity at PTT

- Two frequencies per PTT
Antenna Diversity at Receiver
PTT System
PTT Testing

- PTT testing conducted at Rosum Headquarters in Mountain View, California.
- Deploy PTTs in pre-surveyed locations on all sides of building
  - Four PTTs, each broadcasting at two frequencies
  - Broadcast power of 10 W EIRP
- Test at 12 representative pre-surveyed locations inside
  - Test across both floors
- User device makes 16 measurements per position fix
PTT Field test results

First floor test locations

Second floor test locations

<table>
<thead>
<tr>
<th>Test *</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
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<tbody>
<tr>
<td></td>
<td>67%</td>
<td>3.1</td>
<td>2.8</td>
<td>5.6</td>
<td>3.0</td>
<td>6.8</td>
<td>6.6</td>
<td>10.4</td>
<td>2.5</td>
<td>2.8</td>
<td>8.0</td>
<td>5.1</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>95%</td>
<td>6.2</td>
<td>28.2</td>
<td>8.3</td>
<td>4.0</td>
<td>11.1</td>
<td>8.5</td>
<td>27.6</td>
<td>6.0</td>
<td>5.2</td>
<td>19.9</td>
<td>8.0</td>
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<tr>
<td>Yield</td>
<td>100%</td>
<td>96%</td>
<td>99%</td>
<td>100%</td>
<td>97%</td>
<td>100%</td>
<td>86%</td>
<td>100%</td>
<td>100%</td>
<td>98%</td>
<td>100%</td>
<td>100%</td>
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Conclusion

• Wide-Area System
  – Metro-regional coverage
  – 30-50m accuracy
  – Situational awareness

• PTTs
  – Fixed or mobile
  – Stand-alone or Wide-Area augmentation
  – 3-10m accuracy
  – Tactical awareness
Thanks!
Rosum Wide-Area Positioning
FCC: For handset-based location technologies
- 67% of all fixes must be less than \(50\text{m}\) from ground truth
- 95% of all fixes must be less than \(150\text{m}\) from ground truth