IMO 1.0 Vehicles (Recap)

Two Vehicle Types (10 each)
Based in NV Districts 2 & 3
Along I-80 Corridor

- Snowplows
- Light Duty Vehicles (Crew, general purpose)
### IMO 1.0 Road & Weather Data (Recap)

<table>
<thead>
<tr>
<th>Devices</th>
<th>Time &amp; Location Data</th>
<th>Air Temperature</th>
<th>Pavement Temperature</th>
<th>Relative Humidity</th>
<th>Atmospheric Pressure</th>
<th>Maximum Logging Interval (sec)</th>
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</thead>
<tbody>
<tr>
<td>Airmar</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>1.0</td>
</tr>
<tr>
<td>GPS</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
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<tr>
<td>Omega</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>1.0</td>
</tr>
<tr>
<td>RoadWatch</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>Vaisala</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>0.2</td>
</tr>
<tr>
<td>CANbus</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>1.0</td>
</tr>
</tbody>
</table>
NV IMO 2.0 GOALS (Recap)

1. Fill in the gaps in coverage areas (to the extent feasible)
2. Increase coverage in higher-population areas (Reno-Carson)
   Higher density data for forecast/nowcast
   - Cellular coverage
   - Easier to pilot (local to Reno)
3. Develop lower-cost hardware
   - Simplify hardware and software
   - Remote “push” of software updates
4. Diversify fleet (passenger vehicles)
4. Implement and evaluate applications
   - MMS
   - EMDSS
   - Others (as time permits)
FILL IN THE GAPS FROM IMO 1.0
DENSE DATA– FOCUS ON POPULATED AREAS
NIMO 2.0 Vehicle Hardware

Off-the-Shelf Serial Devices:
Road Watch
- Air Temperature
- Surface Temperature

Also useable for:
- Vaisala Surface Patrol
- OBD Scan Tools
- EDACS Radios

Remote Wx Sensors

Multiplexer

Custom Sensors:
Pulse Counters
- Spreader shaft speed

Weather Sensors (I2C)
(remote mount on vehicle)
- Air Temperature
- Barometric Pressure
- Relative Humidity
- Dew Point

Main Processor
(Android-OS Cellular Phone)
- GPS (location, time)
- Cellular data link
- Accelerometers
- Compass
- Bluetooth OBD link
NIMO 2.0 System Framework

**MULTI-MODE RECEIVING STATION**
- Receives data from mobile stations
  - Cellular
  - EDACS radio
- Archives and forwards data

**PRIORITIZED MODE-SWITCHING TELEMETRY**
- Cellular when available
- EDACS when cellular not available (rural)
- Store-and-forward when necessary

**APPLICATIONS**
- IMO 1
- IMO 2

**EDACS Radio**
- Connects to EDACS system

**Cellular**
- Connects to cellular network
## NIMO 2.0 Cost Comparison

<table>
<thead>
<tr>
<th>Item</th>
<th>IMO 1</th>
<th>IMO 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Processor System</td>
<td>$800</td>
<td>$100</td>
</tr>
<tr>
<td>EDACS capable radio</td>
<td>$900</td>
<td>$0</td>
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<tr>
<td>Device Multiplexer</td>
<td>$173</td>
<td></td>
</tr>
<tr>
<td>Custom Weather Sensor</td>
<td>$75</td>
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<tr>
<td>Roadwatch sensor w/RS232</td>
<td>$750</td>
<td>$750</td>
</tr>
<tr>
<td>Airmar GPS/weather sensor</td>
<td>$1,000</td>
<td>$0</td>
</tr>
<tr>
<td>OBD/J1939 Scan Tool</td>
<td>$625</td>
<td>$150</td>
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<tr>
<td>Custom cabling</td>
<td>$100</td>
<td></td>
</tr>
<tr>
<td>Custom mounting hardware</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td><strong>Non-Recurring Totals:</strong></td>
<td><strong>$4,325</strong></td>
<td><strong>$1,248</strong></td>
</tr>
<tr>
<td><strong>Recurring Data Expenses</strong></td>
<td></td>
<td>$36/month</td>
</tr>
</tbody>
</table>

**Does NOT include costs of instrumenting spreader**
NIMO 2.0 Vehicle Plans (Recap)

- 25 new vehicles (Total = 45)
  - 3 snow plows along I-80 using IMO 1.0 hardware
    - 7 snow plows using IMO 2.0 hardware
    - 15 LDV and PV using IMO 2.0 hardware
## IMO1 & 2 Vehicle Installations

<table>
<thead>
<tr>
<th></th>
<th>Snowplow</th>
<th>Light-Duty Vehicle</th>
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</thead>
<tbody>
<tr>
<td><strong>IMO1</strong></td>
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</tr>
<tr>
<td>Planned</td>
<td>11</td>
<td>9</td>
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<tr>
<td>Installed</td>
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<td><strong>IMO2</strong></td>
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<tr>
<td>Planned</td>
<td>10</td>
<td>15</td>
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<tr>
<td>Installed</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>

**vehicle installations proceeding all summer**
NIMO 2.0 Challenges

- Assessing vehicle transmission capability - hard to determine if a vehicle is being used or not
- Access to NDOT vehicles was not always easy (3 months without any installation – back on track now)
- Weather sensor circuit corrosion problem addressed and deployment of repaired sensors has been made
- Power management issues seem to have been resolved (2+ months without incident)
- Browser/platform incompatibilities limited access to EMDSS and MAW applications
Future Plans

- Interface IMO2 hardware with EDACS radio (multi-modal capability)
- Further evaluate sending message alerts to drivers via EDACS radio
- Onboard spreader measurements (MMS)
- How to manage/maintain current equipped fleet after end of IMO2
- Evaluate benefits of friction coefficient measurements
Lessons Learned

- Proof of concept for 800MHz radio communications (future evaluation of multi-modal and P25)
- Evaluate long term options, costs and capabilities before expanding and further developing equipped fleet
- Need buy-in and support from end users (greater communication and education paired with applications)