AVL Technologies on Provincial Highways in Ontario

CALTRANS Peer Exchange

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Maintenance Management Office
October 27 2016
Agenda

• The Province of Ontario, Canada
• Winter maintenance overview
• Maintenance contracting
• AVL implementation history and specifications
• Inputs and data flow
• Examples; maps and analysis tools
• What works well and what needs work
• Lessons learned and Conclusions
Province of Ontario, Canada

Area 415,600 sq miles
Population 13.6 M
Highways 11,700 cl miles
February temp
(north) -15 to 8 F
(south) 21 to 34 F
Snowfall 31 to 130 inches
Days with snowfall 22 to 101

Hwy 401 Toronto AADT >420,000
Toll Hwy 407 - 99 year concession
# Winter Highway Classifications

<table>
<thead>
<tr>
<th>Class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic WADT</td>
<td>&gt;10,000</td>
<td>2,000-10,000</td>
<td>1,000-2,000</td>
<td>500-1,000</td>
<td>&lt;500</td>
</tr>
<tr>
<td>Service Level</td>
<td>Bare 8 hours</td>
<td>Bare 16 hours</td>
<td>Bare 24 hours</td>
<td>Center-Bare 24 hours</td>
<td>Snow-Packed</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>1.3 hrs</td>
<td>1.9 hrs</td>
<td>2.9 hrs</td>
<td>4.9 hrs</td>
<td>8.0 hrs</td>
</tr>
</tbody>
</table>

- Cycle time
- Bare Pavement*
- Material rates

*Time to achieve bare pavement
Winter performance measure

% time BPRT was achieved

Annual winter severity index

[Graphs and tables showing data for Kenora and Thunder Bay E.]
Winter Equipment and Facilities

1000 combination units
~30 anti-icing routes
65 tow plows
8 FAST
250 IR thermometers
Winter Materials

200+ material storage yards
Rock salt ~600,000 tons
Winter sand ~400,000 tons
Winter liquid ~500,000 + gallons
  pre-wet and anti-icing
Road Weather Information System

- 144 instrumented sites
  - Met (ESS)
  - Surface
  - Subsurface
  - 2 spectral cams
  - 6 mobile RWIS
  - 8 frost/thaw depth

Fully outsourced
- Installation, maintenance
- Polling
- Forecast
- Archive
- Web access
### Winter Patrol Reports

#### Road and weather conditions (5 x day)
- Light east
- Light east
- Moderate north/east

#### All plowing and spreading trips (daily report)
- Precip. begin-end, road covered, operations begin-end, BP restored

#### Materials and equipment hours roll-up 2 x month

<table>
<thead>
<tr>
<th>Date (yyyy/mm/dd)</th>
<th>Start Time</th>
<th>End Time</th>
<th>Requested by</th>
<th>Total Hrs</th>
<th>Route #</th>
<th>Truck #</th>
<th>Operator Name</th>
<th>Initial</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-09-11</td>
<td>11:00</td>
<td>17:00</td>
<td>John Daugh</td>
<td>6.0</td>
<td>104-1C</td>
<td>8.0</td>
<td>Joe Blank</td>
<td>JB</td>
<td>Breakdown - see patrol diary</td>
</tr>
<tr>
<td></td>
<td>11:00</td>
<td>18:00</td>
<td>John Daugh</td>
<td>7.0</td>
<td>110-2C</td>
<td>8.0</td>
<td>Allan Blank</td>
<td>AB</td>
<td>Standby at the yard for 2 hrs</td>
</tr>
</tbody>
</table>

Other: Visitors Complaints, hired equipment, contract operations

- Sweeping operations ongoing on Hwy 417 at Vanier Parkway interchange in both directions.
- Catch basin clean out operations ongoing at the Hwy 417/416 interchange westerly.
Area Maintenance Contracts in Ontario

21 AMC contracts
5 companies
300 - 600 CL mi.
summer and winter
Minor capital
Performance-based

<table>
<thead>
<tr>
<th>Area</th>
<th>AMC Contract Number</th>
<th>Company</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingston/Brock</td>
<td>2003-03</td>
<td>Shear &amp; Swane</td>
<td>May 01, 2004</td>
</tr>
<tr>
<td>Cornwall/Glenros</td>
<td>2003-04</td>
<td>Crackwich</td>
<td>May 01, 2004</td>
</tr>
<tr>
<td>North Bay</td>
<td>2003-05</td>
<td>TWG</td>
<td>May 01, 2004</td>
</tr>
<tr>
<td>Sudbury</td>
<td>2003-06</td>
<td>Belanger</td>
<td>Jun 01, 2004</td>
</tr>
<tr>
<td>Sault Ste Marie (MO)</td>
<td>2003-07</td>
<td>MOS</td>
<td>Apr 17, 2005</td>
</tr>
<tr>
<td>Thunder Bay West (MO)</td>
<td>2003-08</td>
<td>MOS</td>
<td>Jun 01, 2004</td>
</tr>
<tr>
<td>Kapuskasing</td>
<td>2004-09</td>
<td>MOS</td>
<td>Apr 17, 2005</td>
</tr>
<tr>
<td>Temiskaming</td>
<td>2004-10</td>
<td>MOS</td>
<td>Jun 01, 2004</td>
</tr>
<tr>
<td>Timmins</td>
<td>2004-11</td>
<td>MOS</td>
<td>Jul 31, 2005</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-12</td>
<td>MOS</td>
<td>Aug 15, 2006</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-13</td>
<td>MOS</td>
<td>Sep 16, 2005</td>
</tr>
<tr>
<td>Timmins</td>
<td>2004-14</td>
<td>MOS</td>
<td>Oct 17, 2005</td>
</tr>
<tr>
<td>Kapuskasing</td>
<td>2004-15</td>
<td>MOS</td>
<td>Nov 18, 2006</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-16</td>
<td>MOS</td>
<td>Dec 29, 2007</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-17</td>
<td>MOS</td>
<td>Jan 30, 2008</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-18</td>
<td>MOS</td>
<td>Feb 28, 2009</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-19</td>
<td>MOS</td>
<td>Mar 31, 2010</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-20</td>
<td>MOS</td>
<td>Apr 30, 2011</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-21</td>
<td>MOS</td>
<td>May 31, 2012</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-22</td>
<td>MOS</td>
<td>Jun 30, 2013</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-23</td>
<td>MOS</td>
<td>Jul 31, 2014</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-26</td>
<td>MOS</td>
<td>Oct 31, 2017</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-27</td>
<td>MOS</td>
<td>Nov 30, 2018</td>
</tr>
<tr>
<td>North Bay</td>
<td>2004-28</td>
<td>MOS</td>
<td>Dec 31, 2019</td>
</tr>
</tbody>
</table>
Contractor Winter Responsibilities

- Provide equipment, operators, materials
- Monitor weather
- Patrolling
- Call-out, managing and scheduling operations
- Anti-icing
- Plowing, salting, sanding
- Material control
- Traffic protection for incident control
- Reporting
AVL History

• 1999-2005  Generation 1 and 2 AMC
  • MTO outfits most maintenance vehicles using contracted service - Grey Island Systems
  • Maintenance vehicle tracking
  • Road patrol diary
  • Infra-red thermometer
  • Electronic Spreader Control records
  • On-line map and analysis tools

• 2006+  Generation 3 AMC (AMDCS)
  • AMCs provide own AVL service - DM&T, Webtech, Lynxfield
  • MTO spec for variables, data format and frequency
  • Hardware, software, communications, website, archive
  • MTO access to service provider web
  • Monthly hard media archive to MTO

• 2014-15 +
  • Service providers begin track-my-plow linked to 511
  • 1 → 3 → 15
1005.04.15 Automated Locator Requirements:

The Contractor is required to install and maintain an Automated Mobile Data Collection System (AMDCS) for all motorized equipment, including sub-contracted equipment working on the Contract for periods of more than 2 weeks. All sub-contracted equipment providing electrical maintenance and pavement markings must be equipped with AMDCS. AMDCS is not required on equipment performing in-scope capital improvements or data collection work.

The system shall be capable of tracking, storing and reporting movements and actions, in Real-time, for all vehicles including patrol trucks, Winter Vehicles and general purpose vehicles every 10 to 12 seconds while in use, 24 hours a day, 7 days a week.

The on-board AMDCS/GPS unit must be capable of allowing for data to be stored when there is no wireless network present, and then uploaded once network service is regained. The on-board unit’s software shall continuously run tests to determine whether or not network coverage exists prior to transmitting data, to ensure there will be no data loss. If a loss of coverage is detected, the unit shall immediately begin to store the data within the on-board memory allocated to this application.

The AMDCS must be capable to read and transmit all data captured by the Electronic Spreader Control units in all Spreaders and/or combination units.

The Contractor shall provide, at minimum, the following operational characteristics:

The Contractor shall provide, at its cost, access to electronic data via a web browser on a continual basis. Access shall be provided to the Contract Administrator or designee. The Owner reserves the right to request manually downloaded data at any time, including equipment or spreader controller(s).

The Contractor shall provide to the Contract Administrator, not less frequently than every two weeks, a complete copy of electronic data. The Contractor shall provide the electronic data in XML 1.1 (second edition) format.
Standard AVL inputs

- Header: Contractor, Vehicle ID, type, Region
- Date, time, heading, Lat/long (10 second default or change in sensor data=\sim 50 \text{ ft})
- IR thermometer
- Spreader controller (granular and liquid rate, spinner, material)
- Plow, wing up/down
- Winter dashcam
- Zone marking liquid and bead rate
AVL data flow

- AVL provider’s server
- Web page
  - Real-time
  - On-line archive

- AMC
  - Real-time planning
  - Business operation
  - Reports to MTO

- 511
  - Contract oversight

- MTO
  - Legal discovery
  - Salt management
  - Standards analysis

- Maintenance Management Office
Real-time 511

- Click through from 511 website
- Time stamp and cut-off
- User preference setup
- Privacy re public dashcams

13/20 areas

http://www.trackmyplow.com/
Replay with dash-cam and activity
## AVL Vehicle # Daily Equipment Report

### Spreader/Plow Report

<table>
<thead>
<tr>
<th>Time Out</th>
<th>Time In</th>
<th>Total Hours</th>
<th>Spreader KM Serviced</th>
<th>Plow KM Serviced</th>
<th>Total KM</th>
<th>Average Rate</th>
<th>Salt Used (Tonnes)</th>
<th>Sand Used (Tonnes)</th>
<th>Prewet Brine Used (L)</th>
<th>DLA Brine Used (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-02-11 02:24</td>
<td>2016-02-11 03:52</td>
<td>1.5</td>
<td>29.50</td>
<td>0.02</td>
<td>55.77</td>
<td>409.0 kg/km</td>
<td>0.00</td>
<td>9.62</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 04:00</td>
<td>2016-02-11 05:45</td>
<td>1.8</td>
<td>8.30</td>
<td>0.02</td>
<td>49.84</td>
<td>570.0 kg/km</td>
<td>0.00</td>
<td>4.70</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 06:04</td>
<td>2016-02-11 07:25</td>
<td>1.4</td>
<td>28.10</td>
<td>0.02</td>
<td>49.95</td>
<td>130.0 kg/km</td>
<td>3.69</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 07:34</td>
<td>2016-02-11 08:50</td>
<td>1.3</td>
<td>26.00</td>
<td>0.01</td>
<td>49.48</td>
<td>130.0 kg/km</td>
<td>3.50</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 08:59</td>
<td>2016-02-11 10:23</td>
<td>1.4</td>
<td>29.20</td>
<td>0.01</td>
<td>55.76</td>
<td>130.0 kg/km</td>
<td>3.80</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 10:35</td>
<td>2016-02-11 12:40</td>
<td>0.1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.28</td>
<td>-</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 11:22</td>
<td>2016-02-11 13:27</td>
<td>1.1</td>
<td>0.00</td>
<td>9.75</td>
<td>49.79</td>
<td>128.8 kg/km</td>
<td>0.15</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 13:39</td>
<td>2016-02-11 15:04</td>
<td>2.4</td>
<td>0.50</td>
<td>21.57</td>
<td>49.27</td>
<td>130.0 kg/km</td>
<td>0.07</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 16:38</td>
<td>2016-02-11 17:44</td>
<td>1.1</td>
<td>0.80</td>
<td>3.76</td>
<td>49.59</td>
<td>127.4 kg/km</td>
<td>0.08</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 20:27</td>
<td>2016-02-11 21:58</td>
<td>1.5</td>
<td>28.80</td>
<td>39.07</td>
<td>51.05</td>
<td>467.8 kg/km</td>
<td>0.00</td>
<td>14.49</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2015-02-11 22:11</td>
<td>2016-02-11 23:41</td>
<td>1.5</td>
<td>24.00</td>
<td>50.08</td>
<td>55.57</td>
<td>475.7 kg/km</td>
<td>0.00</td>
<td>13.68</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
# AVL vehicle type daily report

## Equipment Report

<table>
<thead>
<tr>
<th>Vehicle #</th>
<th>Trip #</th>
<th>Trip Start</th>
<th>Trip Stop</th>
<th>Total Distance</th>
<th>Main Plow Info - On Time</th>
<th>Main Plow Info - Off Time</th>
<th>Main Wing Info - On Dist. (km)</th>
<th>Main Wing Info - Off Dist. (km)</th>
<th>Wing Plow Info - On Time</th>
<th>Wing Plow Info - Off Time</th>
<th>Wing Plow Info - Off Dist. (km)</th>
<th>Avg. Speed</th>
<th># of Stops</th>
<th>Total Stop Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2016-02-11 00:04:52</td>
<td>2016-02-11 01:16:07</td>
<td>0.0</td>
<td>55 mins</td>
<td>0.0</td>
<td>16 mins</td>
<td>0.0</td>
<td>56 mins</td>
<td>0.0</td>
<td>15 mins</td>
<td>0.0</td>
<td>46.9</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2016-02-11 00:05:37</td>
<td>2016-02-11 01:42:50</td>
<td>0.0</td>
<td>1 hours 30 mins</td>
<td>0.0</td>
<td>7 mins</td>
<td>0.0</td>
<td>0.0</td>
<td>1 hours 30 mins</td>
<td>0.0</td>
<td>37.9</td>
<td>1</td>
<td>2 mins</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2016-02-11 00:06:31</td>
<td>2016-02-11 01:47:12</td>
<td>0.0</td>
<td>1 hours 38 mins</td>
<td>0.0</td>
<td>3 mins</td>
<td>0.0</td>
<td>1 hours 34 mins</td>
<td>0.0</td>
<td>6 mins</td>
<td>0.0</td>
<td>39.8</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- 2016-02-11: Date of the report.
- 00:00-01:16:07: Time range for the report.
- 55 mins, 16 mins, 56 mins, 15 mins: Time spent on plowing activities.
- 46.9, 37.9, 39.8: Average speed during the trips.
<table>
<thead>
<tr>
<th>Date</th>
<th>Image</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-02-11</td>
<td>HIGHWAY 23, Town of Minto 2016-02-11 00:28:47</td>
<td>43.904591</td>
<td>-80.684978</td>
<td>2010-08-</td>
</tr>
<tr>
<td>2016-02-11</td>
<td>HIGHWAY 23, Town of Minto 2016-02-11 00:29:33</td>
<td>43.899893</td>
<td>-80.88392</td>
<td>2010-08-</td>
</tr>
</tbody>
</table>
Working well

- Capturing data real-time and store-forward
- On-line reporting tools and summaries
- On-line tracking in real-time
- Direct to 511 track my plow
- Service provider archive in the cloud
Needs Work

• QA
  • Missing records
  • Cell drop outs
  • Sensor failure
  • Sensor accuracy
• Automation of tablet input reports
  • Distracted driving
• Client’s in-house archive
  • Input through firewall
• Road-user privacy with dashcams
• Data retention interval, aggregation scale
AVL vs paper records

Extreme outliers removed
- ESC or AVL not working
- WOR missing records
Lesson Learned

- Operator buy-in
- Supervisor/manager buy-in
  - Prove accuracy
  - Reliable internet, new technology
  - Admit failures and have a backup
- AMC contractor buy-in
  - Achieve paperwork reduction
- Legal record
Conclusion

- Fully developed technology
- Know your objectives
- Identify specific deliverables

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