Variable Speed Limit
How is it working for WSDOT

Vinh Q. Dang, PE
Region Freeway Ops Engineer.
Washington State Dept. of Trans.
Early deployments

- I-90 Snoqualmie Pass, 1998
- US 2 Stevens Pass, 2005
- Often use “look-up” table.

<table>
<thead>
<tr>
<th>TRACTION REQUIREMENTS</th>
<th>SPEED LIMIT</th>
<th>PAVEMENT CONDITIONS</th>
<th>VISIBILITY</th>
<th>WEATHER</th>
<th>BLOCKING INCIDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>65</td>
<td>DRY OR BARE / WET LIGHT SNOW, SLUSH, OR ICE IN PLACES</td>
<td>GOOD: CLEAR&gt;0.5 MILES</td>
<td>FAIR TO MODERATE RAIN</td>
<td>INCIDENT ON SHOULDER</td>
</tr>
<tr>
<td>TRACTION ADVISORY</td>
<td>55</td>
<td>LIGHT SNOW, SLUSH, OR ICE IN PLACES</td>
<td>MODERATE: FOG&lt;0.2 MILES</td>
<td>HARD RAIN</td>
<td>INCIDENT ON SHOULDER</td>
</tr>
<tr>
<td>TTREQ / VEH OVER 10000 GVW CHAINS REQUIRED</td>
<td>45</td>
<td>COMP. SNOW/ICE, DEEP SLUSH, SHALLOW WATER</td>
<td>POOR: BLOWING SNOW&lt;0.1 MILES</td>
<td>HEAVY RAIN OR SNOWFALL</td>
<td>LANES BLOCKED TRAFFIC MOVING</td>
</tr>
<tr>
<td>CHAINS REQUIRED ALL VEH EXCEPT ALL WHEEL DRIVE</td>
<td>35</td>
<td>SEVERE FREEZING RAIN, DEEP SNOW, SLUSH OR STANDING WATER</td>
<td>POOR: BLOWING SNOW&lt;0.1 MILES</td>
<td>HEAVY RAIN OR SNOWFALL</td>
<td>LANES BLOCKED TRAFFIC STOPPED AHEAD</td>
</tr>
<tr>
<td>EMERGENCIES or EXTREME CONDITIONS ONLY</td>
<td>25</td>
<td>USE THIS SPEED FOR SEVERE CONDITIONS AS REQUESTED BY CREWS ON THE SCENE. CONFIRM WITH SUPV., WHEN AVAILABLE. POOREST POSSIBLE ROAD CONDITIONS AND HUMAN LIFE ENDANGERED. Conditions should be well documented. Return to higher speed limit as soon as possible.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

End of poorest possible road conditions and human life endangered.
Transitioning to automation

In-house software development team.

- 2009 - developed VSL process for the WSDOT Traffic Management Suite, NG_TMS.
- 2010 - integrated VSL process into the full ATM module.
- 2011 - enhancement.
System description

Purpose
The system shall detect area of differential speed, calculate and display transitioning speed (limits) to smooth out the difference.

Operation needs
• Command attention.
• Relevant.
• User friendly.

Requirements
• DMS graphics/message looks and feels like static speed limit sign.
• Display speed limit with proper explanation (SMS) timely.
• Use the same GUI as for other modules of the current software.

Algorithm
• Calculate local speed and display upstream.
• Other processes can override speed display.
Establishing speed limit

- Speed trap – calculated from travel time over a set of 2 in-line loops with known spacing.
- Speed estimate – calculated from occupancy (time dwell) over a single loop.
- Rolling average of three consecutive 20-second sampling periods.
Sample operator interface
Detail explanations

- Gantries spaced ½ mile & associated with data station, usually downstream.
- VSL and Junction warning processes are running in the background.
- VSL detected queue at downstream station and display transition speeds from free flow down to stop and go.
- Junction Warning detected heavy on-ramp demand and display warning message overriding VSL on lane 1.
- HOV and GP speeds are calculated independently. Displays are constraint within limit.
Displays on the road

- 1st gantry “slow traffic ahead”
- 2nd gantry - maximum speed reduction of 15 MPH from the immediate upstream gantry – hence 45 MPH
- 3rd gantry – minimum limit 30 MPH.
- Dynamic junction warning override the speed limit sign over lane 1, “heavy merging traffic ahead”
Lesson learned

Design:
- Software development adhere to SE process.
- Speed limit values are graphic images reside at the controller.
- Use fonts and color conforming to MUTCD requirements.
- Standardized sign memory address.

Operation:
- All displays must be credible and reasonable.
- Use speed trap to measure speed at fine granularity – 20 sec
- Update display frequently - 1 min.
- TMC staff must be trained to recognize anomaly and override any automatic processes promptly.