IntelliDrive<sup>SM</sup> Traffic Signal Control Algorithms

UVA Center for Transportation Studies

Transportation Research Board
90<sup>th</sup> Annual Meeting

January 24, 2011
Five Tasks

1. Investigation of the IntelliDrive Data Sources
2. Development of New Traffic Control Signal Algorithms under IntelliDrive
3. Development of Tools for Generating Arterial MOEs from IntelliDrive
5. Deployment Analysis
Traffic Signal Control Algorithms

- Oversaturated conditions
- Vehicle clustering
- Predictive microscopic simulation
Oversaturated Conditions

- IntelliDrive uniquely suited to handle oversaturation
  - Queue detection
  - Intersection blockages
- Algorithm detects backup, cuts short the upstream green
- Uses a rolling estimation of IntelliDrive market penetration to predict queue lengths
Oversaturated Conditions
Oversaturated Conditions

ECG: Early cut-off green. IMP: IntelliDrive market penetration
Vehicle Clustering

- Decentralized, non-cyclic, no detectors
- Vehicles are grouped by time-to-intersection using k-means clustering
- Next phase given to approach with highest cumulative wait time
- Green extended until gap in platoons
Vehicle Clustering

Determining Remaining Green Time

Expected Time to Intersection [sec]

Distance to Intersection [ft]
## Vehicle Clustering

<table>
<thead>
<tr>
<th>Penetration</th>
<th>Average Values</th>
<th>Delay [s]</th>
<th>Stopped Delay [s]</th>
<th>Speed [mph]</th>
<th>Fuel Consumption [l]</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Actuated</td>
<td>58.43</td>
<td>33.48</td>
<td>27.81</td>
<td>2736.72</td>
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<tr>
<td>100%</td>
<td>VCA2</td>
<td>54.44</td>
<td>22.42</td>
<td>28.61</td>
<td>3016.58</td>
</tr>
<tr>
<td>% Difference</td>
<td>VCA2</td>
<td>-6.83%</td>
<td>-33.03%</td>
<td>2.88%</td>
<td>10.23%</td>
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<tr>
<td>75%</td>
<td>VCA2</td>
<td>54.66</td>
<td>22.99</td>
<td>28.59</td>
<td>3032.74</td>
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<tr>
<td>% Difference</td>
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<td>-6.45%</td>
<td>-31.33%</td>
<td>2.80%</td>
<td>10.82%</td>
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<tr>
<td>50%</td>
<td>VCA2</td>
<td>56.12</td>
<td>24.99</td>
<td>28.34</td>
<td>3028.58</td>
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<tr>
<td>% Difference</td>
<td>VCA2</td>
<td>-3.95%</td>
<td>-25.36%</td>
<td>1.91%</td>
<td>10.66%</td>
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<tr>
<td>25%</td>
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<td>46.59</td>
<td>25.33</td>
<td>3058.65</td>
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<tr>
<td>% Difference</td>
<td>VCA2</td>
<td>30.22%</td>
<td>39.16%</td>
<td>-8.92%</td>
<td>11.76%</td>
</tr>
</tbody>
</table>
Predictive Microsimulation

- Rolling horizon using microscopic simulation
- Decentralized, non-cyclic
- Procedure
  - A model of the intersection is populated with all equipped vehicles within range
  - Vehicles simulated 15 seconds into future against all phases
  - Lowest cumulative delay is next phase
  - Recalculate once approach delay is zero
Predictive Microsimulation
Predictive Microsimulation

Percent Changes in Performance of PMSA

Delay/vehicle  Speed  Stopped delay/vehicle  CO2 Emissions

-25%  -20%  -15%  -10%  -5%  0%  5%  10%

25% Market Penetration  50% Market Penetration  75% Market Penetration  100% Market Penetration
IntelliDrive\textsuperscript{SM} Compatibility

- All algorithms fully compatible with IntelliDrive\textsuperscript{SM}
- Requires only information from Basic Safety Message Part I
  - Sent 10 times per second, but required no more than once per second
Performance Measures

- Many existing measures can be measured more accurately, more often

- New measures
  - Vehicle occupancy / person-delay
  - Sudden decelerations
  - Changes in lateral acceleration
  - Aggregate regulation compliance
TRB Posters

- Application of IntelliDrive to Address Oversaturated Conditions on Arterials, (11-2649) - F06
  Event Number: 390
  Jan 24 2011 7:30PM- 9:30PM, Marriott Salon 2

- IntelliDrive Traffic Signal Control Algorithms, (P11-1779) - E05
  Event Number: 393
  Jan 24 2011 7:30PM- 9:30PM, Marriott Salon 2
For More Information

Brian L. Smith
briansmith@virginia.edu

Noah J. Goodall
njg2q@virginia.edu

http://www.cts.virginia.edu/IntelliDrive_2.html