Unlock DDI's Capacity by Re-Routing Left-Turns at Nearby Intersections

Presented by Grant Schultz on behalf of

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Greetings from the Authors
Dr. Kronprasert was injured Sept 20, 2014 and had to cancel the trip

Outline

- Introduction
- Current DDI Implementations in USA
- Constraints to DDI's capacity utilization
- Proposed Solutions
- Application to Alaska DDI
- Conclusions
Introduction

33 DDIs in 16 states in the U.S. (as of March 2014)

Number of Built DDIs by Year

- 2009: 1
- 2010: 4
- 2011: 5
- 2012: 8
- 2013: 14
Constrains to DDI’s capacity utilization – congested adjacent intersections

The Problem

- DDIs usually are planned and constructed at locations where the cross street corridors are congested.
- For coordination, the signal cycle length of nearby traffic signals determine the signal cycle length of DDI.
- The signal cycle length of DDI is inherently much shorter than the required signal cycle length of nearby intersections.

To address this limitation, the signal operation of DDI’s adjacent intersections must be made shorter and more compatible with the short signal cycle at DDI crossovers.
Proposed Solution – Relaxed Bow-tie Intersection

- Introduce two mini-roundabouts on the minor road; re-route major road left-turn traffic while the major road through traffic is being served. This design eliminates the protected left-turn phase on major road.

Proposed Solution - Superstreet

- Install raised islands at main intersection and U-turn openings at median. All minor road traffic must turn right; minor road left-turn/through traffic can U-Turn back to the main intersection to continue the intended trip.

- This design converts one multi-phase intersection into four 2-phase T-Intersections; each direction can be timed/coordinated independently. It can easily reduce the signal cycle length at the main intersection by half.
Proposed Solution – Quadrant Road Intersection

- Use existing back road with connections to both major and minor roads, convert a single left-turn into 3 right turns.
- This design eliminates the protected left-turn phase and likely the protected pedestrian crossing phase at the main intersection.

Glenn-Muldoon Interchange, Anchorage, Alaska

Source: Alaska DOT (2013)
Glenn-Muldoon Interchange, Anchorage, Alaska

- Five intersections along the Muldoon Rd corridor
  1. Zuckert Rd
  2. Golden Bear Dr
  3. DDI North Ramp
  4. DDI South Ramp
  5. Boundary Ave

Traffic Demand and Turning Movement Counts

Year 2040 PM
Design Alternatives Analyzed (3)

<table>
<thead>
<tr>
<th>Intersections</th>
<th>Design Treatment Scenarios</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersection#1 (Muldoon Rd and Zuckert Rd)</td>
<td>Signal</td>
<td>6-phase, 160-sec cycle</td>
<td>Superstreet 2-phase, 110-sec cycle</td>
<td>Quadrant 2-phase, 120-sec cycle</td>
</tr>
<tr>
<td>Intersection#2 (Muldoon Rd and Golden Bear Dr)</td>
<td>Signal</td>
<td>6-phase, 160-sec cycle</td>
<td>Superstreet 2-phase, 110-sec cycle</td>
<td>Relaxed Bowtie 2-phase, 120-sec cycle</td>
</tr>
<tr>
<td>Intersection#3 (North ramp)</td>
<td>DDI</td>
<td>2-phase, 160-sec cycle</td>
<td>DDI 2-phase, 110-sec cycle</td>
<td>DDI 2-phase, 120-sec cycle</td>
</tr>
<tr>
<td>Intersection#4 (South ramp)</td>
<td>DDI</td>
<td>2-phase, 160-sec cycle</td>
<td>DDI 2-phase, 110-sec cycle</td>
<td>DDI 2-phase, 120-sec cycle</td>
</tr>
<tr>
<td>Intersection #5 (Muldoon Rd and Boundary Ave)</td>
<td>Signal</td>
<td>6-phase, 160-sec cycle</td>
<td>Relaxed Bowtie 2-phase, 110-sec cycle</td>
<td>Relaxed Bowtie 2-phase, 120-sec cycle</td>
</tr>
</tbody>
</table>

Default driver behaviors defined in VISSIM were used in the simulation analyses.

Case 1: DDI Only

Design Controls

Measures of Effectiveness
Case 1: DDI Only

Case 2: DDI with Superstreet and Bowtie

Design Controls

Measures of Effectiveness
Case 2: DDI with Superstreet and Bowtie Intersections

Case 3: DDI with Quadrant and Bowtie

Design Controls

Measures of Effectiveness
### Case 3: DDI with Quadrant-Road and Bowtie Intersections

#### Design Alternatives Vehicle-Hours of Travel (veh-hr)

<table>
<thead>
<tr>
<th>Design Alternatives</th>
<th>Vehicle-Hours of Travel (veh-hr)</th>
<th>Travel Time Savings (veh-hr)</th>
<th>Annual Cost Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1: DDI only</td>
<td>357.9</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Case 2: DDI with Superstreet and Bowtie</td>
<td>282.6</td>
<td>75.3</td>
<td>$267,600</td>
</tr>
<tr>
<td>Case 3: DDI with Quadrant and Bowtie</td>
<td>291.9</td>
<td>66.0</td>
<td>$234,600</td>
</tr>
</tbody>
</table>

The cost saving is calculated for PM peak-hour only. Assume 260 days/year and the value of time is $13.67/hr (Tx$13.67/hrx260days/yr).
Capacity Utilization

Conclusions

- DDI design is becoming main stream in the U.S. due to its low cost and high capacity, especially for retrofitting projects.
- DDI’s capacity utilization is often limited by adjacent signal intersections.
- Broader implementation of DDI design requires low cost ways to reduce signal cycle length at nearby intersections.
- Relaxed Bowtie, Superstreet, and Quadrant Road intersections are suitable and cost effective treatments for boosting capacity at nearby signals.
- Specific treatment for re-routing the left-turn traffic should be decided based on the given traffic demands patterns at each adjacent intersection.
THANK YOU!

QUESTIONS?

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