**AN INTELLIGENT SAFETY-BASED SIGNAL DESIGN TO PREVENT REAR-END COLLISIONS AND ANGLED CRASHES**

*Traffic Safety and Operations Lab*

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### Introduction

- Many suburban high-speed intersections are plagued by:
  - Angled crashes
  - Rear-end collisions
- By integrated intelligent intersection control system (III-CS), most
  - Angled crashes can be prevented with the dynamic all-red extension system
  - Rear-end crashes can be prevented with the dynamic green termination system

**Objectives:**
- Develop a dynamic green-termination (DGT) strategy to reduce rear-end collisions at signalized intersections.
- Integrating the DGT control with dynamic all-red extension (DAE) algorithm to constitute a safety-based intersection signal system.

### System Configuration

- **Key components of the system:**
  - Wide-range sensor
  - In-cabinet computer
  - Controller
  - Communication hardware

### Control Logic

- **Dynamic Green Termination (DGT)**
  - Terminates the green beyond the initial green interval at the min-risk gap—before reaching the max. green
  - Executes prior to the max-outs
  - Measure the risk of collisions in real time and estimate the risk level over the projected time horizon up to Gmax:
    - 8 vehicles trapped in the indecision zone over each projected time point up to Gmax

### Dynamic All-red Extension (DAE)

- Extends dynamically
- Without protection
- With DAE

### Deployment

- **US 40 @ Western Maryland Pkwy., Washington County**
- **US 40 @ Red Toad Rd., North East**
- **MD 213 @ Locus Point Rd./Williams St., Elkton**
- **US 40 @ Red Toad Rd., Prince George County**
- **MD 4 @ Forestville Rd., Prince George County**
- **US 301 @ Billingsley Rd., Charles County**
- **US 301 @ Governor Bridge Rd., Prince George County**

### Results

- **Dynamic Green Termination (DGT)**
  - Baseline: DAE only
  - Strategy A: DAE + enhanced gap-out
  - Strategy B: DAE + enhanced gap-out + DGT
  - B1: online risk calculation based on # of cars trapped
  - B2: online risk calculation based on the probability of taking the “go or stop” action on the yellow phase

**Table: Dynamic All-red Extension (DAE)**

<table>
<thead>
<tr>
<th>MOE</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red-light-running rate (#/100 cycles)</td>
<td>1.6</td>
</tr>
<tr>
<td>Extension call %</td>
<td>31.7%</td>
</tr>
<tr>
<td>Detection rate</td>
<td>100%</td>
</tr>
<tr>
<td>False alarm rate</td>
<td>30.1%</td>
</tr>
</tbody>
</table>

### Conclusions

- Intersections with an advanced actuated controller can significantly reduce both the rear-end collisions and angled crashes by employing the proposed intelligent control
- **Side-angled crash:** prevented with the dynamic all-red extension module (proven with the field deployments at Elkton, Hagerstown, and North East, MD)
- **Rear-end collisions:** minimized with the two-stage Dynamic Green Termination algorithm:
  - supported by the simulation experiments with field data
  - to be deployed at suburban intersections near Bowie, Forestville, and Waldorf, MD for field test.