USING DETECTION-CONTROL SYSTEM (D-CS) TO IMPROVE SIGNALIZED INTERSECTION SAFETY

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Outline

- Introduction
  - Background
  - Indecision/dilemma zone
  - D-CS concept
  - Evaluations of D-CS
- High-speed intersection environment
  - Options for protecting decision zone
  - D-CS compared to other options
- D-CS considerations
  - Before/After test results
  - Site criteria for D-CS
- Current D-CS deployment

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Introduction

- Background
  - Previous treatments for high-speed intersections
    - Green extension systems
      - TTI Truck Priority system
      - LHOVRA
    - Green termination systems
      - Self-optimizing signal (SOS) system
      - Detection-Control system
  - TxDOT Research Project "Detection-Control System for Rural High-Speed Intersections"
    - Original research: Sept 1, 2000 - Aug 31, 2002
    - Safety and operational considerations

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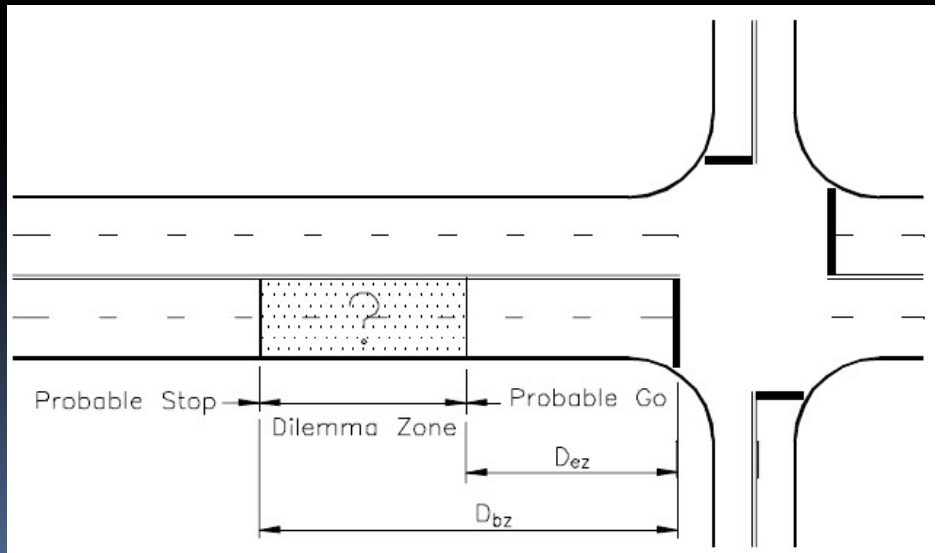
Introduction

- Indecision/dilemma zone
  - Defined as travel time to stop line (e.g., 2.5-5.5 s)
  - D_{bz}: Begin zone-90% of drivers stop & 10% proceed
  - D_{ez}: End zone-90% of drivers go & 10% stop
  - Trucks vs. non-trucks
    - 2.5-5.5 s non-trucks
    - 2.5-7.5 s trucks



D_{bz} = distance to the beginning of the dilemma zone
D_{ez} = distance to the end of the dilemma zone

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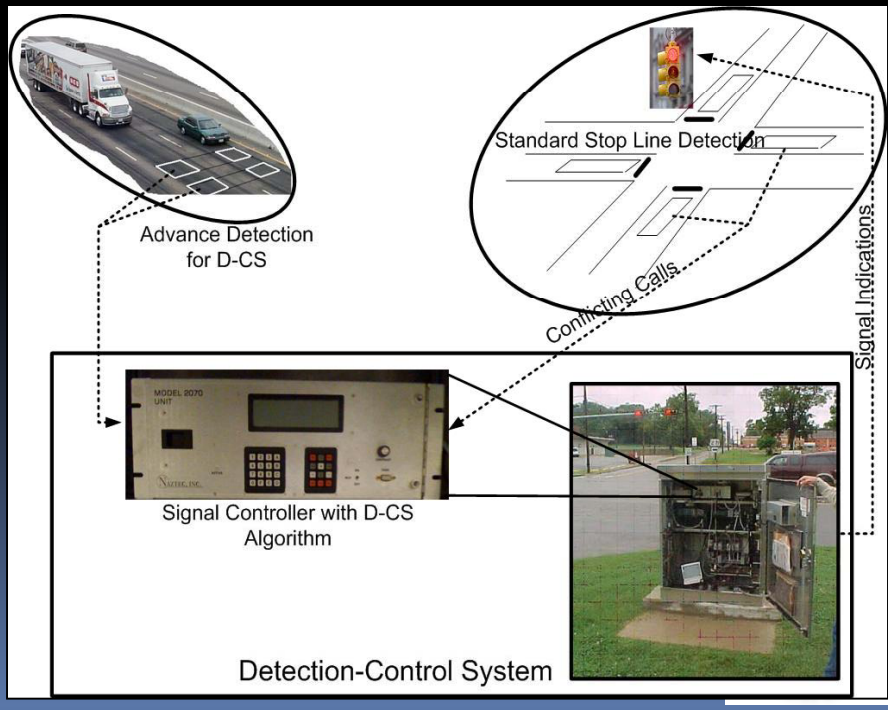
Introduction

- D-CS Concept
  - Overcomes multi-point detection limitations
  - Intelligently forecasts best-time-to-end green
    - Vehicle arrival in DZ
    - Speed/type vehicle
    - Conflicting delay
  - Safety objective
    - Reduce crashes
  - Operational objective
    - Minimize delay



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Introduction

- Evaluations of D-CS
  - TxDOT – eight sites in Texas
    - Red-light runners
    - Delays/stops
    - Crash history
  - FHWA – eight sites in four states
    - Red-light runners
    - Vehicles in indecision zone
    - Phase max-outs
    - Crash history

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High-Speed Intersection Environment

- Options for protecting indecision zone
  - Single advance detectors
  - Multiple advance detectors
    - Inductive loops
    - Magnetometers
    - Other point detectors
  - Non-intrusive detectors
    - Wavetronix SmartSensor Advance
    - Hybrid detectors by Iteris and FLIR
  - Detection-Control System

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High-Speed Intersection Environment

- Multiple advance detectors
  - Advantages
    - Well known concept and components
  - Disadvantages
    - Loop failure rates may be high
    - Potential damage from roadside work
    - Exposure to traffic
    - Might not find adequate gap in high demand situations
    - No special consideration for trucks

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High-Speed Intersection Environment

- Wavetronix Advance (SS-200)
  - Advantages
    - Non-intrusive
    - Simple setup
    - Tracks vehicles in real time
    - Adapts to variations in vehicle speeds
  - Disadvantages
    - Requires bucket truck to install
    - No left- or right-turn detection
    - Does not detect vehicles by lane
    - SS-200 max range is 600 ft from detector
    - Does not distinguish trucks (although SS200E does)

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High-Speed Intersection Environment

- Detection-Control System
  - Advantages
    - Distinguishes trucks
    - Lane-by-lane detection
    - Adapts to variations in vehicle speeds
    - Considers minor movements directly
    - Forecasts best time to end phase
  - Disadvantages
    - Uses inductive loops (although others could be used)
    - Cost of trenching and wiring
    - Point detection (not continuous)
    - Requires lane closures for installation

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Comparison of Wavetronix Advance with D-CS

Wavetronix Advance	Detection-Control System
Non-intrusive	Intrusive (loops, magnetometers)
Tracking (real-time)	Point detection
Area detection	Detection by lane
Classifies 80% of trucks	Classifies 95% of trucks
Requires bucket truck	Requires lane closure
Considers side-street delay indirectly	Considers side-street delay directly
Uncertain of accuracy in high volume	Works well in high speed, high volume
Uncertain of readiness for Conn. Veh.	Connected Vehicle potential
Intersection cost: $16,090	Intersection cost: $28,450 to $51,312

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D-CS Impacts–TxDOT Findings

- Red-light violations (10 approaches)
  - All vehicles: 58% reduction overall
  - Heavy vehicles: 80% reduction overall
- Operational measures
  - Overall changes (10 approaches)
    - Reduction in total control delay: -14%
    - Reduction in total vehicles stopping: -9%
- Crashes
  - Overall changes (5 intersections)
    - All vehicles: 39% reduction
    - Overall range from -6% to -64%

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D-CS Impacts—FHWA Findings

- Red-light violations (16 approaches)
  - All vehicles: 82% reduction
  - Heavy vehicles not evaluated separately
- Operational measures
  - Max-outs reduced by 63%
  - Vehicles caught in indecision zone reduced by 73%
- Crashes
  - Angle and rear-end crashes
    - Overall reduction 9%
    - Limited sample size

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Site Criteria for D-CS

- Isolated full-actuated intersections
- Intersection of major road & minor road
- 85th percentile speed (or speed limit) > 45 mph
- Total turn percentage (right plus left) <40%
- Truck traffic >10% (off-peak) or >5% (peak)
- Crash rates (rear-end & right angle) > similar local intersections

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Current D-CS Deployment Project

- Objectives
  - Improve safety at rural high speed signalized intersections
  - Make D-CS technology available from other signal controller manufacturers
  - Develop marketing and training materials in support of D-CS deployment

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Current D-CS Deployment Project

- Prioritize Signal Controller Platforms for D-CS Implementation
- Develop Design Specifications
- **Develop Verification Plan**
- Develop Marketing and Training Material
- Coordinate D-CS Implementation Work

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