Model Systems Engineering & Design Guidance for Intersection Conflict Warning Systems (ICWS)

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Outline

- ENTERPRISE Program
- Background
- Model systems engineering
- Design guidance
- What's next

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The ENTERPRISE Program

Members

- Arizona DOT
- Georgia DOT
- Idaho Transportation Department
- Illinois DOT
- Iowa DOT
- Kansas DOT
- Maricopa County, Arizona
- **Michigan DOT**
- Minnesota DOT
- Mississippi DOT
- Oklahoma DOT
- Pennsylvania DOT
- Texas DOT
- Virginia DOT
- **Washington State DOT**
- Ontario Ministry of Transport
- Transport Canada
- Dutch Ministry of Transport
- FHWA

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Program Focus

Goals

- Facilitate rapid progress in the development and deployment of ITS technologies
- Accelerate the systematic advancement of selected ITS projects

Members carry out ITS projects and activities including fundamental research, technology development, demonstration, standardization and deployment.

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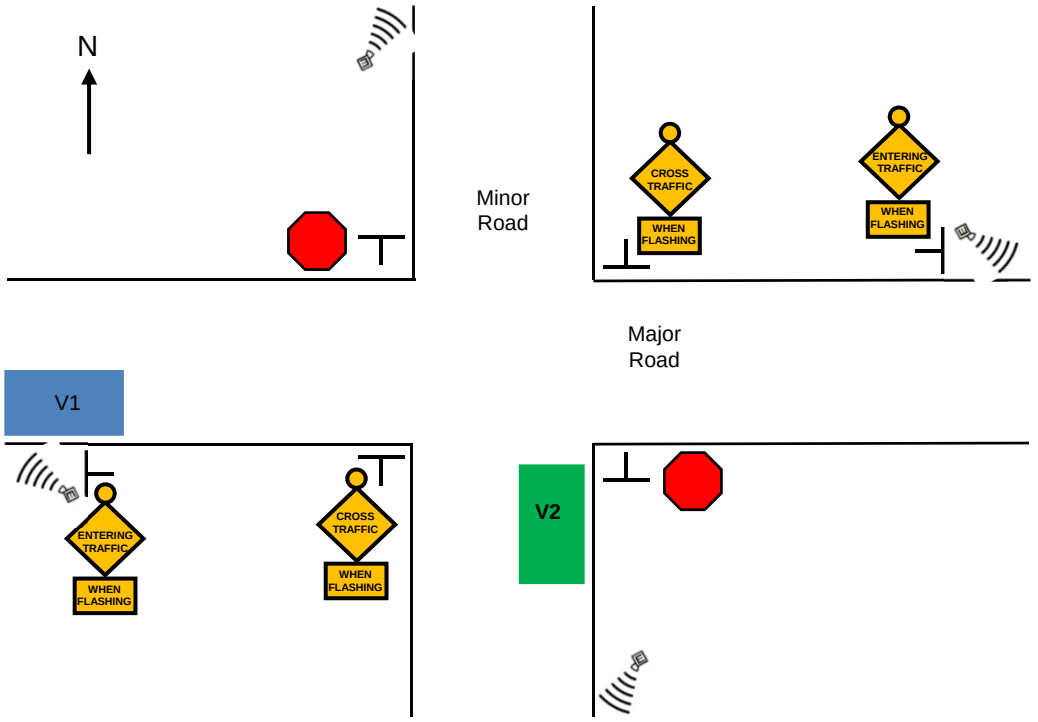
What are ICWS

Intersection conflict warning systems are used at stop-controlled intersections to provide drivers – on either or both major and minor roads – with dynamic warning of other vehicles approaching the intersection



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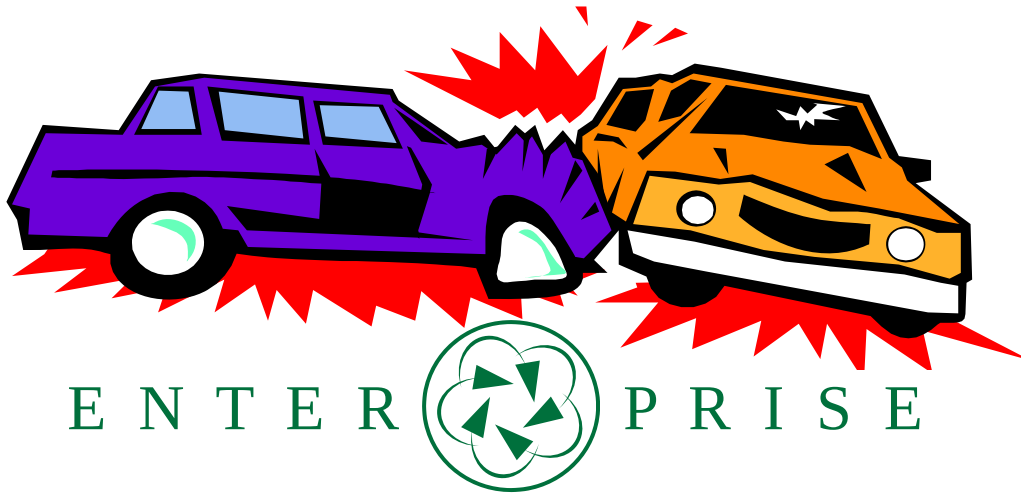
Why ICWS?

Nature of the problem

- 2,210,000 crashes at intersections in 2009 (US)
  - 40% of the 5,505,000 total crashes
  - 46% of the 699,000 injury crashes
  - 22% of the 6,770 fatal crashes



Why ICWS?

Crash Factors in Intersection-Related Crashes: An On-Scene Perspective (NHTSA, 2010)

- 96% of crashes attributed to drivers
  - 55.7% driver recognition errors
    - Inattention, internal and external distractions, inadequate surveillance, etc.
  - 29.2% driver decision errors
    - Too fast for conditions or aggressive driving, false assumption of other's actions, illegal maneuver, and misjudgment of gap or other's speed

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ICWS Background

Many agencies have deployed versions of ICWS

- Wide variety of design and operational approaches
- Very little guidance available for deployment
- Limited information available on safety effectiveness

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ENTERPRISE's Role

ENTERPRISE sought to:

- Understand what had been done and what had been learned
- Bring together organizations that have developed and deployed ICWS
- Develop an approach for more uniform deployment and further evaluation of ICWS
- Recommend preliminary design and evaluation guidance for MUTCD consideration
- Develop model systems engineering and preliminary design guidance (warrants)

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ENTERPRISE's Role

Brought together numerous stakeholder groups

- AASHTO SCOTE
- NCUTCD
- FHWA
- ATSSA
- State and local transportation agencies
- Evaluation of Low Cost Safety Improvements Pooled Fund
- Traffic Control Devices Pooled Fund

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ENTERPRISE's Role

Developed Model Systems Engineering Materials

- Offer a starting point for transportation agencies deploying ICWS
- Designed to be tailored to reflect unique or additional needs driven by agency need

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Model Systems Engineering

Design and Evaluation Guidance

- Looked national at state of the practice
- Highlights four typical layouts based on warning direction and intersection configuration
- Offers technical insight and recommended practice regarding local conditions, intended driver use, layout, options, notes and references
- Provides a common framework for evaluation

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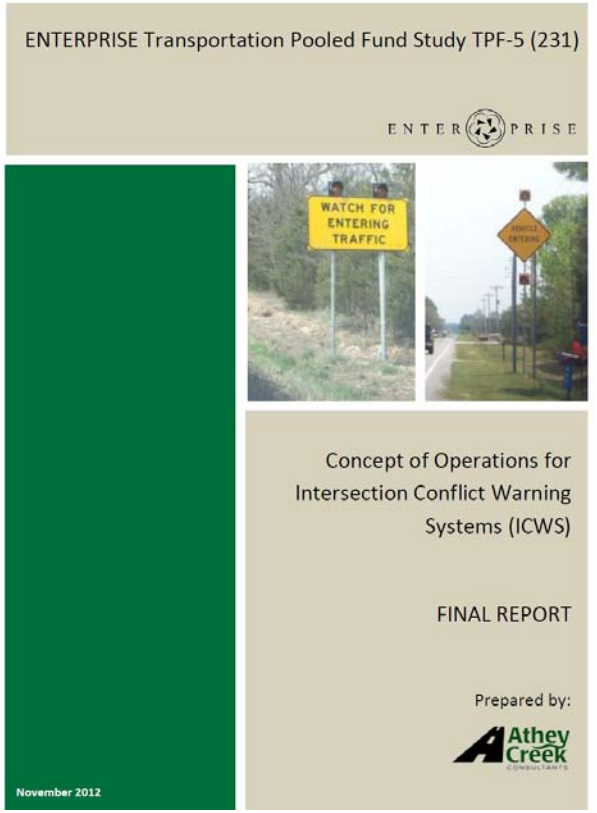
Model Systems Engineering

Concept of Operations

- Identifies stakeholders, needs, operational concept and system components
  - Articulates basic needs and operational concept surrounding ICWS
  - Based on known practices nationally
  - Does not mandate ICWS deployment, nor does it limit engineering or policy discretion of transportation agencies



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Model Systems Engineering

Example - Major road driver perspective

- Needs are rooted in challenges that drivers face at stop-controlled intersections

Challenge	ID	Need
Major road drivers approaching an intersection may not see or be aware of vehicles at stop signs or yield signs on the minor road.	1	**Major road drivers** approaching an intersection equipped with ICWS **need an alert** to indicate when vehicles are approaching, at stop signs, or at yield signs on the minor road.

- 20 specific challenges/needs were identified and detailed with operational concepts, systems components, and operational scenarios

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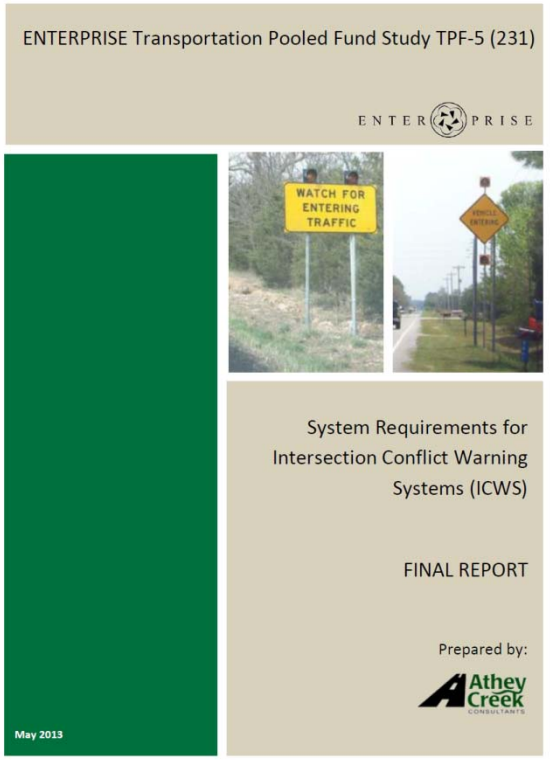
Model Systems Engineering

System Requirements

- Defines what ICWS must do and sets the basis for system design, procurement, installation and operation
- Based on needs identified in the Concept of Operations
- Requirements are verifiable and includes details that define what an ICWS will do, how well it will perform or what conditions it must perform under



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Model Systems Engineering

Example requirement based on a need from the major road driver perspective

- Covered all 20 identified needs

ID #	Needs	ID #	High Level Requirements	ID #	Detailed System Requirements
1	**Major road drivers** approaching an intersection equipped with ICWS **need an alert** to indicate when vehicles are approaching, at stop signs or at yield signs on the minor road.	1.1	ICWS **shall detect** all vehicles approaching and waiting at the stop or yield signs on the minor road.	1.1.1	ICWS **shall detect vehicles from both directions on the minor road** as they are a. approaching the intersection less than time *t*, and b. as they are waiting at the stop sign or yield sign on the minor road.
Considerations: Time *t* is a single constant for the intersection and is the largest time computed based on the major road vehicle lag time from 2.5 seconds in advance of the major road warning sign to the intersection at the posted speed limit. Distances are based on the typical condition for deceleration to the listed advisory speed for the warning of a potential stop situation as defined in MUTCD Table 2C-4. The distances are based on the 2005 AASHTO Policy, Exhibit 3-1, Stopping Sight Distance, providing a PRT (Perception-Response Time) of 2.5 seconds, a deceleration rate of 11.2 feet/second, minus the sign legibility distance of 180 feet. The distances shown in Table 2C-4 are provided as an aid for determining sign location and can be adjusted for roadway features, other signing or alert conditions and to improve visibility. Time *t* is applied to the minor road as a range for detecting vehicles that will activate the major road alert. An illustration of how time *t* may be applied is provided in Appendix A for ICWS 3 and ICWS 4. Yield sign location is included in this requirement to accommodate deployments on median-divided roadways.					

Specific Design Guidance

Design Guidance (Warrants)

- ICWS defined as a traffic control device placed on major, minor or both roads of an intersection to provide drivers with a real-time dynamic warning of vehicles approaching or waiting to enter the intersection
- ICWS are typically installed to address crash factors associated with limited sight distance and poor gap selection at stop-controlled intersections

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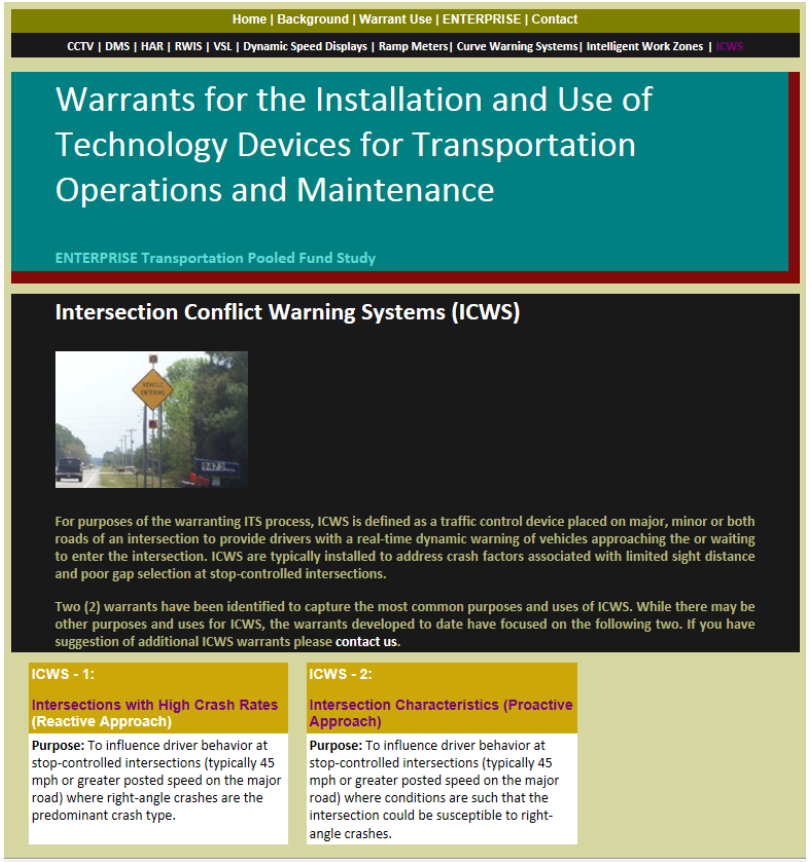
Specific Design Guidance

Two Design Guidance applications have been identified which capture the most common application focuses of ICWS:

- High crash rates
- Intersection characteristics



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Design Guidance - 1

ICWS – 1: Intersections with High Crash Rates (Reactive Approach)
Purpose: To influence driver behavior at stop-controlled intersections (typically 45 mph or greater posted speed on the major road) where right-angle crashes are the predominant crash type.

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Design Guidance - 1

ICWS – 2: Intersection Characteristics (Proactive Approach)
Purpose: To influence driver behavior at stop-controlled intersections (typically 45 mph or greater posted speed on the major road) where conditions are such that the intersection could be susceptible to right-angle crashes.

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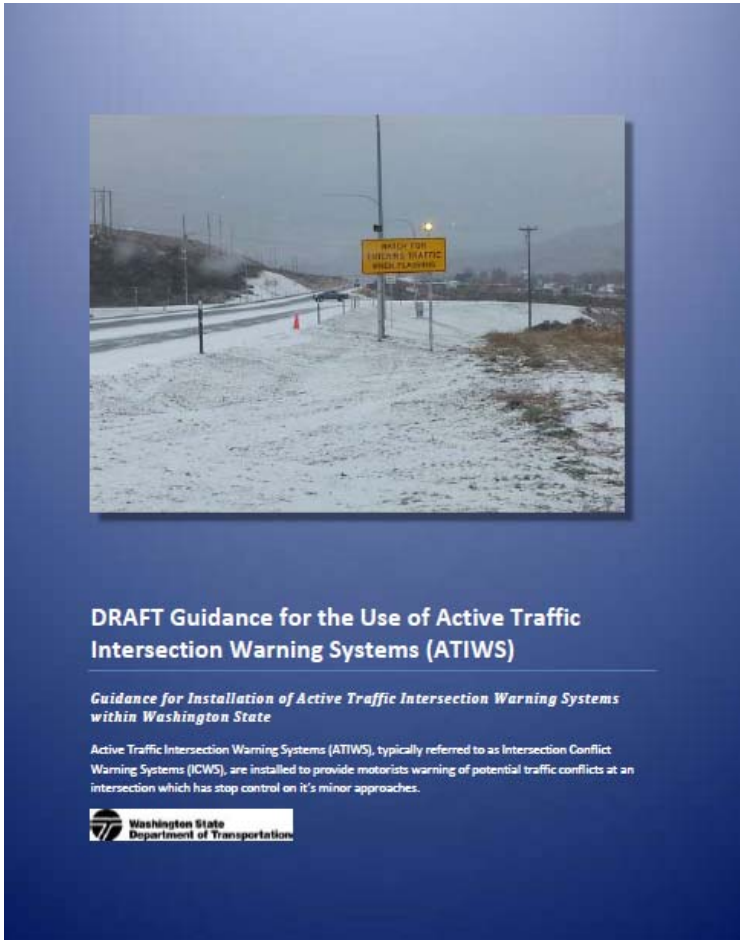
Putting it all together

Washington State tailored the model systems engineering documents, and the Design Guidance to their state's deployment needs by developing a overall guidance document:

ATIWS=ICWS



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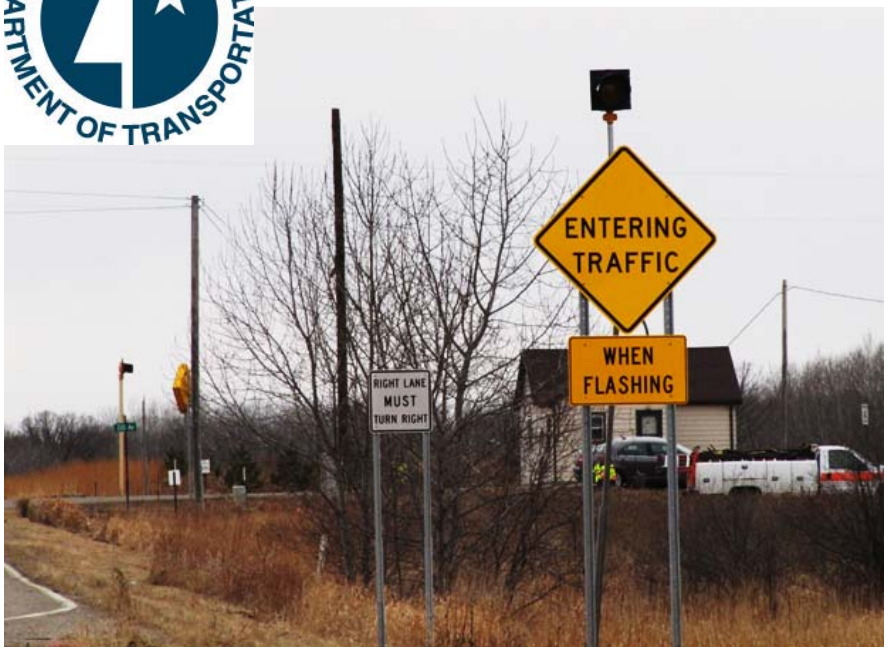
Next Steps - National

- Complete national safety effectiveness evaluation
  - Evaluation by the Low Cost Safety Improvements Pooled Fund
    - MN, MO and NC data showed consistency in crash reduction across all three analyses for total crashes
- Research human factors on sign placement and legend - Traffic Control Devices Pooled Fund
  - Will explore wording on signs, flash rate/pattern and flasher location
- Determine what will appear in 2017 MUTCD
  - NCUTCD R/WSTC Task Force recommended language to FHWA for next MUTCD

Next Steps-Deployment

Deploying more ICWS

- MnDOT Rural ICWS design-build deployment
  - 19 systems are now operational, another 13 systems will be built in fall 2014, and 17 additional ICWS in 2015
  - Total of 49 installations under the Rural ICWS project
- WSDOT deployment
  - 6 systems, 3 different design approaches for evaluation



Next Steps-ENTERPRISE

ENTERPRISE's ICWS work will also continue

- Working with SCOTE to provide Design Guidance review
- Working with the FHWA Office of Safety development of material to support engineering outreach
- Continued stakeholder coordination
- Ongoing deployment support to ENTERPRISE members

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Washington State Department of Transportation