I-35 Connected Work Zone

Project Status Overview

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Texas A&M Transportation Institute

Texas Department of Transportation

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

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Vehicle to Infrastructure (V2I) Consortium
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VOLVO Volvo Group North America

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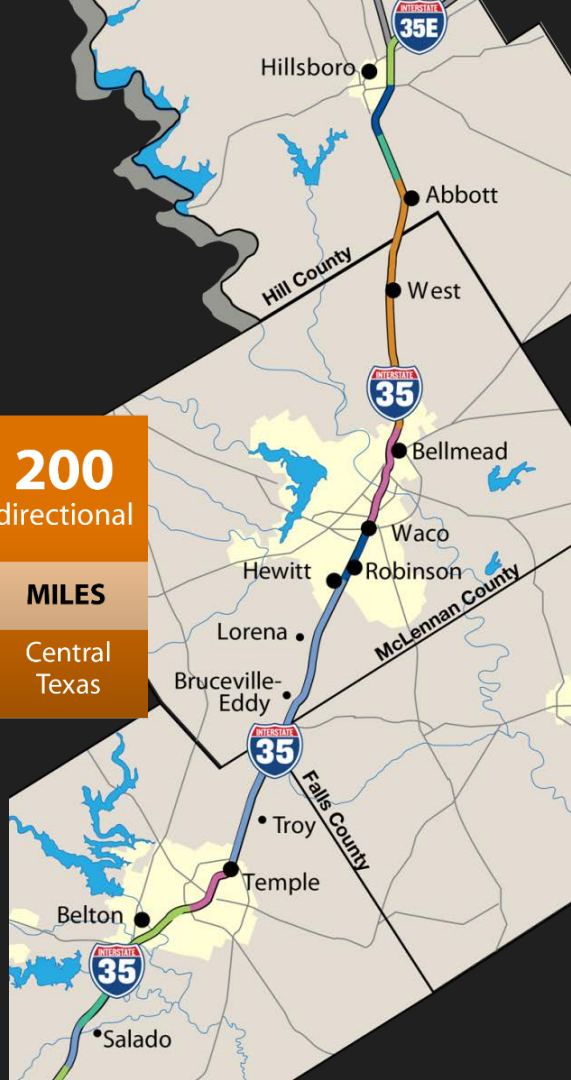
The National Transportation Systems Center

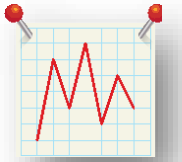
- Introduction and Welcome
- Background
- What have we done so far?
- Identified issues and mitigations
- Proposed two-tier approach
- Where are we now?
- Next tasks

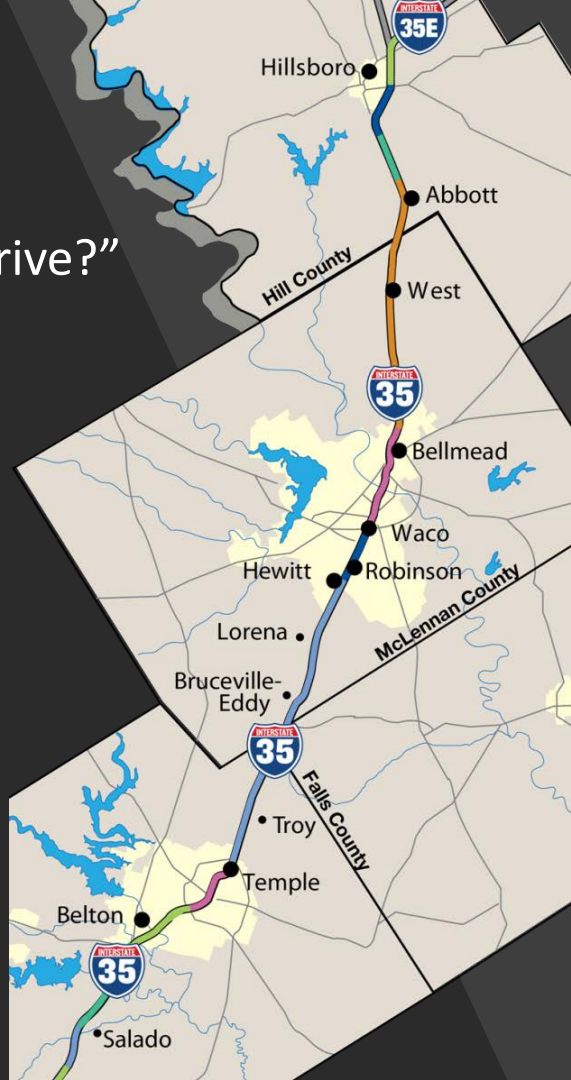
I-35 Traveler Information During Construction

$2.1 billion	Coordination of **17**	**55,000 to 111,000**	**30 million**	**25% to 35%**	Peak **construction**	**200** directional
96-MILE	**DIFFERENT PROJECTS**	**VEHICLES**	**TRAVELERS**	**TRUCK**	**2012–2014**	**MILES**
corridor construction project cost	with multiple contractors	per day	per year	traffic	estimated complete 2019	Central Texas



- “What are traffic conditions like now?”
- “What will traffic conditions be like on any portion of my drive?”
- “Where might I be delayed by work zone lane closures?”

DELAYS 	CURRENT TRAVEL TIMES 	INCIDENTS 	LANE CLOSURES 
FORECASTED TRAVEL TIMES 	DETOUR ROUTES 	CURRENT SPEEDS 	SNAPSHOTS 



Collaboration and Testbed Opportunities

- Federal Highway Administration impressed by depth and breadth of work zone information.
- Developed $2M grant to test concepts of connected vehicles with work zones in the I-35 corridor.
- Three focus areas:
  - Corridor optimization: freight
  - Connected work zone: different daily setups
  - Virtual connected vehicle testbed: test multiple applications

LISTING COVERS 7AM FRIDAY, NOVEMBER 24 THROUGH 7AM FRIDAY, DECEMBER 1

This listing is subject to change due to inclement weather or other unforeseen events that may occur.

NB NORTHBOUND SB SOUTHBOUND CR CROSS ROAD HIGH IMPACT CLOSURE

HILLSBORO THRU WAXAHACHIE (I-35E)

	DATES/TIMES	LOCATION	ROADWAY	CLOSED	MAP
NB	11/27 - 11/28, 9PM - 6AM	I-35 at US-287, Waxahachie	I-35 E Mainlanes (MM 402.0)	All lanes closed	LINK

DELAY	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM
11/27										10	15	15

	DATES/TIMES	LOCATION	ROADWAY	CLOSED	MAP
NB	11/28 - 11/29, 9PM - 6AM	I-35 at US-287, Waxahachie	I-35 E Mainlanes (MM 402.0)	All lanes closed	LINK

DELAY	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM
11/28			5	5	5					10	15	15

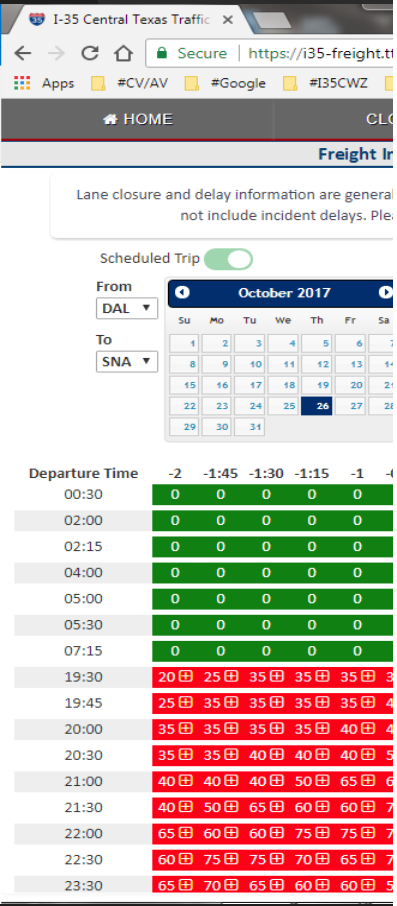
	DATES/TIMES	LOCATION	ROADWAY	CLOSED	MAP
NB	11/29 - 11/30, 9PM - 6AM	I-35 at US-287, Waxahachie	I-35 E Mainlanes (MM 402.0)	All lanes closed	LINK

DELAY	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM
11/29			10	15	10					5	10	10

	DATES/TIMES	LOCATION	ROADWAY	CLOSED	MAP
NB	11/30 - 12/1, 9PM - 6AM	I-35 at US-287, Waxahachie	I-35 E Mainlanes (MM 402.0)	All lanes closed	LINK

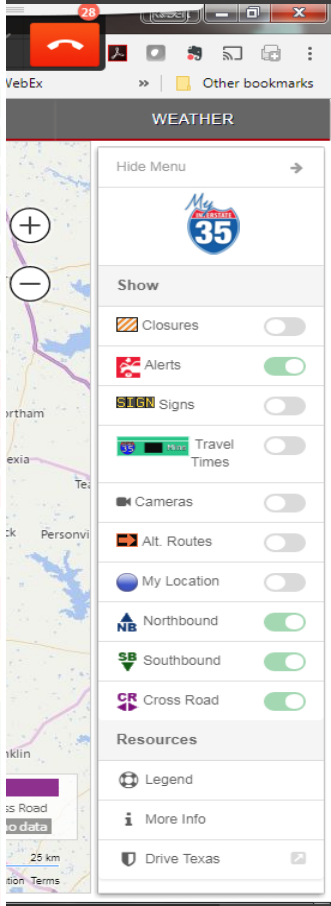
DELAY	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM
11/30			5									

SB	Current Delay as of 3:30 PM	NB
0 min	Hillsboro (MM 368) to Waco (MM 334)	0 min
75 min	Waco (MM 334) to Temple (MM 301)	5 min
0 min	Temple (MM 301) to Salado (MM 279)	5 min



Lane closure and delay information are generally available for the next 7 days and may change frequently. Trip times do not include incident delays. Please consider all information sources in your trip planning.

Departure Time	-2	-1:45	-1:30	-1:15	-1	-0:45	-0:30	-0:15	0	+0:15	+0:30	+0:45	+1	+1:15	+1:30	+1:45	+2
00:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:30	20	25	35	35	35	35	40	40	40	50	65	60	60	75	75	70	65
19:45	25	35	35	35	35	40	40	40	50	65	60	60	75	75	70	65	70
20:00	35	35	35	35	40	40	40	50	65	60	60	75	75	70	65	70	65
20:30	35	35	40	40	40	50	65	60	60	75	75	70	65	70	65	60	60
Closures	Expected Delay: 10 min -- Sterrett Rd to FM 387, Waxahachie: 10/26/2017 8:00:00 PM - 10/27/2017 6:00:00 AM, MM 407.5 - 405.0, Asphalt paving.																
	Expected Delay: 30 min -- I-35 E At US-287, Waxahachie: 10/26/2017 8:00:00 PM - 10/27/2017 6:00:00 AM, MM 404.7 - 403.3, Relocating traffic barrier.																
	Expected Delay: 10 min -- Brookside Rd to Cantrell, Waxahachie: 10/26/2017 8:00:00 PM - 10/27/2017 6:00:00 AM, MM 402.5 - 398.0, Placing traffic barrier.																
	Expected Delay: 0 min -- Pecan Tree Rd to Pecan, Waxahachie: 10/26/2017 6:00:00 PM - 10/27/2017 7:00:00 AM, MM 397.3 - 391.0, Pavement striping.																
	Expected Delay: 0 min -- Derr's Chapel Rd to FM 934 (35E), Italy: 10/26/2017 6:00:00 PM - 10/27/2017 7:00:00 AM, MM 384.0 - 379.0, Pavement striping.																
	Expected Delay: 0 min -- FM 308 to FM 566, Milford: 10/26/2017 6:00:00 PM - 10/27/2017 7:00:00 AM, MM 382.0 - 378.0, Removing traffic barrier.																
	Expected Delay: 30 min -- Private Dr. to Hart/Berger Rd, North of Temple: 10/26/2017 7:00:00 PM - 10/27/2017 6:00:00 AM, MM 306.0 - 305.0, Asphalt Paving.																
21:00	40	40	40	50	65	60	60	75	75	70	65	70	65	60	60	50	50



GOAL (Focus Area 2)

Deploy and test the Reduced Speed Zone Warning / Lane Closure (RSZW/LC) application

- Real-world work zone situations
- Interstate 35

Multiple Objectives to Get to Goal

Establish methodologies to create, deliver, and test work zone information to connected vehicles

1. Utilize existing I-35 lane closure information as start
2. Establish methodology(ies) to map work zone
3. Augment database with mapping information
4. Augment Lonestar™ with a connected vehicle module
5. Create connection from lane closure database to Lonestar™
6. Build connected work zone (RSU deployment)
7. Operate connected work zone via Lonestar™
8. Build reference vehicle(s)
9. Test connected work zone (using reference vehicle)
10. Operate RSZW/LC application / collect data / analyze

I-35 Connected Work Zone

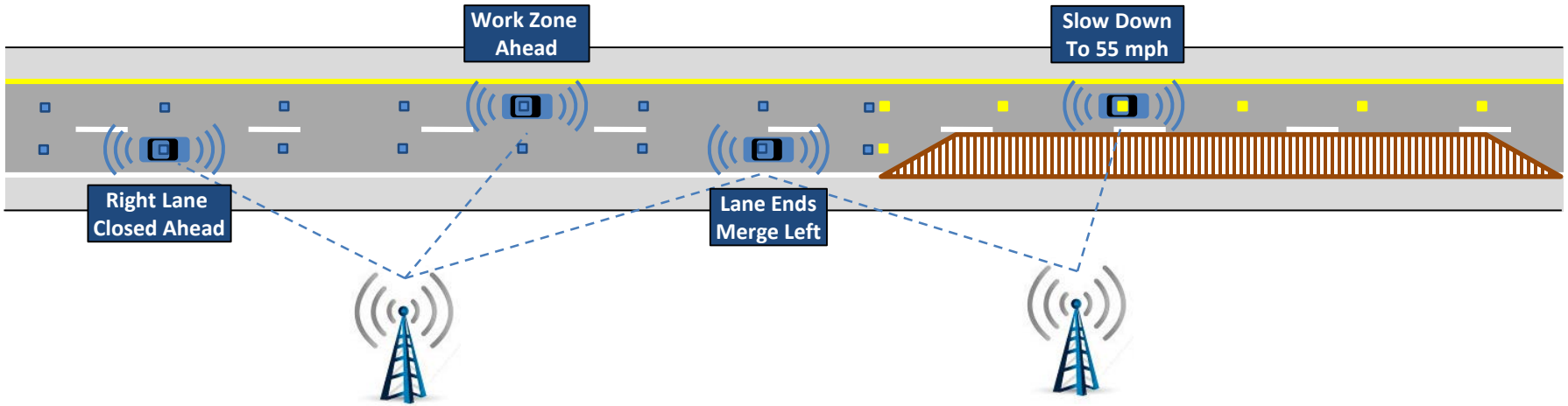
ITS Lonestar Intelligent Transportation System

SwRI Southwest Research Institute

CAMP LLC
Vehicle to Infrastructure (V2I) Consortium
HONDA Honda R&D Americas
NISSAN
HYUNDAI-KIA MOTORS
Ford
SUBARU
GM
VOLKSWAGEN
mazda
VOLVO Volvo Group North America

Texas Department of Transportation

Texas A&M Transportation Institute



What Have We Done So Far ?

Established multi-agency working relationships

Developed and refined project timeline

Established on-going technical communication process

Communicated technical details on:

- I-35 lane closure database
- I-35 lane closure real-time work zone feed
- RSZW/LC concept of operations
- Initial mapping needs and procedures
- Initial elaboration of RSZW/LC application detail
- Initial concept of operations for TxDOT Lonestar™ CV module
- Shared initial equipment list for revised concept of reference vehicle “briefcase based”

Initial collaboration with TxDOT districts for ultimate work zone placement

Issue #1

Work Zones on I-35 are significantly different from those tested in Michigan

- Short-term (from 7 or 10 pm until 7 am next morning)
- Dynamic (different lanes may be closed the same night)

Impact:

- Mapping of work zone may be difficult to accomplish prior to placement

Potential mitigation strategies:

- Search for locations where closure would be same for multiple nights
- Use less fidelity in mapping

Issue #2

Current lane closure database provides only approximate location of scheduled lane closures

- Existing information is geared for traveler information
- Not a complete map of the affected roadway geometry

Impact:

- Not enough existing detail to explicitly map locations at level RSZW/LC needs

Potential mitigation strategies:

- Increase level of detail in lane closure database
- Reduce level of detail needed for RSZW/LC application

Issue #3

Exact location of reference point at start of closure (work zone taper) is not known until the closure is actually deployed

Impact:

- Critical information to RSZW/LC application is missing

Potential mitigation strategies:

- Approximate reference point information
- Create smart barrel technology for reference point
- Reduce information needs for RSZW/LC application

Issue #4

Different lanes closed at the same location during the same timeframe requires re-mapping the roadway

Impact:

- Critical information to RSZW/LC application is missing or delayed until a re-mapping procedure is completed

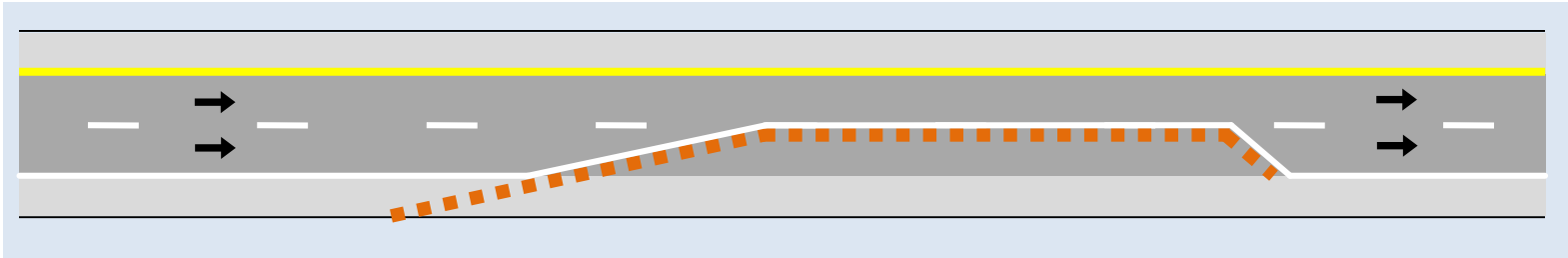
Potential mitigation strategies:

- Approximate reference point information
- Reduce information needs for RSZW/LC application
- Don’t test/use application on nights where this occurs (not realistic for wide-spread use)

Lane Closure Configurations on I-35

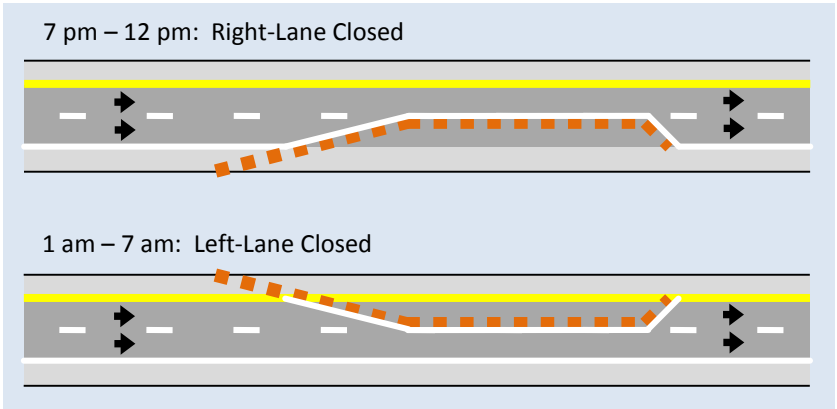
Most Common:

One of two lanes closed

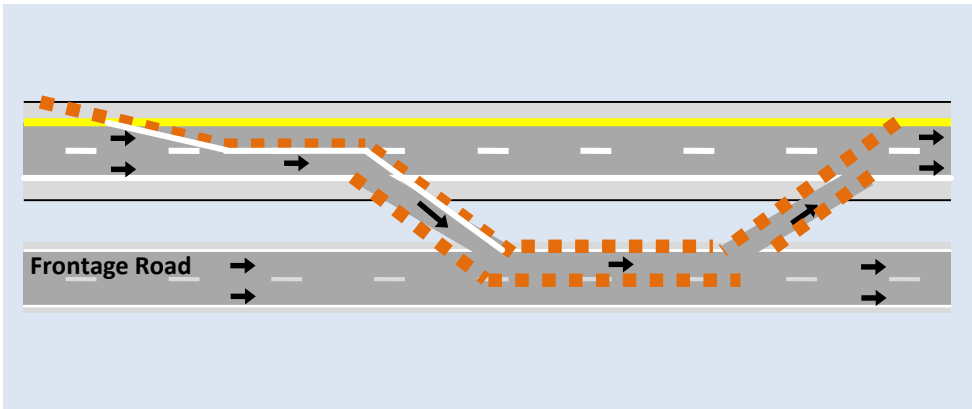


Others:

Different Lanes Closed at Different Times



Full Closure with Diversion to Frontage Rd



Recapping the Issues …..

Desire exists to test RSZW/LC to the fullest potential

Information doesn't (yet) exist to do so

Developing that is a complicated (and time consuming) process that

- involves multiple parties,
- would change how construction is contracted,
- and performed in the state of Texas

Approach: Two-Tiered Solution

High fidelity scenario

- Detailed lane-level mapping of the roadway and work zone is possible
- Reference point (beginning of lane closure taper) can be accurately defined
- Full information load for RSZW/LC application is supported

Lower fidelity scenario

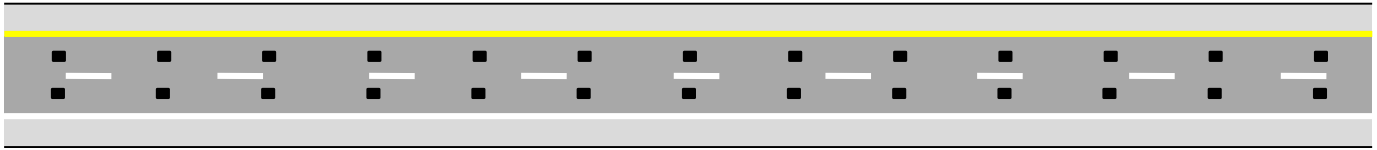
- Less detail mapping of the roadway and work zone
- Reference point is estimated
- Reduced information load for RSZW/LC application is supported

Additionally

- CAMP has developed multiple mapping procedures which can be used to support the above fidelity points

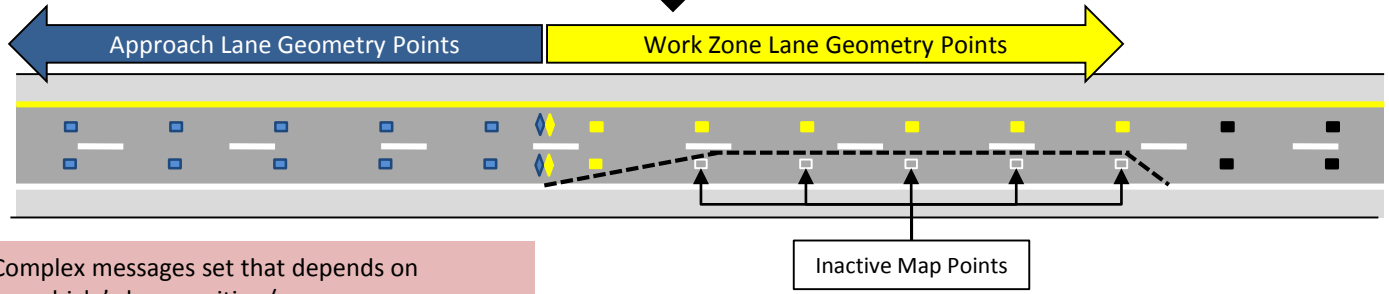
High-Fidelity Scenario

Lane-Level Mapping of the Roadway



WZ Lane Closure Data

- Lane Closure location and length
- Which lane is closed
- Time and duration of closure

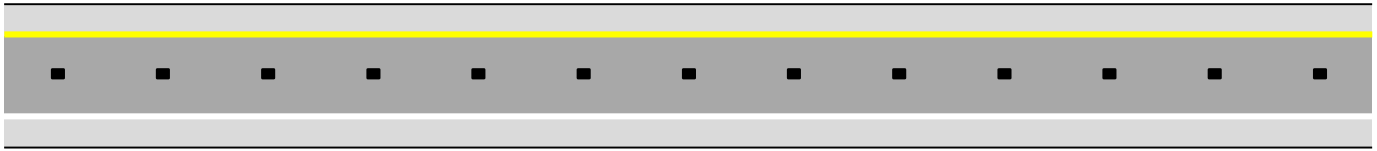


Complex messages set that depends on

- vehicle's lane position/occupancy
- distance from Ref. Point (lane closure taper)

Lower Fidelity Scenario

Road-Level (Center-Line) Mapping of the Roadway



WZ Lane Closure Data

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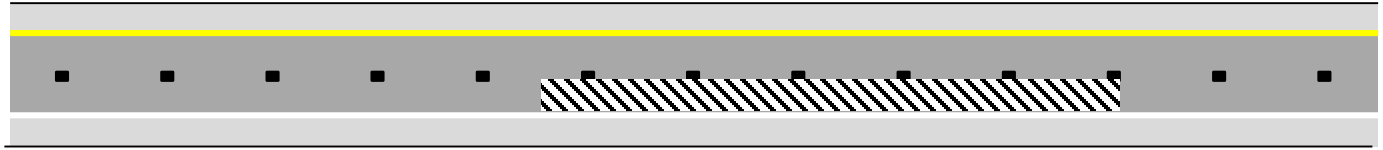

Simple Messages (e.g. Right Lane Closed Ahead)

- Does NOT depend on lane position/occupancy
- May depend on distance from lane closure

Multiple Mapping Procedures

Instrumented vehicle

- Drive work zone area
- Stay in lane
- 10 Hz data collection
- CAMP data reduction routine to ensure contiguous points and geometry stay in lane
- Identify offsets to other lanes and replicate
- Identify reference point and WZ end points
- Process XML for RSU upload

Google Earth

- Virtually drive work zone area
- Identify reference point and WZ end points
- Pick lane geometry node points for each lane
- Relies on updated imagery
- CAMP data reduction
- Process XML for RSU upload

Current Status

- Progressively elaborating technical issues
- Successfully collaborating between agencies
- Establishing definitive direction for a complex issue
- Creating plans and timelines for next steps

Next Steps

- Baseline information needs between high and lower fidelity scenarios
- Establish procedure for locating mapping data
- District and contractor look-ahead/coordination
- Multi-agency meeting and field visit (THIS MEETING!)
- Equipment procurement (possibly significant lead times)
- Equipment testing

QUESTIONS