Work Zone ITS Peer Exchange Summary Report
Bettendorf, Iowa
May 21 – 22, 2013

Introduction

A peer exchange on work zone intelligent transportation systems (WZ ITS) was held in May 2013 through the Federal Highway Administration's (FHWA) Work Zone Peer-to-Peer (P2P) Program. Attendees had varying levels of experience with WZ ITS deployments and included representatives from State Departments of Transportation (Illinois DOT, Iowa DOT, Kansas DOT, Michigan DOT, Minnesota DOT, Missouri DOT, North Carolina DOT, Ohio DOT), Texas A&M Transportation Institute (TTI), FHWA, the Enterprise Pooled Fund, Road-Tech, and the American Traffic Safety Services Association (ATTSA) ITS Council.

The workshop agenda (Appendix A) was organized to provide participants with a range of information and topics for discussion. It began with an opportunity for attendees to express why their agency may not be fully embracing work zone ITS tools as a normal course of business. This was followed by information on the various aspects of a work zone ITS project, including basics of WZ ITS, deciding when to use WZ ITS, details of how to design, specify, and procure a system and, how to use the data acquired from a system, to the variety of options available now and in the near future. This information flow was punctuated at regular intervals by discussion periods and case studies presented to provide examples and share experiences from actual deployments. All attendees participated in the discussions and contributed information.

Feedback gathered at the conclusion of the workshop indicated that each attendee had gained information from this workshop that would be valuable to take back to their respective agencies with a desire to further consider work zone ITS. In addition, they were very satisfied with the workshop and were interested in further peer exchange opportunities.

This report summarizes the key information shared during discussions at the peer exchange and is intended to accompany the presentations. The appendices contain the agenda for the peer exchange workshop (Appendix A) and details on the presentations and discussions (Appendix B).

Key Takeaways

A summary of the presentations and discussions during the peer exchange can be found in Appendix B of this report. This section provides the key takeaways of each of the 14 agenda items covered during the workshop.

Agenda Item: Workshop Overview and Introductions

Key takeaway: The audience at this peer exchange was a mix of stakeholders with and without experience in WZ ITS deployments.

Agenda Item: **Overview of Work Zone ITS**

Key takeaway: WZ ITS has been evolving over the last 15 years and has matured. Early, there were many unknowns, but as systems are becoming more flexible and tested they are becoming more proven. There will always be challenges managing and operating work zones. There are many types of WZ ITS technologies and applications, that when used wisely, can be an effective tool to help address some of these challenges.

Agenda Item: **Barriers to Using WZ ITS**

Key takeaway: Regardless of the level of experience an agency has with WZ ITS, there are still challenges to successful deployments. These challenges include procurement methods, contracting language, defining system requirements, project management, inspection and validation. We can work together and share information and experiences with fellow practitioners to help overcome these barriers. Table 1 in Appendix B provides a list of the barriers identified during the group discussion.

Agenda Item: How do I decide when to use WZ ITS?

Key takeaway: To ensure the best solution, agencies need to think carefully about the cause of any work zone issue before designing and deploying WZ ITS. Proper problem identification and definition will guide WZ ITS system requirements. Participants indicated that WZ ITS deployment decisions are currently made on a project-by-project basis, with consideration sometimes triggered by certain project characteristics (see Table 2 in Appendix B for more details). Participants do not currently use tools such as a project selection checklist for determining if a WZ ITS deployment is applicable for a work zone and indicated that tools could be useful if provided in a combination of formats, including tables or matrices. WZ ITS is generally not included in annual training at agencies, but it is sometimes discussed in case studies or lessons learned during training. Planners and designers were identified as a key target for training because project decisions affecting the ability to deploy WZ ITS are made during the planning and design stages.

Agenda Item: Case study #1 – Texas I-35 Project

Key takeaway: By following a rigorous process of identifying project issues, constraints, objectives, and user needs, Texas DOT was able to develop specific system requirements and ultimately deploy a WZ ITS solution to both meet the agency's needs as well as meet the public's needs and improve work zone safety and mobility.

Agenda Item: How do I get what I need? – Designing/Specifying WZ ITS

Key takeaway: Performing a systems engineering analysis (even if it is abbreviated) provides an agency with a solid process to identify and define its needs, and select and design a WZ ITS technology or platform. Going through the systems engineering process helps the agency obtain a system that meets its requirements and provides a clear way to test the system delivered by the vendor to ensure they delivered what was promised.

Agenda Item: How do I get what I need? – Procuring WZ ITS

Key takeaway: There are different procurement methods available for agencies to deploy WZ ITS. Each method has advantages and disadvantages. Agencies should understand these advantages and disadvantages before selecting their method.

Agenda Item: WZ ITS – Simple, low cost solutions

Key takeaway: The scope/design of WZ ITS ranges from simple to very complex, but if deployed correctly the agency can obtain benefits regardless of scope/design. WZ ITS does not have to be complex or costly. There are examples of WZ ITS deployments that are simple and low cost to an agency that can generate considerable benefits to both the agency and traveling public.

Agenda Item: Open Discussion

Key takeaway: Because few agencies have experience in all aspects of WZ ITS deployments, it is vital to leverage off of the success of peers around the country. Various efforts, such as case studies and guides developed by FHWA and the work being done by the ENTERPRISE Intelligent WZ project (see workshop presentation by Ms. Roelofs) and the Smart WZ Deployment Initiative can help.

Agenda Item: Data, how to make it work for you

Key takeaway: An agency can never have too much data, but it can be a challenge to manage all the data. Data must be formatted and collected with goals and project specifics in mind. Even if different projects seem similar, the data or alerts you need may not be the same and should be tailored to the project needs. WZ ITS sensors are almost always portable equipment and can be moved or repositioned during construction activities. This enables system flexibility and also means that agencies need to monitor their sensors to ensure that the sensors are appropriately positioned and providing accurate information.

Agenda Item: Case study #2 – Minnesota I-35 Project

Key takeaway: Clear and easily understood system requirements are critical in the contract to ensure that the agency and contractor have the same understanding and the contractor can provide what the agency requires.

Agenda Item: New Technology/Systems for WZ ITS

Key takeaway: WZ ITS is evolving quickly and there are many solutions available to improve work zones both for the DOT and the contractor. It is important to understand the agency's needs and what the technology can provide to select the appropriate WZ ITS solution.

Agenda Item: Case study #3 – Kansas I-35 Project

Key takeaway: Kansas DOT was able to take advantage of an existing Federal program (Highways for Life) to try out WZ ITS on its I-35 construction project for its first major WZ ITS deployment.

KDOT has learned a lot already and hopes to greatly advance its understanding of WZ ITS systems through this deployment, as well as retaining the equipment for future use.

Agenda Item: Wrap-up Discussion

Key takeaway: Work zone practitioners need to continue to remove the silos within their agencies that often limit communication between the construction, traffic, and ITS experts, and advance the deployment of WZ ITS on projects of varying sizes and scopes. This peer exchange assisted in developing a comprehensive list of barriers to deployment, and the next steps include identifying who and how each of the barriers can be addressed to further advance and increase the effectiveness of WZ ITS deployment. The following ideas were mentioned by participants as ways to help advance WZ ITS deployment:

- Continue to identify the barriers to WZ ITS deployment and address these barriers;
- Tear down 'silos' between entities within an agency to begin to work together. For example, permanent ITS and work zone ITS personnel need to better communicate;
- Obtain momentum by leveraging successful deployments within agencies and across agencies by sharing success stories. Continuing involvement in peer-related activities can help agencies leverage successes in other states;
- Develop guidance on standard specifications of WZ ITS systems;
- Provide guidance on procurement methods;
- Conduct more evaluations of existing systems to better document the benefits; and
- Consider more human factors testing of WZ ITS deployments.

Resources/References

FHWA WZ Web site:	Case studies, evaluation reports, and other information about WZ ITS, http://www.ops.fhwa.dot.gov/wz/its/index.htm
Enterprise Pooled Fund:	Intelligent WZ project and other studies on application guidelines and best practices for WZ ITS. http://www.enterprise.prog.org/
Smart WZ Deployment Initiative:	Studies related to work zones, including several on WZ ITS. http://www.intrans.iastate.edu/smartwz/
WZ ITS Blog:	Blog on various topics of WZ ITS by Joe Jeffrey of Road-Tech http://workzoneitsblog.com/

Appendix A – Agenda

Work Zone ITS Peer Exchange

May 2013

Agenda

Day 1

8:30 – 8:45 am	**Workshop Overview and Introductions**	Tracy Scriba, FHWA Kristi Pyle, KDOT
8:45 – 9:15	**Overview of Work Zone ITS** Definition of WZ ITS, history, technologies, components	Tracy Scriba, FHWA
9:15 – 10:15	**Barriers to Using WZ ITS** a. Identifying them b. If you're not using WZ ITS, why?	Group Discussion led by Jon Jackels, MnDOT
10:15 – 10:30	**Break**	
10:30 – 12:00 pm	**How do I decide when to use WZ ITS?** a. Selection of system b. Selection of possible projects c. Guidelines for Use: Would application guidelines be helpful? What format would work?	Tina Roelofs, Enterprise Pooled Fund Steve Kite, NCDOT Group Discussion
12:00 – 1:00	**Lunch** (on your own)	
1:00 – 1:30	**Case study #1 – Texas I-35 Project**	Jerry Ullman, TTI
1:30 – 2:30	**How do I get what I need? – Part 1** Designing/Specifying WZ ITS a. Using systems engineering b. Determining system requirements and specs	Karen Gilbertson, FHWA-KS Group Discussion
2:30 – 2:45	**Break**	
2:45 – 3:45	**How do I get what I need? – Part 2** Procuring WZ ITS a. Developing effective contract documents b. Paying for WZ ITS	Jon Jackels, MnDOT Group Discussion

3:45 – 4:30	**WZ ITS – Simple, low cost solutions** Your experience with using strategies like speed feedback signs, sensors, changeable speed limit signs.	Group Discussion led by Ken Wood, FHWA
4:30 – 5:00	**Open Discussion**	Group
5:00 pm	**Adjourn for day**	

Day 2

8:00 – 9:15 am	**Data: How to make it work for you** a. Collecting it b. Using it	Joe Jeffrey, Road Tech Group Discussion
9:15 – 9:45	**Case study #2 – Minnesota I-35 Project**	Jon Jackels, MnDOT
9:45 - 10:00	**Break**	
10:00 – 11:00	**New Technology/Systems for WZ ITS** Industry perspective on new developments and trends and how they can help with ITS in work zones.	WD Baldwin, ATSSA ITS Council
11:00 – 11:30	**Case study #3 – Kansas I-35 Project**	Kristi Pyle, KDOT
11:30 – 12:00	**Wrap-up Discussion** What can be done to help you deploy ITS solutions in your work zones and advance these technologies and applications in your State?	Group Discussion led by Jon Jackels, MnDOT
12:00 pm	**Adjourn**	

Appendix B – Meeting Summary

Workshop Overview and Introductions

Presenters: Tracy Scriba, FHWA and Kristi Pyle, Kansas DOT

Tracy Scriba (FHWA) and Kristi Pyle (Kansas DOT) provided an introduction to the peer exchange. Then each participant provided a brief introduction that included their organization, role, and experience with work zone ITS (WZ ITS). The group of participants ranged in experience with WZ ITS, with some participants new to WZ ITS and others with years of experience.

Overview of Work Zone ITS

Presenter: Tracy Scriba, FHWA

Tracy provided an overview of WZ ITS, presenting a definition of WZ ITS from past years and then took that definition and added in recent thoughts to revise the definition to make it more current. Specifically, the use of data (perhaps purchased from a third party who owns the data monitoring/collection technology) has become a more recent component to the definition. Further, in recent years agencies have been using WZ ITS to focus on customer satisfaction in addition to more traditional goals of safety and mobility.

Tracy discussed the challenges with work zones and how WZ ITS can overcome these challenges. She continued the presentation with applications of WZ ITS including brief case studies of WZ ITS deployments including: dynamic merges, work zone automated enforcement, WZ ITS to support driver route choice, and performance monitoring and management. She also discussed how WZ ITS fits in the larger framework of work zone management and transportation management plans (TMPs), and provide some references to FHWA and other WZ ITS resources.

Group Discussion

Following the presentation, the group held an open discussion on the topic of WZ ITS. Participants acknowledged that customer satisfaction has been increasing in importance in recent years, but agencies have had difficulty measuring it. If they cannot easily measure customer satisfaction, it is difficult to sell a project to their management. Others noted that the importance of capturing data to manage traffic is obvious, but it is also important to think how the data could also be used to assist in managing the projects and measuring performance.

Participants voiced concern with dynamic merging, especially with truck drivers that drive side by side and obstruct the merge process. Minnesota DOT (MnDOT) indicated that they have had similar issues with truck drivers when using dynamic merges and to reduce the issues they have used enforcement, public outreach at rest stops, and trucking advocates, which has helped. North Carolina DOT (NCDOT) had similar issues even with typical lane closures and agreed with MnDOT in that outreach to the trucking agencies has been useful in reducing the frequency of these issues. NCDOT recommend explaining the issues that rolling roadblocks could cause to the overall transportation network.

Barriers to Using WZ ITS

Group discussion led by: Jon Jackels, MnDOT

Near the beginning of the peer exchange, a moderated discussion was held with participants on the barriers they see to the deployment of WZ ITS in their agency. By naming these barriers upfront, participants could help identify possible ways to overcome them as the workshop progressed.

Table 1 includes the barriers listed by the group as well as a description of each barrier. These barriers covered numerous topics, including procurement methods, system design, project selection, system operation, deployment evaluation, and intra-agency collaboration. Many of these challenges were related to the level of experience at the agency. For example, as agencies continue to advance their understanding and familiarity of WZ ITS systems and deployments, they will be able to more accurately define their needs and deploy WZ ITS solutions.

Table 1: Barriers to WZ ITS Deployment

Barrier		Description
Topic: Procurement		
1	Funding limitations	Lack of available funding to include WZ ITS on projects.
2	Lack of qualified providers	Many providers can quickly and accurately set up temporary traffic control (TTC), but these organizations generally do not understand WZ ITS technology. There are many vendors that can provide and understand WZ ITS technology, but they are not necessarily experienced with TTC.
3	Need for methods to select qualified providers	Agencies need more guidance and/or methods for selecting WZ ITS providers to ensure that the provider is qualified.
4	Need better understanding of procurement methods	Agencies do not have a good understanding on when to purchase versus rent WZ ITS equipment.
5	WZ ITS is a small part of a construction contract	Construction contractors do not always understand the ITS component of the project and then subcontract the WZ ITS tasks to a vendor who may not meet agency objectives.
Topic: System Operation		
6	Bad past experience	A bad experience with WZ ITS can hinder future deployments because it can lead to things like a lack of confidence in the technology or difficulty in gaining approval for funding.
7	Need for inspection/validation methods	Once a WZ ITS system is in place, the agency has to have a means to inspect the deployment and validate the data being collected.
8	Difficulty coordinating ITS for moving/mobile operations	Deployments of WZ ITS can be difficult for mobile operations, as much coordination is needed to ensure that all equipment is in the proper locations through different stages of the project.
9	Difficulty setting and tracking performance-based contract terms	If an agency rents a device and is only paying for the days it is in operation, there are additional administrative costs to track the times/days when the equipment is operating correctly to ensure the contractor is being paid properly.
10	Reliability takes effort	Once the WZ ITS system is in place, the agency has to determine who/how they will maintain the system to ensure reliability.

Barrier		Description
Topic: Project Selection		
11	Difficulty determining benefit-cost value	Agencies find it difficult to quantify some of the WZ ITS benefits (e.g., customer satisfaction) and thus cannot easily generate a simple benefit-cost ratio to share with leadership to justify a project.
11	Lack of a selection matrix/tool for WZ ITS projects	Agencies often need additional guidance to determine 1) what projects should receive WZ ITS deployments, and 2) what type of WZ ITS should be deployed. A selection matrix/tool would be helpful.
12	Results focus versus technology focus	There can be a disconnect between the objectives of agency staff and management. Agency staff often focuses on what type of WZ ITS technology they will deploy; however, management is focused on the results of the deployment.
13	Inadequate planning for WZ ITS	WZ ITS needs to be included in project scoping and TMPs. WZ ITS technologies are often not included during project scoping and this makes it challenging to add into the project later. WZ ITS requires a certain level of detail, such as what is developed during design and TMP development, which may not be enough time to plan for it.
14	Maintenance needs not addressed	WZ ITS systems are not generally deployed in maintenance projects due to lack of resources and because maintenance departments may not recognize its value.
Topic: System Design		
15	Difficulty estimating costs	It can be difficult for agencies to accurately estimate costs related to WZ ITS deployments.
16	Uncertainty in how to present information to travelers	WZ ITS deployments can assist agencies with collecting data, but it can be difficult to determine how an agency should share that data with the traveling public. Benefits are lessened if the public cannot use the information to modify their travel behavior (e.g., no alternate routes exist).
17	Challenges using existing systems	Agencies often are challenged to integrate WZ ITS with their existing systems.
18	Poor definition of the WZ problem/issue	Before an agency deploys any WZ ITS, they first need to define the problem that the systems are looking to mitigate. This has often been overlooked, making it difficult to show how successful the deployment was.
Topic: Deployment Evaluation		
20	Inconsistent WZ ITS evaluation scope	WZ ITS benefits are often evaluated at the project level; however, often times the quantifiable benefits for these deployments may be better captured at the program level.
21	Lack of evaluation	WZ ITS deployments often lack a formal evaluation.

Barrier		Description
Topic: Intra-Agency Collaboration		
22	Lack of management support	More management support for WZ ITS is required to make WZ ITS a priority to ITS personnel and to garner resources and consideration during project planning.
23	Culture change needed to use data from ITS	WZ ITS provides the ability for agencies to monitor performance in near real-time. Making use of this information may require a change in culture.
24	Inadequate communication between WZ staff and ITS staff	Work zone personnel and ITS personnel generally do not communicate often/well within an agency
Topic: General		
25	Need for WZ ITS training	There is a need for WZ ITS training for agency personnel.
26	Need to improve credibility of near-time versus real-time	Agencies often provide travelers with 'near-time' information which is not the same a real-time and can change by the time a driver arrives at the location. If this delay causes the information to become inaccurate, it can be difficult to rebuild traveler trust in the system.
27	Lack of understanding public demand	Agencies need to have a better understanding of what the public expects regarding types of traveler information and accuracy.

How do I decide when to use WZ ITS?

Presenters: Tina Roelofs, Enterprise Pooled Fund and Steve Kite, North Carolina DOT (NCDOT)

Tina began this session with an introduction to the ENTERPRISE program and its ITS Warrants Project. The ITS Warrants Project began as a way to determine when/where WZ ITS is needed. Warrants, or application guidelines, were developed for 10 ITS applications, with WZ ITS as one of the ten. Tina highlighted the questionnaire that they developed to guide deployments – it is a series of yes/no questions that allow agencies a quick way to determine if ITS deployment is warranted on a project. Several states use this method as input for real world deployments.

Tina then described the Intelligent Work Zone (IWZ) Research Project that is also being done through ENTERPRISE. This project has a focus on: dynamic merges, end of queue crashes, alternate routes, and variable speed limits. The purpose of the research is to track WZ ITS projects in different states that focus on the four categories and share the information to leverage off of the success of peers around the country.

Steve Kite of North Carolina DOT provided the next presentation and discussed North Carolina's experience with WZ ITS. NCDOT does not have a formal process for deploying WZ ITS; they use guidelines and targets. Capacity reduction projects need a strong TMP that can be augmented by WZ ITS, but WZ ITS alone will not address capacity issues when major travel lanes are closed. Steve discussed different projects on which NCDOT has deployed WZ ITS, and how the technology worked. He noted that WZ ITS does not necessary stop all crashes, but certainly can assist in making responders and drivers aware of the crash promptly and allowing first responders the ability to better coordinate. These benefits assist in reducing secondary crashes.

Steve also discussed performance measurement for work zones in North Carolina. NCDOT will primarily use Inrix data. He noted that Inrix works well in more urban areas with closely placed interchanges and more TMCs. If the work zone is more rural, Bluetooth will likely be more useful. NCDOT's measures will be a combination of acceptable queue lengths and queue durations.

Group Discussion

Following Steve's presentation, the group was offered an opportunity for open discussion. The participants began by discussing the different types of data. Participants noted that Inrix data is generally useful information, but during times or areas with low volume, the data quality could be poor. Michigan uses NAVTEQ data, but they found in some areas where there are not enough probes, NAVTEQ uses historic data and that may not be accurate. Steve noted that this is true and for work zones in those areas, the data would have to be supplemented with Bluetooth probes.

Next, Tracy asked the participants how their agencies decide to use WZ ITS. Participants discussed what guidelines are used or could be used for applying WZ ITS in their State. Some States shared their criteria or approach and a summary of the guidelines offered by these States is provided in Table 2. All stakeholders that responded during this discussion indicated that WZ ITS deployment decisions are currently made on a project-by-project basis.

Table 2: Summary of WZ ITS Application Guidelines in Use

State	Guideline and Criteria for WZ ITS Deployment
Kansas	*Guideline*: WZ ITS deployments are reviewed on a project-by-project basis.
	Criteria: Field personnel can request WZ ITS or Headquarters can include it in project design; KDOT hopes to have criteria developed by summer 2014 to support project-by-project decision-making
Michigan	*Guideline*: Michigan DOT reviews most TMPs in the State and considers WZ ITS deployment at this stage on a project-by-project basis
	Criteria: Criteria that may warrant the use of WZ ITS include expectations of major delays and queues or full closures.
Missouri	*Guideline*: WZ ITS deployments are considered on a project-by-project basis.
	Criteria: Criteria that may warrant the use of WZ ITS include detours and regional impacts.
Ohio	*Guideline*: WZ ITS deployments are considered on a project-by-project basis.
	Criteria: Criteria that may warrant the use of WZ ITS include major delays, significant detours, regional impacts, and exceptions to Ohio DOT's lane closure policy.

Following are some additional details on how States decide when to use WZ ITS:

- KDOT is looking to make a list of available ITS equipment that would be distributed to the field so they could request ITS equipment for work zones.
- Ohio decides on a case-by-case basis, and times when they have exceptions to the lane closure policy or anticipate significant delay, significant detour routes, or regional impacts are when

they would often look for WZ ITS solutions. Ohio also has a Project Impact Advisory Council that reviews larger projects and they can have input for WZ ITS.

- Missouri generally has different levels of strategies and looks at them on a project-by-project basis. They may start reviewing working on off-peak work hours, or detour routes but if those do not seem to provide the benefit needed they can look at more costly options like WZ ITS. Missouri tries to keep delays less than 15 minutes. In the St. Louis area, they use the permanent ITS system to monitor all work zones as available. This information is used to supplement other work zone information for major issues.
- Illinois does not have any formal criteria, but does use end-of-queue systems (e.g., iCone, Ver-mac) in areas where there may be particular concerns.
- Iowa is looking for criteria for the use of portable systems for WZ ITS. There is interest in tying these systems into the traffic operations centers so they know what is going on in the work zones.

Ken Wood noted that end-of-queue systems seem to be a popular topic and questioned if any agencies provide detour information. Michigan noted that MDOT does provide some detour information via WZ ITS, but they do not do this very often. Minnesota has deployed alternate route information on projects in the past, and recently had portable changeable message signs (PCMS) up to 60 miles out from the work zone and found it successful.

Tracy handed out a packet on examples of possible WZ ITS criteria that included a project selection checklist. She then asked the participants if they would use such a checklist. Responses indicated that a similar checklist could be a first step to determine what systems to use, but no participants indicated using a similar checklist. Participants noted that a checklist may not be the most useful format in all instances – it is possible that a combination of formats would be best (e.g., checklist, table, matrix, etc.).

Ken then asked about work zone training, and if any of the agencies include WZ ITS in their annual training requirements. MDOT noted that WZ ITS generally comes up in their training, but it is not a specific training topic and more often comes up as case studies or lessons learned. When asked who WZ ITS training should target, a number of participants indicated that the training should target planners and designers as many of the project decisions that affect WZ ITS are made during these stages. Design-build is becoming a common project delivery strategy in North Carolina and is a good opportunity to include WZ ITS. Training could target the design-build consultants and contractors.

Case study #1 – Texas I-35 Project

Presenter: Jerry Ullman, TTI

Jerry Ullman of Texas Transportation Institute (TTI) provided a case study of the I-35 project TTI supports in Texas. This project involves approximately 200 miles of highway expansion on I-35 in Central Texas with daily traffic volumes ranging from 55,000 to 111,000 vehicles per day. This effort includes 19 contracts over 14 segments of road at a cost of $2.1 billion and is scheduled for completion in 2017. Over the course of the project, TxDOT has determined what WZ ITS to include on the project. There are numerous potential issues and constraints on the project, including lane closure constraints, potential for queues, and limited alternate routes. One of the first steps when designing this project was to identify user needs. TTI looked into the different types of travelers including local, regional, and long distance drivers to see how they would be affected by the work zone.

After defining user needs, TTI developed system requirements. They looked into alternates – standard TxDOT systems, commercial off-the-shelf (COTS), and other. Neither the traditional or COTS seemed to meet all of the system requirements so a blended technology solution was required. TTI developed an analysis of potential impacts of lane closures (LCAS) to assist in determining where to deploy queue warning systems. The analysis is contained in a live document that is linked to the actively managed lane closure database (PCNS) and the data is updated periodically based on Bluetooth sensors in the field. The Bluetooth sensors are generally placed at 2 to 5 mile intervals on the project.

Jerry described the traveler information systems on the project, including end-of-queue warning systems, advance notification (via e-mail, website, etc.) of lane closures up to a week before the closing and updated daily, a project website, and PCMS. There has been an evaluation of the public outreach efforts with over 1,000 responses; results were mostly positive for all evaluation metrics.

Group Discussion

Questions were asked following Jerry's presentation. Participants wanted to know how Bluetooth was selected versus others systems. Jerry noted that various sensor technologies are being used depending on the purpose. He indicated that they found that in some scenarios (e.g., bottlenecks) that spot sensors (e.g., Wavetronics) did not seem to be as accurate as Bluetooth, and may not provide an accurate depiction of travel speeds. TxDOT does use Wavetronics sensors for volume data.

How do I get what I need? – Part 1

Presenters: Karen Gilbertson, FHWA-KS

Karen Gilbertson of FHWA's Kansas Division Office provided a presentation laying the framework for an agency to move from identifying needs to developing systems requirements to procuring a solution that meets their needs. Karen focused the presentation on the systems engineering (SE) process, providing a simplified version of the systems engineering "V" diagram.

Karen discussed 23CFR940.11 that includes requirements stating all ITS projects be developed using a SE analysis. The analysis needs to be on a scale commensurate with project scope, and shall address seven requirements. The purpose is to ensure that agencies get what they and their stakeholders need.

When deploying ITS technology, agencies tend to follow a "consumer reports" deployment option where existing technology is evaluated, vendors are consulted, a small scale deployment done, evaluation performed, and the deployment abandoned or expanded based on the results. Karen explained that this process is not as effective in generating results an agency may be looking for as too much emphasis is placed on the technology rather than the objectives, needs, and constraints. SE allows a focus on the process and not the technology.

The basic SE deliverables include a concept of operations, requirements, high level design, a verification plan, and a validation plan. Finally, Karen discussed the outcomes of following a SE process: an informed technology selection (and one that meets requirements for Federal funding).

Karen stressed that following an SE analysis (even if it is abbreviated or simplified) allows an agency a thorough process to select a WZ ITS technology or platform, and helps protect the agency against vendors making claims they 1) cannot deliver or 2) solutions that do not meet the original requirements.

Group Discussion

Participants discussed prior experiences they had or that they have heard of where an agency wanted a WZ ITS deployment, but did not receive what they had expected. Most participants noted that previous bad experiences with WZ ITS often occurred when agencies did not understand what requirements they had and/or did not communicate these requirements to the vendor. As a result, the agency was given a solution that did not meet their needs.

How do I get what I need? – Part 2

Presenter: Jon Jackels, MnDOT

Jon Jackels of MnDOT gave a follow up presentation on different procurement methods that could be used once the WZ ITS solution is defined. Jon covered four major procurement types:

1. **Including WZ ITS in the Construction Contract**. This method is generally the easiest method for an agency to do because the ITS component can be part of the overall construction contract and payment can be included in the lump sum payment. However, there are many potential challenges with this method. By including the WZ ITS with the construction contract, the WZ ITS component may be only a small portion in overall contract value and thus a low priority for the general contractor. Because the general contractor may not have WZ ITS experience, they will likely subcontract the WZ ITS component to another vendor and it can be difficult for the agency to communicate directly with the subcontractor about the system. Because the general contractor may not understand the WZ ITS, the solution provided may not function in the way that the agency requires.
2. **Standalone Contract for WZ ITS Project**. By developing a separate, standalone contract for the WZ ITS component of a construction project, the agency can often get more focused support as they will likely hire a vendor/contractor whose only concern is the WZ ITS. This method provides the agency more control than including it with the construction project. However, there are still challenges with this method. Because the WZ ITS contract is separate from the construction contract, it can be difficult to coordinate the WZ ITS with rapid changes in the construction project due to staging, change orders, etc. In addition, having a separate contract requires the agency to manage the separate contract so there are addition administrative resources needed.
3. **Standalone Contract for Multiple Projects**. This method is similar to the previous method in that a separate vendor/contractor is hired to provide WZ ITS solutions on construction projects, but this contract would include several projects. A benefit over the single project procurement is the value of volume; the more technology being deployed, the lower costs on a per unit basis can be provided by the vendor/contractor.
4. **On-call Contract**. MnDOT has experience with the previous three contract types, but is looking to move to an on-call contract for WZ ITS deployments. An on-call contract could have either a single vendor/contractor or group of contractors on-call to assist the agency with WZ ITS needs. This type of contract would be the most flexible for the agency and provide the ability for the agency to include WZ ITS on rapidly changing construction projects, smaller projects, or maintenance projects. The challenge with this type of contract is that the agency would have to carefully consider the contract language to ensure that the vendor/contractor can meet the needs of the agency over the life of the contract.

Group Discussion – Question and Answer

Question: How would MnDOT fund an annual on-call contract for WZ ITS?

Response: The funding for this is a mix. MnDOT uses some ITS dollars, some funding comes from 'Destination Innovation' which is to be used for innovative solutions, and some of the funding is general construction funding. The one challenge is maintenance projects, for which MnDOT is still looking to determine a funding source.

Question: Would MnDOT release an RFP for an annual on-call contract?

Response: Jon envisions it would be done with a RFP.

Question: How would MnDOT scope the RFP for an annual on-call contract?

Response: This is still being determined, but one idea is to allow multiple vendors for different scale projects.

Question: Is there value in developing WZ ITS projects in a stepwise function – starting small and growing as your agency gains experience, or would it be better to begin with larger projects?

Response: Jon believes that it was useful for MnDOT to start small and continue to grow with experience.

Question: Did MnDOT specify the systems or let the vendors select?

Response: MnDOT did not necessary specify all of the components of the WZ ITS solutions, but they were very careful in describing MnDOT's existing systems and stating that the solution would be required to integrate with the existing systems.

Question: What type of communication is used and how large of an area is covered by MnDOT's existing ITS?

Response: MnDOT prefers fiber optic communication for these ITS projects, but they do not have that statewide. However, using wireless communication they could have coverage statewide. The downside to wireless communication is that it limits the amount and type of information that can be transmitted (e.g., still images as opposed to video).

Ken Wood posed the question to the audience to see if any other agencies had the ability to have statewide coverage for WZ ITS projects. Iowa DOT indicated that they have one central system and that could have coverage anywhere in the state.

A participant asked about renting versus owning for WZ ITS equipment. MnDOT rents their equipment and has a service contract to maintain it. Other participants liked this idea, but some cautioned that the agency needs to have some inventory of the equipment on hand for unforeseen events where the contractor cannot get his equipment on-site in the required timeframe.

WZ ITS – Simple, low cost solutions

Group Discussion lead by: Ken Wood, FHWA

Ken Wood led a discussion to highlight the availability of simple or low cost WZ ITS solutions for improving safety or mobility in work zones (e.g., speed feedback signs, changeable speed limit signs, etc.) and to highlight agency experiences with these options.

MnDOT described a low cost solution that they successfully implemented regarding the ingress and egress of construction vehicles. MnDOT required a contractor to only enter and exit the work zone in a specific area and had a sensor deployed at those entries and exits. When any vehicle would pass the sensor, a signal was sent that enabled flashers on an upstream sign that indicated trucks entering. A second example offered by MnDOT was during construction on a four lane divided highway where new signals were being deployed. MnDOT put a PCMS sign upstream of the signal

that was tied to the signal status and would warn approaching drivers when the signal was red to assist in preventing end-of-queue crashes. A third example provided by MnDOT involved their snow plowing operation. MnDOT's snow plow vehicles continually transmit their location via dedicated short range communications (DSRC) and this information is picked up by nearby PCMS. When a snowplow passes a PCMS, the PCMS identifies its presence and updates the PCMS message to alert drivers that a plowing operation is ahead.

Michigan DOT provided an example of how they have been using PCMS. In some work zones where the field staff had good relations with the contractor, they have been able to have the contractor reposition nearby PCMS in the event of a crash and update the sign to provide drivers with incident information.

Ken asked the group if they had any experience with speed feedback signs. The majority of the participants indicated that they seem to provide a benefit at first, but without enforcement drivers will return to previous speeds. Jon Jackels noted that in his experience, the one benefit speed trailers have in work zones is that while they may not greatly reduce the mean or 85th percentile speeds, they do tend to reduce speed variance in the work zone.

Ken also asked the group for experience with variable speed limits. MnDOT indicated that they had some experience with variable advisory speed limits, but only have a limited dataset so all findings are anecdotal; in Minnesota, variable speed limits seem to help reduce rear-end crashes by reducing the shockwave. Tracy Scriba indicated that Virginia DOT deployed variable speed limits on a project, and while she was not aware of the exact results of the project, from her memory she believed that it had not been as effective as Virginia DOT had hoped. St. Louis deployed variable speed limits on a recent project but had issues with credibility. The speed limit signs would show a 45 mph speed limit, but when congestion caused traffic to travel less than 20 mph some travelers did not think the speed limits were accurate.

Iowa DOT asked if anyone had experience with countdown clocks for pilot cars. This would be a PCMS positioned as the driver approached the queue and would indicate the time until the next pilot car arrives. The purpose for deploying this type of WZ ITS solution would be strictly to improve customer satisfaction. The only agency that had experience with this type of WZ ITS deployment was Kansas DOT, and their limited experience did not find it to work well. Some issues in Kansas were that the countdown clock only went to 2 minutes, and for the last 2 minutes the PCMS would be switched off. Also, the time was based on the previous four travel times, so if there were any outliers or issues the countdown clock could be off; the general consensus of both the public and project staff was that the signs were not accurate enough to be effective.

Open Discussion

Missouri DOT asked the group what their policy was for reducing speed limits in work zones. Traditionally, MoDOT does not reduce work zone speed limits unless they have to, but the construction contractors generally push for lower speeds limits in an effort to protect workers. Iowa DOT noted that contractors in Iowa have the same concerns, but what has worked was to meet with the contractors and discuss how speed variance is more dangerous to the workers than the average speed and lowering the speed limit too much will increase speed variance if it has a poor compliance rate. North Carolina DOT leaves the speed limit reduction up to the regional traffic engineers, but unless there is a severe reason, there will not be a reduction of more than 10 mph. Tracy Scriba noted that a new NCHRP project selected for funding will look at compiling state WZ speed limit policies, and will also look at how states define a work zone.

Another question was asked regarding studies before and during the work zone to determine how the work zone affected safety and mobility on the road. Michigan DOT indicated that they have completed a number of these studies, but the results were mixed. On some projects, the work zone saw a lower crash rate, but on others the crash rate increased. It is sometimes difficult to determine if the crash occurred because of the work zone, or if it would have occurred regardless. Jerry Ullman recommended that anyone interested in this should review NCHRP Report 627 which has a section that discusses this type of study.

Data, How to make it work for you

Presenter: Joe Jeffrey, Road Tech and author of WZ ITS blog (http://workzoneitsblog.com/)

The second day of the peer exchange featured presentations from vendors as well as State DOTs. The first presentation of the day was given by Joe Jeffrey of Road Tech on work zone data, including what types of data exist and how the data from WZ ITS can benefit an agency. Joe discussed how data can be used (e.g., real-time data can be used for work zone management while historic can be used for planning), and how to think about data collection. Joe noted that agencies often wait until after an incident takes place to modify any temporary traffic control (TTC) in a work zone. Collecting enough data would allow agencies to monitor performance and make changes to TTC prior to an incident taking place. He stressed that agencies must think about what measures they are trying to capture when collecting the data to ensure that the data collected will be useful. Joe discussed the different types of data, including system outputs such as traffic condition information, security and systems information, and WZ ITS device maintenance information, as well as the types of metrics that each type of data could provide.

This presentation also covered the importance of raw data. Joe noted that while many WZ ITS solutions offer the ability to set up alerts to notify the agency when a certain activity occurs in the work zone, it is useful to continually monitor the raw data that trigger these alerts to gain additional information, minimize false alarms, and refine the alerts.

Joe concluded his presentation with guidance on collecting work zone data. He noted that agencies should ensure that sensors are placed far enough upstream to properly measure queue length, agencies should monitor their sensors to ensure that they are collecting the intended information (i.e., they have not been moved or repositioned during construction activities), and that the frequency of collecting data often is a function of the type of data being collected (e.g., data for queue warnings will need to be collected more frequently than data for travel times).

Group Discussion

Jon Jackels noted that generally all WZ ITS systems collect data on traffic traveling through the work zone. Jon would like to see more of an emphasis on data collection for the construction. For example, Jon believes agencies and construction contractors alike can benefit from instrumenting their equipment and workers so that there is a better understanding of where equipment is at all times, and how different work zone activities affect traffic in the work zone. Often work zones are set up when no construction activity is underway, and this is frustrating for the public.

Joe asked the group what they believed metrics should be to establish a baseline for safety data. In Michigan, MDOT has used the average baseline crashes before the work zone, but in some instances there were work zones up or down stream from the current work zone that may have affected the data. Ken Wood indicated that if an agency had enough data, they could conduct analysis of the transportation system to identify segments of similar type where a work zone was established to establish baselines as opposed to simply looking for other work zones on the same road. Steve Kite

indicated the challenge with Ken's proposed method was that often work zone datasets are either limited in the data collected or vary greatly, so it is difficult to conduct this type of analysis.

The group also discussed work zone performance measures, including what these measures are and how should they be used. Steve indicated that he has been focusing on mobility as the performance measure for work zones because mobility impacts are generally the measure seen by most of the traveling public. Kristi Pyle noted that agencies should also ensure that they understand how to convey performance measures into contract language to ensure that the performance measures established by the agency will be enforceable.

Joe does not believe that there is can be 'too much data', but many of the participants indicated that managing data is a challenge to them. Agencies have to determine what data they will use and in what format and put that information into contract language for the provider. Joe indicated that he does provide some analysis for his customers, but generally his role is to provide the raw data. Joe believes that WZ ITS vendors need to be more proactive with agencies and show the agency what type of alerts or reports they can generate to assist the agency in maximizing the use of their WZ ITS systems and the data they provide.

Case study #2 – Minnesota I-35 Project

Presenter: Jon Jackels, MnDOT

The second case study covered a MnDOT project on I-35 and was presented by Jon Jackels. Jon provided an overview of the project and lessons learned about WZ ITS. This project covered approximately 70 miles of I-35 between Hinckley, MN and Duluth, MN with an objective of providing travel time and congestion information to motorists on rural freeways using an innovative approach. The project implemented the use of static/dynamic hybrid travel time signs to provide information to drivers so they could make educated route choices. On the project, MnDOT had a standalone contract for the travel time signs. They pre-qualified three vendors and used best value procurement based on: qualifications and experience, schedule, quality, and performance-based criteria.

MnDOT used pay for performance on the project by establishing how they expected the system to operate and only paid the contractor if the system worked as described. This method transferred the risk to the contractor to ensure that the system was working. In this project, there was an instance where the sensors were collecting data properly, but the data was not being pushed to the PCMS and the contractor was penalized pay for that day. Jon also discussed the quality control aspect of MnDOT's deployment. Agencies need to think about how they will determine the appropriate level of inspection.

A challenge experienced during this project was that the contract required the contractor to have a project website and have the website linked to MnDOT's 511 website. Both MnDOT and the public did not like this system because it involved two separate websites. For future projects, MnDOT will require data from any WZ ITS projects to be pushed to their statewide system so the information can be populated on their existing 511 website.

Open Discussion – Question and Answer

Question: How do you decide what type of inspection for travel times?

Response: MnDOT used the floating car method for travel times because they wanted a low cost method and they did not want to set up independent sensors. Jon does not believe MnDOT would use the floating car method for all projects in the future. The results of the floating car runs found that the travel times were off less than five percent of the time. The times were mostly correct

during free flow and congested times; it was the transition between the two when there were some inaccuracies.

Question: What arguments did the contractor have with regard to pay for performance?

Response: The contractor argued that MnDOT did not state the requirements clearly enough.

New Technology/Systems for WZ ITS

Presenter: WD Baldwin, ATSSA ITS Council

This presentation provided the group with an industry perspective on new developments and trends and how they can help with ITS in work zones. WD Baldwin was presenting on behalf of the American Traffic Safety Services Association (ATSSA) ITS Council and began the presentation with background on the ITS Council and discussed the different categories of WZ ITS. He discussed how the challenge is not always the technology itself, but implementing the technology. He provided an update on recent technologies and systems for WZ ITS, including:

- **Applications**: performance measures, dynamic work zones;
- **Technologies**: automatic video analysis, comparison; and
- **Approaches**: Texas (consistent methodology for deployment of queue detection and reporting), Utah (reduce work zone queues and delays for paving).

WD discussed a complex project he supported in Oregon that used new WZ ITS systems and technologies. This project had 365 work zones for bridge construction to be addressed over a period of 8 years. It was vital that the systems were deployed and verified to ensure that data was correct. In Oregon, staff conducted hand counts and calculations to verify the sensors, but it would have been useful to have independent systems to automate this procedure.

New WZ ITS systems and technologies are providing agencies and contractors alike the ability to monitor and react to changes in real-time. For example, it can be useful for the contractor to look at real time volumes so they can compare the actual to the planned volumes and adjust their work activities if possible. If the contractor expected 1,400 passenger cars per hour at the onset of lane closures, but the actual was 2,000 passenger cars per hour, the contractor might be able to reschedule the lane closure to minimize delay. WZ ITS technologies will assist performance measurement as well, such as in design-build projects where the contractor is responsible for meeting measures such as "keeping traffic moving" or other measures difficult to capture with traditional methods.

WD believes that WZ ITS is heading in the direction of a focus on in-vehicle technology, cell phone sources, a focus on results, open platforms, and portability/flexibility. He concluded his presentation with the benefits of WZ ITS. WZ ITS can improve safety, reduce congestion, assist the contractor in scheduling work activities, and allow the agency to make more informed decisions regarding their work zones.

Open Discussion – Question and Answer

After WD's presentation, he asked the participants if they believed their agency would prefer to own the WZ ITS equipment or if they just wanted results of the system deployment? Most participants indicated that their agency would prefer the results and not the equipment. Another opportunity would be to purchase equipment for the work zone, but leave that permanently after the work zone is completed to add to their ITS infrastructure. Kristi Pyle noted that Kansas DOT will be purchasing some WZ ITS equipment shortly and that owning the equipment will allow them

an opportunity to learn how it operates so they can better develop requirements and move to renting in the future.

Question: Is ATSSA is looking to develop training so that a list of 'qualified WZ ITS vendors' can be established?

Response: At the current time, WZ ITS is so varied and tailored to specific projects, it is difficult to develop standardized training akin to ATSSA's traffic control training.

Question: Can the cost of WZ ITS be estimated as a percentage of total project cost?

Response: No because of the variations of types of projects and budgets. For example, a WZ ITS component would be a much higher percent cost on a small value construction project than a large one. Further, the type of WZ ITS system affects cost; a standalone queue warning system would be much less costly than WZ ITS deployment fully integrated with existing systems.

Case study #3 – Kansas I-35 Project

Presenter: Kristi Pyle, Kansas DOT

Kristi Pyle of Kansas DOT presented the third case study, an I-35 project in Kansas. This project is constructing a new interchange on I-35 in southwest Kansas City. The project includes a smart work zone with delay information, queue detection and warning, variable speed limits, cameras for visual confirmation, and a public website. Kansas DOT is deploying the WZ ITS on the project and is retaining the WZ ITS equipment, but not the vendor's software system. KDOT will integrate the equipment into Kansas's system following completion of the project. One of the goals of this WZ ITS deployment is to collect as much data as possible and use it both during and after the project.

KDOT has had a number of challenges. This deployment was a construction project and the WZ ITS contract was issued to a subcontractor to the construction contractor. The low bid vendor did not read the system specifications and it took time to ensure that the system would meet KDOT's needs. Also, this project has a very aggressive schedule and this caused a lot of the details to be decided quickly.

Kristi provided a demonstration of the vendor software. She ended her presentation with the benefits KDOT sees from this WZ ITS deployment. As this was their first major WZ ITS deployment, the ability to work with the vendor's programming team was very valuable. Also, because KDOT will retain the WZ ITS equipment following completion of the project, they can continue to work with and learn from the system to improve future projects.

Open Discussion – Question and Answer

Question: How will KDOT evaluate the project's performance?

Response: The three metrics are safety, congestion, and user satisfaction.

Question: MnDOT does not want to own the WZ ITS equipment as it leads to administrative, storage, maintenance, etc. costs. Why does KDOT want to retain the equipment?

Response: WZ ITS is new in Kansas, so owning the equipment will allow KDOT to learn. KDOT wants to have equipment on-hand in the event they have a need to quickly deploy it in a work zone.

Question: How long was KDOT originally intending to use the WZ ITS system?

Response: Originally the project was scheduled for two construction seasons. However, the schedule was compressed to only 60 days.

Question: What was the cost for the WZ ITS and equipment?

Response: The contract was valued at $1.1 million.

Question: What is the spacing for the variable speed limit (VSL) signs?

Response: The work area is about 2.5 miles in length and they have 1 advanced VSL, 1 at the taper, 1 at the middle, and 1 (resume speed) at the end.

Wrap-up Discussion

Group Discussion

The final session was a group discussion that focused on what can be done to help deploy ITS solutions in work zones and advance these technologies and applications. The following ideas were mentioned by the audience to help advance WZ ITS deployment:

- Continue to identify the barriers to WZ ITS deployment and address these barriers;
- Tear down 'silos' between entities within an agency to begin to work together. For example, permanent ITS and work zone ITS personnel need to better communicate;
- Obtain momentum by leveraging successful deployments. Further, continuing involvement in peer-related activities can help agencies leverage successes in other states;
- Develop guidance on standard specifications of WZ ITS systems;
- Provide guidance on procurement methods;
- Conduct more evaluations of existing systems to better document the benefits; and
- Consider more human factors testing of WZ ITS deployments.