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Good afternoon my name is Sally and I will be your conference operator today. I would like to welcome everyone to the conference call. All lines have been placed on mute to prevent any background noise. After the speaker's remarks there will be a question-and-answer session. If you would like to ask a question at this time simply press star and the number one on your telephone keypad. To withdraw your question press the pound key.

Good afternoon or good morning depending on where you are. Welcome to the tenth webinar in the Smarter Work Zones webinar series “Designing ITS based on identified Needs.” I will moderate today's webinar. Recently we have been experiencing issues with the voice over IP in Adobe Connect. Adobe is working to resolve this issue, however a permanent fix is not yet in place. If you experience poor audio quality, the best solution is to call the teleconference line. If the computer audio completely disconnect please bear with us for a moment as we fix this issue.

Today we have three presenters Todd Peterson of the FHWA Office of Operations, Solomon Haile, of the Colorado Department of Transportation and Jon Jackels of SRF consulting group. Todd Peterson is a member of the Smarter Work Zones Implementation Team for FHWA’s Every Day Counts Initiative and works to promote the adoption of Work Zones Intelligent Transportation System (ITS) solutions to better coordinate highway construction project to accelerate project delivery and reduce costs reduce congestion. Todd is a licensed PE and PTOE and received his master degree in civil engineering from Virginia Tech. Solomon Haile in the resident engineer, and has been with Colorado's DOT for 23 years. In his position as resident engineer, he develops transportation systems management and operations strategies for implementation during highway construction that include safety and mobility improvements, congestion reduction strategies about transportation system management and operation strategies for implementation during highway construction that include safety and mobility improvements, congestion reduction strategies, and coordinated, integrated multi-modal systems management to yield an optimized transportation system and reliable travel times for travelers, commercial vehicle operators, bicyclists, and pedestrians. Solomon Haile is a licensed PE and the received his Master’s degree from University of Colorado at Boulder.

Jon Jackels of SRF consulting group is a senior associate and has more than 40 years of traffic engineering experience including nearly 40 years with Minnesota DOT, and his most recent role as a development engineer in the ITS Section of the office of traffic, safety and technology. Jon’s duties have included researching new technologies, understanding how new and existing technologies can be adapted for new applications, managing and developing systems engineering for the design of new systems, and evaluating the performance of these new systems and technologies. Jon is a licensed PE and certified PTOE and received his bachelor’s degree in Civil Engineering from the University of Minnesota. Today's webinar will last 90 minutes. If during the presentation you think of a question you can type it into the chat area. Please make sure you send your question to everyone and indicate which presenter your question is for. Presenters will be unable to answer during the presentation but we will come halfway through to answer questions. We will answer questions again at the end of all presentations. In addition of time

allowed and will open up the phone lines. The PowerPoint presentation used is available for download from the file download box in the lower right-hand corner. The presentation will also be available online within the next few weeks along with the recording and transcript. I will notify all attendees once this is posted online. FHWA does not certify participation for continuing education credits though it still may be claimed for credit towards professional development hours. Please contact your professional certification board for reporting requirements. Your registration confirmation is the only proof of attendance we will be able to provide. I'm now going to turn it over to Todd Peterson.

Thank you Nicole. This is the 10th in our biweekly smarter work zones webinar series associated with our EDC-3 initiative, Smarter Work Zones. We covered a lot ground in the webinars to date, all the topics you see listed here we discussed in the past and the webinars that we have conducted to date are available on our work zone safety information clearinghouse website at the link given below. We have both the slides and recorded sessions for most if not all of the prior webinars. I encourage anyone who has not seen them to catch up on them.

Our next webinar number 11 will be Wednesday, March 23, considering a topic to conduct as a follow-up here. I know at some point we will be talking about the later steps and the guide but today we will be talking about the steps one through three of the Work Zone ITS implementation guide. That the purpose of today's webinar. It plays into the technology application initiative under smarter work zones and we will talk a bit about what that is relative to the Smarter Work Zones initiative. We will give a detailed discussion of what steps one through three actually are and will take the opportunity to cover some examples on smarter works on ITS implementation step that have occurred in the context of one through three of the guide. One of the interesting things is that the Work Zone ITS implementation guide with a fairly new document and not a lot of agencies have had the opportunity to follow strictly through those steps, so these are presented as an example in the context of what those steps are and how they can be applied in future implementations of ITS.

Just to give an overview of what the initiative is Smarter Work Zones and during general is an idea of increasing the ability to manage and operate works on using technologies in use techniques to enhance safety, by reducing works on crashes, reducing enhancing the ability by reducing works on legs and increasing those sorts of things. Smart works on for using new technology and techniques, one of the ideas is to give agencies opportunity to get their hands on some enhanced tools for works on strategies to assist with managing work zones.

One of those there is two parts of the smarter work zone project coordination application. Project coordination is more of a procedural policy based initiative that involves coordinating multiple works on activities within the right-of-way to minimize the collective impact of multiple works on a construction. That also includes some tools and often tied into technology application which itself is specifically for the employment of intelligent transportation systems geared to managing what happening in your work zones, collecting data, providing feedback back to the agency, and ultimately delivering information, and travel information to drivers, communication with construction staff on-site this really ties to use of technology and enhancing works on operations management.

Technology application a little more understanding of what it is really tight to improving driver awareness, by enhancing the flow of information from the field through the agency into better informed, more actionable guidance. To drivers and the people that actually have ownership of managing the work done. You see this provides an example, telling a driver something that useful is better than just saying work ahead, which doesn't tell a whole lot, just tell them something specific contributions to the end of the work zone. That's what we are trying to implement through technology application.

As far as the smarter work zone initiative we have two goals, the first is that by the end of this year, through the smarter work zone initiative 35 state DOTs will have implemented business processes for work zone ITS technologies identified in the work zone ITS implementation guide. It's helping agencies operate the policies for state practices, what they do, how they go through the process, as part of a reintegrate the idea of how to implement work zone technologies in the eye.

The second goal we are looking for 35 agencies who have utilized at least one work zone ITS technology application for the management. The first role was primarily related to policy, this is related to actually implementing the systems.

With that overview, I want to take some time to talk about the work zone ITS and limitations it. Specifically the initial step in the discussion of case studies. The guide was published in January 2014, I think it's a great publication provides good guidance, it's six steps to work through that agencies should consider. Rather than being sort of a technical folks review of specific tools and procedures as a project management tool that agencies can use to walk through those six steps that provides some system engineering approach to work some ITS implementation. It is available to download as well as hard copies are available. It is also available online on the link here.

This shows in the six steps, it walks through the very early stages of planning, that the ITS systems are intended to address, all the way to operating and maintaining an evaluating the system to learn how well they work you can do better next time. The first three steps are what we're going to focus on today this will take users from the early planning stages through details as the planning, design, to the point where you are ready to buy and install the systems. Those are since we're talking about today. We're going to take about five minutes for each to walk through and explain it.

The first step is assessment of needs, which is harder than it sounds. It should be pretty easy to say what you want to do in terms of and the traffic to feel safely and quickly and you don't want there to be any delays with the worksite. That was easy. When you think about it though it works on an depending on the project that he was involved in it., There is a lot of different stakeholders, people, different parties, conflicting priorities. The question is a bit harder than just we want everything to work smoothly. So how are you going to do that? Lots of possibilities, the inclination is to kind of try and with the traditional traffic control measures but it can also be a desire to get new and improved, and you just heard about a new technology that you want to give it a try, but it's important thing is that back and take a systematic approach to assessing your needs and that for this step is about. You're trying to answer what you want to do? In another

sense maybe the better question to ask is who you want to serve? Who are your users? What are their needs? You can get sources for answering this question could be your traffic management plans, your agency policy, the regulations such as real-time recording rule, works on – work zone process review, that provide some guidance into what is the agency trying to accomplish in order to start collecting information, using it and providing enhanced direction to drivers. What are the things are going to be considering in this process looking at stakeholders, who is affected by the project? There is the agency is trying to manage works on, the public, contractor who is working in work zone, there is a community that are affected by the congestion, the delay, noise, disruption to their normal routine, and other systems that are reliant on operating infrastructure such as transit systems, freight operators, that are running out of schedule. Others that have responsibility for managing the facilities such as law-enforcement, or port authorities. There is a wide variety of stakeholders that have a stake in how well the project is managed and extended benefit from the proper use of transit system. As an agency we don't want to produce delay, and hence driver awareness, and it crashes, but those are big objectives, it's hard to say how well the system is going to be able to meet that. You want to drill down, consider your system objectives, acronyms, you probably heard smart goals are smart criteria, what smart stands for it the specific, measurable achieving results-based and time bound. I will not going to have a whole lot but the idea is to have a specific, something very specific that can be designed into the system and you can say whether you met that goal or not and if you didn't, how close you hit. The smart goal might be something like when your travels these are used to 10 miles an hour below the speed limit, approaching the work some providing the work what my upstream. Specific constraint that boundary for what that he is, when disputed that the specific level, you want the system to provide an alert for specific location up stream. This is something we will talk about in the next step.

Talk about stakeholders a little bit. Your project team, your stakeholders group, these are obvious operations, private contractors, ITS contractors, key representatives from your communities law-enforcement and so forth and these are the people in the project team are the ones that they're going to have a hand in selecting implementing operating the system and have some responsibility for success or failure.

Final thing you want to look at in assessment of needs is considering your ITS resources, what assets that the agency have to draw upon in designing the system. Is there something in house that the agency could use? Are their agreement with contractors to provide ITS management services? What can be agency draw upon easily to get the job done? These are all things to consider.

Key takeaways from step one is one, you want to plan with the goal in mind, working towards assessing your needs, envisioning the system, working to achieve the goal, so you're trying to work towards your must-have for the project. One thing to consider is wanting to use ITS by itself is not a need, that's getting ahead of the idea of the guide, which is the intention here is for the need to drive the use of ITS, not the other way around. Not for the user ITS to satisfy certain needs. Big coordinated approach is important, you have a lot of different parties, and stakeholders, and you are looking for how to system is going to operate in the field, and establishing what those needs are and tying it back to the overall chain document and policies that God the delivery of the project. The step one of, you're going to have to define needs that

must be addressed by the concept of operations, you have identified your stakeholders and your project team, and you will have identified what assets you have available, and what are the major constraint to deal with. Those things are covered in step one and now we are ready to move on to the next step.

Concept development and feasibility is that to. This is the next stage where we are going from the realm to just thinking about what you want and start to think about how you are going to do it. The diagrams a good one because step two is really not a linear process per se, you can think of each of these things as one of the building blocks of the way to developing your concept of operations. A couple of things. One, you are making the technical case for how the ITS is going to address your smart goals, how is it going to action, how Doyle going to fit together and was responsible for what. The other part is you are starting to build your business case for how the system is going to be working. A couple of ways you can address those things. Starting down at the bottom with the challenges you can consider available ITS solutions that will address your smart goals. What are the options? Are you doing it in-house, better system that are suitable to businesses situation complex enough, as we start thinking about those type of specifics. Whatever it is you have in mind, you need to start considering do those solutions path that filter or some restrictions, either legal or policy issues within the agency. Some of the smart goals addresses the need for speed control, approaching the work some, but if your state doesn't have enabling for automated enforcement, or you don't have law-enforcement on variable speed limit, and that's really not appropriate to select. You're going to start the feel of available tools by going through this process, what you want to do, and whether or not those of feasible approaches.

[Indiscernible] Internal to the agency in these systems that have to be you have to make a business case for it as I mentioned before. Identifying the potential benefits and you are looking for a value adhere to some extent where the ITS systems can provide and whether or not the investment you are creating the system is not only addressing the needs on the project but towards broader goal and set aside some other needs for works and operations management that the agency might have. You are looking for opportunities for the ITS system itself to have value just beyond this one project.

An example of that would be an mentions the works of work zone process review that the requirement that agencies by and we should conduct a review of your methods to work zone operations, so the kind of data you are collecting with the ITS work zone, report some ideas assistance -- process review there can be a lot of value in that. You're looking for opportunities to get [Indiscernible] and take advantage a want to use these ITS systems. To answer all these questions we are trending towards a preferred solution that feasible and all the steps, basically by virtue of having made it this far in the process. If you're going through all these questions you have a short list of tools or potential tools, or ideas you want to get on one preferred tool, and put yourself in a position where you can start to develop your concept of operation. It answers the question how the agency envision the system will operate within the work zone. What are the moving parts, where is the information coming from, how is it going to be used, was the workflow, these sorts of things. It doesn't necessarily need to be tied to a specific system so there's still some flexibility going or what that's work through the Internet.

One of the things you're going to consider as you go through this step two is you going to be thinking about what your needs are that you have identified and what some of your purpose tool might be. There's always room for innovation but there are some tools that have been developed and are fairly portable from one project to the next in terms of the concept. Some of these are listed here in this table but are also in table 7, on page 26 of the ITS Implementation Guide that walk through some of the potential ITS solutions and what they address and what their application is and here's a few of them. I will just call out a few, queue warning system always is getting a more place these days, you hear in the news, and agencies are looking to implementing a queue warning system to provide advanced warning went to start spinning back from capacity problems created by the workshop. The idea being you may have euro signs out that they required that if you have a queue working back from the work some combat creating this.traffic but if you get out into a rural area, where drivers are never used to encountering a slowdown or a backup, a system can provide a heads up especially if you're driving a big truck, he takes a long time to slow down queue warning systems can provide that alert. Agency doing work sounded a rural area there has been a history of queue crashes that provides a rationale for considering something like a queue warning system. That's sort of the logic of the process so that the needs of feeding the selection of that system.

At the end of step two, you basically walk through the process of looking at your needs and considering what ITS tools are really appropriate. One thing that put here is a source of expertise and part of this step is getting to this point between steps one and two it's all been a fair high level at this point especially if you start looking at the tools and if it is your situation, it's important to engage your ITS staff, get your technical understanding of what these tools can do about the capabilities are. We want to work that into the development of a solution and the concept of operation. This is, this step is where you got to that point figuring out what's happening, was moving parts are, roles and responsibilities, and making sure you have your consensus for all the parties they expect to be involved with this is one thing up and running. Part of developing that consensus is clearly communicating to the stakeholders and ideas including them in the process of developing it. At the end of the step you should have your concept of operation, and you are ready to move on to the next step.

Step three this is where we start to go from the realm of ideas and concepts into you really have a heart understanding of what is going to be happening technically, where to go, what notifications are being provided, and this step is where you end up with your specification for the system. There is a lot that goes on here. It's really impossible to walk through this step in a sort of an all-encompassing matter because every project is going to be a little different but this serpentine list of tasks is the items that are made out in the guide, these are described a little bit more detailed in the guide. I want to focus on a couple of these to discuss a little bit what these take.

Determining your system requirements and specifications and a fairly large task. What you're dealing adhere determining not just what the system, what shape it going to take, but what is going to do. But how do you expect the system, it has certain capabilities in terms of what the resilience and communications ranges, just the hard specs for the equipment itself but we also need to specify what the system is going to accomplish, what you need to you that the requirements are going to define your performance, see if your performance and try to grab the design features. That's something to consider as you are designing the system, you want to make

sure that you're keeping into the development of your specifications. The requirements should link ideally to a specific user needs, and identify before, as you go from your con ops you start to keep an understanding that the system is going to need and is verifiable and performance compliance that you can actually have that capability to do that once the system is in operation.

Another feature in planning for public outreach. The things to keep in mind here is that the outreach, once it actually becomes out of reach, goes from the that outreach must speak the language of the audience. Talking about the DOT's, if you can put it in terms of increasing travel times, that sort of thing, length of delays, length of cues, that's a bit more understandable. If there is a process in place to make that output valuable to the end user and that the system actually facilitate that level of communication.

Finally, the planning for evaluation is an important part of it because eventually you're going to have the system up and running in the field, you're going to be called to answer for how well the system is operating, how well is he doing his job that you set up for. Is it living up to the investment? Those are questions that will be asked and is a lot easier to plan for the need for that evaluation in designing the system rather than being faced with having to figure out how to do it down the road. It's an important thing to keep in mind as you are designing the system.

A couple of examples of evaluation criteria. Again, with the idea time the performance of the system to the actual goals and the actual specifications for about the system does. Evaluation of objectives is something along the lines of mobility, you're reducing the delay and optimize travel time, the hypothesis is that your ITS system will produce travel time during construction. How are you going to measure that? You can measure the change in travel time, you can compare that to the overall travel time based on some baseline and calculate the change accordingly. The data you need from that is your baseline, you may be looking at other alternate routes, you may look at some analog measures such as Q1, and how you can walk through the process of looking at your objective, your need and determining how you evaluate it.

Step three we are not talking about procurement yet, that's step four, but you should be working through step three with a pretty good idea how you're going to end up procuring the system. You want to put a little thought into those issues as you going through the process of thinking through the design. If you're using in-house software, your limited to that is a solution. If you're going for a third-party, their systems may have some limitations you may need to be aware of. If you're going for a custom system you have more flexibility. You want to add some idea how you're actually going to go as your designing it so this step is not completely separate from step four at the end of the process you will have all the information you need to view into procurement. The documentation you're coming away with step three you should have your plans, specifications and estimates of what your expect the system to cost. All of these things will build off of the concept of operation and a clear knowledge of what the system requires, what the requirements are to keep your stakeholders involved, as defined in your con ops. Basically documenting is part of designing the system. What you're setting yourself up for is the ability to run the system without going back and second-guessing yourself what the system is up and running because you've already gone through the process, this is how we're going to prove what we expected to do. That's the idea. Once you have gone to this point, you're ready to start talking about actually

hearing the system and like I said at that point you're looking into spec for of the implementation guide.

I'm going to turn it over to Solomon Haile, he will give us a case study of how to utilize the work zone on a project of the I-70 and he will provide some insight the steps one through three of the guide can inform the implementation of the ITS project.

Thank you. My name is Solomon Haile, I'm from the Colorado department of transportation. We will talk about what our experience regarding the smart work zone in the state of Colorado. Colorado so far to date we only have one time used the smart work zone application so were going to share our experience. I'm going to tell you where we use it, what was the reason, we were using the smart work zone in I-70 corridor, that's the nature hop and also geographically extremely challenging location because it a mountain getaway for the recreation area into the all the other mountain towns and interested route to go to Utah and many other states. There was many major projects along that corridor for nearly 40 years. The idea was to add one additional lane into existing four-lane situation. The highway had about 45,000 AADT with 7% trucks and adding a link where we have a bottleneck issue at the tunnel area, we are located $100 million with the project when he decided to use the innovative contracting method and selected a contracted to design and build an excited to go fly with two projects. The construction project is mainly for going into the construction of the traffic part is to do something better than the traditional approaching traffic control ways to deal with the traffic along the corridor.

I-70 is a major corridor, we have about 4.8 billion budget, I mean revenue, according to Denver Post, it's a huge economy impact. Because of that situation, we needed to avoid this key season up to any construction or major construction work last time. The slowest time is where we don't have a lot of snow, between April to November, that's the time that have been selected to the work 24 hours a day pretty much. During that time there was several lasting sequences per day, Traffic stopped 20 to 30 minutes with pretty much everything cleared up and available on the routes to the traffic. During that time basically all traffic in the Eastern bound direction around the tunnel with the detours into the front which is 35 miles speed limit, you can see that coming from the Denver area around 65 miles per hour dropping to 35 miles per hour dropping to 35 and so on one side is 35 and the other side is 45. How do we come to the smart work zone Colorado? In June 2012 it was held here in Colorado Springs, the upper management saw that the benefit was Texas DOT has implemented a long I-35 corridor and as a selling point, we have to utilize something in our construction project using some IT devices. We selected this context to get a task to write the specification into prepared a plan, and we advertised the project, it took $342,000, which was the construction budget and along without TK to other companies came up PDP and Yourway. TK being the primary contractor didn't have any idea whatsoever regarding smart work zone. PDP Associated is the only one that knows what smart work zone is their experience in Atlanta during the goals tournament they have done a lot of smart work zone applications so that was the biggest selling to us. And Yourway is the traffic control supervisor company, they provide to PDP their borders and so on. That's pretty much what it is during that time there wasn't any guideline was published or anywhere else see if we had known what we know now we could have avoided some of the challenges we end up facing the project. I will tell you what we talked about. The object of the project was to improve the work zone management operation, improve work zone safety mobility, reduce travel case, provide real-time information

to drivers, and provide local residents at the vicinity of the tunnel is a major way in and out to the major area to Denver or to Evergreen, a nearby town for shopping and so on. We have to come up with a way to let them know what we can do for them. The idea is beginning we need to do something better for this massive project just beyond and above we need to see the capabilities. But with the idea and with that we decided to go with the project with a major media blitz at the time, the media office PR office, pretty much knowing it's going to be a major headache this project, to the public, we have been provided -- how are you going to cope with the situation. As we have a work zone you can be able to see the construction activity, the flow of traffic on smart phone, that's going to help you to deal with the everyday headache, and what we have now with the two lanes is going to be remaining a Chilean operation during the construction time. If you have any major issues, vehicles stalled, around the construction site, we have a stunt by control, the media basically told the general public enjoy the mountain, come out, dining, shop, or whatever you like. With that in mind the project went down, smart work zone came up with its own website for an application, and we had a project hotline, in you can view what's going on in real time out in the field. That was a new thing for Colorado drivers besides to see the real-time construction.

Basically the corridor, the act of construction zone was nearly about 8 miles, from the first call to the last call. The construction area. We decided to place our DMS along the corridor to give drivers an alternate route. We have a 56 mile construction where we have various devices. We have implemented the following hardware, eight VMS panels, 10 portable Wavetronics, and about nine cameras and down the road we did a change order to add to the two sensors. What you see here is what was looks like the two-lane, what you see here, is exactly during the construction time.

The object was like we talked earlier real-time, every 2 to 3 minutes, to let the driver know what's going on. With this project what we did 37 miles away although t eastbound direction, we placed the VMS in hoping the general public could be able to look at it and choose an alternate route. The alternate route, there isn't any alternate route, basically the alternate route is going to be three hours delay, probably take a hotel to stay, the other alternate route would be 3 to 4 hours additional trip using a local road, state highways to come back to Denver. Pretty much we don't have an alternate route but it gives them just in the eastbound direction the first VMS board 34 miles away, second one 22 miles away, the other one is within proximity of the project site, 12 miles away from the project site. Similarly we copied similar things in the westbound direction, we placed the VMS board, and the message we came up with at the time to internal constructions, 37 miles, along takes you, to go to that works on.

As you're reading this message, you would think yes, I'm driving through the construction, 37 miles ahead, what it takes me is 21 minutes to go through that construction so the general public it would take them about 21 minutes to go to work corridor. There's a misconception. The website we advertised to the public looks like this. Anyone who has access with a smart phone they would have been able to click any of the devices, VMS board and be able to see what's going on. Among the other benefits when the construction staff every bit as they were looking at our cameras to see what kind of traffic was stop and go through that corridor. I will share some of the observations and the experience we had. Let inventions the public kind of misunderstood what the delay would be, 37 miles away when you set up a VMS board and you have sensors

between 4 miles away, with active construction zone, and another sensor you have between 4 miles in the other active construction some and is sending you messages 37 miles and 34 miles away. He created confusion to estimate what it takes them to the travel time. We decided we have to do something when we noticed that. We took several different measures. Among many others we also observed in Colorado, in the mountain area, there is not very uncommon to see emergency rock fall. We have similar situation in the Glenwood Canyon, the rock fall closes the major tragedy corridor around the Canyon for the last two weeks. We have similar situation and determine what it takes from Denver to the Grand Junction takes 10 hours. It kind of relate to the rock fall was a situation came up in the middle of the construction zone which is basically the rock fall Georgetown Hill was 14 miles away from the active construction zone. We have a sensor here, within 4 miles, from active construction zone, but 40 miles away you don't have a sensors and you have rock fall mitigation, they have to scale the rocks, stop the traffic, you see the message 37, 30 you see the message 37, 35 miles away, you are approaching what you have been given to you, the information is completely wrong. We kind of had to do on the fly to do something about coordinate with the situation with the rock fall project. This was unexpected so we heard a lot of public noise, basically the public when he sometimes advertising message, if you take 222, 25 minutes the general public they take it as a promise, this is what it takes 35 minutes, you told me, actually took two hours for me. So that's a public nuisance in a way that have to be dealt with. The other observation we had and the challenge we had in this project is a choice of words between a message was also the major headache especially for the project staff. We have a concern came from the twin tunnel project staff, we don't like the words tunnels because we have two tunnels. The twin tunnels right now has been renamed to Veteran’s tunnel, prior to that the location used to be between two twins. Nearly 28 miles away we have the tunnel so when we're talking about telling the general public tunnel, but does not fly so you have to specify which tunnel. Instead of twin tunnels they preferred to have that house, to use Idaho Springs, so this would be an opportunity to marketing to tell the general public company miles a minute it takes to Idaho Springs. During this project when he goes to advertising, as the new for Colorado smart work zone, there was an attempt to coordinate and to tap the existing smart devices we have in the corridor. We had a lot of electronics, cameras, sensors in the corridor, highly visible corridor for Colorado. At the time the management, especially in talking about ITS management who safeguards the devices in the quarter, they put it basically off-limits to any other devices to being cooperated in connection with construction to use any devices even as a read-only. There wasn't any ability to tap resources that already existed in the corridor. With that we came up somehow with the choice we had, like I told you earlier, we had 35 miles in that frontage Road, the maximum speed limit, we dropped also the existing two-lane and on the westbound to 45 mile limit. As you know with the experience we have there was a publications definitely from the work zone implementation guide equipment are very comfortable of doing a lot of different things. They can give you a lot of information, travel time and so on. When we prefer that the time is to use the speed. We had the speed, when we have the traffic less than 20 miles speed with the sensor closest to the tunnel, we came up kind of basically a decision from upper management to introduce different messages. The reason was that upper management decided the average Joe, they don't understand when you tell them is 20 miles per hour is the current the works on. Rather than that they preferred to have an easily understandable method to the general public to let them know what the current situation is, whether it's stop and go, whether it's the current traffic and stopped, or is normal. Some kind of suggestion to change those VMS. It was not an easy process during the construction, contractor have to reprogram and

have to display a message, most of you know as a computer programmer is not an overnight or something you can do on a flyby. It takes sometimes a couple of days to reprogram those displays to come up. We have a few conditions, when the traffic is moving better than 20 miles per hour, when there was a delay of more than four minutes, we eliminated the word delay that was one of the messages that was not very accepted and be kind of changed it to avoiding the word delay to work some speed. That was first introduced, the work some – work zone speaks. To let us know what the average speed would be. But like I mentioned that was not easily understood and the management demanded to have different situation to come up and also that time we were able to have existing I-70 devices. During the construction we had been allowed to give a re-access to see electronics along the corridor so that kind of give us an ability to read the electronics not only the works on – work zone but along the 35 mile corridor to topic to do real-time to tell drivers with existing conditions is. This is what has been decided at the time. Instead of showing the work speed, or current speed, it has been recommended to show works on traffic. So we're kind of working together, in a way sometimes interfering to come between management and engineering, something that will be easily understood by the public. We came up what has been recommended when the speed is really low rushing a message like traffic is slow, and so on. After we were able to establish existing devices in the corridor, fully integrated everything, so now we came up with the underground speech, that's another word of choice, how we can address those issues. On route speed would be this comment traffic is normal. On routes is that, traffic is this way. That's the kind of things we had were posted on the VMS. So we had at least 4 to 5 changes during that time on -- 9 months project. So what we learned about the Colorado project at the time, we did not spell out what kind of hard requirements we had, what's available on the market. Our project documentation or art design, is beyond our scope in a way to know what's available and we didn't have a very thorough investigation to know exactly what's available. Ligated at the beginning, if we had all what we know now, we could have avoided all the major changes. And we have been able to select much smarter devices that we have the time.

It was a very good learning experience for Colorado. We tried to address every driver’s confusion or front office feedback, what we need to do, cannot be done. Also an agency may have learned is we have now an option that's available in the Colorado DOT in the future to use a work zone some we have to be able to capitalize on our resources using existing hardware to find out what kind of data can provide to you. That's a great lesson we have learned. When consent is beginning the idea as major idea the experience also on I_35 in Texas was to give drivers of alternate route. We went with blindfolded eyes, in a way, I'm sorry for my expression here but to do something better than the traditional traffic guidelines, to use something better but our blindfold I approach definitely did not pay off. Not something that's in the progress establishing our own selection criteria which project we should be able to utilize, we have a lot of areas and Denver Metro area where we have a multiple point where drivers can be select alternate routes, those are the areas we can be able to work around using a smart work zone using the tools available right now is definitely we have learned a lot and we are definitely looking in the near future to have a better smart work zone approach to any of the situations we a counter from now on. With that I will pass it over to Nicole.

Thank you. And this time we don't have any questions. We are running a little short on time so we're going to go ahead and move to Jon Jackels.

I am here. Good afternoon. In January 2014 the Iowa DOT initiated a traffic critical projects program to address mobility and safety concerns in and around construction zones. Major points of this program was development and reducing these impacts. This presentation this afternoon will highlight in the base is intelligent work zone systems over the last two years. As they started out talking about the implementation guide, this is an excellent resource available for you to assist you in doing this and it's not just a guide, you can see many different ways, and stated highlight that.

The first step is to understand and define user needs. If you're not familiar with the state of Iowa, it is primarily agriculture-based economy where everyone out is the ability to travel a mile a minute wherever and whenever they go. For the most part is true even in urban areas and in rush hours.

Because of his ability to travel in my limited, a major focus are the traffic operations in Iowa etc. and mitigate nonrecurring congestions. The three primary causes are weather, traffic incidents and how it works out. However, you cannot control the weather and incidents and the impact they have on traffic safety and mobility. Fundamental principles for the Iowa critical projects program is that you can control the impact and construction and maintenance activity they have traffic operations.

The next step is associate it needs to establish systems: objective to accomplish this the Iowa DOT conceived and initiated the concept of a new traffic critical projects program identify key project that may come significant safety or mobility issues identified implement various medication methods including intelligent work zone and to reduce or eliminate potential safety or mobility impacts. A unique feature of this Iowa experience that is not a single product or project writer is a statewide program which provides only things intelligent work zone insistence on multiple projects over multiple years. As with any new programs is important to establish a vision, mission and goals. The vision to provide safe reliable and efficient travel through construction and maintenance work zones supported by all stakeholders but leaves a great deal of room for interpretation. The mission statements identified and implement traffic management strategies that address safety and mobility challenges encountered in instruction work zones helps all of them to focus how this mission can be achieved.

Once the goals and objectives are defined is essential to identify all stakeholders and establishing in assessing needs. A common mistake when trying to identify and address needs for a program or system is to forget and completely ignore a major stakeholder group. As no transportation the office stakeholders are travelers, they rely on the system be in and day out whether for business, community, or leisure needs all of these stakeholders must be considered. Other stakeholders including emergency responders, law enforcement, and offices. Last but not least you have to include everyone involved in the transportation agency from Landers, designers, construction maintenance, traffic engineer and traffic operations personnel. The next step identified in the implementation guide is determined to be of the project team. Since this is a statewide program with multiple project several different teams were established. These teams include people from top administrative personnel, to give the program direction support. The working group supports direction policies to ensure the program was effective in achieving the mission and goals of the vision by the top officials. Key element of this effort has been developing and deploying

appropriate effective intelligent work zone systems on a construction project across the state. Intelligent work zone team has many members. Some work for private companies, with the runway again. Work for private companies and are hired by Iowa and related systems. This makes it important for everyone to understand each other's roles and responsibilities and clearly communicate. The entire program was managed by the Iowa DOT with the assistance of consulting. The statewide intelligent provide temporary equipment and transported on the contract to provide software, software integration and maintenance for the Iowa TMC and is an integral part. TMC operations are overseen by the Iowa DOT but are provided by Schneider electric making communication operators needs critical system design and operations. Iowa State University Center for transportation research and education is responsible for the evaluation of the systems and input needs concepts requirements and design is essential for success of the evaluation plan and traffic critical project program.

To maintain communication and information exchange this team holds weekly teleconference is reversed issues. Also share information by a private webpage. Then established a single central email address used by all stakeholders. The central email system helps facilitate a prompt response and resolution of any stakeholder needs.

The next step in implementation guide is identified what if any ideas resources are available. I want to give an overview of Iowa that is important to understand. First I will not have a single large special population area, rather 09 issue areas spread across the state. This led the Iowa unity establish a statewide traffic management center to address the needs of all these areas 24 hours a day, 73, 355 days per year.

The system has over 300 cameras not only able to TMC operators of also by the public and others interested in seeing what traffic looks like.

DMS Along with the there's a statewide plan. All of these statewide resources resulted in the DOT decided to use their existing TMC infrastructure to manage and telephone works in operation. The next major step is for a concept development and feasibility analysis. The first step is to determine the overall concept for project in Iowa it was determined that the intelligent work zone vendor will provide areas components and subsystems for integration into the existing statewide and operated and managed by TMC.

The next step is identify what intelligent work zone are available. This was based on actual needs as they talked about earlier, just what the industry or technology have to offer. In the previous steps of establishing the needs for the IWZ system, it's important to listen to planners, designers, traffic engineers and operations professional as well as construction engineers and managers. The program in Iowa this resulted in several other systems that in the rises to the better contractor. This is a DOT the flexibility to select a system needed to mitigate mobility and safety concerns on individual traffic critical project.

There was a need to establish formal traffic incident management from any of the traffic critical project. These plans enable first responders to work together to assess and respond to any incidents, this response is coordinated with TMC operators to ensure safe and successful response including answering quickly. The intelligent work zone contract in Iowa a lot for the

consideration and deployment of these systems is important and enhances planning and response needs.

An essential part of seconds that is identify potential benefits for the intelligent works on the employment. Benefits will be discussed along with evaluation.

Question always ask is how much will this cost? The Iowa concept is a major expansion of using the existing system and being able to provide the systems at a reasonable cost. For 2015 the Iowa DOT paid Street Smart Rentals $1.4 million to provide intelligent work zone systems and 27 construction projects. The DOT is using an average product cost of $40,000 in urban area, and $43,000 in rural areas.

Implementation guide includes identifying and addressing institutional and jurisdictional challenges. If you want to address these properly to have the potential derailing the entire effort. Important to remember that the systems represent a change in the way of doing business and require a relocation of to accomplish the goals. All this makes it essential to engage respond all stakeholders and team members for the project development. It is also necessary to evaluate the performance of these systems they can demonstrate the value not only intelligent work on mitigation, but all efforts to improve mobility and safety and construction zones.

While facing these challenges, is important to focus on program attributes that make the program and systems a success. In Iowa we had the support of management to achieve the goals of the program. Even so all stakeholders at team members have a desire to make a vessel to get the job done. This is a result to have input into the policies and procedures and being able to critical input and the needs concepts requirements and design of the system. While managers are essential of the traffic critical project program.

Is also important to continue to communicate progress to all stakeholders and to first and finally for this project is important to show that we are leveraging existing resources and using qualified intelligent works on vendors and application of technology to improve safety in work zones.

Final step in implementation for developing concepts as his ability to determine how to obtain support from internal and external stakeholders. When developing this program in Iowa it was important to include a communications plan to keep all agencies stakeholders informed with the system and add a method to ensure that the various stakeholder groups not only understood but had a form to connect to, and then be heard.

As with any real-time system, support for an adherence to the information has to be part of delivering accurate up-to-date actionable information at all times.

The third step with Federal Highway administration implementation guide is detailed system planning and design, beginning with the system requirements and specifications. At engineers elected jumping to this step, however it's a step in system development deployment that needs, concepts and requirements that were earlier established by stakeholders. On the surface these same simplified since the are integrating into the existing system, however these are not always easy as ABC. Is it hard for all team members understand the design requirements for the ATMS

and statewide TMC. It's necessary to clearly communicate these requirements to the IWZ vendor so they understand what is needed for successful integration and operational system. The procedures and contract document also includes appropriate equipment test plans, and procedures needed to verify all needs and requirements are being met. Including the ability to evaluate equipment and system performance.

System requirements and design must ensure that all devices used for IWZ operations, both temporary and permanent, work seamlessly as a single system to provide timely and accurate information to drivers. The Iowa DOT TMC has been controlling rental PDMS since 2013, so the concepts and requirements for this service were clearly defined and included in the RFP used to select the IWZ vendor.

Traffic Sensors are a critical component of any ITS application and this is especially true of IWZ systems. To ensure compatible and accurate operation the IWZ vendor RFP required the use of the same sensors used for permanent applications by the TMC. These sensors are capable of providing traffic counts and speeds every 20 seconds to reduce latency and ensure accurate information can be provided to the motorists.

While not as critical to immediate response, the traffic cameras used by the TMC are the “eyes” of the TMC operators that are constantly used to verify the conditions reported by sensors are accurate. The cameras also provide more detailed information operators use to improve response to each situation. In urban areas, the requirements for the temporary CCTV cameras were identical to those used in permanent applications and used radio communications to connect to a fiber optic backbone for communication. This allows for continuous operation of the cameras and complete integration into the ATMS software. In rural areas that rely on cellular communications, this design was inappropriate due to the cost of maintaining this high bandwidth communication with the cameras. Therefore, the requirements for the operation of these cameras was on a as needed basis and as the IWZ systems matured, several options such as Q-vision, that uses video clips and provides “tours” for each direction have been integrated into the system. This system powers down the camera after 5 minutes to ensure the camera does not continue to transmit data resulting in a higher than expected cellular data bill.

Although technically a part of a procurement discussion, now is a good time to talk about communicating system requirements and designs to the IWZ Vendor or provider.
There are two unique needs for the use of ITS in work zones. The first and more traditional is that to provide temporary traffic control warning and guidance to motorists traveling through work zones. These devices, typically PDMS, are provided by the construction contractor or traffic control sub-contractor as part of the temporary traffic control plan.
The second need is to provide IWZ components and systems to mitigate mobility and safety impacts on TCP. To accomplish this the Iowa DOT implemented a unique method to provide these systems by implementing a statewide standalone contract with the IWZ vendor to provide temporary system components such as CCTV, PDMS, and traffic sensors. This allows the use of the TMC to manage the IWZ systems and allows the DOT to utilize existing permanent cameras, signs and sensors, augmented by the temporary devices provided by Street Smart Rental. This philosophy, while sound from an investment perspective, makes it necessary to clearly define and communicate the goals, responsibilities and authorities to all of the providers to ensure the

team members cooperate and meet the needs of all team members. These contract documents must clearly define the testing plans and procedures needed to ensure the equipment meets all needs and requirements.

[Event has exceeded scheduled time. Captioner must proceed to captioner's next scheduled event. Disconnecting at 12:25 pm.]

[Event concluded]

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