Module 11—Understanding User Needs for ESS Systems

Ken Leonard: ITS standards can make your life easier. Your procurements will go more smoothly and you'll encourage competition, but only if you know how to write them into your specifications and test them. This module is one in a series that covers practical applications for acquiring and testing standards-based ITS systems.

Ken Leonard: I'm Ken Leonard, the Director of the U.S. Department of Transportation's Intelligent Transportation Systems Joint Program Office. Welcome to our ITS Standards training program. We're pleased to be working with our partner, the Institute of Transportation Engineers, to deliver this approach to training that combines web-based modules with instructor interaction to bring the latest in ITS learning to busy professionals like yourself. This combined approach allows interested professionals to schedule training at your convenience, without the need to travel. After you complete this training, we hope that you'll tell your colleagues and customers about the latest ITS standards and encourage them to take advantage of these training modules, as well as archived webinars. ITS Standards training is one of the first offerings of our updated Professional Capacity Training Program. Through the PCB Program, we prepare professionals to adopt proven and emerging ITS technologies that will make surface transportation safer, smarter, and greener. You can find information on additional modules and training programs on our website at www.pcb.its.dot.gov**.** Please help us make even more improvements to our training modules through the evaluation process. We look forward to hearing your comments, and thank you again for participating, and we hope you find this module helpful.

Raman Patel: This module "A313a, Understanding User Needs for ESS Systems based on NTCIP 1204 v04 Standard" is an updated module. We have revised it since the last one, based on the current version of NTCIP 1204. The standard has a little bit more of an elaborate user needs arrangement and much more of a new approach in terms of user needs. This module reflects this.

Raman Patel: I am Raman Patel. I worked for New York City for about 30 years as Chief of Systems Engineering. I have been involved in standards-making processes for the last two decades or so, and currently I am teaching at New York University's Tandon School of Engineering in the Master's program for Urban Infrastructure.

Raman Patel: This module has four learning objectives. Review the structure of the standard. The second learning objective is to identify specific ESS operational needs. The third learning objective is to use the PRL to select user needs and traceability to requirements. And the last learning objective is to discuss how to prepare a project-level PRL—which stands for Protocol Requirement List—for the ESS specification.

Raman Patel: Collectively, these learning objectives give us the skillset we need to prepare a good specification. The first learning objective will allow us to go into the structure of the standard and figure out where the information is.

Raman Patel: Let's look at some of this terminology that we are going to use in this module. Sensor. What is a sensor? A sensor is a device that responds to a physical stimulus and transmits a resulting impulse to a remote processing unit. It has only one output, and that output is transmitted to a remote processing unit nearby.

Raman Patel: Environmental Sensor Station—ESS, or sometimes we also refer to it as a plural "Stations"—is a location where all the sensors are located for that particular area. It is located perhaps on a bridge or a roadway, and it collects weather data using a range of sensors. As you can see on the left, you have the station. On the right, you have a few more details about how a particular ESS station collects data from sensors.

Raman Patel: Remote Processing Unit—or RPU—is a part of an ESS controller out there in the field, as shown here on the right side. An RPU is part of the controller—inside the controller—to manage the different sensors that we get. It collects data from the sensors and then transmits it to the Central Management Station.

Raman Patel: Road Weather Information System—RWIS—is another terminology that's being used heavily in weather management systems. It is a network of ESS that relay road and weather conditions to a computer system. Usually, the computer system is located at the Central Traffic Management Station. As you can see here on the left side, we have an image of a roadway where all kinds of weather information is shown. Also on the right, we have multiple sensors mounted on a pole, and then there is a map in between. What it tells us is that RWIS, as a system, provides us weather-related coverage over a wide area—perhaps over a region, such as metropolitan areas.

Raman Patel: There are three types of RWIS. The permanent—or fixed locations-based ESS—provides us sensor data information from one particular location. The portable one is vehicle-based, but it moves and continuously supplies the information that the sensors collect. It's sort of a maintenance vehicle providing mobile data. The third one is transportable. Sometimes you have a location where you need to put a vehicle-based system. Then you are done with it and you want to move it to some other location. It could be transported to a newer location where you have similar information available. However, in the transportable mode, you can only transmit information once you go to the next location. It does not transmit data during the moment.

Raman Patel: Flashing beacons are mounted on the roadsides of some locations where you want to alert people or the traveling public—motorists—about a new message. It's just a lamp that flashes to gain attention from the traveling public. For example, there is an optional video monitoring. Whenever there is a beacon, some kind of camera statement is also available so that you can see what's going on in the general area.

Raman Patel: This example from Iowa DOT for Road Weather Information Systems collectively projects different ranges of sensors. Here, for example, seven of them are listed on the pole on the right. There is also a video clip available for discussion about Road Weather Information Systems from Iowa DOT on how they are actually doing it. It's a short video, and we have provided a link that you can use to look at the video and see what it says. The first example here is a wind speed and direction sensor mounted at the very top of the pole. The antenna for communication is right there next to it. Also the traffic speed and counting station sensor is mounted there. You have a pan-tilt-zoom color camera in a dome shown here. Precipitation and visibility sensors and air temperature and humidity sensors are also shown at the bottom. You also have the road surface temperature sensor and subsurface temperature sensors below pavement. Collectively, these seven different sensors provide the input to the Road Weather Information System.

Raman Patel: The NTCIP framework provides us with the range of capabilities to provide data dictionaries so that we can actually create a message using the data dictionary elements. That's at the information level. At the lower levels, you have other protocols that are needed to move the message from one place to another. For example, you have SNMP—Simple Network Management Protocol. That protocol is a ruleset. It allows us to move data. It has a built-in messaging structure that we use in this module and the next one.

Raman Patel: A major component of ESS systems includes a Management Station at the central location. You have a RPU—Remote Processing Unit—in the field, which actually has inside it a Sensor Manager, ESS Manager, and a PTS Manager—PTS stands for Pavement Treatment System. Collectively, these three task managers actually provide information to the central location using the NTCIP 1204 interface.

Raman Patel: The ESS standard evolved to v04 in 2016. This recent process was non-SEP, meaning that it was done without the Systems Engineering Process, and therefore there were no user needs written down or described. We had Amendment 1 shortly after that. v02 then provided the SEP process with user needs or features already defined. v03 in 2009 actually updated the SEP content, but also provided test procedures. In Annex C, that detailed procedure is now available. The current version—1204 v04—was released in 2015 with a lot of new material and a lot of new user needs, such as those related to connected vehicles. It also reflected lessons learned from the previous versions and deployments.

Raman Patel: Structure has several sections in it. The standard General section has administrative details. Concept of Operations is in Section 2. Functional Requirements, Section 3. PRL—Protocol Requirements List—is an important tool that we will be discussing in this module and in Section 3.3. Dialogs are Section 4. MIB—called Management Information Base, which defines the object design—is located in Section 5.

Raman Patel: There are several Annexes that come with this standard in v04. Annex A has RTMs—or Requirement Traceability Matrix. Annex B has Object Trees. Test Procedures are in Annex C. Documentation Revisions, and so on. The rest are providing general information to back up the information in the main sections.

Raman Patel: How does the structure relate to the agency ESS/RWIS specification? Going in, we need to develop specifications based on several things. First, Concept of Operations, which is in Section 2—User Needs. We need user needs. Section 3—we need Requirements. Design is in Section 5. In addition, we have a PRL, RTM, and Test Procedures. All of these six items that we are showing here on this slide are actually mapped to the Concept of Operations, Requirements, and the Design on the left side of the Vee leg.

Raman Patel: The standard also supports the Road Weather Data Collection Service Package from the ITS architecture. The communication interface is created to support what goes on between the Roadway and Traffic Management.

Raman Patel: The user needs not covered in v04 are sampling periods. For example, we collect a lot of weather data—air temperature for over a 10-minute or 15-minute interval, or sometimes a five-minute interval. Then we average it and send it back to the central. That part is not configured. We have not

defined user needs—how to do it—because it's left to the project level treatment at the Traffic Management Center. We also need something called File Transfer Protocol—or FTP—to transfer snapshots across the agency network. This is also not standardized because some agencies permit it and some don't. The standard has made no attempt to standardize that. As you can see on the right side, the image on the top shows us a lot of details about the condition of the roadway, while the image on the bottom is about maintenance vehicles and how they're being managed out there. This image with the sensors on the right—on the tower—actually tells us how user needs are met in terms of standards or a description of user needs.

Raman Patel: Our first activity.

Raman Patel: Which of the following is not a correct statement related to the ESS standard? A) Standard supports RWIS, Road Weather Information System; B) Standard supports communications interface; C) Provides traceability tools; D) States sensor hardware requirements.

Raman Patel: The correct is D—States sensor hardware requirements. The statement is false. The ESS standard does not cover physical hardware requirements for the sensor. For example, temperature range. A minus 28 degree, 258 Fahrenheit degree requirement is not part of this standard. It's covered in the hardware specification separately in another standard. A is incorrect because the statement is true. The standard does support RWIS. B, similarly, is also an incorrect answer because the statement is true. The standard does support communication interface. Similarly, answer C is also an incorrect answer because the statement is true. The standard does provide traceability tools, such as PRL and RTM. In fact, PRL and RTM form a key part of the standards help for user specifications.

Raman Patel: Our second learning objective is to identify specific ESS operational needs.

Raman Patel: Let's see what the operational needs are that relate to the ESS. We'll start with the road environment. What are the elements affected within the road environment? Affected by weather, that is. We have four elements that we need to acknowledge. First are the roadways themselves. The roadway is affected in many ways because there are weather conditions out there that will render roadways less useful or less efficient, if you want to look at it that way. The motorists are also affected because now the weather is slowing them down. The speed has dropped and their maneuverability has now increased—limited in visibility and things like that. The vehicle is affected because the roadway conditions have made the pavement more or less efficient, shall we say. Also friction—there is now less friction available, so the traction and vehicle maneuverability is also limited to a great extent. That part is very important to understand—where the safety issues lie. Finally, the assets. The roadside has a lot of assets. There's a divider, there's a marking, there are all kinds of assets out there—boxes, controllers, other furniture—that are also affected in some way. The condition of the pavement in general will also deteriorate or will be damaged.

Raman Patel: Roadway Operational Environment Weather Variables. What are the kind of variables that impact the roadway environment in general? Air temperature and humidity comes to mind right away. Precipitation. Wind speed. Fog. Water level. Pavement temperature. Pavement condition. Snow and sleet. All of these things can make the operational environment less safe and less efficient maybe. Maintenance-wise, it also has an impact. Collectively, we can say that the weather variables are more than one. There are quite a few that really impact the operational environment on the roadway.

Raman Patel: Visualizing what these images are really telling us. The first image on the right tells us how the CBD—Central Business District—is isolated because of the flooding condition over the bridges and viaducts and highways. Another image shows us that because water is collecting in the roadway, cars are just piled up there. They can't move further. A third image shows us at the bottom a hurricane—tornado. On the right, we have a snow removal process underway. All of these images collectively tell us that rain and flooding, snow and ice, low visibility, hurricanes, high winds—these are all events that adversely affect or impact roadway operations. That's what we want to say.

Raman Patel: Here is a picture of Central Business Districts where all the routes are now hampered because there's five feet of water. We can see that flooding is also a major issue that the inner cities and metropolitan areas have to deal with.

Raman Patel: Generally, in a situation like this, there are lots of access routes. Flooding almost always removes or impairs, for example, Central Business District access.

Raman Patel: Operational Concerns for Roadways, Drivers, and Vehicles. There's always a combination of roads, drivers, and vehicles. Let's look at the adverse impacts of roadway conditions. For roadway conditions, we have a situation that now impacts reduced capacity. The roadway was designed for three lanes moving. Now maybe there are two lanes moving, or one lane is partially moving. Roadway conditions result in reduced capacity. Access—we just looked at the access issue for adverse weather conditions; throughput—the number of vehicles passing through a given section.; and Speed.—it's not 55 miles as the highway is designed for. It may be 20 or 30. There is a reduction in speed—that's one of the parameters. Visibility Impairment impacts the driver's behavior. If you don't see far ahead and you suddenly stop—stop-and-go kind of driving. There is a quick reaction. There is also maneuverability of vehicles. Drivers attempt to move this way and that, perhaps trying to find safer ground. All of these things lead to Safety as an impacted variable. Then you have Vehicle. The vehicle is impacted by traction—the availability of friction. Wet weather reduces the friction. That does not allow the vehicle to go fast—or as desired—so vehicle performance is also now impacted. The skidding process continues in wet weather because the pavement doesn't have friction. Relatively speaking, the crash potential also increases with bad weather.

Raman Patel: Then you measure adverse impacts specifically on safety. This is a big issue. In 2015 1.5 million—or 23 percent of annual vehicle crashes related to safety were impacted by weather. You have 800,000 injuries. Seven thousand fatalities—or 20 percent of a total 35,000-plus—were attributed to weather-related vehicle crashes. These statistics tell us that 20 percent is a large percentage of safety-related crashes, and then fatalities coming from there. In this chart on the bottom right, you see that flooding is a big issue. In 2015, 155 fatalities were attributed to flooding conditions. You have tornadoes and you have heat, and so on. All of these add up to poor safety conditions.

Raman Patel: Measuring Adverse Impacts on Mobility. Since highways and infrastructures are designed to provide mobility, we look at it very closely and say, "What really happens on the roadway?" You have roadway closures. You have to close the road. Certain roads are not conducive to driving. That, in turn, impacts the capacity. Capacity, speed, volume—everything goes down. And motorists, traffic signals, vehicles, trucks—all road users are impacted in terms of mobility and its effectiveness on the delivery process.

Raman Patel: If you measure productivity as an impact in terms of how we lose dollars and cents and economic benefits, consider 20 percent for winter maintenance by state DOTs. That's the budget. They spend 20 percent on winter maintenance. That's a pretty high burden for winter weather maintenance. Then you have delays—this costs. Every time you are delayed, there is a cost that goes along with it. Then maintenance worker safety is also impacted. They're out there, they're doing their thing, and suddenly, because of the bad weather or poor visibility and so on, there are additional issues in terms of protecting the workforce. As a sector, trucking losses—they are engaged in goods movement. There was $3.5 billion lost in just roadway damages—potholes, things like that. Trucking losses and roadway damages combined are a lot more than the $3.5 billion stated here. An example from Pennsylvania DOT—their budget for the 2013/14 winter was $189 million and they ended up spending $284 million. This gives you an idea that winter maintenance is not a small issue for state DOTs.

Raman Patel: Operational Need. Assess Roadway Condition with Sensor-Supplied Data. You have a Traffic Management Center. You have a workstation there, which has the roadway weather information system. In the field, you have conditions out there which are measured by sensors. We measure the visibility, precipitation, high winds, temperature extremes, pavement conditions, pavement friction conditions, snow, ice, rain. All of those things are measurable in many ways. That information allows the central location at the TMC to input that to the RWIS and come up with a good formation that we can use to run the operations.

Raman Patel: User Needs are Translations of Operational Needs. Once we know what the operational needs are, the user needs can be defined, as it's done in this standard. Section 2.5.2.1 here, for example, has Monitor Weather Conditions, Monitor Atmospheric Pressure, Monitor Winds, Monitor Air Temperature. The list collectively tells us that there is a way each one of these operational needs can be met by user needs.

Raman Patel: Operational Need. Deploy Road Weather Information System as a Decision Support System to Take Action. RWIS is a decision support system. Using the RWIS, the Management Center makes a good decision and then comes up with actions. What do those actions look like? The first section is to advise. Advisory is classified as the first action. The second one is Control. You may have to control the assets—roadways, bridges, tunnels. That's a control mechanism. Then Treatment. We have to send maintenance workers out there. They go out there and treat the pavement or close the bridge or close the lane. Whatever they need to do in terms of making the roadway safer, that’s what they have to do. So there are three actions—advisory, control, and treatment.

Raman Patel: Generally, for actions we take to advise motorists, we do that through display message signs—variable message signs or dynamic message signs. We put a message on these. We also supply information on a 511 system, providing text messaging, emails, and putting messages on the web. Web messages will provide pictures as well as a description of weather conditions. And we will also inform the media. The media has an interest in receiving information from public agencies, and public agencies have a responsibility to provide information that reaches out to a very wide region or very wide population. Everybody wins from that effort. Actions, for example. Things are bad and then we tell them specifically what they should do. For example, the sign here for a hurricane warning. Hurricane warning—the opportunity for making people safer is very short. If you know about it and the message is out there and says "Seek shelter," people will be advised. It’s a powerful message that says, "Please leave the roadway

and go to a safer place." Also, in dense fog. The sign on the bottom left shows there's dense fog ahead. If there is fog is ahead and you are not near, but someone tells you there's fog ahead, that's additional information you have that will help you to make a better decision. This image on the lower right tells us about the conditions out there on particular arterials.

Raman Patel: When we have to take control actions related to weather, we are either closing a bridge or a tunnel or a section of a road. For example, due to the fog, as we see on this sign on the right.; or on the left, due to icy conditions "Do Not Enter. This Section is Closed." These are very timely and also a very effective way of letting the public know what they are not expected to do.

Raman Patel: Treating the roadway condition. We all have heard about black ice on the roadway—the ice you cannot see because at 30 degrees the ice will freeze and it will hide underneath the pavement, disguising itself. It's not underneath, but in a way it blends with the color, so that's where the black ice name comes from. During the past several years in the country, we have experienced a lot of black ice-related accidents. Many agencies are now well prepared to deal with this in the proper locations, or where they have identified certain needs. During the winter weather, this issue comes up, and agencies now prepare ahead for maintenance work.

Raman Patel: Annex F.1.1 lists the architectural needs that support the operational environment. These architectural needs provide live data when there is a connection. You can actually continue talking to the field device from a Management Station on the left, then the device provides you with continuous data. That's during the live operations. Compressed data. We don't transmit data every second or so. There is a possibility that the network is not efficient or hasn't sufficient bandwidth. In that case, instead of sending data continuously, we compress the data and send it as one piece at certain intervals. When we lose a connection to a central device—sometimes we use a dial-up connection—and don't have communication, the device continues keeping a log and stores data. That data is available. When there is no offline communication, we are able to download data—log data back—and clear the memory and can say "we've got the data now." These operations are supported by architectural needs. Generic features are also supported by architectural needs.

Raman Patel: There are three categories of features supported. Features are like user needs. They're supported by ESS Manager Features in Section 2.5.1; Sensor Manager Features in 2.5.2; and PTS. PTS stands for Pavement Treatment System. Those features are described in Section 2.5.3.

Raman Patel: Let's look at these one by one. ESS Manager Features Supported by Standard. The ESS Manager manages both a Sensor Manager and a PTS Manager. It's like a master manager—if you want to say it that way—that communicates with the central location. Specific ESS features are generally generic for different devices and types. Specific ones—Monitor Door Status, 2.5.1.2; Monitor Power, 2.5.1.3; Monitor Mobile Station Data, 2.5.1.4. What type of ESS exists out there—if you want to know more, you can do that through this feature. So there are several ESS features which are widely used because they are supported by the standard.

Raman Patel: For example, 2.5.1.2 is Monitoring Door Status. A transportation system operator may want to inquire if any doors on the ESS equipment are open, without having to send somebody to the location. This is a good feature. We can say, "Let me make an inquiry and see what the message comes back with."

Raman Patel: Another way to look at overall statewide deployment. For example, weather stations. This is a very good example from Idaho DOT. You have a region-wide treatment—there is more than one ESS station located in the region. Multiple sensor stations are out there. On the left, you have an image from a camera. It's a snapshot of the terrain—what the highway looks like under weather conditions. Then you have variables providing you with different level readings for sensors—precipitation, visibility, wind speed, gust. We have all of these things. Collectively, we get all of the benefits from ITS applications that agencies have in mind when they use these kinds of weather stations.

Raman Patel: More examples of ESS deployments. Alabama has, for example, 26 ESS sites, shown here on the map on the left side. Georgia next to it shows over 27 RWIS sites. Florida on the right shows 52 sites. All of these deployment examples collectively provide information that can be used at the central location through the RPU—the Remote Processing Unit—and this information also can be provided to the public using various technologies, such as cell phones and messaging devices.

Raman Patel: In this example from I-10—Florida DOT—you can see on the left there's an RPU mounted in a cabinet on the pole. On the right side, you have several images shown of the sensors. Each one of these sensors provides us with numerical data of variable ranges. These ranges and data are used very heavily as part of the RWIS system.

Raman Patel: Purpose of ESS Deployment by Transportation Agencies. This map of the U.S. shows deployments are quite widespread across all the states. This is a 2008 map, but it tells us the extent of the ESS progress. Collectively, these ESS stations provide timely, accurate, and relevant road weather conditions. This is just not information that is going to sit there; this is the kind of information that ESS provides which is actually used to make decisions so that the operational conditions can be assessed—roadways, roadway conditions, whether the motorist will be safe, whether the motorist can easily navigate—things like that. There are many ways motorists make their own travel decisions and adjust to the roadway conditions. Once you are on the highways you are there—all you can do is adjust your decision based on whether the roadway is conducive to travel, or you do whatever is necessary in making travel decisions.

Raman Patel: Some examples of ESS Manager. The ESS Manager monitors power. The system operator may wish to monitor the power for the ESS to ensure proper conditions. This can be done remotely. As you can see, the workers on the right-side image are providing a structure—they're erecting something to support the ESS. Such functionality can also be remotely monitored—what data out there is available in a mobile as well as in a fixed environment. Some generic features are also covered.

Raman Patel: This slide shows Sensor Manager features. The Sensor Manager monitors weather conditions and pavement conditions, monitors subsurface conditions, monitors human readings, water levels, and so on—air quality, biohazards, ozone levels, for example. These are all examples of how sensors collect different types of information, and these capabilities are provided by the standard.

Raman Patel: For example, Manage Mobile Spray System. During the winter, one of the most common activities that occurs is salt trucks spraying salt and deicing liquid—shown on the right side. Both anti-icing and de-icing chemicals are used collectively in winter maintenance management.

Raman Patel: Our activity here is now to answer:

Raman Patel: Which of the following is not part of the ESS standard. Answer choices are: A) Collection of atmospheric and environmental data; B) Monitor the status of the ESS; C) Assessing if an ESS is permanent, transportable, or mobile; and D) Creating a weather advisory message on a variable message sign—VMS.

Raman Patel: The correct answer is D. Creating a weather advisory message on variable message signs is not part of the standard. This standard does not support it. But another standard, called NTCIP 1203 DMS, does. Answer A is incorrect because the feature is supported by the standard. B, similarly, is also an incorrect answer because this feature is supported by the standard: monitoring the status of ESS. And C is also an incorrect answer because assessing if an ESS is permanent, transportable, or mobile is actually supported.

Raman Patel: That brings us to our Learning Objective 3. We have to discuss now how to use the PRL to select user needs and provide traceability to requirements.

Raman Patel: What is a PRL? PRL stands for Protocol Requirements List. PRL is a table. It is a matrix. It provides the standardized relationship between user needs and their requirements, and as a template with fixed columns and multiple rows., it guides users and DMS manufacturers and suppliers. You see in this image of a PRL cut-view here there are certain columns. These columns cannot be changed, and the rows have information about particular user needs.

Raman Patel: Standardized Relationships Provided by the Standard. An agency may have one user need which could be met by one requirement. An agency may have one user need that will require two requirements, or more requirements. And then you can also have a situation where many user needs can be served by just one requirement. These situations are out there and the standards can take care of all these different needs. PRL is a place where we find this guidance.

Raman Patel: The PRL template helps the agency to select appropriate user needs and project level user needs. PRL then presents the associated requirements. This is a two-step process PRL handles pretty well. The agency completes the rows using the text from the PRL provided by the standard. The first column is User Need ID; the second column is User Need; the third column is Functional Requirement; the fourth column is the Requirement title; the fifth one is the Conformance; the sixth column is Support; and the last one, Additional Specifications, allows you to enter some notes. This is the basic structure of a PRL and how it provides guidance.

Raman Patel: Let's look at this a little more closely. The first line is the heading for the PRL. Here, the user has no role.; we cannot change anything. That's the way the PRL is. In the second line we have an example of a user need. It shows 2.5.1.2. That is the Monitor Door Status. That is a user need. Anything that starts with Section 2.5 is a user need. In the second line, we have the section number and its title. Then you go down further and you see the optional user need. Under Conformance, “O” stands for optional and “M” stands for mandatory. Optional need is selected by a user by selecting “Yes” or “No” in the next column, which is called Support.

Raman Patel: In the Conformance column, much more information is provided than we think. Here, it says that you have to identify the user needs and a requirement is mandatory. The standard has marked all mandatory requirements in the PRL and all optional requirements also in the PRL. Sometimes we have more optional user needs—then the role for the user is to select at least one of them so that we can

complete the PRL. Some basic user needs are considered mandatory by the standard—they have to be selected. We have no role. We have to accept that and select M—marked User Needs. For example, ESS Type. What does the station look like? Is this a permanent station? How can we identify that? How do you make sure that some location you are not aware of probably has a transportable, which is another type of environmental station? Or a maintenance truck may have a mobile environment where you have the measurement plus the communication network to transport data back and forth. These are important to assess in terms of what the requirements or user needs are.

Raman Patel: What should an agency do? First, circle “Yes” to indicate support for project-level user needs. If you have a user need that you have identified in your project, you must select “Yes.” If there's no identified user need, then you select “No.” If the conformance shows selected user need is mandatory, you must select “M”—then you must circle it, regardless. As we show here, we circle “Yes.”

Raman Patel: In the last column we have placeholders to provide additional information. If you think that it what I'd like be required and help—in some cases you are required to enter additional information—this column will do this for you.

Raman Patel: Let's look at this example for monitoring winds. The agency has established there is an operational need to monitor winds. There's a high bridge structure shown here on the right. Obviously, you can see that there is a need to measure wind conditions over and around the bridge vicinity. This user need will be implemented with the associated requirements in the third column. If the user need is identified and is required—Yes— like in this case, then the associated requirements will be identified, as shown here on the two red boxes on the right side.

Raman Patel: Completing a Project PRL: Functional Requirements. A very important job that we have to go through. These requirements are also from the standard. For each identified user need, the standard has already performed a complete job of identifying particular requirements that you will have to deal with. For every user need, there are associated requirements in the PRL. We don't have to do anything except select “Yes” and support is required—or “No.” Those are the kind of activities we'll be doing in completing the PRL. In this case, we selected “Yes” because we want to monitor winds around the bridges and other structures. In this case, we have selected “Yes—Support.” That means that everything "M" is selected “Yes” and everything "O" is also selected “Yes.” Once you select Operational User Need as “Yes,” you have all associated requirements included in this specification.

Raman Patel: This partially filled-in PRL example shows how we allocate support. We go through these four columns. The first one— User Need. The second—User Need Title, then ID for Functional Requirement, and the Requirement itself. We then select “Yes” for Monitor Door Status. This is another example. If you select “Yes,” the associated requirements will have to be completed in the PRL itself.

Raman Patel: An agency's perspective for project PRL is pretty good, because the agency says, "Here's my user needs. Here's my PRL.” I'm communicating to the outside parties that these are the user needs our project has established. The agency then communicates. PRL communicates the scope of the desired ESS interface. That's a very important point. It makes it easier to specify which interfaces to use because now we can customize. For each user need, we can lift the requirements from the standard and combine them in the project-level PRL. Third, it spells out conformance requirements. We have to conform to the NTCIP standard—PRL will help us do that. It spells out. It acts as a checklist— every user

need is listed in the PRL. We're going to verify and we say, "Check it out later on," and we're going to go into an elaborate process and say, "Are we really at the stage where they have built the right system as per our user needs?" At that point we will also be making sure whether or not we have achieved interoperability. PRL acts like a checklist and, in general, provides multiple services through a very nicely organized structure.

Raman Patel: For vendors and system developers, it's a connected world. You are connected on the same page with your client or user. If you understand what the user wants, then you will understand through the PRL that's a pretty good benefit. It eliminates guessing. "What does my client want? What do they really want? Why do they need this? Wait a minute, they made a decision. They gave us the PRL, so now all the guessing is behind us.“ There is no guessing to be had. But with that, it also brings the element of reduction in risk. If you know what someone wants—your client, your user—then you are also embarking on the right way in providing capabilities in the system. The vendor confirms at the end and says, "You asked for this? Here is what I'm providing you." ESS functionality is confirmed—the first time from the user side; the second time from the vendor side. It's a good thing. The PRL offers optional features. Vendors can also list optional features they are willing to provide to the client.

Raman Patel: Our activity now is to answer:

Raman Patel: Which of the following is not a correct approach to preparing the project PRL? A) Select YES Architectural needs; B) Select Mandatory ESS Manager features ONLY; C) Select YES project-specific features; and D) Let the vendor select ESS features.

Raman Patel: And the correct answer is D, let the vendor select ESS features. The answer is correct because the statement is false. You don't want the vendor to select ESS features. You want the agency to select the features. The entire purpose of providing PRL in specifications is to communicate what an agency needs. A vendor can respond to the PRL, but it is the user telling the vendors what the user really wants. That's the way we need to go to strengthen our understanding. A is an incorrect answer because the statement is true. Architectural needs are provided by the standard. Answer B is also incorrect because the statement is correct. The ESS manager selects mandatory ESS Manager features only. The third is selecting YES project-specific features. That's incorrect, because the PRL must select YES optional user needs. That's the whole idea about the Conformance column in the PRL.

Raman Patel: Our last learning objective is to discuss how to prepare a project-level PRL for an ESS specification.

Raman Patel: Let's go over some of the key elements of what should be in the specification.

Raman Patel: First, let's understand that ESS actually collects weather data and sends it to the Central System Management Station for further processing. Second, the Central System Management Station monitors ESS as part of the RWIS. RWIS is an umbrella system. It's the larger element in the overall capability at the Traffic Management Center. Third, ESS specification begins with identifying user needs and specifying requirements. That's where we want to start— identifying user needs.

Raman Patel: Procurement specifications generally have hardware specifications. These include functional requirements, performance requirements, structural requirements, size, shape, mechanical requirements, fan components, electrical requirements—including power, voltage, current. Environmental requirements include temperature, humidity, and other different items, including other environmental-

related issues. Collectively, hardware specifications provide detailed information from the owner's standpoint about the procurement process. Second, software specifications. There are functional requirements and performance requirements. Third is what we are discussing here in this module and the next one—communication interface specifications. We need user needs, we need functional requirements, we need project-level PRL, a completed RTM, and also testing documentation. At the end of the day, we will also select how we will test the ESS. All of these occur at a system development, testing, deployment, integration, operational, maintenance, and general project-management level.

Raman Patel: Let's look at the key points to remember while completing the project PRL. First, the PRL must be consistent with the hardware specification. We said that the hardware specification is separate—whatever we say there must also match the communication interface specification for ranges, quantities—things like that. ESS specifications should have a project-level PRL. The PRL must be based on the version 1204 with SNMP interface standard. Finally, it must include need-based specific parameters. We don't want to create a PRL or specification that says, "Give me everything you have," or "Give me all I can get." We want to stay away from this concept of getting everything in sight—that's not helpful.

Raman Patel: Conformance and Compliance Issues. Conformance means a specific standard is met. How? To claim conformance to standard 1204 v04, the vendor shall minimally satisfy the mandatory requirements selected YES. Everything "M" in the PRL must be conformed to. Vendors that provide additional features beyond the completed PRL are still conformant as long as they conform to the requirements of the standard. Keep in mind that the standard must conform at every level. Compliance means meeting specification requirements.

Raman Patel: Filling in a PRL—or populating—the PRL with User Needs Requirements. We will use Yes in the Support column to do that. Monitor Winds is a user need. What do we say? We're going to select “Yes.” In the Support column you have to find a place where Yes/No is listed. You're looking at that right now. If you have selected Yes for your project needs—Monitoring Wind Capability—then you have to identify the requirements related to that. Let's do just that.

Raman Patel: Everything selected “Yes” includes architectural needs, generic features, and all those things. If you look in the Conformance column, you have M, M, M, M. Everything is selected “Yes” because M is selected—M, M, M, M. In other words, you are selecting or completing mandatory needs for conformity. That's one. You select “Yes” for a project-level requirement. Now here you have a choice—Yes or No. If it's optional, and if you say your operational needs require you to have this capability—the user need—then you have to select Yes. That's what you will be doing in the Support column. And as soon as you select Yes in the Support column, all the associated requirements will also come by in a manner that is selected in that particular user need. Here, for example, we show Yes or No for Permanent ESS Station. There are three stations out there for ESS in user need 2.5.1.5—Permanent, Transportable, and Mobile. We don't really know which is required, and you probably have one of the three, or maybe two of the three. So you, as the agency, will decide whether it's required or not required. In this case, “Yes” is selected for permanent. That means “No” for mobile and “No” for transportable. These are user needs. This will remind you to select what you need so you don't add additional costs for things that you don't need. If you select something that you don't need, it will add not only just the cost, but also complexity. All these different things tell us that we’d better do a good job in terms of selecting Yes/No in the Support column.

Raman Patel: Addressing Generic Architecture. These are the basic things; These are the basic communication required. We always have to select them. So that's what this means. They're already selected “Yes.” Select “No” if not needed. Not everything is needed. A compressed data scheme may not be necessary if you have a wide bandwidth. And for most agencies today, after 20 years or so of investing in high-speed networks and bandwidth, there's probably no need to compress data. It's okay to have data coming in from the field to the central location every two seconds, and that's how you can look at Yes/No as being good or not. Offline Data Capability—Yes. You should probably always select “Yes,” because sometimes when you lose the communication, you want to be able to restore it through the log data process.

Raman Patel: Version 1204 compatibility to v03, v02, and v01 is nearly complete. If you really need the support for these old versions, then you have to use the PRL and indicate that you are actually looking for support related to a previous version. v04 is being updated with the view that it has to be compatible with the previous version. Another point relates to some of the newer sensor technologies that we have in v04. Technology is changing—these kinds of sensor devices are also not included in older versions of 1204. This is a point to remember. Some headings have also been changed in the tables for the PRL. These are minor issues you shouldn’t be concerned with too much.

Raman Patel: Our activity here then is to answer this question:

Raman Patel: Which of the following is a false statement related to ESS specification? Answer A) ESS specification includes a PRL; B) Conformance requires only meeting mandatory user needs; C) Compliance requires only mandatory user needs; and D) Vendor must use project PRL.

Raman Patel: The correct answer is C. The statement is false. The vendor must meet mandatory and selected optional user needs for compliance to the specification. Answer A is incorrect because the statement is true. The agency specification must include the PRL. Answer B is also incorrect because the statement is true. Conformance requires only mandatory user needs. Answer D is also incorrect because the statement is true. The vendor must use the agency PRL.

Raman Patel: Summarizing the module—what we have discussed today. We reviewed the structure of the standard; Discussed where the information is—sections, PRL, RTM—all those different items in the NTCIP 1204 v04; Identified specific ESS operational needs—why agencies use weather data and how it's being used—those kind of things used for the RWIS. We also learned how to use PRL to select user needs and associated requirements. We also discussed what to do in the specification, identified key issues, and prepared a correct specification based on the PRL.

Raman Patel: We have completed A313a module today, Understanding User Needs.

Raman Patel: The next module will be A313b, Specifying Requirements for v04 ESS Standard. In that module, you will briefly review the structure, use the PRL and RTM to specify standardized structure of requirements, use the RTMs—the RTM stands for Requirements Traceability Matrix—to specify standardized design, also learn how to specify requirements not covered by the standard, and finally, infer the relationship between certain selected requirements and testing. That's what you will be learning in the next module.

Raman Patel: Thank you for completing this module, and we would appreciate your feedback at the end of the training. Again, thanks.