



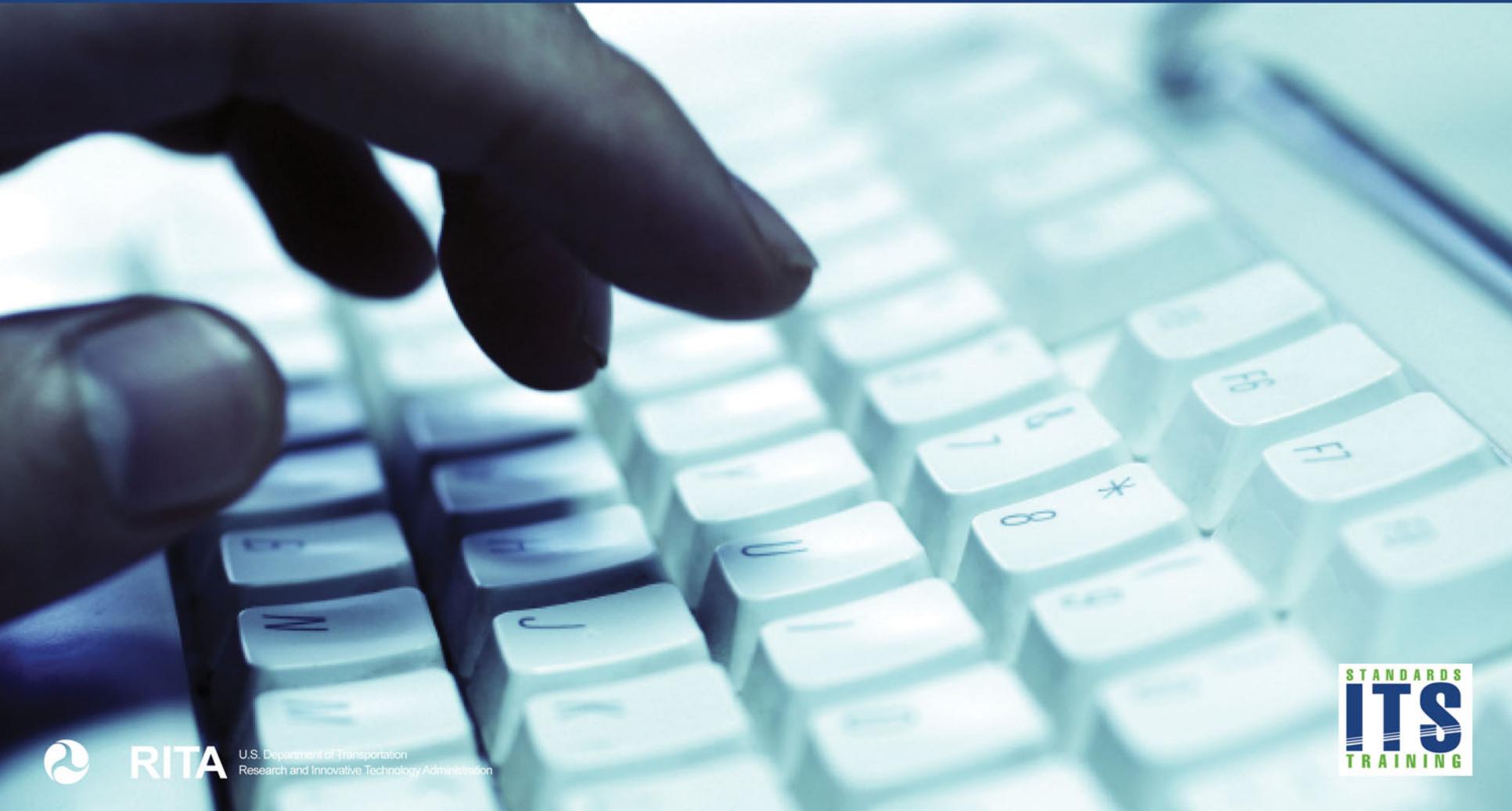
W E L C O M E

**RITA** Intelligent Transportation Systems  
Joint Program Office

# **A312a: Understanding User Needs for Transportation Sensor Systems (TSS) Based on NTCIP 1209 Standard**



# ACTIVITY



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U.S. Department of Transportation  
Research and Innovative Technology Administration



# Instructor



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# Target Audience

- Traffic engineering staff
- Traffic Management Center (TMC)/operations staff
- System developers
- Private and public sector users including manufacturers

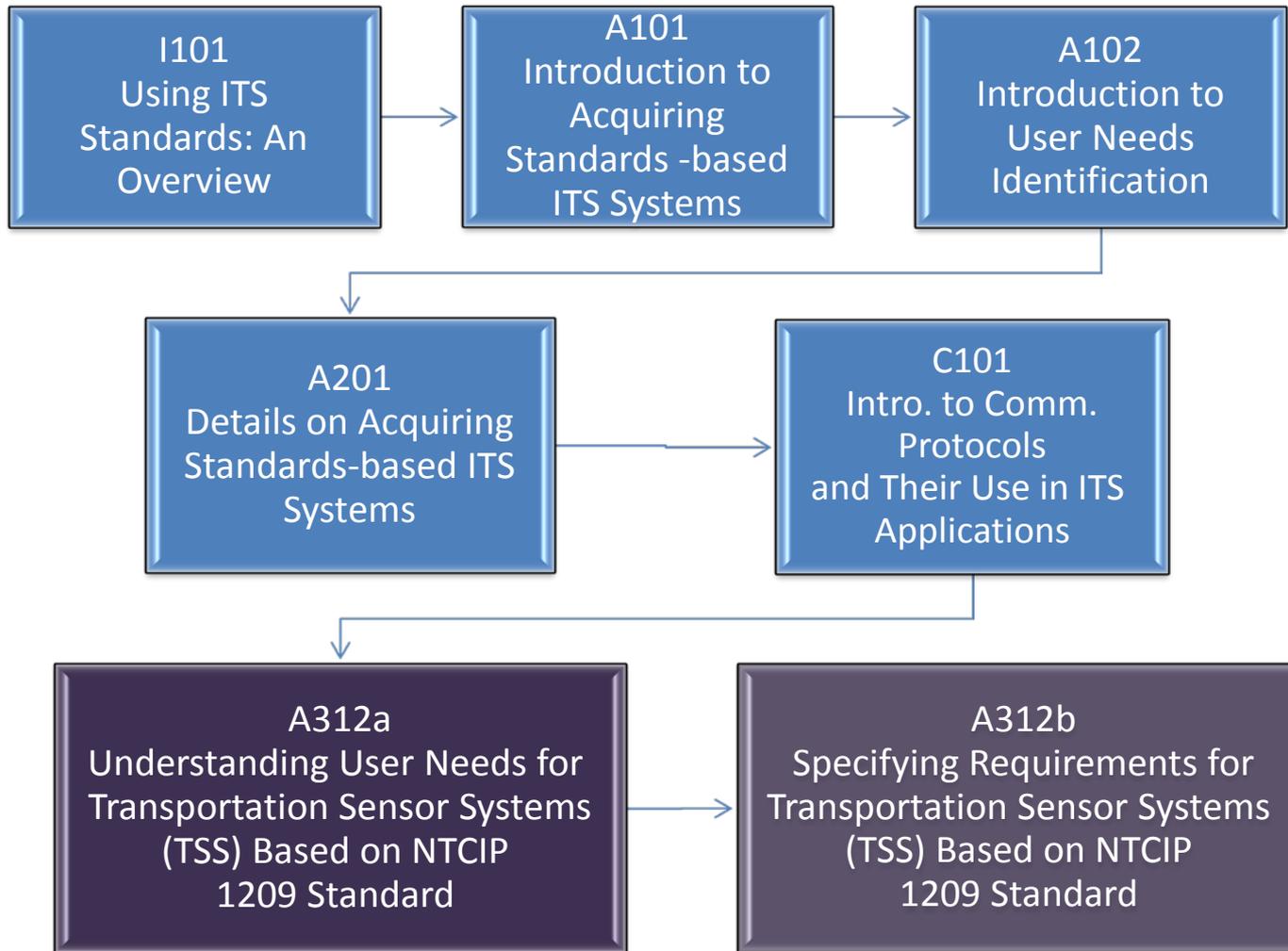


# Recommended Prerequisite(s)

- I101: Using ITS Standards: An Overview
- A101: Introduction to Acquiring Standards-based ITS Systems
- A102: Introduction to User Needs Identification
- A201: Details On Acquiring Standards-based ITS Systems
- C101: Introduction to the Communications Protocols and Their Uses in ITS Applications



# Curriculum Path (SEP)



# Learning Objectives

1. Review the structure of the NTCIP 1209 v02 Standard
2. Identify TSS specific user needs
3. Use the Protocol Requirements List (PRL) to select user needs and link to requirements
4. Explain how the PRL table in the TSS Standard integrates into the specification



# Learning Objective #1 – Review the Structure of the NTCIP 1209 v02 Standard

- Purpose of the NTCIP 1209 v02 Standard
- Structure of the NTCIP 1209 v02 Standard
- How the standard fits into the systems life cycle



# Purpose of the NTCIP 1209 v02 Standard

The purpose of the NTCIP 1209 v02 Standard is to define the **NTCIP communications requirements and specifications**, which **provide interoperability between a transportation sensor system and a management station.**

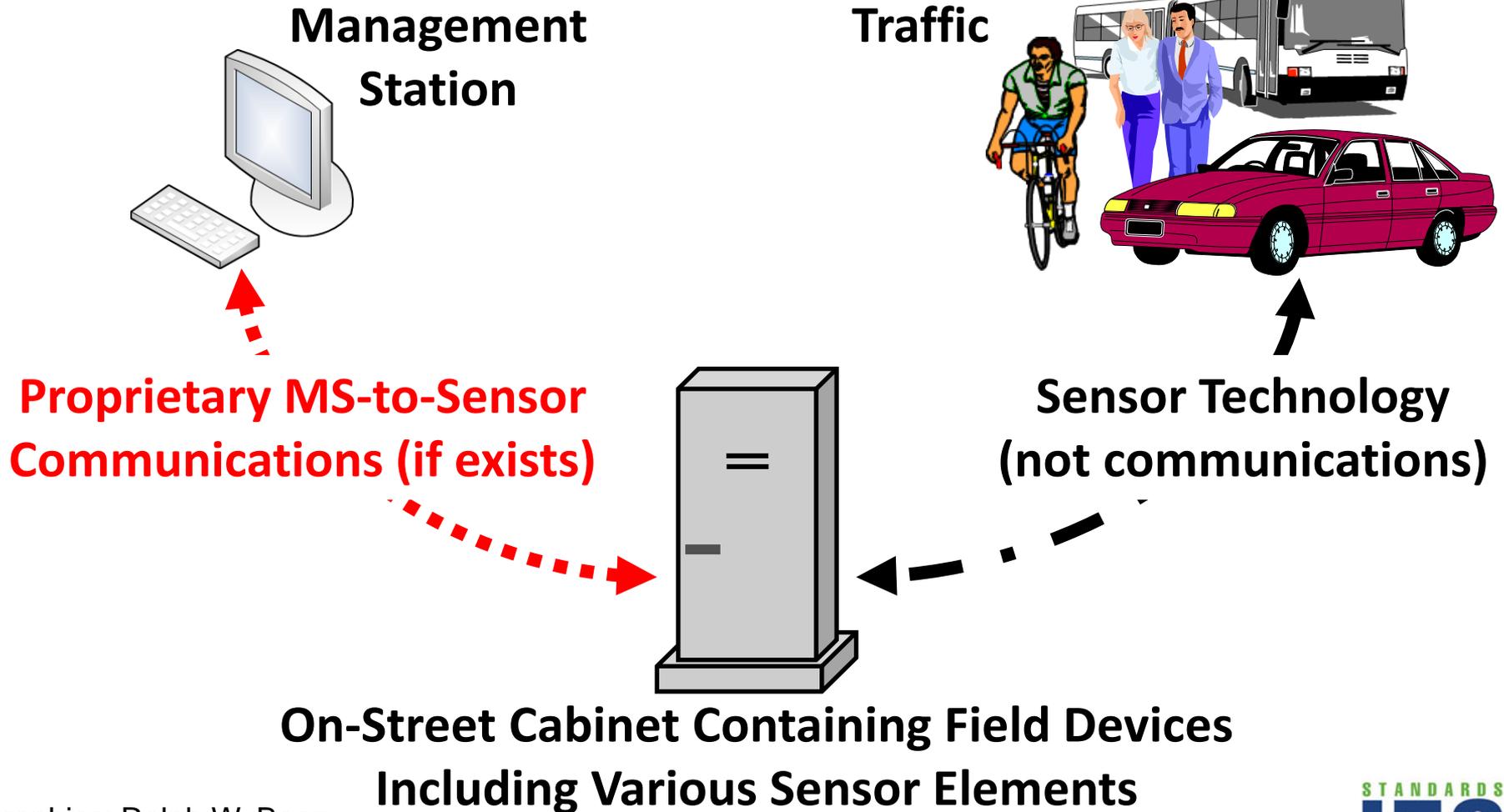


# Definition of a Sensor System

## Sensor, Traffic Sensor, Sensor System

- A physical device used for sensing traffic
- Numerous types of sensor technologies in use today
- Differing sensor technologies have advantages and disadvantages
- Generic term used in the industry when referring to an entire sensing device

# Typical Sensor Deployment



Graphics: Ralph W. Boaz

# Elements of a Sensor

## Sensor Technology Element

- Creates raw sensor data using a specific sensor technology

## Processing Element

- Turns the raw sensor data into usable output data
- Processing for configuration, control, monitoring, and data collection

## Internal Cabinet Communications Element

- Type of communication depends on the cabinet architecture – *typically not using NTCIP 1209*

# Elements of a Sensor (cont.)

## Remote Communications Element

- Often proprietary communications are used
- **Ideal use of NTCIP 1209** – *if customer specifies it*



# Sensor Technologies In Use Today

- Loop
- Video
- Microwave Radar
- Magnetometer
- Acoustic
- Ultrasonic
- Infrared
- Laser
- Piezoelectric
- Pneumatic
- Light-Sensitive
- Others



# Example – Sensor Technology Element

## Video Image Sensor



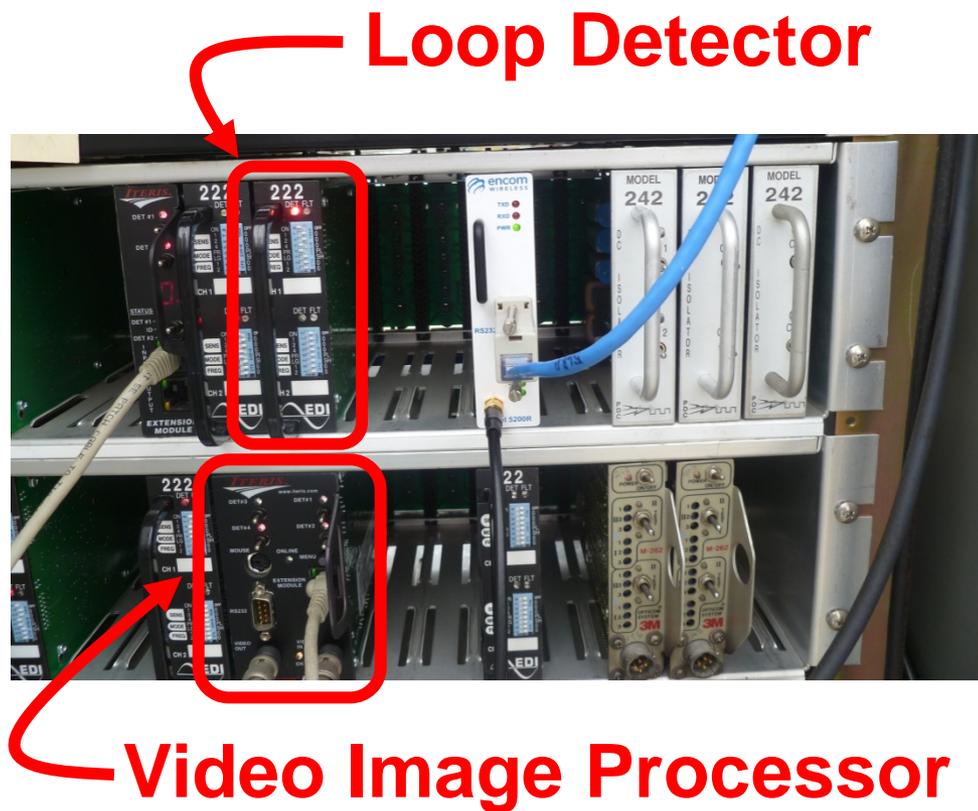
## Inductive Loop



Photos: Ralph W. Boaz

# Example – Processing Element

## Transportation Cabinet



Photos: Ralph W. Boaz

# Example – Communication Elements



Photo: Ralph W. Boaz

- Communication within (this) cabinet uses a connector on the processor to a wired cabinet backplane

***Not covered by NTCIP 1209 Standard***

- Communication for remote access to the video image processor (typically Ethernet or serial)

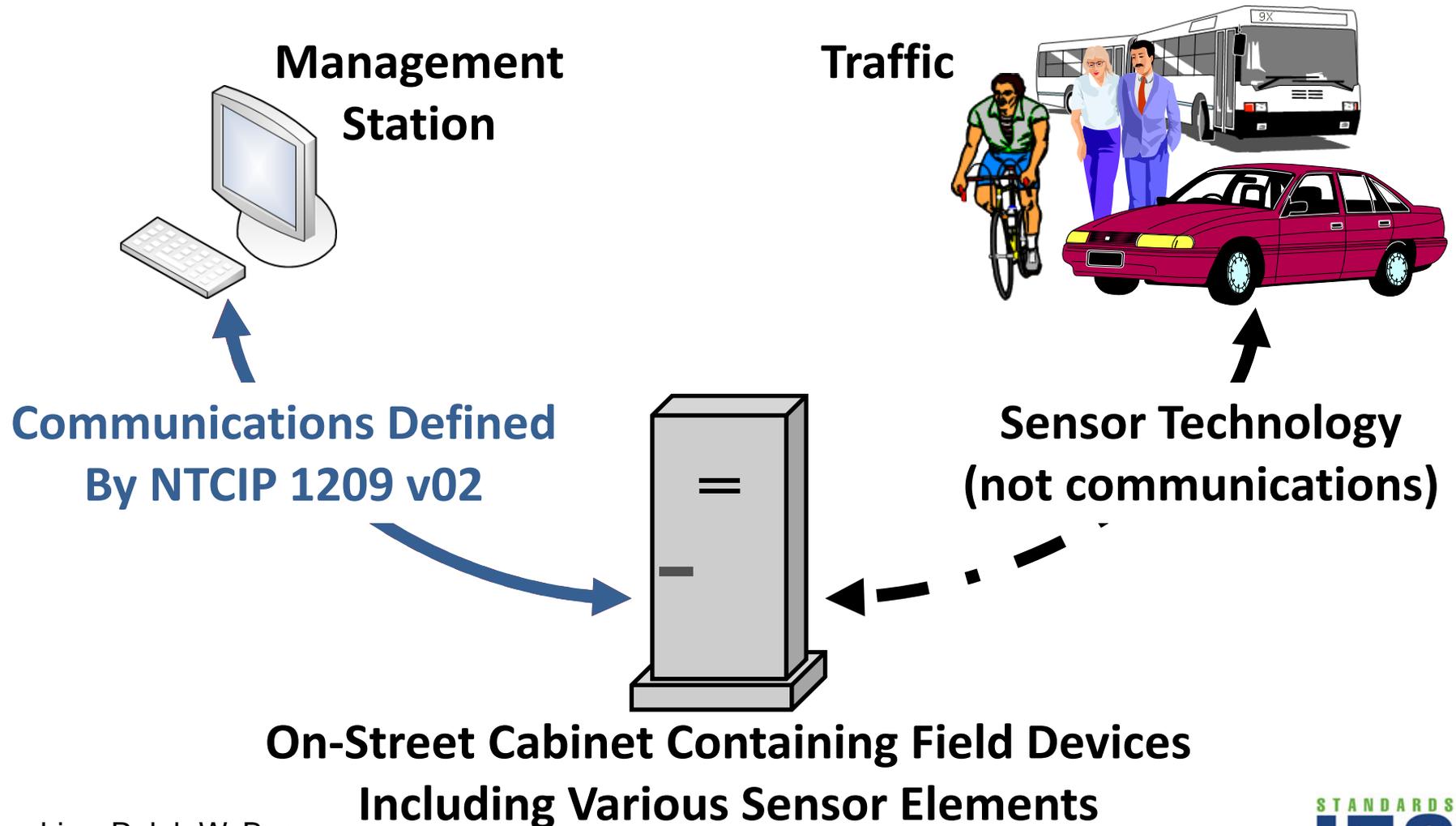
***Covered by NTCIP 1209 Standard if specified by customer***

# Definition of a TSS within NTCIP 1209

A Transportation Sensor System (TSS) is defined as any system or device capable of sensing and communicating **near real-time** traffic parameters using NTCIP.



# TSS Deployment



Graphics: Ralph W. Boaz

# Clarification on Terminology

- A Transportation Sensor System (TSS) is considered a **field device** from an NTCIP perspective
- It may be a relatively simple device or a combination of devices working together
- Don't confuse a TSS with other systems that require center-to-center communications



# Benefits of the NTCIP 1209 v02 Standard

- Identifies operational user needs for traffic parameters within a system
- Establishes a common understanding of the essential features for TSS equipment
- Facilitates testing by providing clear and verifiable interface requirements and specifications



# Benefits of the NTCIP 1209 v02 Standard (cont.)

- Promotes understanding of the standard by providing traceability between user needs, requirements, and detailed specifications
- Provides tools (tables) for users to include in specifications that accurately define an NTCIP TSS interface
- Facilitates compatibility, interoperability, and interchangeability of TSS equipment within a center-to-field system



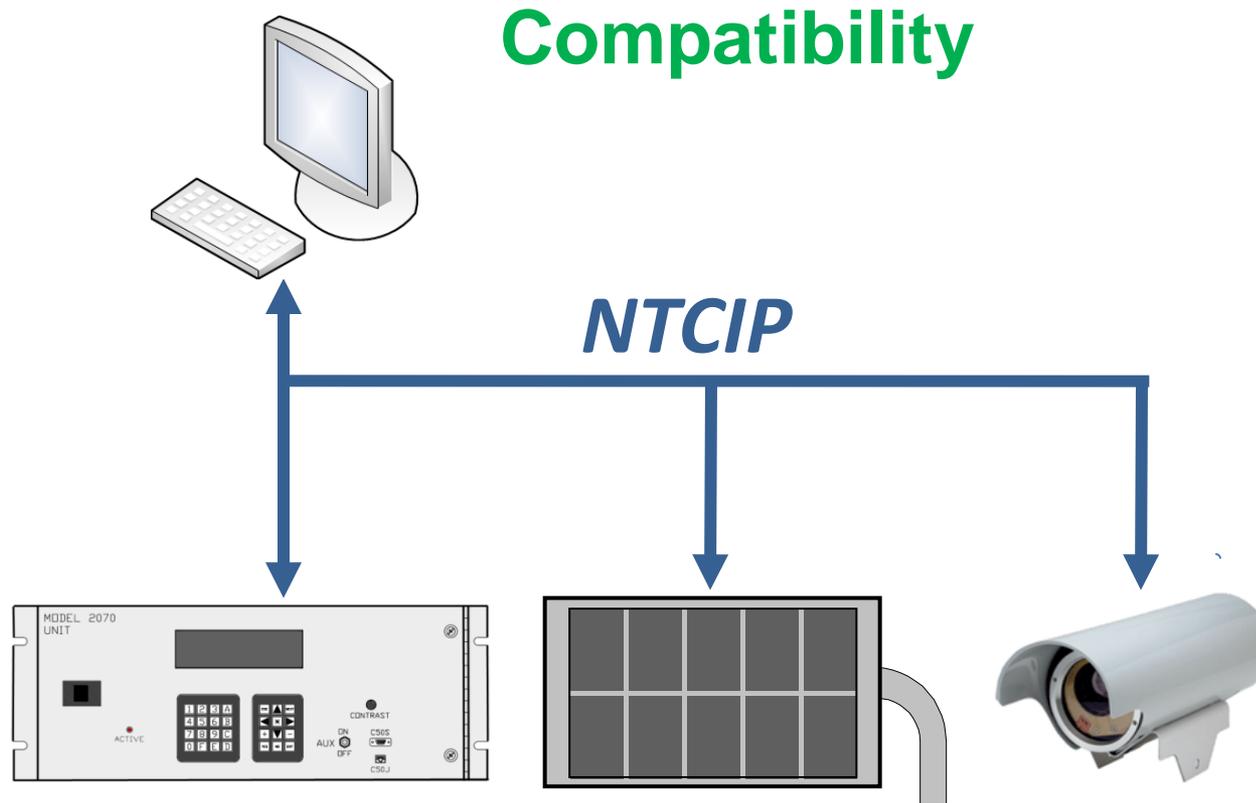
# Facilitates Compatibility, Interoperability, and Interchangeability of TSS Equipment

## Compatibility

- Two or more systems or components perform their required functions while sharing the same environment
- The two components (or systems) do not need to communicate with each other



# Facilitates Compatibility, Interoperability, and Interchangeability of TSS Equipment



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# Facilitates Compatibility, Interoperability, and Interchangeability of TSS Equipment

## Interoperability

- Ability of two or more devices to exchange information
- Ability to use the information that has been exchanged



# Facilitates Compatibility, Interoperability, and Interchangeability of TSS Equipment

## Interoperability



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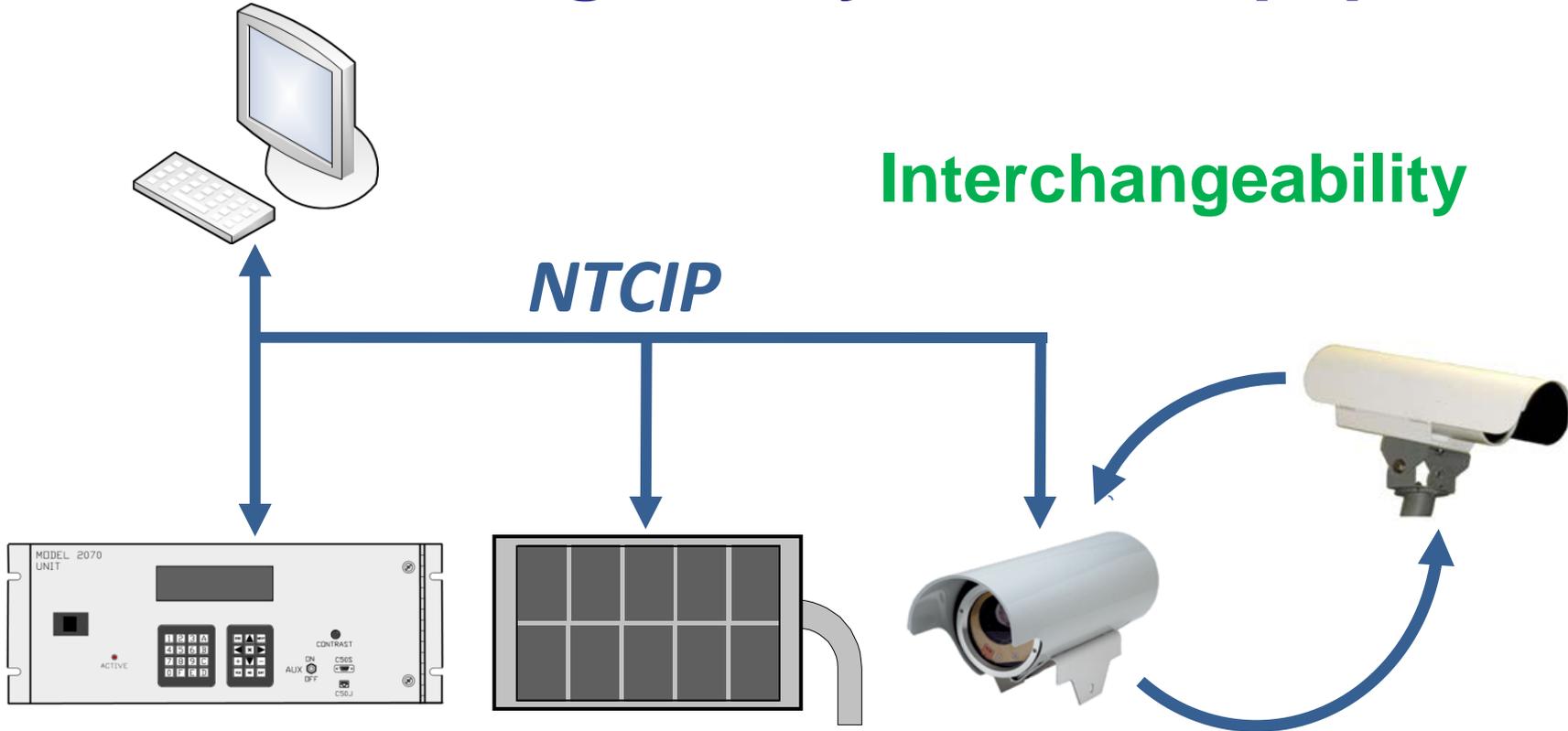
# Facilitates Compatibility, Interoperability, and Interchangeability of TSS Equipment

## Interchangeability

- Same functional and physical characteristics so as to be equivalent in performance and durability (subjective)
- Ability to exchange devices of the same type without alteration to the device or adjoining items (adjustments permitted, subjective)



# Facilitates Compatibility, Interoperability, and Interchangeability of TSS Equipment



Graphics: Ralph W. Boaz

# Structure of the NTCIP 1209 v02 Standard

Section 1 General

Section 2 TSS Concept of Operations (ConOps)

Section 3 TSS Functional Requirements  
**(includes Protocol Requirements List)**

Section 4 TSS Dialogs

Section 5 Management Information Base (MIB)



# Structure of the NTCIP 1209 v02 Standard (cont.)

Annex A Requirements Traceability Matrix (RTM)

Annex B Object Tree

Annex C Test Procedures  
(placeholder for the future)

Annex D Document Revisions



# History of NTCIP 1209

## NTCIP 1209 v01

- Oriented towards inductive loop technology
- Did not contain SE information

## NTCIP 1209 v02

- Added SE information
- Organized around features
- Options for selecting requirements for specific technologies (inductive loop and machine vision)
- Structure conducive for including additional specific technology requirements in the future

# How NTCIP 1209 v02 Fits into the Systems Life Cycle

- A systems engineering process (SEP) was used in the development of NTCIP 1209 v02
- SE information is included in the standard's content
- Helps insure that the standard is complete and correct
- Provides users with the thought process of the standard developers and use of the design items

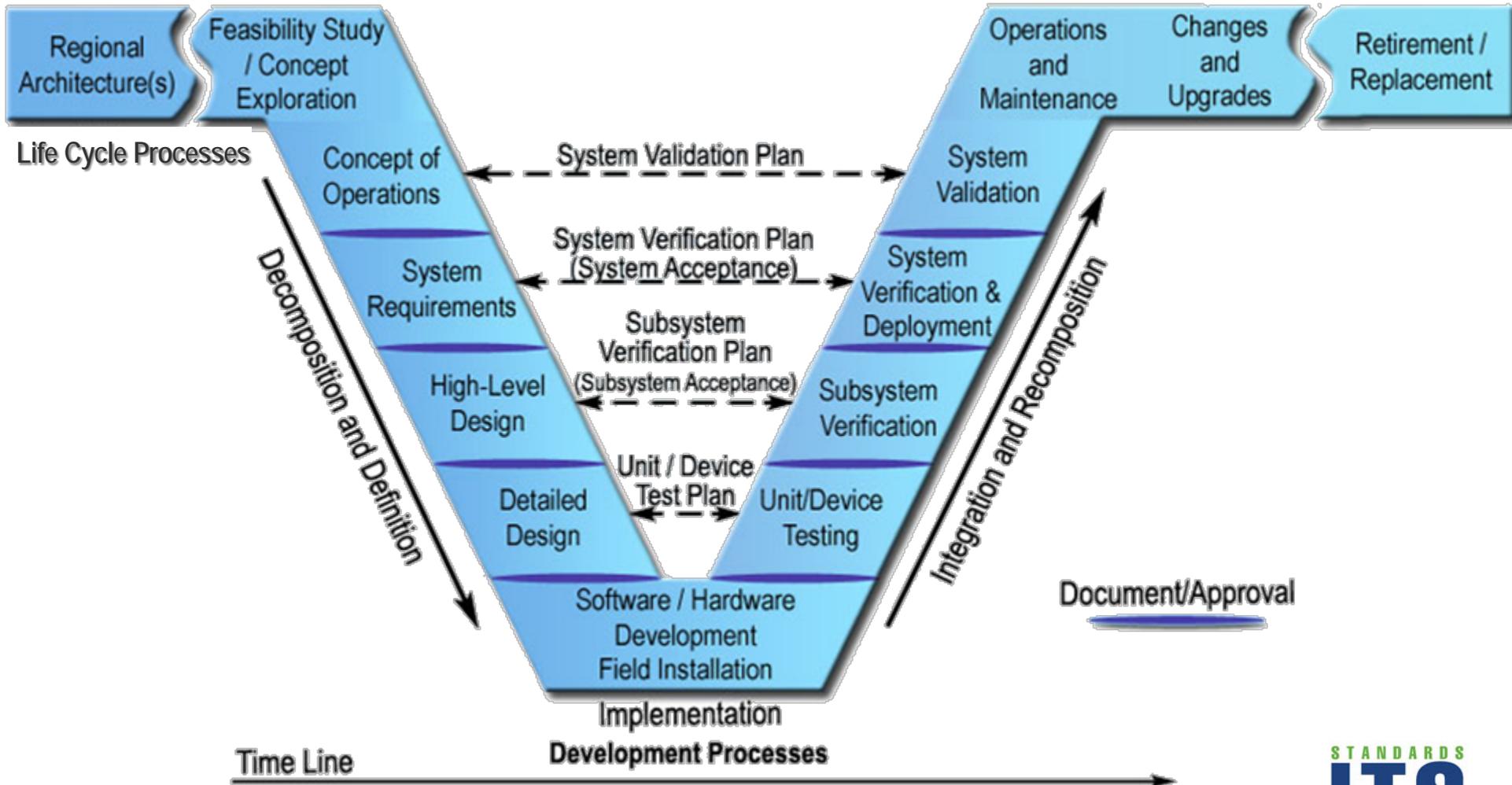


# How NTCIP 1209 v02 Fits into the Systems Life Cycle (cont.)

- Use of NTCIP standards **usually** starts in the design phases of system development
- Considered a part of the subsystem interfaces
- Helps users identify needs and requirements for their own specifications and other documents that reference the standards



# How NTCIP 1209 v02 Fits into the Systems Life Cycle



# How NTCIP 1209 v02 Fits into the Systems Life Cycle

## NTCIP 1209 v02

National Transportation  
Communications for ITS Protocol

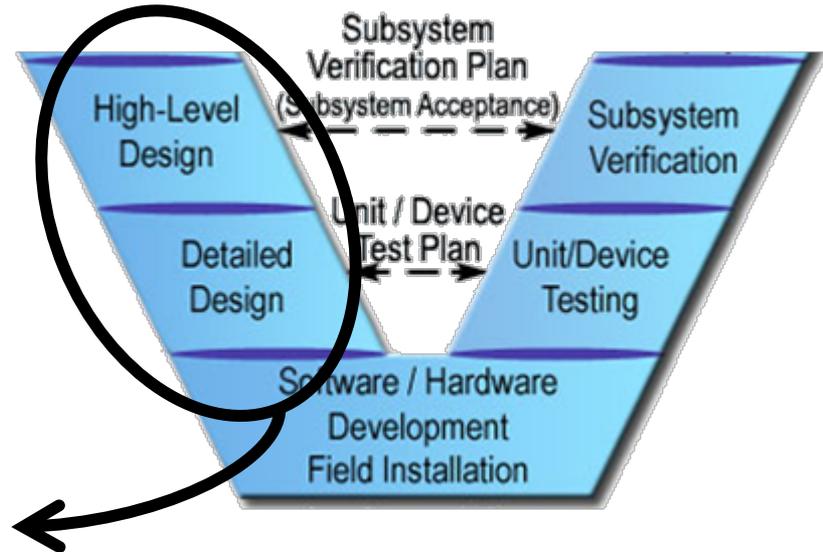
Data Element Definitions for  
Transportation Sensor Systems

Joint Standard of AASHTO, ITE and NEMA



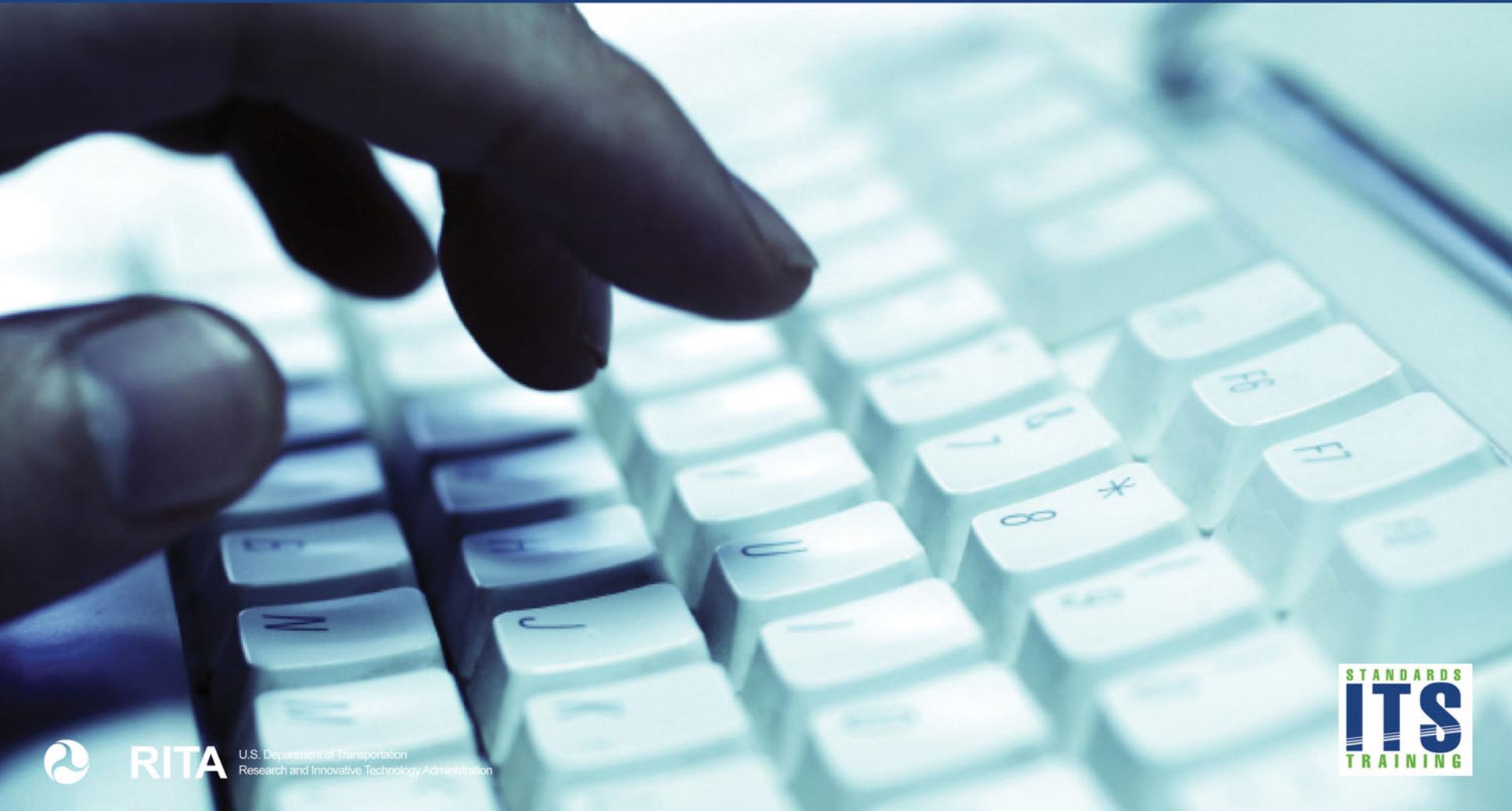
NTCIP Standards Publication

A Joint Publication of  
American Association of State Highway and Transportation Officials (AASHTO)  
Institute of Transportation Engineers (ITE)  
National Electrical Manufacturers Association (NEMA)



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A \_\_\_\_\_ is defined as any system or device capable of sensing and communicating \_\_\_\_\_ real-time traffic parameters using \_\_\_\_\_.

## Answer Choices

- a) detector; fast; Ethernet
- b) controller; conformant; NTCIP
- c) NTCIP; conformant; Ethernet
- d) TSS; near; NTCIP



# Review of Answers



a) detector; fast; Ethernet

*Incorrect. Ethernet is not the only communications medium that can be used for a TSS.*



b) controller; conformant; NTCIP

*Incorrect. A controller doesn't do sensing but it may use the sensor information or provide it to a central computer.*



c) NTCIP; conformant; Ethernet

*Incorrect. NTCIP is a protocol not a system or device.*



d) TSS; near; NTCIP

***Correct. This completes the definition of a TSS.***

# What is the role of the processing element of a TSS?

## Answer Choices

- a) Creates raw sensor data using a specific sensor technology
- b) Turns the raw sensor data into usable output data
- c) Transfers output data to other devices or systems internal to the field cabinet
- d) Transfers output data to other devices or systems external to the field cabinet

# Review of Answers



a) Creates raw sensor data using a specific sensor technology

*Incorrect. This is a role of the sensor technology element.*



b) Turns the raw sensor data into usable output data

***Correct. This is the role of the processing element.***



c) Transfers output data to other devices or systems internal to the field cabinet

*Incorrect. This is the role of the internal cabinet communications element.*



d) Transfers output data to other devices or systems external to the field cabinet

*Incorrect. This is the role of the remote communications element.*

# Summary of Learning Objective #1

## Review the Structure of the NTCIP 1209 v02 Standard

- Purpose of the NTCIP 1209 v02 Standard
- Components and structure of the NTCIP 1209 v02 Standard
- How the standard fits into the systems life cycle

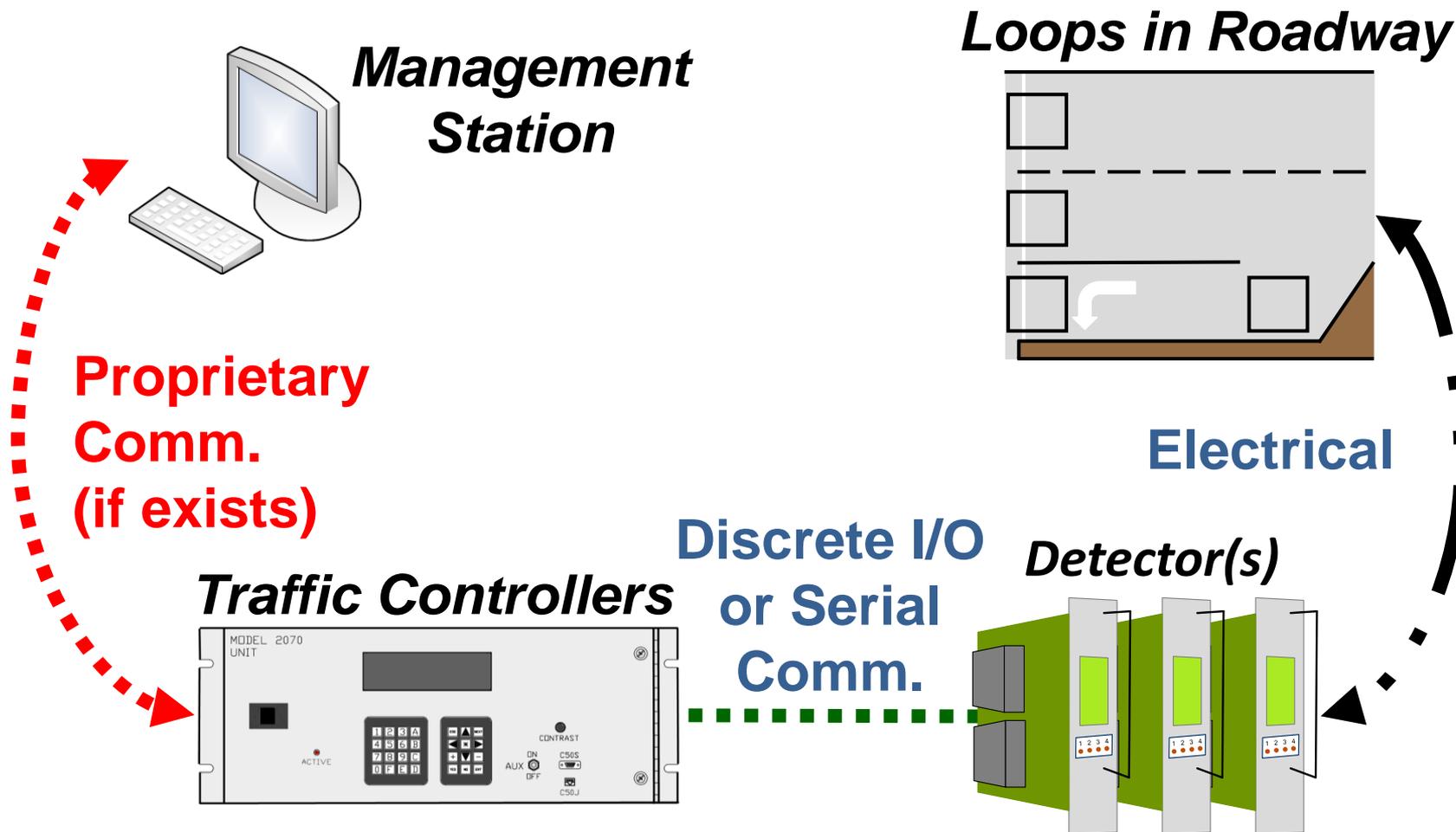


# Learning Objective #2 – Identify TSS User Needs

- Architecture of a TSS
- Define TSS terms and concepts
- User needs (expressed as “Features”)



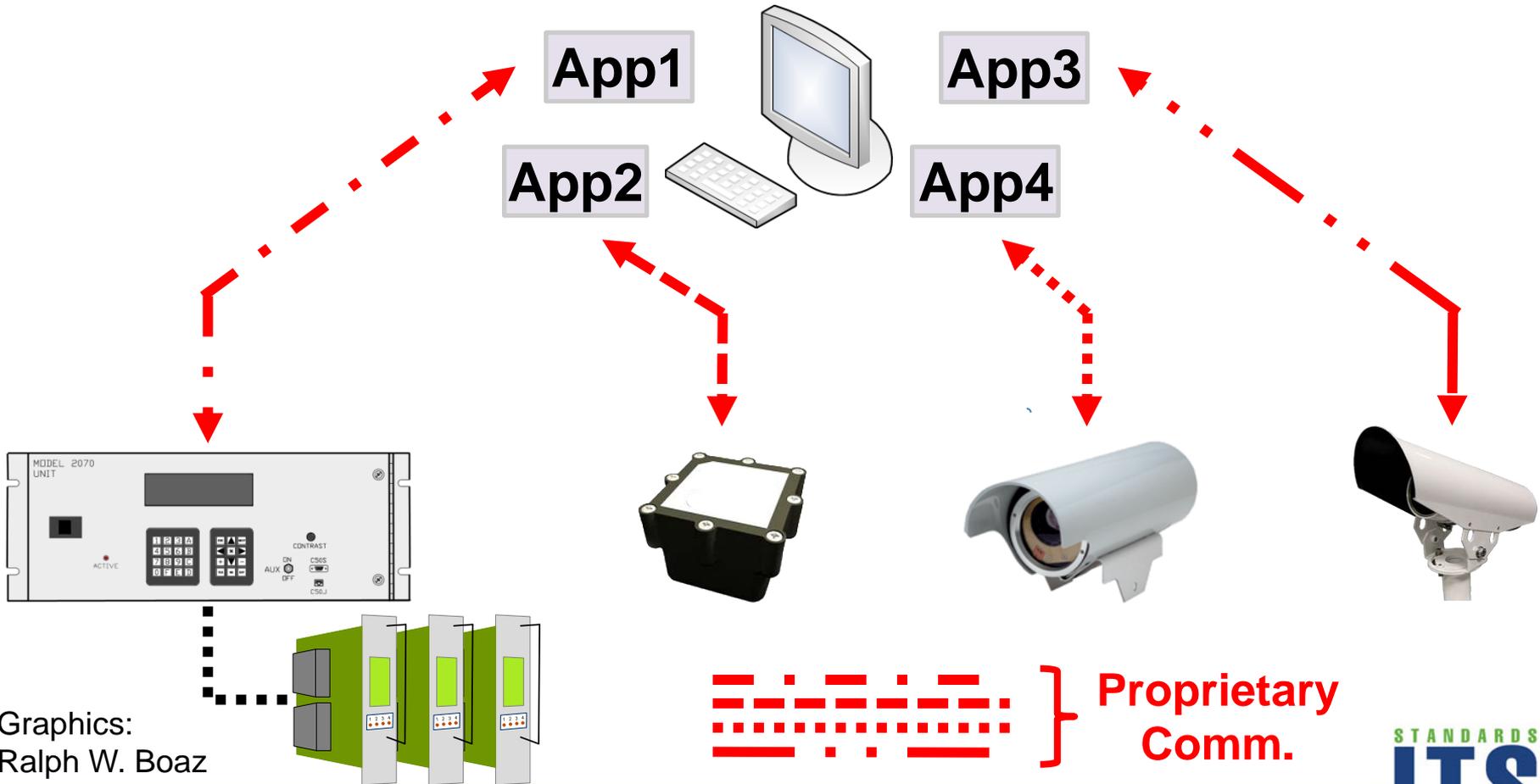
# Traditional Detection Architecture



Graphics: Ralph W. Boaz

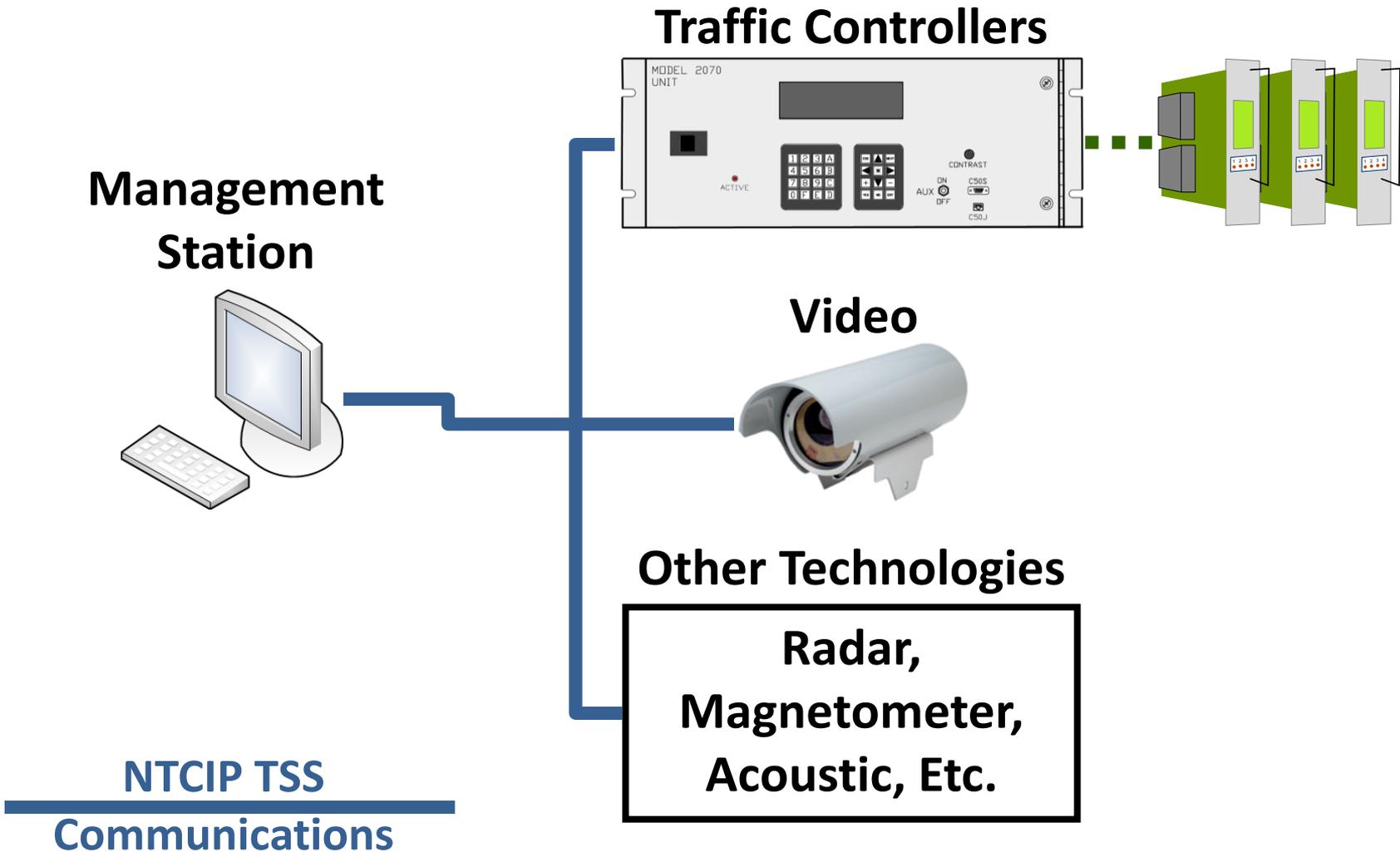
# Traditional Detection Architecture

An application program for each type and brand of sensor device



Graphics:  
Ralph W. Boaz

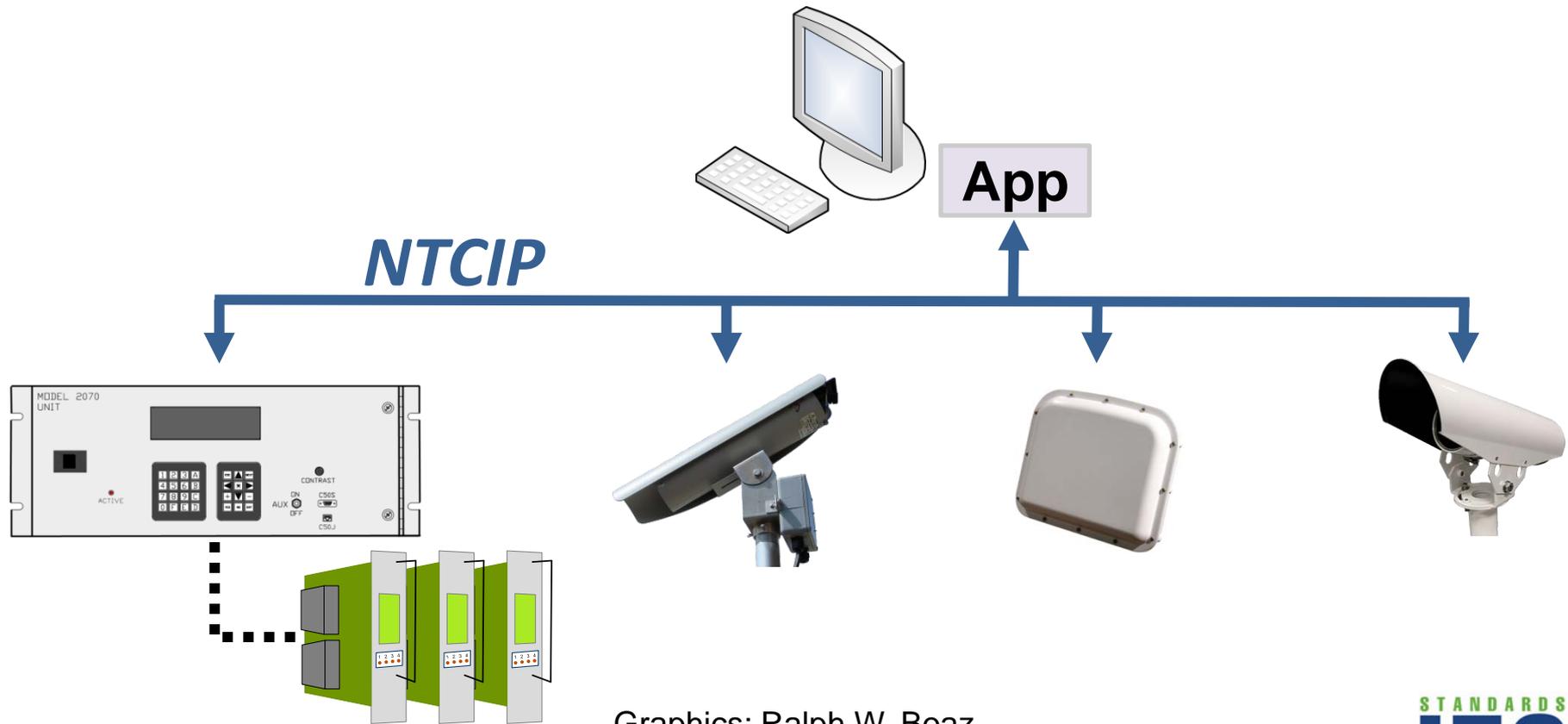
# NTCIP 1209 Detection Architecture



Graphics: Ralph W. Boaz

# NTCIP 1209 Detection Architecture

Single application program for each type and brand of sensor device



Graphics: Ralph W. Boaz

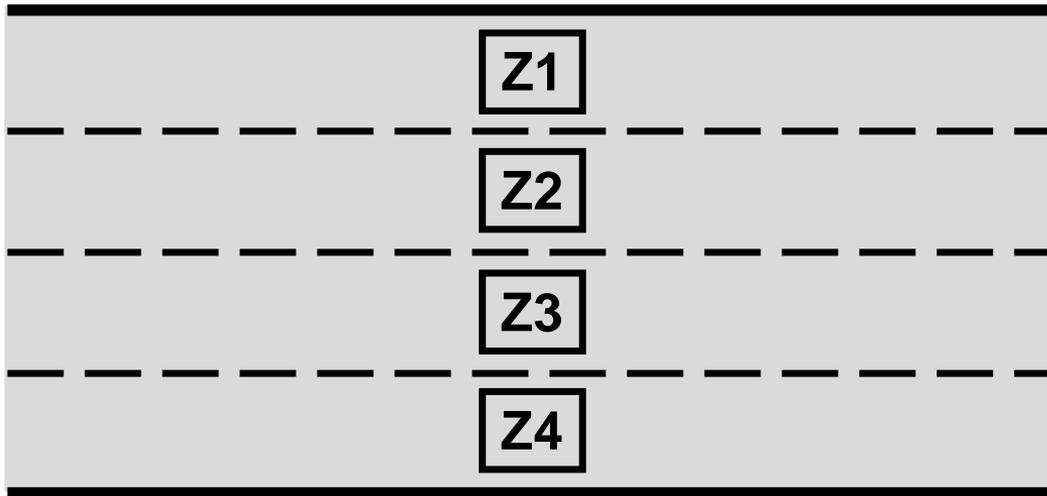
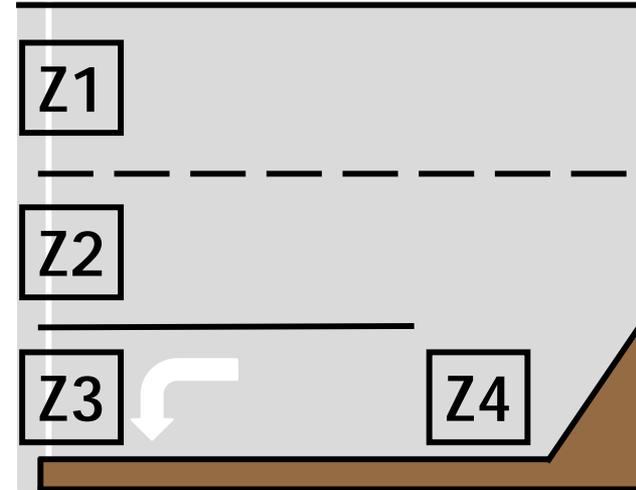
# Definition of Terms

## Zone

- An area in which traffic parameters can be measured and/or traffic data can be generated

# Example Zone Configurations

Zones at an Intersection



Zones on a Highway

Graphics: Ralph W. Boaz

# Definition of Terms

## Sample

- A collection of sensor data for a zone over a known time period

## Sample Period

- Duration of time in seconds when data for the zone is being collected

## Class

- Subdivision of collected historical sample data
- Typically one or more classifications of vehicles as defined by FHWA

# Definition of Terms

## Output

- The condition of an on/off status of a zone generated by a change of state

## Delay

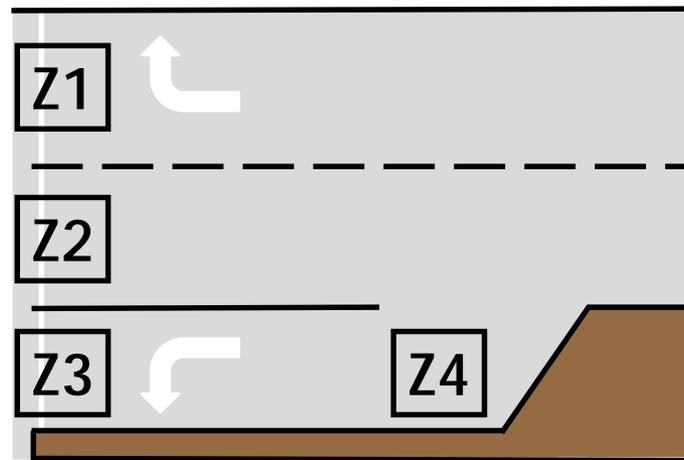
- A feature that allows the zone output to be deferred for a user set time period

## Extension

- A feature that allows the zone output from a TSS detector to be lengthened for a user set time period

# Output After Delay

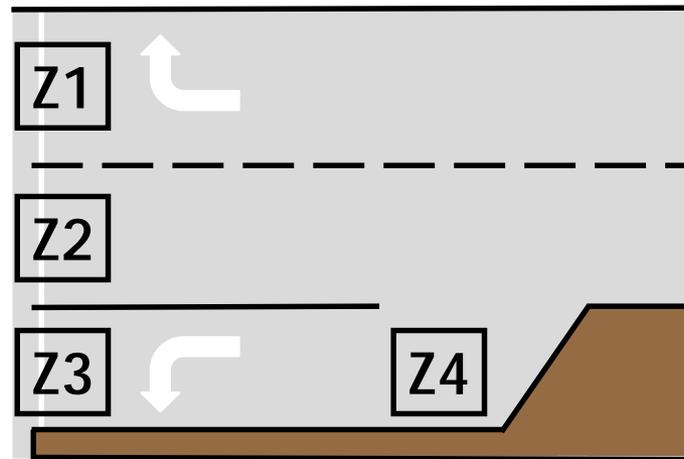
- Output for Zone 1 is ON only if a vehicle is present for  $\geq 4$  seconds
  - Allows right turners to roll over Zone 1 without triggering signal
  - Provides right turners a signal call if they are sitting



Graphics: Ralph W. Boaz

# Output With Extension

- Output for Zone 2 is ON for an additional 3 seconds after a vehicle is no longer present
  - Increases opportunities for straight through traffic flow without changing the signal timing plan



Graphics: Ralph W. Boaz

# Definition of Terms

## Virtual Zone

- A logical combination of one or more zones to create a new zone with its own conditioning and Arming Enables

## Conditioning

- When a zone uses logical ANDing, ORing, or SEQing of the outputs of other zones and/or external Arming Inputs or Arming Pins to activate its own Delay, Extend, or Output



# Zones, Virtual Zones, and Logic

## Multi Lane Detect

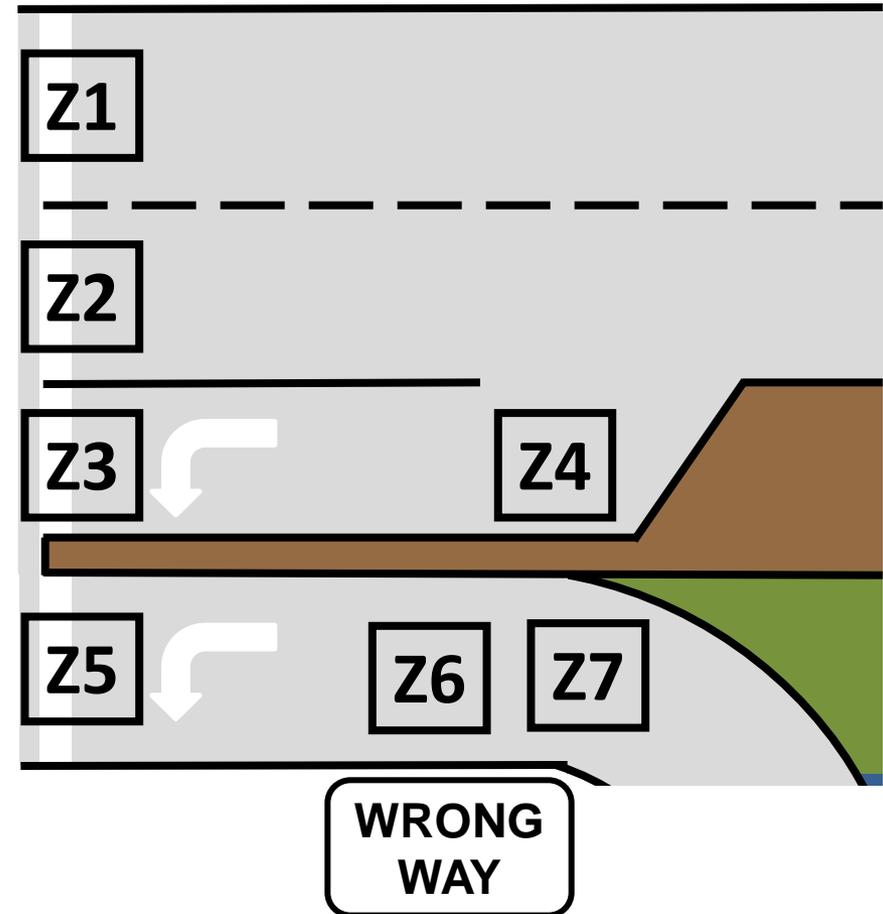
$$Z10 = \underline{\text{OR}} (Z1, Z2)$$

## Queue Detect

$$Z11 = \underline{\text{AND}} (Z3, Z4)$$

## Wrong Way Detect

$$Z12 = \underline{\text{SEQ}} (Z6, Z7)$$



Graphics: Ralph W. Boaz

# Definition of Terms

## Arming Enable

- Used to set the selected state of an Arming Input Bit or Arming Pin of the TSS that is to be used to modify zone operations

## Arming Input Bit

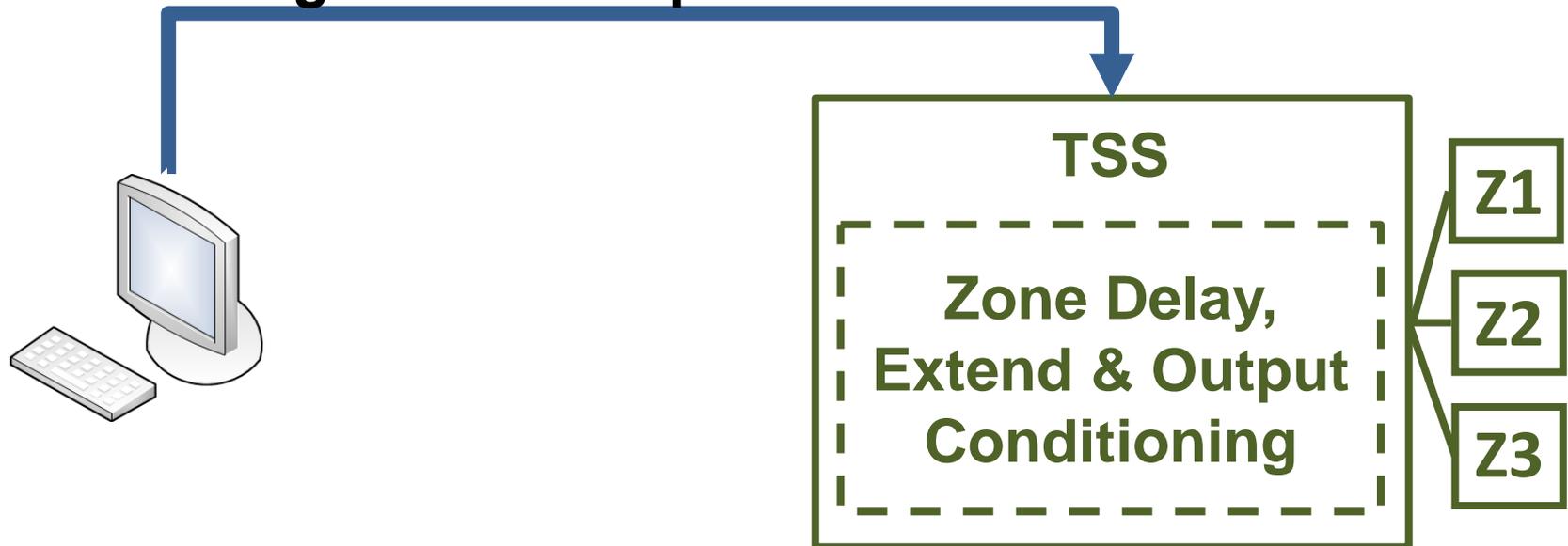
- An external event that is reported to the TSS using this protocol and used to modify its operation

## Arming Pin

- A physical input to the TSS that can be monitored and used to modify its operation

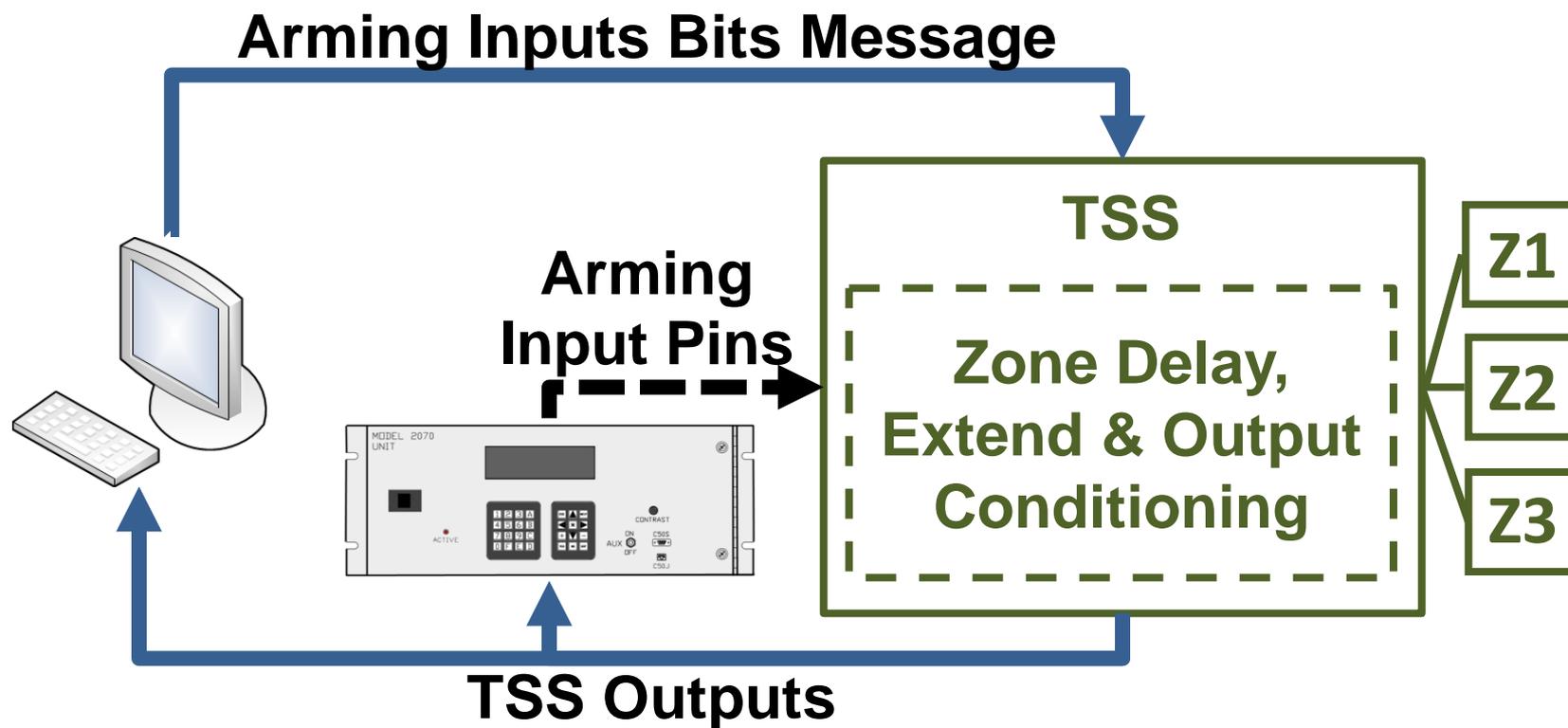
# Arming Features Enable/Disable Zone Delay, Extend and Output

**Arming Enable Messages Assign Arming Pins and Input Bits to Zones**



Graphics: Ralph W. Boaz

# Arming Features Enable/Disable Zone Delay, Extend and Output (cont.)



Graphics: Ralph W. Boaz

# Operations of TSS Devices

- Configure
- Control
- Monitor
- Collect Data



# Features for Configuring TSS Devices

## 2.5.1.1 Determine the TSS Identity (M)

- Used to determine basic information about the TSS
- Includes sensor technology, manufacturer, model, firmware version, hardware version, TSS protocol version, and TSS standards revision

## 2.5.1.2 Determine TSS Capabilities (M)

- Used to determine, configure, and manage the TSS
- Includes maximum number of zones, maximum number of historical data entries per zone, maximum number of sample periods per zone, etc.



# Features for Configuring TSS Devices (cont.)

## 2.5.1.3 Determine the Sequence of Sample Periods (Sample:M)

- Used to determine the sequence of sample periods so that aggregate data can be used to identify changes in traffic

## 2.5.1.4 Determine the Age of Sample Data (Sample:M)

- Used to determine the age of sample period data so that the relevance of the data to current traffic conditions can be determined

# Features for Configuring TSS Devices (cont.)

## 2.5.1.5 Configure Zones (M)

- Used to configure the sampling period, zone label, number of classes, combinations of zones, sequences, and other zone parameters
- Includes special operational parameters for specific TSS technologies

## 2.5.1.6 Configure Arming Enables (Timing:O)

- Used to configure the Arming Enables that are used to modify the zone output, delay, and extension timing

# Features for Configuring TSS Devices (cont.)

## 2.5.1.7 Configure Outputs (M)

- Used to configure the outputs to report the state of zones
- Includes assigning an output to a zone, conditioning of outputs to include delay and extension, assigning fail-safe/fail-secure mode of operation, etc.

## 2.5.1.8 Manage Pending Configuration File Name (O)

- Used to transfer, validate, and execute a configuration file

# Subfeatures for

## 2.5.1.2 Determining the TSS Capabilities

### 2.5.1.2.1 Determine TSS Support for Sampling (M)

- Used to determine if the TSS supports sampling
- Support for sampling indicates the TSS is capable of collecting sample data and storing it for retrieval

### 2.5.1.2.2 Determine TSS Support for Timing (M)

- Used to determine if the TSS supports timing functions
- Support for timing indicates the TSS is capable of modifying the operation of zones and outputs through user-specified timing parameters



# Subfeatures for

## 2.5.1.2 Determining the TSS Capabilities (cont.)

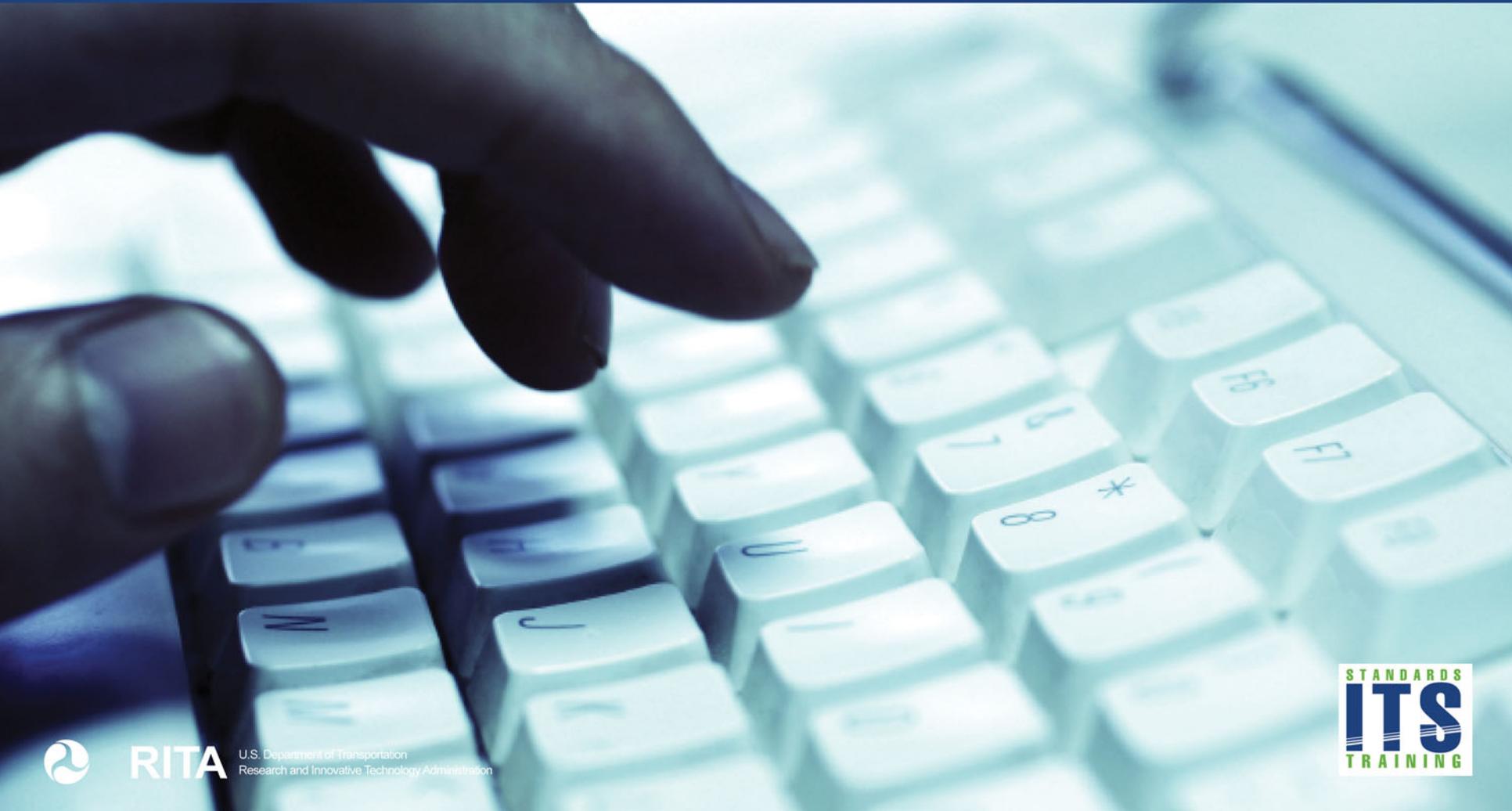
### 2.5.1.2.3 Determine TSS Support for Speed (M)

- Used to determine if TSS supports speed functions
- Support for speed indicates that the TSS is capable of providing vehicle speed and storing it for retrieval through the sampling functions

### 2.5.1.2.4 Determine TSS Support for Real-Time Clock (M)

- Used to determine if TSS supports a Real-Time Clock (RTC)
- Support for RTC indicates that the TSS is capable of providing actual local time

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# Which one of the following choices is NOT considered a capability for the TSS?

## Answer Choices

- a) Sampling
- b) Timing
- c) Location
- d) Speed



# Review of Answers



a) Sampling

*Incorrect. The ability to collect data and store it for retrieval is a capability of a TSS.*



b) Timing

*Incorrect. The ability for users to modify the use of zones through timing parameters is a capability of a TSS.*



c) Location

***Correct. Providing location information is not considered a capability of a TSS at this time.***



d) Speed

*Incorrect. The ability to determine vehicle speed and store it for retrieval is a capability of a TSS.*

# Features for Controlling TSS Devices

## 2.5.2.1 Reset the TSS (M)

- Used to set the TSS to a known condition such as restart, reinitialize, or retune
- Used to cause the TSS to execute, abort, or validate a pending configuration file

## 2.5.2.2 Initiate Sensor Diagnostics (M)

- Used to initiate sensor diagnostic routines

## 2.5.2.3 Synchronize the TSS (Sample:M)

- Used to set the baseline reference for the sampling period



# Features for Controlling TSS Devices (cont.)

## 2.5.2.4 Update Arming Input Bits of the TSS (Timing:O)

- Used to update the status of the Arming Input Bits of the TSS

## 2.5.2.5 Manage the Camera (Video:M)

- Used to enable or disable detection for a particular camera location
- Used to verify a camera is working and is pointing at the correct detection area
- Used to determine number of cameras and video formats
- Can command a camera to build an image file and transfer it to the management station

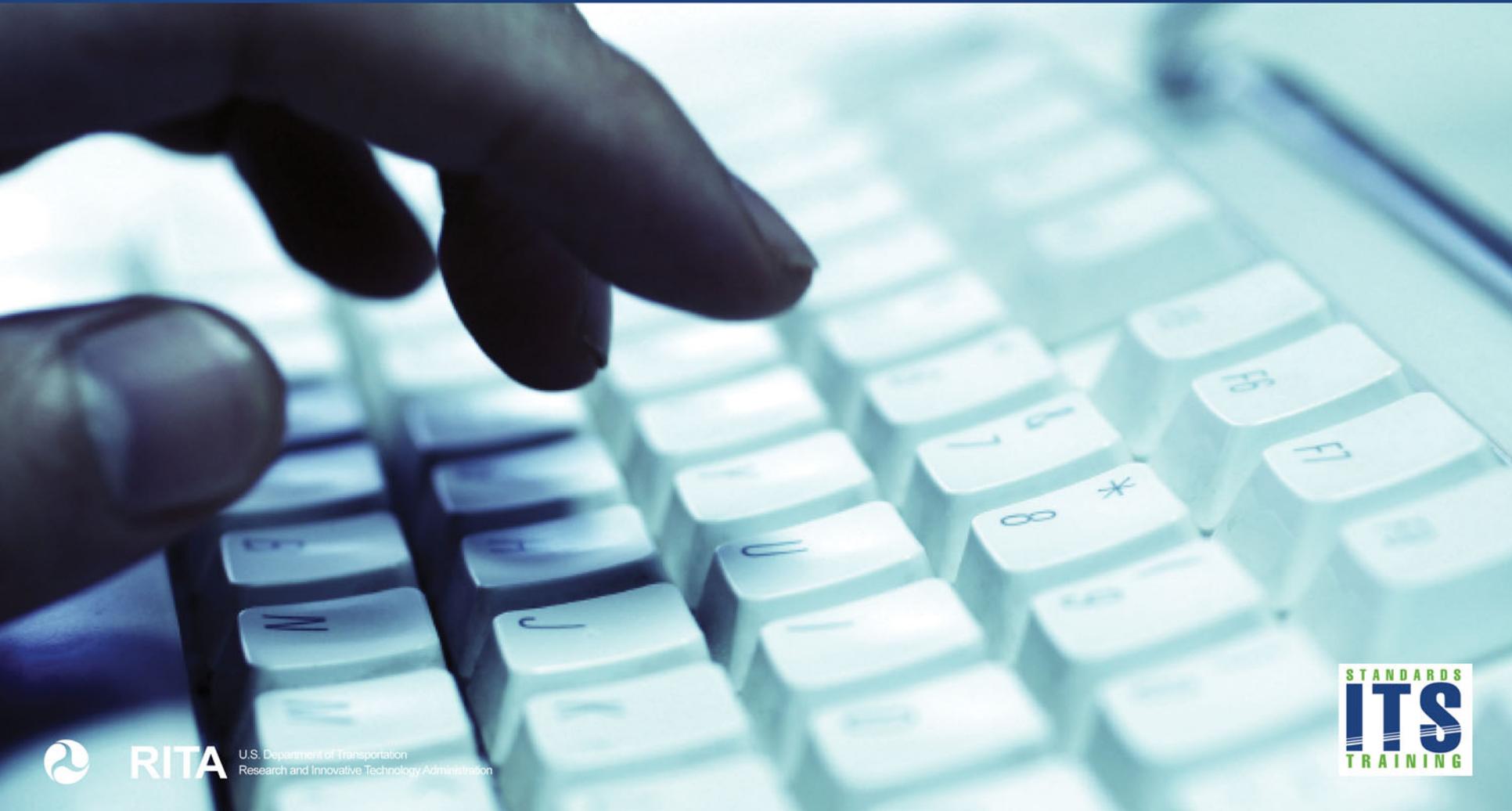
# Features for Controlling TSS Devices (cont.)

## 2.5.2.6 Manage the Real-Time Clock (RTC:M)

- Used to configure an RTC for the purpose of providing a timestamp for sample data
- Clock should be able to support Daylight Saving Time (DST) adjustments



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# Which of the following Control features allows the TSS to be set to a known condition?

## Answer Choices

- a) Synchronize the TSS
- b) Initiate Sensor Diagnostics
- c) Reset the TSS
- d) Update Arming Input Bits of the TSS



# Review of Answers



a) Synchronize the TSS

*Incorrect. This sets the baseline reference for the sampling period.*



b) Initiate Sensor Diagnostics

*Incorrect. This allows operators to initiate sensor diagnostic routines.*



c) Reset the TSS

***Correct. This allows the TSS to be set to a known condition.***



d) Update Arming Input Bits of the TSS

*Incorrect. This updates the status of the Arming Input Bits of the TSS.*

# Features for Monitoring TSS Devices

## 2.5.3.1 Monitor System Status (M)

- Used to monitor the system status of the TSS such that the management station identifies that the system is operating normally

## 2.5.3.2 Monitor TSS Sensor Status (M)

- Used to monitor the status of each sensor within the TSS
- Only the sensor status of inductive loop and machine vision sensors are defined in NTCIP 1209 v02

# Features for Monitoring TSS Devices

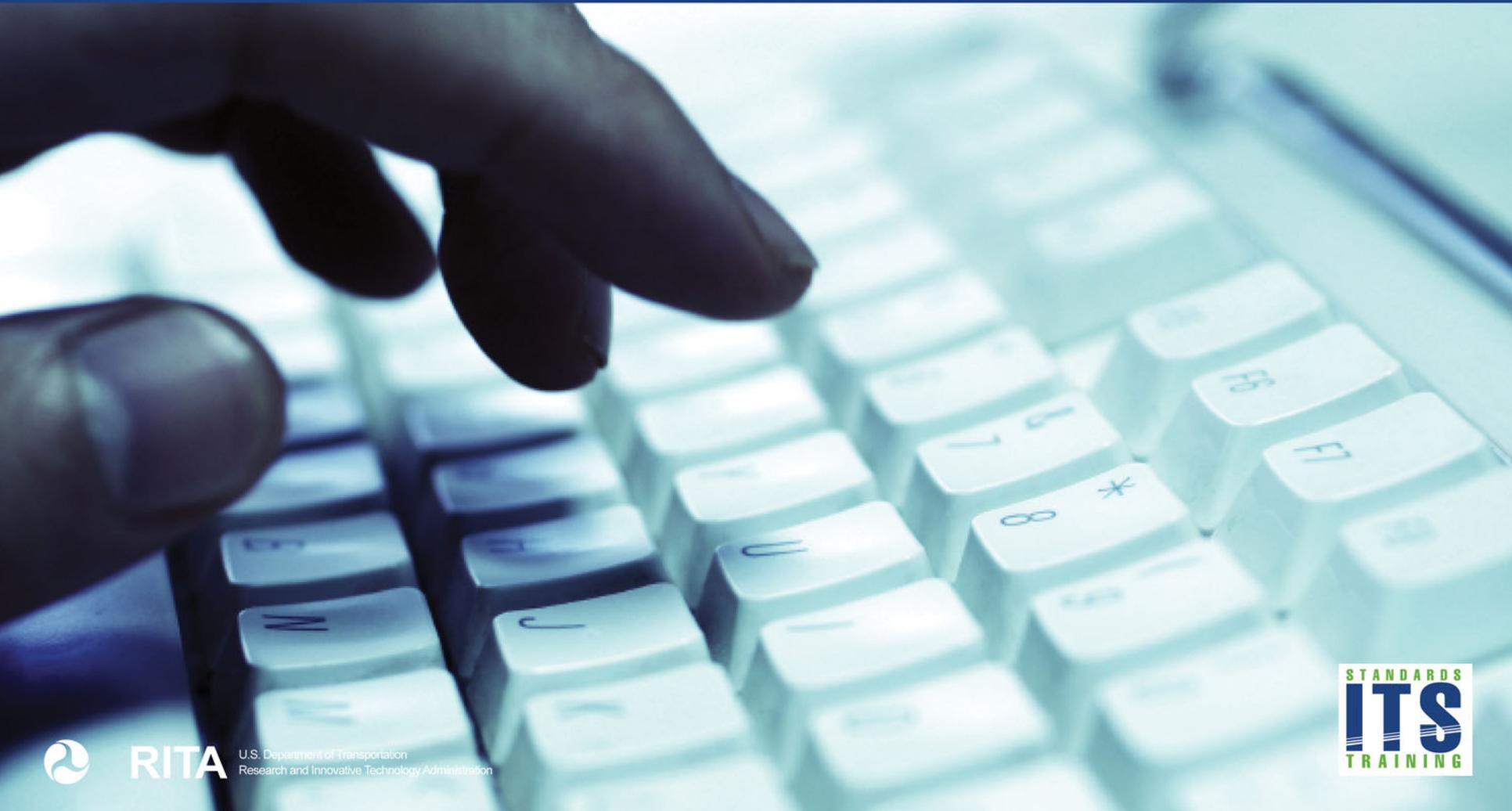
## 2.5.3.3 Monitor Output States (M)

- Used to retrieve the states of multiple outputs of the TSS

## 2.5.3.4 Monitor Zone Status (M)

- Used to monitor the status of each zone

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**Which of the following monitoring features lets a system or user know that there is a loss of contrast on a video detection camera?**

## **Answer Choices**

- a) Monitor System Status
- b) Monitor TSS Sensor Status
- c) Monitor Output States
- d) Monitor Zone Status



# Review of answers



a) Monitor System Status

*Incorrect. This may be used to detect a general problem on the TSS device.*



b) Monitor TSS Sensor Status

***Correct. This is used to detect a problem with the sensor portion of the TSS device.***



c) Monitor Output States

*Incorrect. This is used to retrieve the states of multiple outputs of the TSS device.*



d) Monitor Zone Status

*Incorrect. This is used to retrieve the status of each zone of the TSS device.*

# Features for Collecting Data from TSS Devices

## 2.5.4.1 Retrieve In-Progress Sample Data (Sample: M, Speed: M)

- Used to obtain the data from the in-progress (started but not yet completed) sample period
- Includes length of elapsed time in the reported sample period, volume, percent of occupancy, speed, and zone status during the sampling period

# Features for Collecting Data from TSS Devices (cont.)

## 2.5.4.2 Retrieve Current Sample Data

### (Sample: M, Speed: M)

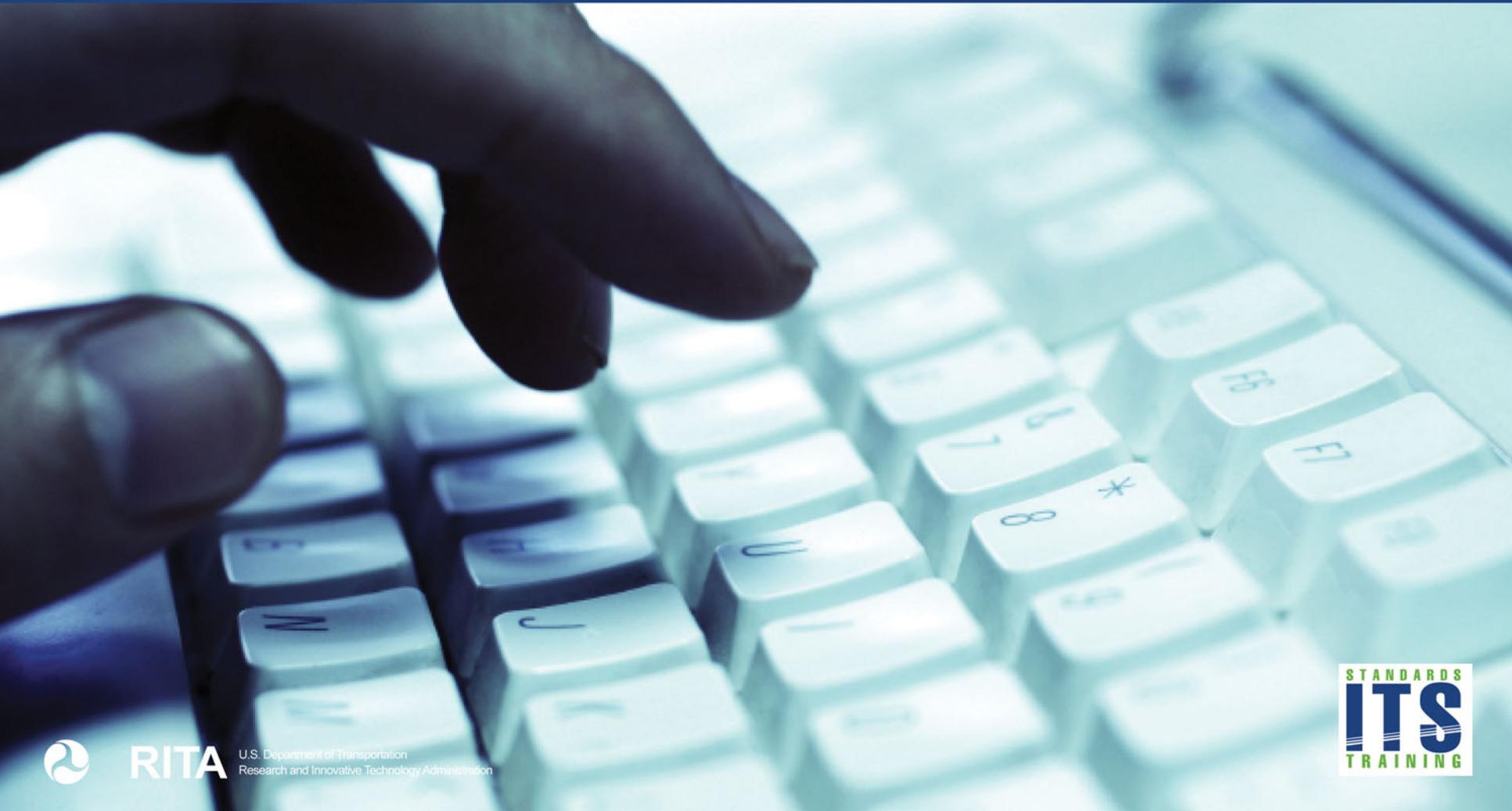
- Used to obtain the data from the current sample period
- Includes when the sample period ended, volume, percent of occupancy, speed, and zone status during the sampling period

# Features for Collecting Data from TSS Devices (cont.)

## 2.5.4.3 Retrieve Historical Sample Data (Sample: M, Speed: M)

- Used to retrieve historical sample data from previous sample periods
- Historical, in this context, refers to **past sample periods** for the sensor – **not an archive of data**

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**Which of the following Collecting features identifies the user need to retrieve yearly average volume data from a TSS?**

## **Answer Choices**

- a) Retrieve In-Progress Sample Data
- b) Retrieve Current Sample Data
- c) Retrieve Historical Sample Data
- d) None of the above



# Review of Answers



a) Retrieve In-Progress Sample Data

*Incorrect. This is used to obtain data for the in-progress (started but not yet completed) sample period.*



b) Retrieve Current Sample Data

*Incorrect. This is used to obtain the data from the current sample period.*



c) Retrieve Historical Sample Data

*Incorrect. This is used to retrieve historical sample data from previous sample periods.*



d) None of the above

***Correct. The TSS device is not required to store data for long periods of time.***

# Summary of Learning Objective #2

## Identify TSS User Needs

- Architecture of a TSS
- Define TSS Terms and Concepts
- User Needs (expressed as “Features”)



# Learning Objective #3 – Use the Protocol Requirements List (PRL) to Select User Needs and Link to Requirements

- Understand the parts of the PRL
- Use the PRL as a tool for project-specific implementations
- Reduce the risk of failure



# Protocol Requirements List

- A table provided in the NTCIP 1209 v02 Standard that is used as a tool by specification writers
- Shows the relationship of user needs (features) to functional requirements and rules for **conformance** to the standard
- Specification writers “tailor” the PRL according to their particular system needs
- Not all user needs and requirements are necessary or possible in a given deployment
- When a deployment satisfies the requirements in the specification, it is said to be **compliant**



# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	O	Yes / No	
		...	...	...	...	

# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	O	Yes / No	
		...	...	...	...	

# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	O	Yes / No	
		...	...	...	...	...

# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	O	Yes / No	
		...	..	...	...	

# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	D	Yes / No	
		...	...	...	...	

# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	O	Yes / No	
		...	...	...	..	

# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	O	Yes / No	
		...	...	...	...	

# Understand the PRL Structure

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.1.7	Configure Outputs			M	Yes	
		3.4.1.6.1	Get Output Sensor Zone	M	Yes	
		3.4.1.6.2	Get Output Failsafe Mode	M	Yes	
		3.4.1.6.3	Get Output Mode Status	M	Yes	
		3.4.1.6.4	Get Output Label	O	Yes / No	
		...	...	...	...	...

# Use Conformance Status and Predicates for Specific Implementations

## Status Symbols

Symbol	Conformance Status
M	Mandatory
O	Optional
O.#	Part of an “Option Group” where “#” indicates the group number (e.g., “O.2” means Option Group 2). If a requirement associated with a particular Option Group is to be supported, then all requirements in the standard that are associated with that Option Group must also be supported.
N/A	Not applicable (i.e., logically impossible in the scope of the standard)

# Use Conformance Status and Predicates for Specific Implementations (cont.)

## Predicate to NTCIP 1209 v02 Section Mapping

Predicate	Section
Loop (Inductive Loop)	Indicates that the PRL item applies to Inductive Loops as identified by Section 2.5.1.1
Video (Machine Vision)	Indicates that the PRL item applies to Machine Vision as identified by Section 2.5.1.1
RTC (Real-Time Clock)	Indicates that the PRL item applies to RTCs as identified by Section 2.5.1.2.4
Speed	Indicates that the PRL item applies to Speed as identified by Section 2.5.1.2.3
Timing	Indicates that the PRL item applies to Timing as identified by Section 2.5.1.2.2

# Use Conformance Status and Predicates for Specific Implementations (cont.)

## Predicate to NTCIP 1209 v02 Section Mapping

Predicates	Section
Sample	Indicates that the PRL item applies to Sampling as identified by Section 2.5.1.2.1
Version1	Indicates that the PRL item applies to objects required to maintain MVI with NTCIP 1209:2005 v01 as identified by Section 2.5.5.1

# Use Conformance Status and Predicates for Specific Implementations (cont.)

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.2.5	Manage the Camera			Video:M	Yes / N/A	
		3.4.1.7.1	Set Disable Detection	Video: O	Yes / No / N/A	
		3.4.1.7.2	Get Disable Detection	Video: O	Yes / No / N/A	
		3.4.1.7.3	Set the Build Image Parameter	Video: O.2	Yes / No / N/A	
		3.4.1.7.4	Set Cancel Build In-Progress	Video: O.2	Yes / No / N/A	

# Use Conformance Status and Predicates for Specific Implementations (cont.)

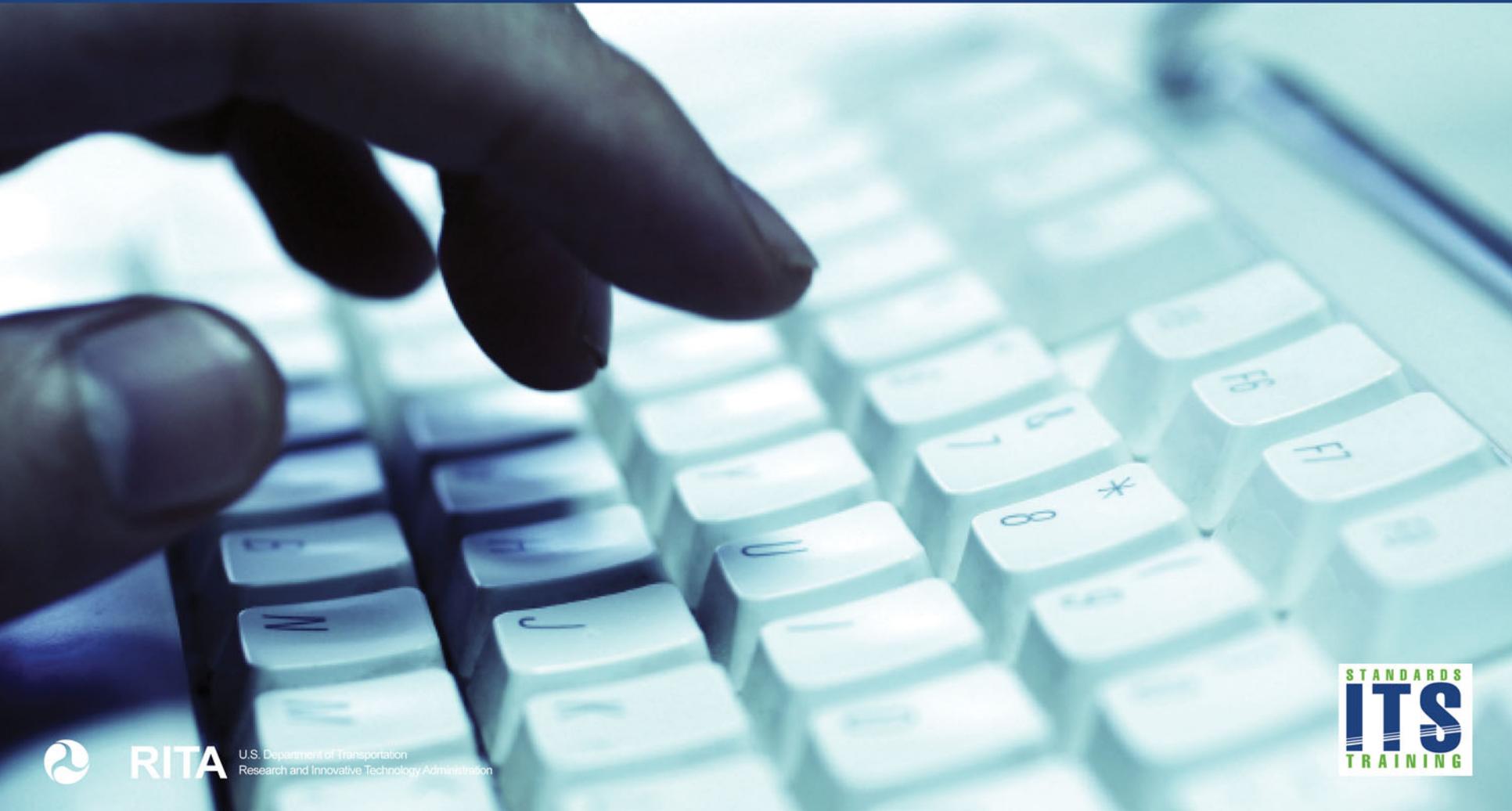
User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Specifications
2.5.2.5	Manage the Camera			Video:M	Yes / N/A	Video Predicate is Specified
		3.4.1.7.1	Set Disable Detection	Video: O	Yes / No / N/A	
		3.4.1.7.2	Get Disable Detection	Video: O	Yes / No / N/A	
		3.4.1.7.3	Set the Build Image Parameter	Video: O.2	Yes / No / N/A	
		3.4.1.7.4	Set Cancel Build In-Progress	Video: O.2	Yes / No / N/A	

# Reduce the Risk of Failure

- PRL allows specification writers to only include the requirements applicable to their system
- The PRL can be used as a check list to explicitly point out whether the product meets the user needs (features) and requirements of the system and whether off-the-shelf interoperability is achievable
- Future purchases from other vendors can be compared
- Using only requirements included in the standard reduces risk



# ACTIVITY



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The PRL is a good tool to \_\_\_\_\_.

## Answer Choices

- a) Tailor an NTCIP specification for a particular TSS technology
- b) Learn the science used in sensor technologies
- c) Specify Ethernet communications
- d) Force TSS providers to support all requirements in the standard



# Review of Answers



a) Tailor an NTCIP specification for a particular TSS technology

**Correct. Different technologies can be included or excluded using predicates and user selections.**



b) Learn the science used in sensor technologies

**Incorrect. NTCIP 1209 addresses the configuration of a TSS and communications interface only.**



c) Specify Ethernet communications

**Incorrect. The PRL is used for specifying interface requirements for a field device, not for the media that carries it.**



d) Force TSS providers to support all requirements in the standard

**Incorrect. It is not reasonable for a TSS to adhere to all requirements in the standard as some may not be compatible.**

# Summary of Learning Objective #3

## Use the Protocol Requirements List (PRL) to Select User Needs and Link to Requirements

- Understand the parts of the PRL
- Use the PRL as a tool for project-specific implementations
- Reduce the risk of failure



# Learning Objective #4 – Explain How the PRL Table in the Standard Integrates into a Specification

- Device Specifications and Agency Procurements
- Integrate the PRL into the Specification



# Device Specifications and Agency Procurements

- Agency specifications written based on how the agency purchases equipment
- TSS devices often bought by contractors in response to construction bids
- Agencies create standing specifications for protection
- An agency may have a prequalified vendors list or have a single vendor selected through a bid process



# Types of Requirements in an Agency Device Specification

- Hardware
- Functional
- Performance
- Environmental
- Interface
- Maintenance
- Procurement
- Warranty
- Others



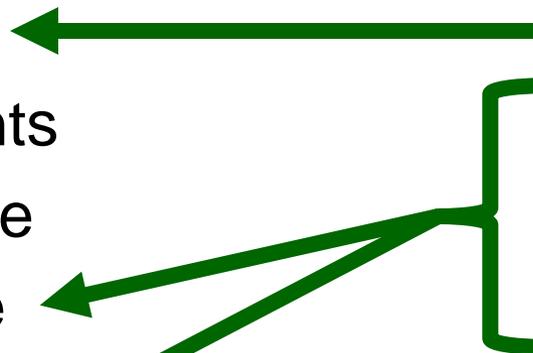
# Draw Information from the NTCIP 1209 v02 Standard

## Example Agency Sensor Specification

- General
- ConOps
- Requirements
  - Hardware
  - Interface
  - Functional
  - Performance
  - Environmental
  - ...

## NTCIP 1209 v02

- General
- ConOps
- Functional Reqs
- Design Details
- Annexes



# Integrate the PRL into the Specification

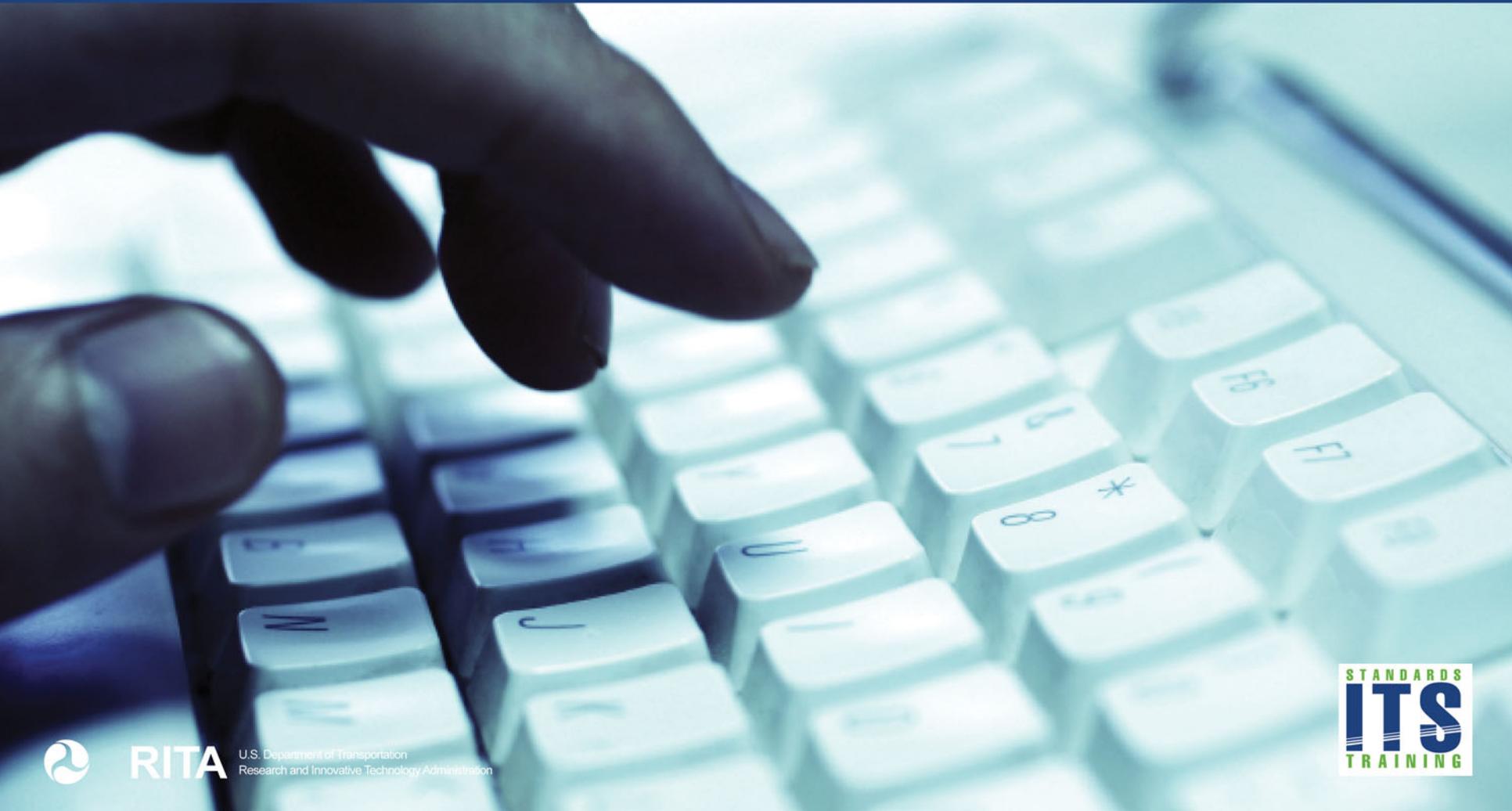
- Think about your system architecture when writing the TSS specification
- Expand the interface requirements of the specification to include NTCIP 1209 v02
- Use a completed PRL table indicating the interface requirements for your TSS devices
- Include the interface requirements for the protocols to be used in your system

# Integrate the PRL into the Specification (cont.)

- Require the product be conformant to NTCIP 1209 v02
- Make sure **all of the requirements are consistent** within the document (not just the interface requirements)



# ACTIVITY



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# Which item below is NOT good practice when writing a specification for a sensor?

## Answer Choices

- a) Including the protocols used to communicate with the sensor
- b) Excluding NTCIP requirements because your favorite vendor does not support them
- c) Consistency between hardware and interface requirements
- d) Conformance to the NTCIP 1209 v02 Standard



# Review of answers



a) Including the protocols used to communicate with the sensor  
*Incorrect. The protocols (e.g. serial, Ethernet) used in the system should be identified in the specification.*



b) Excluding NTCIP requirements because your favorite vendor does not support them

***Correct. Requirements should be based on present or future user needs, not on a favorite vendor.***



c) Consistency between hardware and interface requirements  
*Incorrect. Inconsistent requirements in a specification may result in non-interoperable and non-interchangeable devices.*



d) Conformance to the NTCIP 1209 v02 Standard  
*Incorrect. Conformance to the standard while tailoring the PRL for a specification is essential.*

# Summary of Learning Objective #4

## Explain How the PRL Table in the Standard Integrates into a Specification

- Device Specifications and Agency Procurements
- Integrate the PRL into the Specification



# What We Have Learned

1. Review the structure of the **NTCIP 1209 v02** Standard
2. Identify TSS specific **user needs**
3. Use the **Protocol Requirements List (PRL)** to select user needs and link to requirements
4. Explain how the PRL table in the standard integrates into a **specification**



# Resources

- *IEEE 830-1998 Recommended Practice for Software Requirements Specifications*  
<http://standards.ieee.org/findstds/standard/830-1998.html>
- *ITS Professional Capacity Building Training*  
<http://www.pcb.its.dot.gov/standardstraining/>
- *National Transportation Communications for ITS Protocol 1209 Object Definitions for Transportation Sensor Systems (TSS) Version 02*  
<http://www.ntcip.org/library/documents/>



# Resources (cont.)

- *Systems Engineering Guidebook for Intelligent Transportation Systems Version 3.0*  
<http://www.fhwa.dot.gov/cadiv/segb/>
- *USDOT – FHWA Traffic Detector Handbook: Third Edition—Volume I. October 2006*  
<http://www.fhwa.dot.gov/publications/research/operations/its/06108/>



# QUESTIONS?



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# Next Course Module

## A312b: Specifying Requirements for Transportation Sensor Systems (TSS) Based on NTCIP 1209 Standard

- Describe requirements included in the NTCIP 1209 v02 Standard
- Use the Protocol Requirements List (PRL) to specify an NTCIP TSS interface
- Achieve Interoperability and Interchangeability using the Requirements Traceability Matrix (RTM)
- Incorporate requirements not covered by the standard
- Understand the NTCIP TSS SNMP interface and dialogs

