A317b: Understanding Requirements for CCTV Systems Based on NTCIP 1205 Standard
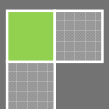
STANDARDS ITS TRAINING

STUDENT SUPPLEMENT

RITA Intelligent Transportation Systems Joint Program Office

A317b: Understanding Requirements for CCTV Systems Based on NTCIP 1205 Standard

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1.   Introduction

Module Description

The purpose of this module is to teach the students how to develop and write requirements for the Closed Circuit Television (CCTV) subsystem based on the content of the NTCIP 1205 v01 CCTV Standard and other sources such as user needs and Systems Engineering Process (SEP)-based standards. The NTCIP 1205 standard does not contain user needs and their detailed requirements, but it does provide design details for typical camera control functions. The focus of this module is to assist technical staff in developing a set of requirements that meet certain operational needs already identified to support traffic management and traveler information service functions. This module focuses on the related requirements and their use in the dialogs and messages to communicate with the devices.
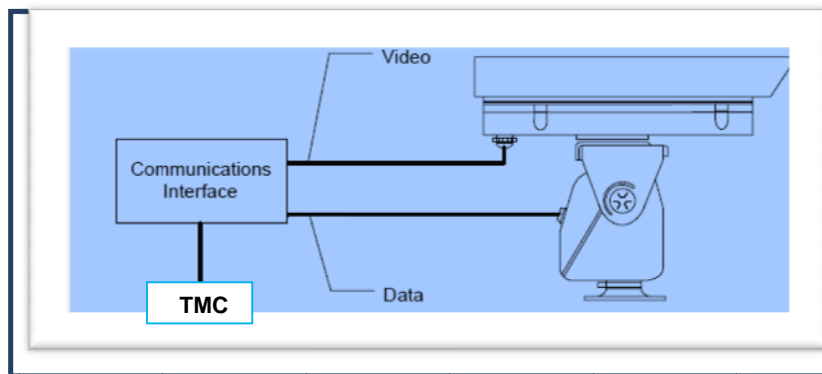
2.   CCTV System Terminology/Glossary

Figure 1: Conceptual Representation of a Communications Interface

CCTV: Closed Circuit Television (CCTV) is a method of distributing video signals such that access to said signals is confined to devices directly connected to a common circuit or system. By contrast, broadcast television signals are available to an unlimited number of receivers, and access to such signals cannot easily be restricted or controlled. CCTV system typically used in the NTCIP-based deployments include a central management station, video display wall, switching mechanism, communications interface, field camera control receiver and camera unit with Pan-Tilt and Lens assembly.

CCTV Subsystem: As shown in Figure 1 illustration, a CCTV system involves two signals-video and data.

- **A video signal** is the output of an operational camera which is transmitted to the central traffic management center on a dedicated channel or circuit provided by the communication medium such a co-axial cable or a fiber optic cable. The video signal being transmitted can be compressed or stored to preserve bandwidth efficiency. The NTCIP 1205 standard is not concerned with this
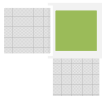
transmission and does not support video formats or standards. ITS applications utilize the industry and the Internet standards for video transmission to a TMC.

- **A Data signal** is a digital **communication** signal (has no video content) originated by a central management station at a TMC and travels to a Camera Control Receiver (CCR) on a communication channel (or alternatively called a communication link). The CCR receives data in the form of a message from the management station to perform a "*read*" or "*write*" operation on the camera function such as positioning camera and adjusting lens focus to provide a sharp image. The NTCIP 1205 standard supports "data transmission" to a field device. The management station (equipped with NTCIP support through SNMP manager) sends digital data to the field device and receives digital data (NOT video) from the device on the same data channel. We are concerned with the data communication process in this module.

For simplicity (in NTCIP 1205), the control of the pan/tilt unit and lens assembly of the camera (ZOOM) will be assumed to use the same physical data communication channel and control processor called a camera control receiver. The camera control receiver receives the data communication and generates the necessary control signals for individual CCTV components such as the lens. The concept of the camera control receiver does not preclude each CCTV device from directly processing the NTCIP messages, as system architecture can vary among manufacturers.

It should be also noted that typically the video surveillance system that exists within the Traffic Management System (TMS) is categorized into three separate equipment locations, interconnected to form a complete communications link. These locations can be identified as the *Remote Camera Sites*, Hub Sites, and the *Traffic Management Center (TMC)*. Camera features and their control functions can be monitored remotely from the TMC using NTCIP communications interface as well as at a local installation capability supplied by the manufacturer device panel.

CCTV Features
In the NTCIP context, the features identify and describe the various functions that users may want the device to perform. These features are derived from the high level user needs identified in the problem statement but are refined and organized into a more manageable structure that form the basis of the traceability tools. The operational environment and features are collectively called the *user needs*.

The number of camera adjustment features has increased dramatically as new technology continues to press the video surveillance industry. Emerging CCTV systems have a diverse set of features that vary depending on manufacturer (Analog, Digital, Network-IP based cameras). A basic array of these features covering configuration, motion and lens control, alarms, inputs, outputs, labels, and camera menu manipulation.
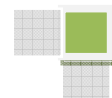
The standard discusses the Horizontal and Vertical Coordinate systems (True-offset, degrees, Zero point) and Position referencing to understand basic needs for supporting objects.

Pan-Tilt- Zoom (PTZ)

The pan/tilt drive unit (a mechanical separate unit on which a camera is mounted) provides a means of remotely positioning the camera with commands from the control center (Figure 1).

The pan/ tilt drive accept and respond to remotely generated preset positioning commands. The pan/tilt drive is typically made weatherproof and dustproof and provides the minimum range of horizontal movement is from 0º to 350º. The pan/tilt units have stops to prevent wrapping the cables around the pole. The minimum range of vertical movement typically is ±90º. The speed of movement is usually 6º/second in the horizontal plane (no wind load condition) and 3º/second in the vertical plane (no load condition).

Presets

A pre-specified position is where a camera is pointed at a fixed point in space. A preset includes pan, tilt, and zoom parameters (PTZ). Presets are typically programmed by manually adjusting the camera position and lens zoom setting followed by initiating a save command from the camera control system.

PTZ cameras used in the outdoor applications enable a number of preset positions to be programmed. Once the preset positions are set in the camera, the TMC operator can easily jump from one position to the next. The number of presets supported by the NTCIP standard range from 0 (no presets supported) to maximum 255. For example, Florida Department of transportation CCTV MIB requires support for 64-255 Dome Type camera and 32-255 for fixed position cameras.

Zoom lenses and PTZ Mechanisms

A camera unit is fitted on a PTZ should be capable of responding to remotely-generated preset positioning. A camera's position and lens focus can be set to a desired configuration (a necessary initial scheme related to parameters) and stored into memory. A single button command will then automatically call up this position, thus reducing the chance of operator error. This is particularly useful when various scenes are covered by a single camera and at different time intervals. For example: *three lanes of I-15 northbound between the hours of 7 a.m., two lanes of SR-52 eastbound between the hours of 3-5 p.m.*
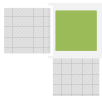
3.   Understanding CCTV Requirements

CCTV Functions that Drive Data Exchange Requirements

The camera control receiver is located in the field cabinet and forms a communications interface to the backbone and receives RS-232 or RS-422 commands signals directly from the TMC (or from TMC via some sort of control panel within the field cabinet). The CCR unit generates all corresponding signals for the camera, zoom lens, and Pan/Tilt/Zoom-PTZ drive unit (assembly), and provides camera position and control feedback (response) information to the TMC. CCR is a processor and provides Digital Signal Processing (DSP).

The CCR (DSP) typically provides some or all of the following functions (partial list shown), which are in turn controlled by the TMC using combination of objects stated in the above NTCIP Objects.

|	
Zoom in/zoom out	Preset 1/Preset 2/Preset 3/……..Preset 10 (Limited number)
Pan left/Pan right	Camera power NO/OFF (Latching)
Tilt up/Tilt down	Heater ON/OFF; Washer ON/OFF; Blower ON/OFF
Focus near/Focus far	ID generator-Labeling, Alarm functions
Iris open/Iris close	[IP Address of the Cameras]

Examples of CCTV Functions

The following case study examples illustrate how the real-world CCTV functions and project level requirements are linked. Later section will provide examples of requirements based on similar functions.

Case Study 1: Design Guidance on PTZ Requirements by Pennsylvania Department of Transportation

"Using a pan/tilt (P/T) platform, CCTV system operators can change camera position about the 360-degree 'azimuth' axis, and adjust camera elevation up or down (within a 90 degree range). Together with a zoom lens, the P/T allows operators to view a scene within any direction about the camera, and within the lens field-of-view and distance ranges. The speed of the pan/tilt mechanism determines the rate of camera coverage, while the horizontal and vertical camera movements determine the coverage area.

Dome enclosed systems provide much higher P/T speeds. Dome systems also have more range than external units, having the ability to look straight down. It should be noted that Dome cameras are "horizon limited" and cannot look up at the sky or up a nearby steep hill very well. However, unless the camera is to be placed in very hilly terrain, this is not a major drawback for roadway traffic monitoring. Barrel cameras should only be considered for installations that only focus on one view, and in locations where the camera will not have to fight strong wind loads such as tunnels and long underpasses. Dome cameras are the preferred camera type." (Ref.5)
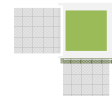
Case Study 2: Specification Guidance on PTZ Requirements from the New York State Department of Transportation (NYSDOT)

Presets 32 (min) stored in non-volatile memory. [Note: NTCIP 1205 allows for no presets-0 to up to 255 presets. Agency must set its own requirements which are reasonable and cost effective]. [Agencies also select specific number of presets for a type of cameras such as 64 minimum for dome type, 32 for positioner type]. The following NYSDOT CCTV system specification example shows how expected value of presets can be traced to a particular conformance group. (A project RTM table is introduced in the module presentation to invoke or link a particular object to a design process). Readers are urged to make use of the project PRL and RTM to handle such requirements as explained in the module A317b.

CCTV Configuration Conformance Group

MIB	Object Or Table Name	NTCIP Reference	NYSDOT Specification Section Reference	Expected Value
3.2.1	rangeMaximumPreset	NTCIP 1205	3.2	32..255

Movements shall be capable of continuous, simultaneous pan and tilt movements, and meeting the following requirements:

**For Barrel Camera type: (motorized step-** divides a full rotation into a number of equal steps).
- Pan: 360 degrees continuous rotation with a steep angle of degrees
- Tilt: -83 to +33 degrees with a steep angle of 0.1 degrees
- Pan Speed: Manual 0.1 to 40 degrees/second
- Tilt Speed: Manual 0.1 to 20 degrees/second

For Dome Camera type:
- Pan: 360 degrees continuous rotation
- Tilt: -90 to +2 degrees with a steep angle of 0.1 degrees
- Pan Speed: Manual 0.1 to 80 degrees/second
- Tilt Speed: Manual 0.1 to 40 degrees/second

Home Position Indication shall be provided on the camera assembly such that the camera assembly may be mounted with home position on the positioning device at true North.

A home position refers to the 0 degree setting at the time of installation.
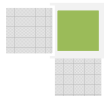
Functions Supported by the NTCIP 1205 CCTV MIB

The standard provides the CCTV MIB (Management Information Base) drawn from the anticipated needs of the ITS community as stated in the previous section. A CCTV MIB is a set of CCTV object definitions or data elements independent of a particular camera product or model. The object has a definite structure provided by the format called Abstract Syntax Notation 1 (ASN.1), which is an international standard for defining objects. The CCTV objects are used in a request-response messaging dialogs to the field Camera device. CCTV objects are organized under 12 nodes in the CCTV MIB.

The following list of CCTV objects cover common functions agencies may need:

List of CCTV Objects (NTCIP 1205-See Section 3.1 to 3.12)

1. CCTV Objects
2. CCTV Range Objects
3. CCTV Timeout Objects
4. CCTV Preset Objects
5. CCTV Positioning Objects
6. CCTV System Feature Control Objects
7. CCTV Alarm Objects
8. CCTV Discrete Input Objects
9. CCTV Discrete Output Objects
10. CCTV Zone Objects
11. CCTV Label Objects
12. CCTV On-Screen Camera Menu Objects

In general, a camera operation includes a position, limit of motion, and timing of motion; all three are controllable remotely from the management station. The alarm objects provide monitoring capability and labeling provides textual display of camera location details. Camera menu function allow for remote activation and access to internal camera manure such as page up-down, and cursor movement. This feature may not be widely used as operators are not too concerned about camera itself. The following discussion is related to the objects provided by the NTCIP 1205 standard.

The following example further explains the link between a user's requirement and the object that satisfy that requirement.

User's Requirement: Configure Range Maximum Presets
The CCTV device shall allow a management station to remotely configure the range of the camera preset position for a maximum number of_____.

User's Basis for Developing this Requirement: Agency sets a number, 0-means no support for preset operation, 255 means total number of possible preset positions supported by the **device**, but note no agency may need that high a capability (If select 255, cost and complexity will rise). When a user writes a requirement, it is based **ONLY** on a User Need. In this case; ask yourself: *Why do I want a preset?* The answer to that will lead you to *How Many?* That is the capability, say you chose 32 presets that will allow the TMC operator to program the device with 32 presets, and be able to JUMP camera quickly to a pre-decided area-location-a fixed point in space and Pan-Tilt and Zoom a camera. Presets and PTZ functions work together. This requirement will set these parameters neatly so that they will work properly as desired by the TMC operator.)

Standard's Role in Satisfying this Requirement: to provide a pre-defined object (design) to satisfy anticipated above requirement. The following object is available and referenced in the project RTM:
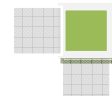
An object defines the attributes, properties and controllable features of the CCTV devices on a network. The CCTV device is remotely monitored, configured and controlled by manipulating the content of an object that defines a function. Figure 2 shows an example of a CCTV system object for number of presets. Note the object provides a pair of variables: {Value and OID}, which forms a message content communicated to the device.
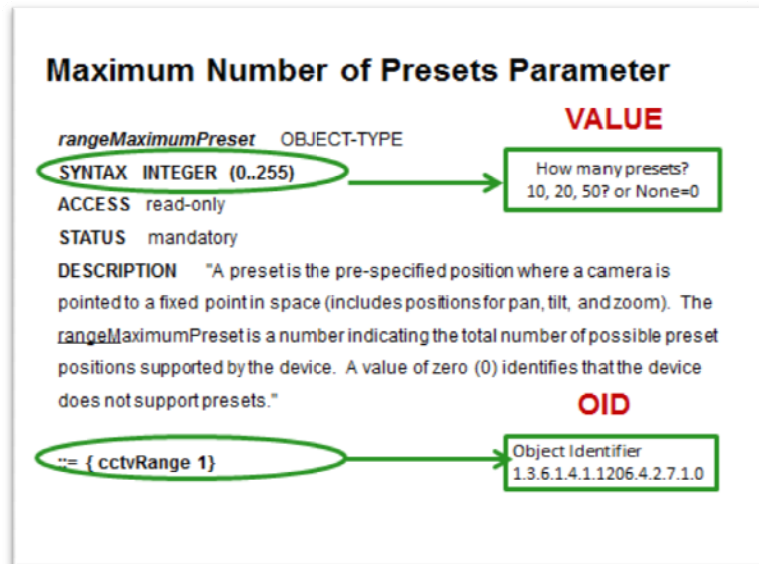

Figure 2: Structure of Maximum Number of Presets Parameter Object

This example of an object structure details include a unique name, rangemaximumPreset, and the syntax field which provides a value-how many presets (should be more than 1, less than 255 but 0 will not deliver preset capability). It states that this is a Mandatory-a required object and it can only be used as read operation (retrieval of a data). The description part explains what the object's function is. The last entry shows Object's unique identification-its location in the MIB tree. We can infer from this definition the number of presets to be provided by the system. For example, a large size Statewide TMC Freeway Management System may need and select 50 presets, while a small city traffic management system may need a small number of presets, say 7.

Project Level Tools: PRL and RTM
The project level PRL links requirements to user needs and RTM links requirements to the design objects provided by the standards. Both are designed to guide the project development. Each serves a specific purpose and allows us to keep track of the development work at each stage.

This module has taught us how to prepare PRL and RTM tables. The next module will guide us on testing of the CCTV requirements.

Sample examples of a project PRL and RTM are provided below.

Project Level PRL

UN ID	User Need	RQ. ID	Requirement	Additional Specs.
1.0	Configure CCTV Device	3.4.1	Data Exchange Requirements	
		3.4.1.1	Configure Range Maximum presets	32 for Dome
		3.4.1.2	Configure Range-Pan Left Limit	
		3.4.1.3	Configure Range-Pan Right Limit	
		3.4.1.4	Configure Range Pan Home Position	
		3.4.1.5	Configure True North Offset	
		3.4.1.6	Configure Range Iris Limit	
		3.4.1.13	Configure Timeout Pan	
		3.4.1.16	Configure Timeout Focus	
		3.4.1.19	Configure Label Table	

Project Level RTM

RQ. ID	Requirement	Dialog	Object Reference and Title NTCIP 1205 Section 3
3.4.1	Data Exchange Requirements		D.1 Generic SNMP SET Interface
3.4.1.1	Configure Range Maximum presets	3.2.1	rangeMaximumPreset
3.4.1.2	Configure Range-Pan Left Limit	3.2.2	rangePanLeftLimit
3.4.1.3	Configure Range-Pan Right Limit	3.2.3	rangePanrightLimit
3.4.1.4	Configure Range Pan Home Position	3.2.4	rangePanHomePosition
3.4.1.5	Configure True North Offset	3.2.5	rangeTrueNorthOffset
3.4.1.6	Configure Range Iris Limit	3.2.10	ranglirisLimit
3.4.1.13	Configure Timeout Pan	3.3.1	timeOurPan
3.4.1.16	Configure Timeout Focus	3.3.4	timeOutFocus
3.4.1.19	Configure Label Table	3.11.2	labelTable
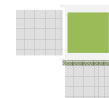
4. Criteria for Writing a Well-Formed Requirement

Definition of a Requirement

"A statement that identifies a system, product, or process' characteristic or constraint, which is unambiguous, clear, unique, consistent, standalone (not grouped), and verifiable and is deemed necessary for stakeholder acceptability." - INCOSE *Systems Engineering Handbook (Ref.4)*

Requirements (or often called Functional requirements) are statements of the capabilities that a system must have ("functions"), geared to addressing the *business needs* that a system must satisfy. *Business needs* are mission-oriented objectives of the organization for which the system is built. The requirements drive system design and development. Functional requirements are major drivers because they define <u>what</u> the system must do, but obviously they're not the only drivers. One way of seeing the impact of requirements on the final system is to look at how all of the front-end activities in the system development effort affect the later stages in the system's evolution.

Criteria for Writing a CCTV Requirement [Learning Objective 1, Slide #30-31]

Specification writers must considerations the following criteria for well-formed requirements:

1. Understand the *Structure* of a Well-Formed Requirement to provide a foundation
2. Capture *Key Characteristics* of a requirement in the content to accurately reflect what is to be done.

The **structure** must address the following factors to provide foundation:

1. **Actor** identifies who or what that does the action
2. **Action** identifies what is to happen
3. **Target** identifies who or what receives the action
4. **Constraint** identifies how to measure success or failure of the requirement
5. **Localization** identifies the circumstances under which the requirement applies
   Localization and constraint portions are important but not all requirements will have both.

The characteristics of a requirement present in the description of a requirement are:

1. <u>**Necessary**</u>: Must be useful and traceable to needs
2. <u>**Concise:**</u> Minimal, understandable and expressed as a ***shall*** statement
3. <u>**Attainable:**</u> Realistic to achieve within available resources and time
4. <u>**Standalone:**</u> Stated completely in one place
5. <u>**Consistent:**</u> Does not contradict itself, nor any other stated requirement
6. <u>**Unambiguous:**</u> Susceptible to only one interpretation
7. <u>**Verifiable:**</u> Requirement can be met through inspection, analysis, demonstration, or test
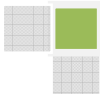
5. Examples of CCTV Requirements

Using the above criteria for writing a requirement, readers can organize these three types of CCTV requirements in their project level specification.

The requirements stated in this module are for learning purpose only, and users are advised to study the **descriptions** and learn how to develop their own requirements that meets specific purpose, and content that conveys the meaning clearly.

Special Notes to Readers

1: The NTCIP 1103 defines a composite, application-layer protocol for the management of transportation equipment. The composite protocol consists of three component protocols: (1) the Internet-standard Simple Network Management Protocol (SNMP), (2) the Simple Fixed Message Protocol (SFMP), and (3) the Simple Transportation Management Protocol (STMP). All three protocols provide the same base services, but are designed for different needs, device complexity, and communications bandwidth. NTCIP 1103 is one of the three documents that replace the rescinded NTCIP 1101 (STMF). CCTV applications are supported by NTCIP 1205 CCTV MIB which by conventions uses ASN.1 based data suitable for SNMP messages only.]

*2: Please be advised that these CCTV configuration requirements are made **Mandatory** by the NTCIP 1205 standard. They are minimum requirements for achieving "Conformance" to the standard. Every CCTV system project level specification (and RTM) must include configuration requirements. Second, without these requirements, interoperability will not be achieved, and remote operations may not be successful. Range-affects parameters values in the form of limit, position and angle degree; time in milliseconds measure and label table set up.*

3: The section does not list Supplemental Requirements as they are specific to a local project and for a CCTV system implementation we have not observed special requirements. However, if needed, a user can develop using criteria discussed in this module. Please make sure that such requirements do not impose conditions that may impact interoperability.

The next Section provides sample examples of the CCTV Architectural Requirements and the Data Exchange Requirements.

Organization of CCTV Requirements

[Note: The development team has chosen to organize examples of CCTV requirements under Section 3.0 for convenience. Like every NTCIP standard, we need to designate a CCTV requirement with a unique identifier and a title. Note all SEP-based standards such as DMS have organized their requirements under Section 3.

Readers: your project specification must use the same Section Number in the project CCTV requirement descriptions, and project PRL and RTM. Your project testing document must also reflect consistent numbering]
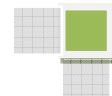
[Also, please note that the NTCIP 1205 standard documentation lists CCTV MIB-Objects under Section 3. These data objects are used in project RTM with standard supplied identifier that begins with 3.x.x.]

3.1 Background Information

Requirements are based on user needs. (User needs discussion in Module A317a provided us with a process to identify and write CCTV User Needs.) An implementation only needs to support the requirements corresponding to the user needs that a particular agency specification addresses. However, several requirements may exist to satisfy a particular user need. The Protocol Requirements List (PRL) prepared for a project maps the project identified CCTV user needs to the requirements stated in this section.

3.2 Architectural Requirements [Developed to Satisfy (Provide) Communications Capabilities]

3.2.1 Provide Live Data

Requirements for specifying capabilities of CCTV device to provide live data to a management station are stated below.

3.2.1.1 Retrieve Data

The CCTV device shall allow the management station to retrieve data from the camera control receiver.

3.2.1.2 Deliver Data

The CCTV device shall allow the management station to deliver data (e.g. configuration data, commands etc.)

#### 3.2.1.3 Data Retrieval and Data Delivery Action Performance

The CCTV device shall process SNMP Get/Set/GetNext commands in response to data retrieval and data delivery actions performed by the management station on the CCTV device in accordance with the performance criteria for the SNMP commands established in NTCIP 1103 v02 Section 3.2.4.

3.2.2 Provide Off-Line Logged Data

The following requirements define the functions needed to support the exchange of data between the management station and a CCTV device for the case where the camera control receiver (CCR) is not sharing a live data connection with the management station, but is instead storing data offline for periodic retrieval by the management station.

3.2.2.1 Retrieve Configuration of Logging Service

The CCTV device shall allow a management station to retrieve the current configuration of the event Logging service, (e.g., the classes and types of events that the CCTV device is currently configured to log).
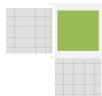
3.2.2.2 Configure Logging Service

The CCTV device shall allow a management station to configure the event logging service, (e.g., configuration of the event classes and event types to log).

3.2.2.3 Retrieve Logged Data

The CCTV device shall allow a management station to retrieve one or more (including all) available log data from the event log.

3.2.2.4 Clear Log

The CCTV device shall allow the management station to clear any or all log entries of a given event class.

3.2.2.5 Retrieve Capabilities of Event Logging Services

The CCTV device shall allow a management station to retrieve the capabilities of the event logging service, including the number of classes, number of event types, and number of events that can be supported by the CCTV device.

3.2.2.6 Retrieve Number of Events Currently Logged

The CCTV device shall allow a management station to retrieve the current number of events that the CCTV device has logged.

3.2.2.7 Set Time

The CCTV device shall allow a management station to set the current time on the CCTV device. The current time value shall be defined in accordance with the Global Time Object defined in NTCIP 1201 v03 Section 2.4.1.

3.2.2.8 Retrieve Current Time

The CCTV device shall allow a management station to retrieve the current time from the CCTV device. The current time value shall be defined in accordance with the Global Time Object defined in NTCIP 1201 v03 Section 2.4.1.

3.2.2.9 Set Daylight Saving Time Mode

The CCTV device shall allow the management station to configure the CCTV device time for Daylight Saving Time. The current time value shall be defined in accordance with the Global Time Object defined in NTCIP 1201 v03 Section 2.4.1.
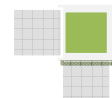
3.3 Data Exchange Requirements [Developed to Satisfy Monitoring-Controlling Camera Functions]

The CCTV device requirements are categorized into three major areas:

> 3.3.1   *Data Exchange Requirements to Manage the CCTV Device Configuration*
> 3.3.2   *Data Exchange Requirements to Control a Camera*
> 3.3.3   *Data Exchange Requirements to Monitor the CCTV Device*

3.3.1   Data Exchange Requirements for Managing the CCTV Device Configuration

3.3.1.1 Configure Range Maximum Presets
The CCTV device shall allow a management station to remotely configure the range of the camera preset position for a maximum number of_____.

3.3.1.2 Configure Range Pan Left Limit
The CCTV device shall allow the management station to remotely configure the panning left limit, 0-360, in 1/100 the degree units in clockwise direction from the home position.

3.3.1.3 Configure Range Pan Right Limit
The CCTV device shall allow the management station to remotely configure the panning right limit, 0-360, in 1/100 the degree units in clockwise direction from the home position.

Additional (Suggested) requirements that a user may add to the list are:

3.3.1.4 Configure Range Pan Home Position

3.3.1.5 Configure True North Offset

3.3.1.6 Configure Range Tilt up Limit

3.3.1.7 Configure Range Tilt down Limit

3.3.1.8 Range Zoom Limit

3.3.1.9 Configure Range Focus Limit

3.3.1.10 Configure Range Iris Limit

3.3.1.11 Configure Range Minimum Pan Step Angle

3.3.1.12 Configure Range Minimum Tilt Step Angle

3.3.1.13 Configure Timeout Pan

3.3.1.14 Configure Timeout Tilt

3.3.1.15 Configure Timeout Zoom

3.3.1.16 Configure Timeout Focus

3.3.1.17 Configure Timeout Iris

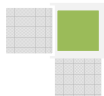*3.3.1.18 Configure Label Maximum*

3.3.1.19 Configure Label Table

3.3.2   *Data Exchange Requirements for Controlling a Camera*

3.3.2.1 Preset Go To Position

The CCTV device shall allow the management station to command the device to move to a preset if that preset exists, and the device shall return the last value written.

3.3.2.2 Programmable Presets

*The CCTV device shall allow the management station to be able **to program** up to **32** presets manually and then allow saving for later use to view a fixed point in space. All presets must function with Pan/Tilt/Zoom capability.*

3.3.2.3 Preset Store Position.

The CCTV device shall allow the management station to command the device to save the current position (store) to the specified preset.

3.3.2.4 Position Pan

The CCTV device shall allow the management station to remotely control a camera position horizontally (Pan- 0º to 360º). This requirement applies to both the primary management station and a backup TMC facility.

3.3.2.5 Position Tilt

The CCTV device shall allow the management station to remotely control a camera position vertically (Tilt-is ±90º). This requirement applies to both the primary management station and a backup TMC facility.

3.3.2.6 Zoom Operation

The CCTV device shall provide a motorized camera-lens equipped with zoom capability to allow management station to remotely adjust lens for a wide and telephoto views.

3.3.2.7 Manual and Auto Focus Adjustment

The CCTV device shall provide a motorized camera-lens equipped to allow the management station to remotely adjust automatically (auto-focus) and manually the lens focus for a far and near views.

3.3.2.8 Manual and Auto Iris Control

The CCTV device shall provide an override capability to the management station for remotely perform manual operation for Iris open and Iris close. The lens shall have an auto-Iris.

3.3.3   *Data Exchange Requirements for Monitoring the Status of the CCTV Device*

***3.3.3.1** Camera Features Status*

The CCTV device shall allow the management station to remotely monitor the device and obtain status of camera power, heater power, wiper washer, and blower functions.

3.3.3.2 Alarm Function Control

The CCTV device shall provide alarm latch status capability to the management station for alarms related to the cabinet, enclosure, video-loss, temperature, pressure, washer fluid level, and local/remote settings.

3.3.3.3 ID Generator (Text Labeling)

The CCTV device shall provide capability for 100 labels with position, font and color information, and shall be able to activate and deactivate labels remotely by the management station and at local site.

3.3.3.4 Labeling of Zones

The CCTV device shall allow the management station to remotely configure, control and label zones for up to 20 zones.

[**Note:** The above list of requirements can be expanded to satisfy additional monitoring needs.]
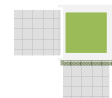
6. Video Formats

Video Basics
- Basic NTSC standard is based on 166 Mb/sec rate without any type of compression
- Video format standards relate to compression of the basic rate video signals for storage and transmission efficiency
- Limited availability of bandwidth, necessitates use of compression format standards
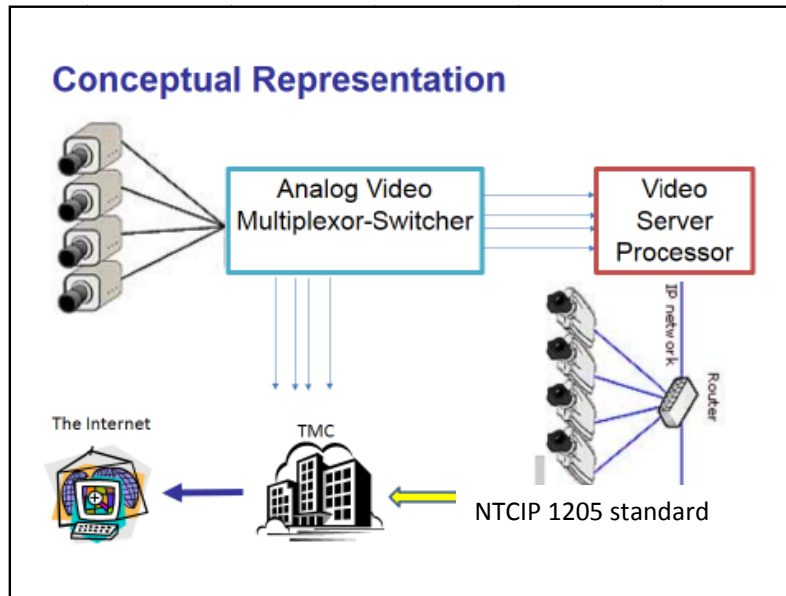- Interoperability may be an issue if different compression formats are used

Figure-3 Conceptual Representation of CCTV Video Transmission

Figure-3 presents a conceptual representation of CCTV video transmission which may be subjected to certain video format standards, analog-digital signal conversion, storage and compression techniques used for transmission of images. These standards are outside of the transportation domain or ITS or NTCIP activities. They are developed and used by the Internet community for video-audio and data transmission. Some camera related information is stated below:

- **Analog camera**-video images require a large amount of bandwidth-capacity and a dedicated cable-point to point, such as a co-axial cable-channel to take it to a recording device or a monitoring device.

- **Digital camera**- provides images as digital "data," and contains a processor that does not need any conversion and can be shared without limit. Digital cameras or Network Cameras as they are referred to in literature, use two types of image sensor technologies: CCD (Charge-coupled device) and CMOS (complementary meta-oxide semiconductor). Modern TMC have opted for such cameras for a networking standpoint.
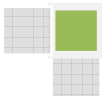
- **Coder-decoder (CODEC)** converts analog signal to digital and compresses signals: In communications engineering, a codec is usually a coder/decoder. Codecs are used in integrated circuits or chips that convert e.g. analog video and audio signals into a digital format for transmission. The codec also converts received digital signals back into analog format. A codec uses analog-to-digital conversion and digital-to-analog conversion in the same chip. Codec can also mean compression/decompression, in which case it is generally taken to mean an algorithm or computer program for reducing the size of large files and programs.

  Once the analog signal is converted to digital signal, it can be placed on a network without accessing issues and can be controlled remotely from the TMC. However, many TMC have inherited legacy Analog video systems and those camera-analogs- can be ONLY controlled using a separate control channel or modulated signal- a cost factor.

Full Motion Video

- **National Television System Committee** (NTSC) is the video system or standard used in North America and most of South America. In NTSC, 30 frames are transmitted each second. Each frame is made up of 525 individual scan lines.
- **Phase Alternating Line** (PAL) is the predominant video system or standard mostly used overseas. In PAL, 25 frames are transmitted each second. Each frame is made up of 625 individual scan lines.

How Does a CCTV System Use Video Compression Technologies?

<u>Video Compression</u> use three dimensions: horizontal, vertical and time (temporal compression)
- ❑ Examples**:** MPEG-4 (Moving Pictures Expert Group) and H.263/H.264
- ❑ MPEG-4 is good for low-bandwidth mobile apps.

<u>Inage Compression</u> use two dimensions: horizontal and vertical dimensions of the image

- ❑ Examples: JPEG and Wavelet (JPEG-2000)

ITS subsystems and TMCs have been exposed to three key standards: Motion JPEG (M-PEG), MPEG-4 Part 2 (or simply referred to as MPEG-4) and H.264. H.264 is the latest and most efficient video compression standard.

- **The Moving Picture Experts Group (MPEG)**: MPEG is the International Organization for Standardization (ISO)-based organization and develops standards for digital video and audio compression. Even today, the MPEG standards are an evolving series, each designed for a different purpose. Please note that the NTCIP effort has realized this and let the industry standard evolve and **<u>not</u>** develop for the transport sector.
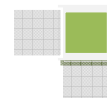
- **MPEG-2/4:** MPEG-2, the standard for broadcast television and DVD's, provides full NTSC or PAL resolution and is practically indistinguishable from uncompressed video. Intelligent Transportation Systems have largely standardized on MPEG-2 transmitted via Transport Streams. ITS systems have fully embraced the Internet Protocol – allowing high quality MPEG-2 and MPEG-4 video to be reliably delivered from hundreds of locations to multiple monitoring locations.

    MPEG-2 is the designation for a group of audio and video coding standards, and is typically used to encode audio and video for broadcast signals, including digital satellite and Cable TV. MPEG-2, with some modifications, is also the coding format used by standard commercial DVD movies.

    MPEG-4 is a group of audio and video coding standards and related technology. The primary uses for the MPEG-4 standard are web (streaming media) and CD distribution, conversational (videophone), and broadcast television. Most of the features included in MPEG-4 are left to individual developers to decide whether to implement them or not. This means that there are probably no complete implementations of the entire MPEG-4 set of standards. To deal with this, the standard includes the concept of "profiles" and "levels", allowing a specific set of capabilities to be defined in a manner appropriate for a subset of applications.

- **RS-232:** RS-232 is a long-established standard that describes the physical interface and protocol for low-speed serial data communication between devices. This is the interface that e.g. a computer uses to talk to and exchange data with a modem and other serial devices.

- **RS-422:** RS-422 is a serial data communication protocol that specifies 4-wire, full-duplex, differential line, multi-drop communications. It provides balanced data transmission with unidirectional/non-reversible, terminated or non-terminated transmission lines. RS-422 does not allow multiple drivers, only multiple receivers. Maximum recommended range is 4,000 feet (1200 meters). Maximum recommended baud rate is 10Mbit/s.

- **RS-485:** RS-485 is an upgraded version of RS-422 that supports up to 32 devices on the same connection. RS-485 is an electrical specification of a two-wire, half-duplex, multipoint serial connection. It enables the configuration of inexpensive local networks and multi-drop communications links. It offers high data transmission speeds (up to 10Mbit/s), and as it uses a differential balanced line over twisted pair (like RS-422), it can span relatively large distances (4000 feet or 1200 meters). RS-485 only specifies the electrical characteristics of the driver and the receiver. It does not specify or recommend any data protocol.

- **H.261: Video conferencing/H.264: High definitions.**
    - Latest MPEG CODEC (CodeDecode) open standard for video encoding for good quality with lower bit rate and latency
    - Entertainment video, telecom services and streaming services
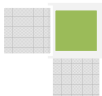   - Widely used for teleconferencing
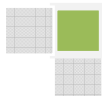
Advice: *ITS Network cameras, video encoders and video management software, system designers and integrators should ensure vendors support for this new open standard.*

- **JPEG** (Joint Photographic Group Experts): storing images: Together with the GIF file format, JPEG is an image file type commonly used on the web. A JPEG image is a bitmap, and usually has the file extension '.jpg' or ".jpeg." When creating a JPEG image, it is possible to configure the level of compression to use. As the lowest compression (i.e. the highest quality) results in the largest file, there is a trade-off between image quality and file size.

- **Open Network Video Interface Forum (ONVIF)**-IP Cameras on the Internet. ONVIF is an open industry forum for the development of a global standard for the interface of IP-based physical security products. The ONVIF specification defines a common protocol for the exchange of information between network video devices including automatic device discovery, video streaming and intelligence metadata.
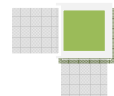
7. References

- NTCIP Guide, Information Report 9001: http://www.ntcip.org/library/

- NTCIP 1205 CCTV v1, and V1.08 Revision Amendment 1 : http://www.ntcip.org/library/
  [Note: Amendment 1 is not yet published by NEMA, but agencies have been using it as it is an approved draft of the NTCIP Committee and does not have backward compatibility issues with v1. We recommend that you consult Amendment 1 for learning purpose].

- PCB Module 8: A203: Writing Requirements when ITS Standards do not have SE content, and Participants Students Supplement: http://www.pcb.its.dot.gov/
  [This module teaches the process of developing requirements].

- *Systems Engineering Handbook,* International Council on Systems Engineering (INCOSE), 2007. http://www.incose.org/ProductsPubs/products/sehandbook.aspx

- *PennDOT Publication 646 Intelligent Transportation Systems Design Guide*
  ftp://ftp.dot.state.pa.us/public/pubsforms/Publications/Pub%20646.PDF

- National ITS Architecture v7.0, 2012: http://www.iteris.com/itsarch/index.htm

- USDOT Standards Program: http://www.standards.its.dot.gov

8. Study Questions

1) Which of the following is a well-written CCTV system requirement?
   a) The CCTV system shall allow the management station to retrieve logged data from the Camera Control Receiver.
   b) The camera position must be controllable at the TMC.
   c) Operator needs to monitor temperature inside an enclosure.
   d) TMC staff must be able to share camera control with the maintenance personnel located at another building.

2) Which of the following Generic SNMP Interface will allow the operator to monitor the current temperature within the camera enclosure?
   a) SNMP SET Interface.
   b) SNMP Get Interface.
   c) SNMP GetNext Interface.
   d) SNMP GetResponse Interface.

3) Which will ensure the precise objects necessary to fulfill a requirement?
   a) The PRL table
   b) The RTM table
   c) SNMP Get Interface
   d) Major Desired Capability (MDC)

4) Which of the following is NOT applicable to the following extended CCTV requirement?
   "The CCTV device shall allow the management station to remotely control selectable shutter speed of the field camera."
   a) All **extended** requirements are non-conformant to the standard, and depend on proprietary vendor-specific objects.
   b) The requirement is well-developed and meets criteria.
   c) This requirement will break the interoperability.
   d) The project RTM will ensure interoperability.

5) Which of the following statements is false?
   a) A CCTV device vendor may support features not selected in the specification PRL
   b) The project PRL contains selected objects
   c) Analog cameras can be controlled with a common digital camera control interface
   d) The interface specification must specify SNMP