

8 ITS Standards Specification Development

8.1 Procurement Specifications

Specifications for ITS Standards-based communications are part of the Detailed/Final Design stages. Successful system procurement and deployment is dependent on the availability of quality specifications. Moreover, an agency cannot develop a good test plan without clearly defining what is required of the device or center system in a clear, concise and testable manner.

It is important to note that a quality specification requires more than the invocation of a list of standards. Procurement specifications must include:

- List of Standards Referenced – both for center-to-center and NTCIP device specific standards:
 - This list must be specific as to version, date of issue, etc. as the standards have changed over time and will continue to change.
 - Communications dialogs (information exchange sequences) that implement a center or device interface.
 - A Requirements Traceability Matrix (RTM) that traces the functional requirements to the communications dialogs
 - List of and value ranges for all data elements (objects) – for example, size of event logs, the number of DMS messages to be supported, and the number of special functions managed.
- Specification of any optional parts of the reference standards that must be included; many of the standards include both mandatory and optional data elements; it is the responsibility of the agency to identify the optional elements which must be supported and the value ranges for those optional data elements (objects) where appropriate.
- Functional requirements that are not covered by the standards; although the NTCIP standards include a description of the data elements (objects) (in XML or ASN.1 format, as appropriate), the agency must review the standards and clearly articulate any specific functionality required or expected from the product understanding that different vendors may interpret the standard differently.
- Performance requirements for the device that are not covered by the standards. The agency must determine what performance requirements to include based on their communications infrastructure, the demands of their central system, and their concept of operations for the ATMS applications. Examples of considerations: the number of units to a channel; the time lag allowed when setting all devices; the poll rate for monitoring status.

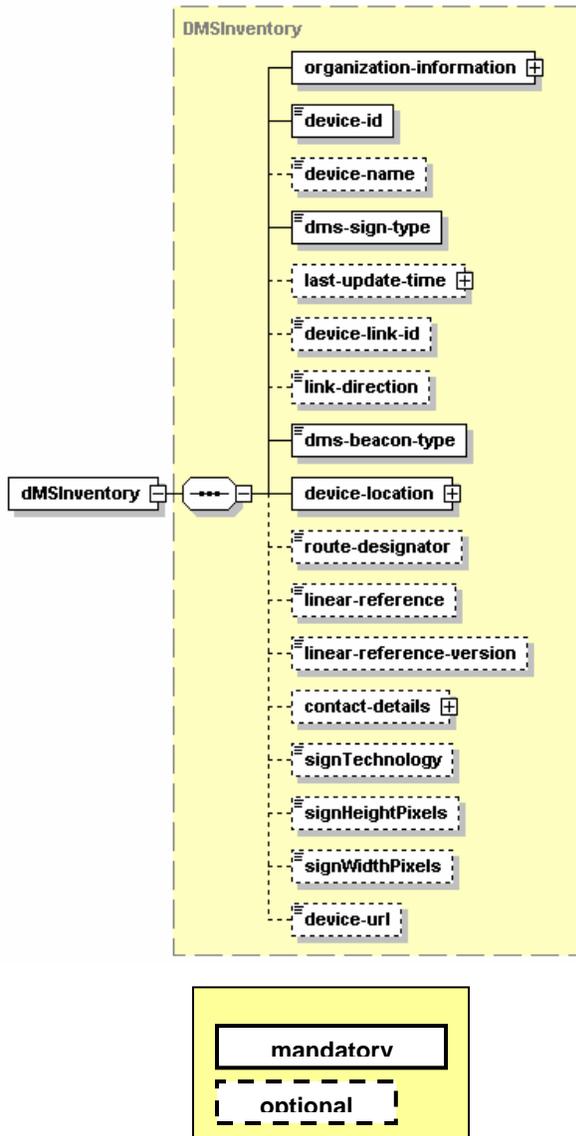
- Environmental requirements (for devices) not covered by the *NTCIP* standards. These requirements are generally part of the NEMA TS 2 or TS 4 documents or generic agency specifications.

8.2 *ITS Standards in Final Design*

The ITS standards contain mandatory and optional elements. Rarely will an agency need all the functions and messages that an ITS standard supports, thus the project specifications should specify the required data objects (center-to-field) or messages (center-to-center) for a project. This customization of the national ITS standards yields a project-specific version of the standard. To conform with an ITS standard, a system must support ALL the mandatory elements of that standard. However, the system is NOT required to support ANY of the optional elements. Thus the project specifications should specify which OPTIONAL elements are required to be implemented for the project.

The concept of OPTIONAL elements is illustrated below using a TMDD center-to-center message as an example.

Figure 8-1. Example DMS ITS Standards Mandatory and Optional Elements



In the case of center-to-field ITS standard, the solutions are usually described in the form of data objects and MIB definitions that must be supported by a field device. In the case of center-based system message set standards, the solutions are in the form of data elements and messages that must be supported.

8.3 Detailed Design

The detailed design is the definition of dialogs, messages, and data elements in the center-to-center world, and dialogs, interfaces and data objects in the center-to-field world. The detailed design is the solution that meets the stated project system requirements and is traceable to those requirements. Chapter 5 contains a discussion of the Dialog Worksheet, which outlines how dialogs, requirements, and detailed design are related.

8.4 Center-to-Field Communications Specification Development

8.4.1 Operations Plan

The operations plan complements the ConOps and focuses more on the details on how the ITS system will be used once the system is deployed, both under normal operation and abnormal operations (such as during an emergency or during maintenance). This operations plan can then be used to develop the detailed system functional requirements, based on the needs and operational concepts identified in the document. The operations plan for an ITS system requiring center-to-field communications should include discussion of the following:

- **Introduction.** The introduction will contain a general overview of the project elements and locations of field equipment.
- **Normal Operations.** This section contains a narrative of how the field and central control system should operate under normal conditions. The focus will be on what functions the ITS system should support. Ideally, a description of what detailed information is required for the function to be completed, paving the way for an analysis of NTCIP object requirements.
- **Exception Operations.** This section will contain a narrative of how the field and central control system should operate under abnormal conditions, such as during equipment or power failures.
- **Operations Modes.** The section will focus on control modes, functions, and which operations are available during which control modes.
- **Monitoring.** The section will outline the behavior of the system during status monitoring, event logging, and diagnostics.

To provide an illustration of the concepts discussed above, an example operations plan for a DMS (dynamic message sign) system is included in Appendix J.

8.4.2 Center-to-Field Communications Specification

A specification for center to field communications should include the following:

- **General Requirements.** This section of the specification should cover general information related to the NTCIP such as definitions, references, conformance clause, and property/ownership rights.
- **Physical Features.** This section will contain an overview of the type or types of equipment being considered, and the physical characteristics of the field and central system.
- **Protocol Implementation Conformance Specification (PICS).** This section of the specification should contain the Protocol Requirements List (PRL) from the NTCIP

standard modified to meet the project requirements. Tailoring the PRL for use in a specification makes it a Protocol Implementation Conformance Specification (PICS).

- **Functional Requirements and Traceability.** This section of the specification should cover any behavior of changes in features of the device in response to communications with the center. Requirements are written in the form of 'shall' statements.
- **Dialogs.** This section should provide a description of each dialog, including sequence of information exchanges between ITS elements.
- **Object Definitions.** The section should include a definition of all object definitions in MIB format.
- **Software and Integration Support.** This section should include any information and assumption made about the behavior or performance of the central software, and what the device vendor's responsibilities are related to software and integration.
- **Installation/Testing.** This section will outline what testing is required under various times/conditions. For example, during installation, routine maintenance, and failure.
- **Documentation.** The specification should stipulate that the vendor provide NTCIP and MIB documentation in electronic form.
- **Example MIB.** Optionally, the agency may desire to include a sample or example MIB, depending on whether the new equipment will need to support the objects defined in an existing MIB.

8.4.3 Center-to-Field Communications Test Plan

This section should include a discussion of the roles and responsibilities of the agency, manufacturer/vendor, and contractor through the various testing phases: factory acceptance test, visual inspection test, startup tests, stand-alone tests, operational test, and integration test.

A partial specification with key portions of the document filled in for a DMS (dynamic message sign) system is included in Appendix J. Appendix L provides guidance on ITS Standards Test Procedure Development and Tools.

8.5 Center-to-Center Communications Specification Development

8.5.1 Center-to-Center Communications Specifications

A specification for center to center communications should cover the following:

- **General Requirements.** This section of the specification should cover general information related to the NTCIP such as definitions, references, conformance clause, and property/ownership rights.
- **Functional Requirements and Traceability.** This section of the specification should cover general information related to the standards such as definitions, references,

conformance clause(s), and property/ownership rights. The requirements table should also include sufficient detail to allow tracing from requirements to the detailed design.

- **Applications Profile for Center-to-Center Communications.** The specification should state which of the two application profiles for center to center communications the vendor shall provide. The two application profiles are:
 - **NTCIP 2306 (NTCIP C2CXML).** Application Profile for XML in ITS Center to Center Communications.
 - **NTCIP 2304 AP-DATEX.** Application Profile for Data Exchange.

It is important to note that the Application Profiles cover only message transport and message encoding options. The content of the messages themselves are an information level standard.

Based on discussions and knowledge of projects being developed in New York, the rest of this section will focus on the XML-based standards for center to center communications.

- **Dialogs.** This section will define the center's interface to external systems including: operations (functions) supported, message inputs and outputs, and message transport. This section of the specification should contain the following:
 - Message Sequence Diagrams. The specification may include graphical depictions of the information exchanges. The sequence diagram should show what operations and message inputs and outputs relate to specific center functions.
 - Dialog Worksheet. This worksheet lists the system interface elements (operations, message sequence, message encoding, message inputs, message outputs, and transport) in table form. The table provides the information necessary to develop the WSDL. Further discussion is included below.

Message Encoding. The NTCIP C2CXML provides for 2 message encoding mechanisms.

- SOAP (Simple Object Access Protocol)
- XML

Message Transport. The NTCIP C2CXML provides for 3 message transport "bundles":

- SOAP Encoded Messages over HTTP
- XML Encoded Messages over HTTP
- XML Encoded Messages over FTP

- **Message and Data Element Definitions.** The section should reference the message set standard(s) and version that will be used in the project, and contain a list of messages (from the message set) that will be used in the project. For each message, this section should specify which optional data element will be made mandatory for the project or deleted, and for data elements that may be repeated in the message a number of times, the maximum number of occurrences.
 - **XML Schema.** The definitions of Messages and Data Elements should be in XML Schema format.
- **Software and Integration Support.** This section should include any information and assumptions made about the behavior or performance of the central software, and what the device vendor's responsibilities are related to software and integration.
- **Documentation.** The specification should stipulate that the vendor provide XML Schema and WSDL documentation in electronic form.
- **Web Services Description Language.** The formal Web Services Description Language document. This must be provided for a center system to be in conformance with the NTCIP C2XML. The agency may select to include only the System Interface Worksheet in the specification and let the vendors provide the WSDL in their bid.
- **XML Schemas and Example Messages.** It may be helpful to provide an example project specific XML Schema and messages that meet the project requirements.

A partial specification with key portions of the document filled in for center to center communications is included in Appendix K. Appendix L provides guidance on ITS Standards Test Procedure Development and Tools.

8.5.2 Center-to-Center Communications Test Plan

A test plan for center-to-center communications focuses on two areas: 1) testing of the information level specifications (dialogs and messages), and 2) application level specifications (message encoding and message transport).

Information Level Standards Testing. The information level test plan includes test procedures to: 1) ensure that the dialogs are implemented as specified. In other words, if message A is sent, message B is received in response; and 2) ensure that systems can extract data element information from messages.

Application Level Standards Testing. The application level test plan ensures that 1) the correct message encoding rules apply, and 2) the correct transport protocols (HTTP, FTP, IP) are implemented as specified

The WSDL and XML Schema, which define the interface to the system – dialogs, messages, data elements, message encoding, and transport – should be used as a guide in developing the test plan and procedures.