9 ITS Standards Specification Catalog and Testing Framework

This chapter covers concepts related to development of an ITS Standards Specification Catalog and Testing Framework, and includes the following topics:

- Standardizing Language and Content of Procurement Specifications (the previous chapter begins this process).
- Interchangeability of Devices and Certification Testing
- Test Plan and Procedures Development
- Test Tools

One such testing framework is documented in the NTCIP 9012 – Testing and Conformity Assessment Users Guide. Though, the 9012 document covers only the topic of center-to-field communications, many of the concepts translate to other areas, such as center-to-center and WAVE/DSRC. It is worth noting that the OmniAir Consortium has initiated a certification testing program for WAVE/DSRC products.

9.1 ITS Standards Specification Catalog

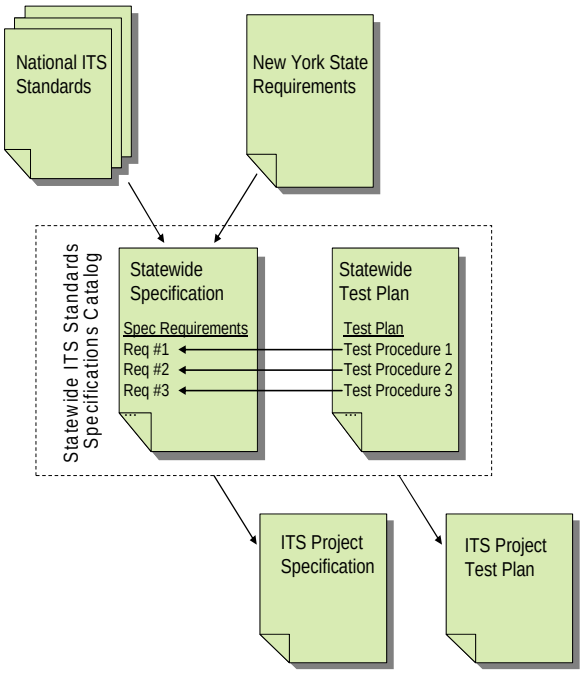
An ITS Standards Specifications Catalog would define the following (as a minimum):

- Sample **concepts of operation** and **functional requirements** for field device communications, center-to-center traffic, traveler, and incident information sharing, and WAVE/DSRC ITS applications. This will define the information needed to support development of the information level specifications.
- Sample detailed specifications included filled in **PICS** (protocol implementation conformance specification) and **MIBs** (management information base) for field device communications (information level specifications).
- Information level standards for **core dialog and message specifications** for center-to-center communications, including **WSDL** (Web Services Description Language) and **XML Schemas**. And **core dialog and MIB definitions** for center-to-field communications.
- Sample specifications to support **specific ITS Standards Communications Packages** ("a complete communications protocol stack") for application, transport, subnetwork, and plant level standards).

Given these pre-defined specifications, ITS engineers could quickly pull together draft ITS specifications, draft feasibility studies for alternatives for deployment of ITS communications, and Systems Engineering Analysis reports.

The concept of using an ITS Standards Catalog is shown below.

Figure 9-1. ITS Standards Specification Development and Testing Framework



9.2 Interchangeability of Devices and Approaches to Certification Testing

One approach for an agency to obtain interchangeable devices from a specification is to examine the standards and resolve the following, as a minimum:

a. Which optional objects a device must support

b. Specify minimum support values for certain capabilities (i.e. the minimum number of plans in a traffic signal controller, the minimum number of phases, size of event logs, number of fonts supported, etc)

c. Interpret objects to have a consistent implementation for the device (e.g., *patternTableType* from NTCIP 1202:1996)

When the functionality is clearly described (in a measurable and observable manner), then devices that use the same objects to manage the same well-defined functionality will be interchangeable.

NYSDOT may consider establishing a centralized testing section or laboratory for New York State, and a qualified products list.

As an alternative, the testing of manufacturers devices may occur at the manufacturers facilities.

9.3 Testing Methodology

9.3.1 Prepare the Test Plan – What Needs to be Tested.

Only the communications interface to a system:

- Dialogs (Checking for proper sequence)
- Message Creation (Data into Messages)
- Message Parsing (Messages into Data)
- Message Delivery (Send / Receipt) - Protocol
- Handling of Failures

The testing of system compliance with the NYSDOT C2C Specification may utilize third party software or vendor provided software as the testing tool. The procurement of any third party software should be coordinated through the Project Manager and Field Test Manager to ensure version control and appropriate tracking of test conditions.

The table below contains an outline of what should be included in a test plan.

Table 9-1. Outline of Field Test Plan Contents

- Test Plan Identifier (assigned by the Field Test Manager)
    - Introduction
    - Background
    - Scope
    - References
- Test Items
- Features to be Tested
- Features Not to be Tested
- Approach
    - Degree of Comprehensiveness Desired
    - Techniques and Tools
- Item "Pass/Fail" Criteria
- Suspension Criteria and Resumption Requirements
    - Test Suspension

    - Resumption Requirements
- Test Deliverables
    - Test Plan
        - Traceability to Requirements Test Cases
    - Pre-test Interviews
    - Test Procedures
        - Step-by-step procedures for each Core Function
    - Test Data
        - Supporting Data and Information
- Testing Tasks and Schedule
    - Testing Tasks
    - Schedule
- Environmental Needs
- Responsibilities
- Staffing and Training Needs
- Risks and Contingencies
- Approvals

9.3.2 Develop Test Procedures

The test procedures provide step by step descriptions of the tests to be performed. The Dialog Worksheet presents an excellent starting point for development of detailed procedures (See Chapter 5). Starting from the Dialog Worksheet allows test plan/procedures to trace to the use case/requirements test cases to ensure verification of the system functionality. The worksheet allows breaking out the test procedures into the following verification steps for each dialog specified:

- Verify communications exchanges and correct sequencing of inputs and outputs.
- Verify message/MIB object input-output compliance with specification XML Schema or ASN.1 definitions.
- Verify encoding of messages/MIB objects – e.g., SOAP for C2C or OER for MIB objects.
- Verrify transport mechanism of messages and MIB objects – e.g., HTTP for C2C or SNMP for MIB objects.

9.3.3 Conduct the Test

Conduct of the test shall begin when all applicable test plans have been approved. The test team should allow enough time on-site to collect all necessary data. Data analysis will not be performed on site, except when necessary to verify an anomalous condition. If an anomaly occurs—it could be related to the standards or the product implementation. Once the anomalous condition is determined NOT to be caused by an error in the standard then no further resolution by the test team is necessary. In some cases, it may be prudent for the test team to assist the host agency and/vendor to further resolve the anomaly, but in such cases these results should not be included in the official test findings.

Test data should be captured in a non-intrusive manner so as not to interfere with normal test site operations. The test team will log all actions in a test log. The format of the log is left up to the discretion of the test team and the Field Test Manager. However the log must include the date and time of all events so that the captured raw test data can be cross-referenced to specific events.

9.3.4 Post Test Analysis

The results of the tests shall be analyzed for problems/ anomalies.

Finally, a post-test workshop should be held to brief all stakeholders of the test findings and recommendations, and to solicit feedback and comments for use in preparation of the final test report for the tested standards. The Project Manager and Field Test Manager will be included in the coordination and planning of the post-test workshop.

9.4 ITS Standards Testing Tools

The section above includes an overview of a methodology to ITS standards testing. This section describes the type of software tools necessary to carry out ITS standards testing:

9.4.1 Center-to-Field Testing Tools

Center-to-Field. Because SNMP, ASN.1, and the MIB are open standards, one can test field elements and center systems separately. A center simulator (or client test software) can be used to test the interfaces to the sign (without having to have a production center system connected to the sign.) A field device simulator can be used to unit test center-based software that will ultimately communicate with a some field device.

The NTCIP standard maps functional requirements to NTCIP Objects, but more importantly, the standard includes a section on Dialogs which indicates which NTCIP Objects must be set and retrieved to enable a specific device function.

NYSDOT can create a standardized statewide MIB. NYSDOT could then require that a device manufacturer show that the MIB, running under the SNMP agent of the device manufacturer, is able to respond to a series of commands outlined in a test plan.

SNMP and MIBs are used throughout network communications. For example, most network routers and communications network devices are monitored using SNMP. As a result a number

of companies exist that provide 3rd party off-the-shelf MIB compilers and SNMP monitoring tools. The primary tools required for testing of field devices are therefore:

- SNMP-based testing software (e.g., NTCIP Exerciser, Intelligent Devices Tester) for testing of client-side (center) and field-side functionality, and
- MIB Compiler to check the validity of the written (ASN.1) form of the MIB

9.4.2 Center-to-Center Testing Tools

The center-to-center communications test plan provides a general template for testing of center interfaces based on the NTCIP XML-based standard – this includes testing of dialogs and messages, and the lower level protocols (HTTP, FTP, IP, etc.).

Testing of the center interfaces specified would involve tools for evaluating the validity of a sample of XML messages and the transport mechanism for moving the XML content from an external center (in this case the test client) to the NYSDOT center software being tested. Therefore, the primary tools for testing of center-based communications would be:

- XML Schema Validation.
- WSDL Validation.
- XML Message Validation. This is a tool that validates that
- Application Level Protocol Validation. An external center system simulator can be developed using a thin client web browser, or simple client scripts that exercise a center's interfaces. This would include testing of message sequences defined in the dialogs, and protocols (HTTP, FTP, etc.).

As with the center-to-field case, because the center-to-center standard is based on open standards that are widely adopted by the IT community, software development tools and testing tools are available.