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Joint Committee on the NTCIP*

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A roadmap to testing for center-to-field communications.

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What's the difference between compliance and conformance?

Compliance is a condition that exists when an item meets all of the requirements of an agency specification.

Conformance is a condition that exists when an item meets all of the mandatory requirements of a standard.

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How do you start conformance testing with system requirements?

Before starting a testing program, a well-defined set of requirements is defined, against which the testing procedure or process is be compared. Well defined requirements are needed to test for standards conformance. Testing verifies that an ITS device complies with requirements in an agency specification.

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What NTCIP test documentation is available?

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What NTCIP test tools are available?

Testing tools, which consist of specialized software and/or hardware, can be used to examine the data interface of NTCIP-based ITS devices.

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ACKNOWLEDGEMENTS

NTCIP 9012 v01 was prepared by the NTCIP Testing and Conformity Assessment Working Group (TCA WG), which is a subdivision of the Joint Committee on the NTCIP. The Joint Committee is organized under a Memorandum of Understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA). The Joint Committee on the NTCIP consists of six representatives from each of the standards organizations, and provides guidance for NTCIP development.

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FOREWORD

NTCIP 9012 v01, an NTCIP standards publication, provides general guidance for testing ITS devices to both the NTCIP standards and agency specifications. NTCIP 9012 v01 is not an NTCIP standard and does not contain any normative text. The NTCIP TCA WG expects NTCIP 9012 v01 to be used by transportation agencies to assist them in developing their own testing program when purchasing and deploying NTCIP “compliant” devices and systems.

NOTE—The term “compliant” was used in the preceding paragraph. NTCIP 9012 v01 discusses the issues of *conformance* to NTCIP standards and *compliance* with agency specifications (including project-specific requirements), and clarifies the differences.

The following keywords apply to this document: NTCIP, testing

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History

In September 1996, an agreement was executed among AASHTO, ITE, and NEMA to jointly develop, approve, and maintain the NTCIP standards. In December 2001, the Joint Committee on the NTCIP formed the TCA WG to investigate issues surrounding conformance testing and develop testing and conformity assessment documentation. The TCA WG held its first meeting in October 2002. The TCA WG began development of NTCIP 9012 v01 in October 2003.

The TCA WG also produced NTCIP 8007 v01, which promotes a consistent look and feel for testing documentation throughout the various NTCIP standards. Consistent test documentation enables the next published versions of NTCIP 1200-series standards, produced by various NTCIP working groups and based on NTCIP 8007 v01, to be used by anyone wishing to test an implementation of an NTCIP standard.

NTCIP 8007 v01 contains valuable insights into the development of test cases and test procedures for verifying NTCIP conformance. NTCIP 8007 v01 can assist both agencies and manufacturers in developing their NTCIP test procedures, where the standards are silent, or by augmenting test procedures where ITS device requirements have been extended beyond the basic NTCIP functionality.

Compatibility of Versions

To distinguish NTCIP 9012 v01 (as published) from previous drafts, NTCIP 9012 v01 also includes NTCIP 9012 v01.27 on each page header. All NTCIP Standards Publications have a major and minor version number for configuration management. The version number syntax is "v00.00a," with the major version number before the period, and the minor version number and edition letter (if any) after the period.

NTCIP 9012 v01 is designated, and should be cited as, NTCIP 9012 v01. Anyone using NTCIP 9012 v01 should seek information about the version number that is of interest to them in any given circumstance.

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Section 1 INTRODUCTION

1.1 OVERVIEW

NTCIP is a series of communication standards intended to promote deployment of interoperable Intelligent Transportation Systems (ITS). NTCIP 9012 v01 is intended to be used by agencies as a reference to assist in the incorporation of NTCIP testing into a testing program to be used when procuring ITS devices for which there is an NTCIP standard. NTCIP 9012 v01 focuses on center-to-field communications.

The NTCIP standards have been well received by the ITS industry, and many agencies specify NTCIP standards for new deployments. In the past, an agency would procure the proprietary communications protocol already used in agency-operated ITS devices. Today, agencies may choose to specify an ITS device communications interface based on NTCIP. NTCIP-based agency specifications mitigate the risk of procuring proprietary manufacturer solutions.

NTCIP testing is emerging as a new activity. NTCIP testing insures that:

- a) ITS devices delivered incorporate the mandatory requirements of the NTCIP standards (referred to as **standards conformance**); and
- b) that an agency's project requirements and specifications are fulfilled (referred to as **agency specification compliance**).

NOTE—Annex A contains complete listings for references, definitions, and acronyms.

1.2 INTENDED AUDIENCE

NTCIP 9012 v01 has been developed to inform a knowledgeable reader about NTCIP testing. A knowledgeable reader is one familiar with NTCIP standards plus the transportation management system hardware standards such as NEMA TS 2 and NEMA TS 4. If you are unfamiliar with the NTCIP communication standards and the NEMA hardware standards, it is recommended you have access to the following standards as representative examples: NTCIP 1202 or NTCIP 1203, and NEMA TS 2 or NEMA TS 4. Annex A contains a glossary of terms and acronyms that a reader may want to have available, also. The intended audience for NTCIP 9012 v01 is comprised of public agencies; independent testers – both laboratories and consultants; ITS device manufacturers; and specification and test documentation developers.

NTCIP 9012 v01 provides a roadmap to help an agency become an active participant in the testing process and those processes leading up to testing (requirements definition and specification development).

NTCIP 9012 v01 provides guidance on:

- a) NTCIP testing concepts and processes;
- b) where NTCIP testing fits within a broader testing program that includes hardware testing;
- c) test documentation necessary to insure that an NTCIP testing program is complete;
- d) a phased approach to test execution;
- e) testing tools; and
- f) manufacturer pre-qualification.

Collectively, these are the testing themes discussed in NTCIP 9012 v01.

A testing roadmap is presented in Figure 1. The testing roadmap explains concisely how the testing themes covered in NTCIP 9012 v01 may be structured into a testing program. It also serves as an NTCIP 9012 v01 roadmap.

Section 2

NTCIP Standards

- The standards for ITS device communications interfaces describe the information content, structure, and sequence of exchanges across the interface boundary.

Section 3

Agency Requirements and Specifications

- You state your system requirements.
- You include in your specification all the mandatory requirements of the standard.
- You include in your specification optional elements of the standard that apply.

Section 4

Test Documentation

- You prepare and plan the testing to be executed.
- Test documentation states what to test, the test environment, test procedures, who does the testing and when, and criteria for pass/fail.

Section 5

Test Execution

- Test execution verifies that your system requirements are fulfilled in the implementation.
- You execute a test plan and document the results: pass, fail, test incidents, and re-testing required.
- Testing occurs in phases prescribed in the test documentation.

Section 6

Test Tools

- Test tools implement the test procedures of the test plan.
- Test tools are described as part of the test environment specified in the test plan.

Section 7

Qualified Products List

- Some agencies pre-qualify vendors based on agency-standardized test documentation.

Figure 1 Testing Roadmap

Section 2 NTCIP AND ITS STANDARDS BACKGROUND

A comprehensive ITS device testing program verifies implementation of hardware, environmental, and communications interface requirements. Section 2 provides a brief overview of ITS device standards to assist agencies to understand the role of NTCIP testing in the context of a broader testing program for deploying a traffic management system.

2.1 PURPOSE OF ITS DEVICE STANDARDS

ITS device standards, including the NTCIP series of communications standards, are intended to promote:

- a) **Compatibility** among system components (and ITS devices), so that different system components can share a common communications infrastructure;
- b) **Interoperability** between system components, so that system components from different manufacturers can work together to provide the necessary functionality; and
- c) **Interchangeability** of system components, so that system components can be changed out (switched) with similar components from different manufacturers.

Any component that does not conform to the requirements of the NTCIP standards (and comply with NTCIP-based agency specifications) inhibits or precludes some of these goals from being realized.

2.2 NTCIP ITS DEVICE COMMUNICATIONS INTERFACE STANDARDS

NTCIP standards are organized into a framework of levels modeled after the Open Systems Interconnect (OSI) model. The NTCIP 9001 v03 (known as “the Guide”) contains a more complete discussion of NTCIP standards and their development and usage.

For ITS devices, the NTCIP information level standards (designated as part of the NTCIP “1200 series”) define the data (called objects), structure of data (contained in a Management Information Base, or MIB), and sequence of data exchanges (dialogs) that manage ITS device operation, monitor status, and collect necessary data for analysis. Information level standards specify the data elements (parameters) that are used to manage ITS device functionality or to provide specific measurements (e.g. traffic volumes, temperature, voltages) and ITS device status. NTCIP working groups standardized the data content and dialogs necessary to manage the operation and monitoring of conditions and status of various ITS devices, including: Actuated Signal Controllers (ASC), Dynamic Message Signs (DMS), Environmental Sensor Stations (ESS), CCTV Cameras, and Ramp Meters. For a complete list of NTCIP standards, see the NTCIP document library at www.ntcip.org.

NTCIP base standards represent the lower level communications standards and protocols, and define how data are encoded and transmitted over a variety of media types (e.g. fiber, twisted pair, wireless) and protocols (TCP/IP, UDP/IP, point-to-multi-point or point-to-point protocols). These lower level standards are neutral as to ITS device type and data content. Agencies should consider the unique aspects of their existing and planned ITS communications infrastructure during system acquisition to ensure that agency specifications define the requirements that satisfy agency needs.

Figure 2 is a graphical representation of the NTCIP framework, and summarizes the relationship between information level and base (lower level) standards.

NOTE—Figure 2 is adapted from NTCIP 9001 v03. Refer to NTCIP 9001 v03 for a complete description of the NTCIP standards framework.

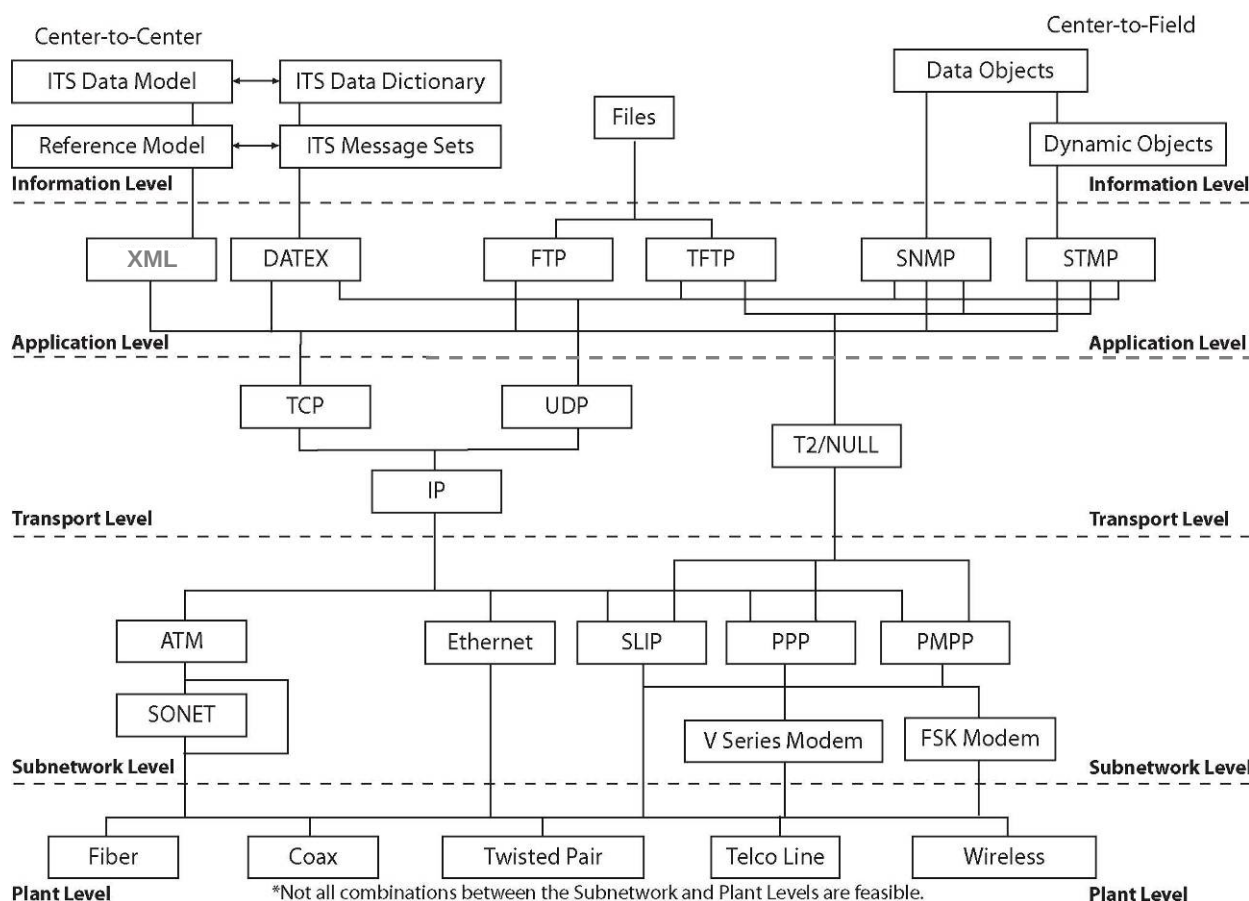


Figure 2 NTCIP Framework

2.3 HARDWARE AND ENVIRONMENTAL STANDARDS

Standardization of traffic signal controllers and cabinets dates back to the late 1970's, beginning with NEMA TS 1. Since then a number of hardware and environmental standards for ITS devices have been developed including:

- NEMA TS 2**—Developed as a design guide for traffic signal devices and provides operational features not covered by NEMA TS 1-1989. NEMA TS 2 supports equipment interchangeability between manufacturers and includes minimum functional requirements for effective intersection control, equipment requirements including environmental standards, and testing procedures.
- NEMA TS 4**—Developed as a design and implementation guide for traffic messaging devices, such as dynamic message signs. NEMA TS 4 provides hardware requirements including environmental standards and testing procedures.
- Advanced Transportation Controller (ATC)**—The ATC suite of standards provides an open architecture hardware and software platform for a wide variety of ITS applications. The ATC suite of standards includes hardware requirements for the traffic controller and the cabinet (enclosure).

These standards aid agencies in specification of ITS devices by standardizing functional, hardware (electrical and mechanical requirements), performance and environmental requirements, as well as identifying requirements for testing. For example, an agency procuring traffic signal controllers may reference the appropriate NEMA standard (e.g. NEMA TS 2-2003), which includes a description of

functionality, environmental requirements, and testing procedures. Likewise, for DMS, the agency might invoke portions of NEMA TS 4-2005.

NOTE—While NTCIP 9012 v01 references the basic designator for the above standards, the procuring agency should reference the particular version or approval year of the referenced standard, as indicated in the preceding example.

2.4 STANDARDS CONFORMANCE VERSUS AGENCY SPECIFICATION COMPLIANCE

Since completion of the initial versions of the NTCIP standards in 1996, agencies have become interested in testing ITS devices for conformance to standards and compliance with agency specifications.

- **Standards Conformance** – When an item fulfills all of the mandatory requirements as defined by a standard
- **Specification Compliance** – When an item fulfills all the requirements of an agency specification

NTCIP testing focuses on verification of the NTCIP requirements. This includes verification of the mandatory requirements in the standard (referred to as **standards conformance**), and verification of the requirements in your agency specification (referred to as **agency specification compliance**). NTCIP testing may also be extended to encompass verification of the ITS device functions that result from NTCIP communications.

Whether standards conformance or specification compliance, an NTCIP testing program should be designed to show that the ITS device communications interface implementation fulfills requirements and uses appropriate objects to manage ITS device functions. Where dialogs are specified (i.e. a specific sequences of message interactions), testing should be planned to ensure that the ITS device accepts and responds with the correct data and that the ITS device performs the required function.

2.4.1 Standards Conformance

Conformance is a condition that exists when an item fulfills all of the mandatory requirements defined by a standard. Conformance testing is designed to verify that the ITS device fulfills the mandatory requirements of the applicable standard(s). Hence, before starting testing, one should first ensure that a set of well-defined requirements exists and can be verified—requirements are the basis for testing and verification. Conformance testing addresses all parts of the standards that are mandatory for the ITS device, whether that part of the standard is required as part of the agency specification or not. For example, an ITS device that conforms to all parts of NTCIP 1201:2005 implements dynamic objects independent of whether they are used by the project.

As a minimum, the conformance test for NTCIP should cover the following items:

- a) Verification of the ability to GET and/or SET each object defined in the required standards and in the correct order.
- b) Verification that range limits for the specific objects are satisfied. This is especially important if non-contiguous ranges are specified.
- c) Verification that the values SET in the ITS device are reflected in the proper internal location, i.e. that a SET of the cycle length for plan 5 actually sets the cycle length for plan 5, not plan 50. This is typically done by verifying the variables through the ITS device's local display or observing the resultant behavior of the ITS device.
- d) Verification that the values retrieved from the ITS device are pulled from the proper location within the controller; again, this is typically done by verifying the values through the front panel display, or by verifying that the behavior of the ITS device matches the values retrieved. For example, observing that the temperature reported by a DMS matches the ambient temperature within the measured area.
- e) Verification that all objects identified in the standard(s) have the desired operational effect. To do so, the operation of the ITS device is observed or inputs are simulated to measure proper operation (volumes, voltages, temperature).