

DATE: September 29, 2009

TO: AASHTO, ITE, and NEMA

SUBJECT: **Recommended Standard Policy of NTCIP 8004 v02,
Structure and Identification of Management
Information (SMI) – Version 02**

ACTION: Request for Ballot to Approve

RECOMMENDATION. This Bulletin reports that the Joint Committee on the NTCIP accepted the proposed NTCIP 8004 v02, *Structure and Identification of Management Information (SMI) – Version 02*, as a Recommended Standard on Information Management Policy, and agreed to refer the document to AASHTO, ITE, and NEMA for balloting and approval.

The acceptance was approved at the Dallas meeting, held on November 15-16, 2007, after instructed revisions, by the required 12-vote super majority of the 18-member Joint Committee, and carried with 13 affirmative votes, no negative votes, no abstentions, 5 members absent, and no vacant seats.

The Joint Committee on the NTCIP contributes to the joint standards development process by accepting a proposed draft document at two stages in its development – first as a User Comment Draft and then again as a Recommended Standard.

BACKGROUND. This document was developed to be a Joint AASHTO / ITE / NEMA Standards Publication, part of the NTCIP family of standards and profiles. The document is in the 8000-series of NTCIP document numbers, and is a Process, Control, and Information Management Policy document. Process, Control, and Information Management Policy documents define the policies and procedures used by the Joint Committee and its working groups in developing and maintaining NTCIP standards and documents.

The NTCIP 8004 defines a process and control policy standard for the rules and procedures for defining the structure and identification of management information in transportation related communications. The specifications in NTCIP 8004 apply to the NTCIP 1200-series and other NTCIP standards that deal with device data dictionaries.



The NTCIP 8004 SMI specifies a set of rules and protocols for organizing, describing, and defining transportation management information to be exchanged between transportation management applications, and/or transportation equipment, so they interoperate with each other. NTCIP 8004 is based on the Internet Advisory Board Standard (IAB STD) 16 - *Structure and Identification of Management Information for TCP/IP-based Internets*, and the International Standards Organization / International Electrotechnical Commission (ISO/IEC) 8824 - *Abstract Syntax Notation One (ASN.1)*.

NTCIP 8004 SMI covers four major areas:

- Organization and Object Identification
- Object Specifications
- Meta Attributes
- Management Information Bases

The relationships among many of the different terms within NTCIP 8004 are shown in Figure 1, using Unified Modeling Language symbols. This “message meta-model” is a “quick reference” that connects many of the terms used by NTCIP practitioners.

The two most important changes in 8004 v02 are (1) the Object subfields are revised to align with revisions in NTCIP 8005, and (2) Section 2.6 was added to set rules for defining and revising both new and existing Objects.

NTCIP 8004 also defines the MIB object status conditions of mandatory, optional, deprecated, and obsolete; and sets the rules for creating extensions to, or new versions of, MIBs.

At the November 2007 Dallas meeting of the NTCIP Joint Committee, there was extended discussion regarding the backward compatibility of the major version editions of NTCIP 1200-series standards, and the rules for revising MIBs. The Joint Committee instructed the BSP2 WG to revise the proposed NTCIP 8004 v02.12 to include the discussed revisions to the definitions of Deprecated and Obsolete, and to include the TMDD registered as node 4.

In the January 2008 teleconference, and again at the April 2008 Atlanta meeting of the NTCIP Joint Committee, the discussion continued to clarify the definitions of Mandatory and Obsolete, and the MIB maintenance rules.

The definitions in NTCIP 8004 v02.15 Section 1.3 are edited versions from the Joint Committee discussions, combined with those from Perkins and McGinnis *Understanding SNMP MIBs*.

NTCIP 8004 v02 was developed by the Joint Committee’s Base Standards and Profiles Working Group, which is chaired by Bob De Roche (Bob De Roche Consulting). The BSP2 WG has nine members, and seeks new members from both the public and private sectors.

DOCUMENT ORGANIZATION. The NTCIP 8004 v02 includes three sections and five Annexes. The NTCIP 8004 v02 revisions are listed in Annex E.

The Standards Development Report required by the ITE standards development process is attached. The SDR provides a summary of the document development milestones, the working group members, and other standards that have been examined with regard to harmonization and duplication of content.

An electronic copy of the Recommended Standard Policy is posted in the LIBRARY area of the NTCIP Website, at www.ntcip.org.

USER COMMENT DISPOSITION. All user comments regarding NTCIP 8004 v02 were recorded and the disposition of each comment is reported. In the report, official "User Comments" are designated with a "UC0000" number in the User Comment Number field.

The disposition report from the User Comment database is posted in the NTCIP Web site's Forum for Standards, in the "NTCIP 8004 SMI" Conference. The User Comment disposition report includes 60 pages and 120 comments. The User Comment disposition report includes a typo – the field reference to "v02.27" should be to 8004 "v02.07," which was the User Comment Draft minor version that was distributed.

NOTES. The Joint Committee accepted NTCIP 8004 version v02.12, November 2007, as the Recommended Policy. Additional technical editing and quality improvement have now been included in version v02.15. The continued resolution of discussion, and editing and administrative delays, postponed the issue of this Standards Bulletin.

NAVIGATE THE PDF. To help users navigate the large document, the PDF file was authored with embedded links. The links can be found in the Table of Contents, Figures, and figures numbers and URLs within the text.

To use the links when browsing with Adobe® Reader®, select the Hand tool, and the Hand will change to the pointing finger when over a link. To return to the prior page after clicking a link, use Alt + Left Arrow to return to the Previous View. See the reader's View menu for more shortcuts.

BALLOT INSTRUCTIONS. The eligible voting representatives who receive this Bulletin are asked to follow the ballot instructions of their standards organization.

**ATTACH-
MENTS:** 1. NTCIP 8004 v02, *Structure and Identification of Management Information (SMI) – Version 02*, version v02.15, September 2009, ~59 pages.

2. ITE SDR for NTCIP 8004 v02, rev2, 9/25/09, 5 pages.

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A Recommended Standard of the Joint Committee on the NTCIP

NTCIP 8004 version v02.15

National Transportation Communications for ITS Protocol Structure and Identification of Management Information (SMI)

v02.15 September 2009

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Reference Status Table 1 (To be deleted on publication)

References included within 8004 v02	Title	Type (Norm, Other)	Dependency and Status Note	Date and Next Action for Resolution
NTCIP 8005 v01	<i>Procedures for Creating Management Information Base Files and a Functional Area Data Dictionary</i>	Other	Publication anticipated. Needs 8005 v01. Ref in 8004 v02 is to 8005 v01.	9/2009 Awaiting issue for SDO ballot.
Other Documents that reference this document 8004 v02				
NTCIP 1103 v02	<i>Transportation Management Protocols (TMP)</i>	Other	Publication anticipated.	SDO ballot initiated 04/28/2009
NTCIP 2301 v02	<i>Simple Transportation Management Framework (STMF) Application Profile (AP) (AP-STMF)</i>	Norm	09/28/09 B0133 issued v02.18 to SDOs for ballot/approval. 08/2009 resolved 9 points prior to issue to SDOs. 07/02/2009 Awaiting resolution/clarification of 9 points	In ballot; awaiting SDO Joint Approval.

ACKNOWLEDGEMENTS

NTCIP 8004 v02 was prepared by the NTCIP Base Standards and Profiles 2 (BSP2) Working Group (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.

At the time that NTCIP 8004 v02 was prepared, the following individuals were members of the NTCIP BSP2 WG:

- Ralph Boaz
- Bob De Roche (Chair)
- Bud Kent
- Jim Mahugh
- Greg Mizell
- Alex Mousadi
- Peter Ragsdale
- Robert Rausch
- Joerg "Nu" Rosenbohm

Other individuals providing input to NTCIP 8004 v02 include:

- Blake Christie
- Kenneth Vaughn

In addition to the many volunteer efforts, recognition is also given to those organizations that supported the efforts of the working group by providing funding for NTCIP 8004 v02, providing travel support, and submitting comments, including:

- U.S. Department of Transportation,
Research and Innovative Technology
Administration
- Econolite Control Products
- Noblis
- Pillar Consulting
- Robert De Roche Consulting
- Siemens ITS
- Transcore
- Telvent Farradyne
- Trevilon
- US Traffic
- URS Greiner
- Washington State Department of
Transportation

FOREWORD

NTCIP 8004 v02 specifies a set of rules and protocols for organizing, describing, and defining transportation management information to be exchanged between transportation management applications and transportation equipment. NTCIP 8004 v02 defines requirements that are applicable to all NTCIP devices that exchange data in that environment.

In addition, NTCIP 8004 v02 contains mandatory requirements that are applicable to all devices claiming conformance to NTCIP 8004 v02. NTCIP 8004 v02 also contains optional and conditional requirements, which may be applicable to a specific environment in which a device is used. NTCIP 8004 v02 has five annexes, but only Annex A is normative. NTCIP 8004 v02 uses only metric units.

NTCIP 8004 v02 is also an NTCIP Process, Control, and Information Management document, which defines the practices and policies used by the NTCIP Joint Committee in developing and maintaining NTCIP standards publications. Specifically, NTCIP 8004 v02 is applicable to the NTCIP 1200 series and other NTCIP standards that deal with device data dictionaries.

User Comment Instructions

The term “User Comment” includes any type of written inquiry, comment, question, or proposed revision, from an individual person or organization, about any part of this standard publication’s content. A “Request for Interpretation” of this standard publication is also classified as a User Comment. User Comments are solicited at any time. In preparation of this NTCIP standards publication, input of users and other interested parties was sought and evaluated.

All User Comments are referred to the committee responsible for developing and/or maintaining this standards publication. The committee chairperson, or their designee, may contact the submitter for clarification of the User Comment. When the committee chairperson or designee reports the committee’s consensus opinion related to the User Comment, that opinion is forwarded to the submitter. The committee chairperson may report that action on the User Comment may be deferred to a future committee meeting and/or a future revision of the standards publication. Previous User Comments and their disposition may be available for reference and information at www.ntcip.org.

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Please include your name, organization, and address in your correspondence.

Approvals

TBD NTCIP 8004 v02 was separately balloted and approved by AASHTO, ITE, and NEMA after recommendation by the Joint Committee on the NTCIP. Each organization has approved NTCIP 8004 v02 as the following standard type, as of the date:

AASHTO—Standard Specification; ***TBD***
ITE—Software Standard; ***TBD***
NEMA—Standard; ***TBD***

History

In 1992, the NEMA 3-TS Transportation Management Systems and Associated Control Devices Section began development of the NTCIP. The Transportation Section's purpose was in response to user needs to include standardized systems communication in the NEMA TS 2 standard, *Traffic Controller Assemblies*. Under the guidance of the Federal Highway Administration's NTCIP Steering Group, the NEMA effort was expanded to include the development of communications standards for all transportation field devices that could be used in an Intelligent Transportation Systems (ITS) network.

In September 1996, an agreement was executed among AASHTO, ITE, and NEMA to jointly develop, approve, and maintain the NTCIP standards. The Joint Committee on NTCIP has sponsored the development of a number of standards that define device data dictionaries. After the NTCIP Class B Profile was published, the Joint Committee on the NTCIP determined that the communications profiles should be modular to meet the varied needs of different communication environments. The Joint Committee on the NTCIP formed both the Base Standards and Protocols Working Group (BSP WG) and the Profiles WG. After reorganization, the two WGs merged to form the Base Standards and Profiles (BSP2) WG. The first meeting of the working group was in January 1999.

During early stages of development, portions of NTCIP 8004 v02 were part of NTCIP 1101:1996, which was also numbered and referenced as NEMA TS 3.2-1996. However, to provide a more systematic approach to an organized numbering scheme, and to reflect the joint copyright of AASHTO, ITE, and NEMA, the current designation is NTCIP 8004 v02.

NTCIP 8004 v02 was originally part of NTCIP 1101:1996, *Simple Transportation Management Framework*. In July 1999, the Joint Committee on the NTCIP approved a work item to separate a predecessor of NTCIP 8004 v02 into a stand-alone document. In January 2000, the BSP WG submitted a work plan and initiated development of NTCIP 8004 SMI.

NTCIP 8004 v02.04, 2006—NTCIP Joint Committee accepted the User Comment Draft, which included changes harmonized to NTCIP 8005 v01.18. The references to the <DescriptiveName> and <DataType> subfields were deleted, and a new <Object identifier> subfield was added to reflect the full Object identifier value from the root node. For version v02.07 in January 2007, the Joint Committee further accepted the addition of new Section 2.6 in the User Comment Draft, in accordance with TCF recommendations on backward compatibility. In January 2007, Standards Bulletin B0118 issued v02.07 for review and comment.

NTCIP 8004 v02.12, October 2007—The Joint Committee accepted as a Recommended Standard, with instructions for two revisions. January 2008—Revised definition of deprecated per Joint Committee and updated figures to reflect new nodes.

NTCIP 8004 v02.15, September 2009—NTCIP Standard Bulletin B0134 issued for ballot and approval, after v02.13 to v02.14 edited during March 2008 to July 2009 for object STATUS definitions and related content.

Compatibility of Versions

To distinguish NTCIP 8004 v02 (as published) from previous drafts, NTCIP 8004 v02 also includes NTCIP 8004 v02.15 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 8004 v02 is designated, and should be cited as, NTCIP 8004 v02. Anyone using NTCIP 8004 v02 should seek information about the version number that is of interest to them in any given circumstance. The MIB, the PRL, and the PICS should all reference the version number of the standards publication that was the source of the excerpted material.

Compliant systems based on later, or higher, version numbers MAY NOT be compatible with compliant systems based on earlier, or lower, version numbers. Anyone using NTCIP 8004 v02 should also consult NTCIP 8004 v02 for specific guidelines on compatibility.

NOTE—The reference to NTCIP 8004 v02 is template information. The circular nature of the reference is recognized.

INTRODUCTION

NTCIP 8004 v02 is a process, control and information management standard for the rules and procedures for defining structure and identification of management information in transportation-related communications.

The following keywords apply to NTCIP 8004 v02: AASHTO, Dynamic Objects, ITE, NEMA, NTCIP, SMI, SNMP, STMP, process and control Standard.

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Section 1 GENERAL

1.1 SCOPE

NTCIP 8004 v02 specifies a set of rules and protocols for organizing, describing, and defining transportation management information to be exchanged between transportation management applications and transportation equipment. NTCIP 8004 v02 defines the Structure and Identification of Management Information (SMI) used in transportation related devices. NTCIP 8004 v02 is applicable to the NTCIP 1200 series and other NTCIP standards that deal with device data dictionaries.

NOTE—NTCIP 8004 v02 relies on widely accepted conventions, generally designated as “SMIv1.” and defined in IAB STD 16, as well as some elements of SMIv2, as defined in IAB STD 58.

1.2 REFERENCES

Normative references contain provisions that, through reference in this text, constitute provisions of NTCIP 8004 v02. Other references in NTCIP 8004 v02 might provide a complete understanding of the entire protocol and the relations between all parts of the protocol. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard listed.

1.2.1 Normative References

IAB STD 16	(RFC 1155: 1990, Structure and Identification of Management Information for TCP/IP-based Internets; RFC 1212: 1991, Concise MIB Definitions)
IAB STD 58	(RFC 2578) Structure of Management Information Version 2 (SMIv2), K. McCloghrie, D. Perkins, J. Schoenwaelder, TU Braunschweig, April, 1999
ISO/IEC 8824-1:2002	Information technology—Abstract Syntax Notation One (ASN.1): Specification of basic notation
ISO/IEC 8824-2:2002	Information technology—Abstract Syntax Notation One (ASN.1): Information object specification
ISO/IEC 8824-3:2002	Information technology—Abstract Syntax Notation One (ASN.1): Constraint specification
ISO/IEC 8824-4:2002	Information technology—Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications
ISO 1000:1992	SI Units and recommendations for use of their multiples and of certain other units

1.2.2 Other References

IAB STD 8	(RFC 0854: 1983, Telnet Protocol specification, and RFC 0855: 1983, Telnet Options Specifications; J. Postel, J. Reynolds)
AASHTO / ITE / NEMA NTCIP 1103 v02	<i>Transportation Management Protocols (TMP)</i> (publication anticipated)
AASHTO / ITE / NEMA NTCIP 1201:2005	<i>Global Object (GO) Definitions—version 02</i> published October 2005
AASHTO / ITE / NEMA NTCIP 1202:2005	<i>Object Definitions for Actuated Traffic Signal Controller (ASC) Units— version 02</i> published November 2005
AASHTO / ITE / NEMA NTCIP 7001	<i>Assigned Numbers Summary—Part 1</i>
AASHTO / ITE / NEMA NTCIP 8005 v01	<i>Procedures for Creating Management Information Base (MIB) Files</i> publication anticipated
NEMA TS_2	<i>Traffic Controller Assemblies with NTCIP Requirements</i> 2003

Perkins, D; McGinnis, E., *Understanding SNMP MIBs*, Prentice-Hall, Inc., 1997, ISBN 0-13-437708-7

Stallings, William, *SNMP, SNMPv2, and CMIP: The Practical Guide to Network-Management Standards*, Massachusetts, Addison-Wesley Publishing Company, 1993, ISBN 0-201-63331-0

Larmouth, John, *ASN.1 Complete*, Academic Press, a Harcourt Science and Technology Company, May 1999, ISBN 0-12233-435-3, <http://www.oss.com/asn1/booksintro.html> (October 9, 2000)

Dubuisson, Olivier, *ASN.1 Communication between Heterogeneous Systems*, June 5, 2000, ISBN 0-12-6333361-0, <http://www.oss.com/asn1/bookintro.html> (October 9, 2000)

Booch, Grady, Rumbaugh, James, Jacobson, Ivar, *Unified Modeling Language User Guide*, September 30, 1998, ISBN 0201571684

UML basics: An introduction to the Unified Modeling Language,
www-106.ibm.com/developerworks/rational/library/769.html#N10090.

1.2.3 Contact Information

1.2.3.1 NTCIP Standards

For revision information on NTCIP 8004 v02, contact:

NTCIP Coordinator
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209-3801
e-mail: ntcip@nema.org

For draft revisions of NTCIP 8004 v02, recommended revisions of the NTCIP Joint Committee, and all other NTCIP standards publications, visit www.ntcip.org.

1.2.3.2 IAB/RFC Documents

Internet Advisory Board (IAB) documents, or Request for Comment (RFC) electronic documents are available from several repositories on the World Wide Web, or by “anonymous” File Transfer Protocol (FTP) with several hosts. Browse or FTP to:

Internet Architecture Board (IAB)
www.rfc-editor.org
www.rfc-editor.org/repositories.html

1.2.3.3 ISO/IEC Standards

Members of ISO maintain registers of currently valid ISO/IEC International Standards. For the USA, the member of ISO is the American National Standards Institute (ANSI), which may be contacted as follows:

ANSI
11 West 42nd Street, 13th Floor
New York, NY 10036
(212) 642-4900
<http://global.ihf.com>

1.3 DEFINITIONS AND ACRONYMS

For the purposes of NTCIP 8004 v02, the following terms and definitions (with acronyms, where appropriate) apply. For terms not defined in this section, English words are used in accordance with their definitions in the latest edition of *Webster's New Collegiate Dictionary*. Electrical and electronic terms not defined in this section or in *Webster's New Collegiate Dictionary* are used in accordance with their definitions in IEEE Std 100-2000.

agent	The entity that receives commands and transmits responses to the received commands.
block object	A grouping of individual objects primarily for the purpose of referring to the group with a single name and identifier.
compatible	The ability of two or more systems or components to exchange information. [from the IEEE Std. 610.12-1990: IEEE Standard Glossary of Software Engineering Terminology]
data	Information before it is interpreted.
datagram	A self-contained unit of data transmitted independently of other datagrams.
deprecated	In the context of a MIB, “deprecated” is an object STATUS value that indicates the object is valid in limited circumstances, but has been replaced by another. NOTE—This definition is modified from “Understanding SNMP MIBS.” To maintain multi-version interoperability (backward compatibility) for legacy implementations, objects with a STATUS value of “deprecated” may require support. When necessary to support legacy implementations, required support for objects with a STATUS value of “deprecated” is indicated using the PICS or Protocol Requirements List (PRL).

file	<p>A grouping of individual or block database objects into a single sequence of bytes that can be referred to by file operations.</p> <p>NOTE—A file exists nominally in a directory, and can have an associated path.</p>
Intelligent Transportation Systems (ITS)	<p>The application of advanced information processing and communications, sensing, and control technologies to surface transportation with the objective of promoting more efficient use of the existing highway and transportation network, increasing safety and mobility, and decreasing environmental impacts.</p>
International Organization for Standardization (ISO)	<p>An international standards organization.</p> <p>NOTE—ANSI is the primary interface to ISO within the United States. Often thought to be International Standards Organization, because of its acronym ISO.</p>
Internet	<p>A large collection of connected networks, primarily in the United States, running the Internet suite of protocols.</p> <p>NOTE—Sometimes referred to as the <i>DARPA Internet</i>, <i>NSF/DARPA Internet</i>, or the <i>Federal Research Internet</i>.</p>
Internet Protocol (IP)	<p>The network protocol offering a connection-less mode network service in the Internet suite of protocols.</p>
interoperable	<p>The ability of two or more systems or components to exchange information and use the information that has been exchanged.</p> <p>[from IEEE Std. 610.12-1990: IEEE Standard Glossary of Software Engineering Terminology]</p>
IP address	<p>A 32-bit quantity used to represent a point of attachment in an internet.</p>
management information base (MIB)	<p>A structured collection or database of related managed objects defined using Abstract Syntax Notation One (ASN.1).</p>
mandatory	<p>In the context of a MIB, an object STATUS value that indicates the object is valid.</p> <p>NOTE—In SMIv1, “mandatory” also indicates implementation is required for conformance. This definition is modified from “Understanding SNMP MIBS.”</p>
manager	<p>The entity that sends commands to entities and processes their responses.</p>
National Transportation Communications for ITS Protocol (NTCIP)	<p>A family of protocols that provide common control and data collection services as well as accommodating various system topologies and data routing duties.</p> <p>NOTE—NTCIP is designed to support not only currently deployed systems, but also new systems and technologies as they become available.</p>
network	<p>A collection of subnetworks connected by intermediate systems and populated by end systems.</p>

network layer	That portion of an OSI system responsible for data transfer across the network, independent of both the media comprising the underlying subnetworks and the topology of those subnetworks.
object	An instance of object type is a data structure that can be used to describe the attribute or properties of a single data element or a group of data elements, such as a table.
OBJECT IDENTIFIER	A unique name (identifier) that is associated with each type of object in a MIB that is a defined ASN.1 type.
object type	A data structure used to describe the attribute or properties of an object or a group of objects.
OBJECT-TYPE	A macro used to define the meta attributes of an object in an SNMP MIB.
obsolete	In the context of a MIB, an object STATUS value that indicates the definition is no longer valid, was found to be flawed, was redundant or not useful. NOTE—In the next (or some future) edition of a standard, the object or group with a STATUS value of “obsolete” may be removed. This definition is modified from “Understanding SNMP MIBS.”
protocol	A specific set of rules, procedures, and conventions defining the format and timing of data transmissions between devices that are accepted and used to understand each other.
Simple Network Management Protocol (SNMP)	A communications protocol developed by the Internet Engineering Task Force (IETF), used for configuration and monitoring of network devices.
Simple Transportation Management Framework (STMF)	Describes the organization of information within devices and methods of retrieving or modifying any information within the device. NOTE—STMF also explains how to generate and use computer-readable information organization descriptions.
subnet/ subnetwork	A physical network within a network on which all devices share the same physical media.
trap	An event within an SNMP agent that generates a message for a management station.

1.4 OTHER ABBREVIATIONS AND ACRONYMS

Other abbreviations and acronyms used in NTCIP 8004 v02 are defined as follows:

ASC	Actuated Signal Controller
ASCII	American National Standard Code for Information Interchange.
ASN.1	Abstract Syntax Notation One
IAB STD	Internet Activities Board Standard
IANA	Internet Assigned Numbers Authority

IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
NVT	Network Virtual Terminal
OER	Octet Encoding Rules
OSI	Open Systems Interconnection
PICS	Protocol (or Profile) Implementation Conformance Specification
PDU	Protocol Data Unit
RFC	Request for Comments
SMI	Structure and Identification of Management Information
STMP	Simple Transportation Management Protocol
TCP	Transport Control Protocol
TMIB	Transportation Management Information Base
UML	Unified Modeling Language

Section 2 CONFORMANCE

2.1 INTRODUCTION

NTCIP 8004 v02 specifies a set of rules and protocols for organizing, describing, and defining transportation management information to be exchanged between transportation management applications and/or transportation equipment such that they interoperate with each other. NTCIP 8004 v02 is based on the Internet Advisory Board Standard (IAB) STD 16 and ISO/IEC 8824. NTCIP 8004 v02 intends that a high level of compatibility, including interoperability, be maintained between traffic management systems and field ITS devices.

NTCIP 8004 v02 covers four major areas:

- a) Organization and Object Identification
- b) Object Specifications
- c) Meta Attributes
- d) Management Information Bases (MIBs)

Within NTCIP, each piece of information is described by a number of characteristics. These characteristics are also referred to as meta-attributes. Most of the characteristics are defined by RFC 1212 (IAB STD 16) and are used to represent the logical concept of an “object” such that it can be used with NTCIP protocols. The specific set of characteristics used varies based on the type of object being defined. The general format for documenting these characteristics is known as the **base object specification** and is discussed in Section 2.3.1. This general definition is then further refined for three specific cases: a simple object, a block object, or a dynamic object.

The simple object specification is used to document how simple atomic pieces of information can be exchanged by Simple Network Management Protocol (SNMP) or Simple Fixed Management Protocol (SFMP). The details for defining simple objects are discussed in Section 2.3.2.

In some cases, it is desirable to predefine groups or structures of data that can be referenced by a single identifier. This NTCIP representation is specified within the **block object specification**. A block object is treated as a single object in terms of identification and exchange but the values within the block reflect more elemental objects (e.g., simple objects). The details for defining block objects are discussed in Section 2.3.3.

The third case is given by the **dynamic object**. A block object is always a predefined sequence of variables. In other words, the variables that make up the sequence and the order in which they appear is defined by a standard and does not change unless the standard is changed. Simple Transportation Management Protocol (STMP) extends this concept to allow the structure of a group of objects to be defined at run-time. These objects can be defined and redefined at any time during the operation of the system and do not require a change to the standard. The complete specification for defining dynamic objects and how they are used is covered in NTCIP 1103 v02 Section 5.

In each of the preceding cases, it is necessary for each processing entity involved in an exchange to have some predefined knowledge about what is or can be transferred. The means of sharing this information is through the use of a **MIB**. A MIB is a computer-readable file that contains the definition of individual objects. The details of defining a MIB are covered in Section 2.5. It should be emphasized that definitions of block object contents are external to a MIB.

Whereas a MIB is a computer-readable file, users may need additional information in order to understand, handle, and process objects. Users also need to know general configuration information about a MIB. The description of these NTCIP defined meta-attribute requirements are Section 2.4.

2.1.1 Message Meta-Model

The relationship among many of the different terms of a message can be depicted in the Unified Modeling Language (UML), as shown in Figure 1.

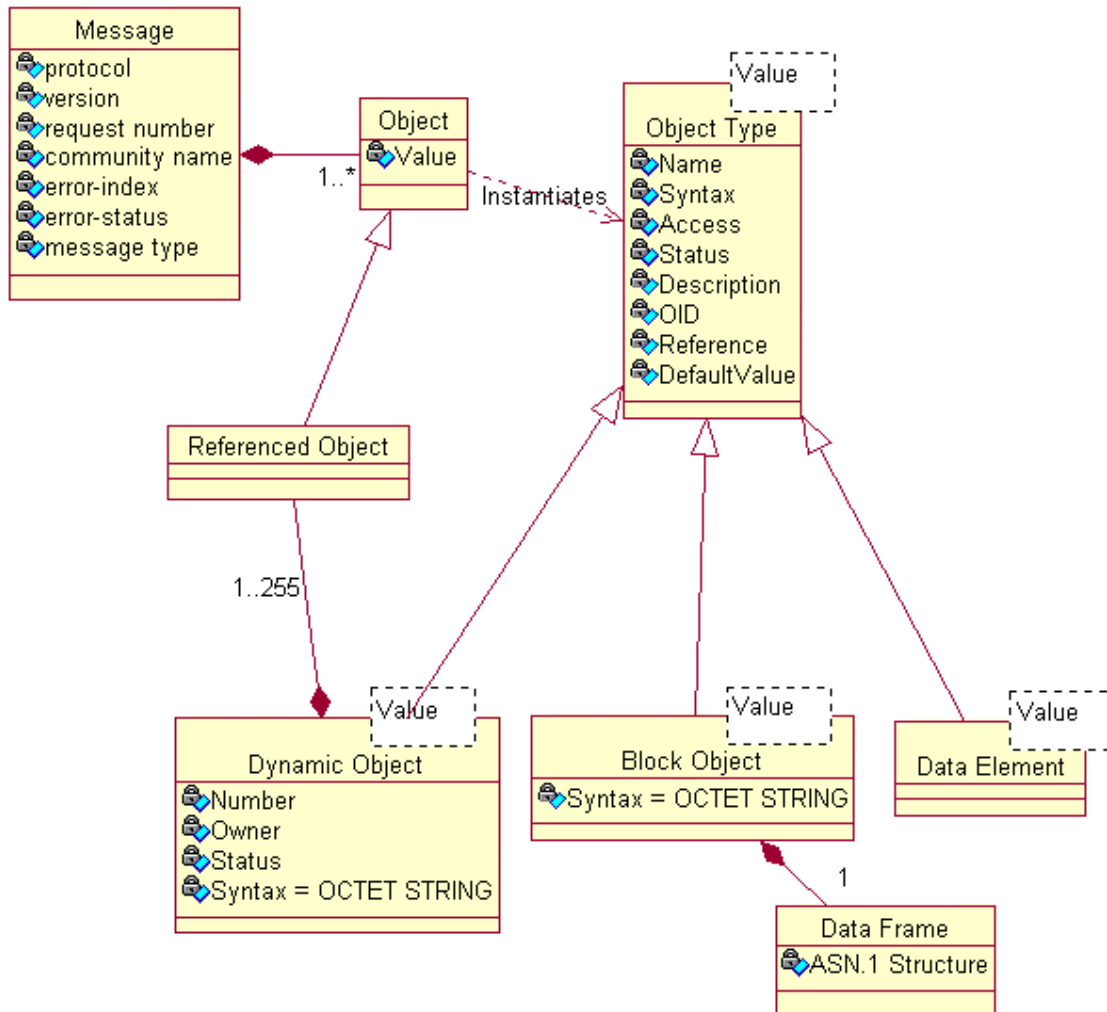


Figure 1 Relationships Among Terms

Starting in the upper-left corner of Figure 1, a message is the logical structure behind the Data Packet (i.e., byte-stream) that is exchanged by protocol entities. It consists of a variety of information, such as the request number, community name, and the type of message along with one or more Objects. (Although in the case of STMP and SFMP, the message is limited to containing a single Object.)

An Object is an instance of an Object Type. An Object Type is the structure that is defined in a MIB. For example, a MIB might define a table that contains information. The MIB only defines the columns of the table and which columns are used as indices. Each column would be an Object Type, and each cell in the table would be an Object, i.e., an instance of the respective Object Type as defined for that column.

There are three specializations of Object Type: Data Element, Block Object, and Dynamic Object. The simplest form of an Object is the Data Element. A Data Element is a single piece of information that can be represented using normal SNMP syntax, for example, an integer.

However, at times, there is a need to deal with more complex structures than a single piece of information. The Block Object provides this. A Block Object is the byte-stream (i.e., serialization) representing a defined structure. From the perspective of the message, a Block Object is merely an embedded byte-stream, but the end-application on either end of the communications link can translate this byte-stream into a more complex structure. However, the structure is required to be statically defined and implemented within each end-application.

A Dynamic Object takes this concept one step further. It allows the content of the data structure to be defined at run-time rather than forcing a static definition at design-time. A management station may configure a Dynamic Object to reference any combination of other Objects stored within the device (with few exceptions). The referencing mechanism is termed a Referenced Object. While this mechanism only allows for simple sequences of data, it still provides the management station with a powerful tool in managing communications over a link. However, Dynamic Objects are only accessible via STMP.

Annex D provides some additional material on UML.

2.2 ORGANIZATION AND OBJECT IDENTIFICATION

As defined in the SMI MIB in Annex A, NTCIP data is organized through the use of a global naming tree. The naming tree was created by the ISO-OSI community and is commonly referred to as the ISO Naming Tree. The tree consists of three root nodes, each connected to a number of sub-nodes falling underneath the root node. Each sub-node may, in turn, have sub-nodes of its own. Each node, whether a root node or a sub-node, is managed by some organization. For example, the three root nodes are managed by ISO, the International Telegraph and Telephone Consultative Committee (CCITT), and jointly by ISO and CCITT. The manager of any node may delegate the management responsibility for any sub-node underneath its branch. In this case, the delegated node is termed a sub-tree. Just as any sub-node may have its own set of sub-nodes, sub-trees can have their own sub-trees. This structure may continue to any level of depth in order to meet the needs of the managing organization. Each node on this tree is assigned both a label and an integral number.

The label assigned to any node is the OBJECT DESCRIPTOR for that node. An OBJECT DESCRIPTOR is a user-friendly textual name used to convey some meaning and semantic understanding of the object being described.

The sequence of integral numbers starting from a root node and traversing the tree to a subject node is termed to be the OBJECT IDENTIFIER for that node. Through the proper management of the sub-nodes at each level in the tree, one is able to obtain a globally unique identifier.

The unique identifier can be used for any purpose for which an identifier may be useful. For example, most standards organizations have an OBJECT IDENTIFIER assigned to it for the purposes of identification. The tree can also be used for managing groups of related data. For example, all object related to an Actuated Signal Controller are organized under a node defined as 'asc'. In short, these attributes are a means for identifying some object, regardless of the semantics associated with the object.

Central to the notion of the OBJECT IDENTIFIER is the understanding that administrative control of the meanings assigned to the nodes may be delegated as one traverses the tree.

2.2.1 Naming Tree Administrative Nodes

The first two root nodes of the naming tree are administered by CCITT (ccitt) and ISO (iso). The third node is jointly administered by the ISO and the CCITT (joint-iso-ccitt). Under the "iso" node, ISO has designated one subtree for use by other (inter)national organizations (org). Under that subtree, one of the U.S. National Institute of Standards and Technology nodes is assigned to the U.S. Department of Defense (dod). The initial development of the Internet was a Department of Defense project and, therefore, the Internet community was assigned a node in the dod subtree. The Internet Activities Board (IAB) administers the "internet" node. The descriptive name "internet" is defined as:

internet OBJECT IDENTIFIER ::= { iso org dod 1 }
(also known as 1.3.6.1)

Because of the ease of obtaining a node from IAB, NEMA has requested and received a node that it can administer. This node is defined as:

nema OBJECT IDENTIFIER ::= { iso org dod internet private enterprises 1206 }
(also known as 1.3.6.1. 4.1.1206)

All data related to NTCIP Device Data Dictionaries or Protocols shall be defined under the NEMA branch of the tree. The organization of the naming tree down to the "nema" node is shown in Figure 2.

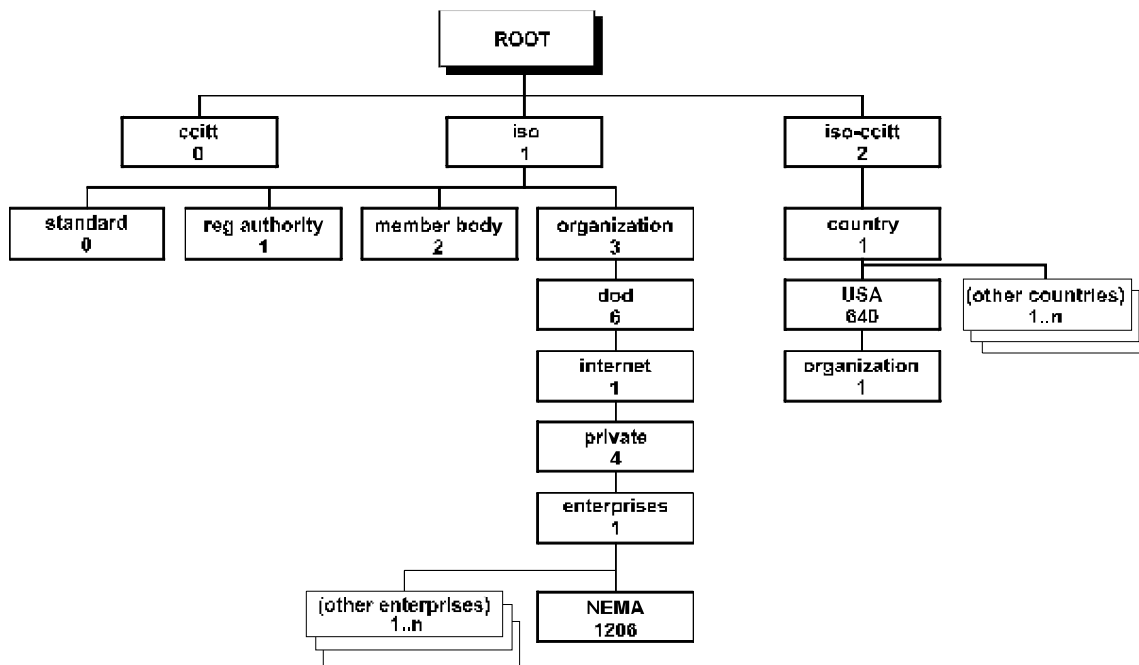


Figure 2 NEMA Authority Hierarchy

2.2.2 NEMA Node

To organize information under the NEMA node, the subtree is further organized as shown in Figure 3.

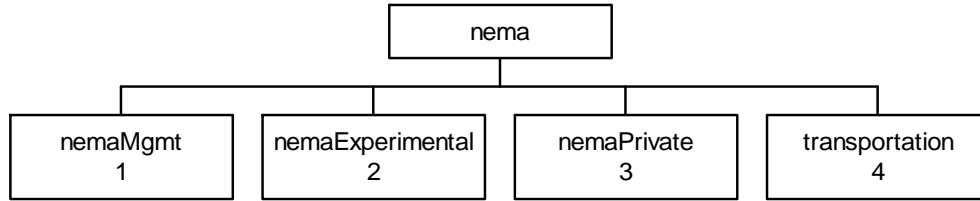


Figure 3 NEMA Node

This represents the organization under the nema node at the time NTCIP 8004 v02 was written. Current information can be found in NTCIP 7001.

2.2.2.1 NemaMgmt Node

The "nemaMgmt" node is used to register and identify objects that are defined in NTCIP standards that contain a MIB.

2.2.2.2 NemaExperimental Node

The "nemaExperimental" node is used to identify objects used only on an experimental basis. New MIBs, prior to being assigned a node number, can be put here. In the Internet community, multiple manufacturers use a MIB within the experimental area before it can move to a permanent location. As a part of the assignment process, NEMA may establish requirements as to how this subtree is used. For example, an initial MIB proposed for objects related to loop-detectors could be defined and placed here for experimental usage. It might receive subnode number 17 and any objects would be identified with an OBJECT IDENTIFIER prefix of {nemaExperimental 17} or 1.3.6.1.4.1.1206.2.17.

2.2.2.3 NemaPrivate Node

The "nemaPrivate" node is used to identify objects defined unilaterally. Administration of the nemaPrivate subnode is by NEMA. NEMA assigns nodes to enterprises for the purpose of defining enterprise-specific MIBs. A request for a node assignment can be sent to the NTCIP Coordinator at ntcip@nema.org.

Upon receiving a node the enterprise may, for example, define new MIB objects under this node. In addition, it is strongly recommended that the enterprise also register its transportation devices under this subtree, in order to provide an unambiguous identification mechanism for use in management protocols. For example, if the "ABC, Inc." enterprise produced transportation devices, then it could request a node under the nemaPrivate node from NEMA. Such a node might be numbered:

1.3.6.1.4.1.1206.3.99

The "ABC, Inc." enterprise might then register their "Widget Controller" under the name of 1.3.6.1.4.1.1206.3.99.1, ensuring a unique identification. Thereafter, each enterprise is responsible for ensuring unique identification of information objects within their subtree. NEMA delegates the role of assigning numbers under each nemaPrivate node to those to which they are assigned, except of course for the initial enterprises number.

2.2.2.4 Transportation Node

The "transportation" node is used to register subnodes for protocol-related parameters, different classes of transportation equipment, and a subnode for the transit community. See Figure 4.

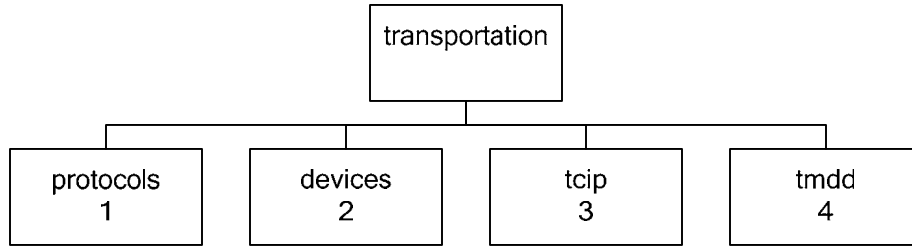


Figure 4 Transportation NODE

This represents the organization under the transportation node at the time NTCIP 8004 v02 was written. Current information can be found in NTCIP 7001.

2.2.2.4.1 Protocols Node

The “protocols” node shall be the beginning of a subtree that holds information related to specific protocols at various layers in a protocol stack, profiles that cover several layers, and one specific to Dynamic Object Management. The first four nodes in the subtree are assigned to:

- a) Layers
- b) Profiles
- c) Dynamic Object Management
- d) NTCIP Traps

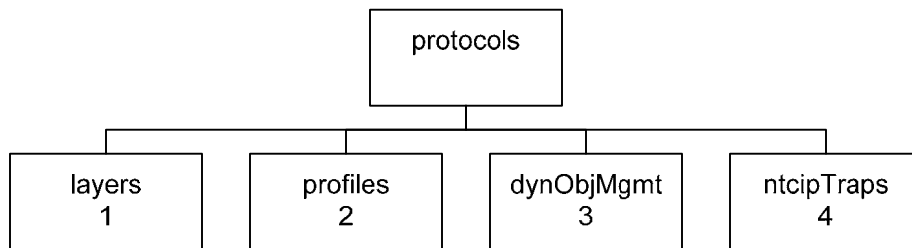


Figure 5 Protocols NODE

Figure 5 represents the organization under the protocols node at the time that NTCIP 8004 v02 was written. Current information can be found in NTCIP 7001.

2.2.2.4.2 Devices Node

The devices node shall be the beginning of a subtree that holds information about various standard transportation device objects. See Figure 6. The first few nodes in the subtree are assigned to:

- a) Actuated Signal Controllers
- b) Ramp Meter Controllers
- c) Dynamic Message Signs
- d) Transportation System Sensors
- e) Environmental Sensor Stations
- f) Global

All approved standardized objects defined under each of these subtrees are standard objects specific to each class of transportation device.

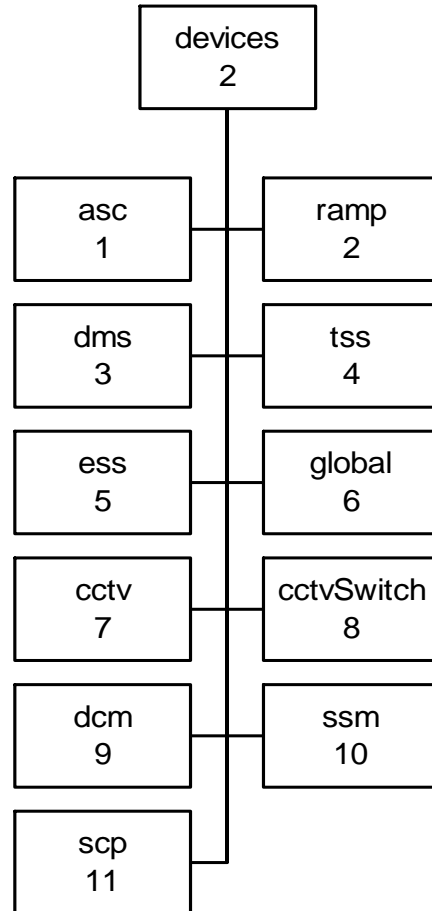


Figure 6 Devices NODE

This represents only part of the organization under the devices node. Current information can be found in NTCIP 7001.

2.2.2.4.3 TCIP Node

The "tcip" node has been assigned to the Transit Communications Interface Profiles Technical Working Group. Assignment of any nodes under this subtree is delegated to that group.

2.2.2.5 Other Nodes

NTCIP 7001 provides a listing of all node numbers that have been identified for use within the NTCIP suite of protocols. NTCIP 7001 is a living document and, as the need arises, new node numbers (and other types of identifiers) are added.

2.3 OBJECT SPECIFICATION

2.3.1 Base Object Specification

The base object specification shall be the OBJECT-TYPE Macro defined in IAB STD 16 (RFC 1212), but with the following restrictions and additions:

- a) The ACCESS field shall never be assigned a value of "write-only".
- b) The DESCRIPTION field shall be present.
- c) If specified, the DEFVAL field value shall be used as the default value.

The OBJECT-TYPE Macro requires that each object definition consist of the following fields:

- a) Object Name
- b) SYNTAX
- c) ACCESS
- d) STATUS
- e) DESCRIPTION
- f) INDEX
- g) REFERENCE
- h) DEFVAL
- i) Object Identifier

The INDEX field is only used in table entry constructs. The REFERENCE and DEFVAL fields are optional.

NOTE—Sections 2.3.1.1 through 2.3.1.9 are provided to put preceding and subsequent sections in context.

2.3.1.1 Base Object Name

This field shall consist of a textual name, termed the OBJECT DESCRIPTOR, for the object type being defined. An OBJECT DESCRIPTOR is an identifier consisting of one or more letters, digits, or hyphens. The initial character shall be a lower-case letter, and the final character shall not be a hyphen. Further, a hyphen shall not be immediately followed by another hyphen. The descriptor shall be unique and mnemonic, and shall not exceed 64 characters in length. The use of hyphen only applies to module names. Within the MIB, the hyphen is not allowed as a character in any descriptor.

This OBJECT DESCRIPTOR is equated with the value of the specified OBJECT IDENTIFIER field.

2.3.1.2 Base Object SYNTAX

IAB STD 16 (RFC 1155, Section 6) states that an object's SYNTAX fields shall resolve to an instance of one of the following primitive ASN.1 types:

- a) SEQUENCE
- b) INTEGER
- c) OCTET STRING
- d) OBJECT IDENTIFIER
- e) NULL
- f) Counter
- g) Gauge
- h) TimeTicks
- i) Opaque
- j) IpAddress

The term "resolve" is used because specification writers may use a textual convention or alias to create terminology that is more meaningful. This list of syntax types does not include all primitive ASN.1 types defined in ISO/IEC 8824.

Any object with a SYNTAX of "OBJECT IDENTIFIER" can be defined such that object represents an invalid/neutral state by setting its value to "null".

Unless specific normative text to the contrary is stated, any object that resolves to a SYNTAX of OCTET STRING (OPAQUE, for example) shall not be padded. For example, the string "test" shall be encoded as '0x74 65 73 74' and not 0x00 74 65 73 74 or 0x74 65 73 74 00.

2.3.1.3 Macro ACCESS

As defined in IAB STD 16, the ACCESS field is to be assigned one of the following values:

- a) read-write
- b) read-only
- c) not-accessible
- d) write-only

The values of read-write and read-only are straight forward. The value of not-accessible is used to define structural definitions primarily related to tables. The write-only access does not have a practical application.

For use within NTCIP, write-only access shall not be used.

2.3.1.4 Macro STATUS

As defined in IAB STD 16 (SMlv1) or IAB STD 58 (SMlv2), the STATUS field can take on one of the following values:

- a) Mandatory—In SMlv1, this value indicates the definition is valid and implementation is required for conformance. In SMlv2, this value is not in use.
- b) Optional—In SMlv1, this value indicates the definition is valid; however, implementation is not required for conformance. In SMlv2, this value is not in use.
- c) Deprecated—The value is valid in specified implementations, for example to maintain backward compatibility, but the object may have been replaced.

NOTE—To maintain backward compatibility for legacy implementations, objects with a STATUS value of “deprecated” may require support. When necessary to support legacy implementations, required support for objects with a STATUS value of “deprecated” is indicated using the Protocol Requirements List (PRL).

- d) Obsolete—The definition is no longer valid, was found to be flawed, was redundant or not useful.

A status of mandatory is used to mean that if a group of objects expresses the functionality implemented in an entity, then the specific mandatory objects within that group are to be implemented. A status of optional is used to mean that this data element object may be optionally implemented.

The decision whether an object is required should be defined in a conformance statement, PICS, or PRL. Developers or specifiers of such statements should call for implementation if the functionality modeled by the definition is present or desired in the system.

2.3.1.5 Macro DESCRIPTION

The DESCRIPTION field is an ASCII-NVT string, which defines the semantics of the data element object type. The object description shall provide an unambiguous definition of what the object does. The description field shall be present in all OBJECT-TYPE definitions, and shall contain a meaningful definition of the purpose of the object.

ASCII-NVT is a 7-bit code representing ASCII characters 0 through 127. In ASCII-NVT, the following control characters have significance and support is required:

- a) NULL (NUL)
- b) Line Feed (LF)
- c) Carriage Return (CR)

Other control characters are defined but, as stated in RFC 854 (IAB STD 8), support is not required. This includes the Tab (TAB) character. Its use is discouraged because specific character spacing cannot be

guaranteed. Except for the CR and LF control characters, the ASCII characters 0 through 31 and 127 are interpreted as NUL.

According to IAB STD 16, the DESCRIPTION field need not be present. For NTCIP, the DESCRIPTION field shall always be present and used. Other information that shall be included in this field is defined in Section 2.4.

2.3.1.6 Macro INDEX

The INDEX field, which may be present only if that object type corresponds to a TableEntry, defines instance identification information for that object type.

2.3.1.7 Macro REFERENCE

The REFERENCE field is a textual cross-reference to a standard or document and specific section that provides information about specific range or values that quantify the object of interest.

2.3.1.8 Macro DEFVAL

As defined in IAB STD 16, the DEFVAL field is optional and is used to define an acceptable default value, which may be used when an object instance is created.

For NTCIP, if the DEFVAL field is specified, the value specified shall be used as the default value.

2.3.1.9 Macro Object Identifier

The Object Identifier shall consist of the subtree identifier's descriptive name of the node and the position of the object under that name.

2.3.2 Simple Object Specification

A simple object is an object type representation of a type of data element. The term simple object is used to differentiate it from those defined with the standard OBJECT-TYPE Macro, those defined with the block object specification, and those defined with the dynamic object specification.

The simple object specification shall be the base object specification as defined in Section 2.3.1, but with the following additions or modifications:

- a) The DESCRIPTION field shall include the Data Dictionary meta attributes for:
 - 1) <Definition> - delimiting original OBJECT-TYPE Macro DESCRIPTION Field
 - 2) <Object Identifier> - full identifier from the root node
- b) As appropriate, the DESCRIPTION field may include the Data Dictionary meta attribute for:
 - 1) <TableType>
 - 2) <Unit>
 - 3) <Format> (Bit Map)
- c) The REFERENCE field shall provide a textual cross-reference to a standard or other document defining the Reference Value Domain

2.3.2.1 Simple Object DESCRIPTION

In addition to the base object specification requirements for the DESCRIPTION field, the meta attributes subfields <Definition> and <Object Identifier> shall be used and defined.

- a) The original DESCRIPTION is delimited by "<Definition>".
- b) The <Object Identifier> subfield shall be included and is the full Object Identifier from the root node.
- c) The document editor of an NTCIP standard shall derive the Object Identifier by compiling the MIB. All object definitions defined in that NTCIP standard shall be contained in the MIB that is compiled, and use the resulting output file. The MIB compilation output file contains both the object name and the full Object Identifier. The Object Identifier for each object shall be copied from that output file and be

pasted into the Description field of the corresponding object definition. The Object Identifier subfield shall not include an instance identifier.

- d) The optional <TableType> subfield shall be included if the base object specification defines a table construct.
- e) The optional <Unit> subfield shall be included if the SYNTAX defines an object specification where a unit of measure is warranted to clearly define the syntax.
- f) The optional Bit Map <Format> subfield shall be included if the base object specification defines a bitmapped object wherein each bit of the object has a specific meaning.

2.3.2.2 Simple Object REFERENCE

The REFERENCE field shall be a textual cross-reference to a standard or document and specific section that provides information about specific range or values that quantify the object of interest.

For example, NEMA TS 2-1998 Section 3.5.3.1 defines the values for the Yellow Change as 3.0 to 25.5 seconds.

2.3.3 Block Object Specification

A block object shall be defined as an object type representation of a data-frame. It is a merging of IAB STD 16 and meta-attributes defined by NTCIP 8004 v02. The term block object refers to an object that has a syntax of OER Encoded String. Unlike the opaque syntax defined in IAB STD 16, the syntax shall be an "external" textual description of the objects to be encapsulated in the block. The external portion shall take the form of a non-compileable SEQUENCE or SEQUENCE OF construct.

The block object specification shall be the base object specification as defined in Section 2.3.1 but with these additions or modifications:

- a) The Object Name shall end with the term "Block".
- b) The SYNTAX shall be equated to an "OerString".
- c) The ACCESS shall be either read-only or read-write
- d) The DESCRIPTION field shall include the Data Dictionary meta attributes for:
 - 1) <Definition> - delimiting original OBJECT-TYPE Macro DESCRIPTION Field
 - 2) <Object Identifier> - from the root node
- e) An External Construct that shall list the Object Descriptors of the objects to be encoded in the OerString.

2.3.3.1 Block Object Name

The block name shall follow the same form as defined in Section 2.3.1.1 but shall end with the suffix "Block".

2.3.3.2 Block Object Syntax

The block SYNTAX shall be a textual convention that resolves to an "OerString" type. The "OerString" type is defined in Transportation Management Information Base (TMIB-III) as an unconstrained OCTET STRING. The actual size of the string shall be defined by the OER encoded value of the external construct.

The "OerString" type shall be imported into any module that uses it.

2.3.3.3 Block Access

The ACCESS value of block objects shall be restricted to one of the following:

- a) read-only
- b) read-write

Any block object containing a read-only object in the external construct shall have an ACCESS of read-only. For a set operation on a block object to succeed, all the objects with the block object shall have an access of read-write.

2.3.3.4 Block Description

The Block Description shall follow the same form as defined in Section 2.3.1.5. Block objects may encapsulate columnar objects and, therefore, all index values used in the identification of an object shall be clearly defined.

2.3.3.5 Block External Construct

An NTCIP message may need to include objects that are specific instances of objects and objects that are defined in multiple MIBs. Since this is outside the scope of a MIB, an external structure shall be used to define the objects contained in a message. This permits a variation that allows a clear and unambiguous reference to the objects defined in the MIB structure. Any Type or TypeReference field may be replaced with an NTCIPObjectReference defined as:

NTCIPObjectReference ::= NTCIPObjectName "." IndexSuffixes ExternalReference

The NTCIPObjectName is a name of an accessible object within a MIB.

The IndexSuffixes shall be as follows:

IndexSuffixes ::= IndexSuffix | IndexSuffixes "." IndexSuffix
IndexSuffix ::= DefinedValue

Thus, the IndexSuffixes field is a list of the associated indexes as required to explicitly identify the exact instance of a given object-type. Each index may be identified as either a specific value or a variable; if a variable is used, the variable shall be defined within the same module.

A leaf object shall always include a ".0" as a suffix.

The ExternalReference is included when any object in the block object is not defined in the current module. The ExternalReference is an ASN.1 comment indicating what module defines that object. The ExternalReference takes the form:

ExternalReference ::= "-- @ " <module descriptor>

where <module descriptor> is the name of the external MIB Module where the subordinate object is defined. All block object definitions shall be mapped in a valid ASN.1 module structure per the rules above. Annex B provides several examples.

2.3.4 Dynamic Object Specification

A dynamic object shall be defined as an object type representation of a data-frame. A dynamic object is an implied, simple sequence of specific NTCIP objects, similar to a block object, but the component objects within a dynamic object are defined at run-time by the management station rather than being defined in a static definition.

The objects used in a DynObjectEntry shall be defined using the base object specification defined in Section 2.3.1, but with the following additions or modifications:

The DESCRIPTION field shall include the Data Dictionary meta attributes for:

- a) <Definition>—delimiting original OBJECT-TYPE Macro DESCRIPTION Field
- b) <Object Identifier>—from the root node

2.4 META ATTRIBUTES

To support additional understanding of objects, various meta-attribute subfields are added to the DESCRIPTION Field of various object specifications. These include:

- a) Definition
- b) Object Identifier
- c) Table Type
- d) Unit of Measure
- e) Format (Bit Map)

In addition to the description of the MIB that is defined in a standard, a compileable, text-only version of the MIB is also produced. The procedures for creating this file are defined in NTCIP 8005 v01. NTCIP 8005 v01 defines a set of "meta-attributes" that appear in that version of the MIB. These meta-attributes are the file header that is expressed in the form of comments. Technically, the header consists of the following "NTCIP Defined" meta-attributes that are added to each MIB Module:

- a) Filename
- b) Source
- c) Description
- d) MIB Revision History
- e) Copyright Statement
- f) MIB Distribution Notice

NOTE—Some of the DESCRIPTION subfields and elements of the Object Type Macro are also used to fill out meta attributes. For example, an entry for an ASN.1 Name is automatically derived from OBJECT DESCRIPTOR (see Section 2.3.1.1) as part of the process in entering the information in a data registry. NTCIP 8005 v01 contains further information and how some other meta attributes are derived.

2.4.1 Definition

To delineate the original intended content of the DESCRIPTION field of the OBJECT-TYPE Macro as defined in IAB STD 16 (RFC 1212), the text of that field shall be preceded by the delimiter <Definition> in order to separate it from other subfields that may now appear in the DESCRIPTION field.

2.4.2 Table Type

The DESCRIPTION field of an object specification that defines a table shall include a Table Type subfield. It is delimited by <TableType> and the value shall be either "static" or "dynamic". The term static shall apply to tables where all entries exist irrespective of whether they have been initialized or not. The term dynamic shall apply to tables where an entry does not exist until it is created by a management application.

2.4.3 Unit of Measure

The value of the Unit of Measure subfield is delimited by <Unit>. The units typically refer to a measure of time, distance, weight, or volume. General use values shall be defined in accordance with ISO 1000, which recommends selected decimal multiples and submultiples of units, such as seconds, deciseconds, and milliseconds. If ISO 1000 does not provide for a definition of <Unit>, then the <Unit> field can be left blank; however, the statement "<Unit>" shall be shown.

2.4.4 Bit Map Format

The content of the Bit Map Format subfield is delimited by <Format> and shall be defined according to the following:

- a) If a Bit Map format is contained in a SYNTAX of 'INTEGER', then the following format shall be used when defining the DESCRIPTION field within an object:

Bit Number	Name	Description
Bit <x>:	<bitName>	= <description>
	...	
Bit 1:	<bitName>	= <description>
Bit 0:	<bitName>	= <description> (Least Significant BIT of the Least Significant Byte)

- b) If a SYNTAX of 'BITMAPx' (i.e., BITMAP8, BITMAP16, BITMAP32, BITMAP64) is used for an object definition, then each bit should be explicitly defined as defined for a SYNTAX of 'INTEGER' preceding.

- c) If a Bit Map format is contained in a SYNTAX of 'OCTET STRING', then the definition within the DESCRIPTION field of an object shall explicitly state what each bit means and particularly where the first bit is and how to proceed within a matrix (first to right/left or first up/down).

Figure 7 shows the position of Most Significant Bit (MSB) versus Least Significant Bit (LSB) within each byte and the position of Leading Octet versus Trailing Octet. Figure 7 also shows which bits within an octet need to be padded, if fewer bits than the bits within a full octet are used.

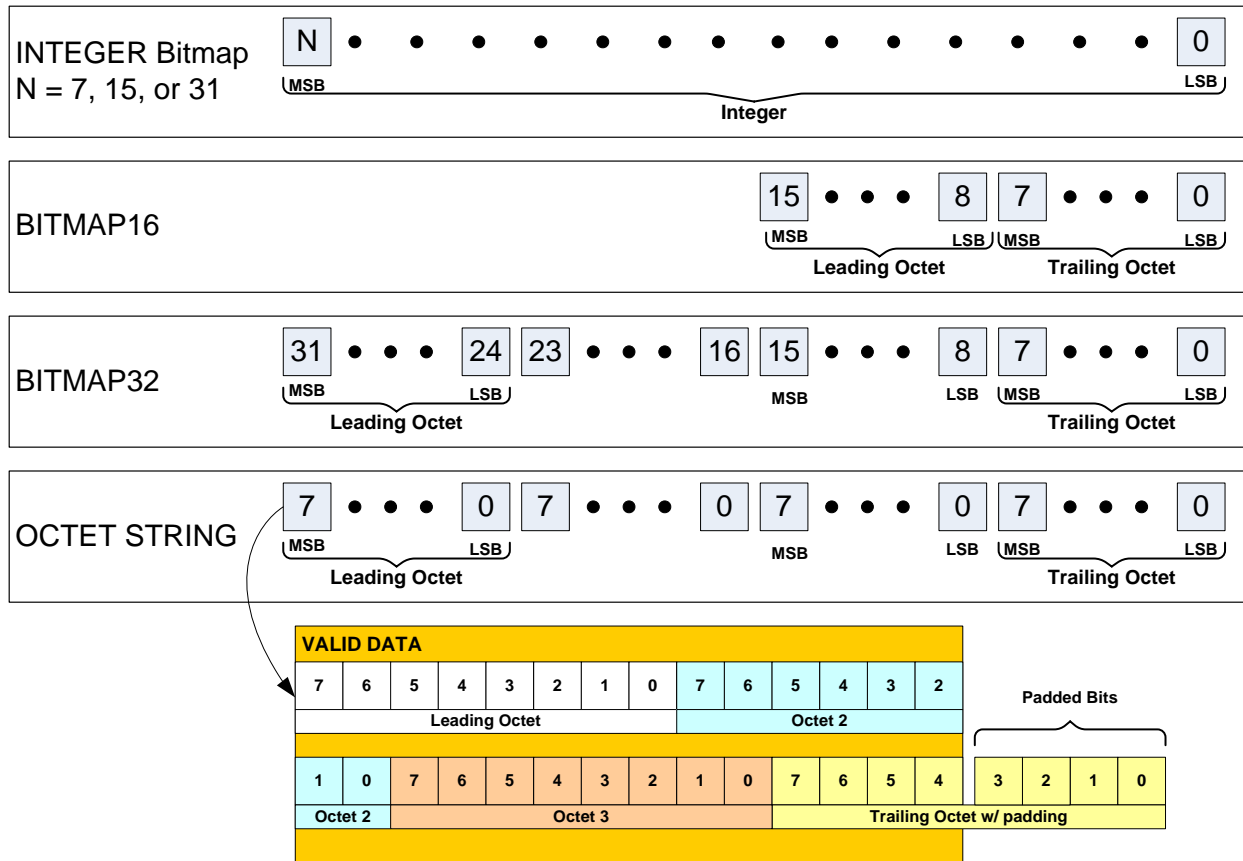


Figure 7 Most Significant Bit (MSB) versus Least Significant Bit (LSB)

2.4.5 MIB Module Meta-Attributes

The definition of the "NTCIP Defined" MIB Module meta-attributes can be found in NTCIP 8005 v01. These meta-attributes are the same for all of the objects in a NTCIP 1200 Series Document MIB and,

therefore, are defined on a MIB Module basis. Furthermore, they may not necessarily be defined by the NTCIP Working Group but by the NTCIP Data Steward when the MIB Module is created or when the MIB Module is checked for proper syntax and construction. The exact definition of each MIB Module meta attribute can be found in the NTCIP standard and are only referenced here to show completeness.

2.4.6 Description Field Meta Attribute Encapsulation

Meta attribute subfields are added to the DESCRIPTION of various object definitions using the following format. In IAB 16 (RFC 1212), the description field is defined as:

```
DescrPart ::= "DESCRIPTION" value (description DisplayString) | empty
```

This is modified to include one or more of the meta-attributes as shown below:

```
DescrPart ::= "DESCRIPTION" "<Definition>"          value (description DisplayString)
                "<Object Identifier>"              full Object Identifier value from the root node
                "<Unit >"                          value (unit of measure DisplayString)
```

The meta attribute subfields shall appear after the last character of the "description" but before the closing quote. They shall start on a new line and appear on their own separate lines. The closing quote of the DESCRIPTION shall appear immediately after the last encapsulated meta-attribute. See Annex A for examples.

2.5 MANAGEMENT INFORMATION BASE (MIB)

A Management Information Base (MIB) is a structured collection of objects. The objects represent the individual variables, parameters, and status, and other types of information that may be exchanged between two devices. Objects that are related to each other are defined in a MIB Module. All the groups (or MIB Modules) that represent the total information that may be exchanged between two systems are referred to as a MIB.

2.5.1 Logic Behind the Documentation Format

By defining information according to the rules defined in IAB STD 16 and those defined in ISO/IEC 8824, there is an unambiguous and coordinated method for sharing that information. Independent groups can be simultaneously developing object sets (data dictionaries) for different functional areas of a device. The rules and procedures also permit an organization or vendor to extend the basic set of standard information to cover implementation or application-specific requirements.

Entire MIBs or individual Object Definitions can be combined and used for development of an integrated approach to the management of information. NTCIP Object Definitions, Internet MIBs, and Vendor-specific MIBs can be imported into a program that treats them as a single entity. This concept is illustrated in Figure 8 These modules also serve as the foundation for defining file structures. A program can interpret the data in a file by parsing it according to the description in the MIBs.

The result of creating and identifying managed objects using ASN.1 is a computer readable description of the information. These modules are ASCII-NVT text, not binary. Management applications running on central control hosts can read these modules in order to gain information about the capabilities of remote devices. Many SNMP management applications can dynamically load and unload modules (MIBs) describing the information within remote networking devices.

Manufacturers supplying transportation equipment should make available manufacturer specific MIB modules for the equipment. All manufacturers need to obtain a vendor number from either NEMA (see Section 2.2.2.3) or IANA prior to creating MIB modules that have manufacturer specific data.

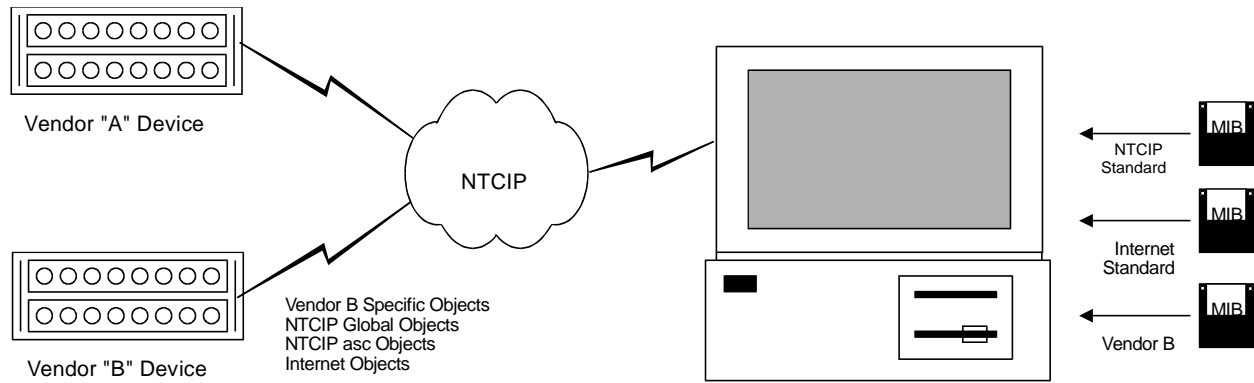


Figure 8 MIB Integration

2.5.2 Extensions to the MIB

Every NTCIP Standard MIB Revision supersedes all previous revisions. New versions shall:

- a) Identify object STATUS as “deprecated,” when appropriate, but shall not delete the object names;
- b) Identify object STATUS as “obsolete” for those objects with a prior STATUS value of “deprecated” (if necessary), but shall not delete their names;
- c) augment the definition of an object type corresponding to a list by appending non-aggregate object types to the object types in the list, as appropriate;
- d) define entirely new objects, as appropriate.

New versions shall not change the semantics of any previously defined object without re-defining that object, i.e., changing the name of the object and assigning a new OBJECT IDENTIFIER.

A new object definition that deprecates a previously defined object should note that fact in the new object’s DESCRIPTION Field.

2.6 MULTI-VERSION INTEROPERABILITY (MVI-BACKWARD COMPATIBILITY)

With the development and publication of newer versions of various NTCIP standards, the need to address and ensure multi-version interoperability (MVI, often referred to as “backward compatibility” with a previous version, or interoperability to a defined extent with future versions) arises. Provisions in Section 2.6 are designed to permit multi-version interoperability.

2.6.1 Rules For Existing Objects

The STATUS of an object may be changed to “deprecated,” “obsolete,” or “mandatory.” Often, a new object is created to replace one with a STATUS value of “deprecated.” Examples of reasons to change the STATUS value of an object to “deprecated” include:

- 1) The associated functionality is no longer relevant. For example, the object may be redundant, or might not have been implemented; or
 - 2) The current design of the object is flawed or ambiguous in design, and cannot be corrected within the existing object given constraints on making changes to existing objects.
- a) Any new NTCIP object shall be assigned a textual name and OID that is unique among all NTCIP standards, even if it is replacing the capabilities of a deprecated object.
 - b) Deprecation of a particular instance (value) of an enumerated object is allowed. For example:
`INTEGER { oldValue(0) -- deprecated, the value zero created problems`

- c) The DESCRIPTION of an object shall not be changed or added to except to make a minor editorial correction. It is acceptable to add an informative statement within the DESCRIPTION, by inserting the key word <Informative> prior to such statement. For example, an informative addition to the DESCRIPTION of a deprecated object might reference the replacement object, potential issues related thereto, and the reason for deprecation.
- d) The standard shall make appropriate provisions in the PICS or PRL that may be used to require support of objects with a STATUS value of "deprecated" when needed to permit MVI.
- e) Adding new enumerations is permissible.
- f) Adding new columns to a table is permissible.
- g) An object textual name can be changed to adhere to rule b) in Section 2.6.1 and rule a in Section 2.6.2.
- h) The meta attributes within the DESCRIPTION field of an object can be changed according to Section 2.4, except if the change creates an interoperability problem for center-to-field interfaces.
- i) Extending the range of an Integer object is permissible.

2.6.2 Rules Allowed for New and Existing Objects

- a) Strictly follow "Table" and "Entry" naming conventions.
- b) Do not allow unused IMPORTS and textual conventions.
- c) Do not allow DEFVAL on counters. An initial value can be specified in the DESCRIPTION if needed, or in an informative addition to the DESCRIPTION for an existing object.
- d) Do not allow bad modeling practices in table design, which prohibits the following:
 - 1) Specifying the same item more than once in the same index.
 - 2) Specifying an object that is not under the entry object in the OID tree.
 - 3) Using the indices from another table in a different order than specified in the other table.
 - 4) Using only a subset of the indices from another table.
 - 5) Specifying additional index items before all the index items from another table.
 - 6) Specifying the index items from more than one table.
- e) Strictly follow Access rules, which prohibit:
 - 1) Using write-only.
 - 2) Using not-accessible except in table entries and table indexes.
- f) Require all OCTET STRINGS to have a size, and all INTEGERS to have a range. This requires standards developers to consider the impacts of unconstrained data types. The data type Counter has an implicit range of 0..4294967295 per RFC 1155. If a smaller counter is desired, use an integer range and describe the desired behavior. Also, the data type INTEGER has a default range of 1..2147483647.

2.6.3 Rules Application and Exceptions

Rules in Section 2.6.1 apply to existing objects only. Rules in Section 2.6.2 apply to both new and existing objects. The intent is that existing objects be modified one time only to bring them in compliance with Section 2.6.2. Any change made to an existing object per rules in Section 2.6.2 shall satisfy rules in 2.6.1. In some cases an existing object may need to be deprecated in favor of a new object to achieve this.

Any exceptions to rules in Section 2.6.1 and Section 2.6.2, or their application per Section 2.6.3, shall explained to and approved by the Joint Committee on the NTCIP.

Section 3 NTCIP PROCEDURES

3.1 NTCIP ELEMENTS OF PROCEDURES

The IAB STD 16 does not elaborate on a number of functions related to different types of table constructs. The definition of traps was not introduced until sometime later and does not deal with the definition of enterprise-specific traps. Section 3 defines additional requirements that shall be followed when defining tables.

3.2 TABLES, ROWS, AND BLOCK OBJECTS

SNMP tables are special types of SNMP objects, which allow sequences of information to be supported. Tables are distinguished from scalar objects in that tables relate all items in a row to an index for that row. The developers of IAB STD 16 wanted a method to construct imaginary, tabular structures as part of the collection of objects that constitute the MIB. Each such conceptual table contains zero or more rows, and each row may contain one or more objects, termed columnar objects. This conceptualization is implemented by using the OBJECT-TYPE Macro to define both an object that corresponds to a table and an object that corresponds to a row in that table. However, at the protocol level, relationships among columnar objects in the same row are a matter of convention, not of protocol. The convention used within SNMP is that a table or row of a table is not-accessible and operations only apply to scalar objects and cells within a table.

The SNMP limitation of operating only on individual object instances can impose a severe penalty in cases where communications bandwidth has to be considered. In order to address this issue, NTCIP has added the concept of block objects. From the standpoint of SNMP or any similar protocol, a block object is treated as a single object.

When the number of rows in a table is defined, the minimum value of a maxObjects definition shall not be specified as 0. For example, NTCIP 1201:2005 defines the following:

```
globalMaxModules OBJECT-TYPE
  SYNTAX      INTEGER (1..255)
  ACCESS      read-only
  STATUS      mandatory
  DESCRIPTION
    "<Definition>The number of rows that are listed in the globalModuleTable.
    <Object Identifier> 1.3.6.1.4.1.1206.4.2.6.1.2
    <Unit>module"
 ::= { globalConfiguration 2}
```

The use of SYNTAX INTEGER (0..255) would be incorrect. Support of the table is indicated by a conformance statement and not by specifying that the number of rows is 0. When a table is not supported, accessing any associated maxObjects shall return a "noSuchName" Error.

3.3 TABLE OPERATIONS

Unless specifically prohibited by normative text added, extensions to the standard tables are permitted.

The values associated with the columnar objects in a table can lead to ambiguities unless specific steps are taken. This is especially true for dynamic tables. The row status definitions in Section 3.3.1 should be used to indicate that the objects in the row when taken as a whole, satisfy any relationships (consistency checks) and/or can be used by the end application.

3.3.1 Row Status in Static Tables

In a static table, all rows exist irrespective of whether the columnar objects contain appropriate values. The value of a columnar object within a row may be inappropriate when the values of other columnar objects in the row are considered. An entire row itself may also be considered inappropriate under some circumstances. If this is the case, a static table shall include an additional columnar object that defines row status and has the SYNTAX of RowStatusStatic.

```
Where RowStatusStatic ::= INTEGER
    { other (1),
      standby (2),
      available (3),
      invalid (4),
      activate (5),
      deactivate (6) }
```

RowStatusStatic has four states and two commands associated with it. The four possible states are defined as:

- a) Other—Status is actually controlled or defined by a user or manufacturer specific object.
- b) Standby—All the columnar data in the row have passed any consistency but are not to be used by the end-application.
- c) Available—All the columnar data in the row have passed any consistency and are to be used by the end-application
- d) Invalid—One or more columnar objects has a value that caused the row to fail the consistency check.

Setting RowStatusStatic equal to one of these values shall return a badValue Error.

The only two possible command values that may be set by a management application are:

- a) Activate—Make the columnar data in the row available for use by the end-application.
- b) Deactivate—Make the columnar data in the row unavailable for use by the end-application.

The UML state transition diagrams for RowStatusStatic are defined as indicated in Figure 9, Figure 10, or Figure 11.

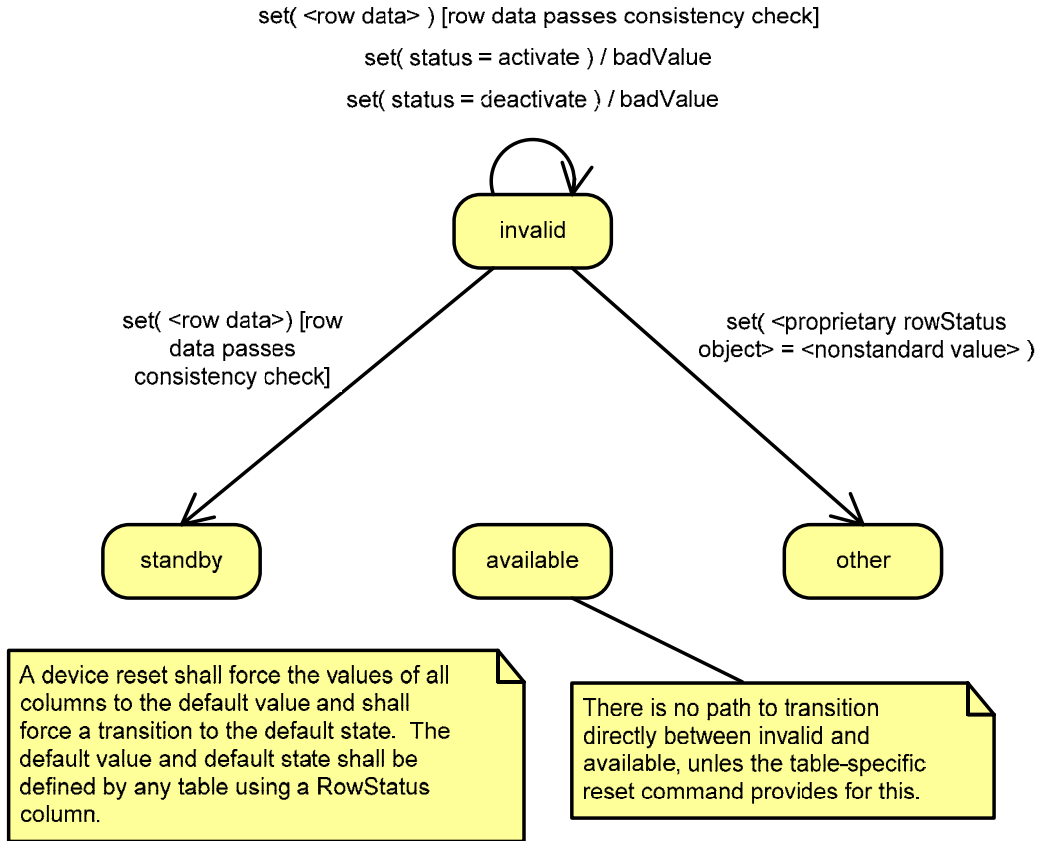


Figure 9 Row Status Static—Invalid

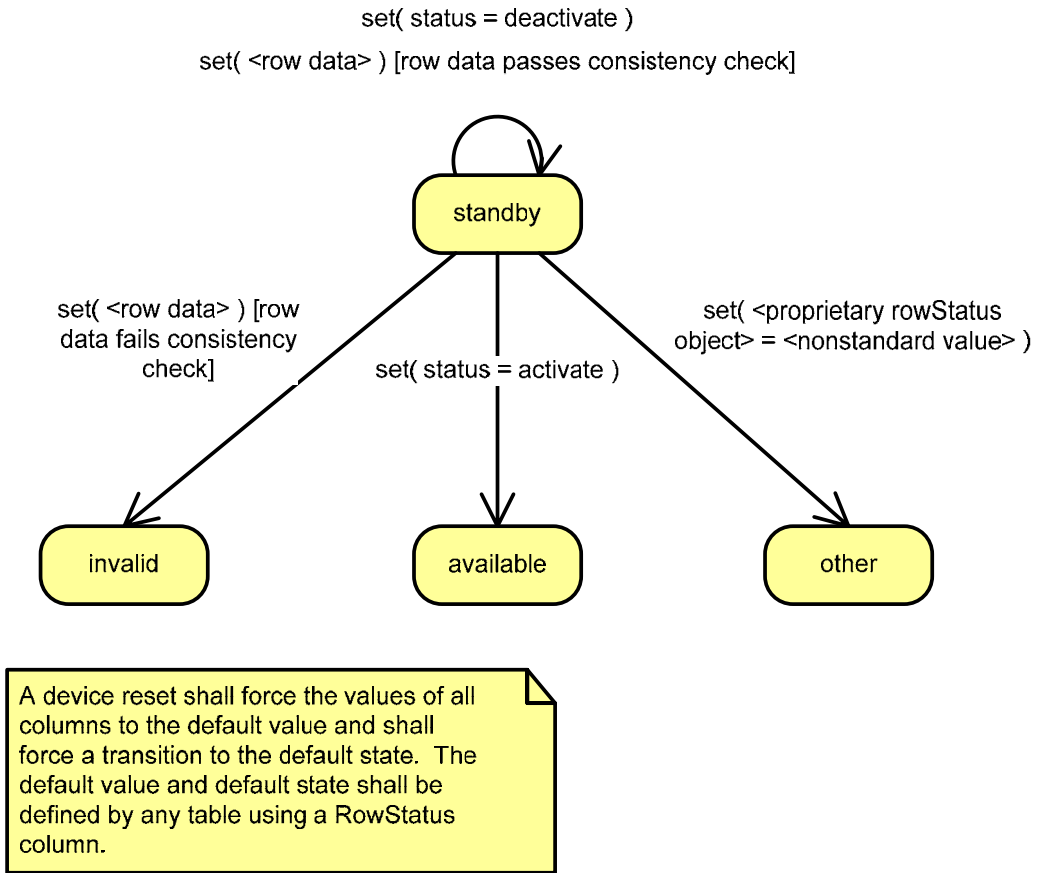


Figure 10 Row Status Static—Standby

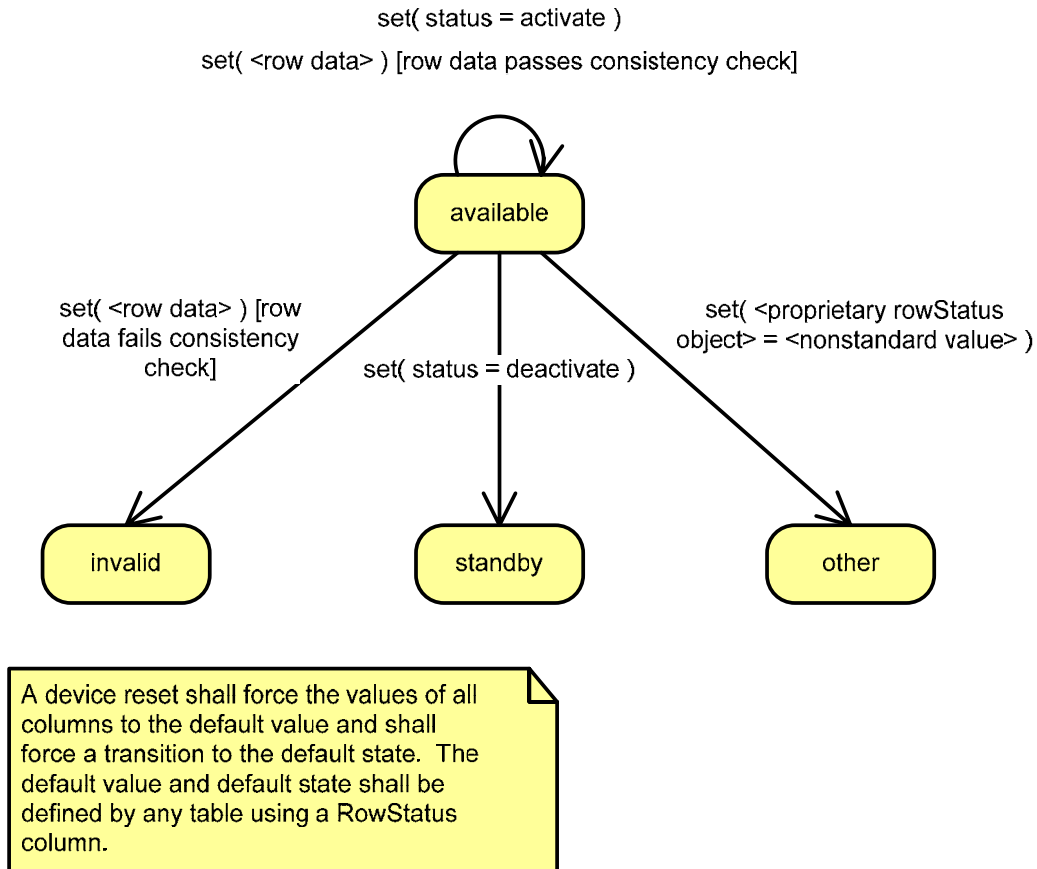


Figure 11 Row Status Static—Available

3.4 ENUMERATIONS DEFINED AS OTHER

All values of NTCIP objects that are not defined by the standards are reserved for committee use. A management application may not set an enumerated type to a value declared as “other”. An attempt to write a value of “other” shall return a badValue error to a management application.

Unless normative text is added to specifically prohibit the use of the “other” state, a user or manufacturer specific object shall be permitted to define an object specification that extends the possible states. For example, NTCIP 1202:2005 includes the following object:

```

coordCorrectionMode    OBJECT-TYPE
  SYNTAX    INTEGER { other (1),
                    dwell (2),
                    shortway (3),
                    addOnly (4) }

  ACCESS    read-write
  STATUS    mandatory
  DESCRIPTION
    "<Definition> This object defines the Coord Correction
    Mode. The possible modes are:
    other: the coordinator establishes a new offset by
    a mechanism not defined in this standard.
  
```

dwell: when changing offset, the coordinator shall establish a new offset by dwelling in the coord phase(s) until the desired offset is reached.

shortway (Smooth): when changing offset, the coordinator shall establish a new offset by adding or subtracting to/from the timings in a manner that limits the cycle change. This operation is performed in a device specific manner.

addOnly: when changing offset, the coordinator shall establish a new offset by adding to the timings in a manner that limits the cycle change. This operation is performed in a device specific manner.

...

To define a new correction mode, something like the following proprietary object could be used:

```
coordCorrectionModeExt  OBJECT-TYPE
    SYNTAX  INTEGER { other (1),
                    subOnly (2),
    ACCESS  read-write
    STATUS  mandatory
    DESCRIPTION
        "<Definition> This object defines an extension to the Coord Correction
        Mode as defined in NTCIP 1202. The possible modes are:
        other: the coordinator establishes a new offset by
        according to NTCIP-1202::coordCorrectionMode. Upon setting of
this
        object to other, NTCIP-1202::coordCorrectionMode is automatically
        set to shortway.
        subOnly: when changing offset, the coordinator shall
        establish a new offset by subtracting from the timings in such a
        manner that limits the cycle change. This operation is performed
        in a device specific manner
        ...
```

In this case, setting coordCorrectionModeExt equal to "subOnly" forces coordCorrectionMode equal to "other". Setting coordCorrectionModeExt equal to "other" forces coordCorrectionMode equal to "shortway".

3.5 RESERVED BITS

Any object that has reserved bits shall return a bad value if a management application writes a one to them.

3.6 MULTIPLE MANAGEMENT ACCESS

NTCIP 8004 v02 does not preclude the potential for two or more management applications from simultaneously accessing the same object. The objects in the Global Database Management and Security groups do not prevent multiple management applications from accessing the data simultaneously. It is the responsibility of any agencies involved in inter-jurisdictional control to define procedures to ensure against this situation.

3.7 BITMAPPED OBJECTS

Objects that define an entity that gives specific meaning to the individual bits of the entity should use one of the BITMAP textual conventions (BITMAP8, BITMAP16, or BITMAP32) as its SYNTAX and include the Bit Map <Format> subfield in the DESCRIPTION field.

Annex A NTCIP STRUCTURE OF MANAGEMENT INFORMATION MIB (MIB) [Normative]

Annex A defines the overall structure of the NTCIP-defined management information and several textual conventions that are believed to be useful for a broad range of applications. The text provided from A.1 through Annex A.3 (except the headings) constitutes the standard NTCIP 8004 v02 MIB.

Text preceded by a double hyphen in the MIB definitions represents normative text for NTCIP 8004 v02.

A.1 SMI HEADER

```
--
*****
-- Filename:      8004v0215MIB
-- Source:        NTCIP 8004 v02.15
-- Description:   This MIB defines the overall structure of the
--               NTCIP-defined management information and several textual
--               conventions that are believed to be useful for a broad range
--               of applications
-- MIB Revision History:
-- 10/01/96      NEMA TS 3.2 approved
-- 01/01/98      Preliminary Release of TS 3.2 NEMA_SMI MIB formatted for
--               80 columns and no tabs
-- 07/08/98      Added Copyright Notice
-- 10/08/98      Amendment 1 approved
-- 03/09/00      Changed filename and updated copyright years
--               Updated the MIB to Amendment
-- 08/09/00      Modified header format and wording of copyright and MIB
--               Distribution Notice
-- 11/16/01      Incorporated into NTCIP 1103, defined tree down to and
--               including device nodes, and changed filename
-- 9/19/02       Incorporated into NTCIP 8004 and changed filename and module
--               name
-- 09/27/04      Updated header information and END remark
-- 01/26/05      Added chap and modem to list of Object Identifier nodes.
-- 02/12/05      Removed embedded comment indicator between EXPORTS and
--               EVERYTHING
-- 11/29/07      Added tmdd and ntcipTraps nodes
--
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--enterprise number;
--(ii) use of the MIB is restricted in that the syntax field may be modified
--only to reflect a more restrictive sub-range or enumerated values;
--(iii) the description field may be modified but only to the extent that:
--(a) only those bit values or enumerated values that are supported are
--listed; and (b) the more restrictive subrange is expressed.
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--*****
```

NTCIP8004v02 DEFINITIONS ::= BEGIN

-- Initial definitions for Structure of Management Information.
-- This contains only structure information, no managed objects are defined

IMPORTS

 DisplayString
 FROM RFC1213-MIB
 enterprises
 FROM RFC1155-SMI;

-- EXPORTS EVERYTHING

A.2 STRUCTURE INFORMATION

nema OBJECT IDENTIFIER ::= { enterprises 1206 }
-- NEMA has received ID 1206 from IANA
-- NEMA starts at { iso org dod internet private enterprises 1206 } in the
-- global naming tree.

nemaMgmt OBJECT IDENTIFIER ::= { nema 1 }
-- The mgmt subtree is used for standard NEMA object definitions that span
-- different NEMA sections.

nemaExperimental OBJECT IDENTIFIER ::= { nema 2 }
-- The experimental subtree is used for technical committees developing
-- objects that may become standard in the future.

nemaPrivate OBJECT IDENTIFIER ::= { nema 3 }
-- The private subtree is used for unilaterally defined objects. One common
-- use is for manufacturer specific or customer specific MIB definitions.

transportation OBJECT IDENTIFIER ::= { nema 4 }
-- The transportation subtree is used by the NTCIP to define
-- standard objects specific for the transportation industry.

Protocols	OBJECT IDENTIFIER ::= { transportation 1 }
devices	OBJECT IDENTIFIER ::= { transportation 2 }
tcip	OBJECT IDENTIFIER ::= { transportation 3 }
tmdd	OBJECT IDENTIFIER ::= { transportation 4 }
layers	OBJECT IDENTIFIER ::= { protocols 1 }
application	OBJECT IDENTIFIER ::= { layers 7 }
profiles	OBJECT IDENTIFIER ::= { protocols 2 }
dynObjMgmt	OBJECT IDENTIFIER ::= { protocols 3 }
ntcipTraps	OBJECT IDENTIFIER ::= { protocols 4 }

```
asc          OBJECT IDENTIFIER ::= { devices 1 }
ramp         OBJECT IDENTIFIER ::= { devices 2 }
dms          OBJECT IDENTIFIER ::= { devices 3 }
tss          OBJECT IDENTIFIER ::= { devices 4 }
ess          OBJECT IDENTIFIER ::= { devices 5 }
global       OBJECT IDENTIFIER ::= { devices 6 }
cctv         OBJECT IDENTIFIER ::= { devices 7 }
cctvSwitch   OBJECT IDENTIFIER ::= { devices 8 }
dcm          OBJECT IDENTIFIER ::= { devices 9 }
ssm          OBJECT IDENTIFIER ::= { devices 10 }
scp          OBJECT IDENTIFIER ::= { devices 11 }
networkCamera OBJECT IDENTIFIER ::= { devices 12 }
elms         OBJECT IDENTIFIER ::= { devices 13 }

chap         OBJECT IDENTIFIER ::= { layers 1 }
modem        OBJECT IDENTIFIER ::= { layers 2 }
```

A.3 COMMON TEXTUAL CONVENTIONS

```
OerString ::= OCTET STRING
```

```
Byte        ::= INTEGER (-128..127)
Ubyte       ::= INTEGER (0..255)
Short       ::= INTEGER (-32768..32767)
Ushort      ::= INTEGER (0..65535)
Long        ::= INTEGER (-2147483648..2147483647)
```

```
BITMAP8     ::= OCTET STRING (SIZE (1))
BITMAP16    ::= OCTET STRING (SIZE (2))
BITMAP32    ::= OCTET STRING (SIZE (4))
```

```
OwnerString ::= DisplayString (SIZE (0..127))
```

```
-- This data type is used to model an administratively assigned name of the
-- owner of a resource. This information is taken from the NVT ASCII
character
-- set. It is suggested that this name contain one or more of the following:
-- management station name, manager's name, location or phone number.
--
-- SNMP access control is articulated entirely in terms of the contents of
MIB
-- views; access to a particular SNMP object instance depends only upon its
-- presence or absence in a particular MIB view and never upon its value or
-- the value of related object instances. Thus, objects of this type afford
-- resolution of resource contention only among cooperating managers; they
-- realize no access control function with respect to uncooperative parties.
--
-- Objects with this syntax are declared as having
--     SIZE ( 0..127 )
```

```
RowStatusStatic ::= INTEGER
    { other (1),
      standby (2),
      available (3),
      invalid (4),
      activate (5),
      deactivate (6)}
```

```
END -- NTCIP8004v02 Definitions
```

Annex B NTCIP OBJECT TYPE MACRO EXAMPLES [Informative]

The following examples show the form of the OBJECT TYPE Macro with possible subfields in the DESCRIPTION field.

```
globalSetIDParameter OBJECT-TYPE
  SYNTAX  INTEGER (0..65535)
  ACCESS  read-only
  STATUS  optional
  DESCRIPTION "<Definition> Specifies a relatively unique ID for all user-
              changeable parameters of the particular device-type currently
              implemented in the device. Often this ID is calculated using a
              CRC algorithm.
  <Object Identifier> 1.3.6.1.4.1.1206.4.2.6.1.1"
  ::= {globalConfiguration 1}
```

```
maxPhases OBJECT-TYPE
  SYNTAX  INTEGER (0..255)
  ACCESS  read-only
  STATUS  mandatory
  DESCRIPTION "<Definition> The Maximum Number of Phases this Actuated
              Controller Unit supports. This object indicates the maximum rows
              which shall appear in the phaseTable object.
  <Object Identifier> 1.3.6.1.4.1.1206.4.2.1.1.1"
  ::= {phase 1}
```

```
dmsSignType OBJECT-TYPE
  SYNTAX  INTEGER{
              other (1),
              bos (2),
              cms (3),
              vmsChar (4),
              vmsLine (5),
              vmsFull (6),
              portableOther (129),
              portableBOS (130),
              portableCMS (131),
              portableVMSChar (132),
              portableVMSLine (133),
              portableVMSFull (134)}
  ACCESS  read-only
  STATUS  optional
  DESCRIPTION "<Definition> Indicates the type of sign. The descriptions
              are:
              other: Device not specified through any other definition, refer
              to device manual,
              bos: Device is a Blank-Out Sign,
              cms: Device is a Changeable Message Sign,
              vmsChar: Device is a Variable Message Sign with character matrix
              setup,
              vmsLine: Device is a Variable Message Sign with line matrix setup,
```

vmsFull: Device is a Variable Message Sign with full matrix setup.
Same is true for all portable signs.
<Object Identifier> 1.3.6.1.4.1.1206.4.2.3.1.2"
 ::= { dmsSignCfg 2 }

essNtcipNum OBJECT-TYPE
SYNTAX IpAddress
ACCESS read-write
STATUS mandatory
DESCRIPTION "<Definition> The unique IP Address of the station. This
will make duplication of a BUFR identification number less
likely to appear.
<Object Identifier> 1.3.6.1.4.1.1206.4.2.5.2.1.1"
 ::= { essNtcipIdentification 1 }

rangeMaximumPreset OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION "<Definition> A preset is the pre-specified position where
a camera is pointed to a fixed point in space (includes
positions for pan, tilt, and zoom). The maximumPreset is a
number indicating the total number of possible preset positions
supported by the device. A value of zero (0) identifies that
the device does not support presets.
<Object Identifier> 1.3.6.1.4.1.1206.4.2.7.1.1"
 ::= { cctvRange 1 }

rmcCommRefreshThreshold OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-write
STATUS mandatory
DESCRIPTION "<Definition> This is a global parameter that is being
used
for each metered lane. If no successful SET command
communication has been issued to the rmcCommAction-object of
a metered lane for the time indicated in this threshold, the
value of the rmcCommActionStatus-object for that metered lane
shall be set to 'noComm'. A suggested usable range is 0, 20 to
14400 in 1-second increments. A value of zero (0) shall
inhibit
communications refresh timing.
<Object Identifier> 1.3.6.1.4.1.1206.4.2.2.1.1
<Unit> Second"
REFERENCE "see Annex A.3"
 ::= { rmcCfg 1 }

inputStatus OBJECT-TYPE
SYNTAX OCTET STRING (SIZE(1)) -- BITMAP8
ACCESS read-only
STATUS mandatory
DESCRIPTION "<Definition> Input status denotes a bit mapped value that
indicates the current state of eight (8) user defined discrete
inputs, as outlined below:

<Format>
Bit Number Name Description
Bit7 Input 8 0 = OFF, 1 = ON for the active status of discrete Input 8,
Bit6 Input 7 0 = OFF, 1 = ON for the active status of discrete Input 7
Bit5 Input 6 0 = OFF, 1 = ON for the active status of discrete Input 6,
Bit4 Input 5 0 = OFF, 1 = ON for the active status of discrete Input 5,
Bit3 Input 4 0 = OFF, 1 = ON for the active status of discrete Input 4,
Bit2 Input 3 0 = OFF, 1 = ON for the active status of discrete Input 3,
Bit1 Input 2 0 = OFF, 1 = ON for the active status of discrete Input 2,
Bit0 Input 1 0 = OFF, 1 = ON for the active status of discrete Input 1.
<Object Identifier> 1.3.6.1.4.1.1206.4.2.7.7.1"
::= { cctvSwitchInput 1 }

sensorSystemReset OBJECT-TYPE
SYNTAX INTEGER { restart (1),
reinitialize (2),
shortDiagnostics (3),
fullDiagnostics (4),
commandComplete (255) }
ACCESS read-write
STATUS mandatory
DESCRIPTION "<Definition> This object commands the entire sensor system to
reset. Reading a value other than 255 indicates the presence of a pending or
executing command. A write to this object is not allowed unless the current
value is 255. The reset commands are described as follows:
Value Meaning
1 Restart command shall cause the unit to enter restart state and
go through a complete shut-down and start-up process;
2 Reinitialization commands shall cause the unit to flush all volatile
memory and reinitialize all settings to their default values;
3 Short diagnostics command shall cause the unit to go through an
abbreviated vendor specific diagnostic routine which may be the
same as full diagnostics for some vendors;
4 Full diagnostics shall cause the unit to go through a complete
vendor specific diagnostic routine which may be the same as
short diagnostics for some vendors;
5..128 Reserved for future use;
255 Command complete shall be the default-state for which writing
causes no action.
<Object Identifier> 1.3.6.1.4.1.1206.4.2.4.1.1"
::= { tssSystemSetup 1 }

controlModeTable OBJECT-TYPE
SYNTAX SEQUENCE OF ControlModeEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION "
<Definition> This object describes a static table of
parameters that control and define the plan and special
function values to put into effect.

<TableType> static
<Object Identifier> 1.3.6.1.4.1.1206.4.2.10.10.1.0"
::= { controlMode 1 }

```
controlModeEntry OBJECT-TYPE
  SYNTAX      ControlModeEntry
  ACCESS      not-accessible
  STATUS      mandatory
  DESCRIPTION "
    <Definition> This object describes the parameters in the rows
    of the Mode Table.

    <Object Identifier> 1.3.6.1.4.1.1206.4.2.10.10.1.1.0"
  INDEX      { sectionNumber }
 ::= { controlModeTable 1 }
```

Annex C BLOCK OBJECT EXAMPLES (Informative)

As defined in Section 2.3.3, the definition of a Block Object consists of two parts. The first part uses a slightly modified version of the ASN.1 Macro that is defined in RFC 1212 and is placed in the body of a MIB Module. The second part uses a textual convention that is placed outside the body of the MIB.

C.1 MAP DATA EXAMPLE

The following provides an example of how a block object for the data meant for a traffic signal control map display might be defined

MIB Definition:

```
EXAMPLE-MIB DEFINITIONS ::= BEGIN

    IMPORTS
        OBJECT-TYPE
        FROM RFC-1212
        OerString
        FROM TMIB-II;

    signal1-8StatusBlock OBJECT-TYPE
        SYNTAX             OerString
        ACCESS             read-only
        STATUS             mandatory
        DESCRIPTION " <Definition> An OER encoded string containing signal
        indications for phases 1-8 and a time stamp. The indexes for the
        columnar objects are can take on the value 1 through 8.
        <<Object Identifier>>"

        ::= {phase 12}

    split1PhaseDataBlock OBJECT-TYPE
        SYNTAX             OerString
        ACCESS             read-write
        STATUS             mandatory
        DESCRIPTION " <Definition> An OER encoded string containing a the
        split time, split mode and coord phase programming for the phases
        associated with split 1. The index can take on the value of any phase
        number.
        <<Object Identifier>>"

        ::= {phase 13}

END
```

The DESCRIPTION clearly states the indexes for any columnar objects and the values used.

The external, textual portions that are encoded as an OerString and would appear outside of any module definition might appear as follows:

External Definitions:

```
SignalStatus1-8 ::= SEQUENCE {
    phaseStatusGroupGreens.x,
    phaseStatusGroupYellows.x,
    phaseStatusGroupWalks.x,
    phaseStatusGroupVehCalls.x,
    phaseStatusGroupPedCalls.x,
    overlapStatusGroupGreens.x,
    overlapStatusGroupYellows.x,
    globalTime.0
} -- @NTCIP1201v0232
```

```
Split1PhaseData ::= SEQUENCE {
    splitNumber.1.x,
    splitPhase.1.x,
    splitTime.1.x,
    splitMode.1.x,
    splitCoordPhase.1.x
}
```

C.2 PHASE TIMING DATA EXAMPLE

The following is an example of how a block object can be defined as self-indexing and then used to retrieve all timing data associated with any enabled phase.

MIB Definition:

```
databaseGroupPhaseBlock OBJECT-TYPE
    SYNTAX      OerString
    ACCESS      read-only
    STATUS      mandatory
```

DESCRIPTION " <Definition> An OER encoded string containing phase parameters for phases that are enabled. By use of the extension marker (...), a phase's data may include parameters that are not defined in this current definition. This could apply to agency or vendor specific parameters.

This block object is self-indexing. The phaseNumber in each sequence defines the index for subsequent data. The phase numbers included in the frame are defined by the current state of bit 0 of the phaseOption object.

```
<Object Identifier> "
 ::= {phase 12}
```

External Definition encoded as OerString:

```
DatabaseGroupPhasesBlock ::= SEQUENCE OF PhaseTimingParameters
-- Indexes of SEQUENCE OF are defined by enabled phases
```

```
PhaseTimingParameters ::= SEQUENCE {
    phaseNumber.x,
    phaseWalk.x,
    phasePedestrianClear.x,
    phaseMinimumGreen.x,
    phasePassage.x,
    phaseMaximum1.x
```

```
phaseMaximum2.x,  
phaseYellowChange.x,  
phaseRedClear.x,  
phaseRedRevert.x,  
phaseAddedInitial.x,  
phaseMaximumInitial.x,  
phaseTimeBeforeReduction.x,  
phaseCarsBeforeReduction.x OPTIONAL,  
phaseTimeToReduce.x,  
phaseReduceBy.x OPTIONAL,  
phaseMinimumGap.x,  
phaseDynamicMaxLimit.x OPTIONAL,  
phaseDynamicMaxStep.x OPTIONAL,  
phaseStartup.x,  
phaseOptions.x,  
... }
```

END

Annex D UML INFORMATION (Informative)

It is beyond the scope of NTCIP 8004 v02 to provide a rigorous or complete explanation of the UML Diagrams used within NTCIP 8004 v02. However, “UML basics: An introduction to the Unified Modeling Language,” and “The Unified Modeling Language User Guide” may provide a more complete understanding of UML. See Section 1.2.2

Annex E HISTORY OF CHANGES (Informative)

Annex E summarizes the changes made between the prior version of NTCIP 8004, and NTCIP 8004 v02:

E.1 TITLE PAGE

The document status, version, and date were updated.

E.2 NOTICES

The new Notices section was added. However, the PRL and RTM copyright notice was deleted because NTCIP 8004 v02 does not contain such tables.

E.3 ACKNOWLEDGEMENTS

Individuals, agencies, companies, or universities contributing or commenting on NTCIP 8004 v02 were modified to reflect current status.

E.4 FOREWORD

History was updated.

E.5 SECTION 1.1 SCOPE

Added "and other NTCIP" to scope.

E.6 SECTION 1.2.1 NORMATIVE REFERENCES

- a) Removed reference to ISO 14817. Aided by NTCIP Joint Committee decision in 2007, BSP2 WG removed all ISO 14817 references because data fields other than those defined in NTCIP 8004 v02 are not necessary for center-to-field communications, which NTCIP 8004 v02 addresses.
- b) Added reference to ISO 1000:1992 as the reference basis for the data field <unit>.
- c) Updated the versions of referenced standards to the now valid versions.

E.7 SECTION 1.2.2 OTHER REFERENCES

- a) Updated the versions of referenced NTCIP standards to the now-valid versions.
- b) Added reference citations to other references contained in NTCIP 8004 v02.

E.8 SECTION 1.3 DEFINITIONS

- a) Added several definitions, particularly 'obsolete' and 'deprecated'.
- b) Deleted some of the definitions no longer applicable.

E.9 SECTION 2.1 AND FOLLOWING

Due to removal of ISO 14817 reference (see Annex E.6), any text containing this reference was modified.

E.10 SECTION 2.3.2 SIMPLE OBJECT SPECIFICATION

- a) Removed reference to ISO 14817 and associated meta attributes no longer necessary.
- b) Added the <Object Identifier> subfield definition.
- c) Created separate items for the <table type>, and <Unit> subfield definitions.

E.11 SECTION 2.3.3 BLOCK OBJECT SPECIFICATION

- a) Removed reference to ISO 14817 and associated meta attributes no longer necessary.
- b) Added the <Object Identifier> subfield definition.

E.12 SECTION 2.3.4 DYNAMIC OBJECT SPECIFICATION

- a) Removed reference to ISO 14817 and associated meta attributes no longer necessary.
- b) Added the <Object Identifier> subfield definition.

E.13 SECTION 2.4 META ATTRIBUTES

- a) Removed reference to ISO 14817 and associated meta attributes no longer necessary.
- b) Added text for the <Object Identifier> subfield definition.

E.14 SECTION 2.4.3 UNIT OF MEASURE

Expanded on definition of this subfield

E.15 SECTION 2.4.4 BIT MAP FORMAT

Expanded the definition and explanation of bit map setup used within SYNTAXes of INTEGER versus OCTET STRING, and added diagram to further explain the difference.

E.16 SECTION 2.5 MANAGEMENT INFORMATION BASE (MIB)

Removed references to ISO 14817 meta attributes.

E.17 SECTION 2.6 MULTI-VERSION INTEROPERABILITY (MVI-BACKWARD COMPATIBILITY)

Added this entire Section defining how and under what circumstances object definitions might be deprecated in order to ensure MVI.

E.18 SECTION 3.2 TABLES, ROWS, AND BLOCK OBJECTS

- a) Removed reference to ISO 14817 and associated meta attributes no longer necessary.
- b) Added the <Object Identifier> subfield definition.

E.19 SECTION 3.3.1 ROWSTATUS IN STATIC TABLES

Updated Figures 9, 10, and 11.

E.20 ANNEX A.1 SMI HEADER

Revised version number and history, and added tmdd node under the transportation node

E.21 ANNEX B NTCIP OBJECT TYPE MACRO EXAMPLES

Updated all examples to comply with preceding modifications. Removed ISO 14817 reference and associated meta attributes no longer necessary, and added <Object Identifier> subfield definition.

E.22 ANNEX C BLOCK OBJECT EXAMPLES

Updated examples to comply with preceding modifications. Removed reference to ISO 14817 and associated meta attributes no longer necessary, and added the <Object Identifier> subfield definition.

E.23 ANNEX E HISTORY OF CHANGES

Added section showing changes between the prior version of NTCIP 8004 v02, and NTCIP 8004 v02.

§

**ITE Standards Development Report (SDR) for
NTCIP 8004, *Structure of Management
Information – version v02***

Date prepared: January 29, 2008
Prepared by: Robert De Roche
BSP2 WG chair
r-deroche@gmail.com

Updated: rev2 on 9/25/2009 by Schopp: revised doc reference to v02.15; edited text.

TO: Staff of the Institute of Transportation Engineers

CC: NTCIP Coordinator

The following Standards Development Report is provided to meet the requirements of the Institute of Transportation Engineers (ITE) Standards Development Procedures, dated May 2003, and as part of the joint development and approval process for the NTCIP.

1. Latest version of the draft Recommended Standard.

The document number and full name of the proposed document is

NTCIP 8004 v02.15, August 2009, *National Transportation Communications for ITS Protocol Structure and Identification of Management Information (SMI) – version 02.*

To review the document, see the filename

8004v0215.doc or *.pdf

To review a redlined version comparing this version to 8004v01.37a, see the filename

8004v0212 compared with 0137a.doc or *.pdf

2. Summary status indicating the current stage in the ITE standards development process.

See the Development Milestone table in Item 3. As of the date of this SDR, the subject standard has achieved Milestone 11 – the NTCIP Joint Committee has accepted the proposed draft as a Recommended Standard.

3. Status report, including for each procedures step, the dates, balloting results, and other information explaining the actions taken to carry out each step.

The following Development Milestones table notes the date for each ITE development process stage.

ITE Standards Development Milestone	Date, Description of Action Taken and Other Background Information
1. Decision Made and Effort Announced	Jan 2000. Joint Committee discussed scope of work and charter WG.
2. Committee Formed	Jan 2000. Joint Committee approved WG Bylaws and roster.
3. Committee Develops Draft Proposed Standard	Jan 2000. WG met to begin development effort.
4. Committee Ballots Draft Proposed Standard	Aug 2005 - May 2007. WG developed Working Group Draft of Version 2
5. Standard Review Panel Ballots Draft	May 2007. WG developed proposed User Comment Draft.
6. Draft Proposed Standard Approved	Jun 2007. Joint Committee accepted proposed User Comment Draft.
7. Proposed Standard Published to Solicit Comments	Jun 2007. User Comment Draft distributed by AASHTO, ITE, and NEMA for review and comment by memberships.
8. Comments Considered by Committee	Aug 2007 - Oct 2007. Worked Group met to resolve and dispose of user comments.
9. Committee Ballots Revised Proposed Standard	Oct 2007. Working Group reached consensus on disposition of user comments.
10. Standard Review Panel Ballots Revised Proposed Standard	Oct 2007. Working Group reached consensus on a proposed draft Recommended Standard.
11. Revised Standard Approved	Nov 2007. Joint Committee accepted the proposed Recommended Standard. Mar 2008 to July 2009. Edited and revised figures for SDO balloting.
12. Intent to Adopt Announced	<i>ITE staff receives NTCIP Standards Bulletin with referral for approval and announces intent.</i>
13. ITE Standard Adopted by the ITE Board	<i>ITE Board of Direction adopts Standard.</i>
14. Maintenance of Standard	<i>SDOs maintain the Standard on a five-year review cycle.</i>

Note-Steps in italic are future milestones.

To accomplish Development Milestones 4, 5, 8, 9, and 10, the Working Group discussed this standard during a series of meetings on these dates and at these locations:

November 29-December 3, 2005 in Orlando, FL
February 14-17, 2005 in Reno, NV
May 17-20, 2005 in Anaheim, CA
August 15-15, 2005 in Atlanta, GA
January 9-11, 2006 in Austin, TX
April 17-20, 2006 in Colorado Springs, CO
March 5-8, 2007 in Tampa, FL
June 13-14, 2007 in Dallas, TX
September 25-28, 2007 in Austin, TX

In addition to the nine face-to-face meetings, aspects of this standard were discussed at five teleconference calls on:

January 18, 2007
May 22, 2007
July 12, 2007
November 8, 2007
December 12, 2007

There were delays in the progress of developing the NTCIP 8004 - SMI standard because of issues related to conformance to ISO 14817, *Transport information and control systems — Requirements for an ITS/TICS central data registry and ITS/TICS data dictionaries*. The NTCIP Technical Coordination Forum (TCF) and NTCIP JC also raised and resolved issues related to deprecated objects and backwards compatibility.

4. Table listing each written comment received to date from committee members, registrants, and others. For each comment, the table shall include the actions taken (or proposed to be taken) in response to that comment, and the reason(s) for the action.

The Comments are recorded in an Access Data Base. To review the database, see the filename:

8004 Comments for SDR Version 02.pdf

5. Committee objectives

The scope and objectives of the BSP 2 Working Group is to serve as a subdivision of the NTCIP Joint Committee, and to develop and maintain the NTCIP communication level standards publication and other documents that define the technical specifications for all field devices. For additional information see BSP WG Bylaws v3 dated January 27, 1999 and BSP WG Charter v1 dates January 27, 1999.

6. List of Committee Members

The following are active participating members of the BSP2 Working Group:

Ralph Boaz - Pillar Consulting
 Bob De Roche - Robert De Roche Consulting
 Bud Kent - Siemens ITS
 Jim Mahugh - Washington State Department of Transportation
 Greg Mizell - Econolite Control Products
 Alex Mousadi - URS Greiner
 Peter Ragsdale - US Traffic
 Robert Rausch - Transcore
 Joerg "Nu" Rosenbohm - Telvent Farradyne

In addition to the above active/voting members, the following numbers of observing and liaison members subscribe to the BSP2 email reflector:

10 Observing members
 3 - Public Sector
 2 - Consultants
 5 - Vendors
 2 Liaison members

The following are WG voting members, observing members, and/or liaison members who are affiliated with non-U.S. companies or organizations:

Mr. Lesly Bien-Aimé - Signalisation Ver-Mac, Inc

7. Other Material of Interest

This standard was developed with funding assistance from the U.S. DOT / RITA. The standard is likely to be most applicable in the U.S.; however, the standard is available for use by anyone.

8. Declaration confirming that any other known national and international standards have been examined with regard to harmonization and duplication of content, and that no significant conflicts with another known standard have been identified.

IAB STD	16	(RFC 1155) Structure and Identification of Management Information for TCP/IP based Internets; M. Rose, K. McCloghrie; May 1990; and (RFC 1212) Concise MIB Definitions; M. Rose and K. McCloghrie; March 1991.
ISO / IEC	10165	Information Technology - Open Systems Interconnection- Structure of Management Information.

To the working group's knowledge, none of the existing similar standards are tailored to the needs of Intelligent Transportation Systems. Numerous existing standards are designed to be compatible with a public data infrastructure network. Numerous existing standards describe an SNMP interface. Numerous existing standards have the ability to log or store information for maintenance purposes. The working group examined these existing standards and found no significant conflicts with NTCIP 8004.

9. Abstract of the Standard

The NTCIP 8004 v02 publication defines a process and control standard for the rules and procedures for defining structure and identification of management information in transportation related communications. NTCIP 8004 v02 defines requirements that are applicable to all NTCIP devices that exchange data in that environment. NTCIP 8004 v02 also contains optional and conditional clauses that are applicable to specific environments for which they are intended. There are five annexes to this document but only the Annex A is normative.

During early stages of development, portions of NTCIP 8004 v02 were part of NTCIP 1101:1997, which was also numbered and referenced as NEMA TS 3.2-1996. However, in order to provide a more systematic approach to and organized numbering scheme, and to reflect the joint copyright of AASHTO, ITE, and NEMA, the document is now numbered NTCIP 8004.

The NTCIP 8004 v02 document is an NTCIP 8000-series Process, Control, and Information Management document. Process, Control, and Information Management documents define the practices and policies used by the NTCIP Joint Committee and the Joint Committee's subdivisions in developing and maintaining NTCIP standards and documents. The 8000-series policies are balloted and approved by AASHTO, ITE, and NEMA after acceptance as Recommended Policy by the NTCIP Joint Committee. An NTCIP Process, Control, and Information Management document equates to the following standard types:

- AASHTO – Recommended Practice
- ITE – Informational Report
- NEMA – Authorized Engineering Information

NTCIP 8004 contains mandatory requirement statements that are applicable to all devices claiming conformance to this standard. NTCIP 8004 v02 also contains options and conditional requirements, which may be applicable to a specific environment in which a device is used.

The following keywords apply to this document: AASHTO, Dynamic Objects, ITE, NEMA, NTCIP, SMI, SNMP, STMP, Process and Control Standard.

The NTCIP 8004 v02 *Structure and Identification of Management Information* is a process and control base standard for use in association with certain Application Layer protocols in transportation related communications such as SNMP, STMP, SFMP, FTP, and TFTP.

10. Description of Alternate Processes

The process used in the development of this standard is defined in the NTCIP 8001 v01.07, *NTCIP Joint Standardization Policies and Procedures*, which includes the former *Joint Standards Committee Standards Development Process White Paper v05*, September 2000. See the White Paper section 6 for the relationship to the ITE standardization process.

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