

A Recommended Standard of the Joint Committee on the NTCIP

NTCIP 1203 version v02.39

National Transportation Communications for ITS Protocol Object Definitions for Dynamic Message Signs (DMS)

v02.39b November 2010

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NR Reference Status Tracking (to be deleted on publication)

Reference Designation	Title	Type (Norm, Other)	Status	Pending
NTCIP 1201 v03	GO	Norm.	Publication anticipated. Needs 1201 v03. Change refs in 1203 v02 to 1201 v03..	In SDO ballot 5/2010
NTCIP 8004 v02	SMI	Other	Published	Published
NTCIP 2301 v02	AP-STMF		Published	Published
NTCIP 1103 v02	TMP		Publication anticipated. Change refs in 1203 v02 to 1103 v02.	Published

Recent Minor Version Revision History

revision	DATE	NOTE new on top
v02.39b	11/15-17/10	RS for SDO balloting and approval. Posted JC acceptance action comments: from Tighe, references to 1201 v2 vs. historical v02 vs. v03 clarified, and Fig 16 refers to 1203; from Mulligan/Brookshire, 4.2.2.6, 2.4.2.2, 2.5.2.3.3, 2.5.2.3.5, 2.5.2.6 non-support of time objects made to 1201 v02 or v03; 2.5.1.3 spelling; 2.5.2.4 non-support; 2.5.2.5 deletion; from Vaughn, inserted notes re UC0527 at 4.2.2.1.
v02.39	11/03 to 11/04	page revisions and PDF checks resulting in file < 1203v0239 proRepl RSa.doc > for JC acceptance
v02.39	11/01/2010 to 11/03/2010	series of test PDF authoring and page revisions files leading to < 1203v02v39 20101103 445PMEDT NOREVS.doc >
v02.38B	5/20/2010 to 8/12/2010	series of edits from v03 consulting team Brookshire and Chan; Johnson email exchanges with Chan; and staff edits. Used file < 1203v02-38B 20100520 JJ MID-EDIT with DMS WG F2F and PXC edits 1008.doc >

Edit Clean-Up List and Notes

Open and Repair 11/4/10; no reported repairs.

PRL,--Supplemental, at 3.6.7.3,
revised "volatile messages (0..65535) and _____ bytes of volatile memory" text. LEFT as only "1203 v02" ref.

in the PRL, Sec 3.3.8 at 2.5.4 Control External Devices, I've deleted the following entry in Add'l Project Requirements: JJ replaced it with: NTCIP 1203:1997 (version v01)____etc (version v02)____ POSTED

At A.1, at 3.5.4, the section references from 1201:2005 are not the same in NTCIP 1201 v03 (in SDO ballot). These should probably be revised (in A.1—Not in 1201 v03.) JJ put in a note, until someone can do this.

Figure 16 contains references to Version 1 and Version 2 Method. JJ presumes that these are to the NTCIP 1203:1997 (version v01) and NTCIP 1203 v02 methods, put in NOTE; have to revise figure.

(to be deleted on publication)

ACKNOWLEDGEMENTS

NTCIP 1203 v02 was prepared by the NTCIP Dynamic Message Sign Working Group (DMSWG), 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 NTCIP development effort is guided by the Joint Committee on the NTCIP, which consists of six representatives from each of the above organizations.

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In addition to the many volunteer efforts, recognition is also given to those organizations who supported the efforts of the working groups by providing comments and funding for the standard, including:

- U.S. Department of Transportation, Research and Innovative Technology Administration, ITS Joint Program Office
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- American Signal Company
- MTA Bridges and Tunnels
- California Department of Transportation
- ConSysTec
- Daktronics, Inc.
- DMJM + Harris
- Fiberoptic Display Systems, Inc.
- Idaho Transportation Department
- Intelligent Devices Inc.
- Iowa Department of Transportation
- LedStar
- Maine Department of Transportation
- Mark IV
- McCain Traffic
- Minnesota Department of Transportation
- New York State Department of Transportation
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- Ontario Ministry of Transport
- Port Authority of New York New Jersey (PANYNJ)
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- Texas Transportation Institute (TTI)
- TransCore
- Trevilon Corporation
- US Traffic Corp.
- Ver-Mac
- Virginia Department of Transportation
- Vultron, Inc.
- Washington State DOT

FOREWORD

NTCIP 1203 v02 identifies and defines how a management station may wish to interface with a field device to control and monitor dynamic message signs (DMS), providing definitions of data elements for use with DMS. The data is defined using the Simple Network Management Protocol (SNMP) object-type format in RFC 1212, and would typically be exchanged using one of the NTCIP recognized Application Layers (e.g., SNMP).

NTCIP 1203 v02 defines requirements that are applicable to all NTCIP DMS. NTCIP 1203 v02 also contains optional and conditional sections that are applicable to specific environments for which they are intended. The content of one object, the dmsMessageMultiString object, uses a complex syntax called the Mark-Up Language for Transportation Information (MULTI) format, also defined in NTCIP 1203 v02.

NTCIP 1203 v02 is an NTCIP Device Data Dictionary Standard. Device Data Dictionary Standards provide formal definitions of data elements for use within NTCIP systems.

The following keywords apply to this document: AASHTO, ITE, NEMA, NTCIP, DMS, VMS, CMS, data, data dictionary, object, message sign, message board, sign, MULTI.

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Page:

Section, Paragraph, or Clause:

Comment:

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Suggested Alternative Language:

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Approvals

XXXTToBeUpdatedAfterBallotAndApprovalXXX. NTCIP 1203 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 1203 v02 as the following standard type, as of the date:

AASHTO—Standard Specification; Month 2011

ITE—Software Standard; Month 2011

NEMA—Standard; Month 2011

History

In 1992, the NEMA 3-TS Transportation Management Systems and Associated Control Devices Section began the effort to develop the NTCIP. The Transportation Section's purpose was to respond 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. Message signs were identified as one of the highest priority expansion areas. As a result, in August 1995, NEMA created the DMS Technical Subcommittee to standardize DMS equipment.

In September 1996, an agreement was executed among AASHTO, ITE, and NEMA to jointly develop, approve, and maintain the NTCIP standards. One of the first tasks of this joint effort was to finalize the work that NEMA had already begun on the object definitions for dynamic message signs.

NTCIP 1203:1997 was also known as NEMA TS 3.6. In 1999, NTCIP 1203:1997 was published as version v01.15. NTCIP 1203:1997 is also referred to as NTCIP 1203 v01, or NTCIP 1203:1997 version v01.

In 2001, 1203 Amendment 1 was accepted by the Joint Committee on the NTCIP and subsequently Jointly Approved by the three SDOs. The 1203 Amendment 1 did not add additional functionality, but clarified object definitions and MULTI tags, and responded to questions from actual implementations.

NTCIP 1203 v02 was developed to reflect lessons learned, to update to the new documentation formats, and to add new features such as the colors, graphics, and a 3-tiered equipment management structure.

NTCIP 1203 v02 is a major version revision of NTCIP 1203:1997 v01.15, and includes approved revisions from NTCIP 1203 Amendment 1 v07.

NTCIP 1203 v02 includes additional functionalities, and was a pilot work item to develop ITS standards using a 'systems engineering' approach adapted from software system and other large systems development projects. Several new sections were added to relate user needs identified in a concept of operations, functional requirements, interface specifications and a requirements traceability matrix.

NTCIP 1203 v02 Sections 4 (Group Definitions) and 5 (Conformance Statement) in NTCIP 1203:1997 have been deleted and are replaced by Section 2 (Concept of Operations and User Needs); Section 3 (Functional Requirements and particularly the Protocol Requirement List (PRL)); and Annex A (Requirements Traceability Matrix (RTM)).

NTCIP 1203 Annex C is the placeholder for the section which shall define test procedures that satisfy the functional requirements, to be provided in 1203 major version v03.

The major changes in NTCIP 1203 v02 are listed and explained in Annex D (Documentation of Revisions).

Between 2002 and 2007, NTCIP 1203 v02 was issued twice for review and comment as two different User Comment Drafts. Between 2007 and 2010, NTCIP 1203 v02, in two different minor versions, was accepted by the Joint Committee as the Recommended Standard. And between 2008 and 2010, progress on NTCIP 1203 v02 was placed on hold, pending the development stage advancement of cited Normative References. For example, and in response to changes in the NTCIP 1201 v03, *Global Object Definitions*, particularly in the Daylight Saving Time method, drafting of NTCIP 1203 v02 was put on hold and in 2008, subsequently updated to reflect the DST changes.

The history of NTCIP 1203 DMS and NTCIP 1201 GO is closely related, and is further explained in other sections of this NTCIP 1203 v02 standard. Agency specifiers using the PRL, for certain user needs and requirements, and to plan for the interoperability of multiple-version devices and centrals in their systems, have choices to make. Some of the DMS choices depend on selecting either NTCIP 1203 v01 or NTCIP 1203 v02 for the object set to support. Other choices depend on the support of time objects from the Global Objects, and reference is made to either NTCIP 1201:1996 v01 GO, or NTCIP 1201:2005 v02 GO, or NTCIP 1201 v03 GO. Please make careful note of the document numbers and major version numbers.

Compatibility of Versions

To distinguish NTCIP 1203 v02 (as published) from previous drafts, NTCIP 1203 v02 also includes NTCIP 1203 v02.39 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 1203 v02 is designated, and should be cited as, NTCIP 1203 v02. Anyone using NTCIP 1203 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 1203 v02 should also consult NTCIP 8004 v02 for specific guidelines on compatibility.

CONTENTS

	Page
Section 1 GENERAL [Informative].....	1
1.1 Scope.....	1
1.2 References	1
1.2.1 Normative References.....	1
1.2.2 Other References	2
1.2.3 Contact Information	2
1.3 Terms.....	3
Section 2 CONCEPT OF OPERATIONS [Normative]	19
2.1 Tutorial [informative]	19
2.1.1 About NTCIP 1203 v02.....	20
2.1.2 Who are you?	20
2.1.3 How NTCIP 1203 v02 is Organized	21
2.1.4 Intended Audiences for the Sections in NTCIP 1203 v02	22
2.2 Current Situation and Problem Statement [informative]	22
2.3 Reference Physical Architecture [Informative]	22
2.3.1 Typical Physical Architecture.....	22
2.3.2 DMS Characteristics	23
2.4 Architectural Needs / Description of System Environment.....	24
2.4.1 Fundamental Needs Driving DMS Deployment.....	24
2.4.2 Operational Environment.....	25
2.5 Features.....	25
2.5.1 Manage the DMS Configuration	25
2.5.2 Control the DMS	26
2.5.3 Monitor the Status of the DMS	28
2.5.4 Provide for Multi-Version Interoperability of DMS to NTCIP 1203 v1.....	30
2.6 Security.....	30
2.7 Operational Policies and Constraints / Assumptions	30
2.8 Relationship to the National ITS Architecture.....	31
Section 3 DMS FUNCTIONAL REQUIREMENTS [Normative]	32
3.1 Tutorial [Informative].....	32
3.2 Scope of the Interface [Informative]	33
3.3 Protocol Requirements List (PRL).....	33
3.3.1 Notation [Informative]	33
3.3.2 Instructions for Completing the PRL [Informative].....	33
3.3.3 Requirements Column.....	34
3.3.4 Conformance Column.....	34
3.3.5 Support / Project Requirements Column.....	35
3.3.6 Additional Project Requirements Column.....	35
3.3.7 Conformance Definition	36
3.3.8 Protocol Requirements List (PRL) Table.....	37
3.3.9 Protocol Requirements List—Supplemental Table	59
3.3.10 MULTI Field Traceability Matrix.....	66
3.4 Architectural Requirements	74
3.4.1 Support Basic Communications	74
3.4.2 Support Logged Data	74
3.4.3 Support Exception Reporting	74
3.4.4 Manage Access	74
3.5 Data Exchange and Operational Environment Requirements	75
3.5.1 Manage the DMS Configuration	75
3.5.2 Control the DMS	78
3.5.3 Monitor the Status of the DMS	83

3.5.4	Providing for Multi-Version Interoperability with NTCIP 1203:1997	88
3.6	Supplemental Non-Communications Requirements	89
3.6.1	Supplemental Requirements for Fonts	89
3.6.2	Supplemental Requirements for General Illumination Brightness	89
3.6.3	Supplemental Requirements for Automatic Brightness Control	89
3.6.4	Supplemental Requirements for Control Modes	89
3.6.5	Supplemental Requirements for Message Activation Request	90
3.6.6	Supplemental Requirements for Message Definition	91
3.6.7	Supplemental Requirements for Locally Stored Messages	95
3.6.8	Supplemental Requirements for Color Scheme	95
3.6.9	Supplemental Requirements for Monitoring Subsystems	96
3.6.10	Supplemental Requirements for Scheduling	96
3.6.11	Supplemental Requirements for Graphics	97
3.6.12	Supplemental Requirements for Page Justification	97
3.6.13	Supplemental Requirements for Line Justification	97
Section 4 DIALOGS [Normative]		98
4.1	Tutorial [Informative]	99
4.2	Specified Dialogs	100
4.2.1	Calculating the Checksum Value	100
4.2.2	Managing the DMS Configuration	100
4.2.3	Controlling the DMS	107
4.2.4	Monitoring the Status of the DMS	114
4.3	State Transition Diagrams	119
4.3.1	Font State Machine Definition	119
4.3.2	Graphic State Machine Definition	123
4.3.3	Control Mode State Machine Definition	126
4.3.4	Message Table State Machine Definition	128
4.3.5	Message Activation Consistency Check Definition	131
Section 5 MANAGEMENT INFORMATION BASE (MIB) [Normative]		132
5.1	Object Definitions	132
5.2	SIGN CONFIGURATION AND CAPABILITY OBJECTS	135
5.2.1	Sign Access Parameter	135
5.2.2	Sign Type Parameter	135
5.2.3	Sign Height Parameter	136
5.2.4	Sign Width Parameter	136
5.2.5	Horizontal Border Parameter	136
5.2.6	Vertical Border Parameter	137
5.2.7	Legend Parameter	137
5.2.8	Beacon Type Parameter	137
5.2.9	Sign Technology Parameter	138
5.3	VMS CONFIGURATION OBJECTS	138
5.3.1	Character Height in Pixels Parameter	138
5.3.2	Character Width in Pixels Parameter	138
5.3.3	Sign Height in Pixels Parameter	139
5.3.4	Sign Width in Pixels Parameter	139
5.3.5	Horizontal Pitch Parameter	139
5.3.6	Vertical Pitch Parameter	139
5.3.7	Monochrome Color Parameter	140
5.4	FONT DEFINITION OBJECTS	140
5.4.1	Number of Fonts Parameter	140
5.4.2	Font Table Parameter	140
5.4.3	Maximum Characters per Font Parameter	144
5.4.4	Character Table Parameter	145
5.4.5	Maximum Character Size Parameter	146

5.5	MULTI CONFIGURATION OBJECTS	146
5.5.1	Default Background Color Parameter	146
5.5.2	Default Foreground Color Parameter	147
5.5.3	Default Flash On Time Parameter	147
5.5.4	Default Flash On Time Parameter at Activation	147
5.5.5	Default Flash Off Time Parameter	148
5.5.6	Default Flash Off Time Parameter at Activation	148
5.5.7	Default Font Parameter	148
5.5.8	Default Font Parameter at Activation	148
5.5.9	Default Line Justification Parameter	148
5.5.10	Default Line Justification Parameter at Activation	149
5.5.11	Default Page Justification Parameter	149
5.5.12	Default Page Justification Parameter at Activation	149
5.5.13	Default Page On Time Parameter	150
5.5.14	Default Page On Time Parameter at Activation	150
5.5.15	Default Page Off Time Parameter	150
5.5.16	Default Page Off Time Parameter at Activation	150
5.5.17	Default Background Color RGB Parameter	151
5.5.18	Default Background Color RGB Parameter at Activation	151
5.5.19	Default Foreground Color RGB Parameter	151
5.5.20	Default Foreground Color RGB Parameter at Activation	152
5.5.21	Default Character Set Parameter	152
5.5.22	Color Scheme Parameter	152
5.5.23	Supported MULTI Tags Parameter	153
5.5.24	Maximum Number of Pages Parameter	154
5.5.25	Maximum MULTI String Length Parameter	154
5.6	MESSAGE OBJECTS	154
5.6.1	Number of Permanent Messages Parameter	154
5.6.2	Number of Changeable Messages Parameter	154
5.6.3	Maximum Number of Changeable Messages Parameter	155
5.6.4	Free Bytes within Changeable Memory Parameter	155
5.6.5	Number of Volatile Messages Parameter	155
5.6.6	Maximum Number of Volatile Messages Parameter	155
5.6.7	Free Bytes within Volatile Memory Parameter	155
5.6.8	Message Table Parameter	156
5.6.9	Validate Message Error Parameter	160
5.7	SIGN CONTROL OBJECTS	160
5.7.1	Control Mode Parameter	160
5.7.2	Software Reset Parameter	160
5.7.3	Activate Message Parameter	161
5.7.4	Message Display Time Remaining Parameter	161
5.7.5	Message Table Source Parameter	162
5.7.6	Message Requester ID Parameter	162
5.7.7	Message Source Mode Parameter	162
5.7.8	Short Power Loss Recovery Message Parameter	163
5.7.9	Long Power Loss Recovery Message Parameter	164
5.7.10	Short Power Loss Time Definition Parameter	164
5.7.11	Reset Message Parameter	164
5.7.12	Communications Loss Message Parameter	165
5.7.13	Communication Loss Time Definition Parameter	165
5.7.14	Power Loss Message Parameter	165
5.7.15	End Duration Message Parameter	166
5.7.16	Memory Management Parameter	166
5.7.17	Activate Message Error Parameter	166
5.7.18	MULTI Syntax Error Parameter	168
5.7.19	Position of MULTI Syntax Error Parameter	168

5.7.20	Other MULTI Error Parameter	169
5.7.21	Pixel Service Duration Parameter	169
5.7.22	Pixel Service Frequency Parameter	169
5.7.23	Pixel Service Time Parameter	169
5.7.24	Message Code of the Activation Error Parameter	170
5.7.25	Activate Message State Parameter	170
5.8	ILLUMINATION/BRIGHTNESS OBJECTS	170
5.8.1	Illumination Control Parameter	170
5.8.2	Maximum Illumination Photocell Level Parameter	171
5.8.3	Status of Illumination Photocell Level Parameter	171
5.8.4	Number of Illumination Brightness Levels Parameter	172
5.8.5	Status of Illumination Brightness Level Parameter	172
5.8.6	Illumination Manual Level Parameter	172
5.8.7	Illumination Brightness Values Parameter	172
5.8.8	Brightness Values Error Parameter	173
5.8.9	Status of Illumination Light Output Parameter	174
5.9	SCHEDULING ACTION OBJECTS	174
5.9.1	Action Table Entries Parameter	174
5.9.2	Action Table Parameter	174
5.10	AUXILIARY I/O OBJECTS	175
5.11	Sign Status	175
5.11.1	Core Status	175
5.11.2	Status Error Objects	177
5.11.3	Power Status Objects	201
5.11.4	Temperature Status Objects	202
5.12	GRAPHIC DEFINITION OBJECTS	204
5.12.1	Maximum Number of Graphics Parameter	204
5.12.2	Number of Graphics Parameter	204
5.12.3	Maximum Graphic Size Parameter	204
5.12.4	Available Graphic Memory Parameter	205
5.12.5	Graphic Block Size Parameter	205
5.12.6	Graphics Table Parameter	205
5.12.7	Graphics Bitmap Table Parameter	210
Section 6 MARKUP LANGUAGE FOR TRANSPORTATION INFORMATION (MULTI) [Normative] ..		215
6.1	Scope	215
6.2	MULTI - Setup and Definition	215
6.2.1	Definition	215
6.3	Rules to apply attribute tags	215
6.4	Defined Tags	216
6.4.1	Color Background	217
6.4.2	Page Background Color	218
6.4.3	Color Foreground	218
6.4.4	Color Rectangle	219
6.4.5	Fields	220
6.4.6	Flash Time	222
6.4.7	Font	224
6.4.8	Graphic	224
6.4.9	Hexadecimal Character	225
6.4.10	Justification—Line	226
6.4.11	Justification—Page	227
6.4.12	Manufacturer Specific Tag	228
6.4.13	Moving Text Tag	228
6.4.14	New Line	231
6.4.15	New Page	231
6.4.16	Page Time	232

6.4.17	Spacing – Character	233
6.4.18	Text Rectangle	233
Annex A	Requirements Traceability Matrix (RTM) [Normative]	236
A.1	NOTATION [Informative]	274
A.2	MULTI Field Traceability Matrix	285
Annex B	Object Tree [Informative]	291
Annex C	Test Procedures [Normative]	293
Annex D	Documentation of Revisions [Informative]	294
D.1	General	294
D.2	General MIB Changes	294
D.3	Added Default Values (DEFVAL) to many objects	295
D.4	Added Maximum Number of Pages Object	295
D.5	Added Maximum Length of Message Text Object	295
D.6	Modified Method to Control the Illumination/Brightness Output	295
D.7	Added Objects to Define and Differentiate Between Different Color Schemes	295
D.8	Added Critical Temperature Objects	295
D.9	Fan Failures Object	296
D.10	Fan Test Activation Object	296
D.11	Deprecated Values within object definitions	296
D.12	Moved Auxiliary Input/Output Object Definitions	296
D.13	Additional Reporting Capabilities via the Short Error Object Definition	297
D.14	Three-Tiered Reporting Mechanism	297
D.15	Added Graphics Functionality and Object Definitions	297
D.16	Added Method to Define Text/Graphic Location on Sign Display	297
D.17	Color Definition Functionality	297
D.18	Added Method to Determine the Supported MULTI Tags	297
Annex E	Frequently Asked Questions [Informative]	298
E.1	Does NTCIP 1203 v02 include a feature to automatically blank a sign (or take other action) When the sign becomes illegible due to pixel errors?	298
E.2	Does NTCIP 1203 v02 include a feature to automatically dim an LED sign at a defined high temperature in an attempt to reduce internal heat?	298
E.3	Does NTCIP 1203 v02 include a feature to control multiple physical signs from a single controller?	299
E.4	Does NTCIP 1203 v02 include a testing/training mode whereby a central can operate signs without any messages appearing on the face of the sign?	299
E.5	Does NTCIP 1203 v02 include a feature to control external devices such as HOV lane gates?	299
E.6	Wouldn't it be useful to have an object to report back the version of NTCIP 1203 v02/MIB that is implemented in the device (e.g. DMS)?	299
E.7	Does NTCIP 1203 v02 support the control of Lane Use Signals.	299
E.8	Why is the range of the "brightness output" in the dmsIllumBrightnessValues table 0..65535 instead of 0..dmsIllumNumBrightLevels?	299
E.9	What is the correct way to interpolate a brightness table, and why would you do it?	300
E.10	Why does NTCIP 1203 v02 not address NTCIP-specific traps?	300
E.11	Does NTCIP 1203 v02 support the capability to provide moving graphics (similar to moving text or arrows)?	301
E.12	How does NTCIP 1203 v02 address inverted fonts?	301
E.13	a mechanism to allow triggers to activate actions was Included in User Comment Drafts, but does Not appear in NTCIP 1203 v02. Why?	301
Annex F	ASCII Table and Description [Informative]	302
F.1	Standard ASCII Chart (7 bit = 2 ⁷)	302
F.2	Extended ASCII Codes (8 th bit => 2 ⁸)	302

Annex G SNMP Interface [Normative]	304
G.1 Generic SNMP Get Interface	304
G.2 Generic SNMP Get-Next Interface	304
G.3 Generic SNMP Set Interface	305
G.4 Variable Binding List Structure	306
G.5 Additional Requirements	306
G.5.1 Grouping of Objects in a Request	306
G.5.2 Support of Get	306
G.5.3 Support of Get-Next.....	306
G.5.4 Support of Set.....	306
G.5.5 Performance	307
Annex H NTCIP 1201 v03 Derived User Needs, Functional Requirements, and Dialogs [Informative]	308
H.1 Introduction	308
H.2 Derived GLOBAL Functional Requirements.....	308
H.2.1 Determine Device Component Information	308
H.2.2 Manage Time.....	308
H.2.3 Schedule Device Actions.....	308
H.2.4 Determine Supported Standards.....	309
H.2.5 Supplemental Requirements for Scheduling	309
H.2.6 Supplemental Requirements for Event Monitoring.....	309
H.2.7 Support a Number of Events to Store in Log.....	310
H.3 Derived GLOBAL Dialogs.....	310
H.3.1 Manage Communications Environment	310
H.3.2 Automatic Reporting of Events (SNMP Traps).....	312
H.3.3 Determining Device Component Information	312
H.3.4 Global Time Data.....	312
H.4 EXTERNAL DATA ELEMENTS.....	313

FIGURES

	Page
Figure 1 View of a Typical DMS System Architecture	23
Figure 2 Configuring a Font	102
Figure 3 Storing a Graphic.....	105
Figure 4 Configuring Light Output Algorithm.....	107
Figure 5 Activating a Message.....	108
Figure 6 Defining a Message	110
Figure 7 Defining a Schedule.....	112
Figure 8 Graphic State Machine	124
Figure 9 Control Mode State Machine	127
Figure 10 Message Table State Machine	129
Figure 11 Object Tree for NTCIP 1203 v02	292
Figure 12 SNMP Get Interface.....	304
Figure 13 SNMP Get-Next Interface	305
Figure 14 SNMP Set Interface	305
Figure 15 SNMP Interface—View of Participating Classes	306
Figure 16 Global Time Data.....	313

TABLES

	Page
Table 1 Relationship between Main User Needs Groups and National ITS Architecture Flows	31
Table 2 Symbols Indicating Status.....	34
Table 3 Predicate Notations.....	34
Table 4 Predicate Mapping to NTCIP 1203 v02 Sections	35

Table 5 Support Column Entries	35
Table 6 Possible Font State Machine Transitions	120
Table 7 MULTI Tags	216
Table 8 Field Descriptions.....	221
Table 9 Line Justification Codes	226
Table 10 Page Justification Codes	227
Table 11 Standard ASCII Chart	302
Table 12 Common Extended ASCII Codes	303

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Section 1 GENERAL [Informative]

1.1 SCOPE

NTCIP 1203 v02 specifies the logical interface between Dynamic Message Signs (DMS) and the host systems that control them (commonly referred to as “central” systems). NTCIP 1203 v02 describes the supported DMS functionality in terms of user needs and requirements; however, the nature of the interface is determined in part by the operational nature of the devices being controlled, and therefore NTCIP 1203 v02 touches on such operational issues on occasion.

NTCIP 1203 v02 assumes a model of DMS operation in which DMS controllers possess intelligence, and the data used for message display and sign configuration is resident at the DMS controller. In particular, data elements, such as fonts, graphics, message text, time-based schedules, and others, may reside at the DMS controller, and the controller renders messages on the sign face based on this data. (This model is typical of existing DMS applications, and may be contrasted with an alternate model in which, for example, the DMS controller only knows how to display static bitmaps, and all message layout and composition is performed by the central system.).

The DMS controller’s status, control, and configuration data are referred to as the “controller database”; NTCIP 1203 v02 specifies interfaces whereby the central system can manipulate this data. There are no imperative commands such as “Display a message” or “Report status”; the central system controls the behavior of the DMS purely through queries of, and changes to, the controller database using a suite of communication protocols appropriate for the underlying communications infrastructure. These communications protocols are defined in NTCIP Application Layer protocols (the NTCIP 2300-series), NTCIP Transport Layer protocols (the NTCIP 2200-series), and NTCIP Subnetwork Layer protocols (the NTCIP 2100-series).

NOTE—NTCIP 1203 v02 does not address the test procedures that are needed for each functional requirement. A successor of NTCIP 1203 v02 may address these test procedures..

When used for remote control of roadside and other transportation management devices, NTCIP-based devices and software can help achieve interoperability and interchangeability. When used between transportation and emergency management centers, NTCIP standards facilitate agency coordination and information sharing. For an overview of NTCIP standards, see NTCIP 9001 v04.

1.2 REFERENCES

Normative references contain provisions that, through reference in this text, constitute provisions of NTCIP 1203 v02. Other references in NTCIP 1203 v02 might provide a complete understanding of the entire protocol and the relationships 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

AASHTO / ITE / NEMA NTCIP 1102:2004	<i>Octed Encoding Rules (OER) Base Protocol</i> published October 2005
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AASHTO / ITE / NEMA NTCIP 1103 v02	<i>Transportation Management Protocols (TMP)</i> published July 2010
AASHTO / ITE / NEMA NTCIP 1201 v03	<i>Global Object (GO) Definitions</i> Publication anticipated
AASHTO / ITE / NEMA NTCIP 2301 v02	<i>Simple Transportation Management Framework (STMF) Application Profile (AP) (AP-STMF)</i> published July 2010

1.2.2 Other References

IAB Std. 16 / RFC 1155:1990 *Structure and Identification of Management Information for TCP/IP-based Internets*

IAB Std. 16 / RFC 1212:1991 *Concise MIB Definitions*

AASHTO / ITE / NEMA NTCIP 8004 v02	<i>Structure and Identification of Management Information (SMI)</i> published June 2010
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AASHTO / ITE / NEMA NTCIP 9001 v04	<i>The NTCIP Guide</i> published July 2009
---------------------------------------	---

NTCIP 2100—series	<i>NTCIP Subnetwork Profiles</i>
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NTCIP 2200—series	<i>NTCIP Transport Profiles</i>
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National ITS Architecture, Version 6.1	<i>National ITS Architecture, FHWA, 2009</i>
---	--

OMG Unified Modeling Language Specification, Version 1.5	<i>OMG Unified Modeling Language Specification, Object Management Group, 2003</i>
--	---

1.2.3 Contact Information

1.2.3.1 National ITS Architecture

The National ITS Architecture may be viewed on-line at <http://itsarch.iteris.com/itsarch/>.

1.2.3.2 NTCIP Standards

For revision information on NTCIP 1203 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 to NTCIP 1203 v02, and recommended revisions of the NTCIP Joint Committee, visit www.ntcip.org.

1.2.3.3 Object Management Group Documents

Copies of OMG standards may be obtained electronically from the Object Management Group at <http://www.omg.org>.

1.2.3.4 IAB Documents

For Internet Architecture Board (IAB) documents, contact:

Internet Architecture Board (IAB)

www.rfc-editor.org
www.rfc-editor.org/repositories.html

1.3 TERMS

The following glossary exhibits many DMS-related terms and abbreviations used in the ITS industry in an attempt to support the standardization of DMS-related terms. Terms NOT directly referenced in this document are indented. The development of this glossary was closely coordinated with the NEMA TS4 development effort.

activate	The action of placing a message in the current buffer and performing the logic of running the message. NOTE—Contrast with 'Display', which manipulates the sign display to make the current message visible to the driving public.
Activate Message	The command to direct the sign controller to display the message on the sign face.
Activation Priority	A numeric value between 1 and 255 that the controller compares to the Run-time Priority of the current message. NOTE—If the Activation Priority is greater than or equal to the Run-time Priority of the current message, the controller can replace the message. If the Activation Priority of the new Message is less than Run-time priority of the current message the controller rejects the activation of the new message.
Alternating Message	A message that contains more than one page of information/text.
Ambient Light Level	The amount of light surrounding the sign location.
ASCII	American Standard Code for Information Interchange, a 7-bit wide code used to represent a character set.
attribute	Shorthand notation for Message Attribute. Defines how a Message is displayed. See Message Attribute.
Axial Intensity	The brightness of light on the axis horizontally and vertically perpendicular to the sign face.
Backup Lamp	In a two lamp system, the secondary lamp that is used when the primary lamp has failed. Also, it may be turned on with the primary/normal lamp to create an over-bright illumination of the message.
beacon	A device that directs light in one direction and flashes (similar to a one-section traffic intersection signal head). The device is intended to increase a driver's attention to a message. The color is undefined (see also Strobe Light).

bitmap	A digital representation of an image having bit reference pixels.
BITMAP	A subset of the SYNTAX type OCTET STRING where every bit is a representation of a part or function (e.g., lamp 1 = bit 1, lamp 2 = bit 2).
BITMAP16	BITMAP with 16 bits.
BITMAP32	BITMAP with 32 bits.
BITMAP8	BITMAP with 8 bits.
Blank Message	A message that is devoid of informational content (blank) and the sign face is clear (all pixels off, or shutters closed depending on the display technology).
Blank Sign	A command or condition caused by a user command, error or fault condition, or default state in which a sign is not displaying a message, and depending on the display technology of the sign, has turned off lamps, LED drivers, etc.
Blank-Out Sign (BOS)	A type of DMS that has the capability to show a blank message or one fixed message.
border	The blank area between the outer most edge of the sign face and the outermost edge of the sign housing.
brightness	See Luminance.
Brightness Control	A term that defines how the light intensity of a sign is determined/set. Automatic control uses local detection of ambient light to determine the brightness level of the sign, whereas manual control defines the brightness level by a control command.
Brightness Level	The intensity of the light used to form a message or that would be used to form a message if one is not currently displayed. Usually selected in one of several ways. Some examples: a) NONE b) ON / OFF c) DAY / NIGHT/ OVERBRIGHT d) x of y levels e) a percent of maximum brightness output level
Bulb Matrix	See Lamp Matrix
cabinet	An enclosure that protects the device's controller from the elements.
Candela (cd)	An SI unit of measure for luminance.
Central Computer (CC)	A computer system that operates as a control source for one or more signs in the signage system. A computer/server that is host to its signs, also referred to as the host or central computer. The signage system may be controlled by central computers installed in more than one location. Or, it may be a remotely located central computer capable of managing the operation of one or more signs. NOTE—Also referred to as Central Control Computer.
Central Control Mode	A state whereby control of the sign is from the Central Computer. Preferred term for remote control mode.

Central Override Mode	A state whereby commands from Local Control Panel are ignored.
Central System (Sign Management Software)	The software that operates on the central computer controlling/monitoring signs.
Changeable Memory	A generic term for a type of memory that allows a user to modify the content. The content of the memory is not lost when power is turned off. See also Permanent Memory, Non-Volatile Memory, and Volatile Memory.
Changeable Message Sign (CMS)	A sign that is capable of displaying one of two or more predefined messages, or a blank message. The capabilities associated with a CMS are: a) drum sign with several faces, or pixel matrix b) several predefined message c) downloading of new messages, graphics or fonts not possible d) uploading of messages and graphic definition possible e) blank message possible f) all messages are defined g) may support more than a monochrome color scheme (each drum face may have a different color scheme, each face may have multi-color text) h) error report capabilities similar to VMS i) exercising of pixels
Changeable Messages	A library of messages stored in non-volatile memory/storage devices. See also Permanent Messages and Volatile Messages.
character	One symbol from a specific alphabet, font or character set.
Character Font	See Font.
Character Group	See Character Module.
Character Height	The vertical pitch times the number of pixels in the column of pixels.
Character Matrix Sign	A DMS sign that uses character matrixes with a fixed amount of blank space (no pixels present) between character matrixes to achieve the inter-character spacing. There is also blank space (no pixels present) between lines of characters to achieve the inter-line spacing.
Character Module, N	Component required to display N characters. This includes, but is not limited to, a subset of the following items based on the display technology of the sign: lamps, fiber, shutter, color filter, LED's, and frame to hold all of the above parts together as one unit.
Character Size	See Character Height.
Character Spacing	The spacing, in pixels, between two characters in line matrix or full matrix signs. The fixed amount of space between two characters on a character matrix sign.
Character Width	The horizontal pitch times the number of pixels in the row of pixels.
Characters Per Line	The number of characters that can be displayed on one line. Used in character oriented signs. Line matrix and full matrix signs are described as 'n' columns (pixels) wide.
checksum	A data error-detection scheme; the result of an algorithm performed on a block of data.

Climate-Contol	The ability to control the temperature and other factors affecting the environment in which the DMS electronics operates.
color	The chromaticity specified in terms of the CIE 1931 Colorimetric System. A visually perceived characteristic of light, specified at a particular wavelength in nanometers. NOTE—Color is one attribute used to display a message. Depending on the display technology of the sign, the color used to display a message may be fixed or selectable.
column	A vertical line of pixels.
Communication Failure	The condition when a central computer cannot communicate with the sign controller due to errors or malfunctions.
Communication Interface	The communication port(s) on the controller used to communicate with other device(s).
compatible	The ability of two or more systems or components to exchange information (IEEE Std. 610.12-1990: IEEE Standard Glossary of Software Engineering Terminology).
Cone of Vision	The geometric figure (cone) used to define the area in which a message on a sign can be legibly viewed. It is measured in degrees. It is twice the angle from the axis of the pixel to the 50% brightness point on an LED display. The cone of vision is also known as the “viewing angle”.
configuration	The setting of the parameters within the controller to operate the sign with a defined set of ranges, parameters and functions.
configure	To change one or more settings in the device.
consistent	The ability of two or more systems or components to exchange information, and use the supported information that has been exchanged, and gracefully reject any unsupported information according to defined rules.
Contrast Ratio	The amount of measured light emanating from the message divided by the amount of measured light reflected from the background.
Control Mode	Defines the current method by which the sign controller receives instructions.
controller	See Sign Controller.
Controller Address	See Sign Address.
Controller Failure	The condition caused when the DMS Controller does not properly perform its intended functions.
Controller Reset	A function that restarts the controller from an initialization process. NOTE—This may be activated via time-outs of an event (watchdog, power loss), local reset button, or software command.
current	a) Reflecting the conditions at the present time (or at the time at which the data is time stamped) as determined by the controller. b) b) The amount of electric charge flowing past a specified circuit point per unit time

Cyclical Redundancy Check (CRC)	A data error-detection scheme. A polynomial algorithm is performed on a block of data. NOTE—There are different algorithms involving a different number of bits and bytes in the calculation such as CRC-16 and CRC-32. (see also Frame Checking Sequence)
Default Message	Under normal operating conditions, this term specifies the neutral message. Under default conditions, communications failure, power loss, power recovery, and communications time-out, the default message is the message displayed as defined by the corresponding objects (see Section 5). These may or may not be the same as the neutral message.
Default State	A defined mode of operation assumed when no other instructions have been received.
deprecated	This term is defined in NTCIP 8004 v02.
depth	The distance between the front and back of a sign or other enclosure. It can be measured as both inside and outside dimension.
determine	To read information from the device.
diagnostics	A set of routines operated in the controller used to verify the proper operation of the DMS components.
display	To reveal a message to the traveling public once it has been activated. NOTE—Also see related terms: sign face (a DMS component), activate message (a command), and message (the image)
Display Activation Time	The length of time required to display a page of text on the sign once the complete command has been received by the controller.
Display Module	See Character Module.
Display Technology	The means used to present a message, e.g., shuttered fiber, LED, flip disk, lamp matrix, combination of the two, etc.
Display Times	The time parameters within a message attribute.
DMS Controller	See Sign Controller.
DMS Housing	The enclosure that environmentally protects the components of the Dynamic Message Sign.
DMS Manufacturer	The company that maintains a factory and staff that develops, engineers, and manufacturers the complete DMS sign assembly and DMS Controller from raw materials and components.
dot	One pixel in a display matrix.
download	To transfer information from the central computer into the referenced field device.
drum	The multifaceted cylinder, with associated lighting, motor/brake drive unit and position sensing switches that rotates to display one face to the motorist.
Drum Sign	A type of CMS using one or more drums to display a message.

Dynamic Message Sign (DMS)	Any sign system that can change the message presented to the viewer, such as VMS, CMS and BOS. It includes the following major components: sign face, sign housing, controller, and, if present, the controller cabinet.
Electrically Erasable Programmable Read Only Memory (EEPROM)	A variation of an EPROM chip in that instead of erasing the memory by placing it under UV light, portions of the chip can be erased electrically, and, thus, does not need to be removed from the circuit, provided the circuit supports erasing the chip.
Electromagnetic Shutter	A device that can be positioned via a pulse of electricity, and stay in the desired position due to an internal magnet.
Environmental Controls	Equipment to control the temperature and/or humidity within an enclosure, typically the sign housing and/or controller cabinet. This can include fans, heaters, thermostats, humidistats, override timers, motorized louvers, filters, ducting.
Erasable Programmable Read Only Memory (EPROM)	A variation of a PROM chip where the contents can be changed by erasing the chip with a UV light eraser and then programming the chip again.
external device	A component that is not normally considered part of a DMS, but is connected to the DMS by some interface.
External Illumination	A light source shining on the face of the sign so that its message may be read by the motorist.
External Input	The communication interface with an external device.
Extinguishable Message Sign (EMS)	See Blank-Out Sign.
Feature	A service provided by / behavior of the device.
Fiber Optic	A slender thread-like strand of material used to carry light.
Fiber Optic Bundle	Many fiber optic strands combined into one larger group. A fiber optic bundle terminates at one end on the sign face, the other end terminates at the light source.
Fiber Optic Harness	A number of fiber optic bundles grouped together with one common end. The common end is inserted in the lamp module.
Fiber Optic Sign	A light emitting sign whose pixels are made of ends of fiber optic bundles.
Fiber Optic/Flip Disk Hybrid	A reflective flip-disk type of sign that employs a fiber optic display technology in addition to the reflective flip disk.
firmware	The logical programming stored in a controller's memory to operate the controller.
Flash EPROM	A type of EEPROM with rapid programming capability.
flasher	A device that causes beacons to flash.
flashing	A message attribute causing all or parts of a message to turn on and off.
Flashing Beacons	See Beacon.
Flashing Display	A one page message that alternates between on and off.

Flip Disk	A two-state display technology using an electro-mechanically actuated disk for each pixel position. One side of the disk displays the ON state of the pixel and another side represents the pixel's OFF state.
Flip LED	A hybrid display technology that combines flip-disk and LED technology.
font	A type style for a set of characters (letters, numbers, punctuation marks, and symbols).
Forced Air Cooling	A device used to reduce the temperature within an enclosure or housing by moving air.
Forced Air Ventilation	A device used to force out the air inside the enclosure or housing and introduce new air from the outside.
Frame	See Page.
Frame Checking Sequence (FCS)	Defines the value to be used within data packet frames for error detection. Implementations claiming conformance with this standard shall use the default International Telegraph and Telephone Consultative Committee (CCITT) 16-bit FCS as defined in ISO/IEC 13239:2002. NOTE—Object definitions representing a CRC result in NTCIP 1203 v02 rely on this ISO/IEC 13239:2002 definition and that the FCS is determined most significant byte first, but transmitted least significant octet first.
front	The side of the sign containing the visible message.
Front Access	Access to the internal components of the sign accomplished via access panels or access doors located on the front of the sign.
Full Matrix	A type of VMS with the entire display area containing pixels with the same horizontal pitch and the same vertical pitch without fixed lines or characters. A full matrix sign is characterized by its ability to address and change each pixel independently.
Full Standardized Range	The range of values identified and fully specified within a standard. Values left for proprietary use (e.g., the value 'other' in enumerated lists) are not a part of the Full Standardized Range since the meaning of the value is not 'fully specified'.
graphic	An image that is stored within the controller's memory and can be inserted into a message.
Graphical User Interface (GUI)	The presentation of information to the user on a screen in graphic format.
Host Computer	See Central Computer.
housing	The enclosure of the sign containing the display elements.
Illumination Power	The energy source for message illumination.
intensity	The brightness of light emanating from the display, expressed in candela per unit area.

interchangeability	A condition which exists when two or more items possess such functional and physical characteristics as to be equivalent in performance and durability, and are capable of being exchanged one for the other without alteration of the items themselves, or adjoining items, except for adjustment, and without selection for fit and performance. (National Telecommunications and Information Administration, U.S. Department of Commerce)
Interoperable	The ability of two or more systems or components to exchange information and use the information that has been exchanged (IEEE Std. 610.12-1990: IEEE Standard Glossary of Software Engineering Terminology).
interface	An interface is a named set of operations that characterize the behavior of an element (Unified Modeling Language Specification)
Inter-Line Spacing	The amount of vertical space between two lines. The distance from the bottom of the bottom pixel on a line to the top of the top pixel on the line immediately below. On full matrix signs, it is measured as the number of pixel rows between lines of characters.
Internal Illumination	A light source within the sign housing that shines through the front of the sign, so that its message may be read by the motorist.
Internal Lighting	The lighting used for maintenance inside an enclosure or housing, independent of message illumination.
interoperability	The ability of two or more systems or components to exchange information and use the information that has been exchanged. NOTE—See IEEE Std. 610.12-1990.
lamp	A light source used to illuminate the utilized pixels other than on a pixel-by-pixel basis. Fiber optics technology uses lamps to illuminate bundles of pixels.
Lamp Control Module	The device used to control the power going to the lamps.
Lamp Driver Module	An electronic board that directly supplies or disconnects power to the lamps to turn them on or off.
Lamp Driver System	See Lamp Control Module.
Lamp Matrix	A type of display technology where an incandescent light source is used for each pixel.
Lamp Status	The feedback data which indicates the operational status and condition of the lamp circuit.
LAN	Local Area Network – An intelligent control network that facilitates communication between devices that sense, monitor, communicate and control.
Lane-Use Control Sign (LCS)	Overhead sign having displays that permit or prohibit the use of a lane or that indicate impending prohibitions of use [excerpted from MUTCD, clause 4E-8]. A sign that contains multiple symbols to indicate the permissive use of the lane in the direction of travel. Abbreviated LCS.

LED Driver Module	An electronic board that contains the control and memory elements to provide the signals to switch the LED pixel state, and which detects the operation of each individual pixel that it controls.
LED Sign	A sign with pixels made from LED's.
LED/Flip-Disk Hybrid	A type of VMS display technology that forms pixels with a combination of LED and flip disk technology. The LED is used for night viewing and the flip disk is used for daytime viewing.
legend	Unchangeable text on a sign face.
Legibility Distance	The 85 percentile distance at which people with 20/20 corrected vision can read the display.
Light Emitting Diode (LED)	A type of display technology using a semi-conductor device that emits a point of light in a controllable manner. The characteristics of the point of light are determined by the type of LED used, e.g. color, cone of vision, luminance, etc. Abbreviated LED.
Light Output Level	See Brightness Level.
line	A horizontal row of character modules (character or line matrix signs) or number of rows of pixels (full matrix signs) used to display text.
Line Matrix	A type of VMS sign that has no hardware defined blank spaces (no pixels) between characters. The entire line contains columns of pixels with a constant horizontal pitch across the entire line.
Local Control Mode	One of several possible control modes to control a DMS. Local control mode is the primary control mode from the local control point (this could be a Local Control Panel or a locally connected device such as a laptop or a Personal Digital Assistant (PDA)).
Local Control Panel	A system of switches or a keyboard located at the DMS that allows a person on-site control of the DMS, as opposed to control from a remote location via external communication.
Locally Activated Messages	Stored messages, which are activated from the local control panel.
Lumen	The unit of luminous flux emitted in a solid angle of one steradian by a uniform point source that has an intensity of one candela.
Luminance	The intensity of light per unit area at its source. Usually measured in candela per square foot or candela per square meter.
LUS	See Lane-Use Control Sign.
Lux	A measurement of light. A unit of luminance produced on a surface area of one square meter by a luminous flux of one lumen uniformly distributed over the surface. (1 lux = 1 lumen per sq. meter)
Magnetic Memory	Memory based on magnetic power to keep an object in a desired position without the use of continuous electrical power.
Maintenance Computer	See Portable Maintenance Computer.
Maintenance Portable Computer	See Portable Maintenance Computer.
Manage	To monitor, command, and/or control.

Management Information Base (MIB)	Set of object definitions that define the attributes, properties and controllable features of devices on a network, which can be remotely monitored, configured and controlled. The information is provided in a format called Abstract Syntax Notation. 1 (ASN.1), which is an international standard for defining objects.
Management Station	A computer or computer network that can interact with the device via the defined interface to realize the features of the device.
Management System	See Management Station
Mark Up Language for Transportation Information (MULTI)	Name of format of the textual part of a message. NOTE—The format is defined in NTCIP 1203 v02 Section 6 (NTCIP 1203: 1997 Section 3).
Master Computer	See Central Computer.
Master Computer Software	See Central Computer.
Master Controller	Obsolete term for central computer.
Master/Slave	The master is the controlling entity on a data link. It can give permission to any slave on the same link to transmit data. A slave transmits data only in response to permission from the master and it returns control to the master after finishing a transmission.
Matrix	An array of pixels that can display an image.
Matrix Sign	A DMS that uses an array of pixels to display a message or part of a message (e.g., a line or character). Matrix signs are typically VMS because the pixel array allows for a large variety of possible displays.
Message	The information to be displayed to the traveler and how it is to be displayed.
Message Attribute	The characteristics that define how a message shall be displayed. This includes how many pages of text, the amount of time each page is displayed, any flashing of text, the flashing time characteristics, and color definition. Not all technologies / manufacturers support all display attributes. Specific support for these items is based on the type of display technology and manufacturer.
Message Command	A controller command to activate a message on the sign.
Message Display Time	See Message Duration.
Message Duration	The time from message activation to message deactivation.
Module	One assembly of components, like several similar assemblies, that each fit together to make one larger single unit with a unique purpose.
Multi-Drop	A communications architecture where multiple devices share a common communications channel.
Multi-Message Sign	See Changeable Message Sign.
Multi-Page Message	A message that has more than one page of text / graphics.

Neutral Message	A predefined generic message that is displayed when the sign is not commanded to show time-sensitive information.
Neutral State	When a sign is blank or displaying a neutral message.
Non-Volatile Memory	A generic term for memory that does not lose its content when power is turned off. See also Changeable Memory, Permanent Memory and Volatile Memory.
Normal Lamp	See Primary Lamp.
object	A data structure used to monitor or control one feature, attribute or controllable aspect of a manageable device.
obsolete	This term is defined in NTCIP 8004 v02.
Off-Axis Angle	The angle from the optical axis of the LED, at which, the luminous intensity is one-half that at the optical center.
operator	An individual who needs to interact / interface with the device via the central system software to control and/or monitor its operations.
Optical Center	The point on an LED or output end of a fiberoptic bundle where luminous intensity is at its maximum.
Optical Fiber	See Fiber Optic.
page	The information that can fit on a sign at one time, together with its message attributes.
Permanent Memory	A generic term for memory that cannot be changed without physically replacing hardware components. See Changeable Memory, Non-Volatile Memory, and Volatile Memory.
Permanent Messages	A library of stored messages in read-only devices. See also Changeable Messages and Volatile Messages.
phase	See Page
Photo Sensor	A light measuring device used to quantify the ambient light conditions at the sign.
Photocell	See Photo Sensor.
Photoelectric Cells	See Photo Sensor.
Physical Address	The Data Link identifier which differentiates a field device in a multi-drop or point-to-point communication circuit, to allow the central computer to communicate with a specific field device. Also see 'sign address'
pitch	The center-to-center distance between two adjacent pixels, that is measured either horizontally or vertically.
pixel	The smallest independently controllable visual element of a VMS.
Pixel Service	A generic term for a cyclic maintenance service that exercises mechanical pixels to prevent sticking. The service may or may not be enabled during the display of a particular message.
Point-To-Multi Point	A communications architecture that supports communications between a central system and many devices. Also called multi-drop communication.

Point-To-Point	A communications architecture that supports dedicated communications exclusively between two devices.
Portable Maintenance Computer (PMC)	A portable computer running maintenance software. It can communicate with a sign controller, control activation of the sign, and perform diagnostics on the controller.
Portable Remote Computer	A portable computer running as a remote computer.
Primary Lamp	In a two-lamp system, the lamp that is turned on first.
Primary/Secondary	See Master/Slave.
Programmable Read-Only memory (PROM)	A semiconductor device, memory chip that can be programmed once with a specific data set via a specialized electronic instrument, PROM programmer. The data programmed into the chip cannot be altered once it has been programmed.
Protocol	A specific set of handshaking rules, procedures and conventions defining the format, sequence and timing of data transmissions between devices.
Random Access Memory (RAM)	Memory that can be independently accessed at any location in a sequential or non-sequential order. Depending on the technology, the content of memory may be lost when power is turned off. Abbreviated RAM.
recovery	The action(s) performed by a controller to restore normal operation after an interruption disrupts or terminates the controller's normal operation.
Remaining Message Display Time	The amount of time before the message currently being displayed is turned off.
Remote Computer	A computer that can access the central computer from a remote location.
Remote Computer Software	The application software that runs on the remote computer enabling it to communicate with the central computer's software.
Remote Control Mode	See Central Control Mode.
requirement	A requirement describes a condition or capability to which a system must conform; either derived directly from user needs, or stated in a contract, standard, specification, or other formally imposed document. A desired feature, property, or behavior of a system.
Requirements Traceability	The ability to follow or study the logical progression among the needs, requirements and design details in a step-by-step fashion.
reset	See Controller Reset.
Resident Software	The software located in the controller. See also firmware.
retired	Within the SYNTAX field of an 'OBJECT-TYPE' macro, a status term used to classify an enumerated value for those values found to be flawed, or not useful, or no longer relevant. The term is only used within object definitions with enumerated values.
return	When discussing device requirements for providing data when an external system requests it, the term 'return' shall be understood that the data is sent to the requester.

rotate	To move a shutter to its opposite state (open or closed). To move a drum to the next position.
Rotational Shutters	A type of shutter that spins in one direction on an axis perpendicular to the light blocking device.
rotor	The motor/brake drive unit and position sensing switches that rotates to display one face of a drum to the traveler.
Run-time Priority	A numeric value between 1 and 255 that the Controller uses to determine the importance of a message, 1 lowest and 255 highest. NOTE—To activate a new message, the Activation Priority of the new message is required to be greater than or equal to the Run-time Priority of the current message. If the Run-time Priority of the current message is greater than the Activation Priority of the new Message, then the controller rejects activation of the new message.
scenario	A preset plan which assigns specific displays or actions to a specific sign or device when a predefined condition is detected. Also known as sequence.
schedule	A mechanism by which an operator can define times in the future at which the controller performs actions.
Secondary Lamp	The lamp that is turned on to replace a failed primary/normal lamp (see Backup Lamp). Also turned on with the primary/normal lamp to create an over-bright illumination of the message.
Semi-Graphic Character	A character font that contains graphic shapes that fit within a character matrix.
sequence	See Scenario.
Shutdown Power	A type of power that is often referred to as 'last breath power'. NOTE—The exact number of minutes/seconds associated with this type of power is not defined, but should be sufficient to allow the device's computer to save the already collected data and to safely boot down.
shutter	A non-reflective device that either completely occludes or completely allows light from a light emitting pixel. NOTE—A shutter and a flip disk are not to be intermingled or confused.
Shutter Driver Module	An electronic board that supplies the low voltage pulses to move the shutters into their open or closed positions.
Shutter Power Supply Module	An electronic board that supplies and monitors power to the shutters.
Shuttered Fiber	A type of DMS display technology using shutters and fiber optic.
sign	The sign housing, all of its contents, and all items attached to the sign housing that are used as part of the sign (e.g. photo sensors, contrast shields, static message signing, beacons, etc.).
Sign Access	The approach direction or mechanism used to gain access to the internal components of the sign, e.g. front, rear, walk-in.

Sign Address	A unique value assigned to each device on a communication channel. Used to identify the device for which the data packet is intended. Also called controller address, drop address.
Sign Controller	A device used to control and monitor the operations of a sign. It can have a variety of control interfaces, such as a local control panel, a local portable maintenance computer, or a central computer. The equipment within the controller is not specified by this term.
Sign Erasure	The act of clearing a message from the sign face.
Sign Face	The portion of the sign that can be controlled by the user or a management station.
Sign Height	The vertical dimension of the sign face.
Sign Housing	The sign face enclosure.
Sign Off	The state in which the sign is not displaying a message and all message drivers (lamps, LED drivers, etc.) are turned off. This is different from a display that contains all spaces.
Sign Status	The feedback data returned from the sign controller that indicates the operational condition of the sign, or the sign's components.
Sign Subsystem	A primary component of the DMS that can be separately monitored.
Sign Width	The horizontal dimension of the sign face.
Sign Writing	The process of changing a sign from its previous state to displaying a message.
spacing	The blank area between 2 adjacent characters. This is a hardware defined fixed distance in character matrix signs. In a line matrix sign, the horizontal (inter-character) spacing is variable and controlled by the controller software and the pixel spacing of the sign. In a full matrix sign, both horizontal inter-character and vertical inter-line spacing is variable and controlled by the controller software and pixel spacing of the sign.
Agency Specification	The project-specific detailed requirements for a DMS to be purchased by an agency or a statement by a manufacturer defining the detailed features provided by the DMS. NOTE—In NTCIP 1203 v02, often refers to the text contained in the 'Additional Project Requirements' column of the PRL.
Start-up State	Either a blank message, a default message or the last valid display before the start-up.
Static Display	A message that uses only one page of text.
Static Message Panel	See Legend.
status	The current condition of a referenced function or device.
Stored Messages	All messages loaded in a sign controller's memory.
strobe	A form of a Beacon.
Strobe-Light	See Strobe.
Stroke Width	The width or diameter of a pixel.

Sub-feature	A service that is part of a larger service. A specialization of a more generic feature.
Supplemental Beacon	See Beacon.
Temperature Sensor	A device used to measure the temperature and report it to another device.
Temporary Memory	A sign controller's storage area, or memory, that contains a message or message library that can be manipulated while the controller is operating on-line. This feature enables a central computer to download and update a message or message library into the sign controller.
Text (Sign Text)	The characters used to create a message, without any information on how the characters are displayed.
Traffic Management Center (TMC)	The location of the central computer and equipment which allows operations staff to monitor and manage traffic through roadside field devices (e.g. vehicle detectors, VMS, etc.).
Traffic Operations Center (TOC)	See Traffic Management Center.
traveler	A person that is using the publicly accessible transportation network.
upload	To transfer information from the referenced field device to the central computer, or an attached portable computer.
user	A person who uses the system that is developed.
User Need	The business or operational problem (opportunity) that must be fulfilled to justify purchase or use. While this is termed a 'user need' within the NTCIP community, it reflects needs of all stakeholders.
validate	To ensure that an item of interest is as intended. For example, to ensure that a graphic has been stored without any errors.
Variable Message Sign (VMS)	A type of DMS, which allows a user to create and download the message to be displayed into the temporary memory area of the sign controller.
Ventilation	The process of replacing existing air with new air. Typically done to cool the enclosure (sign housing, controller cabinet).
Viewing Angle	See Cone of Vision.
Visibility	The ability to view an object. The greatest distance at which the sign can be seen without the aid of any instruments. NOTE—This term does not reflect Legibility.
Volatile Memory	A generic term for memory that allows a user to modify the content, however loses its content when power is turned off. See also Changeable Memory, Permanent Memory, and Non-Volatile Memory.
Volatile Messages	A library of messages stored in read-write memory devices that lose their data upon loss of power. See also Changeable Messages and Permanent Messages.

Watchdog

Circuitry that monitors the controller software and firmware for a stall condition. While the DMS Controller is powered on, the software polls the watchdog and resets the timing circuitry. If the watchdog circuitry times out without being reset by the software, the watchdog counter is incremented and the controller hardware is reset to clear the potential stall condition.

X by Y Character Matrix

An array of pixels, X columns wide by Y rows high, used to display a single character. The pixels are based on the display technology of the sign, fiber optic, LED, bulb, flip disk, etc. A single character module having 5 columns and 7 rows of pixels could be called a “5 by 7 character module” or a “5x7 character module”.

Section 2

CONCEPT OF OPERATIONS

[Normative]

Section 2 defines the user needs that subsequent sections in NTCIP 1203 v02 address. Accepted system engineering processes detail that requirements are developed to fulfill well-defined user needs. The first stage in this process is to identify the ways in which the system is used. In NTCIP 1203 v02, this entails identifying the various ways in which transportation operations personnel may use DMS information to fulfill their duties.

This concept of operations (ConOps) provides the reader with:

- a) A detailed description of the scope of NTCIP 1203 v02;
- b) An explanation of how a DMS device is expected to fit into the larger context of an ITS system;
- c) A starting point in the procurement process; and
- d) An understanding of the perspective of the designers of NTCIP 1203 v02.

Section 2 is intended for all readers, including:

- a) Transportation operations managers
- b) Transportation operations personnel
- c) Transportation engineers
- d) System integrators
- e) Device manufacturers

The first three categories of readers may use Section 2 to understand how DMS equipment can be used in their system. Section 2 also serves as the starting point in the procurement process, gaining familiarity with each feature covered by NTCIP 1203 v02, and determining whether a feature is appropriate for their implementation. If the feature is, then the agency specification requires the feature, and all of the mandatory requirements related to that feature.

The last two categories of readers may use Section 2 to gain a more thorough understanding as to why more detailed requirements (specified in subsequent sections of NTCIP 1203 v02) exist.

2.1 TUTORIAL [INFORMATIVE]

For readers and users, Section 2 provides a more succinct overview of NTCIP 1203 v02.

A concept of operations, or 'ConOps', describes a proposed system from the users' perspective. Typically, a ConOps is used on a project to ensure that system developers understand users' needs. In NTCIP standards, the ConOps documents the intent of each feature for which an NTCIP standard supports a communications interface. The ConOps also serves as the starting point for users to select the features may be appropriate for their project.

The ConOps starts with a discussion of the current situation and problems that have led to the need to deploy systems covered by the scope of the standard, and to the development of the standard itself. Using layman's terms, both potential system users and system developers understand and appreciate the situation.

The ConOps then documents key aspects about the proposed system, including the:

- a) **Reference Physical Architecture**—The reference physical architecture defines the overall context of the proposed system and defines the specific interface addressed by NTCIP 1203 v02. The reference physical architecture may be supplemented with one or more samples that describe how the reference physical architecture may be realized in an actual deployment.
- b) **Architectural Needs**—The architectural needs section discusses the issues and needs relative to the system architecture that have a direct impact on NTCIP 1203 v02.
- c) **Features**—The features identify and describe the various functions that users may want the device to perform. These features are derived from the high level user needs identified in the problem statement, but are refined and organized into a more manageable structure that form the basis of the traceability tables in Section 3 and Annex A.

The architectural needs and features are collectively called ‘user needs.’ Section 3 uses these user needs in the analysis of the system to define the various DMS functional requirements. Each user need is required to be traceable to one or more functional requirements, and each functional requirement is required to be derived from at least one user need. This traceability is shown in the Protocol Requirements List (PRL) as provided in Section 3.3.

While NTCIP 1203 v02 standardizes communications across a wide range of deployments, it is not intended to mandate support for every feature for every deployment. Therefore, the PRL also defines each user need and requirement as mandatory, optional, or conditional. The only items marked mandatory are those that relate to the most basic functionality of the device. To obtain a device that meets specific needs, the user first identifies which optional needs are necessary for the specific project.

Each requirement identified is then presented in the Requirements Traceability Matrix (RTM) in Annex A, which defines how the requirement is fulfilled through the standardized dialogs and data element definitions provided in Sections 4 and 5.

In conclusion, the ConOps describes the degree to which security issues have been addressed by NTCIP 1203 v02, and provides a description of how NTCIP 1203 v02 relates to the National ITS Architecture.

2.1.1 About NTCIP 1203 v02

NTCIP 1203 v2 specifies the logical interface between Dynamic Message Signs (DMS) and the host systems that control them (commonly referred to as central systems). NTCIP 1203 v02 describes the supported DMS interface functionality in terms of user needs and requirements.

As for limitations, NTCIP 1203 v02 defines the data that could be transmitted between a central system and a conformant DMS, but NTCIP 1203 v02 does not define the functionalities and functions available within a DMS or a central system. Also, NTCIP 1203 v02 does not claim to address all potential capabilities of a DMS or a controlling/monitoring Central System; if NTCIP 1203 v02 made this claim, no progress could be made (e.g., if NTCIP 1203 v02 would not allow for the possibility of defining extensions, no additional functionalities could be added, by either NTCIP 1203 v02 itself or by vendors or agencies).

Readers should understand that not all functionalities have to be supported by a DMS (or a Central System) to claim conformance to NTCIP 1203 v02. Instead, the project-specific or agency specifications that do reference and incorporate desired applicable functionalities from NTCIP 1203 v02 (NTCIP 1203v2) are the guiding requirements that determine compliance.

2.1.2 Who are you?

In writing NTCIP 1203 v02, we, the NTCIP DMS Working Group, made some assumptions about who you are and what you are seeking from NTCIP 1203 v02. Even if only one of the following describes why you are looking into NTCIP 1203 v02, you are part of the target audience for this document:

- a) You have heard about the National Transportation Communications for ITS Protocols (NTCIP) and are interested in its applicability for deploying variable message signs, changeable message signs (drum signs), or blank out signs.
- b) You are involved in writing project-specific or agency specifications to procure these types of signs.
- c) You are involved in reviewing submittals to procure these types of signs.
- d) You are involved in the software development, be it the firmware of a sign or the software of a central system.
- e) You are involved in testing the signs and/or the central system.
- f) You are involved in the operational use of these types of signs.

2.1.3 How NTCIP 1203 v02 is Organized

NTCIP 1203 v02 includes the following sections:

- a) Section 1, General—Provides references, glossary, and other information.
- b) Section 2, Concept of Operations—Provides a description of user needs (needs for features and needs related to the operational environment) applicable to DMS systems.
- c) Section 3, Functional Requirements—Defines the functional requirements that address the user needs identified in the ConOps. It includes a Profiles Requirements List (PRL) that defines conformance requirements, thereby allowing users to select the desired options for a particular project. An additional table identifies supplemental requirements that show requirements that are used more than once by different main functional requirements. A third table identifies the supplemental requirements for the MULTI tags and provides an indication of the functional requirement that a particular MULTI tag fulfills.
- d) Section 4, Dialogs—Describes how each functional requirement is fulfilled. Dialogs define the standardized procedures for a central system to manage a sign.
- e) Section 5, Management Information Base (MIB)—Defines the data elements (object definitions) exchanged during communications (an update of NTCIP 1203:1997 Section 2).
- f) Section 6, Markup Language for Transportation Information (MULTI)—Defines the language used to communicate to the sign how a message is to be displayed. Similar to HTML, tags are included to specify the attributes of a message and how it is displayed on a sign (an update of NTCIP 1203:1997 Section 3).

NTCIP 1203 v02 also includes seven annexes:

- a) Annex A, Requirements Traceability Matrix (RTM)—Provides two tables. The first table traces each requirement to a dialog, one or more interfaces, and its associated list of objects. The second table identifies supplemental traces for requirements that are used more than once for various requirements.
- b) Annex B, Object Tree—Provides a depiction of the high-level object tree showing the nodes and some of the scalar objects. This object tree provides the user with a high-level orientation tool to navigate the data elements.
- c) Annex C, Test Procedures—Currently a placeholder for standardized test procedures that address the needs and requirements. These test procedures have not been finalized, and, therefore, no test procedures are provided.
- d) Annex D, Documentation of Revisions—Documents (significant) revisions in NTCIP 1203 v02 that have been made since the preceding version of NTCIP 1203 v02.
- e) Annex E, Frequently Asked Questions (FAQs)—Provides answers to some user questions.
- f) Annex F, ASCII Table and Description—Provides ASCII tables and the descriptions of the ASCII characters used, to avoid ambiguities among different versions, particularly for the extended ASCII character.
- g) Annex G, SNMP Interface—Defines the functionalities associated with the Simple Network Management Protocol (SNMP).
- h) Annex H, NTCIP 1201 v03 Derived User Needs, Functional Requirements, and Dialogs—Derived user needs, functional requirements, and dialogs are presented.

2.1.4 Intended Audiences for the Sections in NTCIP 1203 v02

NTCIP 1203 v02 has been designed for different audiences. For example, as an agency specification Writer, a good understanding of functional and operational requirements and the contexts for which the overall technical requirements of the signs are to be used. As a Submittal Reviewer, a Firmware/Software Developer, and/or a Tester, project-specific or agency specifications (or Technical Provisions) are also needed. For an audience, the following section(s) may be of particular interest:

- a) General Interest Users—Review Sections 1 and 2, and Annex E.
- b) Agency Specification Writers—Review Sections 1, 2, and 3, and Annex E
- c) Submittal Reviewers—Review Sections 1, 2, and 3, and Annexes A and E.
- d) Firmware/Software Developers—Review all sections and annexes
- e) Testers—Review all sections and annexes
- f) Operators—Review Sections 1 and 2, and Annex E.

2.2 CURRENT SITUATION AND PROBLEM STATEMENT [INFORMATIVE]

Transportation system managers use DMS in a variety of ways to improve transportation system operations. To perform their jobs, transportation system managers need to convey a variety of information to the traveling public. The information can be:

- a) Advisory, such as information about transit vehicle arrival times, road closures, traffic congestion, estimated travel times, and weather warnings,
- b) Regulatory, such as speed limits, mandatory detour information, or high occupancy vehicle (HOV) lane access requirements.

DMS are one tool that can be used to convey this information to the traveling public. Based on their perceived needs, transportation system managers decide what capabilities they may need within their DMS and where DMS are deployed.

Depending on the needs and other factors (such as resources), DMS may be deployed in a network to provide coordinated operations, or as stand-alone devices to provide information to travelers in areas where no integrated network capability exists.

DMS can be deployed in both stationary deployments, such as the roadside (overhead or side mounted), or on transit platforms, or portable on moveable vehicles. Additionally, different communications technologies—such as dial-up (e.g., via land-lines for stationary signs or to portable signs placed on permanent pads where dial-up lines have been provided), serial (mostly provided to stationary signs), or Ethernet (e.g., via hardwire or even over wireless networks)—are used to communicate with DMS.

2.3 REFERENCE PHYSICAL ARCHITECTURE [INFORMATIVE]

NTCIP 1203 v02 addresses the communications interface between a management station and a controller. Further explanation of the typical physical architectures used in conjunction with DMS, and addressed by NTCIP 1203 v02, follows.

2.3.1 Typical Physical Architecture

Once installed, the operator is able to control the DMS through one of three mechanisms:

- a) Central computer—this type of operation configures and manages DMS from a computer located at a traffic management location, such as a Traffic Management Center (TMC). This is known as either 'central' control or 'remote' operation.
- b) Local computer—this type of operation performs the same functions as a central computer, but uses a portable (e.g., laptop) computer connected directly to a port at the DMS sign controller. This is a form of 'local' control.

- c) Locally—this type of operation uses the control devices (e.g., keyboard, switches) at the DMS sign controller to perform the functions of configuring and managing the DMS. This is another form of 'local' control.

The connection between the central computer and the DMS runs over a telecommunications network, which can be either wireline or wireless in nature. Figure 1 depicts the physical architecture of the key components related to a typical DMS system controlled from a central location.

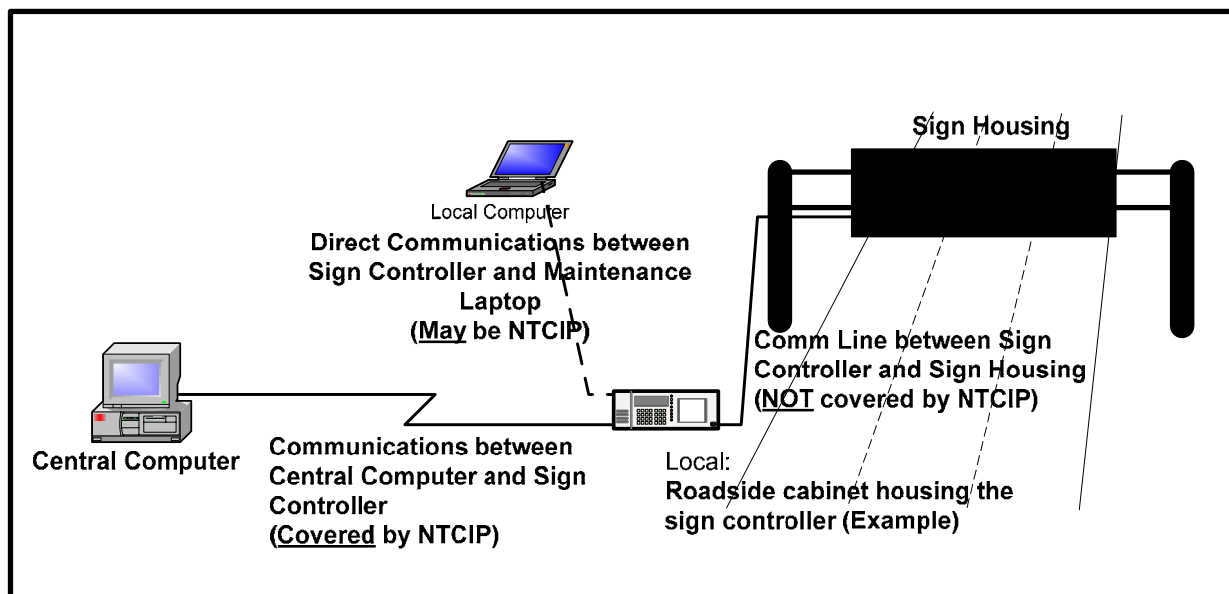


Figure 1 View of a Typical DMS System Architecture

NTCIP 1203 v02 is only concerned with the interface between an external computer and the DMS sign controller. To fulfill all of the end-user services, additional requirements may be necessary for the external computer.

2.3.2 DMS Characteristics

A factor that complicated the development of NTCIP 1203 v02, and that complicates the work of an agency specification writer, is that there are a wide variety of DMS available in the marketplace. To promote interoperability among the different signs, NTCIP 1203 v02 provides a single protocol that is compatible with all of these varied DMS. However, the varied nature of these signs dictates that many of the features defined in NTCIP 1203 v02 are not applicable to all DMS. Thus, the user is required to categorize the DMS according to several key characteristics prior to determining which requirements are mandatory for a particular project and/or type of DMS (in a way). These characteristics include DMS Type, DMS Technology, and DMS Display Matrix Configuration.

NOTE—An agency specification can allow for any of several types, technologies, or display matrix configurations by leaving the selection of these items as optional, while noting that the support of the option is left to the manufacturer; requiring the manufacturer to choose at least one. For example, an agency specification could allow for either a line matrix or a full matrix sign by:

- a) selecting 'Yes' on line 2.3.2.3.2,
- b) selecting 'Yes' on lines 2.3.2.3.2.1, and leaving 2.3.2.3.2.2 blank, and also entering the required configurations, and
- c) selecting 'No' on line 2.3.2.3.2.3 in Section 3.3.8.

2.3.2.1 DMS Types

There are many types of DMS and they can be characterized in many ways. One way is by the capabilities the DMS offers for handling messages. This characterization places a DMS into one of three major categories:

- a) Blank-out Sign (BOS)—This type of DMS can only show one fixed message or nothing.
- b) Changeable Message Sign (CMS)—This type of DMS can display one of two or more predefined messages, or be blank.
- c) Variable Message Sign (VMS)—This type of DMS is one in which the message to be displayed can be created after the sign is installed in the field. It can also have predefined messages in its library of stored messages. By policy and/or system design, the management system may restrict the rights of selected operators to ensure that only authorized personnel can modify or create messages “on-the-fly”.

2.3.2.2 DMS Technologies

DMS can also be characterized by the technology that is used in the sign. The technologies used can include any combination of the following technologies:

- a) Fiber Optic
- b) Light emitting diode (LED)
- c) Flip disk or Shutter
- d) Lamp matrix
- e) Drum (rotating, multifaceted cylinder)

2.3.2.3 DMS Display Matrix Configuration

Finally, DMS can be characterized by the type of display layout employed by the sign, as follows:

- a) No matrix (i.e., it is not a pixel matrix sign)
- b) Matrix sign
- c) Full matrix
- d) Line matrix
- e) Character matrix

NOTE—Typically, matrix signs are VMS and VMS are matrix signs, but this is not always true; for example, the term VMS would also include: 7-segment displays, electronic ink displays, etc.

2.3.2.4 DMS Display Support (Beacons)

The display of the DMS can also be supported or enhanced by the addition of beacons, which are blinking lights attached to the DMS display. These may be activated as part of particular messages.

2.4 ARCHITECTURAL NEEDS / DESCRIPTION OF SYSTEM ENVIRONMENT

2.4.1 Fundamental Needs Driving DMS Deployment

The provision of timely and reliable information to the traveling public improves public safety and convenience by providing advance notification of items that may be of interest (e.g., downstream road conditions or the arrival of a transit vehicle). DMS are typically dispersed along interstate highways, arterial roadways, and at transit stops.

2.4.2 Operational Environment

NTCIP 1203 v02 addresses the interface between a DMS and a management station (e.g., a central computer). To enable communications between these components, the transportation system manager needs to establish a communication system that links the DMS with a management station. For some systems, communications resource requirements may be minimal, and the system may be designed for constant polling; other systems may encounter significant resource requirements for communicating with the DMS, and the system may be designed to minimize data exchanges.

When deploying a DMS, the system designers consider which of the following operational environments need to be supported.

2.4.2.1 Live Data Exchange

The typical operational environment allows the management system to monitor and control the DMS by issuing requests (e.g., requests to access information, alter information, or control the sign). In this environment, the DMS responds to requests from the management station immediately (e.g., through the provision of live data, success/failure notice of information alteration, or success/failure of the command).

2.4.2.2 Logged Data Exchange

Some operational environments do not have always-on connections (e.g., dial-up links). In such environments, a transportation system operator may wish to define conditions under which data is placed into a log, which can then be uploaded at a later time. For example, the operator may wish to maintain a log of all messages posted on the sign, regardless of which management station or algorithm posted the message.

2.4.2.3 Exceptional Condition Reporting

In some operational environments, it may be desirable to have the DMS automatically transmit data to the management station when certain conditions occur. Under this scenario, the transportation system operator can define under what conditions the operator wishes to be notified, and the device automatically notifies the management station when the condition occurs. An example may be the transportation system manager who wants to know when the cabinet door is open.

2.5 FEATURES

Section 2.5 identifies and describes the various standardized user needs addressed by and features that may be offered by a DMS. Section 3 uses these features in the analysis of the system to define the various functional requirements of a DMS.

The operation of a DMS can be categorized into three major areas:

- a) Manage the DMS configuration
- b) Control the DMS
- c) Monitor the status of the DMS

2.5.1 Manage the DMS Configuration

The various sub-features for managing the DMS configuration include:

- a) Determine the DMS Identity
- b) Determine Sign Display Capabilities
- c) Manage Fonts
- d) Manage Graphics
- e) Manage Brightness
- f) Address Multi-Version Interoperability (MVI, formerly known as backward compatibility)

Sub-feature details follow.

2.5.1.1 Determine the DMS Identity

This feature allows the operator to determine basic information about the DMS, such as the type, technology, manufacturer, model, and version number of the DMS. It includes the ability to access information about both hardware and software elements of the DMS.

2.5.1.2 Determine Sign Display Capabilities

This feature allows the operator to retrieve the necessary information to produce a rendering of a suggested or active message. This feature also allows the system to ensure that a message can be displayed on the DMS. The feature allows the operator to determine the detailed physical limitations of the DMS as well as details regarding the current fonts and any graphics that are stored.

2.5.1.3 Manage Fonts

This feature allows the operator to define and edit the appearance of the fonts used to display messages on the sign face. This helps an operator ensure that messages have a consistent appearance across many DMS in a large system despite the use of different manufacturers, etc. It allows the operator to manage font height, width, and color. It allows the operator to edit or delete existing fonts, and to create new fonts in a controller. It also allows an operator to determine the existing configuration of fonts.

Each font supported by the DMS should support a common set of characters (e.g., ASCII codes) to improve interoperability, including letters numbers and various special characters that are frequently used on DMS.

2.5.1.4 Manage Graphics

This feature allows the operator to manage the graphics stored within a DMS. It allows the operator to define a graphic for later use, manage existing graphics, and determine the graphic storage capabilities of the DMS.

2.5.1.5 Manage Automatic Brightness

This feature allows the operator to configure when the sign may automatically switch from one brightness level to the next. This allows the operator to configure how the sign automatically responds to changing lighting conditions to compensate for sun shining in the traveler's vision or 'wash-out' conditions, such as during early morning and pre-sunset conditions.

2.5.1.6 Configure Speed Limit

This feature allows the operator to configure the speed limit applicable to the location of the DMS.

2.5.1.7 Configure Low Fuel Threshold

This feature allows the operator to configure the threshold at which the fuel in a generator is to be considered low. This feature is associated with DMS using generators, which are typically portable signs.

2.5.2 Control the DMS

The various sub-features for controlling the DMS include:

- a) Control a DMS from More than One Location
- b) Remotely Reset the Sign Controller
- c) Control the Sign Face
- d) Control External Devices
- e) Control the Brightness Outputs
- f) Perform Preventative Maintenance

Sub-feature details follow.

2.5.2.1 Control a DMS from More than One Location

This feature addresses the need for DMS to be controlled both remotely (e.g., from one or more central computers) and locally (e.g., from the controller directly or from a laptop computer connected to the controller). Whether the DMS is controlled remotely or locally, the features and capabilities are the same. This feature also addresses the need to prevent different sources of control from interfering with one another by attempting to control the DMS simultaneously.

2.5.2.2 Remotely Reset the Sign Controller

This feature provides the capability to remotely reset the sign controller to attempt to recover from a software failure. This feature might be desired to avoid a field trip to reset the sign controller.

2.5.2.3 Control the Sign Face

This feature addresses the need to place information on or remove information from the sign face to convey proper information to travelers. The feature includes the following sub-features:

- a) Activate and Display a Message
- b) Prioritize Messages
- c) Define a Message
- d) Blank the Sign
- e) Schedule Messages for Display
- f) Change Message Display based on an Internal Events
- g) Change Message Display based on External Device Inputs

2.5.2.3.1 Activate and Display a Message

This feature allows an operator to activate a previously defined message to be displayed on the sign face. The message can be a blank message or come from a set of previously defined messages.

When activating the message the operator needs to specify the desired duration for the display and the relative priority for the proposed message to override the currently displayed message.

NOTE—Activating a message that is stored in a central system library can be achieved by first downloading the message to the sign controller and then activating the message per this section. A user can also display a message defined "on-the-fly" by the same process.

2.5.2.3.2 Prioritize Messages

This feature allows an operator to prioritize particular messages. For example, a priority scheme allows an operator to maintain an accident-related message, even if the same operator previously scheduled the display of a non-accident related message.

2.5.2.3.3 Define a Message

This feature enables the operator to create a message and to modify its format and content. The feature includes:

- a) Uniquely identifying a message
- b) Ensuring that a message is intact
- c) Defining the exact contents of the message to be displayed on the sign face.
- d) If supported, activating beacons when a message is displayed, to attract the traveler's attention

2.5.2.3.4 Blank a Sign

This feature enables the operator (or logic within the management station) to remove any messages displayed on a sign (causing the sign to appear blank).

2.5.2.3.5 Schedule Messages for Display

This feature enables the operator to configure the DMS to activate messages at a future time ('scheduling'). The operator can indicate a series of times at which an associated message is to be activated. The associated message can be any message stored in the sign controller, including a blank message.

2.5.2.3.6 Change Message Display Based on an Internal Event

This feature allows the operator to indicate which message should be displayed when certain non-scheduled events occur, such as loss of communication or loss of power.

2.5.2.4 Control External Devices

This feature enables the operator to control simple external devices, such as High Occupancy Vehicle Lane Gates, through the auxiliary ports on the sign controller.

2.5.2.5 Control the Brightness Output

This feature enables the operator to control the sign brightness either directly or through an automated algorithm, depending on the capabilities of the DMS. At a minimum, the operator should be able to control brightness of the sign display manually for light emitting signs. In addition, the operator should be able to control the brightness level through the use of light sensors (photocells) on the DMS, if available, that can detect the ambient light levels and adjust brightness levels in an appropriate fashion. This brightness control is needed to compensate for the external environment's effect on the visibility of the message, such as when the sun is shining in the eyes of travelers.

2.5.2.6 Perform Preventative Maintenance

This feature enables the operator to enable or disable the periodic exercise of pixels (activated either manually or via a schedule) to ensure that they are performing reliably.

2.5.3 Monitor the Status of the DMS

The various sub-features for monitoring the status of the DMS include:

- a) Perform Diagnostics
- b) Monitor the Current Message

Subsequent sections detail these sub-features.

2.5.3.1 Perform Diagnostics

This feature enables the operator to test the operational status of system components. It consists of the following sub-features:

- a) Determine Sign Error Conditions (High-Level Diagnostics)
- b) Monitor Sign Subsystem Failures (Mid-Level Diagnostics)
- c) Monitor Subsystem Failure Details (Low-Level Diagnostics)
- d) Monitor Message Errors
- e) Monitor Sign Environment
- f) Monitor the Sign Control Source
- g) Monitor Attached Devices
- h) Monitor Door Status
- i) Monitor Controller Software Operations
- j) Monitor Automatic Blanking of Sign
- k) Monitor Power Source
- l) Monitor Power Voltage

2.5.3.1.1 Determine Sign Error Conditions (High-Level Diagnostics)

This feature enables the operator to determine, at a very high level of abstraction, whether a DMS is experiencing any error or warning conditions. Errors and warnings are reported at the level of sign subsystems. For example, a single flag indicates that there are pixel errors.

2.5.3.1.2 Monitor Sign Subsystem Failures (Mid-Level Diagnostics)

This feature enables the operator to determine which component(s) of a subsystem are reporting errors and/or warnings so that the operator can plan a proper response. The operator may need to monitor any of the following subsystems:

- a) Power sources
- b) Power supplies
- c) External Devices such as HOV Gates or external environmental sensors but controlled via the DMS sign controller
- d) Lamps
- e) Pixels
- f) Light level sensors (commonly referred to as 'Photocells')
- g) Sign Controller
- h) Temperature Sensors
- i) Humidity
- j) Internal Environmental Systems (Fans and/or Heaters)
- k) Drum sign rotors

It is only necessary for the DMS to support information about subsystems actually present in the DMS. For example, a matrix sign need not provide the drum-rotor status items, and a drum sign need not provide the pixel status items. A DMS that contains both matrix and drum display elements should provide both the drum-rotor and pixel status items.

2.5.3.1.3 Monitor Subsystem Failure Details (Low-Level Diagnostics)

This feature enables the operator to obtain detailed information about a reported warning or error condition within a subsystem (detailed-level diagnostics). For example, if the DMS reports that photocell #2 has failed, then this feature enables the operator to determine that photocell #2 is "mounted on top of the sign housing."

2.5.3.1.4 Monitor Message Errors

This feature enables the operator to monitor the errors associated with defining or activating a particular message.

2.5.3.1.5 Monitor Sign Environment

This feature enables the operator to monitor the temperature and humidity within the sign housing and control cabinet. This allows the operator to determine whether the environmental conditions are approaching the environmental limits of the various DMS components.

2.5.3.1.6 Monitor the Sign Control Source

This feature enables the operator to determine the physical location from or mechanism through which the DMS is being controlled. Possible control sources include:

- a) Central computer
- b) DMS time-based scheduler
- c) An individual physically present at the DMS site

2.5.3.1.7 Monitor Attached Speed Detectors

This feature enables the operator to determine the current reading of any speed detectors attached to the DMS.

2.5.3.1.8 Monitor Door Status

This feature enables the operator to determine whether the doors to the sign housing and control cabinet are open or closed. This feature may be used to detect unauthorized physical access to the DMS.

2.5.3.1.9 Monitor Controller Software Operations

This feature enables the operator to determine whether the DMS controller software is operating properly through the use of watchdog timers.

2.5.3.1.10 Monitor Automatic Blanking of Sign

This feature enables the operator to monitor the automatic display of a blank message when diagnostics detect that too many pixels are non-operational or that the light outputs are faulty. This prevents illegible messages from being displayed.

2.5.3.1.11 Monitor Power Source

This feature enables the operator to monitor the source of power that is being used to operate the DMS sign face.

2.5.3.1.12 Monitor Power Voltage

This feature enables the operator to monitor the voltage of power that is being used to operate the DMS sign face.

2.5.3.1.13 Monitor Fuel Level

This feature enables the operator to monitor the level of fuel within the tank of a generator that is being used to operate the DMS. This feature is typically used in portable signs.

2.5.3.1.14 Monitor Engine RPM

This feature enables the operator to monitor the engine RPM that which a generator that is being used to operate the DMS is currently running. This feature is typically used in portable signs.

2.5.3.2 Monitor the Current Message

This feature enables the operator to determine what message is currently displayed on the sign face.

2.5.4 Provide for Multi-Version Interoperability of DMS to NTCIP 1203 v1

The following sub-features were modified within NTCIP 1203 v2 and need to be specifically spelled out to achieve multi-version interoperability for certain features within a DMS conforming to NTCIP 1203v2

- a) Allow a DMS to obtain the number of fan failures using the method defined in NTCIP 1203v1
- b) Allow a DMS to initiate the fan test using the method defined in NTCIP 1203v1
- c) Allow a DMS to utilize a control mode of 'simulation' as defined in NTCIP 1203v1

2.6 SECURITY

NTCIP 1203 v02 does not address any security issues. Any security pertaining to protecting the communications with a DMS should be implemented either physically by protecting the communications access points, or logically by enabling security features associated with the underlying communications protocols.

2.7 OPERATIONAL POLICIES AND CONSTRAINTS / ASSUMPTIONS

Operational policies are agency-specific and need to be determined and implemented by the agency

operating the DMS. NTCIP 1203 v02 does not cover this topic, but instead provides a set of common functions that can support an agency's operational policies.

If assumptions pertaining to the operations of a DMS have been made, they have been stated clearly at the locations where they apply.

2.8 RELATIONSHIP TO THE NATIONAL ITS ARCHITECTURE

There are three National ITS Architecture Flows associated with the operation of a DMS. These are:

- a) Driver Information
- b) Roadway Information System Status
- c) Roadway Information System Data

The Driver Information flow deals with the message the driver sees on the sign. The other two flows deal with configuring, controlling, and monitoring the DMS.

Each Architecture Flow is associated with one or more interfaces identified within the National ITS Architecture as:

- a) Between the DMS (Roadway Subsystem (RS)) and the Maintenance and Construction Management Subsystem (MCMS)
- b) Between the DMS (Roadway Subsystem (RS)) and the Traffic Management Subsystem (TMS)

The National ITS Architecture also identifies the interface between the driver to the DMS (Roadway Subsystem (RS)). This interface is not described in NTCIP 1203 v02 since the focus of NTCIP 1203 v02 is on the electronic interface between a center and the device.

The main user need groups (features), are related to the National ITS Architecture Flows as indicated in Table 1:

User Need Group	Source	Architecture Flow	Destination
Configure the Sign	MCMS	Roadway Information System Data	RS
	RS	Roadway Information System Status	MCMS
	TMS	Roadway Information System Data	RS
Control the Sign	RS	Roadway Information System Status	TMS
	MCMS	Roadway Information System Data	RS
Monitor the Sign	TMS	Roadway Information System Data	RS
	MCMS	Roadway Information System Status	RS
	RS	Roadway Information System Status	MCMS
	TMS	Roadway Information System Data	RS
	RS	Roadway Information System Status	TMS

Table 1 Relationship between Main User Needs Groups and National ITS Architecture Flows

Section 3

DMS FUNCTIONAL REQUIREMENTS

[Normative]

This section defines the Functional Requirements based on the user needs identified in the Concept of Operations (see Section 2). This section includes:

- a) A tutorial
- b) The Protocol Requirements List – A Functional Requirement is a requirement of a given function and therefore is only required to be implemented if the associated functionality (e.g., user need) is selected through the use of the Protocol Requirements List (PRL). The PRL also indicates which of the items are mandatory, conditional, or optional. The PRL can be used by procurement personnel to specify the desired features of a DMS or can be used by a manufacturer to document the features supported by their implementation.
- c) Operational Environment Requirements – These are requirements related to the Operational Environment User needs defined in Section 2.4.2.
- d) Data Exchange Requirements – These are requirements related to the features identified in Section 2.5 that can be realized through a data exchange. For example, this includes the requirement to be able to activate a message on a DMS.
- e) Supplemental Requirements – These are additional requirements derived from the Concept of Operations that do not fall into one of the above two categories. For example, they include requirements related to the content of the message to be displayed on a DMS, which may be a supplemental requirement to activating a message, defining a message, etc.

This section is intended for all readers, including:

- a) Transportation operations managers
- b) Transportation operations personnel
- c) Transportation engineers
- d) System integrators
- e) Device manufacturers

For the first three categories of readers, this section may be useful to understand the details of what NTCIP 1203 v02 requires of a DMS. For these readers, Sections 3.3.8 and 3.3.9 may be particularly useful in preparing agency specifications and mapping the various rows of the PRL to more detailed text contained in the other sections.

For the last two categories of readers, this section is useful in fully understanding what is required of equipment meeting this interface standard. These readers can also use the table in Sections 3.3.8 and 3.3.9 to document the capabilities of their implementations.

3.1 TUTORIAL [INFORMATIVE]

Section 3 defines the formal requirements that are intended to fulfill the user needs identified in Section 2. This is achieved through the development of a Protocol Requirements List (PRL) that traces each user need to one or more requirements defined in this section. The details of each requirement are then presented following the PRL. The functional requirements are presented in three broad categories as follows:

- a) Architectural Requirements—These requirements define the required behavior of the system in exchanging data across the communications interface, including any restrictions to general architectural requirements, based upon the architectural needs identified in the Concept of Operations.