CLASS A

PROFILE

Prepared by:
NTCIP Steering Group

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FOREWORD

The purpose of this document is to provide a definition of the Class A, one of the component standards of the National Transportation Communications for Intelligent Transportation Systems (ITS) Protocol (NTCIP). It is intended as a communications protocol standard for interconnecting transportation and traffic control equipment. NTCIP represents a suite of protocols and information management standards that apply to the entire industry. The Class A Profile addresses the need for a specific protocol that is geared to the communications requirements of field devices such as traffic controllers, variable message signs, camera controllers, and other similar devices that are not directly connected to this controller (i.e., message routing is required).

The original effort in the development of NTCIP began with the National Electrical Manufacturers Association (NEMA) traffic control equipment manufacturers' desire to extend the TS-2 Standard for traffic control hardware to cover the more complex issues of systems interoperability and communications standards. The initial goal was to develop a common protocol and define a minimum set of control and status messages so that end users could intermix not only different manufacturers' controllers and 170-type controllers, but also all other field-related devices. Currently, it is being extended to cover intra- and inter- traffic management and control center communications. The ultimate goal is to define standard protocols for all aspects of communications for transportation and traffic control networks that are needed for ITS.

The figure below depicts the current NTCIP protocol suite family; other protocol suites will be added on an as needed basis. The shaded block indicates the focus of this document.

		PROFILES			
		Class B	Class A	Class C	Class E
PROTOCOLS	Application	STMF	STMF	Telnet FTP SNMP	Telnet FTP SNMP
	Presentation	Null	Null	Null	Null
	Session	Null	Null	Null	Null
	Transport	Null	UDP	TCP	TCP
	Network	Null	IP	IP	IP
	Data Link	PMPP	PMPP	PMPP	PPP
	Physical	EIA 232E FSK	EIA 232E FSK	EIA 232E FSK	EIA 232E

A communications protocol allows devices to talk to one another but it is equally important that they speak a common language. A major portion of the NTCIP development has been spent on defining the structure and identifying the information that will be conveyed by the communications protocols. A message must be understood by the device it was intended for, but it is equally important that it is not misunderstood by some other device that shares the network interface. An integral part of the Class A Profile is the Simple Transportation Management Framework. It defines the procedures for ensuring that any device can use the Class A communications protocols.

In preparation of this Standards Publication, input of users and other interested parties is being sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to:

Attn: Alberto J. Santiago
NTCIP Information /HSR-11
Turner-Fairbank Highway Research Ctr.
6300 Georgetown Pike
McLean, VA 22101
fax: (703) 285-2264

Section 1
GENERAL

1.1 SCOPE

The National Transportation Communications for ITS Protocol (NTCIP) establishes a common method of interconnecting ITS and traffic control equipment, establishes the protocol and procedures for establishing communications between ITS-related components, defines procedures to develop and register a common set of messages related to controlling and managing an ITS, and defines a set of messages specifically related to current traffic control systems. The Class A protocol stack described in this document is appropriate for exchange of information between field devices and controllers that are on separate subnetworks; the primary feature of this profile is support for routing.

1.1.1 Background

As transportation control equipment becomes more sophisticated, planners, users, and equipment manufacturers have recognized the need to establish system inter-operability and integration standards. Different agencies have defined protocols to work with their specific hardware but a problem arises when attempting to integrate additional or other existing hardware into a system. There is no common protocol with which the equipment can communicate. The various systems utilize different synchronizing techniques, data formats, and error-recovery schemes. If a national Intelligent Transportation Systems (ITS) program is to be implemented then communications standards and protocols must be established.

The problem is exemplified by considering just the integration issues related to traffic signal controllers. Currently there is no standardized method to communicate with either NEMA-type controllers or 170-type controllers. In systems that use a remote communications unit to interface with the input/output backpanel signals of the controllers, severe limitations are imposed on the capabilities of the system. Alternately, when systems from different manufacturers are integrated into the same central control system, the communications protocol to each system is different and manufacturer specific. Local controller units operating within the system normally have to be from the same manufacturer of the system.

The integration problem is compounded when existing systems are tied into transportation management systems. Not only do these systems have to deal with traffic controllers, but they must also handle such devices as surveillance cameras, variable message signs, and other ITS-related hardware. Ideally, all of this equipment should be able to share the same communications channel. Industry-wide communications standards are needed not just for connectivity and interoperability reasons, but also to accommodate future technology growth. As the needs of ITS become clearer, the ability to transfer data throughout the system will become crucial. A communications standard must accommodate the presently recognized needs as well as the yet undefined needs of the future.

1.1.2 Purpose of Document

The purpose of this document is to provide the information necessary to establish a functional Class A protocol stack on ITS devices. This document outlines the protocols used at each layer of the NTCIP Class A stack, defines the parameters for each of the protocols, and provides the settings for each of the parameters. The document does not completely describe the requirements of each of the selected protocols; implementors should obtain the appropriate normative references to ensure that any implementation is compliant with the specification requirements and with NTCIP in general.

1.2 REFERENCES

1.2.1 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this Standard. While end users of NTCIP do not need to obtain these documents, they do provide a complete understanding 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 standards listed below. Contact information regarding the referenced standards is given at the end of this section.

NTCIP Steering Group Draft - *Point to Multi-Point Protocol (PMPP)*

NTCIP Steering Group Draft - *Class B Profile*

EIA/TIA-232-C, *Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange*, 1969

RFC 791, *Internet Protocol (IP),* September 1981

RFC 768, *User Datagram Protocol,* J. Postel, September 1980

RFC 1159, *Simple Network Management Protocol*, M. Schoffstall, M. Feder, J. Davin, J. Case, May 1990

1.2.2 Other References

The following list of documents may also be helpful to the reader in gaining a full understanding of the NTCIP.

ITU-T Recommendation X.210 | ISO/IEC 10731, *Information technology ¾ Open Systems Interconnection ¾ Conventions for the definition of OSI services.*

CCITT Recommendation X.213 (1992) | ISO/IEC 8348:1992, *Information technology ¾ Network service definition for Open Systems Interconnection.*

CCITT Recommendation X.200 (1988), *Reference Model of Open Systems Interconnection for CCITT Applications.*

ISO 7498:1984, *Information processing systems ¾ Open Systems Interconnection ¾ Basic Reference Model.*
(The above pair of documents are basically the same in content and text. They will be superseded by a new edition to be published by end of the Summer 1994. At that time, there will only be one version in "identical text" format and the reference will then appear in 1.2.1 above.)

CCITT Recommendation X.212 (1988), *Data Link service definition for Open Systems Interconnection for CCITT applications.*

ISO/IEC 8886:1992, *Information technology ¾ Telecommunications and information exchange between systems ¾ Data link service definition for Open Systems Interconnection.*

1.2.3 Contact Information

1.2.3.1 ISO/IEC Standards

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

ANSI
11 West 42nd Street, 13th Floor
New York, New York 10036
(212) 642-4900

1.2.3.2 ITU-T Recommendations

The ITU-T Secretariat Bureau (ITU-TSB), formerly CCITT, maintains a list of the currently valid ITU-T Recommendations. The ITU-TSB may be contacted as follows:

International Telecommunications Union
Place des Nations
CH-1211
Geneva 20
Switzerland
+41-22-730-5285

1.2.3.3 RFC Documents

Pertinent RFC's may be obtained by writing to:

DDN Network Information Center
14200 Park Meadow Drive
Suite 200
Chantilly, VA 22021

Electronic copies of RFC documents may be obtained using "anonymous FTP" to the host nic.ddn.mil or ds.internic.net.

1.3 DEFINITIONS

application layer: That portion of an OSI system that is responsible for interacting with the actual application program that is performing a specific function. Many application layers may exist in a system, each performing specific functions.

data: Information before it is interpreted.

data link layer: That portion of an OSI system responsible for transmission, framing, and error control over a single communications link.

datagram: A self-contained unit of data transmitted independently of other datagrams.

host: (Internet usage) An end-system's application.

Intelligent Transportation Systems: A major national initiative to improve information, communication and control technologies in order to improve the efficiency of surface transportation.

Internet: A large collection of connected networks, primarily in the United States, running the Internet suite of protocols. Sometimes referred to as the *DARPA Internet, NSF/DARPA, Internet*, or the *Federal Research Internet.*

Internet protocol: The network protocol offering a connectionless mode network service in the Internet suite of protocols.

Internet suite of protocols: A collection of computer-communication protocols originally developed under DARPA sponsorship.

network: A collection of subnetworks connected by intermediate systems and populated by end systems.

network layer: That portion of an OSI system responsible for data transfer across the network, independent of both the media comprising the underlying subnetworks and the topology of those subnetworks.

network management: The technology used to manage in a network, usually referring to the management of networking specific devices such as routers. In the context of this document, refers to all devices including end systems that are present on the network or inter-network.

Open Systems Interconnection: An international effort to facilitate communications among computers of different manufacture and technology.

physical layer: That portion of an OSI system responsible for the electro-mechanical interface to the communications media.

presentation layer: That portion of an OSI system responsible for adding structure to the units of data that are exchanged.

router: A level-3 (Network Layer) relay.

session layer: That portion of an OSI system responsible for adding control mechanisms to the data exchange.

subnet: A physical network within a network.

transport layer: That portion of an OSI system responsible for reliability and multiplexing of data transfer across the network (over and above that provided by the network layer) to the level required by the application.

transportation management: Short for the management of networks of transportation devices and the network itself.

user datagram protocol: The transport protocol offering a connectionless mode transport service in the Internet suite of protocols.

1.4 ABBREVIATIONS AND ACRONYMS

ANSI	American National Standards Institute
CCITT	International Telegraph and Telephone Consultative Committee
DARPA	Defense Advanced Research Projects Agency
EIA	Electronic Industries Association
FSK	Frequency Shift Keying
FTP	File Transfer Protocol
IEC	International Electro-technical Commission
IP	Internet Protocol
IPI	Initial Protocol Identifier
ISO	International Organization for Standardization
ITS	Intelligent Transportation Systems
ITU-T	Intelligent Telecommunications Union, Telecommunications Sector
NEMA	National Electrical Manufacturers Association
NSF	National Science Foundation
NTCIP	National Transportation Communications for ITS Protocol
OSI	Open Systems Interconnection
PMPP	Point to Multi-Point Protocol
PPP	Point-to-Point Protocol
RFC	Request for Comments
SNMP	Simple Network Management Protocol
STMF	Simple Transportation Management Framework
TCP	Transmission Control Protocol
TIA	Telecommunications Industry Association
UDP	User Datagram Protocol

Section 2
CLASS A PROFILE OVERVIEW
(Authorized Engineering Information)

2.1 GENERAL ASPECTS

The Class A Profile is established to facilitate the connection and control of field devices with sufficient processing power and communications capability to support a higher overhead protocol that can support routing between networks. There is no specifically required architecture, but the underlying assumption is that there is a Primary/Secondary relationship between devices and controllers (i.e., this profile does not support contention-based communications). While the profile will function on low speed communications links, the amount of overhead necessary to support the routing functions limits its practicality on these links.

A more complete discussion of the applications of this class profile can be found in NEMA TS 3-1, the NTCIP overview, subsection 2.5 Protocol Profiles.

2.1.1 Optional Features

A particular implementation may add to this standard, but it must also provide the capability stated herein. For example, a product may implement fiber in its physical layer, but to meet standard, it must also support either EIA/TIA-232-E or FSK.

2.1.2 Stack Definition

The Class A Profile is the protocol stack defined for transportation management applications where non real-time exchange of information or routing between networks is necessary. It consists of the seven (7) ISO layers as defined in 3.2.1 through 3.2.7.

2.1.3 Co-residence

Multiple profiles may reside in the same physical unit. If a physical unit can meet the requirements for Classes A, B, and C, then it conforms to each of the three profiles.

Section 3
CLASS A PROFILE REQUIREMENTS

3.1 GENERAL

In referenced RFC documents, all instances of the word “will” in clauses or sections defining required behavior shall be interpreted as the mandatory “shall”; all instances of the word “may” shall be interpreted as the mandatory “must”. Any exceptions to this will be explicitly defined in the profile/specification requirements clauses.

For the purposes of this profile, implementors must assume that all optional features documented in the referenced specifications or RFC’s are NOT present; however, this should not be construed to restrict implementation of any optional feature.

3.2 PROTOCOL STACK

The protocol stack shall be as defined in 3.2.1 through 3.2.7.

3.2.1 Physical Layer Definition

The Physical Layer shall conform at least one of the interfaces defined in NTCIP Steering Group Draft - Class B Profile, 3.2.1.

Parameters shall be as specified in NTCIP Steering Group Draft - Class B Profile, 3.2.1.1 and 3.2.1.2.

3.2.2 Data Link Layer Definition

The Data Link Layer shall conform to NTCIP Steering Group Draft - Point to Multi-Point Protocol.

The IPI shall specify “IP”, i.e., the IPI value shall be 0x’21’.

3.2.3 Network Layer Definition

The Network Layer shall conform to the Internet Protocol as defined in RFC 791.

IP supports a set of “options” in its header. For this profile, options shall not be required.

The protocol field shall specify UDP, 0x’11’.

3.2.4 Transport Layer Definition

The Transport Layer shall implement the User Datagram Protocol as defined in RFC 798.

The well-known UDP ports that shall be supported are:

Content	Port
FTP Data	20
FTP Control	21
SNMP	161
SNMP Trap	162
STMP	????[1]
STMP Trap	????

3.2.5 Session Layer Definition

The Session Layer shall be a NULL layer.

3.2.6 Presentation Layer Definition

This layer shall be a NULL layer.

3.2.7 Application Layer Definition

The Application Layer shall conform to the STMF, NEMA TS-3.2.

[1] The STMF Port numbers are in the process of being assigned.