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TCIP Framework Standard

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This publication was prepared by the ITE's TCIP Project Team, and reviewed and recommended by the Joint Committee on the NTCIP. The Joint Committee is organized under a Memorandum of Understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA). The Joint Committee on the NTCIP consists of six representatives from each of the standards organizations, and provides guidance for NTCIP development.

In February 1997, the TCIP Technical Working Group organized subgroups to standardize the business area data interface objects. The subgroups drafted, considered, and proposed for approval the TCIP Framework Standard. The result was this document. As a consequence, all the subgroups had a hand in crafting this document.

At the time that this document was prepared, the following individuals were active members of the TCIP Technical Working Group:

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

- Federal Highway Administration
- Federal Transit Administration

FOREWORD

This document uses only metric units.

This document is an NTCIP Process, Control, and Information Management document. Process, Control, and Information Management documents define the practices and policies used by the NTCIP Joint Committee in developing and maintaining NTCIP and TCIP standards, documents, and systems. This TCIP Framework Standard was assigned document number NTCIP 1400 to be grouped with the other TCIP documents, rather than a number in the NTCIP 8000-series.

The TCIP family of standards addresses Advanced Public Transportation Systems (APTS) data interfaces, and related automated transit tools and data. The standards also address the business requirements of the APTS data interfaces. In some cases, specialized terms were needed to define general classes of information. For example, different business areas needed to define data elements related to time, date, and footnotes. Special data types were developed so that these data concepts were consistent across business areas, while specific needs were met. These data types are defined in this document.

For more information about NTCIP standards, visit the NTCIP Web site at http://www.ntcip.org. For a hardcopy summary of NTCIP information, contact the NTCIP Coordinator at the address below.

In preparation of this NTCIP document, input of users and other interested parties was sought and evaluated. Inquires, comments, and proposed or recommended revisions should be submitted to:

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Approvals

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

AASHTO – Standard Specification; October 1999
ITE – Software Standard; May 2000
NEMA – Suggested Standard for Future Design; April 2000

History

From 1997 to 1999, this document was referenced as ITE ST-ITS-TCIP-FRAME and/or NEMA TS 3.TCIP-Frame. However, to provide an organized numbering scheme for the NTCIP documents, this document is now referenced as NTCIP 1400. The technical specification of NTCIP 1400 is identical to the former reference, except as noted in the development history below:

TCIP documents version 0.1. Distributed in September 1997 for public review.

TCIP-FRAME Recommended Standard version 01.3, April 16, 1999. Proposed as a Recommended Standard of the Joint Committee on the NTCIP.

NTCIP 1400, version 01.3, April 16, 1999. Approved by AASHTO in October 1999, approved by ITE in May 2000, and approved by NEMA in April 2000.

NTCIP 1400 v01.04, December 1, 2000. Summer 2001 printing. Incremented version number and updated date; added and revised front matter; updated references to NTCIP and NEMA document numbers in Clause on References; updated references to NTCIP document numbers in Clause on Conformance; updated references to ITE document numbers; and deleted Annex A Comment Form.

INTRODUCTION

This document defines the Framework for the Transit Business Area objects that are supported by the Transit Communications Interface Profiles (TCIP). This document introduces the background, basic concepts, and conformance requirements that apply to all TCIP business area requirements.

There are six annexes to this document.

This document defines requirements that are applicable to all NTCIP and TCIP environments and also contains optional and conditional clauses that are applicable to specific environments for which they are intended.

The following keywords apply to this document: AASHTO, ITE, NEMA, NTCIP, and TCIP.

In 1992, the NEMA 3-TS Transportation Management Systems and Associated Control Devices Section began the effort to develop the NTCIP. Under the guidance of the Federal Highway Administration's NTCIP Steering Group, the NEMA effort was expanded to include the development of communications standards for all transportation field devices that could be used in an Intelligent Transportation Systems (ITS) network.

In September 1996, an agreement was executed among AASHTO, ITE, and NEMA to jointly develop, approve, and maintain the NTCIP standards.

In 1997, the ITE, in cooperation with the American Public Transit Association (APTA), the U.S. DOT's Federal Transit Administration, and the U.S. DOT's FHWA, began development of the TCIP. The TCIP Technical Working Group was accepted as another subdivision of the Joint Committee on the NTCIP.

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CONTENTS

Section 1
GENERAL

1.1 SCOPE

The Transit Communications Interface Profiles domain covers the data needs of the functions related to the support of Public Transportation operations, service and planning. This includes all input and output data needed for the following business areas.

- Fare Collection (FC)
- Scheduling/Runcutting (SCH)
- Passenger Information (PI)
- Incident Management (IM)
- Vehicle On-board (OB)
- Transit Control Center (CC)
- Traffic Management (TM).

1.2 REFERENCES

For approved amendments, contact:

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For draft revisions or amendments to this document, which may be under consideration by the relevant TCIP Working Group, and for recommended amendments of the NTCIP Joint Committee, visit the World Wide Web at http://www.ntcip.org or http://www.ite.org.

A copy of the database containing the TCIP data elements and messages for each of the business areas is available. To download a copy of the TCIP database, follow the instructions on either the NTCIP or ITE Websites.

Two types of references are cited in this section. Normative references contain provisions that apply when implementing this standard. Informative references contain rules and guidelines that may provide a more detailed understanding of the data, interface, format, profiles, or application of this standard. Use of informative references is not mandatory in order to conform to this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, however, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standard listed below.

1.2.1 Normative References

ISO/IEC 8824: 1994, *Abstract Syntax Notation One* (ASN.1) (ITU-T X.680 – X.690, July 1994)

Draft IEEE P1489/D0.0.7, *Draft Standard for Data Dictionaries for Intelligent Transportation Systems*, Version 0.0.7, October 9, 1997

Draft IEEE P1488/D0.0.6, *Draft Standard for Message Set Template for Intelligent Transportation Systems*, Version 0.0.6, October 17, 1997

1.2.2 Informative References

NTCIP 1407, *Transit Communications Interface Profile Standard on Control Center Objects*, Version 1.0, September 1998

NTCIP 1401:2000, *Transit Communications Interface Profile Standard on Common Public Transportation Objects*, Version 01.02, December 2000

Draft NTCIP 1408, *Draft Transit Communications Interface Profile Standard on Fare Collection (FC) Objects*, Version 0.3, March 1998

NTCIP 1403:2000, *Transit Communications Interface Profile Standard on Passenger Information (PI) Objects*, Version 01.02, December 2000

NTCIP 1402:2000, *Transit Communications Interface Profile Standard on Incident Management (IM) Objects*, Version 01.02, December 2000

Draft ST-ITS-TCIP-TM, *Draft Transit Communications Interface Profile Standard on Traffic Management (TM) Objects*, Version 0.2, January 15, 1998

NTCIP 1406, *Transit Communications Interface Profile Standard on On-Board (OB) Objects*, Version 1.0, September, 1998

NTCIP 1404:2000, *Transit Communications Interface Profile Standard on Scheduling (SCH) Objects*, Version 01.02, December 2000

NTCIP 1405:2000, *Transit Communications Interface Profile Standard on Spatial Representation (SP) Objects*, Version 01.02, December 2000

NTCIP 8003, *National Transportation Communications and ITS Protocol (NTCIP) Framework and Classification of Profiles* (Draft Version 97.01.08, November 14, 1997)

SAE J1587 – *Joint SAE/TMC Recommended Practice for Electronic Data Interchange Between Microcomputer Systems in Heavy Duty Vehicle Applications*, August 1992

The National Architecture for ITS, U.S. Department of Transportation Joint Program Office, January 1997.

1.2.3 Contact Information

The American National Standards Institute (ANSI), as the U.S. representative on the ISO/IEC International Standards organization, maintains a register of all ISO/IEC standards.

ANSI
11 West 42nd Street, 13th Floor
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The National Electrical Manufacturers Association (NEMA), the American Association of State Highway and Transportation Officials (AASHTO) and the Institute of Transportation Engineers jointly develop, approve, and maintain the NTCIP standard.

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The Society of Automotive Engineers develops and maintains the J1708/J1587 family of standards.

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The Institute of Electrical and Electronics Engineers (IEEE) develops and maintains the IEEE Standard for Data Dictionary and Message Set Template for Intelligent Transportation Systems.

Institute of Electrical and Electronics Engineers
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www.ieee.org/ieeestore

The Intelligent Transportation Society of America (ITSA) distributes documents developed by the U.S. DOT Joint Program Office (JPO) on ITS.

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www.itsa.org/public/archdocs/national.html
or from Odetics at www.odetics.com/itsarch/

Section 2
TERMINOLOGY

For the purposes of this document and to standardize the terminology in the public transportation industry, the following definitions, abbreviations, acronyms, conventions, and notations apply to this document.

2.1 DEFINITIONS

BYTE and UBYTE	Octet sized (8 bits) integers where BYTE is signed (range -128 to 127) and UBYTE is unsigned (range 0 to 255). *(TS 3.2-1996, p. 15).*
CHOICE	As defined by ITU-T X.680, Abstract Syntax Notation One Specification of Basic Notation, a choice type is defined by referencing a list of distinct types; each value of the choice type is derived from the value of an object *(ITU-T, p. 4).*
Component	The closely related functions of a system. A component produces an information product.
Data Dictionary	A listing of data elements (and their characteristics) that meets the information and functional needs of a system.
Data Element	An atomic element of information which is defined within a transit business area. As defined by the IEEE P1489/D0.0.5 (July 14, 1997), a data element is a syntactically formal representation of some information of interest (such as a fact, proposition, observation, etc.) about some entity of interest (e.g., a person, place, process, property, object, concept, association, state, event).
Data Interface	The connection between two or more components through which information (e.g., object or message) is passed.
Dialog	An ordered grouping of messages exchanged between at least two components.
Informative	Non-prescriptive information that provides context to this standard.
LONG and ULONG	Four byte (32 bits) integers where LONG is signed (range–2,147,483,648 to 2,147,483,647) and ULONG is unsigned (range 0 to 4,294,967,295). (TS 3.2-1996, p. 15).
Message	A grouping of data elements, which encapsulate an idea, concept or thing, or convey information. A basic message encapsulates an idea, concept or thing, and a compound message embeds one or more basic messages and other data elements to convey information.
Message Set Catalog	A list of messages and the functional requirements needed to support the exchange of information among components within a system, or between systems.
Message Set Template	The format used to transmit messages among components or between systems.
Normative	The prescriptive requirements for the use of this standard.

Object	The definition of a data element or message including its name, object identifier, description, and syntax.
OBJECT IDENTIFIER	"A value (distinguishable from other such values) which is associated with an object identifier type. A simple type whose distinguished values are the set of all object identifiers allocated in accordance with the rules of [ASN.1]." (ITU-T Rec. X.680, p. 5). The number or address by which an object may be located on the TCIP object tree.
OCTET	An ordered sequence of eight bits. (ITU-T Rec. X.680, p. 5).
Profile	A standard that combines one or more base standards and selects appropriate options or functions within them. (A base standard may be a "standard" or another profile that references standards). (TS 3.PRO-199x, p. 5).
SEQUENCE and SEQUENCE OF	An ordered record or array (respectively) of data elements or objects. "Types defined by referencing an ordered list of types (some of which may be declared to be optional)" (ITU-T Rec. X.680, p. 6)
SHORT and USHORT	Double octet sized (16 bits) integers where SHORT is signed (range -32,768 to 32,767) and USHORT is unsigned (range 0 to 65,535). (TS 3.2-1996, p. 15).
Transaction	See Dialog.

2.2 ABBREVIATIONS

Amt	Amount
Avg	Average
Cd	Code
Char	Character
Desc	Description
Dt	Date
Equip	Equipment
Fac	Facility
FI	Fare Instrument
Hrs	Hours
ID	Identification
Int	Integer
Loc	Location
Max	Maximum
Min	Minimum
Msg	Message
No, Num, Nbr	Number
Pass	Passenger
Pt	Point
Qty	Quantity
Tm	Time
Veh	Vehicle

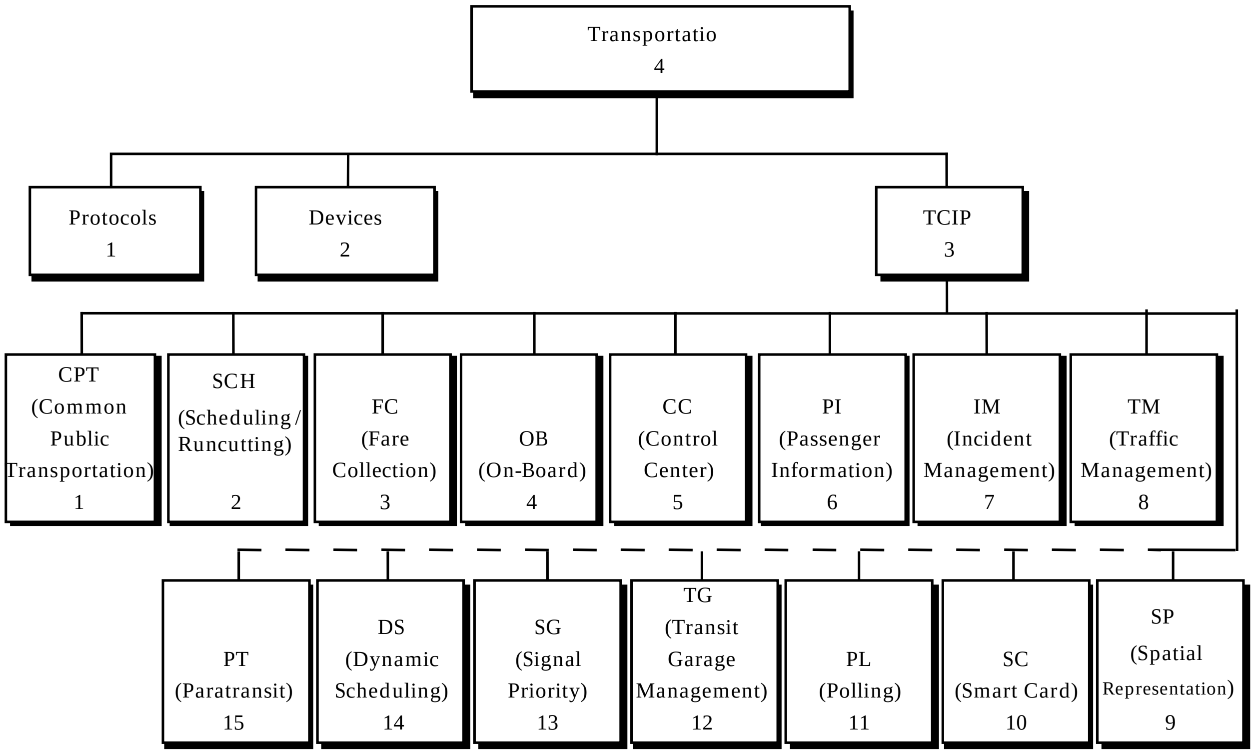
2.3 ACRONYMS

ADA	Americans with Disabilities Act
APTS	Advanced Public Transportation System
ASN.1	Abstract Syntax Notation One
AVI	Automated Vehicle Identification
AVL	Automated Vehicle Location
BA	Business Area
CC	Control Center
CPT	Common Public Transportation [Objects]
DS	Dynamic Scheduling
DD	Data Dictionary
FC	Fare Collection
IEEE	Institute of Electrical and Electronics Engineers
IM	Incident Management
ITE	Institute of Transportation Engineers
ITU	International Telecommunication Union
LOS	Level of Service
NEMA	National Electrical Manufacturers Association
OB	On-board
PI	Passenger Information
PL	Polling
PT	Paratransit
ROW	Right of Way
SAE	Society of Automotive Engineers
SC	Smart Card
SCH	Scheduling and Runcutting
SP	Spatial Representation
TG	Transit Garage Management
TM	Traffic Management
TSP	Transit Signal Priority
USPS	United States Postal Service
VIN	Vehicle Identification Number

2.4 CONVENTIONS

TCIP naming and addressing conventions are based on the hierarchical NEMA object tree. This structure is part of the NEMA transportation (NTCIP) hierarchy.

Figure 2.1 TCIP Classification Scheme



Each tree level is separated by a period. The prefix to the NEMA node is “1.3.6.1.4.1.1206.” The TCIP is the third (3) node under NEMA’s Transportation (4) node. Thus, the prefix to the TCIP node is “1.3.6.1.4.1.1206.4.3.”

The scope of each of the current business area standards is as follows.

2.4.1.1 Common Public Transportation

The common public transportation domain covers standard data types, data elements, and messages (business objects) shared by many of the other business areas. This includes representative class data types and general data concepts related to vehicle, equipment, facilities, activation/deactivation date and times, etc.

2.4.1.2 Scheduling/Runcutting

The scheduling domain covers the data needs of the functions related to scheduling and runcutting. This includes all input data needed to develop the master schedule, trip sheet, run guides, paddles, inventory files and other supplemental information. It also includes output data for several systems and information services: transit garage management, control system, on-board, transit customer information systems, incident and traffic management, paratransit, roadside devices and operating performance history databases.

2.4.1.3 Fare Collection

The fare collection domain covers the data needs of the functions related to the collection of fares from passengers. This includes all input data needed to process any form of electronic or non-electronic payment. It also includes output data for several functions: data to be transmitted from the fare transaction unit back onto the fare media; data reporting the status or health of the unit itself; data which supports the processing of financial transactions; and data which supports the planning of future service.

2.4.1.4 On-board

The on-board domain covers the data needs of the functions related to on-board applications. This includes all data needed for the communication between on-board components within a public transportation vehicle and other transit applications. The data objects defined in this specification are critical to transit agencies because they provide information (such as AVL information) for vehicle performance monitoring and transit operations.

2.4.1.5 Control Center

The control center functions span various centers and systems within transportation and operations. In general, the control system (or Transit Management Center) acts as the clearinghouse for all operations data related to dispatching, operating, monitoring and measuring transit revenue services in real time. The control center concept merges various tasks performed by numerous individuals into a single workstation and operated by just a few technical staff. Moreover, through electronic control and network connectivity, Computer Aided Dispatch (CAD) operators may control many of the functions on-board the transit vehicle (or advise the driver to perform those tasks).

2.4.1.6 Passenger Information

The passenger information domain covers the data needs related to providing passengers and potential customers with the information they need and want in order to plan and make trips on public transportation. This includes input data associated with traveler preferences (departure time, arrival time, mode, cost, etc.), estimated time of arrival, published schedules, and other types of information related to scheduled and actual transit services. It also includes output data necessary for supporting any type of information service: trip itinerary planning, customer service telephone information centers, independent service providers (such as computer on-line services or regional [not limited to transit] traveler information services), incident and traffic management, and remote devices such as dynamic message signs and interactive information kiosks. The passenger information domain relies heavily on the transit scheduling domain for supporting data such as transit schedules, vehicle assignments to routes, etc., and on the control center domain for real-time travel information.

2.4.1.7 Incident Management

The incident management domain covers the data needs related to detecting, verifying, prioritizing, responding to, and clearing of unplanned events (i.e., accidents, weather conditions, crimes, etc.) that affect transit operations. This includes all data needed to identify the date, time, and location of an event, the source of the information about the event, codes for indicating the type of incident, the severity of the incident, detour information, and the dispatch of the emergency response team. It also includes data necessary for providing information to the traveling public about the impacts of the incident on the transportation infrastructure including the impact on transit service. To a large extent incident management data requirements within transit are the same as those within other transportation centers.

2.4.1.8 Traffic Management

Transit agencies are interested in acquiring various types of information from Traffic Management Centers (TMC). These include information about planned, temporary, or permanent changes in the roadway network that affect transit operations (e.g., construction projects). For transit operations dispatching, transit agencies need data related to real-time traffic movements, road and weather conditions. Since these data come exclusively from TMCs, TCIP will rely heavily on data objects developed by the ITE/ITS Traffic Management Data Dictionary effort for data flowing from the TMC to the transit agency.

TMCs may be interested in data generated by transit agencies related to transit service schedules, transit facilities, availability of parking at parking lots or garages at transit stops, the types and number of transit vehicles operating within their jurisdiction, the estimated arrival time of transit services, and passenger counts. Transit vehicles can also serve as traffic flow probes when their location is provided to TMCs.

2.4.1.9 Spatial Representation

The spatial representation (SP) business area objects serve other data elements; messages defined in this business area represent the location of fixed and mobile objects. Among the APTS data interchange needs is the ability to transfer the location of transit objects. Spatial representation is a common attribute (i.e., location reference) of a transit object. For example, a route is generally identified by a route identifier and its physical representation. A route pattern may be represented by a sequence of timepoints, nodes and links, or by a series of intersections (“on” and “at” streets).

Spatial features are composed of three primitive types: zero, one and two dimensional objects, or *point*, *line* and *polygon*. In addition, transit data elements make significant use of complex spatial objects such as linked lines or traversals, which are referred to in this standard as *routes*. These four classes of spatial representations cover most of the business area location referencing needs. These classes may be further specialized into various layers: topologic, geographic, etc. Generally, TCIP business areas use geographic, topologic, and a combined geographic/topologic representations for referencing its business objects (e.g., stop point, pattern).

Each layer of representation has its various referencing methods. Translation from one layer to another is accomplished by indexing (or calibrating) key data elements between two or more layers. Definition or guidelines of data structures that ensure interoperability among location referencing methods are not within the scope of the TCIP standard; however, data elements that can accomplish the translation are contained within the SP business area standard.

Section 3
BASIC CONCEPTS

3.1 ITS NATIONAL ARCHITECTURE/IEEE DATA DICTIONARY AND MESSAGE SET TEMPLATE

The U.S. DOT Joint Program Office on Intelligent Transportation System (ITS) is coordinating the development of a national architecture for ITS, and promulgating consistent, coordinated standards that support interoperability among the architectural systems, subsystems and components. This section describes the National ITS Architecture and the IEEE Data Dictionary and Message Set Template, three of the major efforts that will facilitate coordination between transit (TCIP), and other centers and subsystems within the National Architecture.

3.1.1 National ITS Architecture Data Flows

The National ITS Architecture data flows are defined by the *National Architecture for ITS*. This document describes the National ITS Architecture as a framework for providing a common structure for the design of intelligent transportation systems. To maximize the potential of ITS technologies, system design solutions must be compatible at the system interface level in order to share data, provide coordinated, area-wide integrated operations, and support interoperable equipment and services where appropriate. The National ITS Architecture provides this overall guidance to ensure system, product, and service compatibility/interoperability, without limiting the design options of the stakeholder.

The National ITS Architecture defines the framework around which multiple design approaches can be developed. Each one can be specifically tailored to meet the individual needs of the user while maintaining the benefits of a common architecture. The architecture defines the functions that must be performed to implement a given user service, the physical entities or subsystems where these functions reside, the interfaces/information flows between the physical subsystems, and the communication requirements for the information flows. In addition, it identifies and specifies the requirements for the standards needed to support national and regional interoperability. TCIP addresses the transit-specific data interfaces defined in the National Architecture and adheres to the requirements specified. The following table lists the transit-specific data flows defined in the National ITS Architecture.

Table 3.1 Public Transportation Data Flows from the National Architecture

Source	Destination	Architecture Flow
Emergency Management	Transit Management	transit emergency coordination data
Financial Institution	Transit Management	transaction status
Information Service Provider	Transit Management	demand responsive transit request
Information Service Provider	Transit Management	selected routes
Information Service Provider	Transit Management	transit information request

Source	Destination	Architecture Flow
Intermodal Transportation Service Provider	Transit Management	intermodal information
Map Update Provider	Transit Management	map updates
Other TRM	Transit Management	TRMS coordination
Parking Management	Transit Management	transit parking coordination
Payment Instrument	Remote Traveler Support	payment
Payment Instrument	Transit Vehicle Subsystem	payment
Personal Information Access	Transit Management	demand responsive transit request
Remote Traveler Support	Transit Management	emergency notification
Remote Traveler Support	Transit Management	transit request
Remote Traveler Support	Transit Management	traveler information request
Secure Area Environment	Transit Management	physical activities
Traffic Management	Transit Management	demand management price change request
Traffic Management	Transit Management	signal priority status
Traffic Management	Transit Management	traffic information
Transit Management	Emergency Management	security alarms
Transit Management	Enforcement Agency	violation notification
Transit Management	Financial Institution	payment request
Transit Management	Information Service Provider	demand responsive transit plan
Transit Management	Information Service Provider	transit and fare schedules
Transit Management	Information Service Provider	transit request confirmation
Transit Management	Intermodal Transportation Service Provider	intermodal information
Transit Management	Map Update Provider	map update request
Transit Management	Other TRM	TRMS coordination
Transit Management	Parking Management	parking lot transit response

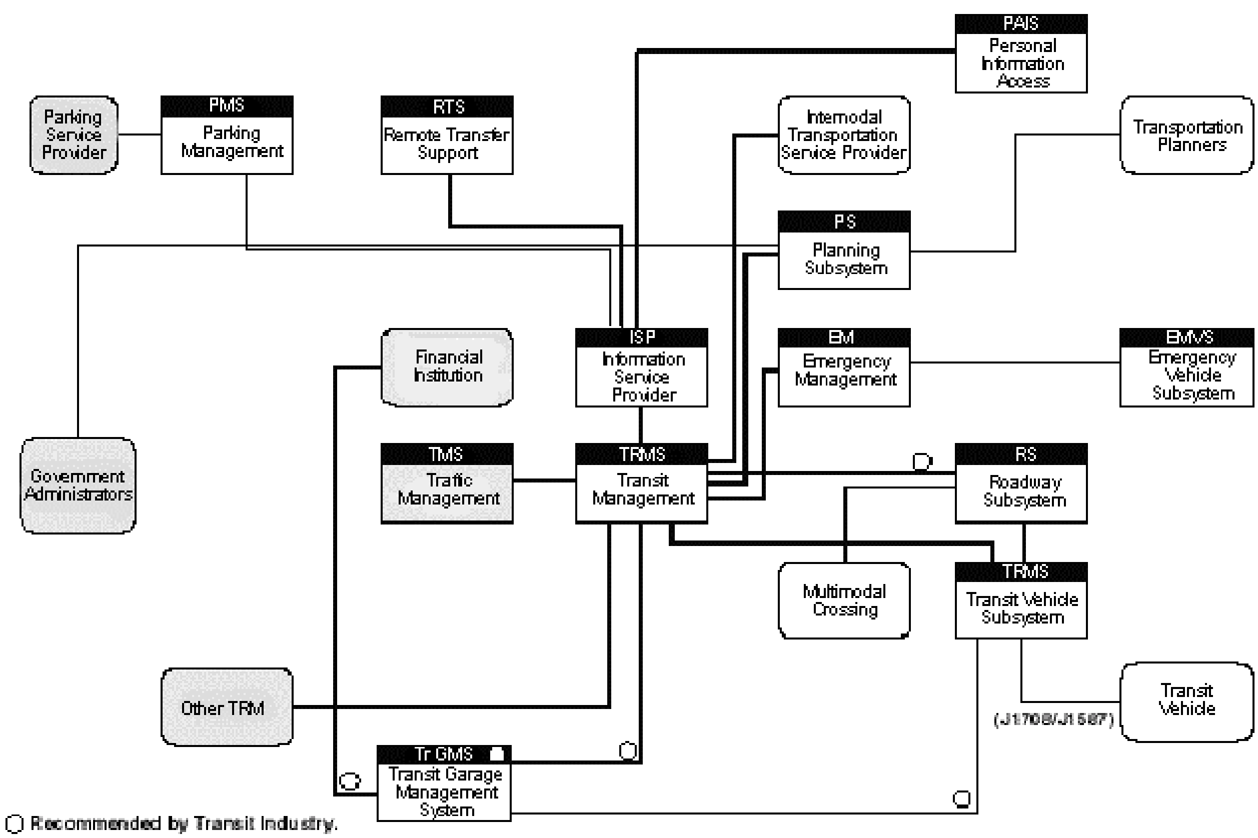
Source	Destination	Architecture Flow
Transit Management	Personal Information Access	demand responsive transit route
Transit Management	Planning Subsystem	operational data
Transit Management	Remote Traveler Support	emergency acknowledge
Transit Management	Remote Traveler Support	transit and fare schedules
Transit Management	Remote Traveler Support	traveler information
Transit Management	Secure Area Environment	emergency acknowledge
Transit Management	Traffic Management	demand management price change response
Transit Management	Traffic Management	request for transit signal priority
Transit Management	Traffic Management	transit system data
Transit Management	Transit Vehicle Subsystem	bad tag list
Transit Management	Transit Vehicle Subsystem	driver instructions
Transit Management	Transit Vehicle Subsystem	emergency acknowledge
Transit Management	Transit Vehicle Subsystem	request for vehicle measures
Transit Management	Transit Vehicle Subsystem	schedules, fare information request
Transit Management	Transit Vehicle Subsystem	traveler information
Transit Vehicle	Transit Vehicle Subsystem	vehicle measures
Transit Vehicle Subsystem	Payment Instrument	request for payment
Transit Vehicle Subsystem	Roadway Subsystem	local signal priority request
Transit Vehicle Subsystem	Transit Management	emergency notification
Transit Vehicle Subsystem	Transit Management	fare and payment status
Transit Vehicle Subsystem	Transit Management	request for bad tag list
Transit Vehicle Subsystem	Transit Management	transit vehicle conditions
Transit Vehicle Subsystem	Transit Management	transit vehicle passenger and use data
Transit Vehicle Subsystem	Transit Management	traveler information request

Source	Destination	Architecture Flow
Transit Vehicle Subsystem	Transit Management	vehicle probe data
Transit Vehicle Subsystem	Vehicle	traveler advisory request
Vehicle	Transit Vehicle Subsystem	vehicle location

3.1.1.1 Definitions of National Architecture Concepts

The following are definitions of the transit-related subsystems outlined by the National ITS Architecture (with some changes to reflect TCIP business area scopes). Figure 3.1 illustrates the relationships between these subsystems.

Figure 3.1 APTS System Architecture



3.1.1.1.1 Transit Management

Monitors and coordinates vehicle fleets including coordination with different modes and service types (i.e., fixed-route and demand-responsive), performs strategic and tactical planning for drivers and vehicles.

3.1.1.1.2 Transit Garage Management

Collects operational and maintenance data from transit vehicles, manages vehicle service histories, and monitors drivers and vehicles. In the National ITS Architecture these functions are included in the Transit Management Subsystem. Because of the way transit systems are deployed there is broad consensus in the industry for breaking these functions into a separate subsystem.

3.1.1.1.3 Transit Vehicle Subsystem

Provides operational data to the Transit Management Center, receives transit network status, provides en-route traveler information to travelers, and provides passenger and driver security functions.

3.1.1.1.4 Emergency Management

Coordinates response to incidents, including those involving hazardous materials (HAZMAT).

3.1.1.1.5 Planning Subsystem

Aids in optimal planning for ITS deployment. Collects and processes operational data from other Center subsystems, as well as the Parking Management Subsystem, and provides the results to Transportation Planners.

3.1.1.1.6 Parking Management

Collects parking fees and manages parking lot occupancy/availability.

3.1.1.1.7 Information Service Provider

This subsystem may be deployed alone (to generally serve drivers and/or travelers) or be combined with Transit Management (to specifically benefit transit travelers), Traffic Management (to specifically benefit drivers and their passengers), Emergency Management (for emergency vehicle routing), Parking Management (for brokering parking reservations), and/or Commercial Vehicle Administration (for commercial vehicle routing) deployments.

3.1.1.1.8 Remote Traveler Support

Provides access to traveler information at transit stations, transit stops, and other fixed sites along travel routes. Traveler information access points include kiosks and informational displays providing schedule information and imminent arrival signals. This subsystem also supports public safety monitoring using CCTV cameras or other surveillance equipment and emergency notification within these public areas. Fare card maintenance, and other features which enhance traveler convenience, may also be provided at the discretion of the deploying agency.

3.1.1.1.9 Personal Information Access

Provides traveler information and supports emergency requests for travelers using personal computers/telecommunication equipment at the home, office, or while on travel.

3.1.2 Classification Scheme

A classification scheme was developed as part of the draft IEEE P1489 Data Dictionary Standard for Intelligent Transportation Systems *(Annex B, Version D.0.7).* The scheme corresponds to the TCIP business areas. The TCIP-related nodes include:

Table 3.2 ITS Classes (Excerpted from IEEE 1489, Annex B, Version D.0.7)

Level 1	Level 2	Level 3	TCIP BA*
Transportation Network	Public Transportation Network	Transit Network	SP
		Rail Network	SP
Facilities	Public Transportation Facilities		SP
User Information (Travelers)	Traveler Information	Rail Information	PI
		Transit Passenger Information	PI
System Management	Transit Management	Schedules and Runcutting	SCH
		Control Center	CC
		Transit Incidents	IM
		Garage Management	TGM
Financial	Transit	Fare Collection	FC
Moving Components (Vehicles)	Transit Vehicles	Public Transportation Vehicle Management	OB

* Where BA refers to Business Area.

These notes refer to the nodes (fields) in the IEEE P1489 ITS Classification Scheme table. The notes describe the fields in the table.

"B.1.1 transportation network: Class covering all GIS and network data for the transportation infrastructure.
B.1.1.2 transit network: GIS features of transit facilities (e.g., transit stop locations).
B.1.1.2.1 transit spatial: GIS features specific to transit.
B.1.1.3 rail network: GIS features of rail network.
B.1.2.1 transit facilities: GIS features of transit facilities (e.g., bus stop locations).
B.1.3 user information (travelers): Class of information provided to travelers.
B.1.3.1 traveler information: Class of information to traveler.
B.1.3.1.3 transit passenger information: Data elements of passenger information processed from basic inputs of AVL and scheduling.
B.1.3.1.6 information: Information about schedules and/or current on time status of rail.
B.1.4 system management: Class of information used and created by the center subsystems.
B.1.4.2 transit management: Class of data passed from the transit management subsystem to other subsystems.
B.1.4.2.1 schedules and runcutting: Encompasses the data relating to non-real time calculation of transit schedules and runs

for transit systems.
B.1.4.2.2 control center: Includes objects relating to transit vehicle to transit control center interface.
B.1.4.2.4 transit incidents: Includes unique incident information relating to transit.
B.1.4.2.3 garage management: Encompasses data sent to and from a transit garage.
B.1.5 financial: Class of information regarding electronic payment, including toll and fare collection.
B.1.5.1 transit: Class of electronic payment for transit.
B.1.5.1.1 fare collection: Objects relating to the collection and processing of electronic fare data.
B.1.6 moving components (vehicles): Class of information regarding operational state data of all vehicles.
B.1.6.2 transit vehicles: Information about transit vehicles.
B.1.6.2.1 public transportation vehicle management (on-board objects): Objects relating to transit vehicle status and performance parameters."

3.1.3 Naming Convention

The TCIP Framework and business area domain data dictionaries use the draft IEEE P1487 naming conventions to ensure consistency with other ITS functional area data dictionaries. The conceptual and internal name fields in the TCIP business area data dictionaries conform to the IEEE P1487 naming conventions. The external name and/or ASN.1 name fields will be used to organize the TCIP data elements. The naming conventions are described below.

3.1.3.1 ITS Naming Conventions (from IEEE P1489, Annex A, Version D.0.7)

The naming conventions describe the entity type, property and representation class (domain value) of the data element. The data element name format shall be structured as follows.

ENTITY_PropertyModifierModifier_representationclassterm/valuedomain

The descriptions that follow are excerpted from the *IEEE Data Dictionary for ITS* standard.

3.1.3.1.1 Entity Type Terms

"An entity type term indicates the entity relevant to the data element. An entity is anything of interest (such as a person, place, process, property, object, concept, association, state, event, etc.) within a given domain of discourse about which there is a need to represent some information (using the data element). It is recommended that the entity type portion of the descriptive name be taken from the classification scheme table in Annex B (Table B.1) or from lower levels of classification that are developed and maintained by the functional-area data dictionary authorities. The maximum length of an entity type term shall be limited to 64 characters.

"An entity type term is written as a singular noun in all capital letters" [pp. 38-39].

3.1.3.1.2 Property Terms

"A property term indicates the information of interest relevant to the data element [that is, the 'something' of interest about the entity type]. The information of interest might be a fact, proposition, or observation about the entity type. The property term is written as a singular noun in initial capital letters, with any modifiers also written in initial capital letters without separators" [p. 39].

3.1.3.1.3 Representative Class Terms

"A term that indicates precisely and unambiguously, the format and syntactic form for data element instance values. The representation class term is a single word or term written in all lowercase letters. Example, the representation class term "date" is the name for a specific representational form and format for date, such as that specified by ANSI X3.30, an explicit and unambiguous value domain associated with that representation class term. Representation class terms and explicit value domain names shall not be used in entity type or property terms.

“Representation class terms and associated value domain references are listed in Annex C. If there is only one value domain reference listed in Annex C for the given representation term (e.g., if the data element includes representation class term ‘date’ and only one value domain reference is listed in Annex C for the representation class term ‘date’), then only the representation class term shall be specified in the name. Otherwise, both the representation class term and the particular value domain reference shall be specified (using a ‘/’ as a separator). If the value domain for the data element is not addressed in Annex C, user-defined representation class terms and associated value domain reference(s) may be used” [pp. 39-40].

3.1.3.2 External Names used as TCIP Naming Conventions

The TCIP names will be found in the External Name and ASN.1 name fields of the Data Dictionary. The external name field contains the TCIP Tree node name or Object Identifier, and the ASN.1 name includes the name used in ASN.1 messages. TCIP naming conventions are completely consistent with the IEEE naming conventions except that value domains and representation class terms are excluded from the data element names.

3.2 ABSTRACT SYNTAX NOTATION ONE BASIC CONCEPTS

The Transit Communications Interface Profiles are being developed to promote interoperability between the Public Transportation sector (i.e., transit) and the remainder of the ITS domain. While interoperability has many facets, for TCIP the crux is the definition of data elements and how they are presented. These two related aspects of interoperability are discussed here.

The Abstract Syntax Notation One (ASN.1) was developed to provide application designers with a notation for defining data structures “suitable for communications, interpretation, or processing by humans or machine.” This notion, associated with the term *data*, “a representation of facts, ideas, or instructions in a formalized manner...” [ANSI X3.285], recognizes the necessity and power of defining basic data types which can be used to denote more complex data concepts.

Further, these ASN.1 structured objects can be combined into distinct sequences to form an infinite number of messages (or more complex objects). Systems adhering to these defined objects can send, receive, and interpret the data without building customized interfaces or maintaining a catalog of predefined messages. The ASN.1 structures are coded into data formats compatible with Application Layer protocols (such as SNMP). The encoding is similar to compiling higher-level languages (e.g., C, FORTRAN, Pascal) into machine code. For this reason, ASN.1 is often referred to as a Data Definition Language (DDL).

Defined data types are specified which provide a common format for all data and messages. The set of data types defined for ASN.1 are listed in Table 3.3.

Table 3.3 List of ASN.1 Data Types

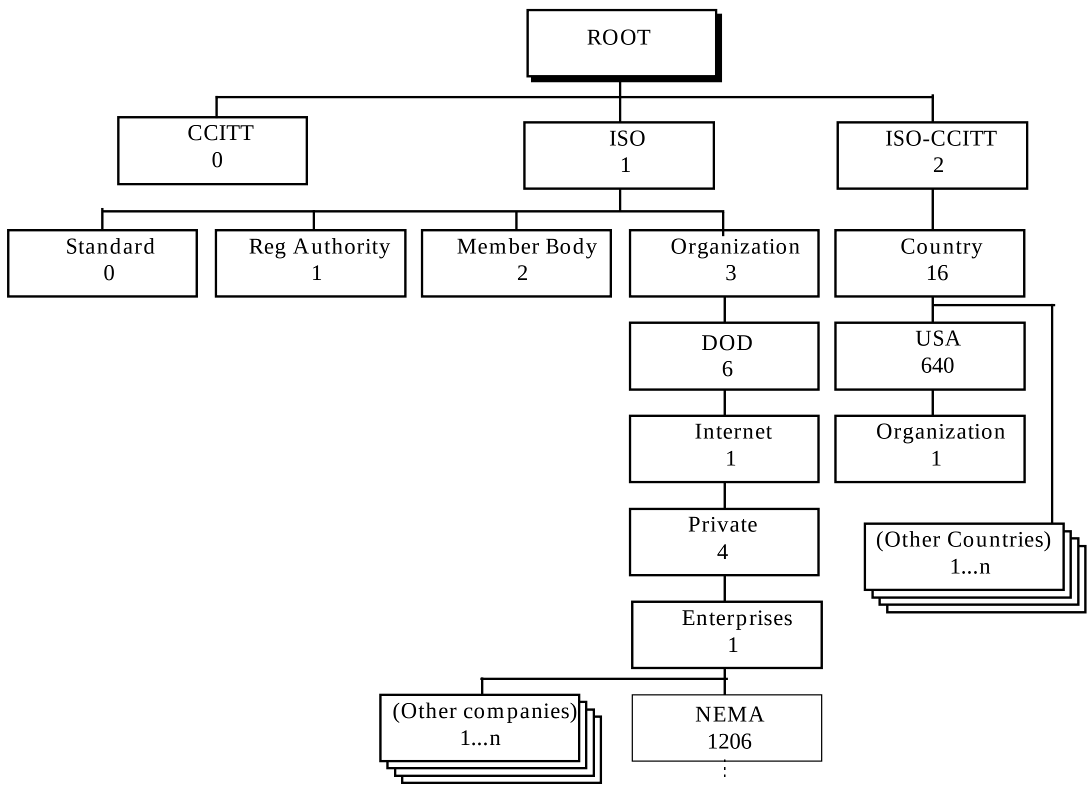
Tag	ASN.1 Type
1	BOOLEAN
2	INTEGER

Tag	ASN.1 Type
3	BIT STRING
4	OCTET STRING
5	NULL
6	OBJECT IDENTIFIER
7	ObjectDescriptor
8	EXTERNAL
9	REAL
10	ENUMERATED
11	Reserved for addenda
12	UTF8String
13-15	Reserved for addenda
16	SEQUENCE, SEQUENCE OF
17	SET, SET OF
18	NumericString
19	PrintableString
20	TeletexString
21	VideotexString
22	IA5String
23	UTCTime
24	GeneralizedTime
25	GraphicString
26	VisibleString
27	GeneralString
28	CHARACTER STRING
29	Reserved for addenda

Abstract syntax allows for the construction of modules with unique identifiers or *tags*. An object identifier is used as an unambiguous reference; organized in a tree structure, which includes a root node and arcs branching to other nodes (see Figures 3.2 and 3.3). Each node is assigned to a responsible body (i.e., registration authority) or allocated to an information object. The nodes (or numbers) are typically assigned sequentially starting at zero.

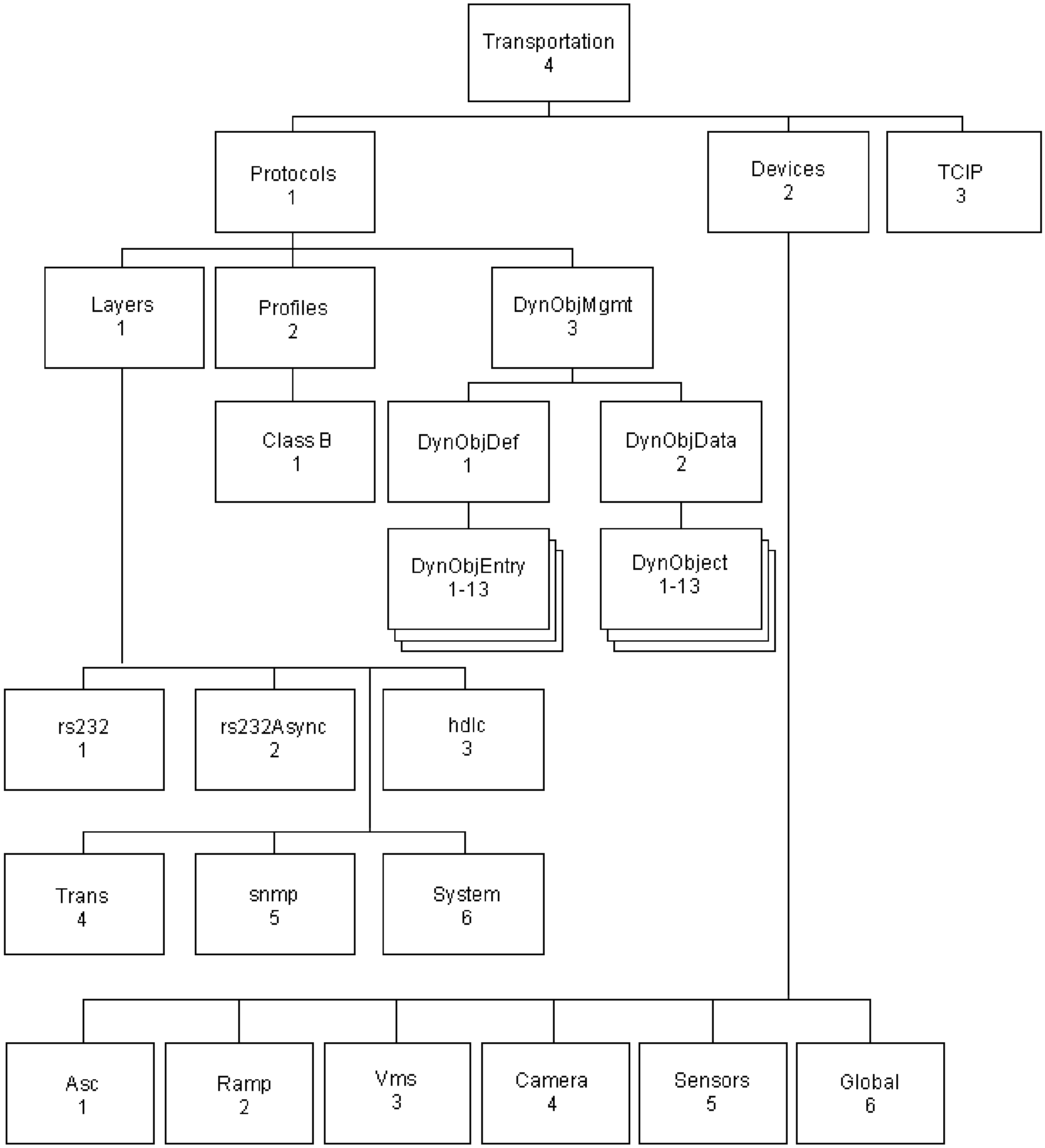
An information object is an encapsulation of a "fact, idea or instruction." These objects are accessed by the node numbers in the hierarchical tree structure. For example, in the NTCIP (NEMA) tree, camera objects will possess an address of 1.3.6.1.4.1.1206.4.2.3 (see Figures 3.2 and 3.3). The grouping of objects into classes provides a framework for the addressing notation. Classification provides for balanced and logical groupings of objects.

Figure 3.2 The Internet Authority Hierarchy



Source: NEMA TS 3.1-1996, p. 33

Figure 3.3 NEMA Tree



All TCIP addresses fall under the TCIP node in the NEMA tree. The addresses provide for globally registering TCIP data elements and messages.

Section 4
CONFORMANCE

4.1 DEFINITION OF CONFORMANCE

Conformance to this standard means that a component that is "TCIP conformant" can successfully compile and interpret an object or grouping of objects (e.g., TCIP data elements and messages) specified in an ASN.1 module and sent in a message template prescribed by this standard. A component may be in conformance with a business area level of conformance as defined in Annexes A through F. Business area documents include any node under the TCIP node in the NTCIP Tree (see Figure 2.1). For example, a kiosk may meet Level 1 conformance for Passenger Information (NTCIP 1403). That means that it can successfully interpret data elements that are needed by passenger information as referenced in NTCIP 1403 standard conformance requirements (Annex D, Level 1). Those include all the data elements from NTCIP 1403 and NTCIP 1401, and referenced data elements from NTCIP 1404, NTCIP 1405, NTCIP 1406, and NTCIP 1408.

4.2 LEVEL OF CONFORMANCE

Components shall conform to Level 1, 2 or 3 as described in Section 3.2.1 through 3.2.3.

4.2.1 Conformance Level 1

In order to be at Conformance Level 1, the following shall be supported.

- All Common Public Transportation Data Dictionary (DD) data elements. (See Annex B: Common Public Transportation Conformance Requirements.)
- All data elements referenced in the business area conformance requirements. (See Business Area Conformance Requirements annexes (Annexes C through F.)
- Dynamic objects including definition creation, definition deletion and object "get" and "set" data functions. (See Annex A: Dynamic Objects Definition Module.)

4.2.2 Conformance Level 2

In order to be at conformance Level 2, the following shall be supported.

- Conformance Level 1
- All messages defined in the Conformance Requirements section of the business area document (see appropriate Business Area Conformance Requirements annex)
- All data elements from other business areas that are included in the message requirements. These data elements will be explicitly referenced in the appropriate Business Area Conformance Requirements annex

4.2.3 Conformance Level 3

Not all business areas include requirements for Level 3 conformance. Those that do require it include a section on Transaction or Dialog processing. For Conformance Level 3, the following shall be supported.

- Conformance Level 2
- Dialog or transaction requirements as defined in the Requirements section of the business area document.

4.3 CONFORMANCE SITUATIONS

Minimum and maximum ranges different from the values of the DATA TYPE field may be enforced by a component within an advanced public transport system.

A component which enforces range limits within the bounds specified by the values of the Data Type field shall not necessarily be categorized as being non-compliant with TCIP.

4.4 CONFORMANCE CRITERIA

Conformance to a TCIP business area will be certified after 100 percent successful completion of conformance tests as described in Section 3.5.

Level 1 conformance will be certified when a component successfully completes the Level 1 test suite.
Level 2 conformance will be certified when a component successfully completes the Level 2 test suite.
Level 3 conformance will be certified when a component successfully completes the Level 3 test suite.

4.5 TEST METHODS

A designated TCIP Conformance Testing Institute will develop test suites for level 1, 2 and 3 conformance testing. The test suites shall perform exhaustive tests in a simulated environment to ensure “TCIP Compliance.” Test methods will be described by the Institute.

Level 1 testing will include exhaustive testing of each data dictionary element, conformance groupings and dynamic objects. Proper interpretation and generation of messaging templates will be tested, as well.

Level 2 testing will include exhaustive testing of each object (message), conformance groupings and dynamic objects. Proper interpretation and generation of messaging templates will be tested, as well.

Level 3 testing will include exhaustive testing of message dialogs for a selected set of typical and atypical transactions. Proper message generation, interpretation and response will be tested.

4.6 CONFORMANCE STATEMENT

A statement claiming conformance to this standard shall specify the business area standard, profile, and level of conformance for each applicable component as defined in Section 3.2. The statement shall be written as follows.

> “This component is conformant with the TCIP [BA] standard [reference] [version #] as tested by [testing institute] on [date]. The standard conforms with this TCIP standard with the following constraints […]”

Exceptions may include additions or restrictions (as stated in the section on Conformance Situations), but shall not diminish from the standard.

Annex A
DYNAMIC OBJECT MODULE DEFINITION

```
Dynamic-Object DEFINITIONS AUTOMATIC TAGS  ::=  BEGIN

IMPORTS TCIP-Class FROM TCIP-CPTDD;
IMPORTS dynObjMgmt, dynObjData FROM TMIB;
EXPORTS -- All
--
****************************************************************************
-- Dynamic Object Definition (dynObjDef) is a table composed of the objects
(identified by
-- object identifiers;
-- The dynObjNumber indexes one of the 13 dynamic objects (data streams)
identified by
-- this table;
-- The dynObjIndex identifies the position in the data stream wherein this
object (referenced
-- by the dynObjectVariable) is located.  For example, if CPT-VehicleID is
followed by
-- SCH-RouteID, then SCH-RouteID is assigned a position of 2.  The sequence
always
-- starts at 1 and up to 256 objects may be included in a data stream.
-- dynObjVariable is used to define the object identifier of the variable that
should-- be
-- included in the data stream.
-- dynObjOwner is any string of Latin 1 characters.  This field is set to NULL
when
-- EntryStatus is invalid (4).
-- dynObjStatus is used as defined below (see EntryStatus).
-- These definitions are consistent with NTCIP TS 3.2-1996 (see Annex B)
--
****************************************************************************
dynObjectDef-class TCIP-CLASS ::= {
   DynObjDef IDENTIFIED BY dynObjectDef
   WITH DESCRIPTION "A list of objects to be included in dynamic object data"
}
dynObjEntr-class TCIP-Class ::= {
   DynObjEntry IDENTIFIED BY dynObjEntry
   WITH DESCRIPTION "A list of Object Identifiers that make up a dynamic
   object"
   -- WITH INDEX { dynObjNumber  dynObjIndex }
}
DynObjDef ::= SEQUENCE (SIZE (13)) OF { DynObjEntry }
DynObjEntry  ::=  SEQUENCE {
dynObjNumber         INTEGER (1..13),
dynObjIndex    INTEGER (1..256),
dynObjVariable       OBJECT IDENTIFIER,
dynObjOwner    OwnerString,
dynObjStatus         EntryStatus
   }
-- Owner String
-- The owner string is used to identify the owner of a resource that stores
information
-- about the object.  This object stores information about who has control of
the associated
-- resource.  This data type is used to model an administratively assigned
name of the
```



```
-- owner of a resource.  This information is taken from the NVT ASCII
character set.  It is
-- suggestede that the name contain one or more of the following information:
management
-- station name, manager's name, location or phone number.
OwnerString ::= IA5String (SIZE (1..128))
-- EntryStatus
-- EntryStatus type definition is used to manage these tables and allows new
rows to be
-- created by the resource owner;
-- invalid indicates that the information in the row is undefined.  Setting
the data element to
-- invalid effectively renders the row undefined;
-- createRequest is used to define a new object defined by a new object
identifier.  It may
-- not be used to define objects that exist in the TCIP Tree;
-- underCreation is used when after an object is created (i.e., createRequest)
for
-- subsequent object instances;
-- valid is used for all other instances.
EntryStatus ::= INTEGER {
valid                   (1),
createRequest           (2),
underCreation           (3),
invalid                 (4)
   }
-- ******************************
-- OBJECT IDENTIFIER Definitions
-- ******************************
dynObjDef   OBJECT IDENTIFIER  ::= {dynObjMgmt 1}
dynObjEntry OBJECT IDENTIFIER  ::= {dynObjDef 1}
dynObjNumber            OBJECT IDENTIFIER  ::= {dynObjEntry 1}
dynObjIndex             OBJECT IDENTIFIER  ::= {dynObjEnrty 2}
dynObjVariable          OBJECT IDENTIFIER  ::= {dynObjEntry 3}
dynObjOwner             OBJECT IDENTIFIER  ::= {dynObjEntry 4}
dynObjStatus            OBJECT IDENTIFIER  ::= {dynObjEntry 5}

--
****************************************************************************
-- Dynamic Object Data (dynObjData) is a stream of objects which correspond to
a
-- dynObjDef
--
****************************************************************************
dynObj1           ::= OBJECT IDENTIFIER { dynObjData 1 }
dynObj2           ::= OBJECT IDENTIFIER { dynObjData 2 }
dynObj3           ::= OBJECT IDENTIFIER { dynObjData 3 }
dynObj4           ::= OBJECT IDENTIFIER { dynObjData 4 }
dynObj5           ::= OBJECT IDENTIFIER { dynObjData 5 }
dynObj6           ::= OBJECT IDENTIFIER { dynObjData 6 }
dynObj7           ::= OBJECT IDENTIFIER { dynObjData 7 }
dynObj8           ::= OBJECT IDENTIFIER { dynObjData 8 }
dynObj9           ::= OBJECT IDENTIFIER { dynObjData 9}
dynObj10    ::= OBJECT IDENTIFIER { dynObjData 10 }
dynObj11    ::= OBJECT IDENTIFIER { dynObjData 11 }
dynObj12    ::= OBJECT IDENTIFIER { dynObjData 12 }
dynObj13    ::= OBJECT IDENTIFIER { dynObjData 13 }
dynObjData-1 TCIP-CLASS ::= {
   DynObjData-1 IDENTIFIED BY dynObj1
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 1.  If no objects are defined for this
dynamic
```



```
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-2 TCIP-CLASS ::= {
   DynObjData-2 IDENTIFIED BY dynObj2
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 2.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-3 TCIP-CLASS ::= {
   DynObjData-3 IDENTIFIED BY dynObj3
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 3.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-4 TCIP-CLASS ::= {
   DynObjData-4 IDENTIFIED BY dynObj4
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 4.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-5 TCIP-CLASS ::= {
   DynObjData-5 IDENTIFIED BY dynObj5
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 5.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-6 TCIP-CLASS ::= {
   DynObjData-6 IDENTIFIED BY dynObj6
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 6.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-7 TCIP-CLASS ::= {
   DynObjData-7 IDENTIFIED BY dynObj7
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 7.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-8 TCIP-CLASS ::= {
   DynObjData-8 IDENTIFIED BY dynObj8
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 8.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-9 TCIP-CLASS ::= {
   DynObjData-9 IDENTIFIED BY dynObj9
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
```



```
   entries with dynObjNumber equal to 9.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-10 TCIP-CLASS ::= {
   DynObjData-10 IDENTIFIED BY dynObj10
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 10.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-11 TCIP-CLASS ::= {
   DynObjData-11 IDENTIFIED BY dynObj11
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 11.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-12 TCIP-CLASS ::= {
   DynObjData-12 IDENTIFIED BY dynObj12
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 12.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
dynObjData-13 TCIP-CLASS ::= {
   DynObjData-13 IDENTIFIED BY dynObj13
   WITH DESCRIPTION "The value of this object is determined by the dynObjDef
   entries with dynObjNumber equal to 13.  If no objects are defined for this
dynamic
   object number, then an error of noSuchNumber shall be returned by the
agent."
}
DynObjData-1            ::= OCTET STRING
DynObjData-2            ::= OCTET STRING
DynObjData-3            ::= OCTET STRING
DynObjData-4            ::= OCTET STRING
DynObjData-5            ::= OCTET STRING
DynObjData-6            ::= OCTET STRING
DynObjData-7            ::= OCTET STRING
DynObjData-8            ::= OCTET STRING
DynObjData-9            ::= OCTET STRING
DynObjData-10           ::= OCTET STRING
DynObjData-11           ::= OCTET STRING
DynObjData-12           ::= OCTET STRING
DynObjData-13           ::= OCTET STRING

END -- *** Dynamic-Object DEFINITIONS **
```

Annex B
Common Public Transportation Conformance Requirements

B.1 LEVEL ONE CONFORMANCE

Data Element Name	Reference*
CPT Data Elements	NTCIP 1401, Section 4.1
SP Data Elements	NTCIP 1405, Section 4.1
CC-PTVehicleIDShort	NTCIP 1407, Section 4.1
OB-MID	NTCIP 1406, Section 4.1
PI-ParkingFacID	NTCIP 1403, Section 4.1
PI-MarkerType	NTCIP 1403, Section 4.1
PI-SignID	NTCIP 1403, Section 4.1
PI-ADAAcess	NTCIP 1403, Section 4.1

* NTCIP 1401, Section 4.1 refers to the Common Public Transit Data Elements.
NTCIP 1405, Section 4.1 refers to the Spatial Representation Data Elements.
NTCIP 1407, Section 4.1 refers to the Control Center Data Elements.
NTCIP 1406, Section 4.1 refers to the On-Board Data Elements.
NTCIP 1403, Section 4.1 refers to the Passenger Information Data Elements.

B.2 LEVEL TWO CONFORMANCE

Message Name	Reference*
CPT Requirements	NTCIP 1401, Section 4.2

* NTCIP 1401, Section 4.2 refers to the Standard on Common Public Transportation Objects message set.

Annex C
Incident Management Conformance Requirements

C.1 LEVEL ONE CONFORMANCE

Data Element Name	Reference*
IM Data Elements	NTCIP 1402, Section 4.1
CPT Data Elements	NTCIP 1401, Section 4.1
SCH-BlockID	NTCIP 1404, Section 4.1
SCH-RouteDirectionName	
SCH-RunID	
SP-CompassDirection	NTCIP 1404, Section 4.1
CC-WorkstationID	NTCIP 1406, Section 4.1
Ob1587-VelocityVector	NTCIP 1406, Section 4.1
TMDD-LaneConfigurationList	Draft TMDD, Sections 1-4
TMDD-LanesBlockedOrClosedCount	
TMDD-LaneStatus	
TMDD-TimelineEstimatedDuration	

* NTCIP 1402 refers to the IM data elements. See Section 4.1 for complete listing. NTCIP 1401 Section 4.1 refers to the Common Public Transportation Data Elements. TMDD Section 1–4 refer to the ITE Traffic Management Data Dictionary.

C.2 LEVEL TWO CONFORMANCE

Message Name	Reference*
IM Messages	NTCIP 1402, Section 4.2
CPT Messages	NTCIP 1401, Section 4.2
SchRouteID	NTCIP 1404, Section 4.2
SpAddresspoint	NTCIP 1405, Section 4.2
SpLandmarkpoint	

Message Name	Reference*
SpLineclass	
SpLocationclass	
SpRouteclass	

* NTCIP 1402 refers to the IM document. See Section 4.2 for complete listing. NTCIP 1401 Section 4.2 refers to the Common Public Transportation Messages. NTCIP 1404 Section 4.2 refers to the Scheduling and Runcutting Messages; and NTCIP 1405 Section 4.2 refers to the Spatial Representation messages.

Annex D
Passenger Information Conformance Requirements

D.1 LEVEL ONE CONFORMANCE

Data Element Name	Reference*
PI Data Elements	NTCIP 1403
CPT Data Elements	NTCIP 1401
SpAddresspoint	NTCIP 1405
SpPointclass	
SCH-DayType	NTCIP 1404
SCH-RouteDirectionName	
SCH-RouteID	
SCH-RouteName	
SCH-ServiceType	
SCH-TripID	
FC-FareInstrumentID	NTCIP 1408
FC-Footnote	
FC-MonetaryInstrumentType	
FC-PassInstrumentID	
FC-RideInstrumentID	
FC -RidershipClassification	

* NTCIP 1403 refers to Section 4.1.
NTCIP 1401 refers to the data elements found in Section 4.1 of NTCIP 1401 v 01.02.
NTCIP 1405 refers to the data elements found in Section 4.1 of NTCIP 1405 v 01.02.
NTCIP 1404 refers to the specific data elements found in Section 4.1 of NTCIP 1404 v 01.02.
NTCIP 1408 refers to the specific data elements found in Section 4.1 of NTCIP 1408 v 0.3:1998.

D.2 LEVEL TWO CONFORMANCE

Message Name	Reference*
PI Messages	NTCIP 1403
CPT Messages	NTCIP 1401
SP Messages (specifically point class messages)	NTCIP 1405
SchMasterScheduleHdr	NTCIP 1404
SchTripTimePoint	
FcFareInstrument	Draft NTCIP 1408
FcMonetaryInstrumentDefinition	
FcRideInstrumentDefinition	
FcPassInstrumentDefinition	
FcFareMediaOtherDefinition	
FcFareTransaction	

* NTCIP 1403 refers to the messages found in Section 4.2 of NTCIP 1403.
NTCIP 1401 refers to the messages found in Section 4.2 of NTCIP 1401.
NTCIP 1405 refers to the messages found in Section 4.2 of NTCIP 1405.
NTCIP 1404 refers to the messages found in Section 4.2 of NTCIP 1404.
Draft NTCIP 1408 refers to the messages found in Section 5.2 of Draft NTCIP 1408 v 0.3:1998

Annex E
Scheduling/Runcutting Conformance Requirements

E.1 LEVEL ONE CONFORMANCE

Data Element Name	Reference*
SCH Data Elements	NTCIP 1404, Section 4.1
CC-RunIDShort	NTCIP 1407, Section 4.1
CPT Data Elements	NTCIP 1401, Section 4.1

* NTCIP 1404 refers to the date elements in Section 4.1 of the SCH document. NTCIP 1401, Section 4.1 refers to the Common Public Transportation Data Elements. NTCIP 1407, Section 4.1 refers to the Standard on Control Center Data Elements.

E.2 LEVEL TWO CONFORMANCE

Message Name	Reference*
SCH Messages	NTCIP 1404, Section 4.2
SpPointclass	NTCIP 1405, Section 4.2
SpAddresspoint	

* NTCIP 1404 refers to the messages in Section 4.2 of the SCH document. NTCIP 1405, Section 4.2 refers to the Standard on Spatial Representation Objects.

Annex F
Spatial Representation Conformance Requirements

F.1 LEVEL ONE CONFORMANCE

Data Element Name	Reference*
SP Data Elements	NTCIP 1405 Section 4.1

* NTCIP 1405 refers to Standard on Spatial Representation Objects. See Section 4.1 for complete listing.

F.2 LEVEL TWO CONFORMANCE

Message Name	Reference*
SP Messages	NTCIP 1405 Section 4.2

* NTCIP 1405 refers to the Standard on Spatial Representation Objects. See Section 4.2 for complete listing.