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Message Sets for Advanced Traveler Information System (ATIS)

RATIONALE

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1. Scope

This SAE Standard describes standardized medium-independent messages needed by information service providers for Advanced Traveler Information Systems (ATIS). The messages contained herein address all stages of travel (informational, pre-trip and en route), all types of travelers (drivers, passengers, personal devices, computers, other servers), all categories of information, and all platforms for delivery of information (in-vehicle, portable devices, kiosks, etc.).

1.1 Purpose

The purpose of this SAE Standard is to enable the rapid development of the market for ATIS products and services.

2. References

The following documents shall be used, when applicable, in the process of populating and developing the message sets of this standard. The specific revision and issued date stated below shall be used for each document. When the following documents are superseded by an approved revision, the revised version shall be reviewed for applicability.

The references cited below shall be included in the references of the other companion volumes of this standard unless specifically excepted.

IEEE Std 1512-2000, IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers. The Base volume (1512-2000) and all subsequent volumes in the same family (1512.1, 1512.2, 1512.3 et al)¹

IEEE Std 1488-2000, IEEE Trial-Use Standard for Message Set Template for Intelligent Transportation Systems.

IEEE Std 1489-1999, IEEE Standard for Data Dictionaries for Intelligent Transportation Systems.

ISO/IEC 8824-1:1998, Information technology—Abstract Syntax Notation One (ASN.1): Specification of basic notation.²

ISO/IEC 8824-2:1998, Information technology—Abstract Syntax Notation One (ASN.1): Information object specification.

ISO/IEC 8824-3:1998, Information technology—Abstract Syntax Notation One (ASN.1): Constraint specification.

ISO/IEC 8824-4:1998, Information technology—Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications.

ITE TMDD, Standard for Functional Level Traffic Management Data Dictionary (TMDD), Standard No. TM1.01.4.³

ITE TCIP-IM, Transit Communications Interface Profiles-Standard on Incident Management Objects, NTCIP 1402v01.02, December 2000.⁴

SAE J2313 –On-Board Land Vehicle Mayday Reporting Interface, September 1999.⁵

¹ IEEE Publications —Available from Institute of Electrical and Electronics Engineers (IEEE), 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855.

² ISO Publications —Available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

³ Standards for Functional Level Traffic Management Data Dictionary (TMDD) —Available from Institute of Transportation Engineers, 1099 14th Street, NW, Suite 300 West, Washington, DC 20005-3438 USA or <http://www.ite.org/standards/index.html>.

⁴ Joint AASHTO/ITE/NEMA Standards —Available from American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol St., N.W., Suite 249, Washington, D.C. 20001 USA. Or from Institute of Transportation Engineers (ITE) 1099 14th Street, NW, Suite 300 West, Washington, DC 20005-3438 USA. Or from National Electrical Manufacturers Association (NEMA), 1300 N. 17th Street, Suite 1847, Rosslyn, Virginia 22209-3801.

SAE J2369 –Standards for ATIS Message Sets Delivered Over Reduced Bandwidth Media, March 2000.

SAE J2540 –Messages for Handling Strings and Look-Up Tables in ATIS Standards, July 2002.

SAE J2540-1 –RDS Phrase Lists, July 2002.

SAE J2540-2 –ITIS Phrases List, February 2002.

SAE J2540-3 –National Names Phrase List, January 2002.

SAE J2630 –Converting ATIS Message Standards From ASN.1 To XML, Draft of July 2002.

3. Terms and definitions

For the purposes of this standard, the following definitions, abbreviations and acronyms apply.

The terms, abbreviations and acronyms cited below shall be a part of the terms of the other companion volumes of this standard and guides unless specifically cited otherwise.

3.1 Definitions

3.1.1 511: A type of phone response system accessed by dialing 511 which uses ATIS message and standard to exchange information with other systems.

3.1.2 application-specific data dictionary: A data dictionary specific to a particular implementation of an ITS application. Local deployments which use ATIS (or other message sets) may often select a subset of the defined messages meeting their specific needs and create an application-specific data dictionary for that deployment.

3.1.3 area: A generic term for a bounded, continuous, two-dimensional object that may or may not include its boundary.

3.1.4 attribute: Any documenting characteristic of any entity. Used in XML to mean a specific type of tagged data found within an element. In general, the ITS use of XML formatting does not make a heavy use of attributes, however some useful exceptions do occur.

3.1.5 BLOB: (slang) Binary Large Object, a term used to refer to a string of encoded information whose internal structure is not known and, hence, is treated as a monolithic lump of data.

3.1.6 bread crumb path: (slang) A term for a periodic sequence of position locations representing a path of interest. Presumably influenced by the tale of Hansel and Gretel.

⁵ SAE Publications —Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

3.1.7 byte type encoding: A type of information encoding where units of information are handled in modular increments of 8 bits.

3.1.8 coordinate system: A reference system for the unique definition of a location of a point in n-dimensional space.

3.1.9 data: Representations of static or dynamic entities in a formalized manner suitable for communication, interpretation, or processing by humans or by machines.

3.1.10 data concept: Any of a group of data dictionary structures defined in this standard (e.g., data element, data element concept, entity type, property, value domain, data frame, or message) referring to abstractions or things in the natural world that can be identified with explicit boundaries and meaning and whose properties and behavior all follow the same rules.

3.1.11 data consumer: Any entity in the ITS environment which consumes data from others. Often called a traveler, even though providing this data to end traveler devices is less common than providing it to other data consumers that may service travelers (typically with a final formatting translation). Data consumers may also act as data suppliers to others at the same time. Data consumers derive some benefit from the data they obtain, this may occur from rendering data to support users, such as rendering it to web pages for human use. In the context of this standard, data consumers make use of the ATIS message set to format and structure the data exchanges in which they engage when communicating with data suppliers.

3.1.12 data dictionary: An information technology for documenting, storing and retrieving the syntactical form (i.e., representational form) and some usage semantics of data elements and other data concepts. The major message sets of ITS, of which ATIS is but one, are kept and represented in a data dictionary.

3.1.13 data element: A syntactically formal representation of some single unit of information of interest (such as a fact, proposition, observation, etc.) with a singular instance value at any point in time, about some entity of interest (e.g., a person, place, process, property, object, concept, association, state, event). A data element is considered indivisible.

3.1.14 data frame: The term Data Structure which appears in the original volume is now more commonly called a Data Frame. The definition, which follows, remains the same. Any construct (including DEs) used to represent the contents of a Data Dictionary. From a computer science perspective, data structures are viewed as logical groupings of DEs, used in this document to describe "messages" or parts of messages. The data structure are comprised of the data elements of the Data Dictionary. They don't "represent the contents of a data dictionary" directly, they organize them within a framework where useful systems can be constructed. (One could say they present the contents of a Data Dictionary in a useful way).

3.1.15 data registry: An advanced data dictionary that contains not only data about data elements in terms of their names, representational forms and usage in applications, but also substantial data about the semantics or meaning associated with the data elements as concepts that describe or provide information about real or abstract entities. A data registry may contain abstract data concepts that do not get directly represented as data elements in any application system, but which help in information interchange and reuse both from the perspective of human users and for machine-interpretation of data elements. Within the ITS industry, there is a data registry established and run by the IEEE which contains the contents of this standard. SAE and the ATIS committee has also developed tools to access and use the data found in the registry as an aid to deployments.

3.1.16 data structure: Any construct (including data elements, data frames, and other data concepts) used to represent the contents of a data dictionary.

3.1.17 data supplier: Any center in the ITS environment which provides data to others. Often called an ISP in older documents. While often thought of as a public agency sending data out, a data supplier may be public or private in nature, and may supply information across various grouping of regional areas or content. Data suppliers may also act as data consumers from other data suppliers. Data suppliers may render data to support end users, such as rendering it to web pages for human use. In the context of this standard, data suppliers will make use of the ATIS message set to format and structure the data exchanges which they engage in when servicing data consumers.

3.1.18 data type: A classification of the collection of letters, digits, and/or symbols used to encode values of a data element based upon the operations that can be performed on the data element. For example, real, integer, character string, Boolean, bitstring, etc.

3.1.19 dialog: A sequence of two or more messages which are exchanged in a known sequence and format (typically of a request followed by one or more replies), which are considered a bound transactional exchange between the parties.

3.1.20 digital map database: A structured set of digital and alphanumeric data that portray geographic locations and relationships of spatial features. Typically, such structures represent, but are not limited to the digital form of hard copy maps. For example, CAD drawings may be imported into a GIS and considered a form of digital base map.

3.1.21 elevation: A vertical distance below or above a reference surface. Terrain elevation is expressed with reference to mean sea level (MSL).

3.1.22 entity: Anything of interest (such as a person, place, process, property, object, concept, association, state, event, etc.) within a given domain of discourse (in this case within the ITS domain of discourse).

3.1.23 exchange standard: A collection of agreements between sender and receiver that enables and assures the receiver's unambiguous understanding of the geographic information that the sender intended. Exchange standards are typically made up of at least three parts, the local agreements on the use and practices involved (intuitional issues), the message set contents defining the structures (this standard in the case of ATIS), and the center to center processes which allow the actual exchange of messages (for example an XML environment using SOAP).

3.1.24 free text: A term often used in describing the message structures to refer to areas where short portions of textual information (typically entered by human operator rather than by machines) can be inserted and expressed. There are also data elements in the ATIS work, as well as other message sets with this name.

3.1.25 functional-area data dictionary (FADD): A data dictionary that is intended to standardize data element syntax, and semantics, within and among application areas within the same functional area. This ATIS standard is a FADD.

3.1.26 geocoding: Process of assigning geographic coordinate locations and / or names to objects.

3.1.27 grid: A set of grid cells forming a regular, or nearly regular, tessellation of a surface. The tessellation is regular if formed by repeating the pattern of a regular polygon, such as a square, equilateral triangle, or regular hexagon. The tessellation is nearly regular if formed by repeating the pattern of an "almost" regular polygon such as a rectangle, non-square parallelogram, or non-equilateral triangle. Alternatively, the Grid profile is one of the LRMS profiles. It is used to define small rectilinear regions of

a surface representing a flat earth projection over a limited area. Often found to be useful in presenting regional maps.

3.1.28 IDX: Incident Description, a type of message found in the IEEE 1512 Incident Management work and used to relate information about an event.

3.1.29 information service provider (ISP): A public or private entity responsible for gathering, fusing, analyzing, and reporting transportation related information to user, including vehicles and non-mobile users. In the context of this standard, an ISP is at least a data supplier. ISP may provide data to other ISP, or to any other type of data consumers. That is, this standard specifies exchanges between ISPs as well. No preference or type of business model is implied by the use of the term ISP in this standard. To some degree this term has become obsolete. See also data supplier and data consumer.

3.1.30 intelligent transportation systems (ITS): Systems that apply modern technology to transportation problems. Another appropriate meaning of the ITS acronym is integrated transportation systems, which stressed that ITS systems will often integrate components and users from many domains, both public and private.

3.1.31 interoperability: The ability to share information between heterogeneous applications and systems.

3.1.32 itinerary: A set of step by step instructions or directions used to transverse a route.

3.1.33 ITIS: International Traveler Information Systems, the term commonly associated with the standard for incident phrases developed by the SAE ATIS Committee in conjunction with ITE TMDD and other standards. This work contains a wide variety of standard phrases to describe incidents and is expected to be used throughout the ITS industry. The codes found there can be used for sorting and classifying types of incident events, as well as creating uniform human readable phrases. In the capacity of classifying incident types, ITIS phrases are recommended for used in many areas. ITIS phrases can also be freely mixed with text and used to describe many incidents.

3.1.34 legacy databases: Databases that exist in an organization that must be maintained and used regardless of new technology changes.

3.1.35 linear referencing: Process of identifying location(s) on a transportation network or specific link in a network by specifying a start position, direction and distance along a particular link or set of links (a route). One of the profiles supported by the LRMS work.

3.1.36 link: A topological connection between two nodes. A link may contain additional intermediate coordinates (shapes points) to better represent the shape of curved features. A link may be directed by ordering its nodes. A link may have a number of attributes (for instance: shoulder widths, travel restrictions, etc.) as well. Much of this information is defined by the efforts of the ITE TMDD committee and reused within various ATIS messages.

3.1.37 link ID: An identifier assigned to a link. Link-IDs may be arbitrary, or may be assigned by convention to assure that multiple occurrences of the same ID will not occur within one network or within the universe of similar networks or databases. As such, these IDs may be used as a shorthand to referne a LRMS location.

3.1.38 link referencing: System which identifies a link in a network, and returns its ID value to an external application.

3.1.39 location referencing system: System of determining the position of an entity relative to other entities or to some external frame of references. The Location Referencing Message Set (LRMS) is a effort over many years to establish several "profiles" which can be uniformly employed in ITS to describe types of locations. At this time the work is the subject of an SAE standards effort.

3.1.40 map matching: The process of matching information (such as incomplete knowledge of an object's position) to the roadway topographic information, expressed by a map to determine a correct estimate of position.

3.1.41 market package: Market packages provide an accessible, service-oriented perspective to the National ITS Architecture. They are tailored to fit, separately or in combination, real world transportation problems and needs. They identify the pieces of the National ITS Architecture that are required to implement a particular transportation service.

3.1.42 media: The physical devices used to record, store, and (or) transmit data. Also used as a term to describe data consumers of the "press", "radio", and "local news" variety.

3.1.43 message: A grouping of data elements and message attributes, used to convey information. For the purposes of this document, a message is a prescribed set of instances of elements, in a defined order, with some elements optional in transmission. A compliant message follows the structures established by the message definitions.

3.1.44 message set: A collection of messages based on the ITS functional-area they pertain to. This ATIS standard is also a message set.

3.1.45 metadata: Data that defines and describes other data.

3.1.46 NAICS: North American Industry Classification System (NAICS) In 1997, the prior Standard Industrial Classification (SIC) was replaced by the North American Industry Classification System (NAICS). This is a six digit code that provides for newer industries. This new format is now the industry-wide classification system has been designed as the index for statistical reporting of all economic activities of the U.S., Canada, and Mexico. In the ATIS standard the prior use of the SIC system has been replaced with the NAICS system.

3.1.47 route: An aggregation of sequentially connected links in a network typically denoting an intended or scheduled path of a transport resource.

3.1.48 route guidance: Delivering real-time or pre-established travel and driving directions to the driver or traveler, based on a determined route and vehicle position or speed.

3.1.49 routing: The problem of calculating least-time, least-cost, or other optimized paths (routes) through a road network which meet the constraints established for the traveler and / or vehicle involved.

3.1.50 syntax: The structure of expressions in a language, and the rules governing the structure of a language.

3.1.51 XML: A common method of exchanging messages made up of tags and values organized in a data structure and typically transported over common Internet formats such as HTTP. XML has a growing number of supporters due to its ability to be implemented in the types of heterogeneous systems often

found in ITS deployments. It is possible to express and exchange the ATIS message set using this method; XML schema definitions are provided in the latter clauses of the standard.

3.2 Abbreviations and acronyms

AAMVA	American Association of Motor Vehicle Administrators
AMPS	Advanced Mobile Phone Service
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Transportation Management Systems
C2C	Center to Center
CCC	Configuration Control Committee
CORBA	Common Object Request Broker Architecture
CRC	Cyclic Redundancy Code
DE	Data Element
DF	Data Frame
DSRC	Dedicated Short Range Communications
ERM	Event Reporting Message
ESN	Electronic Serial Number
ESS	Environmental Sensors Stations
GMT	Greenwich Mean Time
ICC	Interstate Commerce Commission (now the Interstate Authority)
IEEE	Institute of Electrical and Electronics Engineers
IM	Incident Management or inter-modal
IM	Incident Management
ISO	International Standards Organization
ITE	Institute of Transportation Engineers
ITIS	International Traveler Information Systems
NTCIP	National Transportation Communications for ITS Protocols
SAE	Society of Automotive Engineers
SDO	Standards Developing Organization
TCIP	Transit Communications Interface Profiles
TMDD	Transportation Management Data Dictionary
UN	United Nations
XML	eXtensible Markup Language

4. Structure of the Standard

This section contains introductory material about this edition of the ATIS standard, background information on the rationale for the standard, and an introduction to the messages, which follow in Section 5.

4.1 Introduction to this Edition of the Standard

In the period of time between the original edition of the standard (late in 1999) and this revision many areas of ITS practices and specifications have changed for the better. This document is no exception; almost every line of every message has undergone some small improvement in the interim. The core message and structures which were outlined in the original document remain, and continue to trace heavily to flows and market packages established originally by the National Architecture efforts. These core message groups (Traveler Information, Trip Guidance, Directory Services, Parking and Settings) are described in more detail below. Developers who based early deployments on the first edition of the standard (or earlier drafts) can rest assured that the fundamental structural format of a request-response message, with several key top-level message types, remains. Many details have evolved, mostly as a result of a prolonged cooperative exchange with other ITS message set efforts, to reuse and exchange data with each other in consistent ways. Each of the core messages have grown significantly as deployment experience has provided feedback, indicating the need to add additional data elements which have been incorporated. Most of such elements are rendered as "optional" and, therefore, can be ignored without affecting compliance (however the content itself should be considered when conditions permit for the value they add). The result is a message set that has become very robust and can be used to represent the messaging needs of hundreds of deployments which have been examined, as well as exchange information with the other major message sets of ITS (TMDD, TCIP and IM).

In this revision of the standard, almost all the messages, data frames, and data elements from other parts of SAE ATIS standards efforts have also been merged into one coherent and complete document using consistent formatting.⁶ This step was taken in order to better facilitate the cross use and coordination of entries, both within the ATIS effort and with other SDOs which have come to rely on ATIS entries in their own work. SAE J2353 ATIS DATA DICTIONARY (1999) has been updated and incorporated into this edition of J2354. In the future, deployment guidance and various ways of documenting the concept of operations will be issued in the form of standalone guides targeted to specific vertical application areas, and referring to this standard as the definitive source for all data concepts required for that application area.

One of the major revisions of the standard is the integrated use of the International Traveler Information System (ITIS)⁷ code sets. This is a set of over a thousand standard codes and phrases for widely accepted common situations found in ITS systems. This effort, established in a national standard completed in 2001 and reflected in SAE J2540.2 is used both in the ATIS work, and in the standards of all of the other ITS-related SDOs. The effort brought together SAE, ITE and IEEE practices to produce one single set of ITS-wide phrases that could be used by all. It is fair to say that the standard ITIS codes have become an essential component of many ITS message sets. The use of the phrases, sometimes mixed with free text and limited to only phrases in other cases, allows a convenient ability to exchange, filter, and sort data concepts across different types of users. This construct has replaced the former use of strings and free text alone in the original version of the standard. It also supercedes the more primitive versions of codes and phrases developed in SAE-J2369, and also the many *ad hoc* systems deployed around early RDS (Radio Data System) phrases. The trend to moving to the widespread use of ITIS codes in ways that can be

⁶ At this time only the messages found in the reduced bandwidth effort (SAE J2369) are not integrated. These messages use a form of in-line bit level encoding which does not lend itself to being easily described in ASN.1 formats. The actual data elements with which these messages are built are now a part of this standard.

⁷ Note that the acronym and definition have changed over time. Originally, the "International Traveler Information Interchange Standard" (ITIIS) was proposed by the ENTERPRISE Project (1993), based on a North American adaptation of early European RDS codes. It never became a formal standard, but was widely used and adapted. See: <http://enterprise.prog.org/completed/itis.htm>. ENTERPRISE now calls this the "Intelligent Transportation Information System" (ITIS). SAE ATIS has adopted the term International Traveler Information System (ITIS) for the formally adopted U.S. code list (SAE J2540.2).

combined to produce complex situational descriptive statements, is very similar to what can be found in the traveler information messages developed in other countries as well. In this edition of the standard, almost every former textual description field related to an event has been reworked to use ITIS phrases and categorizations.

New formats of entering data in the ITS-wide data registry (which did not exist when the first version was adopted) have produced more consistent styles of specifying data elements and concepts. Tools have now been created to assist in this process. One result of this is a move to the almost universal use of "Type Definitions" for primitive data concepts that are then reused in more complex messages. Almost all definitions also employ size and length restrictions, as needed, to bound the contents of any entry. In the original versions of the standard (as in other standards produced at that time) there was a mixture of in-line definitions and items defined elsewhere. Further, in the ATIS work when an element was to be borrowed and re-used from other work (such as the data dictionary of TMDD) then it would be defined in its primitive form in-line where it was used. This required the reader to have additional information regarding what was intended rather than being able to read the ASN.1 directly to gain the meaning. An example of this would be the speed of travel on a link, which in the original document was defined as an integer with values ranging from 0 to 300. Now this same element is defined with a type (defined in the TMDD work and reused by ATIS) which is called the Link-speed and which appears in the message by that name. The name is preceded by the "module" name (in this case "TMDD") and, taken together, they give a definite reference to the element that is being reused. In places where ATIS had data entries which were similar to other standards, a harmonization process has occurred and the preferred standard is now cited. The weather elements found in the ESS portions of NTCIP are an example of this. Further, all such reused elements are now represented in a section of their own in the document so that the reader can refer to them directly. Any changes and additional restrictions placed on the element when required for ATIS use are documented there as well. The module names (and XML namespaces) used follow guidelines establishing common names used across the functional areas of ITS.

In addition, new content has been added to most messages. In a few cases, information has been deleted when it was more clearly handled elsewhere. The majority of the added elements came from either requests by practitioners or reviews of current deployment practices. A liberal use of the Internet and the URL function to link to further content outside the messages has also been added. This can be used for sending large data sets, such as camera images. Deficiencies found in the original message set, especially with regard to linking relationships between sets of message, have been addressed. Various additional elements, such as the time a message was created, how long it is to be considered valid, what units of currency are used, etc., have been added to a header structure. The header structures allow specifying this type of data once when needed, or not at all if the default value can be assumed. It allows for a message-by-message exception to established values to be made when needed. Most new content is optional in nature as well.

Nearly two years ago, it was decided to issue the messages in the standard with a set of XML expressions to aid in the uniform deployment of Web-based data exchanges. Originally, this took the form of providing analogous XML expressions for the ASN.1 structures found in the standard. During the time that this was being formulated, the W3C organization completed the formulation of the XML schema language, which SAE decided to adopt.⁸ As a result, the SAE issued SAE-J2630 CONVERTING ATIS MESSAGE STANDARDS FROM ASN.1 TO XML, which provides a nearly complete set of recommendations on how to translate an ASN.1 module to a formal XML schema, which can then be used to bound and validate instances of XML wishing to adhere to the standard. The document, as well as a set of utility tools which have been created to follow the recommendations, are now being used in many of the works of other SDOs to issue XML alongside the ASN.1 in their standards. SAE also follows this practice. In this standard, each ASN.1 entry (which is still taken as the definite authority) is followed by an XML schema fragment representing the same concepts. A complete ATIS schema, suitable for use by deployments wishing to validate messages with it, is provided at the end of this document.

⁸ The early process of formulating with DTDs was rejected as being less well structured and unable to reflect the complexity which the ASN.1 already contained. It should also be pointed out that a schema is not required to issue ATIS in XML; it has many positive benefits, but it is not essential.

4.2 ATIS and the U.S. National ITS Architecture

The ATIS standards are derived from the architecture flows identified in the National ITS Architecture Version 5.0 (see: <http://www.its.dot.gov/arch/arch.htm> and click on “National ITS Architecture”). The ATIS standards effort concentrates primarily on the interface between the Information Service Provider (ISP) and those who use the information, identified in the National ITS Architecture as the Personal Information Access subsystem (PIAS – Personal Computers, PDAs, etc.), the Remote Traveler Support subsystem (RTS – public access kiosks and the like), and the Vehicle Subsystem (VS – private vehicles). The ATIS message set also provides messages that are used on the architecture flows into the Information Service Provider from other center subsystems such as the Traffic Management, Transit Management, and Emergency Management subsystems. Since other standards activities are also working on standardizing some of these interfaces, the ATIS message set complements and reuses many of the data elements standardized by those other activities (such as the TCIP, TMDD, and Incident Management standards).

The physical architecture captures these concepts in the following figure.

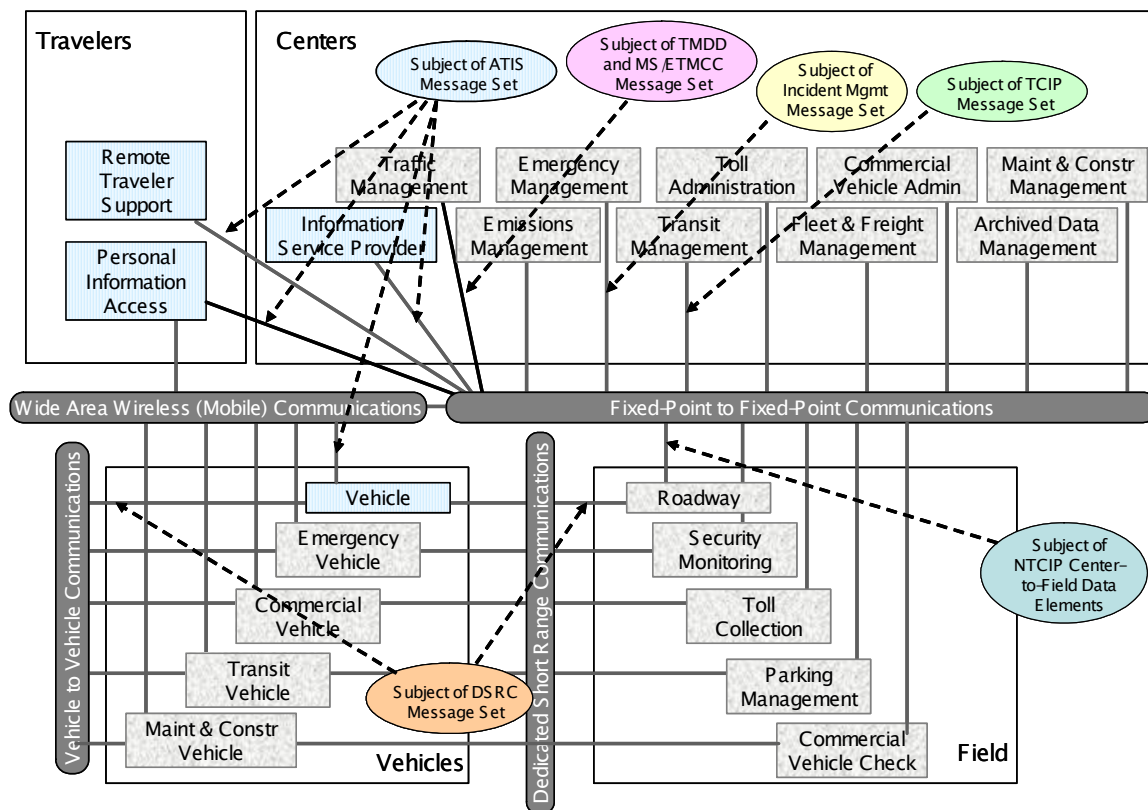


Figure 1 – The ITS Physical Architecture (referred to as the “subsystem diagram”)

It is important to emphasize that the function of the ISP may be performed by many different physical elements, including, for example, a traffic management center, a transit management center, or an emergency management center. An ISP does not have to be a separate, identifiable organization, but may only be a function on a computer within another office, such as a web server. The ISP may be a function performed by a public sector organization, a private for-profit company, or any of a number of combinations and business models.

There are two types of traveler information delivery mechanisms that are not included as part of the ATIS messages and data elements: highway advisory radio (HAR) and electronic message signs (variously called changeable message signs (CMS), dynamic message signs (DMS), or variable message signs (VMS)). These devices are located at specific equipped locations on the road network and typically controlled by a

traffic management function. As a result, the configuration, control, and status messages for these devices are covered by other standards (TMDD and NTCIP). A transit management center controlling a display sign at a bus stop or a parking management center controlling parking availability or guidance signs, would be more examples of the same idea. An ATIS system might query the systems that control the content of the HAR or electronic signs to determine whether the same information could be conveyed in an ATIS message, but an ATIS message would never drive those devices directly.

The National ITS Architecture is based on a set of user services, including the following user services that the ATIS standards support:

1 Travel And Traffic Management User Services Bundle

- 1.1 Pre-trip Travel Information
- 1.2 En-route Driver Information
- 1.3 Route Guidance
- 1.4 Ride Matching And Reservation
- 1.5 Traveler Services Information

2 Public Transportation Management User Services Bundle

- 2.2 En-route Transit Information

See <http://www.its.dot.gov/arch/arch.htm> and click on “National ITS Architecture”, and then select the “User Services” button for descriptions of all of the user services.

The following market packages defined in the National ITS Architecture are supported by this standard:

- ATIS1 Broadcast Traveler Information
- ATIS2 Interactive Traveler Information
- ATIS3 Autonomous Route Guidance
- ATIS4 Dynamic Route Guidance
- ATIS5 ISP Based Route Guidance
- ATIS6 Integrated Transportation Management/Route Guidance
- ATIS7 Yellow Pages and Reservation
- ATIS8 Dynamic Ridesharing

See <http://www.its.dot.gov/arch/arch.htm> and click on “National ITS Architecture”, and then select the “Market Packages” button for descriptions of all the market packages. The market package diagrams for ATIS1 and ATIS2 provide a good overview of how the various architecture flows among the center subsystems are intended to work. These are reproduced on the following page.

ATIS1 – Broadcast Traveler Information

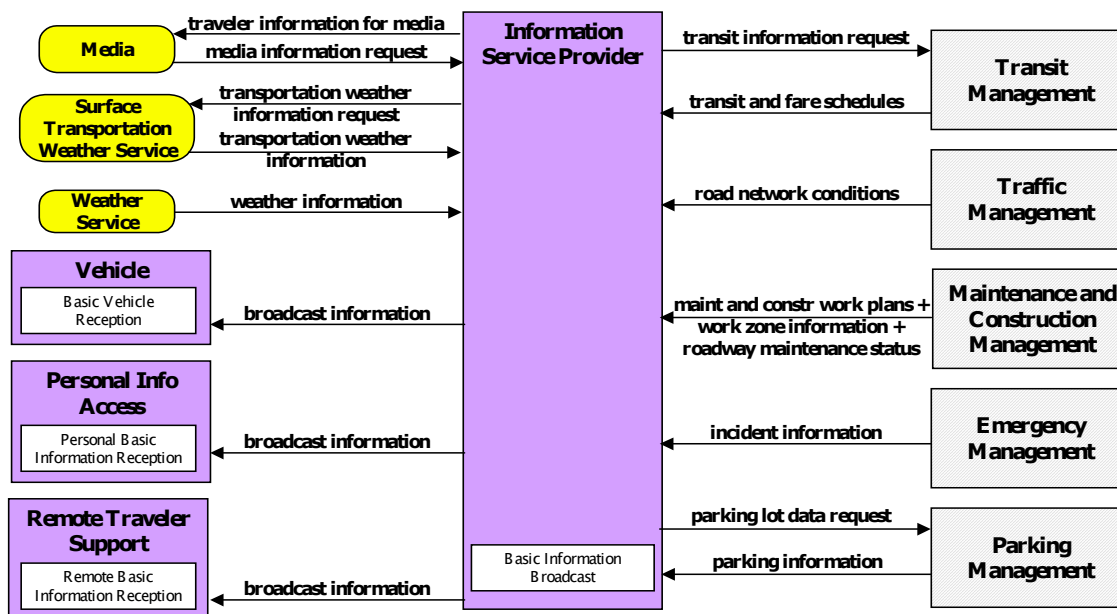


Figure 2 – The National ITS Architecture Broadcast Traveler Information Market Package

ATIS2 – Interactive Traveler Information

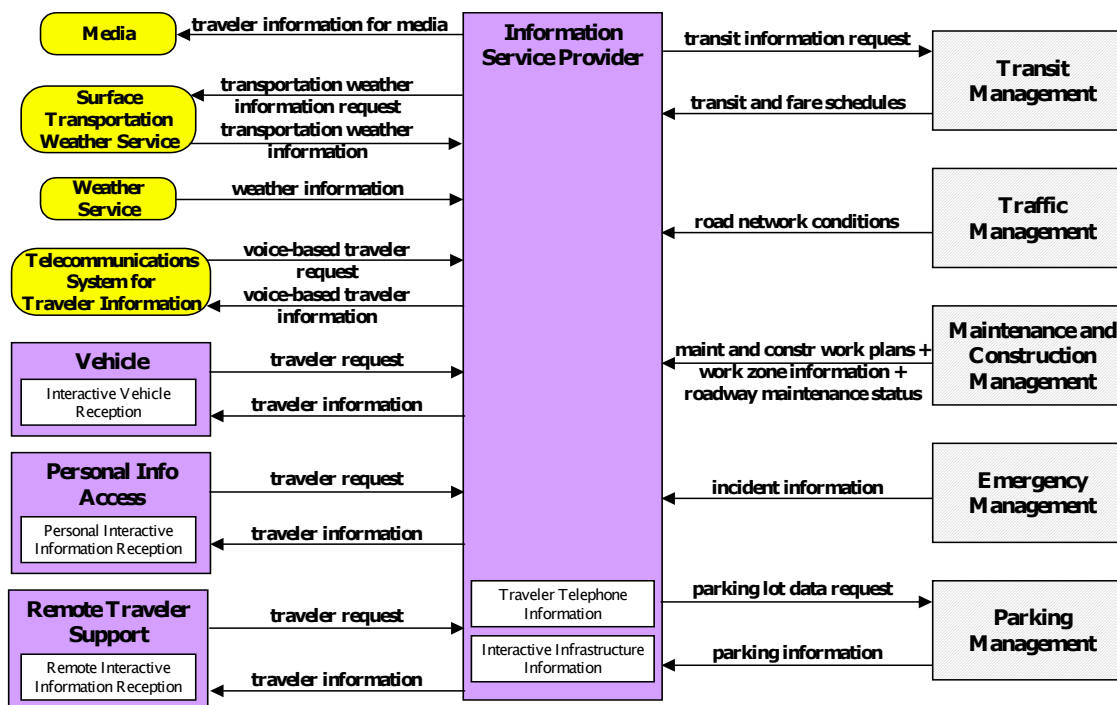


Figure 3 – The National ITS Architecture Interactive Traveler Information Market Package

It is important to note that not all aspects of the above-referenced user services and market packages are supported in their entirety by this standard. For example, other ITS standards (e.g., TMDD, Incident Management, TCIP) define messages that provide information from other centers to the ISP. Also, not all service options shown are supported by this standard. The ATIS standard was designed to expand to accommodate these needs as market demand, technology maturity, and deployment experience dictate.

The following table shows the relationships of Major Message Groupings to National ITS Architecture Flows in the National ITS Architecture. Note that the term “ISP” (Information Service Provider) is used in the National ITS Architecture rather than the term “data provider,” which is preferred and used in this standard. It is important to keep in mind that the data provider in one transaction may, in turn, be the data consumer in another transaction. Similarly, the phrase “traveler” is often represented by the preferred term “data consumer” in this standard. These terms are chosen to better represent the flow of messages between various computer devices (PCs, PDAs, Cell phones, Vehicles, etc.) involved, rather than focusing on the role of the owner of the computer (the traveler). The table also includes flows to/from the “Telecommunications System for Traveler Information” (TSTI) that represent the data interface to voice-based traveler information systems such as 511.

Major Groupings	Source	Architecture Flow	Destination	Comment
Settings	PIAS	Traveler Profile	ISP	Traveler => ISP
	VS	Traveler Profile	ISP	Traveler => ISP
Directory Services	PIAS	Yellow pages request	ISP	Traveler => ISP
	RTS	Yellow pages request	ISP	Traveler => ISP
	VS	Yellow pages request	ISP	Traveler => ISP
	ISP	Yellow pages information	PIAS	ISP => Traveler
	ISP	Yellow pages information	RTS	ISP => Traveler
	ISP	Yellow pages information	VS	ISP => Traveler
Parking	PIAS	traveler request	ISP	Traveler => ISP
	RTS	traveler request	ISP	Traveler => ISP
	VS	traveler request	ISP	Traveler => ISP
	ISP	traveler information	PIAS	ISP => Traveler
	ISP	traveler information	RTS	ISP => Traveler
	ISP	traveler information	VS	ISP => Traveler
	ISP	Broadcast information	PIAS	ISP => Traveler
	ISP	Broadcast information	RTS	ISP => Traveler
	ISP	Broadcast information	VS	ISP => Traveler
	ISP	Parking lot data request	PMS	ISP => Parking Mgmt
	PMS	Parking information	ISP	Parking Mgmt => ISP
	ISP	ISP coordination	Other ISP	ISP => Other ISP
	Other ISP	ISP coordination	ISP	Other ISP => ISP
Traveler Information	PIAS	traveler request	ISP	Traveler => ISP
	RTS	traveler request	ISP	Traveler => ISP

Major Groupings	Source	Architecture Flow	Destination	Comment
	VS	traveler request	ISP	Traveler => ISP
	ISP	traveler information	PIAS	ISP => Traveler
	ISP	traveler information	RTS	ISP => Traveler
	ISP	traveler information	VS	ISP => Traveler
	ISP	ISP coordination	Other ISP	ISP => Other ISP
	Other ISP	ISP coordination	ISP	Other ISP => ISP
	TSTI	voice-based traveler request	ISP	Traveler=>ISP
	ISP	voice-based traveler information	TSTI	ISP=>Traveler
Trip Guidance	PIAS	trip request	ISP	Traveler => ISP
	RTS	trip request	ISP	Traveler => ISP
	VS	trip request	ISP	Traveler => ISP
	ISP	trip plan	PIAS	ISP => Traveler
	ISP	trip plan	RTS	ISP => Traveler
	ISP	trip plan	VS	ISP => Traveler
	PIAS	trip confirmation	ISP	Traveler => ISP
	RTS	trip confirmation	ISP	Traveler => ISP
	VS	trip confirmation	ISP	Traveler => ISP
Mayday	PIAS	Emergency notification	EM	Traveler => EM
	VS	Emergency notification	EM	Traveler => EM
	EM	Emergency acknowledge	PIAS	EM => Traveler
	EM	Emergency acknowledge	VS	EM => Traveler
Reduced Bandwidth	ISP	Broadcast information	PIAS	ISP => Traveler
	ISP	Broadcast information	RTS	ISP => Traveler
	ISP	Broadcast information	VS	ISP => Traveler
	ISP	Traveler information	VS	ISP => Traveler
	ISP	Yellow pages information	VS	ISP => Traveler

Table 1 – The Traveler Information Architecture Flows of the National ITS Architecture

4.3 Fundamental Design Goals

In addition to meeting user requirements derived from the National Architecture, there are a number of general design goals that influenced how the ATIS standards were developed. These include (in no particular order):

- Provide a flexible, expandable framework that allows many options.

- Accommodate user needs that have been demonstrated in deployments, or that are emerging as near-term market trends; leave “hooks” or placeholders for ATIS developments that appear to be longer-term opportunities.
- Design for device and communications media independence.
- Allow for commercial value-added enhancements and local, customized extensions.
- Do not presume any particular business models for delivery of ATIS services.
- Do not presume any specific organizational/institutional roles between and among public and private sector entities.
- Do not specify system design, presentation/display to users, or message priority conflict resolution (see Sec. 4.5.3 below regarding message priority).

By adhering to these goals, the ATIS standards are meant to facilitate, not constrain, deployments.

4.4 Operational Concepts

There are two basic cases of ATIS, based on whether or not the traveler (data consumer) interacts with the ISP (data provider). One-way communication of traveler information includes all means whereby the traveler may receive predefined information. These include radio and TV broadcasts, some types of phone services, and some Web pages. Two-way, transactional traveler information encompasses all means whereby the traveler makes (or pre-registers) specific, personalized requests that are responded to with customized information. These include various Web-based mechanisms and some phone services. While this dimension of how information is provided is important, there are many other considerations.

The most fundamental aspect of ATIS is the complexity of the core concept of traveler information: it can come in many forms from many sources, have widely varying content attributes, be global or highly personalized, be delivered in multiple ways, and serve multiple types of information users. To address this complexity, the ATIS standard has tried to accommodate and anticipate a broad range of present and future ATIS dimensions. These can be summarized in the following table, in a simple construct of who/when/where/what/how. For each dimension, several examples are given; there is no intent to be comprehensive.

WHO	WHEN	WHERE	WHAT	HOW
<u>Information consumers:</u> Individual Travelers Fleet Operators Transportation System Managers News Media	<u>Pre-Trip:</u> Current/dynamic Planned/ Scheduled Predicted	For Fixed or Mobile users	For Driving or Using Public Transportation: Global, area-wide Personalized (location or traveler specific)	<u>Multiple formats:</u> Text Maps, icons Graphics, photos Video Audio
<u>Information providers:</u> Original information sources Information service providers (“aggregators”)	<u>En-Route:</u> Current/dynamic Planned/ Scheduled Predicted	Personal devices PCs PDAs Phones	<u>Traffic conditions:</u> Congestion Incidents Events Tolls	<u>Multiple communications channels</u> Internet Landline phone Wireless phone Radio, TV

		<u>Public devices:</u> Kiosks Signs	Weather, environmental conditions	One-way (broadcast) Two-way (<u>transactional</u>) One-time Subscription
		In-vehicle systems	Routing, guidance	
			<u>Public Transportation</u> Schedules Routes Fares Transfers	
			Ridesharing	
			Directory services, reservations	

Table 2 – Dimensions of the ATIS Messages

With all of these dimensions requiring support, it is not possible to capture all possible combinations in a compact set of operational concepts. The number of likely scenarios is virtually unlimited, due to both localized needs and creative deployers. Instead, the elements of the ATIS standard were developed to be used as building blocks to assemble as simple or as complex a message, as needed, to serve these diverse needs. Focused implementation guides will be developed by the Committee to assist deployers in applying the ATIS standard in the most common scenarios.

4.5 Structure of the Standard

4.5.1 Overview

The standard contains an integrated set of messages containing one or more data frames, which in turn include one or more data elements. While some data elements are defined uniquely for ATIS, many data elements used in the ATIS messages come from other ITS standards. These are listed separately (Section 7) as “external data elements,” so that those using this standard can determine if they need to examine other standards for updates/changes. It is the SAE ATIS Committee’s intention to try to stay synchronized with the other critical standards as much as possible. However, given the varying cycles of revision, adoption, and underlying funding for standards maintenance across the SDOs, the user is cautioned that there may be unavoidable inconsistencies in the exact form of the shared data elements among the published versions of each of these standards.

In compliance with the common IEEE message framework for ITS standards, the messages are presented in ASN.1 notation. To assist deployments, XML schemas are also provided.

Section 8 of this standard includes data elements that appeared in the earlier version of the standard, but are no longer used in the current edition. These are called “deprecated” elements, and are included for reference by those who may have implemented systems using the earlier standard.

4.5.2 Message Framework

The ATIS Standard is intended to be compliant with the IEEE registry, the IEEE Message Set Template, and Data Dictionary specifications. A key portion of this compliance is embodied in the use of ASN.1 to describe the messages included in the Standard.

The ATIS Standard is constructed to support a wide variety of implementations within different information environments and bandwidth availabilities. Part of this flexibility is intended to allow the Standard to be useful in the current operational environment and useful for the foreseeable future as the basis for an ATIS implementation.

It is very likely that should a deployment wish to use the message set in a new and formerly untried transport medium or encoding style, then some set of rules for translating into that form will have to be developed and consistently applied. In the media choice of XML over HTTP, this has been done by the Committee, using the rule set developed in SAE J2630, to produce the XML “productions” and schemas presented in this standard. In any event, such a translation should proceed from the ASN.1, which is considered the representative or correct expression of the data concepts.

In several places in the messages the phrase “...” appears in the ASN.1 text. These are locations where it is foreseen that local deployments may wish to add additional elements or entries to the formal specification. In the area of enumerations and lists (notably the ITIS lists), the “...” construct is used to provide a controlled way for any local implementation to extend and build upon the standard to fulfill local needs. This is potentially a source of abuse, but it also serves in a very controlled way to allow local versions which still preserve national interoperability. In the XML productions from the standard, similar places where local content can be added are preserved. Consult the guide document for further information and examples of how to use this feature.

Finally, in places there is a structure called a “tail” whose purpose is to allow the local deployment to append additional information associated with the message as needed. This is an excellent place to store “meta-data” or to send that one extra data element in a message your deployment cannot live without. The tail structure has the additional benefit that it is already built into the XML schemas and can be used without any further schema changes or changes to the ASN.1. It can also be used dynamically, allowing the ability to construct valid messages with different or new content elements on the fly.

4.6 Inter-relationships

As described above, the ATIS messages derive from the U.S. National ITS Architecture, and are supported by several other standards activities.⁹ Principal among these are:

1. Traffic Management Data Dictionary (TMDD) and External TMC Communications (ETMCC) Message Set, a cooperative effort of the Institute of Transportation Engineers (ITE) and the American Association of State Highway and Transportation Officials (AASHTO). See: <http://www.ite.org/tmdd/index.asp>
2. Incident Management (IM) Message Set, led by the Institute of Electrical and Electronics Engineers (IEEE – P1512). See: <http://grouper.ieee.org/groups/sc32/imwg/index.html>
3. Transit Communications Interface Profiles (TCIP) was initially led by ITE. See: <http://www.ite.org/standards/tcip.asp> A follow-up effort to expand those standards is underway, led by the Federal Transit Administration (FTA) and the American Public Transportation Association (APTA).
4. Location Referencing Message Specification (LRMS), a parallel current effort of the SAE ATIS Committee to develop a U.S. national standard (SAE J2266), in cooperation with related international standards.
5. IEEE Standards for ITS data dictionaries and message sets (IEEE 1488, 1489).
6. NTCIP Standards for center-to-center (C2C) communications
7. NTCIP Standards Environmental Sensors Stations (ESS)

⁹ As well as referring to other SAE standards, such as the use of ITIS (SAE J2540.2).

8. Archived Data Management Systems (ADMS) standards developed under the American Society for Testing and Materials (ASTM Committee E17.54) (see: <http://www.astm.org/cgi-bin/SoftCart.exe/COMMIT/COMMITTEE/E17.htm?E+mystore>)

9. Dedicated Short-Range Communications (DSRC) standards developed by ASTM (Committee E17.51)

The latter two are major standards efforts now emerging that will require increased coordination in the future. The ADMS standards may require changes in the ATIS messages to accommodate archiving of ATIS data, incorporating, for example, any new metadata requirements applied to all ITS applications. A new SAE effort to develop a message set to be carried over DSRC is just getting underway as this edition of the ATIS standard is being published. The development of a DSRC message set to deliver information from the roadside to the vehicle will likely build upon some of the current ATIS messages, but may require other specialized messages to be developed, such as imminent danger alerts. Such applications could evolve with the further development of highway-rail crossing systems and intersection collision warning systems.

These relationships are shown below in Figure 4.

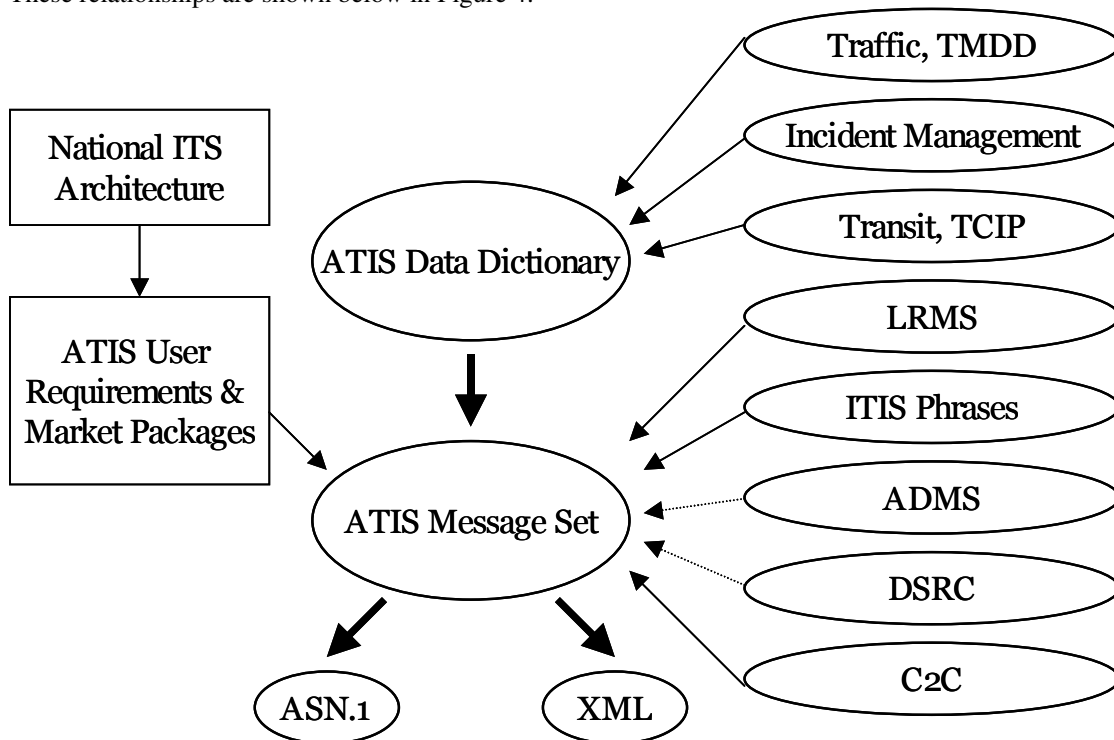


FIGURE 4 - INTER-RELATIONSHIPS AFFECTING THE ATIS STANDARD

There are also key relationships among the ATIS standards themselves, shown below in Figure 5.

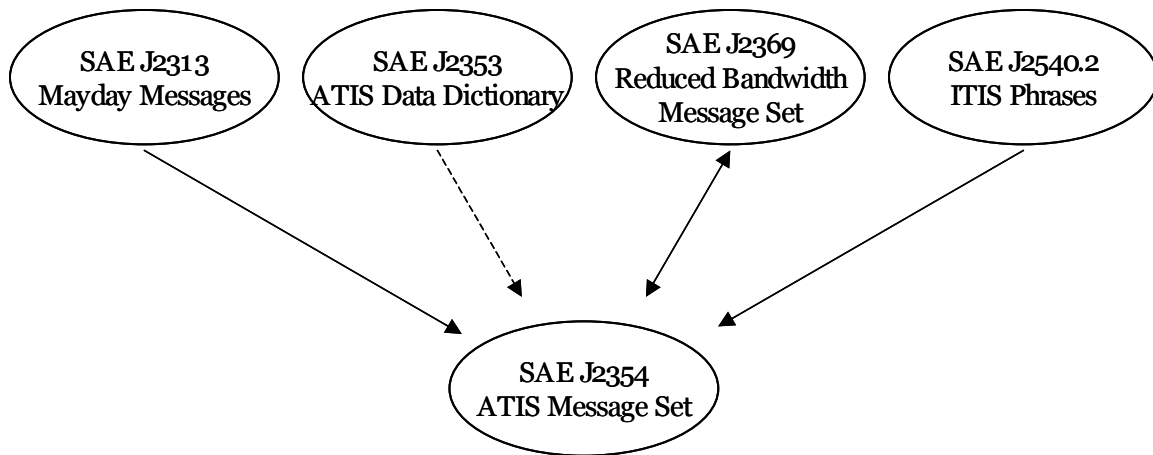


FIGURE 5 - INTER-RELATIONSHIPS AMONG ATIS STANDARDS

4.7 Future Enhancements

With this edition, the core ATIS messages are fully developed. There are several areas of enhancements that have been identified by the Committee for attention in future revisions. These include:

- Improvements and enhancements to -
 - Weather messages
 - Multimodal messages
- Updating the base standard to accommodate coordination with –
 - TMDD
 - IM
 - ADMS
 - DSRC
 - LRMS
- Continuing outreach, education & training –
 - Expansion of training to public sector
 - Completion of comprehensive user guide
 - Focused implementation guides for specific applications

In future years, as needs demand, some areas of the standard that have not been extensively used may need to be re-examined. For instance, the customized preferences of the Settings Messages and reservations under Directory Services Messages have not been used to any degree. Depending on the direction of ATIS deployments in the future, these messages may need to be significantly revised or even deleted. Parking Messages also have seen little use, due the very limited deployment of parking management systems in the U.S.

Users of the standard interested in any of the above topics should contact the Committee in order to be informed of, and participate in, these developments.

4.8 Major Groupings Overview

This section describes the messages defined for different categories of ATIS applications and all possible request/reply sequences of these messages. The five basic groups of ATIS applications are Traveler Information, Trip Guidance, Directory Services, Parking, and Settings. To these groups, two additional groups are added, that of traveler “Mayday” services, and that of “Limited Bandwidth” services. Each of

these latter two groups were originally developed in a stand-alone standard of its own, the messages of which are now merged into this master data dictionary standard. Some additional minor messages developed in various supporting environments are also presented here. This standard represents a compilation of all of the messages, and operational concepts for using some of the message in various applications are presented in the supporting guide document, or in reissued revisions of the original standards.

Returning to the five basic groups, these groups provide data consumers (travelers and other types of users) and data providers (ISPs and other sources) with the following functionality:

- **Traveler Information**—provides information on traffic, incidents, events, weather, environmental conditions (pollution), wide-area travel, and public transit schedules and services. This group provides the major portion of the effort and has been extensively revised in this edition of the standard.
- **Trip Guidance**—enables a data consumer to plan a route to a destination, selecting mode of transportation and the dates, and specifying the level of information to be returned about all the services and points of interest along a selected route. The routing message can also be used by fleet managers and dispatchers.
- **Directory Services**—provides the data consumer with electronic “Yellow Pages,” as well as a way for data providers to offer data consumers value-added information via location-based services. Future applications could include real-time reservations and payment.
- **Parking**—furnishes parking lot and space availability information. Future applications could include parking reservations and payment.
- **Settings**—enables a data consumer to send and store information about personal preferences with a data provider; the data provider can then use this information to update and, otherwise, modify the data consumer’s request.

The following sections include an overview description of each of the groups and the messages which make them up. Again, messages added to the standard from other original SAE standards efforts, retain the discussion portions and concept of operations found in those documents and are not repeated here. Predominately, this pertains to the messages of J2313, the “Mayday” work, and J2369, the “Reduced Bandwidth” work.

A short summary of the major groups is now provided. A more in-depth summary, complete with examples of use and commentary on the proper use of the message contents, can be found in the SAE training guide documents which are part of the outreach and training effort for ITS.

Graphical illustrations showing the top level of message are also provided in this clause and in the guide document. A short summary of the meanings of the various icons used follows. The symbol  indicates that the structure has been “expanded” immediately to the right. The symbol  indicates that the structure contains other elements which are not shown. A box with short lines in the upper left corner indicates a data element, which has a value but does not contain any other elements. The symbol  indicates that the group of elements to the right is a sequence. The symbol  indicates that the group of elements to the right is a choice. A small box with a solid outline is a required element; a small box with a dotted outline is an optional element. A large shaded box with a dashed border is the expansion of the complex type named in the upper left corner.

In addition, users guides targeted for specific vertical application areas are now being developed. Subject topics include areas such as using ATIS in 511 data exchange systems, or using ATIS to drive statewide weather and road closure systems. These guides will contain more specific operational details, as well as real world examples and case studies using the messages.

At this time, the SAE is preparing a full-day training class as part of the ITE-lead Outreach, Education and Training classes. The class is expected to be ready shortly after the balloting process for the standard is completed. This class will explain ATIS from both a technical point of view and from a procurement perspective. A strong theme of implementing ATIS using XML is presented, as well as case studies and a variety of training aids. Deployments are urged to contact ITE regarding the training class schedules.

4.9 Traveler Information Messages

Traveler Information messages are two-way communications between the data consumer and the data server. This section of the standard is the area of most interest to many readers and contains the primary message used to “send ATIS” to others. Extensive coverage of the contents and use of this message group can be found in the guide documents.

Traveler Information encompasses a wide variety of ATIS data elements. It includes information on traffic, incidents, events, detours and evacuations, weather, environmental conditions (and pollution), wide-area travel, and public transit schedules and services. Because much of this information comes from other centers - especially Traffic Management, Incident Management, and Transit Control, a great many of the data elements which support these messages are common to those data dictionaries. This group of messages forms the largest area of ATIS, both in terms of community interest and also in terms of being implemented the most widely. By the use of these common messages to service multiple, different end systems, the data supplier can achieve efficiencies of scale and reuse.

Traveler Information provides two paradigms for communication between the data supplier and the data consumer:

- One-way Traveler Information messages
- Two-way Traveler Information messages (including area or route-specific and type-specific messages)

These two paradigms are deployed in a wide variety of end systems and transport mechanisms. While the messages themselves are expressed in ASN.1 and XML, the use of XML has become very popular in this regard.¹⁰ Many deployments are moving from pre-standard variants of ATIS to standard compliant XML embodiments. However, even within this range, there are many variations of the precise push or pull model used to establish connection between the data consumer and data supplier for this XML-formatted data.

The figure which follows shows the top level diagram containing both the one and two-way messages. The training guide document contains many more such diagrams of the message set in greater detail, as well as extensive text on the operational concepts.

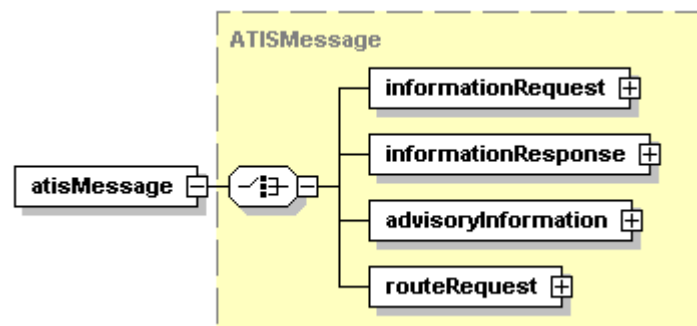


Figure 6 – The Top Level ATIS Message

One of the most simple of these is a model of placing the most current data into a well-known file location accessible on the internet and, periodically, overwriting this file with new data as it occurs. This is essentially a one-way information model, but it has served the needs of many early deployments. It is also a process which lends itself well to developing a parallel translation process of taking the data from the

¹⁰ And it should be noted that many media formats considered unique in some way, are now able to better serve by taking the "standard" XML format and rendering them into different XML formats supported by that media. In this way, the cost to extend ATIS access to "thin clients" such as PDAs, pagers, cell phones, and various mobile platforms has been reduced significantly for all concerned.

legacy format and converting into the standard in an adjacent file. This is a relatively risk free way for an existing deployment to upgrade the message structures which it issues, as both the old and the new message formats can co-exist for a period of time.

A slightly more refined model, two-way in nature, is to use the XML-RPC standards format to expose the top-level messages defined by the ATIS standard. By this method an actual messaging environment is established and the dialogs of request and response messages are supported, as well as any needs for user authorization or security. The depth and complexity of the message filtering to be supported in such a deployment is also determined locally. Both this method and the filter driven one above can co-exist. Many other suitable methods also exist which may make sense for a deployment to consider.

Neither of these two methods addresses the need to discover and bind to the services that a specific data supplier offers, if that supplier is not previously known to the data consumer. Rather, both rely on the data consumer to know that the data supplier exists and where it can be found. To achieve standards in regards to this next step (discovery and binding to offered services) the ATIS committee is still studying the use of SOAP and WSDL, and several other emerging technologies. No definitive advice can be given at this time regarding how to set up a SOAP or WSDL based data supplier.¹¹

4.9.1 One-way Traveler Information Messages

One-way Traveler Information messages are intended to provide wide, potentially modest-bandwidth access to information likely to be important to data consumers. One-way messages include the ability to provide location reference and one or more pieces of information. Often one-way messages are used to drive web pages, exchange data with others in a loose system, update display kiosks, and at other times, these messages are used in consumer media products that are one-way in nature (such as a pager data stream).

The AdvisoryInformation message contains optional sequences of information structures. Each information structure contains a range of fields relevant to a particular type of information. WeatherInformation contains a location reference and a range of fields that detail temperature, sky conditions, pollution elements, precipitation, sunset/sunrise times, etc. TrafficInformation provides a means of detailing specific information about traffic flow in an area, while IncidentInformation and EventInformation provide greater detail about specific traffic problems.

Because most of the information within a structure is OPTIONAL and because each of the structures are themselves an optional SEQUENCE, an AdvisoryInformation message could be as short as a location reference plus one field of information (such as pollution-SmogAlert), or could contain multiple instances of traffic information, incidents, events, weather conditions and pollution measurements, each containing many different fields.

In addition to the AdvisoryInformation, the ATIS Standard provides a wrapper message intended to support backwards compatibility with early RDS phrase-based systems.

4.9.2 Two-way Traveler Information Messages

The messages that support two-way data consumer information dialogs are structured very much like the AdvisoryInformation message. The basic request message is the InformationRequest.

The InformationRequest provides the ability to request information (based on one or more values of the informationRequest-Type) for a route or an area (the Route is a sequence of LocationReferences and the Area is a single location reference). A basic InformationRequest includes the traveler's identity, the location, and a request type (such as weather). The response to a InformationRequest with a type specified but no subtype, start or end should be a one-time reply containing all available information for the requested type(s). The reply is encapsulated in the InformationResponse.

¹¹ However, at this time providing a set of uniform web services and SOAP mappings for use with the ATIS standards is a task being developed by the committees. In this work the committee expects to coordinate closely with the center-to-center working group to ensure results that can be readily used with the other ITS standards as well.

The data consumer can also (or additionally) qualify a request for information by specifying a time period during which the information is of interest. The optional time fields provide this ability. When a InformationRequest includes a subscription time, the data server should continue to provide updates to the data consumer for the requested duration. Frequency of updates is entirely up the discretion of the sender. A field is provided to which the data should be returned. This field may not be needed in some media or applications, but in others can be considered similar to a return address. Supported format expressions include standard expressions for URLs, IPs, and emails; however, each data supplier may not support all possible formats.

The structures in the InformationResponse are identical to those contained in the advisory message (weather, events, incidents, traffic) so that the practical use of these two messages is nearly identical.

Traveler Information has a single Information Request message (Table 3, Message Sequence A) that can be parameterized by the data consumer to request a wide range of ITS-related information. A single Information Reply message is also parameterized to allow the data server to respond with any of the possible types of information requested by the data consumer. The four principal components of this message also exist as separate individual messages as well.

The data server can broadcast one-way unsolicited messages to multiple data consumers using the Advisory Information message. The format of the Advisory Information message is the same as the Information Reply message so that the same general information, in the same formatting, can be carried. Both format messages allow for adding “barge in” messages to alert the data consumer as the data sender sees fit.

The data server can also broadcast unsolicited messages to multiple data consumers using the Broadcast Wrapper Message Table 3, Message Sequence B). A Broadcast Wrapper message consists of information that the data server will send out to passing data consumers via an unacknowledged broadcast. This message exists to support the (outdated) older RDS style of ATIS messages.

Message Sequence: (Numbers Indicate Order)	A	B
Information Request Messages (From Traveler To data server)		
Traveler Information Request	1	
Information Reply Messages (From data server To Traveler)		
Traveler Information Reply	2	
Advisory Information		1
Broadcast Wrapper		1

Table 3 - Traveler Information Request-Reply Message Sequences

4.9.2.1 Traveler Information Request

An Information Request message is sent from the data consumer to the data server. It allows the data consumer to request a specific category of travel information from within a broad category of possible information types.

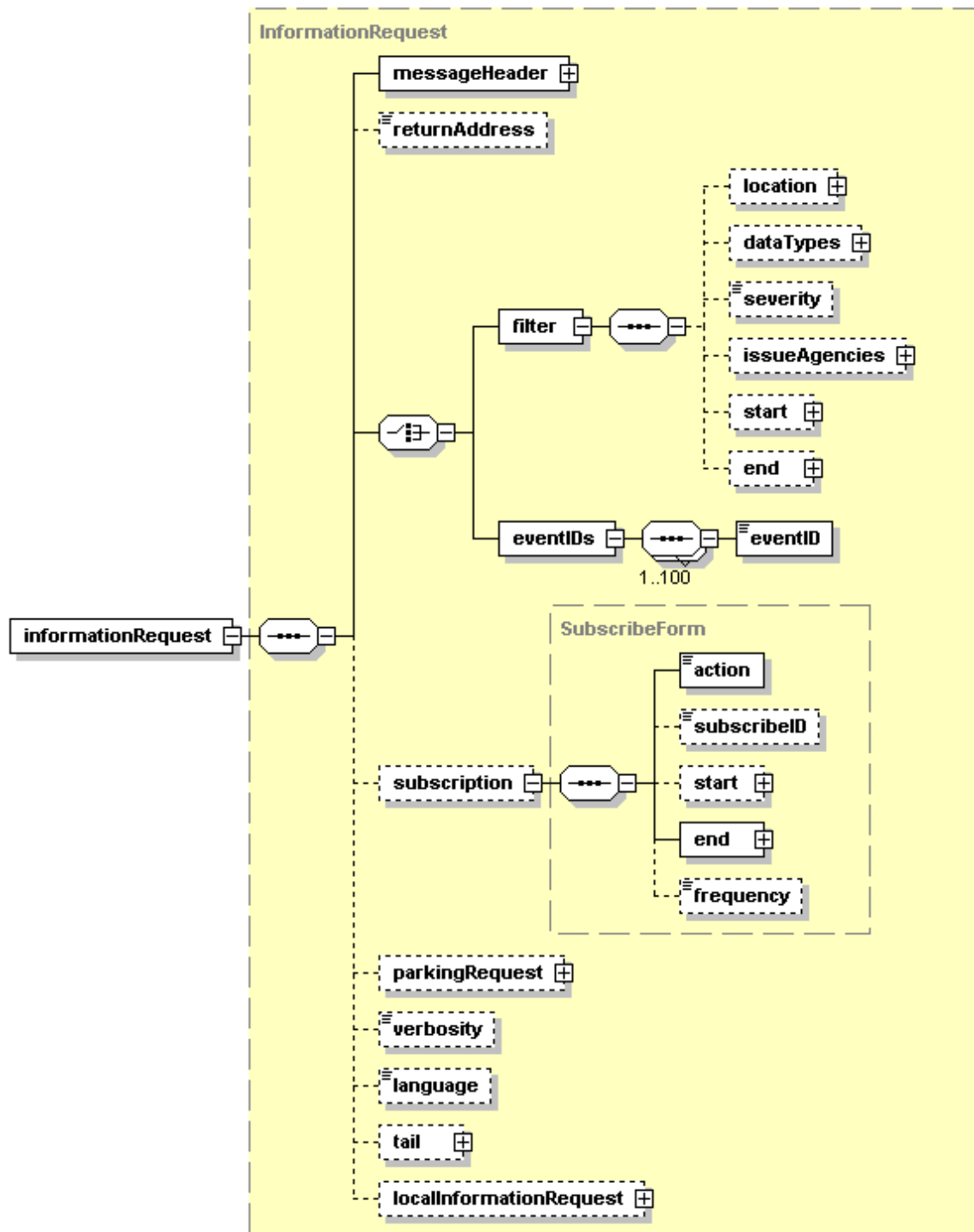


Figure 7 - Information Request Message

4.9.2.2 Traveler Information Reply

The Information Reply is sent by the data server to the data consumer, and is based upon the type of information that the data consumer requested. The response may be in the form of a One-Time reply or a sequence of ongoing replies.

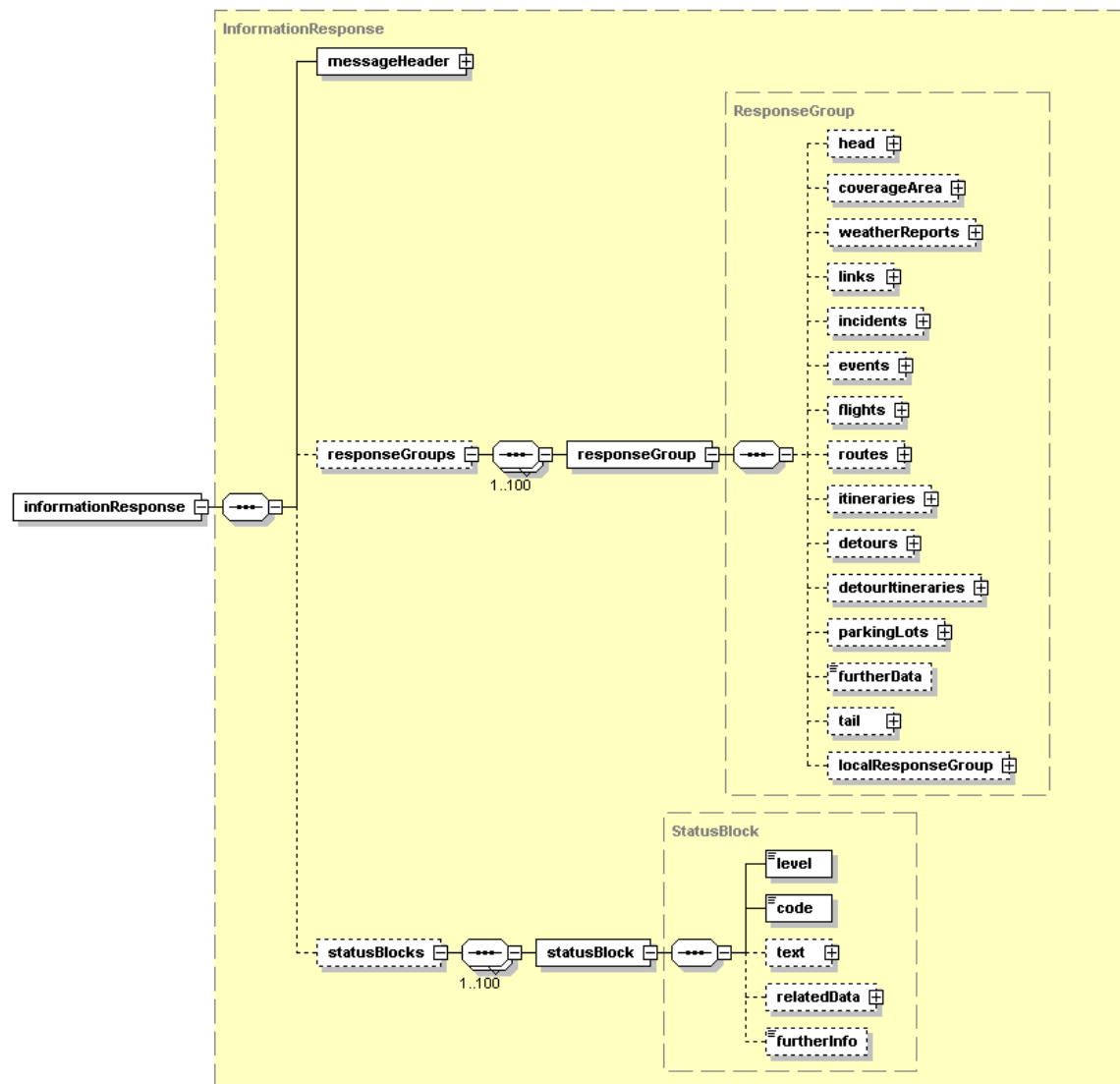


Figure 8 - Information Reply Message

The message contains some or all of the following information shown from the response group. This section of the message contains a wide variety of information content described in much greater detail in the guide document.

4.9.2.3 Advisory Information

An Advisory Information message contains some or all of the same information found in the Information Reply. However, it can be used outside of the scope of *the request-reply* dialog above, so it serves as an alerting message.

4.9.3 Information Request Filtering

This section describes how the filters involved in an information request work in greater detail. An information request is very versatile. It can result in either a single response of events matching the filter criteria, or in an ongoing “subscription” to have such events returned for a period of time. The preferred

language to be used and a “verbosity” level can be used to control the replies as well. The verbosity level, when used in “terse” mode, is a means to obtain summary data on current events as well. In addition, events can be requested directly by their event reference number. This method allows for the requesting of information related to specific events. A graphical representation of the information request message was presented on a prior page. A user may have multiple simultaneous independent subscriptions with a data provider, and by this means develop very complex data relationships. The collection of individual filters within a subscription should be considered to be logically “and-ed” together, and any “event” information held by the data supplier which passes the concatenated set of filters would be returned if the data supplier policies allow it. Supplying no filter elements in an information request implies that the request is to send back all the data.

The request will result in at least one reply (even if the returned data is simply a status block stating that no data matching the request is found). If the subscription times are given, then this request will be re-processed at the interval requested (presuming the data supplier supports this) over the interval of the subscription period. Data requestors should keep in mind that data suppliers will likely not allow every request which can be formed by this message. Perhaps the most trivial example of this is requesting data to be returned more frequently than the data supplier is willing to support in coverage areas not supported. In such events the data supplier will return, by way of the status blocks, information regarding the success or failure of the request and stating any policy issues that the data supplier is using. Keep in mind at all times that the “request” of subscription settings is not the “guarantee” of such services, and that the data supplier will simply make a best effort in most cases.

Events can be requested based on a filtering process of the following basic five types, which should be supported at the message processing level by all implementations as a mandatory requirement. Even if data servers are not able to process and sort entries to return based on these elements, the data supplier shall provide a response message and suitable status blocks stating that a particular element is not supported. Implementations should document the level of support they provide in this regard. This is especially important in the area of LRMS profile support. Implementations are also allowed to extend this to provide further filtering (both in terms of types of filters and more exact refinement of these filter sets) as they wish.

1. By Issuing Agency To allow filtering by the agency which created the data / message (found in the header). Note that issuing agency may not be the same as re-issuing agency in systems which have combined information from other sources. Presumably, such agency names will be assigned following C2C naming rules. Its absence in the information request implies no filtering on this element.
2. By Event Type By using the basic current categories of events (weather, roads, events, incidents, routes, etc.) and the various subtypes of each (accidents, pre-planned events, mobile events, weather, etc.) to filter the type of events which are wanted. This is an area where local content to extend the standard for further filtering is expected to occur.
3. By Time By filtering on both current and future time, the ability to extract pre-planned and known events, such as construction plans, is allowed. Time formats should follow the TMDD concept of a pre-planned event being “active” when underway, but otherwise, overlapping and considered inactive if the requested time interval intersects with the duration of the event. It should be possible to request and receive events several weeks in advance (presuming such data has been created in local data bases). No specific requirement regarding how far in the “past” such event records need to be kept is given, but for the purposes of testing a deployment for compliance with this standard, time is presumed to “start” when the message request is issued, and no requirement to support the filtering of prior (past) time is made.
4. By Location The term location filtering means not only geo-spatial location, but all the various LRMS profiles such as lat/long entries, named links of roadways using cross streets and/or mileposts, by jurisdictional or administrative locations, and by place names. Basically, these are multiple separate requirements. Geographical filters should, at the least, support both points and proximity (“within 1 mile of here”) as well as events occurring within a defined polygon. Note that jurisdictional coverage areas often overlap (state and local) and can change with the hours of the day. Within a jurisdictional boundary, forms of local named requests for gross coverage such as “west side of town” are supported as well.

5. By Severity The TMDD data element “severity” is used to classify events into minor and major (and also disasters) and are also used to filter requests. Its absence in the information request implies no filtering on this element.

Beyond these five basic filtering requirements which transactional requests should support, additional filter elements can be added at the local level if desired. This occurs in the normal way for adding local content to a message. Note that the subtypes associated with each major type of event can also be extended in this way.

A few examples of simple filtering using the various event types, are now provided (in the form of fragments of XML) to better show the filtering request process. For example, to simply request every type that the data provider can give, say:

```
<dataTypes> <all> TRUE </all>
</dataTypes>
```

To request only incidents and events, one would say:

```
<dataTypes>
  <events> all </events>
  <incidents> all </incidents>
</dataTypes>
```

To request only incidents involving multi vehicle events, one would say:

```
<dataTypes>
  <incidents> multiVehicleEvents </incidents>
</dataTypes>
```

To add to the above request to also include weather, say:

```
<dataTypes>
  <incidents> multiVehicleEvents </incidents>
  <weather> all </weather>
</dataTypes>
```

The local deployments can extend this in two ways: first, by creating new filter categories, and second, by adding on to basic top-level sets of categories. If a deployment has a very complex predefined filter, the user community might want to do this as well; then, you could simply request this filter by passing something like¹²:

```
<dataTypes>
  <localFilters> MyFilter </localFilters>
</dataTypes>
```

As the above shows, the contents of the request can become fairly complex, however the structure scales nicely and remains easy to read and understand.

¹² Consider this much like a predefined procedure call in a database query language. The exchanged data need only refer to the call itself, not pass all of its parameters. At the same time, a general purpose parametric passing call environment is supported by the structure.

4.10 Trip Guidance Messages

The ATIS standard provides a structure for defining a Route, and uses that Route structure to enable route requests and trip guidance, and to serve as the basis for itineraries. The Route is also the basis for Directory Information (see section 4.11).

Table 4 presents the trip guidance messages as they relate to dialogs. Guidance messages are two-way messages between the data consumer and the data server. The data consumer requests various route information, modifying it as needed, and the data server returns the requested data. Detour and/or detourItinerary information may be as one-way information in AdvisoryMessages or InformationResponse messages.

Message Sequence: (Numbers Indicate Order)	A	B	C
Route Request Messages (From Traveler To data server)			
Route Request	1	1	
Route Reply Messages (From data server To Traveler)			
Route (in InformationReponse)	2		
Itinerary (in InformationResponse)	2		
Route Error Message		2	
Detour and/or DetourItinerary (in AdvisoryMessage or InformationResponse)			1

Table 4 - Route Request-Reply Message Sequences

4.10.1 Definition of a Route

Figure 9 illustrates the components of the Route dataframe. The required components of a route are an origin and a destination, defined using an LRMS profile. The route may contain any number of points, legs, or subroutes between the origin and destination. Intermediate points (formerly called waypoints) may be cities, tourist stops, stores, or simply intersections where a maneuver is required. Representing a route as a sequence of points is typical for modes of transportation where the traveler must make maneuvers, such as driving, bicycling, or walking. Representing a route as a sequence of legs is typical for transit-type modes, such as bus, train, subway, taxi, or airplane, where mid-leg maneuvers are of no concern to the traveler. The capability of representing a route as a combination of points and legs, and the ability to define subroutes which are themselves routes, maximizes the flexibility for mixed-mode route definitions.

Additional optional components of a route include a head and identifier for connecting to other pieces of information, mode, estimated travel time, total distance, and estimated cost. The maps element allows URLs or other pointers to large objects such as maps. Finally, localRoute elements may be defined using a local schema as described in section 4.9.

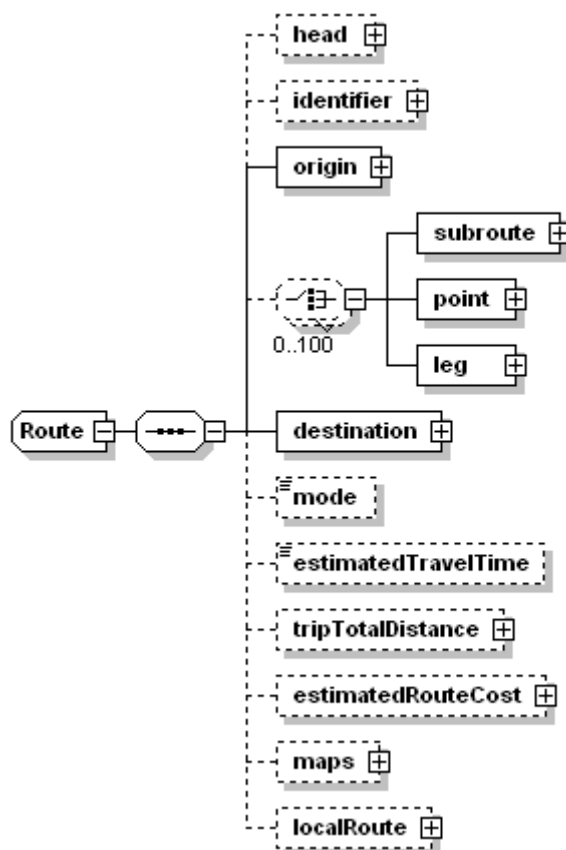


Figure 9 - The Route Dataframe

4.10.2 The RouteRequest Message

A RouteRequest message is used to request a route from an information provider. The structure of a RouteRequest message is shown in Figure 10. A RouteRequest message must contain a MessageHeader element and a routeOutline element. A routeOutline element is of type Route as described in the section above. A minimal RouteRequest would consist of a minimal route, specifying the origin and destination. A more complex RouteRequest may specify waypoints as intermediate points, and may specify particular subroutes or modes. In this manner, a route request could specify different travel modes for different portions of the trip. Essentially a RouteRequest message functions by submitting a Route with none or some of the details filled in, and by requesting the information provider to supply the remaining details.

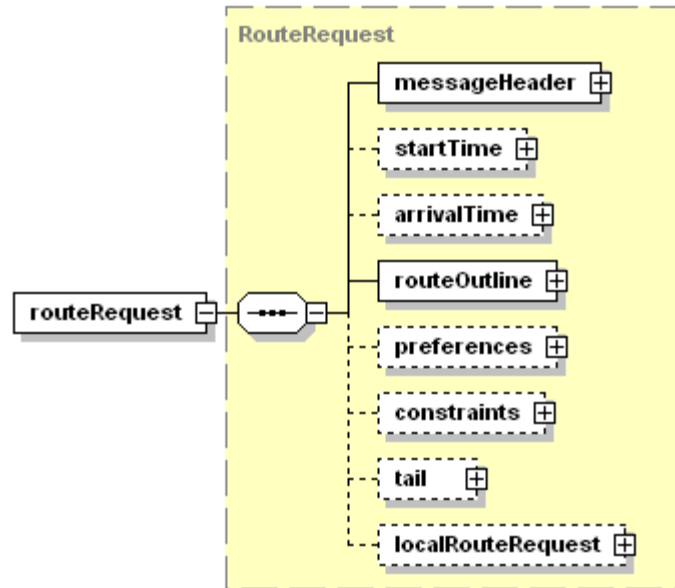


Figure 10 - Route Request Message

In addition to the basic route, the RouteRequest message may contain a desired start time, a desired arrival time, and preference and constraints. Constraints are features about a trip that must be satisfied for the route to be of any use to the traveler. There are three categories of constraints:

- Modes (e.g. the trip must use public transit, or must use private automobile)
- Needs (e.g. handicapped access to public transit, provisions for vision or hearing impairments)
- Vehicle restrictions (e.g. the trip must feature only roads and bridges that can accommodate an oversized or overweight vehicle)

Preferences are features about a route that make it preferable to the traveler over other possible routes, but are not required. There are three categories of preferences:

- Selection criteria (e.g. fastest, cheapest, fewest transfers, least walking)
- Preferred road type (e.g. scenic route, avoid highways, prefer highways)
- Special abilities (e.g. high-occupancy lane, emergency vehicle)

Finally, the tail and localRouteRequest elements allow for elements to be included which are not provided in the standard.

4.10.3 Route Response

There is no separate RouteResponse message because the InformationResponse message already provides for it. The response to a Route Request message is an InformationResponse message with a ResponseGroup containing one or more Route elements (see figure 8). The Route element, which started as a route fragment contained in the RouteRequest, now contains the complete route specification.

If the data server cannot process a trip guidance request, the response includes an ErrorCode in the StatusBlock portion of the InformationResponse message. An error message could be generated either because the data server cannot identify the origin or location of a trip, or because the trip cannot be completed within the constraints specified by the data consumer.

A Detour element is a special case of route. A detour may be specified in conjunction with a traffic incident or planned event such as a parade or a construction project. The route for a detour may be included in the ResponseGroup of an InformationResponse message or an AdvisoryInformation message and linked to the motivating event using the references and id elements in the event and detour head elements.

4.10.4 Itinerary

An itinerary is a detailed set of instructions for following a route. Whereas a route is a timeless sequence of points and/or legs, an itinerary is an instance of that of that route starting at a specified time, containing maneuver and transit instructions, and detailing costs and times. The structure for the Itinerary dataframe is illustrated in Figure 11.

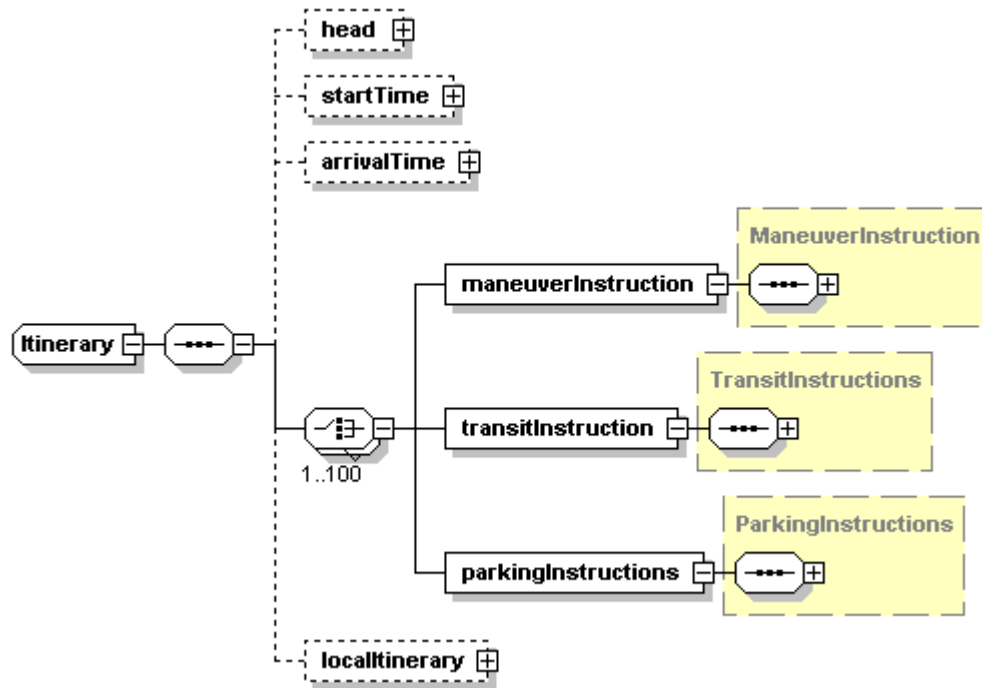


Figure 11 – Itinerary Message

Maneuver instructions apply when the traveler is doing the maneuvering. At each maneuver point, the maneuver instructions state which way to turn, which road to turn onto, the direction or travel, what signage exists at the maneuver point, what is the distance to the next maneuver point, and whether there is a cost associated with the maneuver point (e.g. a toll).

Transit instructions apply when the traveler is not doing the maneuvering, but is concerned with boarding or disembarking from a transit vehicle. The fields for transit instructions include mode, cost, boarding point (platform or gate identification), vehicle label, scheduled departure or arrival time, and known delay.

Parking instructions include the name and location of a parking lot, information about how many spaces are available (possibly categorized by vehicle type), and cost information.

A detourItinerary is a special kind of Itinerary. If a detour is provided in connection with an event or incident, a detourItinerary may also be provided to provide maneuver instructions. The detourItinerary is linked to the detour and the motivating event using the reference and id elements in the respective head elements.

4.11 Directory Services Messages

Directory Services (also known as “Yellow Pages”) form a core component of the ATIS message set. The Directory Services message set provides three broad types of functionality as follows.

- One-way Traveler Information messages

- Two-way Traveler Search Request and Reply messages
- Two-way Traveler Appointment/Reservation messages

Directory Services messages are either a two-way dialog between the data consumer and the data server, or a broadcast of summary information by the data server. A two-way dialog always includes at least one message request by the data consumer and an associated message reply from the data server.

A two-way dialog is typically initiated by a traveler search request message followed by a reply message from the data server. Based on the content of the data server reply, the data consumer may then make an additional request for more detailed information, or a request for an appointment. In addition, as of this revision, provisions have been added to reply with URL pointers which may use Internet methods to link to further returned data content, or even additional application offerings.

The one-way data consumer information message provides a simple way for a multitude of commercial and government entities to interact with data consumer devices. The summarized one-way information flow uses the DirectoryEntry structure within the DirectoryInformation message.

In many respects, this operational concept for Directory Services echoes that specified in the National Architecture. The major extensions beyond the architecture are in the variety of search mechanisms and capabilities supported. The concept of a Search Radius was borrowed from the 1996 Atlanta “showcase” project, and most of the basic flows echo that implementation. However, most existing ATIS implementations and specifications have implemented searching based exclusively on directory type and subtype. This division mirrors classic yellow pages, and forms the core search mechanism implemented here. As powerful and natural as category-based searching is, it does not satisfy a number of likely search situations. And, since Directory Services is an important area for data server value-add, the ATIS message set has been designed to support several additional kinds of search.

Most important of these is the ability to search on a name or name fragment. One existing system has implemented a phonetic name. The decision was made to simply allow passing a name or name fragment, and the data server could choose to implement either a phonetic or traditional search or some combination of the two. ATIS will also support a Search Request allowing multiple Category/Sub-Category pairs to be enumerated.

Finally, the Standard provides an extended keyword search. The keyword search model implemented in the Extended Search Message is based on current practice on Internet search engines. The Extended Search Message allows an application to specify one or more keywords or phrases. Each keyword or phrase includes an Operator with four possible values: must include, should include, should not include, and must not include.

4.11.1 Search Messages

A two-way dialog is typically initiated by the data consumer via a search request. Four possible search request message formats are available: Basic Search, Advanced Search, Name Search, and Extended Search.

The data server responds to a search request with a Search reply if the response contains multiple directory entries – see Message Sequences A to D in Table 5.

The data server responds to a search request with a Detail reply if the response contains a single directory entry– see Message Sequences E to H in Table 5.

Message Sequence: (Numbers Indicate Order)	A	B	C	D	E	F	G	H
Search Request Messages (From Traveler To data server)								
Basic Search Request	1				1			
Advanced Search Request		1				1		
Name Search Request			1				1	
Extended Search Request				1				1
Search Reply Messages (From data server To Traveler)								
Search Reply	2	2	2	2				
Detail Reply					2	2	2	2

Table 5 - Search Request-Reply Message Sequences

4.11.2 Basic Search Request

The Basic Search Request message enables a search to be made on a single directory type and subtype. The provided search boundaries are the radius (about a location) of the search and the maximum number of found entries to return from the search.

Most existing (and presumably future) implementations of Directory Services involve a two-way dialog between the data consumer and the data server. This dialog encompasses at least two messages and will sometimes require an extended dialog between data consumer and data server. The dialog is typically initiated by the data consumer with one of the SearchRequest messages. This basic search request message is the `DirectoryCoreRequest` message.

The `DirectoryCoreRequest` structure includes a data consumer identity (allowing setting mechanisms to be applied), a location for the request (`RouteOrArea`), a search radius, a directory type and subtype, and an optional limit to the number of entries returned by the data server.

The location can be specified as a `RouteOrArea`. This construct allows the data consumer to define a number of different kinds of location requests. The `RouteOrArea` can be a trip route returned by the data server or generated by the data consumer's device (see Integrating Trip Guidance for more information). The data server should interpret the `Route` as a request for directory services at the Way Points and the Destination. The `RouteOrArea` may also be a standard location reference.

The `directoryEntry-LocationType` allows the data consumer to specify the type of location reference that the data server should use when returning results. This is an optional field that can be used by the data consumer or the data consumer's device, to insure that the location settings returned by the data server are of the most useful type for the receiving device.

The data server replies to the directory services request with a list of directory entries. By choosing which fields to deliver from the `DirectoryEntry` structure, the data server has considerable control over the bandwidth demands of the directory services subsystem.

When there is only a single `DirectoryEntry` structure to return (possibly because the data consumer used a location profile specifying an address), then the data server should use the `DirectoryDetailReply` message.

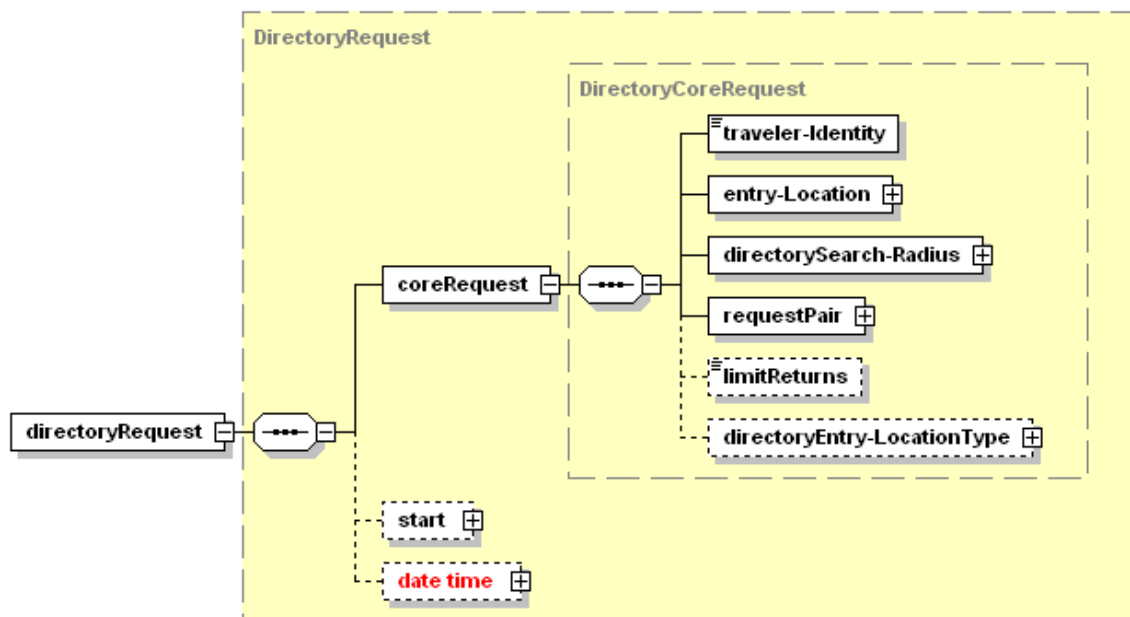


Figure 12 – Basic Directory Request

4.11.3 Advanced Search Request

The Advanced Search Request message allows a search to be made on multiple directory types and subtypes. The provided search boundaries are the radius of the search and the maximum number of found entries to return from the search.

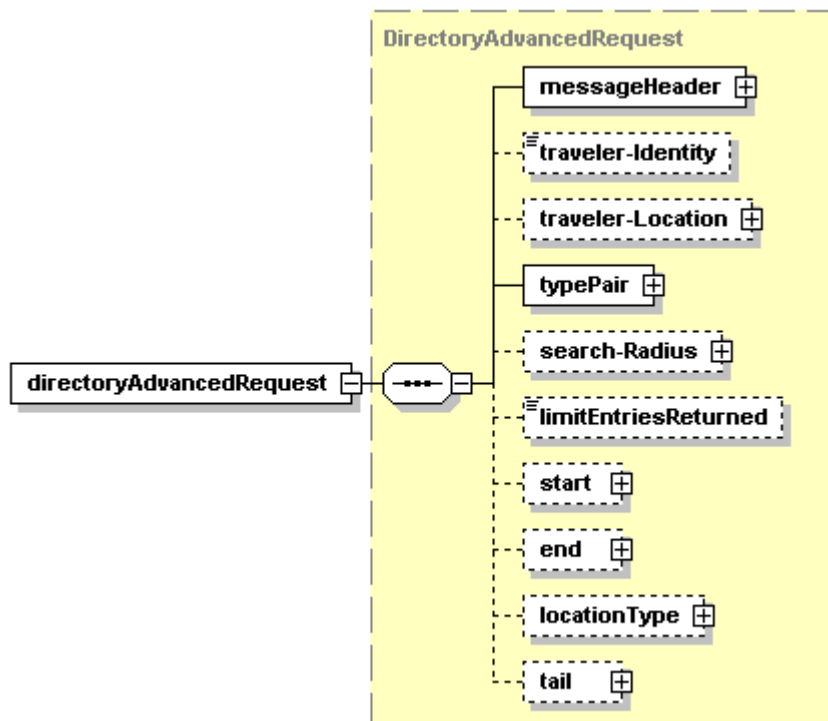


Figure 13 – Advanced Directory Request

4.11.3 Name Search Request

The Name Search Request message allows a search to be made on a directory name. The provided search allow the basic request parameters to be also passed..

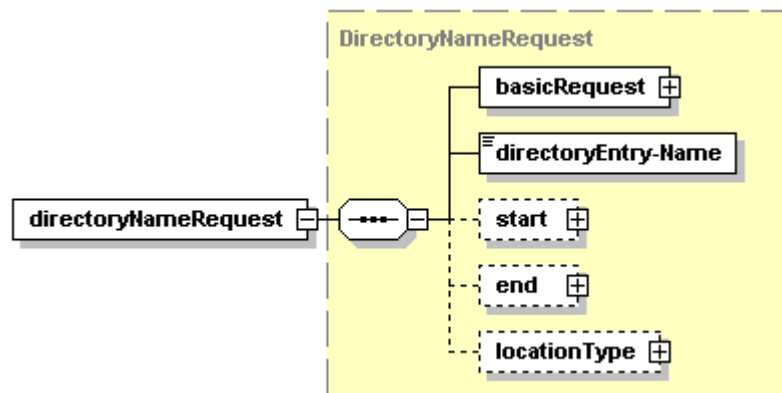


Figure 14 – Name Directory Request

4.11.4 Extended Search Request

The Extended Search Request message allows a search to be made on multiple directory types and subtypes, including Boolean keyword matching. The other provided search boundaries are the radius of the search, the maximum number of found entries to return from the search, and a bounding search setting.

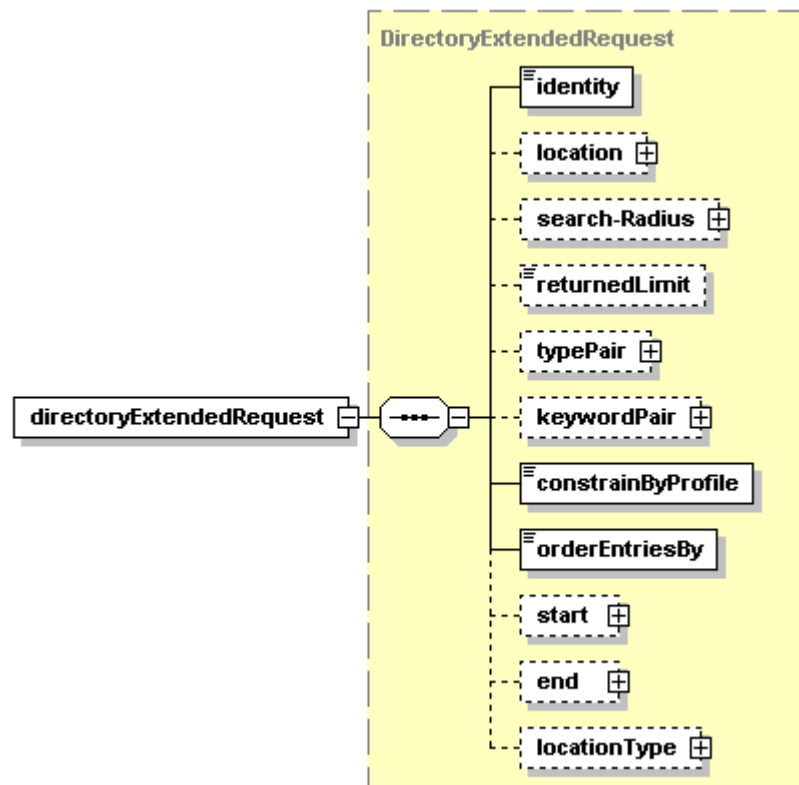


Figure 15 – Extended Directory Request

4.11.5 Extended Information Request

The Extended Information Request is sent when a data consumer requires extensive detail on a directory entry. Note that a Detail Information Reply indicates whether extended information is available for a directory entry.

The Extended ATIS Search also includes the ability to specify a return order. This will control both the physical transmission of returned elements in the list, and the elements actually included when a limit on entries is in force from either the application or the data server. It is important that the Order By operation be applied before the entry limit is enforced.

ATIS will provide a mechanism (the directory entry `ExtendedInformationAvailable`) for the data server to inform the Traveler that data server value-added information is available for a directory entry. ATIS will also support a Traveler Request for Extended Information, a Traveler Device Setting for Extended Information Capabilities (formats the Traveler Device can support), and a data server mechanism for passing any binary object as extended information within the Message Set. This extension provides the data server a way of sending additional rich text information, database information, graphics, sound, or video to the data consumer as appropriate.

Finally, the ATIS Extended Search includes a constraining setting. Where a user has a registered setting, the search request can ask that it be used as part of a search operation. For instance, a setting might specify a restaurant type and subtype preference ordering. An extended Search request for a restaurant could request that the setting be used to further prioritize entries. As with the Order By clause, setting preference ordering should take place before any limit on returned entries is enforced. The device setting can be used by the data server to determine the user application's ability to handle extended information types.

4.11.6 Extended Information Reply

The Extended Information Reply message contains extended detail information on the directory entry specified in the request to which it is replying. The extended detail information is returned as a Binary Large Object (BLOB). The reply may contain multiple BLOBs if there are multiple types of extended information for that directory entry.

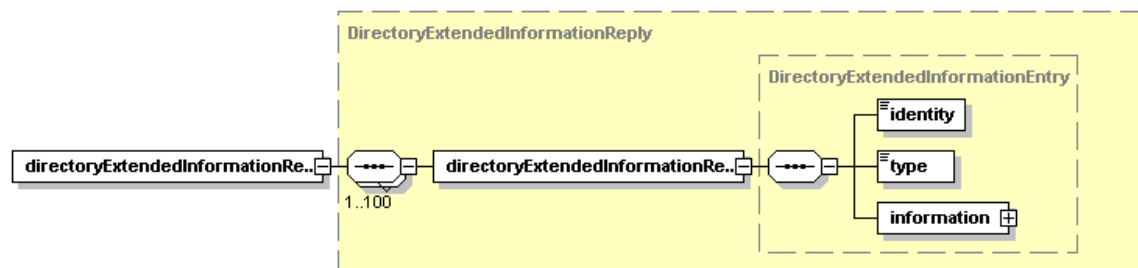


Figure 16 – Extended Information Reply Message

4.11.7 Appointments

Appointment requests are used by the data consumer to make appointments with a directory entry that was previously obtained using one of the search requests.

ATIS will support the ability to request reservations or appointments for directory entry items where the data server can provide this service. This extension is implemented through a `CapabilityCode` on each directory entry (allowing the data server to support this capability for some subset of ENTRIES or Merchants), a Traveler to the data server message requesting an appointment, and a data server to Traveler confirmation or response.

The appointment mechanism will include natural hooks allowing for payment mechanisms to be added to the overall message flows. However, in keeping with the determination made during the element selection phase, commercial transactions will not be supported in this phase.

Only one possible Appointment message sequence exists—a data consumer sends an Appointment Request message and the data server responds with an Appointment Reply.

4.11.7.1 Appointment Request

The Appointment Request message is sent when a data consumer wants to make an appointment with an entity identified by a directory entry.

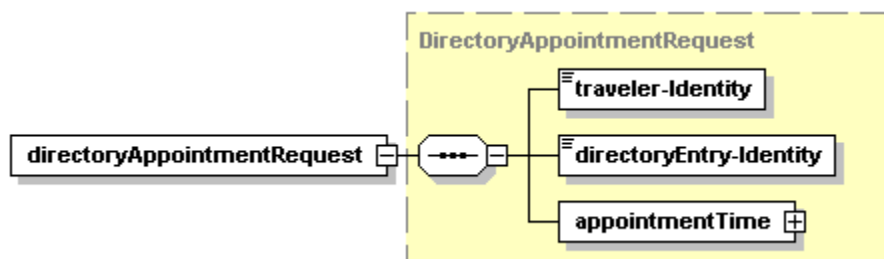


Figure 17 – Appointment Request Message

4.11.7.2 Appointment Reply

The Appointment Reply message contains the time of the appointment and a confirmation number.

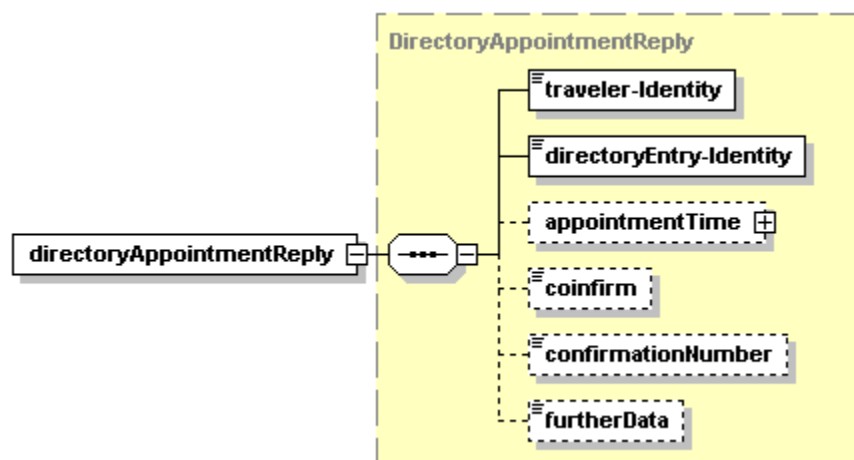


Figure 18 – Appointment Reply Message

4.11.8 Name Search Request

The Name Search Request message allows a search to be made for a specific directory entry within a single directory type and subtype. The provided search boundaries are the radius of the search and the maximum number of found entries to return from the search.