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Road transport and traffic telematics — Automatic vehicle and equipment identification — Reference architecture and terminology

Télématique du transport routier et de la circulation — Identification automatique des véhicules et des équipements — Architecture de référence et terminologie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14814 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 278, *Road transport and traffic telematics*, in collaboration with Technical Committee ISO/TC 204, *Intelligent transport systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Introduction

The interaction between vehicles, the driver and the road infrastructure is of major importance. Various technologies are already used to assist this interaction.

There is a significant and growing requirement to enable moving vehicles to interact with the infrastructure This technical field is generally known by several abbreviations, including RTI (Road Traffic Informatics), TICS (Transport Information and Control Systems) and in CEN as RTTT (Road Transport and Traffic Telematics). More recently, there has been a coalescence to the abbreviation ITS (Intelligent Transport Systems) and both standardization committees are in the process of changing their titles to this name.

A principal means of interaction in the ITS environment is AVI/AEI (Automatic Vehicle Identification/Automatic Equipment Identification).

The data component in an ITS/RTTT environment provides the basis for unambiguous identification of the OBE (On-Board Equipment), and may also share a medium for a bi-directional interactive exchange of data between the host and OBE and to other equipment (such as smart cards or other equipment on board).

Within the ITS/RTTT sector, applications may range from simple vehicle and equipment identification to complex international and national systems. Typical direct applications are road charging, parking, vehicle management, information and control systems.

The Reference Architecture Model and the Data Construct Schemes described in this family of International Standards provide a platform for a wide range of media so that the currency of the International Standard shall remain good both for existing and future technologies. It recognizes that there are existing AVI/AEI applications and provides a means of supporting such data constructs within the International Standard.

This International Standard prescribes the overall parameters within which these subsidiary International Standards are constructed. The Architecture description defined in this International Standard is presented in a form consistent with the recommendations of ISO TC204/WG1, and is supported by that Working Group.

In many cases it is necessary or desirable to use one air carrier frequency and protocol, but this is not always possible nor even desirable in all situations.

However, there is a benefit in using a standard common core data structure that is capable of upwards integration and expandable from the simplest low-cost AVI/AEI system to the more complex functions. Such a structure must be flexible and enabling rather than prescriptive, thus enabling different degrees of interoperability within and between their host systems.

The use of Abstract Syntax Notation One (ASN.1) from the ISO/IEC 8824 and ISO/IEC 8825 series of International Standards as a data identifier structure is now widely accepted, and required by ISO TR 14813-6 for data definition in ITS International Standards. Its usage provides maximum interoperability and conformance to existing standards, and meets the specifically defined requirements for a generic International Standard model for ITS/RTTT in that it:

— enables and uses existing standard coding,

— is adaptable and expandable,

— does not include unnecessary information for a specific application, and

— has a minimum of overhead in storage and transmission.

This document is part of a series of International Standards defining AVI/AEI in the ITS/RTTT environment. Other documents in the series include ISO 14815, ISO 14816, ISO/TS 17261, ISO/TS 17262, ISO/TS 17263 and ISO/TS 17264.

Road transport and traffic telematics — Automatic vehicle and equipment identification — Reference architecture and terminology

1 Scope

This International Standard establishes a common framework to achieve unambiguous identification in ITS/RTTT: AVI/AEI applications.

This scheme and Reference Architecture Model is designed to be an “enabling” structure to allow interoperability between different commercial systems, and not prescriptive in determining any one system. It is not frequency- nor air interface protocol-specific, provides maximum interoperability, has a high population capability, and provides the possibility of upwards migration to more capable systems.

This International Standard provides a reference structure which enables an unambiguous identification and also identifies the data construct as an ITS/RTTT message. This is particularly important within an EDI environment. The construct also identifies which ITS/RTTT data structure is contained in the message.

A wide variety of applications can be supported by the structure determined in this International Standard, such as simple AVI/AEI, complex unambiguous ITS/RTTT messages (in either user-identified or anonymous formats), or new and as yet undefined message structures.

The principles of data element structure determined in ISO/IEC 8824 have been adopted to provide an interoperable architecture within a standard framework. The use of Abstract Syntax Notation One (ASN.1) from ISO/IEC 8824 and ISO/IEC 8825 as a data identifier is widely used.

A key feature of the structure is to provide interoperability of data constructs. This AVI/AEI scheme may also be used as part of a data construct for purposes such as automatic fee collection and enables interoperability with existing standards.

This International Standard does not include the air interface nor any implementation aspect, solely the Reference Architectures. Subsequent International Standards will define data structures for general AVI/AEI and for specific sectors of application.

The Numbering and Data Structure will be capable of operation both by read/write devices, and by read-only devices where there is no requirement (or if there is no possibility) to write to the OBE.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 8824 (all parts), *Information technology — Abstract Syntax Notation One (ASN.1)*

ISO/IEC 8825 (all rules), *Information technology — ASN.1 encoding rules*

ISO 9897, *Freight containers — Container equipment data exchange (CEDEX) — General communication codes*

ISO TR 14813 (all parts), *Transport information and control systems — Reference model architecture(s) for the TICS sector*

ISO 14815, *Road transport and traffic telematics — Automatic vehicle and equipment identification — System specifications*

ISO 14816, *Road transport and traffic telematics — Automatic vehicle and equipment identification — Numbering and data structure*

ISO 14817, *Transport information and control systems — Requirements for an ITS/TICS central Data Registry and ITS/TICS Data Dictionaries*

ISO/TS 17261, *Intelligent transport systems — Automatic vehicle and equipment identification — Intermodal goods transport architecture and terminology*

ISO/TS 17262, *Automatic vehicle and equipment identification — Intermodal goods transport — Numbering and data structures*

ISO/TS 17263, *Automatic vehicle and equipment identification — Intermodal goods transport — System parameters*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
address
data element designating the originating source or destination of data being transmitted

3.2
air interface
conductor-free medium between an OBE and the reader/interrogator through which the linking of the OBE to the reader/interrogator is achieved by means of electro-magnetic signals

3.3
application identifier
in the context of this Reference Architecture Model and its Numbering and Data Structures, the first octet of a data element construct being passed across the reference points Alpha or Beta

NOTE This octet identifies whether the message is a specific ITS/RTTT message.

3.4
ASN.1
Abstract Syntax Notation (Number) One, as defined in ISO/IEC 8824 and ISO/IEC 8825

3.5
Automatic Equipment Identification
AEI
process of identifying equipment or entities that use the surface transportation infrastructures by means of OBE's combined with the unambiguous data structure defined in this International Standard

3.6
Automatic Identification System
AIS
system for achieving accurate and unambiguous identification of a data-bearing OBE, tag, transponder or natural/prescribed feature, the data or feature being interrogated by means of a system-appropriate source

3.7
Automatic Vehicle Identification
AVI
process of identifying vehicles using OBE combined with the unambiguous data structure defined in this International Standard

3.8
carrier signal
electromagnetic signal that can be modulated to carry lower frequency-encoded information across an air interface

3.9
Coding Scheme Identifier
CSI
prescribed list of reference identifiers which relate to prescribed coding schemes determined in this International Standard and/or issued by the authorized numbering scheme administrator

3.10
Constructed Identifier
identification which requires a construct of primitive identifiers, as defined in ASN.1 (ISO/IEC 8824, ISO/IEC 8825)

3.11
data element structure
framework comprising a number of data elements in a prescribed form

3.12
Electronic Data Interchange
EDI
passing of a data message, or series of messages, between computers and/or between different software systems

NOTE Within this context, an EDI message is normally compatible with the form specified in ISO 9897 (CEDEX).

3.13
Electronic Data Transfer
EDT
passing of data sets comprising an entire message from one computer to another or from one software system to another

3.14
incorrect read
failure to read correctly all or part of a data set

3.15
inductive signals
electromagnetic signals, usually below 30 MHz, characterized by the use of the magnetic component of the signals to couple an OBE to a reader by electromagnetic induction

3.16
interrogator
device that performs the functions of a reader (see 3.22), but in addition has the ability to send new data to the OBE via an air interface

3.17
manufacturer
manufacturer of equipment for use within the applications defined in this International Standard

3.18
On-Board Equipment
OBE
device on board or attached to the vehicle/equipment to perform the functionality of AVI/AEI

3.19
operator
commercial operator of an AVI/AEI/RTTT system that uses OBEs for the purposes defined in this International Standard

3.20
Primitive Identifier
Identification as a stand-alone identity that does not require any qualifiers such as expiration date, etc.

NOTE All construct identifiers are built from primitive identifiers.

3.21
Radio Frequency Identification
RFID
common term describing an automatic identification system comprising one or more reader/interrogators and one or more OBEs in which communication and data transfer is achieved by means of electro-magnetic signals varying from low frequency (inductive) to microwave frequencies

3.22
reader
device that transmits a signal as a means of initiating a response in a compatible OBE, and subsequently receives the modulated electro-magnetic response and decodes the data

3.23
read-only
data mode corresponding to an OBE whose data content is encoded prior to use and cannot be changed by the reader/interrogator

3.24
read/write
data mode corresponding to an OBE in which data content can be changed by means of a compatible interrogator via the air interface

3.25
read/write cycle
complete sequence of interaction by the reader/interrogator where the OBE is unambiguously identified and new data, comprising either whole or part of the full data set, is written onto the OBE by means of the air interface

3.26
reference point
connection between two function blocks, where protocols define the information flow across the reference point

NOTE Only in case of functions being separated in different physical implementations is there also an interface point.

3.27
smart card
device of credit card size incorporating an integrated circuit with microprocessor and memory

3.28
user
vehicle/equipment or person carrying the OBE through the point of identification with the objective of unambiguous identification of the OBE being carried

4 Requirements

4.1 General requirements

This International Standard determines an Architectural Framework for Automatic Vehicle Identification (AVI) and Automatic Equipment Identification (AEI) by means of an air interface link using electromagnetic signals such as near-field inductive, radio, microwave or infrared light.

In accordance with the recommendations from CEN TC 278/WG 13 (Architecture), the architecture determined in this International Standard is described on five levels: conceptual architecture, functional architecture, data architecture, application architecture and implementation architecture.

An object-oriented view of architecture, as recommended in ISO TR 14813, has also been provided.

4.2 Conceptual architecture

The “mission” of this International Standard is to provide an “enabling” Reference Architecture Model for generic AVI/AEI. The reference architecture model standard has been designed to accommodate, within the framework, a wide and diverse variety of ITS/RTTT applications from simple AVI/AEI to more complex transactions with a wide variety of uses.

This International Standard accommodates the operation of systems of different capabilities. It enables the interoperability of OBEs in national and international environments, even though the operator systems themselves may be significantly different, as long as there is a common air interface (at reference point Delta; see Figure A.1) and communication protocol. Even where information shall be collected by different air interfaces, the data, once collected, is in a commonly interoperable format, and so may be used accurately and effectively within an EDI/EDT environment.

4.3 Functional architecture

The AVI/AEI function is to provide an unambiguous identification at an appropriate time. For AVI/AEI, the information flow is a simple monologue where, on receipt of an appropriate signal, the OBE returns its identity, and possibly also some limited additional information.

4.4 Data architecture

4.4.1 General

The form of data used by systems claiming conformance to this International Standard shall be defined within a numbering and data structure operating in conformance with ISO/IEC 8824 and ISO/IEC 8825 Encoding Rules (ASN.1).

The data element constructs shall allow combinations of data elements to be used in “composite” data constructs. This International Standard is designed to allow interoperability of the data elements within an EDI/EDT environment, so that even otherwise incompatible structures can be supported in an effective and efficient manner, and shall provide a capability for a significant expansion of the number of ITS/RTTT applications in the future.

This International Standard achieves such interoperability by means of the standardized numbering and data structure architecture. ISO 14816 provides structures within this framework. In summary, the Numbering and Data Structure Architecture may be described as follows:

4.4.2 Numbering and data structure architecture

The reference model architecture provides a framework for the exchange of data in this environment. In order to provide interoperable or compatible exchanges of data, there is a requirement to standardize the data element constructs. However, if these data element constructs are for a wide variety of different purposes, it is

not possible to have a single fixed data structure to cater for all requirements. The ASN.1 Encoding Rules standardized in ISO/IEC 8825 provide an interoperable framework in which otherwise incompatible messages can co-exist.

Whilst many of these numbering and data structures provide only supporting data element constructs, there shall be a requirement for an unambiguous Automatic Vehicle (or Equipment) Identification at the core of most data element constructs. Such schemes are determined in detail in ISO 14816.

The numbering and data structure shall be capable of operation both by read/write devices, and by read-only devices where there is no requirement (nor possibility) to write to the OBE.

The AVI numbering and data structure determined in ISO 14816 is a compact data element construct, and provides a country/issuer/identification structure, where the numbering structure element provides the capability of in excess of four thousand million identifications per issuer.

The numbering and data structure standard recognizes the existence of AVI/AEI systems already deployed prior to the issue of the International Standard, and provides a means of using such “private” numbering within the framework of the scheme so that such systems are not rendered obsolete by the introduction of the International Standard. In order to comply with the systems installed prior to the issue of the International Standard, it shall only be required to use the full data constructs if data is passed beyond the local system (reference point Alpha) and may be constructed at that point. For installations deployed after the introduction of the International Standard, fulfilment of the demands of the International Standard is required in order to claim conformance, but an option to enable “private” schemes to operate within the International Standard according to ISO/IEC 8825 shall always remain.

4.5 Application architecture

4.5.1 Application architecture description

AVI/AEI is a technique to make an identification using an air interface. The technique can be used using a variety of media and, most importantly, in a wide variety of applications. The application architecture can therefore only be defined in general terms.

In the majority of situations, the objective of the AVI/AEI process is to uniquely identify a vehicle or equipment. In some circumstances, the position may be reversed and it may be for a moving vehicle or equipment to identify a static or moving object, such as a location identifier, or another moving vehicle or equipment.

In some cases, it is necessary to protect the identity of a vehicle or equipment for reasons of privacy or security. In these cases, an AVI/AEI system shall provide an “unambiguous identification” that does not necessarily identify the true permanent identification of the vehicle or equipment. It may, for example, identify a smart card temporarily located in an on-board unit. However, such identifications are to be supported within the International Standard.

It is important to remember, however, that the equipment used may provide the functions of more than one entity, or indeed the entity may be performed by a combination of equipment (such as an interrogator plus an antenna).

4.5.2 System specification

ISO 14815 defines, describes and specifies common user requirements (functional, operational and technical) related to a generic AVI/AEI system. It provides a model specification and defines parameters to enable operators to design the optimum system to meet their requirements. The parameters within the scope of this International Standard includes:

— accuracy/reliability criteria,

— service lifetime,

— environmental parameters,

— roadside physical geometry,

— media adaptation,

— equipment positioning,

— compatibility parameters,

— safety, and

— security.

4.5.3 Interface specification

ISO/TS 17264 will define, describe and specify interface(s) in physical and procedural terms. It will provide specifications for both fixed and mobile interfaces, and define parameters to enable implementation of systems to meet relevant requirements.

The parameters within the scope of the interface specification standard include the following:

— Interface requirements on the RF link which are unique to AVI/AEI systems, including results from Dedicated Short Range Communication (DSRC) standardization.

— The interface(s) is specified such that simple AVI/AEI systems are non-contentious with, and upgradeable to, transactional or full ITS/RTTT/RTI systems.

— The fixed inter system interface enables application communication within the AVI/AEI system.

The guiding principle of the interface specification standard is to provide basic link specifications so that a service provider can choose an appropriate link system to meet his requirements for AVI, and so that he can freely mix several links and have them interoperate (as long as they do not interfere/contend with each other).

The application architecture standard does not determine the physical configuration of equipment. This is determined at the “implementation architecture” level.

4.6 Implementation architecture

The AVI/AEI standards of CEN/TC 278 and ISO/TC 204 provide assistance and guidance to those implementing AVI/AEI systems. The “implementation” level of architecture is the mapping of functions into physical boxes at one or a number of locations. Such a determination is likely to form a major part of responses to tender calls. As such, these are a function for commercial consideration, rather than standardization, and the implementation architecture is specifically excluded from this family of International Standards. The standardization of the conceptual, functional, data and generic application aspects of architecture, however, are designed to assist in the preparation of specifications for specific implementations without interfering with the commercial aspects of implementation.

Annex A
(informative)

ITS/RTTT context of AVI/AEI reference architecture model

A.1 Conceptual architecture

The conceptual architecture defined within this International Standard provides an “enabling” reference architecture model for generic AVI/AEI.

This International Standard accommodates the operation of systems of different capabilities. It enables the interoperability of OBEs in national and international environments, even though the operator systems themselves may be significantly different, as long as there is a common air interface (at reference point Delta) and communication protocol. Even where information has to be collected using different air interfaces, the data, once collected, is in a commonly interoperable format, and so may be used accurately and effectively within an EDI/EDT environment.

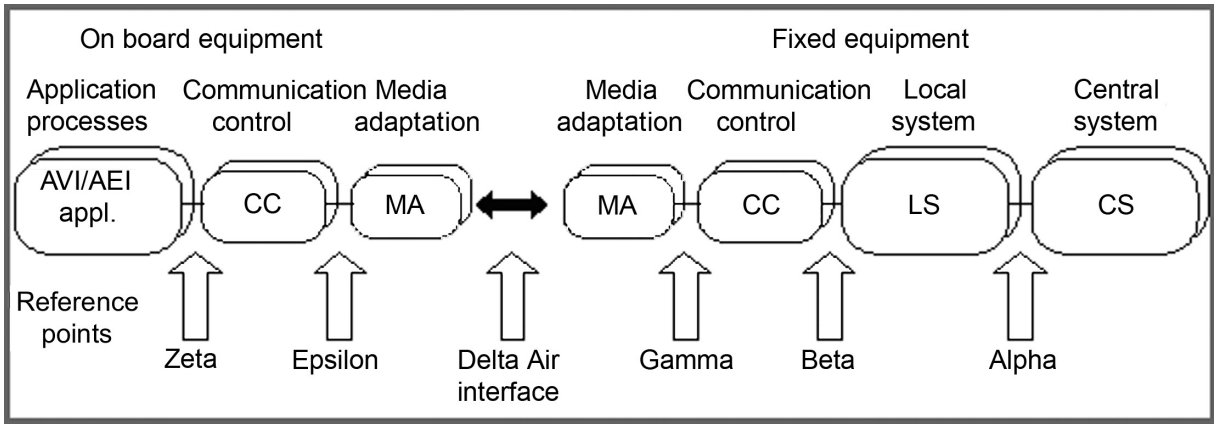

Figure A.1 — Overall conceptual reference architecture model showing the context of AVI

Figure A.1 describes, at a conceptual level, a generic system architecture in which AVI/AEI may be affected. It labels the boundaries between functional entities as reference points. It is important to be aware that functions and reference points do not necessarily correspond to discrete physical boxes or interfaces, but are used to define “entities” of a system that is being described. Taken together, the reference points provide a structure to form a generic reference architecture model which is relevant to most ITS/RTTT environments that involve data exchanges between on board equipment and fixed equipment.

A.1.1 Entity blocks

These consist of the following:

— Central System: Block which contains all centralized functions of AVI/AEI applications.

— Local System: Local (roadside) entity that handles the “real-time” and distributed parts of the AVI/AEI application.

— Fixed Communication Control: Communication block that handles the medium independent part of the communication link.

— Media Adaptation: The medium dependent entity.

— On-board Communication Control: Communication control that handles the medium independent part of the communication link.

— Application Processes: The entity that symbolizes several in-vehicle applications, of which AVI/AEI may be only one application process.

A.1.2 Reference points

These consist of the following:

— Alpha: The reference point which delimits the functions of the central system and the local system.

— Beta: The reference point where data, commands, etc. are passed from the fixed communication control to the local system function, and vice versa.

— Gamma: Between fixed communication control and media adaptation.

— Delta: Between on-board and fixed equipment. This reference point usually corresponds with an air interface in the nature of Dedicated Short Range Communication.

— Epsilon: Reference point between media adaptation and on-board communication control.

— Zeta: Reference point between on-board communication control and application processes.

A.2 Functional architecture

The AVI/AEI function is to provide an unambiguous identification at an appropriate time. For AVI/AEI the information flow is simple and as described in Figure A.2.

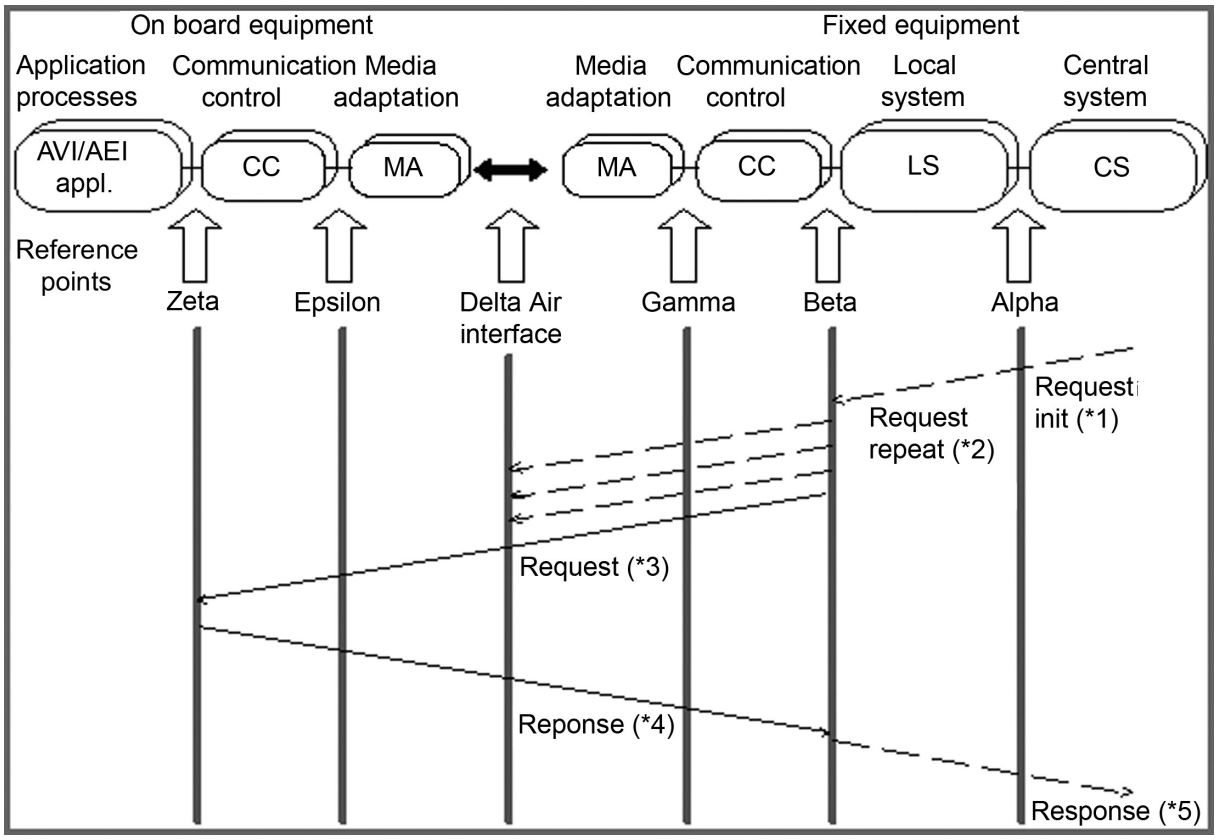

Figure A.2 — Functional (information flow) diagram for generic AVI system

A.2.1 Application information flow:

The following description shows how the information flow for AVI/AEI applications may typically be achieved. This description is for illustrative purposes and does not necessarily prescribe the form of the communication protocol.

a) Request Init: An optional Information Flow Phase where Central or Local system initiates communication subsystem to start single or repeated Request cycling.

b) Request Repeat: An optional Information Flow Phase where Communication Control repeatedly sends out Requests.

c) Request: Fixed system polling On-board system for identity. A “request” may simply be the presence of a signal, or may be a more complex process depending on the nature of the AVI/AEI system.

d) Response: On-board system reply to earlier request. Reply may be initiated either in the Application or Communication Control part of the On-board system. The “Data Construct” shall be in accordance with ISO 14816.

e) Response: An optional Information Flow Phase where Fixed Communication Control transfers received information to Local and/or Central system.

A.3 Application architecture

A.3.1 Application architecture description

AVI/AEI is a technique to make an identification using an air interface. The technique can use a variety of media and, most importantly, can be used in a wide variety of applications. The application architecture can therefore only be defined in general terms.

In the majority of situations, the objective of the AVI/AEI process is to uniquely identify vehicles or equipment. In some circumstances, the situation may be reversed such that it is the task of a moving vehicle or equipment to identify a static or moving object. This can be a location identifier or another moving vehicle or equipment.

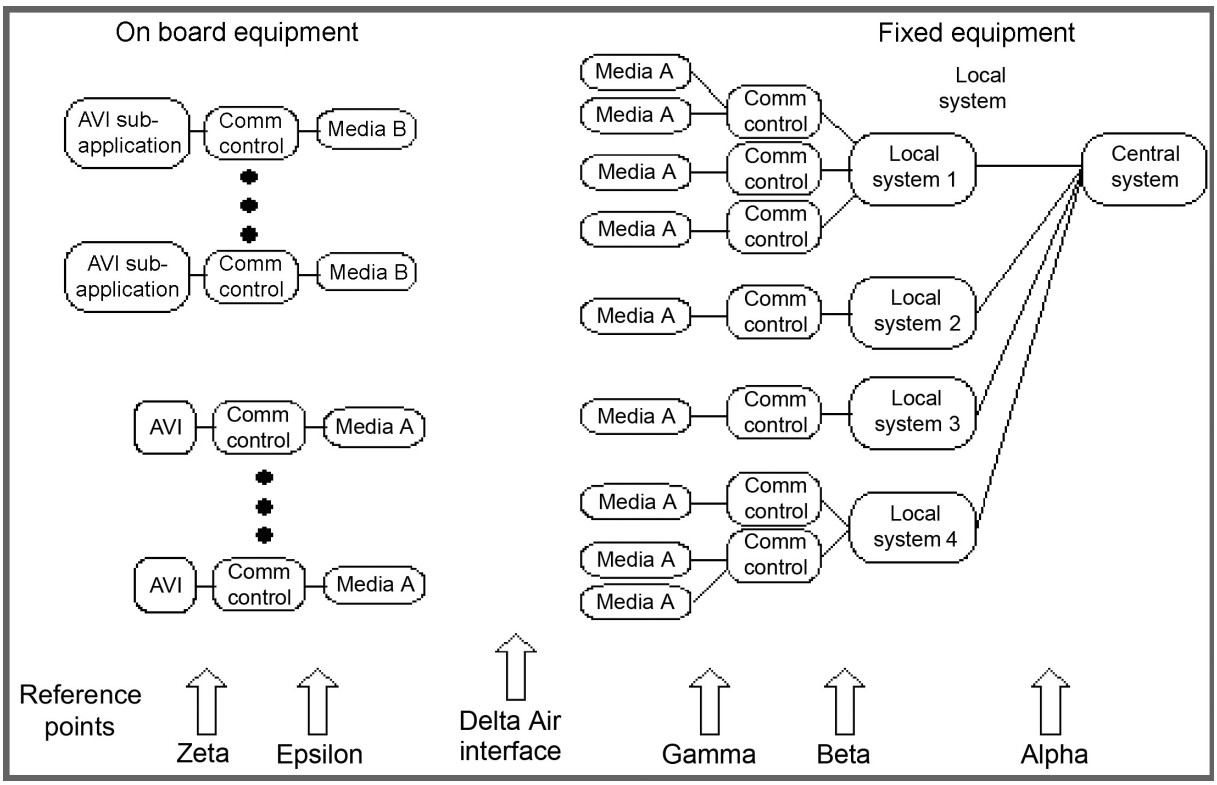

Figure A.3 — Example application architecture model

Figure A.4 shows an example of how the “conceptual” model appears at the application level. In this application example, there is one central system with four local systems. Local system 1 and 4 have multiple communication controllers/media adaptations connected. This example also shows OBEs of two different types, without indication of the exact number of each.

A.4 Object-oriented architecture model

Modern system architectures are now commonly described using object-oriented techniques such as Unified Modelling Language (ISO 19501). ISO TR 14813 advocates such techniques.

An overview of AVI/AEI in object-oriented terms is provided in figures A.4 and A.5 below.

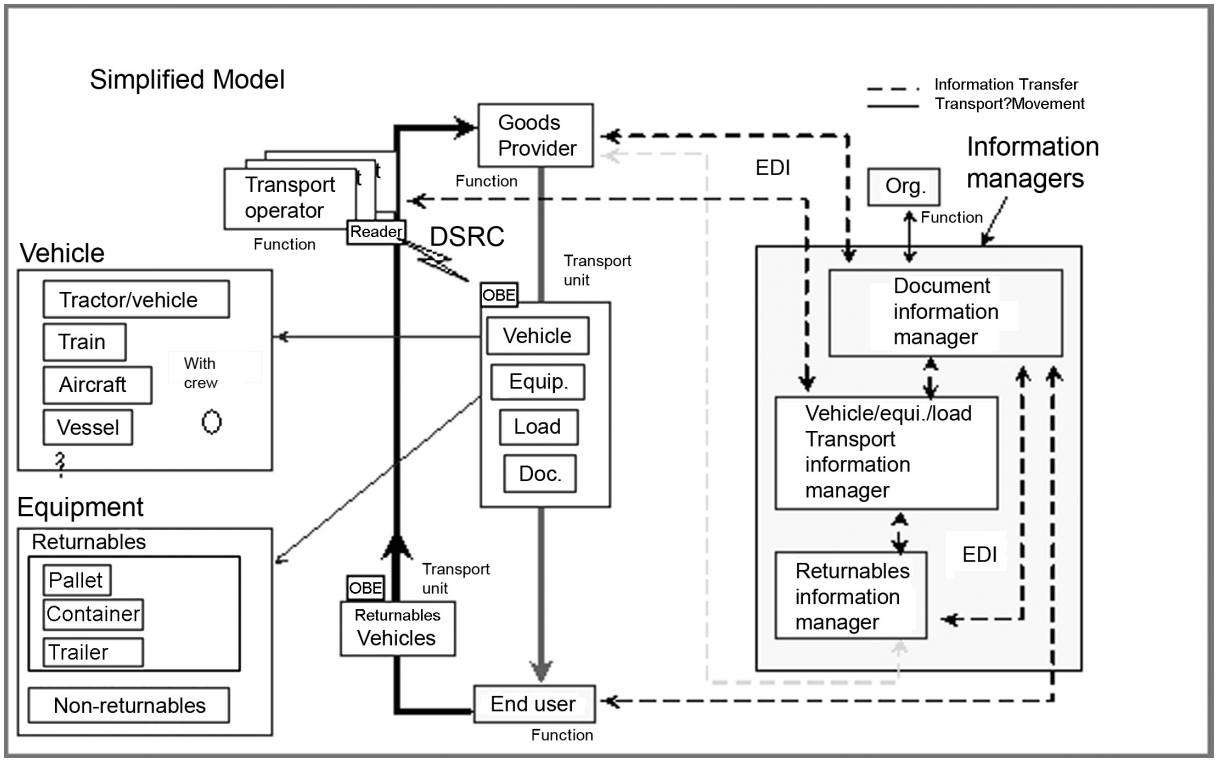

Figure A.4 — Conceptual view of AVI/AEI system classes showing key attributes

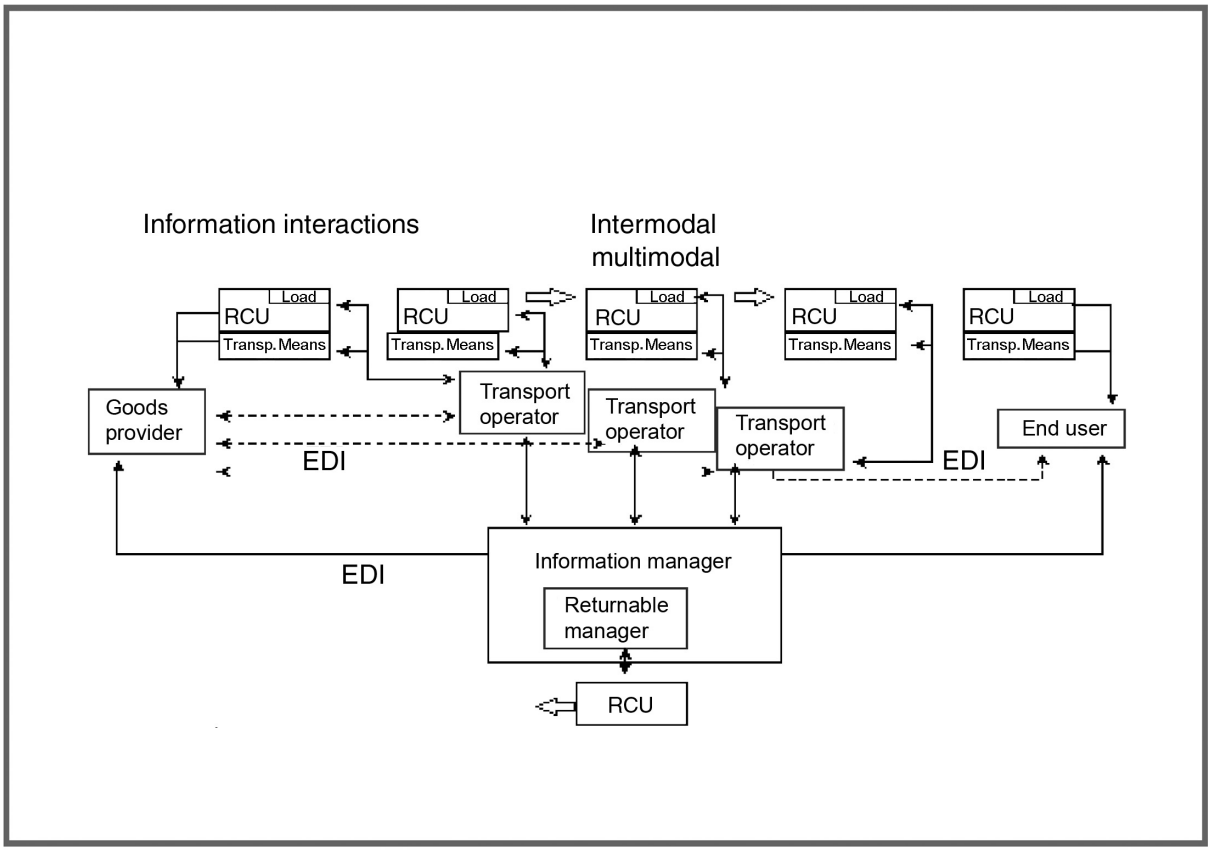

Figure A.5 — Overall application information architecture

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