TECHNICAL REPORT

ISO/TR 14813-3

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Transport information and control systems — Reference model architecture(s) for the TICS sector —

Part 3:
Example elaboration

Systèmes de commande et d'information des transports — Architecture(s) du modèle de référence du secteur TICS —

Partie 3: Élaboration d'exemple

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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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

Technical Reports are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Attention is drawn to the possibility that some of the elements of this part of ISO TR 14813 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 14813-3, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 204, *Transport information and control systems.*

This document is being issued in the Technical Report (type 2) series of publications (according to subclause G.3.2.2 of Part 1 of the ISO/IEC Directives, 1995) as a "prospective standard for provisional application" in the field of transport information and control systems because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this Technical Report (type 2) will be carried out not later than three years after its publication with the options of: extension for another three years; conversion into an International Standard; or withdrawal.

ISO TR 14813 consists of the following parts, under the general title Transport information and control systems — Reference model architecture(s) for the TICS sector:

— *Part 1: TICS Fundamental Services*: This document presents the definition of 32 TICS fundamental services that are the informational products or services or applications areas provided to a TICS user.

— *Part 2: Core TICS Reference Architecture*: This document describes an abstract object-oriented system architecture based on the TICS Fundamental Services.

— *Part 3: Example Elaboration*: This document refines the Core TICS Reference Architecture (Part 2) with some emphasis on traffic management.

— *Part 4: Reference Model Tutorial*: This document describes the basic terms, graphical representations and modelling views exploited in the object-oriented definition of the architecture development of Parts 2 and 3.

— *Part 5: Requirements for Architecture Description in TICS Standards*: Requirements for Architecture Description in TICS Standards: This document describes the terminology and form to be used when documenting or referencing aspects of architecture description in TICS standards.

— *Part 6: Data Presentation in ASN.1:* This document establishes the use of ASN.1 as the normal syntax notation to be used in standards for the TICS sector and a common message form for such ASN.1 based data elements.

Annex A of this part of ISO/TR 14813 is for information only.

Introduction

TC204/WG1 is a working group whose prime objectives are to provide services to ISO TC204 and its working groups. A specific mission of WG1 is to:

"Provide ISO TC204, its working Groups, related bodies and those involved in the TICS sector, with a reference model of Conceptual Reference Architecture(s) that show the structure and inter-relationships of the sector ..."

It is expected that there may well be more than one single TICS Architecture approach to be considered and documented and that existing architecture approaches will have previously-produced documentation developed according to disparate standards and conventions.

It is also implicit in the work being undertaken by WG1, that working group members will require a clear, well-structured understanding of the work of the following participant groups:

— Other TC 204 Working Groups

— CEN TC 278 Working Groups

— Japanese initiatives

— European Road Transport and Traffic Telematics programs

— US Intelligent Transportation Systems program

— Australian initiatives

— Canadian Initiatives

Full documentation of all possible architectural approaches is obviously not feasible given the high level of resources required to carry this out. Indeed full documentation and description of all possible approaches is undesirable as an item for Standardisation.

A defined and consistent approach is however required to facilitate the specification of architecture requirements to enable a clear view to be developed and presented of the work of each participant group This document is one of a set of WG1 documents intended to respond to stated WG1 objectives regarding the production of a TICS Reference Architecture.

In order to document an architecture, graphical and textual components of a model are required. WG1 has adopted a methodology based on the Unified Modelling Language (UML) for documenting the TICS Reference Architecture. A tutorial on the UML is provided in ISO/TR 14813 Part 4. UML is a visual modelling language for building object-oriented and component-based systems. A commercially available Computer Aided Software Engineering (CASE) tool has been used by WG1 to document the Architecture. While the tool is a commercial product, UML is open and non-proprietary.

Transport information and control systems — Reference model architecture(s) for the TICS sector — Part 3: Example elaboration

1 Scope

The architecture of an information and control system merges hardware and software considerations into a coordinated and integrated system view. The system architecture is a high level abstraction, or model, of the system. A system architecture should embrace both today's applications and the applications that are expected in the future. Architecture begins with the definition of the conceptual services (e.g. Part 1 - TICS Fundamental Services). There are several identifiable stages of system architecture development.

a) Reference architecture

b) Logical architecture

c) Physical architecture

A reference architecture is the first of all architectures. It is a concise generic framework which guides the development of more concrete system architectures. It is large enough that distinct concepts are not merged out of necessity and small enough that it does not become unwieldy.

A most significant example of a reference architecture in information systems is the Reference Model of Open Systems Interconnection (often called the seven layer model) developed by ISO in the 1970's. This model has underpinned the development of all modern computer networks, allowing services such as global networking, of which the prime example is the Internet, to become a reality.

A reference architecture is generic and non-prescriptive and captures the concepts of the system. A logical architecture elaborates the conceptual behaviour, and in so doing it provides more detail about the modularity. A physical architecture is reached when the actual distribution of the system modules is defined, thus leading to important implications for communications.

There is no firm demarcation between a reference architecture and a logical architecture. Thus the essence of behaviour and modularity is present in a reference architecture. The TICS Reference Architecture developed by WG1 shows important inter-relationships that arise in the provision of the services of the sector. However the TICS Reference Architecture is more abstract than, for example, the logical architecture of the US National Architecture.

It is envisioned that the TICS Reference Architecture will be used by the TC204 Working Groups to develop their own logical and physical architectures in a cohesive manner.

Some TICS Fundamental Services are already well developed by the industry, while others are less mature. Therefore the TICS Reference Architecture does not have a uniform granularity across all services. This characteristic is a direct result of the fore mentioned requirement that architecture embrace the applications that are intended in the future. This suggests one of the ways in which the architecture will undergo change in the future.

Architectures may present only static characteristics or both static and dynamic characteristics. Dynamic characteristics may be seen as belonging solely to the design/implementation stages of system development. However by including dynamic characteristics at the reference architecture stage one can gain important insights into the static architecture. Thus two orthogonal views of architecture are presented:

a) static relationship view (class diagram)

b) dynamic interactive view (sequence diagram)

Part 2 develops a Core TICS Reference Architecture. The static scope is determined by deriving the system boundary and the use cases from an analysis of the TICS Fundamental Services (Part 1).

The Core Reference Architecture is a reference for the development of national architectures.

This Part elaborates the core by refinement of the two orthogonal views. The elaboration calls upon domain expertise which would be provided by other TC204 Working Groups in the development of ISO standards, or by national groups developing national architectures and standards.

The Core Reference Architecture is elaborated in Clauses 6 to 8. Clause 5 introduces the elaboration method employed. Clause 6 elaborates the classes. Clause 7 elaborates the sequence diagrams. Clause 8 describes the elaborated packages. Clauses 9 and 10 identify some of the main dependencies between the packages.

Readers should refer to Part 4 (Tutorial) for an introduction to the modelling views used in this Part and the overall methodology.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this part of ISO/TR 14813. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/TR 14813 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/TR 14813-1:1999, *Transport information and control systems – Reference model architecture(s) for the TICS sector – Part 1:TICS fundamental services.*

ISO/TR 14813-2:2000, *Transport information and control systems – Reference model architecture(s) for the TICS sector – Part 2: Core TICS reference architecture.*

ISO/TR 14813-4:2000, *Transport information and control systems – Reference model architecture(s) for the TICS sector – Part 4: Reference model tutorial.*

3 Terms and Definitions

For the purposes of this part of ISO/TR 14813, the following semantic definitions apply.

3.1
The **Unified Modeling Language** (UML) is the industry-standard language for specifying, visualising, constructing, and documenting the artefacts of software systems. It simplifies the complex process of software design, making a "blueprint" for construction.[1]

3.2
A **use case** is a coherent unit of functionality provided by a system or class as manifested by sequences of messages exchanged among the system and one or more outside interactors (called actors) together with actions performed by the system.

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[1] http://www.rational.com/uml/

3.3

An **actor** is a role of an object or objects outside of a system that interacts directly with it as part of a coherent work unit (a use case). An Actor element characterises the role played by an outside object; one physical object may play several roles and therefore be modelled by several actors.

3.4

Use case diagrams show elements from the use case model. The use case model represents functionality of a system or a class as manifested to external interactors with the system.

There are several standard relationships among use cases or between actors and use cases.

Communicates - The participation of an actor in a use case. This is the only relationship between actors and use cases.

Uses - A uses relationship from use case A to use case B indicates that an instance of the use case A will also include the behavior as specified by B.

To reinforce the externality of actors a system boundary separates the actor symbols from the use case symbols.

3.5

A **package** is a grouping of model elements. Packages themselves may be nested within other packages. A package may contain both subordinate packages and ordinary model elements. The entire system description can be thought of as a single high-level *system* package with everything else in it. All kinds of UML model elements and diagrams can be organised into packages.

Packages own model elements and model fragments and are the basis for configuration control. Each model element can be directly owned by a single package, so the package hierarchy is a strict tree.

Packages can reference other packages so the usage network is a graph. Relationships drawn between package symbols denote relationships between at least some of the elements in the packages. A dependency relationship implies one or more dependencies among the model elements, in which a change in the targeted element may require a change in the source element.

3.6

A **class** is the descriptor for a set of objects with similar structure, behavior, and relationships. UML provides notation for declaring classes and specifying their properties, as well as using classes in various ways. Classes are declared in class diagrams and used in most other diagrams. UML provides a graphical notation for declaring and using classes, as well as a textual notation for referencing classes within the descriptions of other model elements.

3.7

A **class diagram** is a graph of Classifier elements connected by their various static relationships. (Note that a ''class'' diagram may also contain interfaces, packages, relationships, and even instances, such as objects and links. Perhaps a better name would be ''static structural diagram'' but ''class diagram'' is shorter and well established.)

3.8

An **object** represents a particular instance of a class. It has identity and attribute values. The same notation also represents a role within a collaboration because roles have instance-like characteristics.

3.9

An **operation** is a service that an instance of the class may be requested to perform. It has a name and a list of arguments.

3.10

A binary **association** is an association among exactly two classes (including the possibility of a reflexive association from a class to itself).

3.11
Generalization is the taxonomic relationship between a more general element and a more specific element that is fully consistent with the first element and that adds additional information. It is used for classes, packages, use cases, and other elements.

3.12
A **sequence diagram** represents an **Interaction**, which is a set of messages exchanged among objects within a collaboration to effect a desired operation or result. A sequence diagram shows an interaction arranged in time sequence. In particular, it shows the objects participating in the interaction by their ''lifelines'' and the messages that they exchange arranged in time sequence. It does not show the associations among the objects.

3.13
The **system boundary** depicted in a sequence diagram maps to the same entity in a use case diagram. Thus any interaction emanating or terminating in the system boundary involves an actor.

In the methodology classes are invented for one of three purposes: information, control and interface.

An information class defines objects, which will store data relevant to the operation of the system and the actors and maintain that data with database like services.

A control class defines objects whose primary purpose is to implement the functions of the system.

An interface class defines objects that perform the data presentation and application interfaces for the actors.

3.14
The **architecture boundary** divides the interface classes from those classes, which form the actual architecture, namely the control classes and the information classes.

In the sequence diagrams developed in later clauses there is often an implicit interaction across the system boundary involving an actor. This may be implied whenever a message is initiated or terminated at an interface class.

4   Symbols and Abbreviated Terms

4.1 Use Case diagram
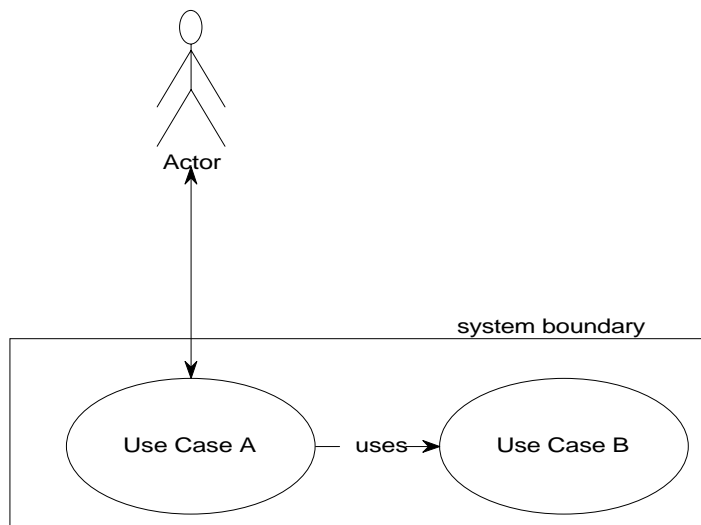
Figure 1 — A use case diagram consisting of two use cases and one actor

4.2 Package Diagram
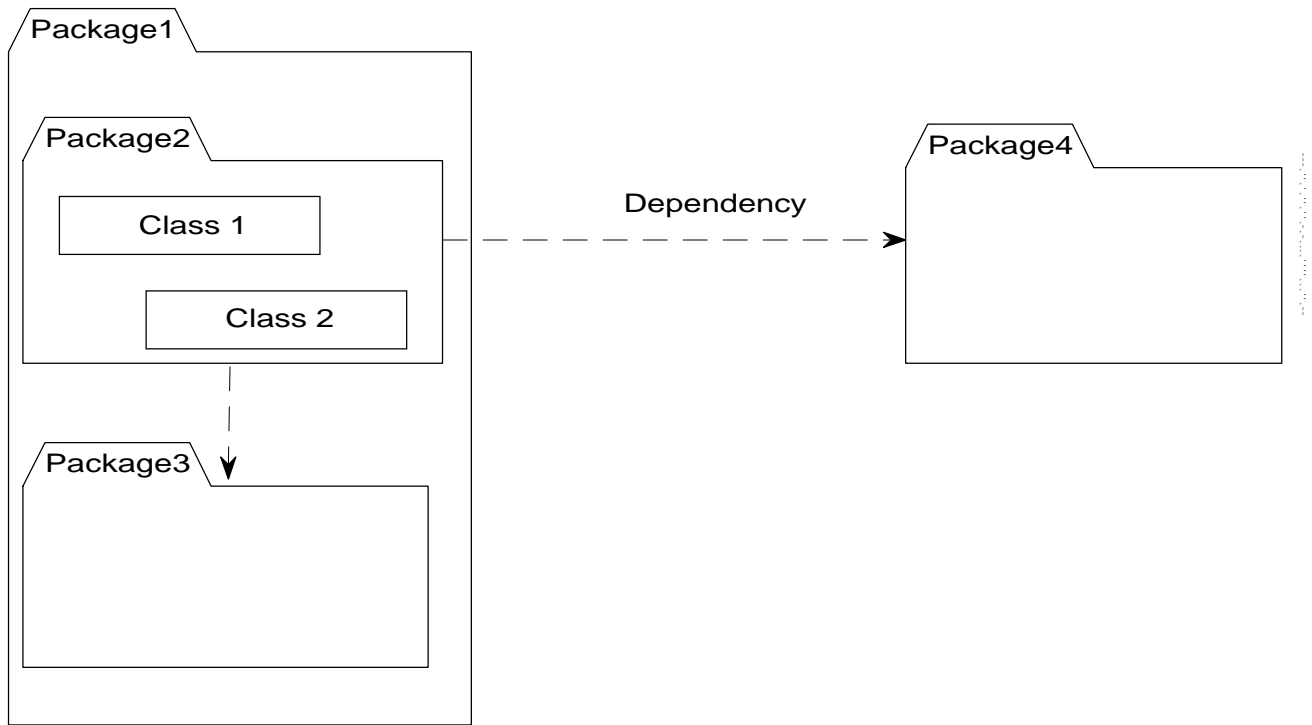
Figure 2 — Package diagram showing nested packages and a dependency relationship

4.3 Class diagram
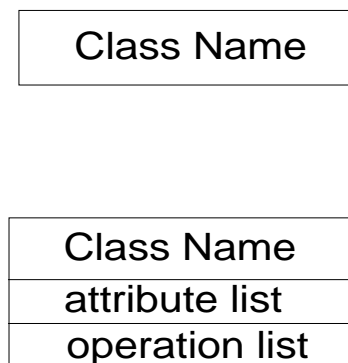
Figure 3 — Class diagrams showing the use of a single name compartment and three compartments

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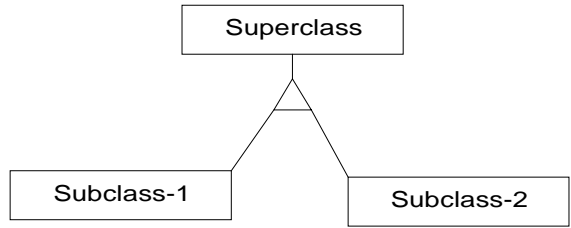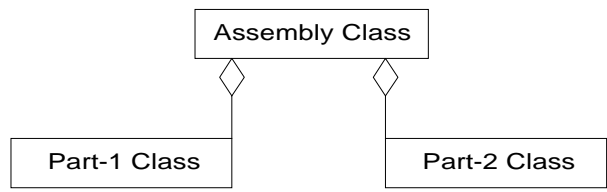
4.4 Association

Figure 4 — Common types of class association

4.5 Sequence (interaction) diagram
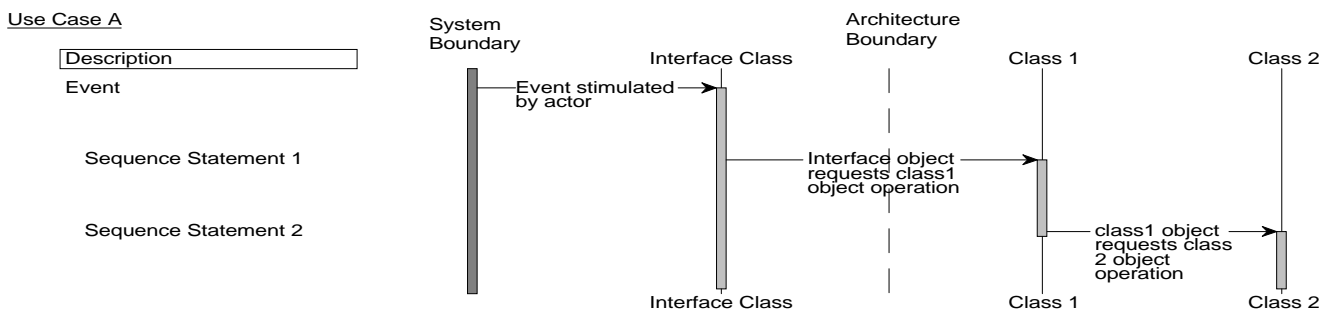
Figure 5 — A sequence diagram consisting of three interactions

5   Elaboration Method

The core Reference Architecture has been defined in ISO/TR 14813 Part 2, using the UML metatypes actor, use case, package and class, as well as sequence diagrams. All the instances of the metatypes in the core architecture are highly abstract. They require a good deal of elaboration before they can be of use in the standards process. That elaboration is now taken a step further.

The elaboration method is presented in Figure 6. There are four stages. While these are ordered in the figure, the whole process is iterative because of the necessity to formulate many new classes and their operations, guided by the principle of reuse.

The first stage is a transformation and refinement of the abstract classes defined in ISO/TR 14813 Part 2. The process is based on an analysis of the class operations identified in the core reference architecture. This analysis leads to some fairly obvious partitions in the light of domain knowledge already documented in the associated use case and the sequence diagram. Each partition is used to define a new control class. Other control classes are identified in the third stage. This first stage is conducted in clauses 6.1 and 6.2.

The second stage would actually be spread throughout the third stage. It involves the formulation of a wide range of information classes that serve to define the parameters of the class operations involved in the object interactions of the new sequence diagrams. In this report the activity is only partially completed. It is focused on traffic management where a large number of information classes are identified from a single reference source.

The third stage is the key to the elaboration and is presented in clause 7. This stage constitutes a major refinement of the sequence diagrams of the core architecture. A sequence diagram is developed for each of the use case identified in the diagrams of the core architecture. Elaborating the logic of each use case results in a significant set of operations being defined for each class. In some cases the parameters of these operations are identified. The process results in the definition of more classes not previously identified in the first two stages.

The fourth stage is a redefinition of the packages based on the expanded set of classes. This is presented in clause 8 for the key classes. Some detailed packaging is defined in 7.2 for classes relevant to Traffic Management.

6   Elaboration of the Classes

The class refinement replaces each abstract class from ISO/TR 14813 Part 2 with a number of classes. These classes fall into the categories:

c)   control classes

d)   information classes

e)   interface classes

Often there is not a clear-cut distinction between control and information classes, but there is usually a dominant role which will be noted. Each class is associated with one of the packages defined in ISO/TR 14813 Part 2.

As in ISO/TR 14813 Part 2 the classes will have operations defined in accordance with the logic of the use case. Here the elaboration of the architecture also includes the definition of the parameters of some of the operations. The abstract level of the parameters means that it is appropriate to define them as information classes associated with the relevant control class. (These information classes are considered to be attributes of the associated control class. Association is the normal means by which complex attributes are implemented in object-oriented software.)

The elaboration will be carried out in several stages. The next clause defines the most important control classes.
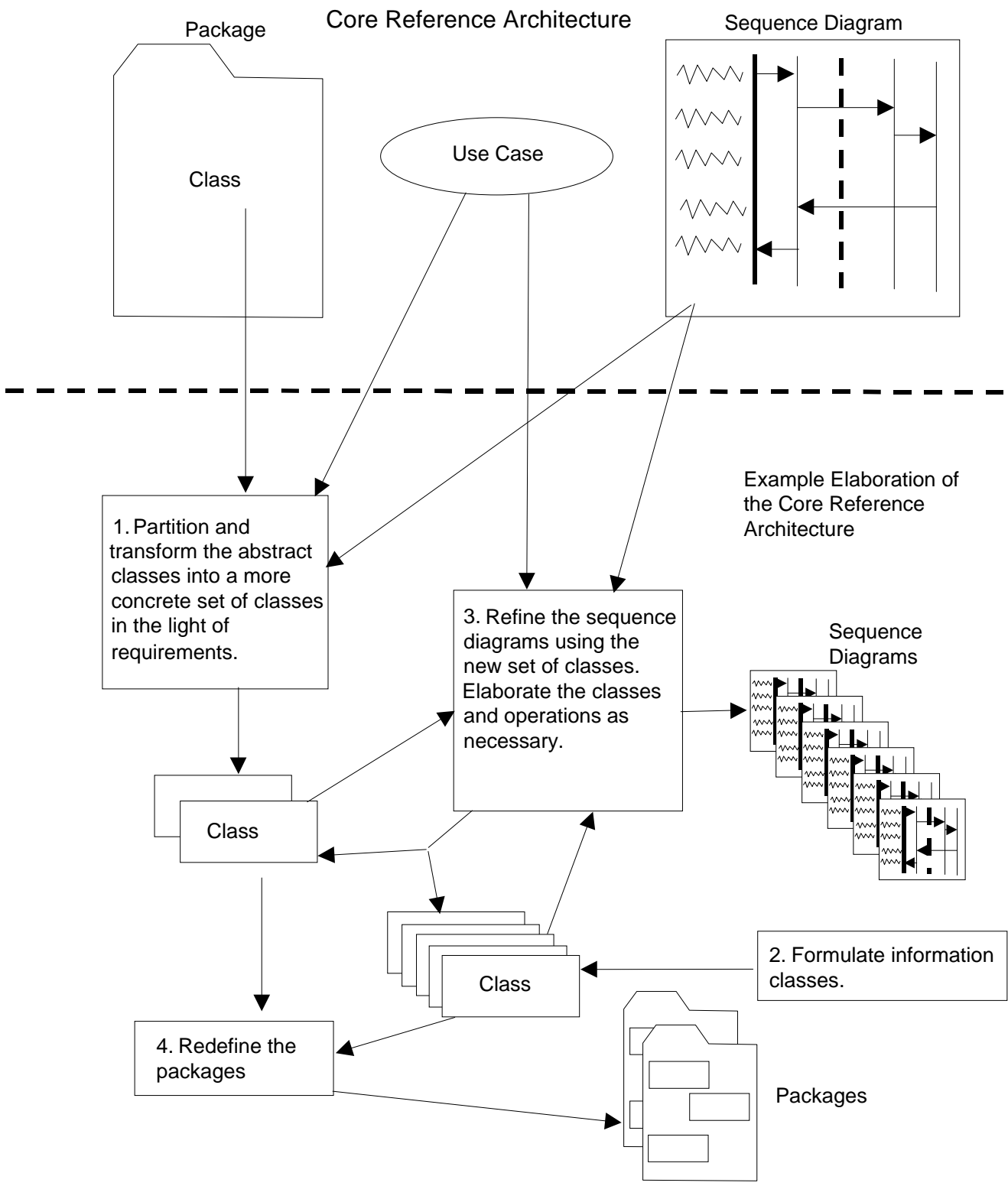
Figure 6 — Steps in the elaboration of the Core Reference Architecture

6.1 Control Classes

This clause infers a number of control classes by systematically grouping the operations of the abstract classes of ISO/TR 14813 Part 2 using general domain knowledge. This systematic grouping is a connection to reality. Each group corresponds to a new control class.

The operations of these new classes will be defined subsequently at a finer granularity, but they will have to deliver the functionality implied by the group of operations derived from the abstract class. Usually the new control classes will have association relationships. The rationale for the identification of each class is presented below.

The reader may wish to refer to ISO/TR 14813 Part 2 for definitions of the abstract operations occurring in the tables below.

6.1.1 Roadway Classes

The operations of the abstract Roadway Class in ISO/TR 14813 Part 2 are classified and grouped in Table 1. This permits the Roadway Class to be replaced in a refinement process by three classes.

Table 1 —Control classes and operations of the Roadway package

Resource	Local Control Group	Roadway Group
accept user credit	measure & local control	access external data
detect and identify vehicle	priority request	access roadway conditions
resource use statistics		compute control actions
vehicle safety and logging		data fusion
		evaluate
		manage demand
		plan construction and maintenance
		predict
		priority request
		support planning
		update geographic data

6.1.1.1   Resource

This class is invented for the purpose of monitoring the use of parts of the roadway network, particularly where commercial vehicle taxes, tolling, and certain safety aspects are involved. A resource object would model a part of the network for which a financial or logging transaction may occur.

6.1.1.2   Local Control Group

This class is invented for the purpose of monitoring and controlling a small or confined part of the roadway such as an intersection or a section of motorway or several such elements which have a geometric relationship. An object of this class might contain one or more Resource objects as shown by the aggregation association in Figure 7.

6.1.1.3   Roadway Group

This class is invented for the purpose of exercising strategic control over the roadway network. An object of this class might contain some geographically extensive Resource objects and a number of Local Control Group objects, the aggregation being defined in strategic design steps. These associations are shown in Figure 7.

There will be additional operations defined for these control classes which allow their cooperation in line with defined associations. Many information classes will be defined and associated with the Roadway Group class to serve the control operations of the classes in Figure 7.
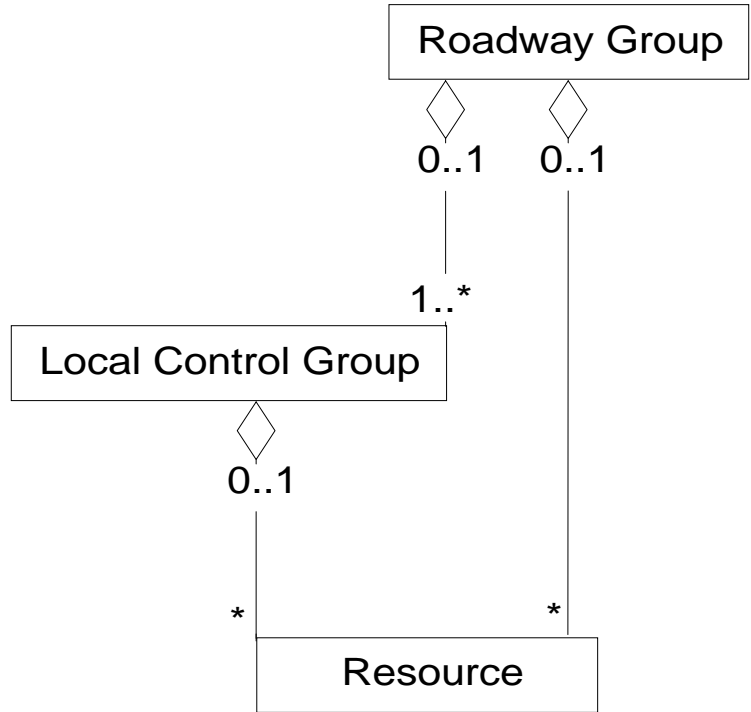
Figure 7 — Control class diagram of the Roadway package

6.1.2   Transport Classes

The operations of the abstract Transport Class in ISO/TR 14813 Part 2 are classified and grouped in Table 2. This permits the Transport Class to be replaced in a refinement process by six classes.

6.1.2.1   Route

This class is invented to model the geographic characteristics for a route. It is specialised into two important sub-classes as shown in Figure 8.

6.1.2.2   O-D Route

This sub-class of Route is invented for the purpose of describing routes for important representative trips. Operations of this class maintain data about services, prevailing conditions and performance, thus it has a role as an information class.

6.1.2.3   Public Transport Route

This sub-class of Route is invented for the purpose of defining and operating the routes of public transport services. The operations also maintain information about stops and interchanges on the roadway network of a public transport service.

Table 2 — Control classes and operations of the Transport package

O-D Route	Public Transport Route	Schedule	Journey	Commercial Vehicle	Forwarder
evaluate post predictions	access running data create & maintain routes & schedules process operational data response request service change request	ad hoc inquiry reservation service	establish journey conditions and options plan journey schedule journey	access incidents monitor vehicle & cargo recognise vehicle	select forwarder

6.1.2.4   Schedule

This class is invented to model all types of public transport schedule. The operations relate to time-tabled and demand responsive public transport services. They maintain time-tables, operational data, and demand responsive vehicle itineraries and dispatching. Every Public Transport Route object has a Schedule object associated with it.

6.1.2.5   Journey

This class is invented to serve route and schedule planning for a transportable item. The operations develop the overall plan for Travellers (i.e. Passengers and all types of Drivers).

It is also an information class for the total movement associated with a journey request. The request might be for a goods item to be taken from Consignor to Consignee, or for a Traveller planning a multi-leg Journey.

Every Journey object has one or more O-D Route objects associated with it, corresponding to the number of legs or trips whch make up the Journey object.

6.1.2.6   Commercial Vehicle

This sub-class of Vehicle (see 6.1.3) is invented for the purpose of controlling commercial vehicles on route and interacting with classes in the Roadway package.

A Commercial Vehicle object which has been assigned to a tour will be associated with a Journey object.

6.1.2.7   Forwarder

This class is invented to model some functions of freight movement which are inside TICS.
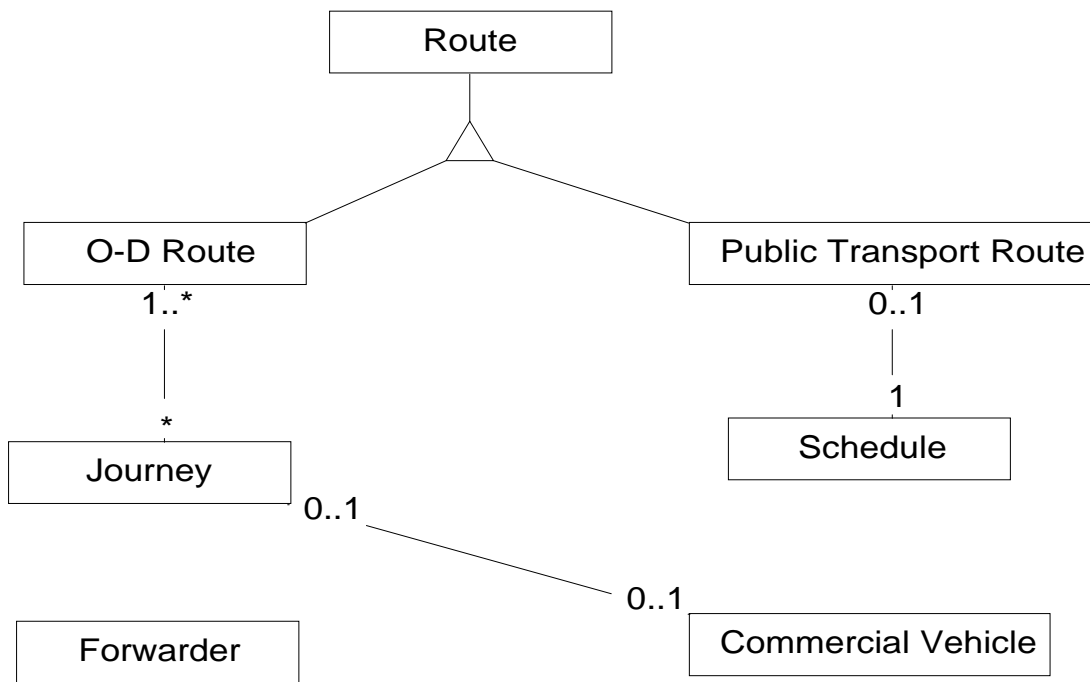
Figure 8 — Control class diagram of the Transport package

6.1.3 Vehicles Classes

The operations of the abstract Vehicle Class in ISO/TR 14813 Part 2 are grouped and retained under a single class in Table 3.

6.1.3.1 Vehicle

This class is invented to model the control of a vehicle for safety and basic operational purposes.
There are special classes of vehicle which inherit these characteristics.

Table 3 — Control classes and operations of the Vehicle package

Vehicle
control vehicle
data fusion
monitor context
support planning

6.1.4 Event Classes

The operations of the abstract Events Class in ISO/TR 14813 Part 2 are classified and grouped in Table 4. This permits the Events Class to be replaced in a refinement process by three classes. (See Figure 9)

Table 4 — Control classes and operations of the Events package

Incident	Emergency	Violation
access incidents	develop strategy	process violations
predicted incidents	process emergency	
suppport planning	request emergency response	
update incidents & emergencies	update incidents & emergencies	
evaluate		

6.1.4.1 Incident

This class is invented to control the process of predicting and handling incidents.

6.1.4.2 Emergency

This class is invented to control the process of detecting and handling an emergency. Thus an emergency object may be associated with an incident object, and vice versa.

6.1.4.3 Violation

This class is invented to control the processing of all violations of regulations. In the case of a serious violation a Violation object may be associated with an Emergency object.
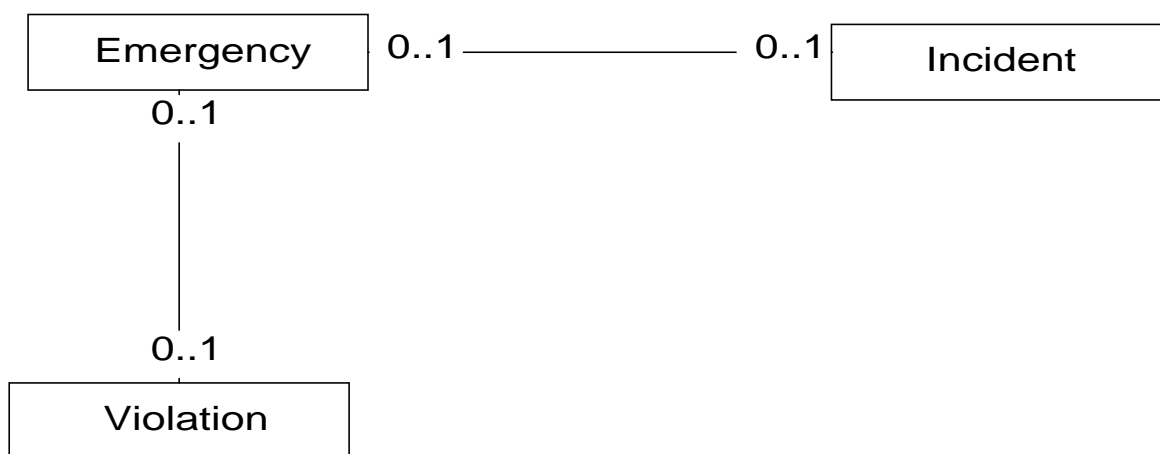
Figure 9 — Control class diagram of the Events package

6.1.5 Payment Classes

The operations of the abstract Payment Class in ISO/TR 14813 Part 2 are classified and grouped in Table 5. This permits the Payment Class to be replaced in a refinement process by three classes.

Table 5 — Control classes and operations of the Payment package

Billing Record	Tariff	Yellow Pages
compute charges	declare tariff	maintain yellow pages
create billing record	response request	
make payment	support planning	

6.1.5.1 Billing Record

This class is invented to support the initialisation and completion of a Resource use, and any payment. A Billing Record object may be associated with a Vehicle object in the case of tolling transactions.

6.1.5.2 Tariff

This class is invented to support the calculation of charges for Resource usage and variations which may be required. A Resource object is associated with a Tariff object.

6.1.5.3 Yellow Pages

This class is invented to maintain the wider information about a general service not held in the Tariff class.

6.2 Interface Classes

The operations of the interface classes are grouped at the same level of abstraction as in ISO/TR 14813 Part 2. They are shown in Tables 6 to 9. The main significance of the interface classes at this stage of architecture elaboration is in the definition of the system boundary and the architecture boundary.

6.2.1 Operating Interface

This interface class generalises all the different types of operating interface. The operations perform data display, support Operator interaction and interaction with a range of external operational systems.

Table 6 — Operating Interface class and operations

Operating Interface
action request
conformance check
request credit issuer payment
reservation request

6.2.2 Travel Terminal

This interface class generalises all the street kiosk interfaces as well as internet and other interfaces. The operations perform data display and support Traveller interaction.

Table 7 — Travel Terminal class and operations

Travel Terminal
accept cash/credit
advertise
debit
payment request
pre-payment
publish traveller information
sense security violation or alert

6.2.3 Vehicle Interface

This sub-class of Travel Terminal is part of the Vehicle package and generalises in-vehicle interfaces. The operations perform data capture and display, other user communications, and support Driver and Passenger interaction.

Table 8 — Vehicle Interface class and operations

Vehicle Interface
access payment means
access vehicle & passenger data
command driver
deploy vehicle and instruct driver
interrogate fleet
notify driver
track vehicle & status

6.2.4 Roadside Peripheral

This interface class is part of the Roadway package. The objects interface signs, some types of sensors and communications beacons. The operations support information flow between Drivers and the Roadway control classes.

Table 9 — Roadside Peripheral class and operations

Roadside Peripheral
notify vulnerable
update control

6.3 Information Classes

With each step in the elaboration of the architecture there is a more rapid growth in the number of information classes than the other types. This is the nature of the large scale information and control system. Control is based on a large amount of real time data, which is reduced to important parameters for key operations. To serve historical, real time and transactional purposes the information classes and their associations constitute schemas for notional object databases.

As noted at the beginning of clause 5, the level of abstraction of an architecture means that the parameters of the class operations are themselves defined as information classes. These information classes are associated with other classes that generate and receive the messages of interest in the architecture.

The definition of the information classes calls for more detailed TICS domain knowledge. In TC204 this domain knowledge will be supplied by the various working groups.

Objects of an information class interact in the standard manner, that is through the operations defined in their interface. These operations maintain data stored in the attributes of the object.

In architecture every information class has the same implicit set of generic operations:

— create(…)

— update(…)

— retrieve(…)

— delete(…)

The difference between each class is the set of attributes and parameters that the operations manipulate. When they serve as parameters in the operations of control classes of the architecture, information objects are always used in their entirety.

6.3.1   Information Classes for Traffic Management and Traveller Information

The draft standard ISO 14827 **Message Format and Information Contexts for Traffic Management and Information Centres (TMIC)**[2)] has recently been developed by TC204/WG9. The data definitions in draft ISO 14827 are not data dictionary definitions, rather they are informal definitions of complex data elements. Most of these data elements map to parameters of the operations in the sequence diagrams for the use cases in Traffic Management and Traveller Information.

In elaborating the architecture a uniform approach was adopted in the use of the ISO 14827 data elements. Each data element definition maps to an information class definition, and the text in ISO14827 is used unchanged. Since that document does not use an object-oriented model there is some inconsistency in terminology. For example, ISO 14827 often refers to a "list of objects"; this should be read as the set of objects belonging to a class. A dictionary of the information classes so derived is given in Annex A.

There are 360 data elements in draft ISO 14827, identified in a naming tree. The root structure of this naming tree has been defined as an aggregate of nine information classes in Figure 10. An information class is associated with each top level data element of ISO 14827, using the name in the ISO 14827 naming tree as part of the class name.

The digits in the leading part of the class name are those used in ISO 14827 to indicate the position in the naming tree. They are included because they are a convenient abbreviation for the information class names where they occur as parameters in the sequence diagrams.

---

2)   The classes derived here are based on draft N173H, 20-01-98.

The remaining information classes were defined in nine hierarchies shown in Figures 11 to 19. The methodology was to first view the leaf nodes (data elements) of the naming tree as candidate information classes. Consolidation of these classes was performed as aggregations to the next level, according to the graph of the naming tree. In order to avoid clutter the leaf information classes are not shown in the Figures 11 to 19. However the parameters of the operations in the sequence diagrams of clause 7 of this report will usually be the aggregate classes.

There are a small number of exceptions where an aggregation association was not appropriate.

In Figure 11 "[1---] infrastructureMap" class is specialised into three subclasses. The ISO 14827 definitions prompting these associations are:

—— [1---] infrastructureMap: These are maps of the static physical network.

—— [11--] generalMap: This base map describes all relevant geographic features of the region.

—— [12--] transportMap: These are facilities operated by the relevant service provider.

—— [13--] roadMap: No definition.

In Figure 12 "[21--] vehicles" class is specialised into two sub-classes and it has two other classes related in standard associations. The ISO 14827 definitions prompting these associations are:

—— [211-] individualVehilceID: No definition – clearly a vehicle attribute.

—— [212] governmentID: This information class shall consist of the vehicles (objects) that an agency wishes to have identified in the manner indicated.

—— [213-] policeListing: This information class shall consist of the vehicles (objects) that an agency wishes to have identified in the manner indicated.

—— [214-] vehicleCondition: No definition – clearly a vehicle attribute.
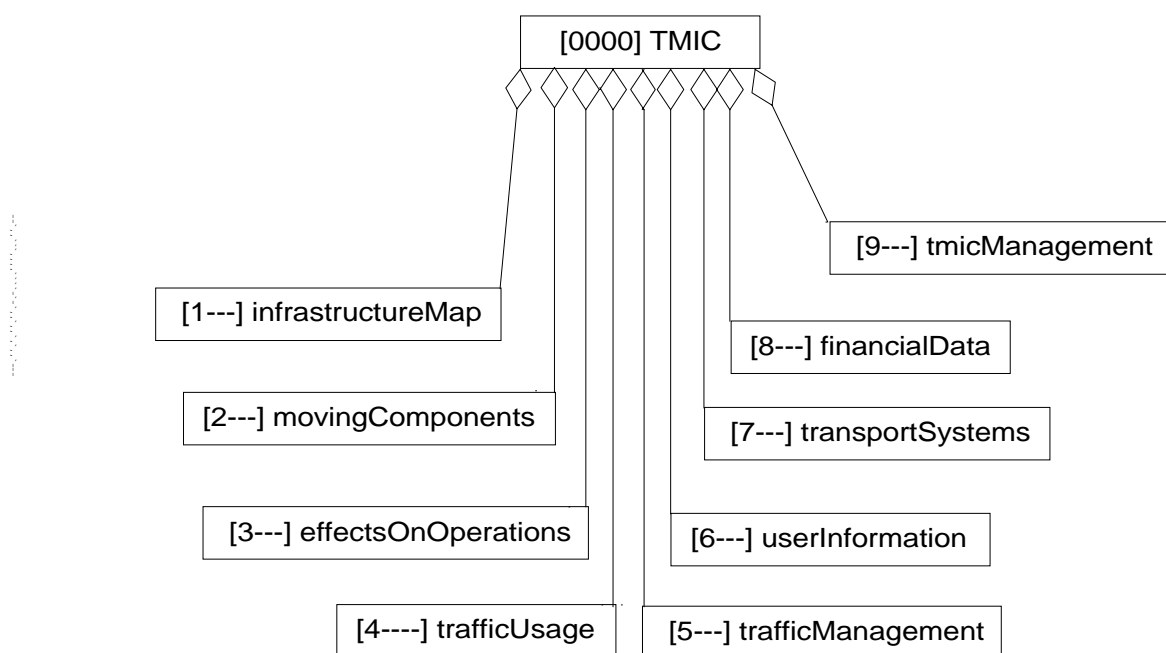
Figure 10 — Top level aggregation of Information classes derived from the 14827 naming tree
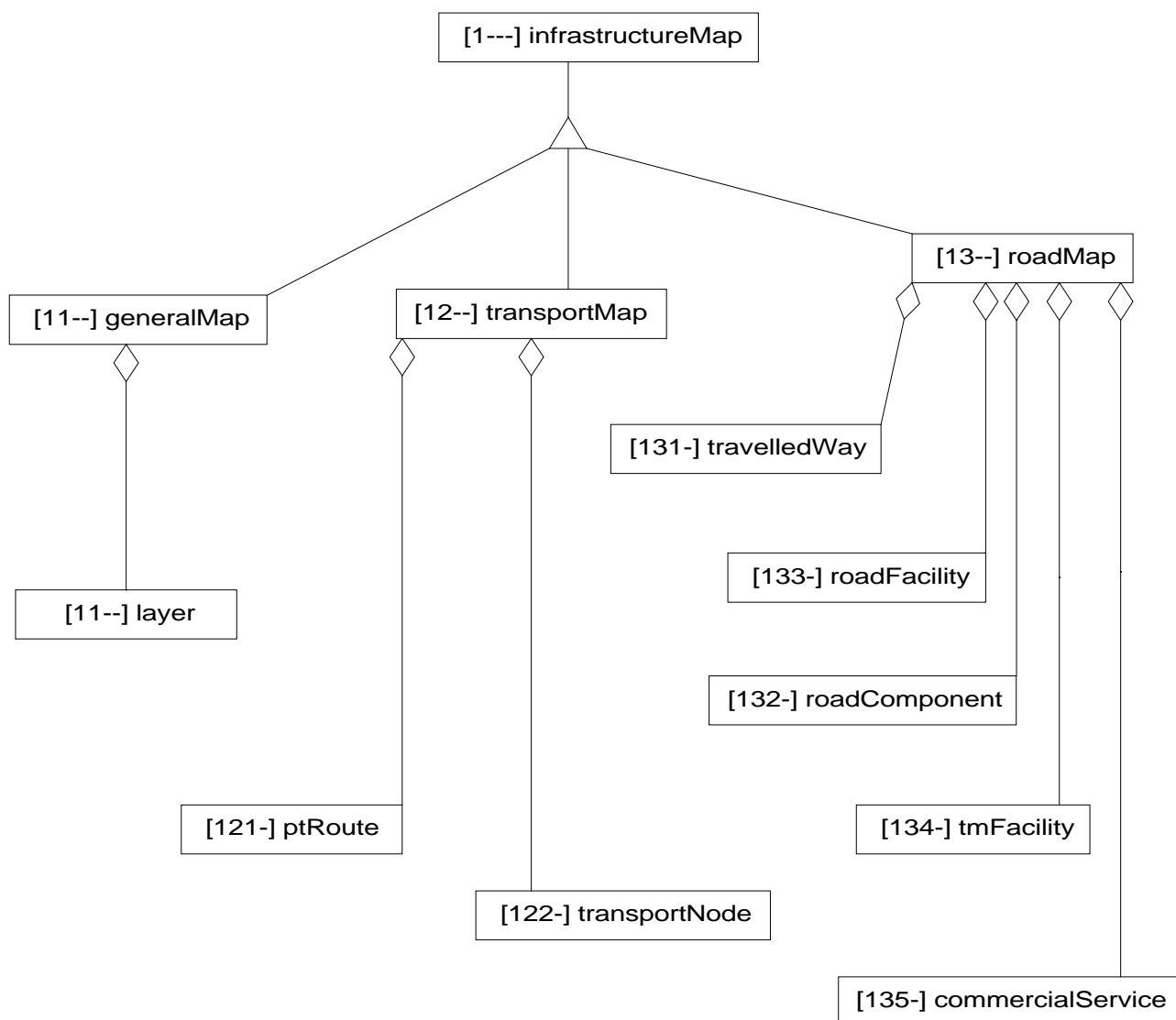
Figure 11 — Information classes in the aggregation of infrastructureMap
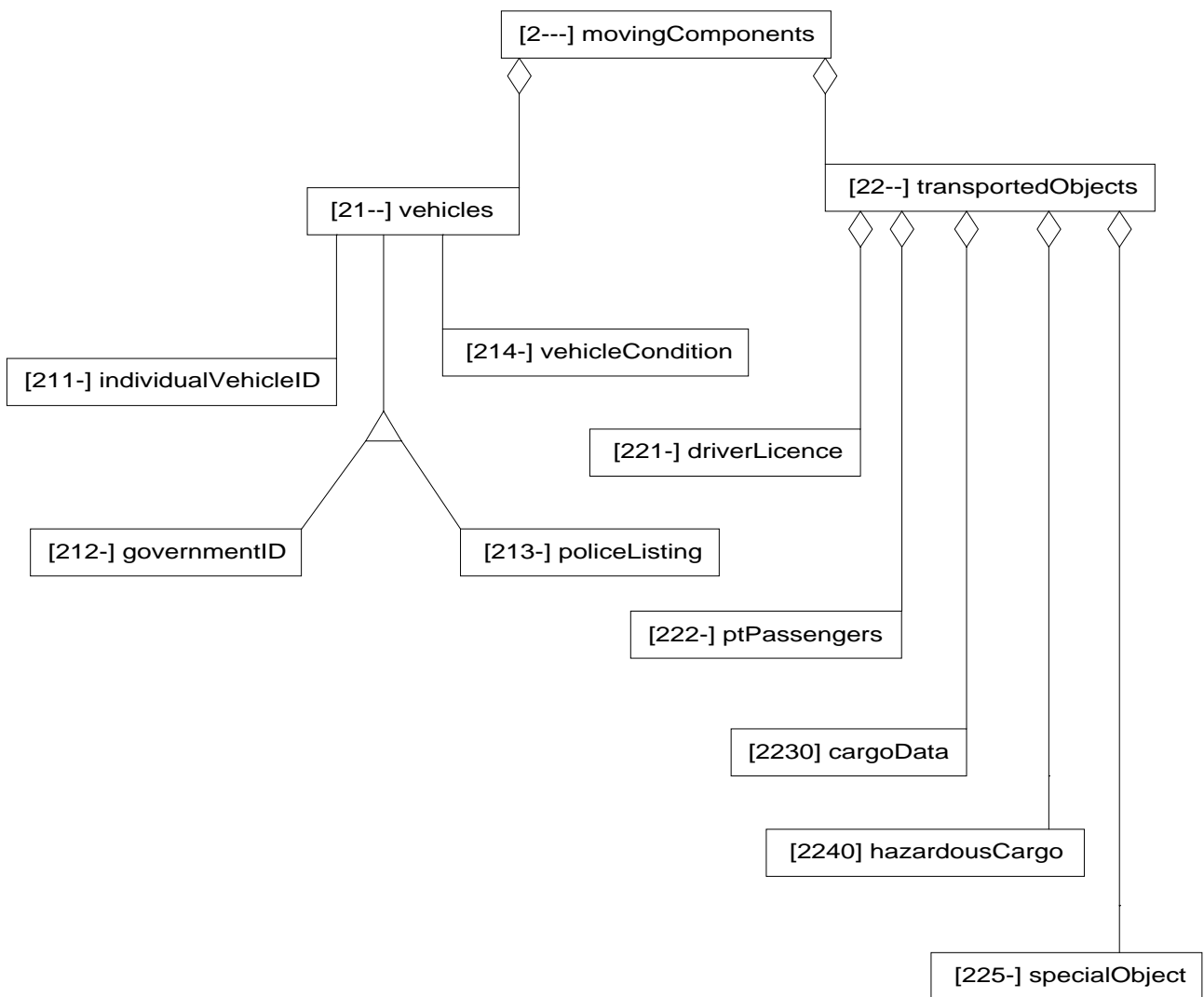
Figure 12 — Information classes in the aggregation of movingComponents

```
                           [3---] effectsOnOperations

            [31--] externalToRoad              [32--] atRoad


  [311-] generalWeather                 [325-] roadWork


     [312-] backgroundEffect              [324-] roadMaintenance


        [313-] naturalEvent                [323-] roadStructure


        [314-] localWeather


           [315-] roadsideIncidents        [322-] roadSurface


              [316-] serviceFailure          [321-] objectsOnRoad
```
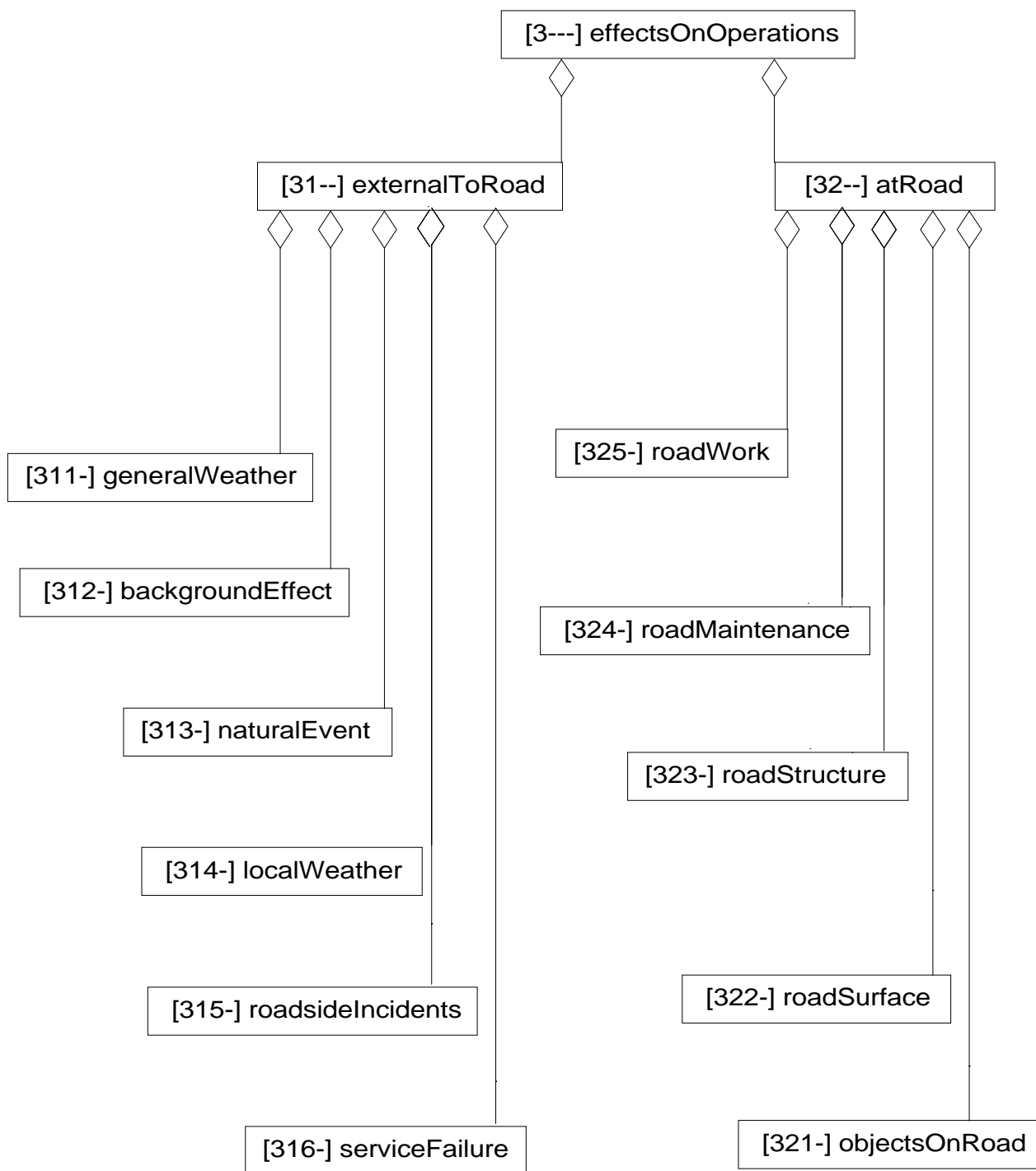
Figure 13 — Information classes in the aggregation of effectsOnOperations
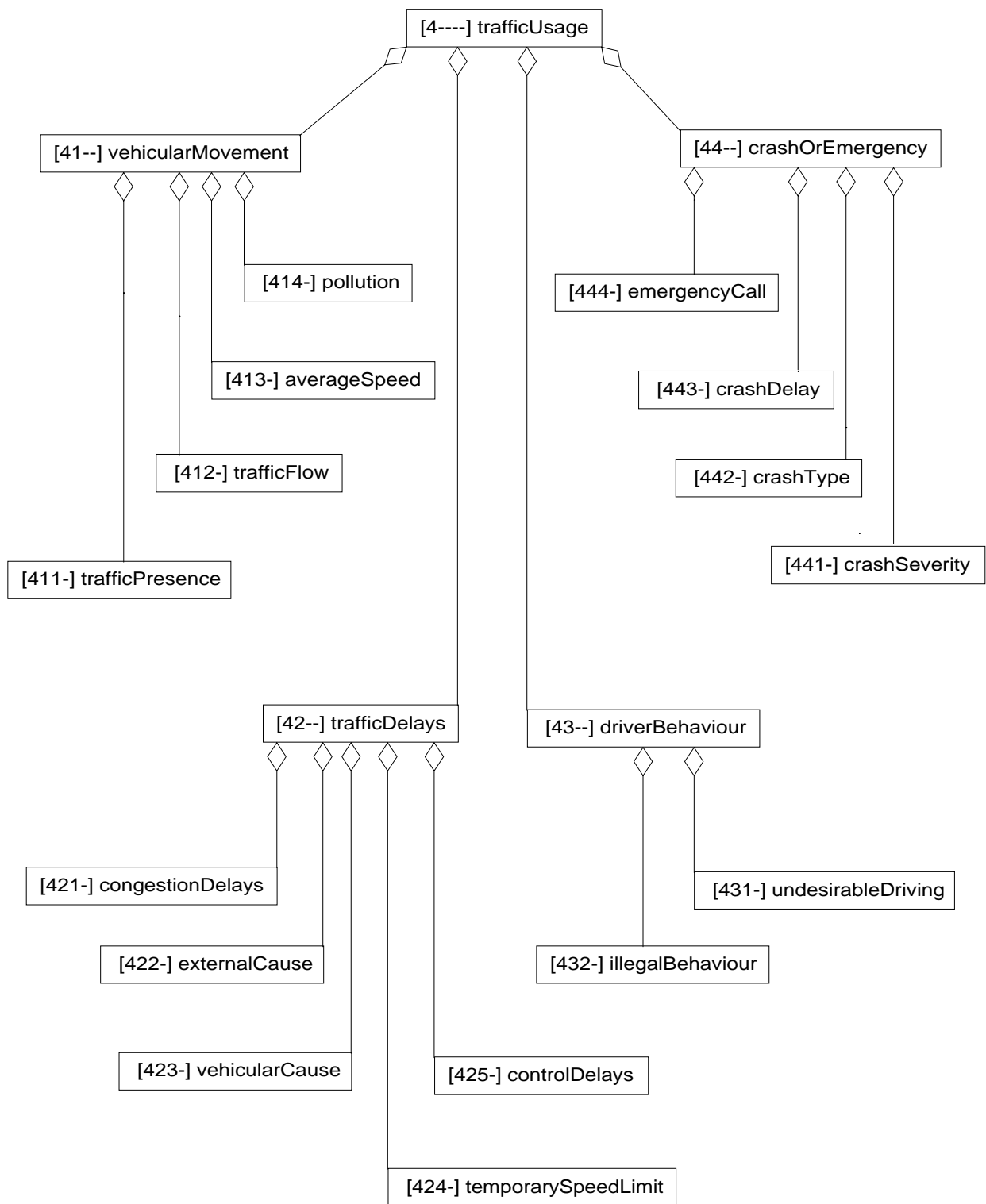
Figure 14 — Information classes in the aggregation of trafficUsage

Figure 15 — Information classes in the aggregation of trafficManagement
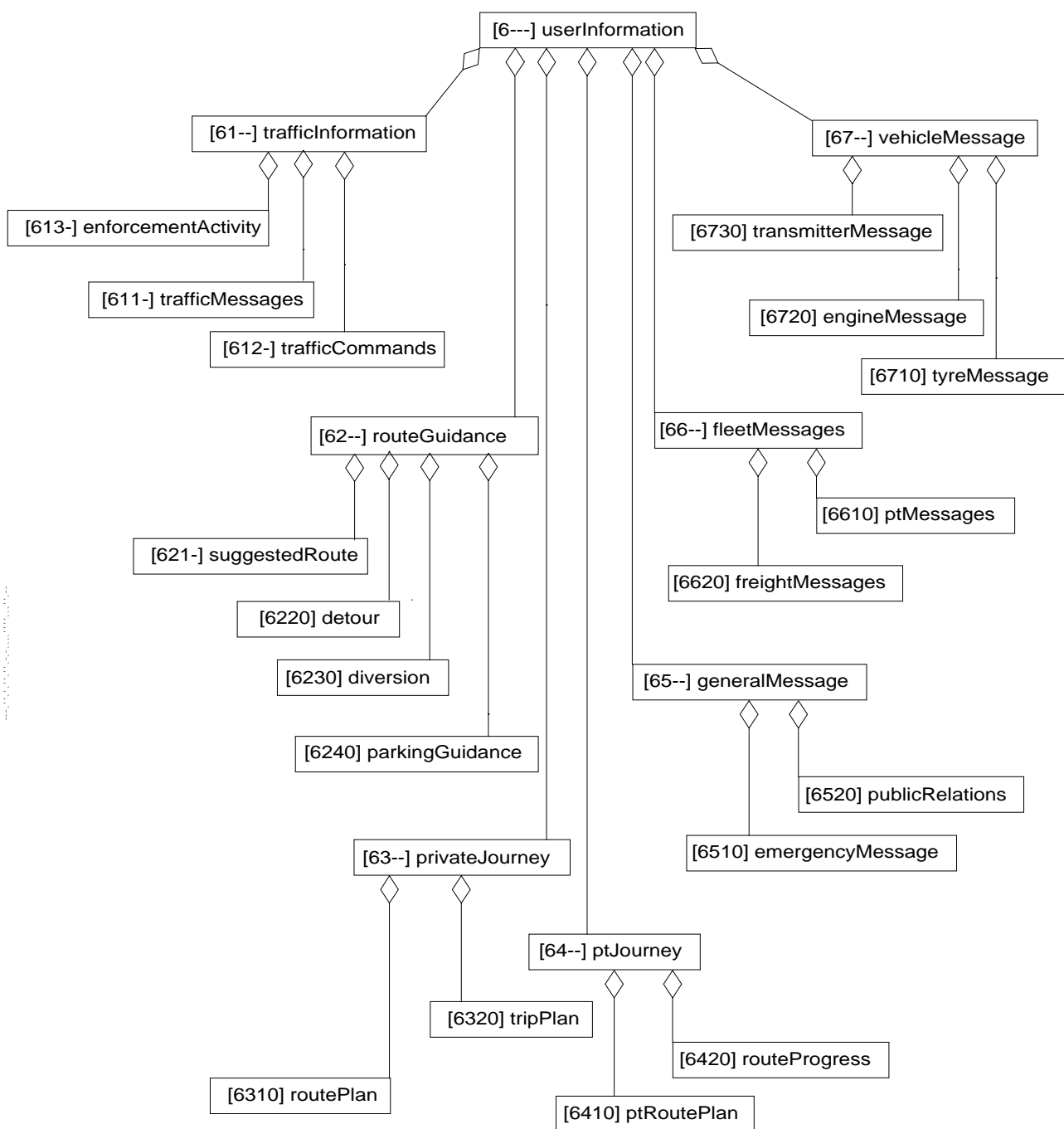
Figure 16 — Information classes in the aggregation of userInformation

```
                              [7---] transportSystems

                  [71--] roadUsers
                                                    [7500] transfers

    [7110] carOccupancy
                                              [74--] taxiOperation

         [7120] rideSharing
                                                      [7420] taxiActuals

            [713-] parkingSupply

               [714-] serviceAreaSupply
                                                 [7410] dispatchEstimate

                  [7150] tollCharges

                                        [73--] freightOperation

                       [72--] ptOperation
                                                      [7310] freightSchedules

          [721-] ptSchedules

             [722-] ptActuals                   [7320] freightActuals

                  [7230] ptSurveillance
```
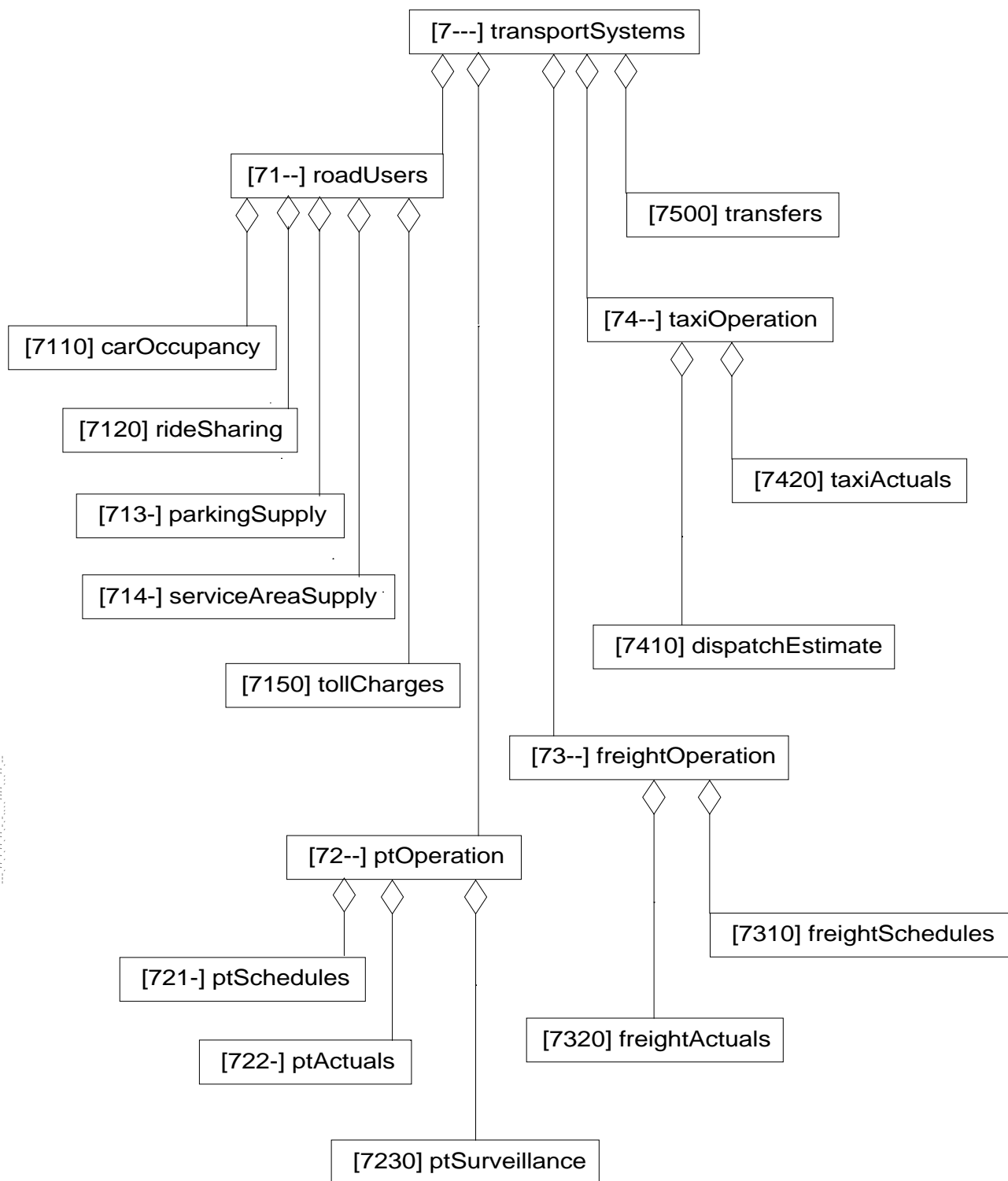
Figure 17 — Information classes in the aggregation of transportSystems
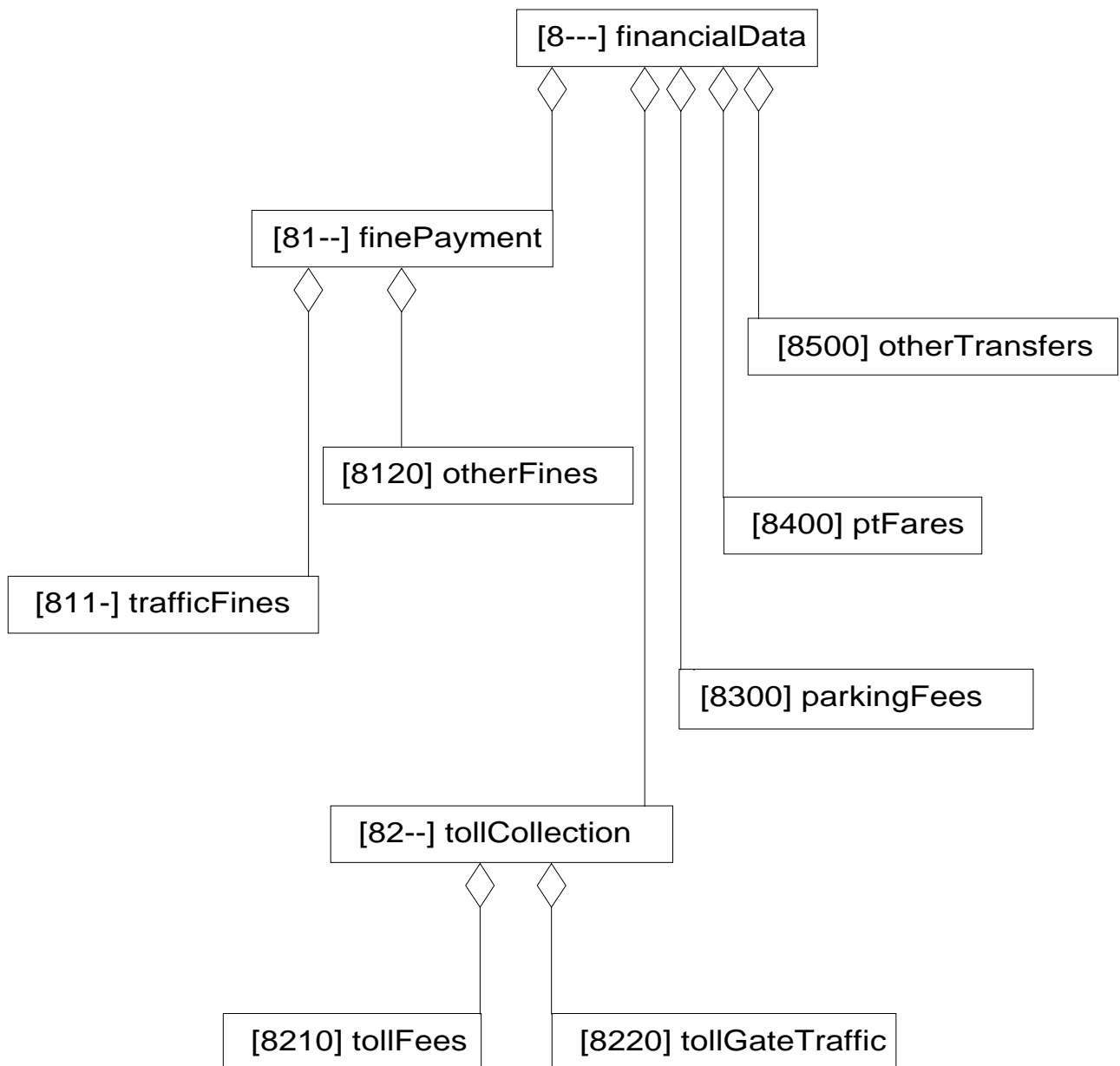
Figure 18 — Information classes in the aggregation of financialData

[9---] tmicManagement

[91--] tmicToTmic

[96--] externalToTmic

[92--] systemOperation

[95--] tmicToExternal

[93--] errorInformation

[94--] performanceMonitor

[9410] systemEfficiency

[9420] systemEffectiveness

[9460] otherStatistics

[9430] totalDelay

[9450] passengerThroughput

[9440] totalCrashes
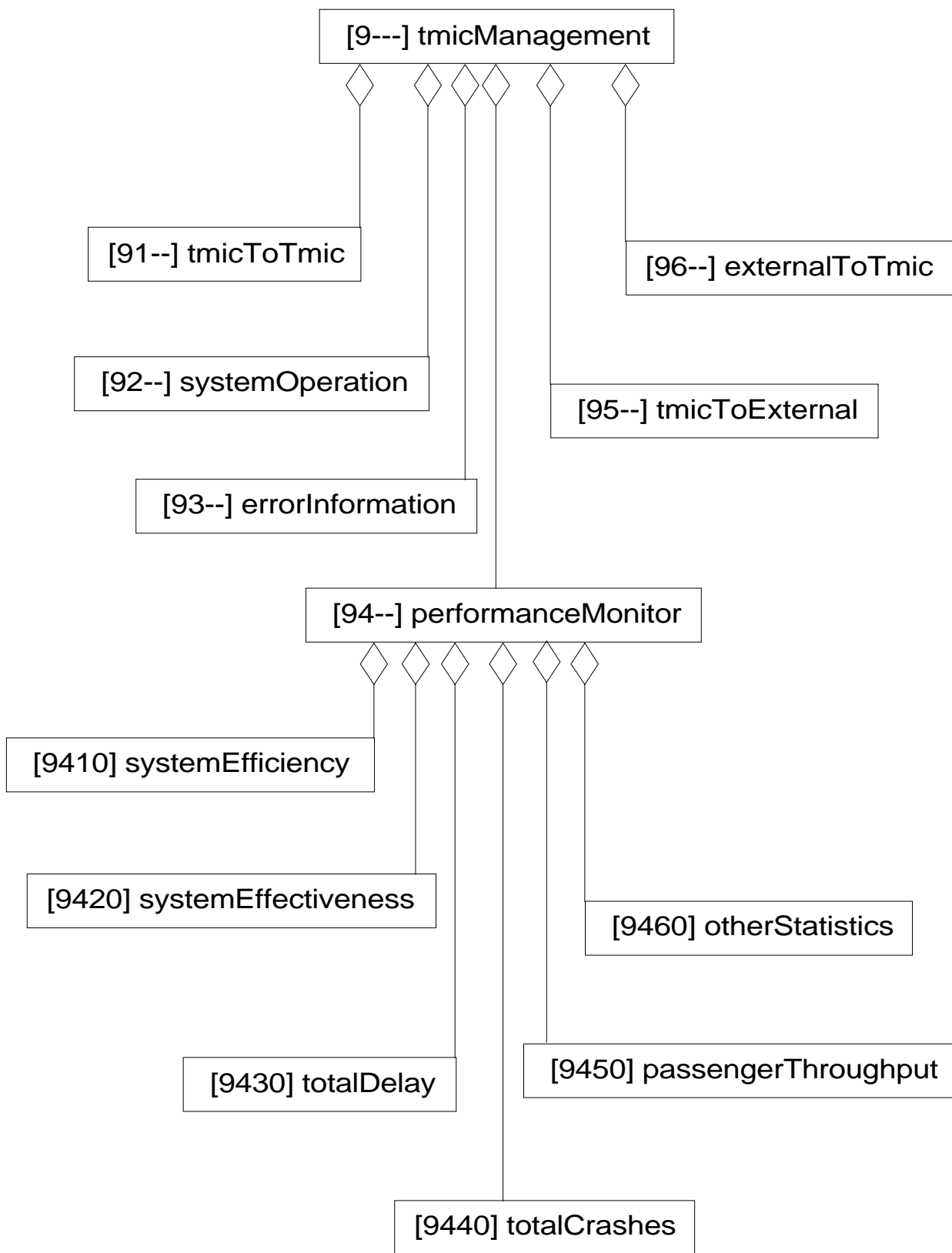
Figure 19 — Information classes in the aggregation of tmicManagement

7 Elaboration of the Sequence Diagrams

This clause presents the results of applying the elaboration method described in clause 5. The primary inputs are the sequence diagrams of the core architecture in ISO/TR 14813 Part 2 and the new classes derived in clause 6 of this document. The object interactions for each use case defined in the abstract sequence diagrams of ISO/TR 14813 Part 2 clause 8 are expanded by mapping each interaction to the expanded set of control classes. In this process the number of object interactions is increased and the class operations defined in ISO/TR 14813 Part 2 are replaced with a finer grained set of operations for the new control classes.

Since sequence diagrams document the logic of the use case, there is a one to one mapping with each use case of the core reference architecture in ISO/TR 14813 Part 2. All the classes involved in a sequence diagram are first identified including some new classes which will be explained as they arise. Any class that provides an operation for an object interaction in a sequence diagram is called a *key class* in this report. Thus key classes are distinguished from classes which only occur as parameters in an object interaction of a sequence diagram.

Within the sequence diagram, each object interaction is represented by a labelled directed line between two objects that are identified by their class name (see Figure 20). The number of pairings of objects is not specified, that is the mapping of an interaction to source and target objects may be one to one, one to many, many to one, or many to many. Also, many occurrences of the same sequence may occur in parallel. The label on the interaction is the name of the operation of the target class which is executed in order to perform that part of a use case transaction. The parameters of the operation (which are transmitted between objects, and which may be input parameters or output parameters or both) are identified in parenthesis after the operation name. In this elaboration the only parameters identified are those defined in 6.3. Thus no parameter list can be regarded as complete, particularly where there are no parameters listed.

Sometimes a parameter of an operation does not map exactly to an information class of 6.3. In these cases, only part of an aggregate object conforming to the specified information class may be relevant as a parameter. If, for example, [41--] is a parameter, this means that there could be one or more of the objects covered by that class aggregation, i.e. [411-] trafficPresence (and recursively any sub-aggregate objects as defined in Annex A), [412-] trafficFlow, [413-] averageSpeed, [414-] pollution. In order to avoid clutter only the digits occurring in the class name are used to identify parameters on the sequence diagram. These digits constitute a unique identifier.

The classes defined in 6.3 have been developed for applications in traffic management and information centres, consequently they are most relevant to the Traffic Management sequence diagrams (7.2) and partly to Traveller Information (7.1). Therefore the development of the sequence diagrams for Traffic Management (7.2) is treated in more detail than that of the other clauses. The object interactions defined for the sequence diagrams in other clauses are largely without parameters.

7.1 Traveller Information

7.1.1 Pre-journey Information

The abstract operations for Pre-journey Information in ISO/TR 14813 Part 2 are provided by the Transport Class. This leads to the following key classes defined in previous clauses.

— O-D Route

— Journey

The following new control and information classes are required:

— Journey Schedule: This class is invented to maintain the mode segments and service times for the trips generated for a journey. The class is associated with the Journey class.

— Public Transport Schedule: A control class which supports the planning and operational functions of a fixed route public transport system.

 Trip: This class is invented to control journey planning and execution. Journeys (for Travellers, Goods Items or Commercial Vehicle Tours) are made up of one or more single mode Trips, thus there is an aggregate association between the Trip and Journey classes. The operations of this class access route information, choose the most suitable route and provide dynamic information.

The sequence diagram for a journey planning exercise is shown in Figure 20. The first stage is to iteratively validate the Traveller's journey request:

 Travel Terminal**.**initiate journey request ([641-])

in the light of feedback information got by comparing requirements with current conditions recorded by objects of the O-D Route class which in turn interact with objects of the Public Transport Schedule class:

 O-D Route.access current conditions ([611-],[72--],[7120],[7131])

 Public Transport Schedule.access public transport running data ([72--])

The main stage is an iteration whereby the validated Journey specification is first defined:

 Journey**.**create ([641-])

Some transactions of Route Guidance and Navigation (Figure 21 at line 2.2) are then invoked which develop the individual Trip and Journey Schedule objects associated with the Journey object. The details of the journey plan are then returned to the Traveller through the nested sequence of operations:

 Journey**.**iterate over trips (…)

 Trip**.**access next segment (…)

 Trip**.**access route ([641-])

 Journey Schedule**.**access schedule ([72--])

If the Traveller commits to this plan the transactions of Journey Payment (7.1.4) are invoked otherwise the journey request is updated and the iteration repeated.

The final transaction is to update the travel statistics:

 O-D Route**.**update travel date([62--])

7.1.2   Route Guidance and Navigation

The abstract operations for Route Guidance and Navigation in ISO/TR 14813 Part 2 are provided by the Transport Class, the Roadway Class and the Event Class. This leads to the following key classes defined in previous clauses.

 O-D Route

 Journey

 Trip

 Public Transport Schedule

 Roadway Group

 Incident

The following new information class is required.

— Probe: This information class is invented to generate resource use statistics from individual travel records which are provided by the Resource control class.

The sequence diagram is shown in Figure 21. The first part is a maintenance iteration for geographic data:

— O-D Route**.**update map data ([131-])

— Journey**.**update map data ([12--])

for traffic data:

— O-D Route**.**update effects data ([3---])

— Roadway Group**.**access prediction data ([522-])

— Probe**.**access route travel time data ([131-],[52--])

— Roadway Group**.**access traffic data ([52--])

— Incident**.**access predicted incidents ([5213],[5214])

and public transport data:

— Public Transport Schedule**.**access public transport running data ([72--])

Related O-D Route objects exchange such data:

— O-D Route**.**exchange data(…)

and data is prepared for application:

— O-D Route**.**generate advice(…)

This supports any routine enquiry by Travellers:

— O-D Route**.**access advisory data ([611-],[7---])

The remainder of the sequence diagram is an iteration for servicing various types of planning, guidance or navigation application. If the request is from a vehicle the journey is defined:

— Journey**.**create([63--])

The Journey (for whatever payload) is then analysed into component trips and the navigation or guidance data generated:

— Trip**.**create ([631-],[641-])

— O-D Route**.**access route conditions([631-],[641-],[52--],[7---])

— Trip**.**generate route and guidance (…)

If the application is for navigation this is accessed as required:

— Trip**.**access route guidance ([62--])

If the application is for journey planning the transactions of Journey Schedule (7.1.3) are invoked.

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7.1.3 Journey Schedule

The abstract operations for Journey Schedule in ISO/TR 14813 Part 2 are provided by the Transport Class. This leads to the following key classes defined in previous clauses.

— Journey

— Trip

— Journey Schedule

The sequence diagram for each journey planning exercise is shown in Figure 22. The first stage is to initialise a schedule:

— Journey Schedule**.**create (…)

The main iteration is repeated for each trip:

— Trip**.**access next segment (…)

For those trips which require reservations the action is taken. The Demand Responsive Public Transport transactions (7.5.3) are invoked if necessary. After each actor interaction the confirmed schedule is recorded:

— Journey Schedule**.**update time confirmation and price (…)

Once all trips have been processed the complete journey is checked:

— Journey Schedule.validate (…)

7.1.4 Journey Payment

The abstract operations for Journey Payment in ISO/TR 14813 Part 2 are provided by Transport Class and the Payment Class. This leads to the following key classes defined in previous clauses.

— Journey

— Journey Schedule

— Billing Record

The sequence diagram for one journey planning exercise is shown in Figure 23. The first stage is to capture the payment means and commit to payment:

— Travel Terminal**.**read payment card/tag ([2214])

— Journey**.**commit ([2214])

The main logic is an iteration whereby each trip in the journey is paid for by invoking the transactions of Payment Transaction (Figure 59 at line 4.4.1):

— Journey Schedule**.**access segment and cost (…)

— Billing Record.create ([2214])

The final action is to give confirmation:

— Travel Terminal**.**confirm(…)

7.1.5   On-trip Traveller Information

The abstract operations for On-trip Traveller Information in ISO/TR 14813 Part 2 are provided by the Payment Class. This leads to the following key classes defined in previous clauses.

— Yellow Pages Service

— Billing Record

The sequence diagram for the set of transactions is shown in Figure 24. The first part of the sequence is devoted to the maintenance of information services:

— Yellow Pages Service**.**update general information (…)

— Travel Terminal**.**provide yp advertisement (…)

The second part is devoted to the maintenance of yellow pages services:

— Yellow Pages Service.update construct yp service (…)

— Yellow Pages Service.update yp service (…)

The main logic is an iteration for the provision of a yellow pages service:

— Travel Terminal**.** yp request (…)

— Travel Terminal**.**read payment card/tag ([2214])

— Yellow Pages Service**.**yp transaction (…)

— Operating Interface**.**yp service order(…)

— Billing Record**.**create ([2214])

followed by use of the Payment Transaction (Figure 59 at line 3) and then

— Travel Terminal**.**confirm yp request (…)

Independent transactions arise in the case of a Traveller revising plans for the remaining trips of a journey. These are described in Pre-Journey Information (Figure 20 at line 3).

Independent transactions support a Driver on route. These are described in Route Guidance and Navigation (Figure 21 at line 2.3).

Pre-journey Information

	Description
1	Traveller initiates journey planning request
1.1	Get current conditions
1.1.1	Public Transport
1.2	Supply default traveller information
2	Revise and proceed
3	
3.1	Record journey parameters
3.1.1	Generate best route (line 2.2)
3.2	Provide route and schedule information
3.2.1	Access next segment of journey
3.2.2	Provide route information
3.2.2.1	Provide schedule information
3.2.2.2	Inform traveller
3.3	IF Traveller satisfied
3.3.1	Give OK
3.3.1.1	Request reservations and payment
3.3.1.1.1	Make payment
3.3.2	END SELECTION
3.4	ELSE
3.4.1	Revise and retry
3.4.2	END SELECTION
3.5	UNTIL Traveller pays or quits
4	IF journey confirmed
4.1	Update route travel statistics
4.2	END SELECTION

Figure 20 — Sequence diagram for Pre-journey Information

Figure 21 — Sequence diagram for Route Guidance and Navigation

Route Guidance and Navigation
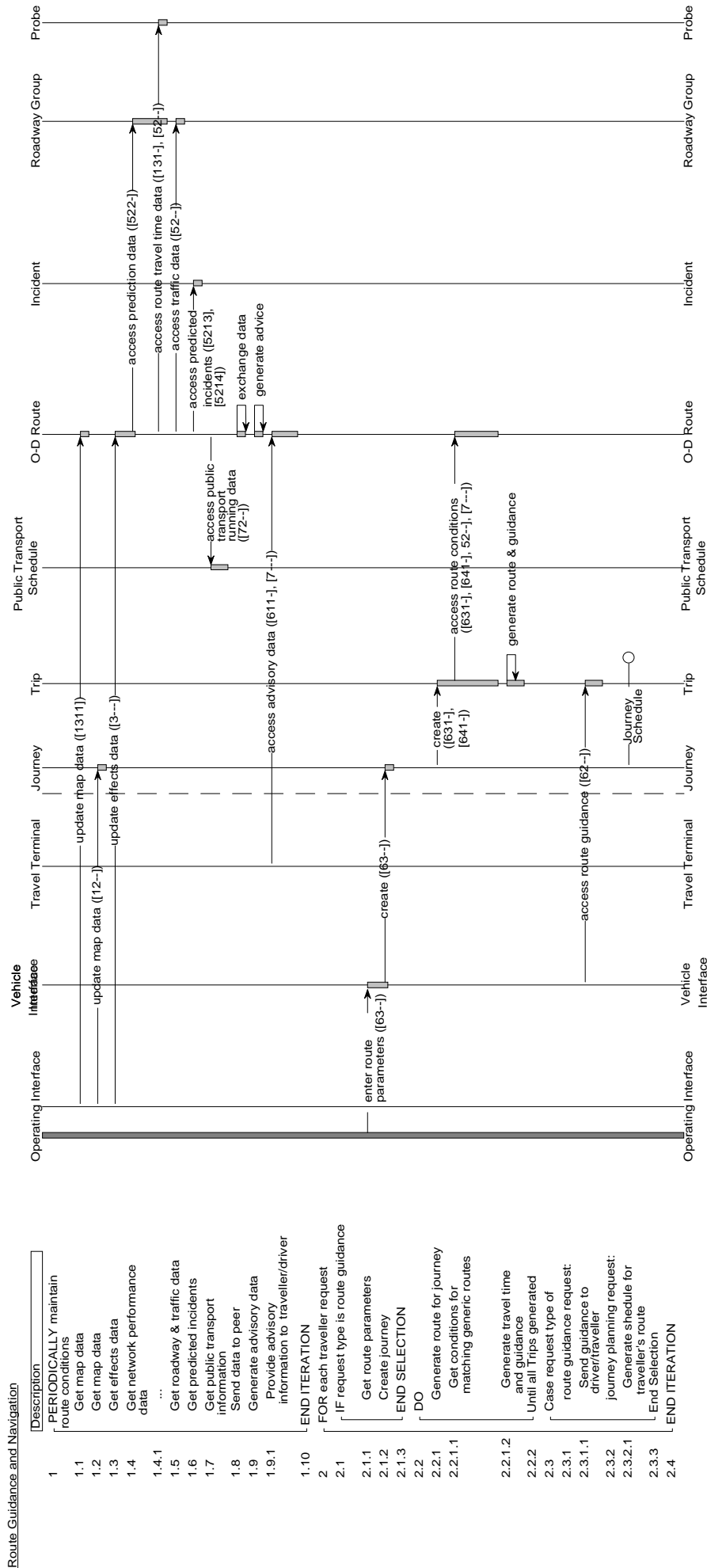
	Description
1	PERIODICALLY maintain route conditions
1.1	Get map data
1.2	Get map data
1.3	Get effects data
1.4	Get network performance data
1.4.1	...
1.5	Get roadway & traffic data
1.6	Get predicted incidents
1.7	Get public transport information
1.8	Send data to peer
1.9	Generate advisory data
1.9.1	Provide advisory information to traveller/driver
1.10	END ITERATION
2	FOR each traveller request
2.1	IF request type is route guidance
2.1.1	Get route parameters
2.1.2	Create journey
2.1.3	END SELECTION
2.2	DO
2.2.1	Generate route for journey
2.2.1.1	Get conditions for matching generic routes
2.2.1.2	Generate travel time and guidance
2.2.2	Until all Trips generated
2.3	Case request type of route guidance request:
2.3.1	Send guidance to driver/traveller
2.3.1.1	journey planning request:
2.3.2	Generate schedule for traveller's route
2.3.2.1	End Selection
2.3.3	END ITERATION
2.4	

Figure 22 — Sequence diagram for Journey Schedule
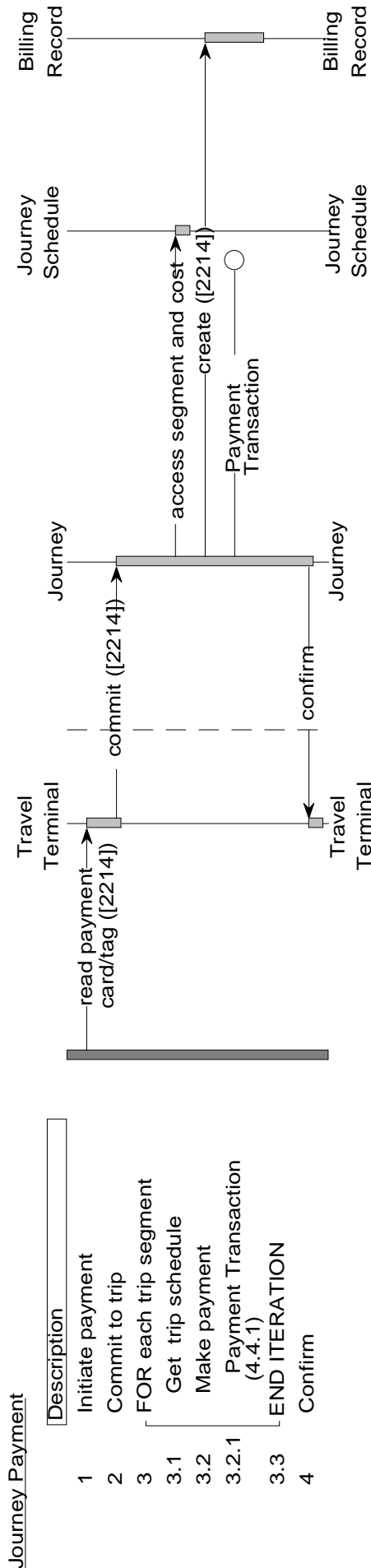
Figure 23 — Sequence diagram for Journey Payment

Journey Payment

Description	
1	Initiate payment
2	Commit to trip
3	FOR each trip segment
3.1	Get trip schedule
3.2	Make payment
3.2.1	Payment Transaction (4.4.1)
3.3	END ITERATION
4	Confirm

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On-trip Traveller Information

ID	Description
1	
1.1	Update weather and media information
1.2	Broadcast yellow pages data, weather and media data
1.3	END ITERATION
2	IF new yellow pages service
2.1	Create yellow pages data
2.2	ELSE
2.3	Update yellow pages data
2.4	END SELECTION
3	FOR each yellow pages service request
3.1	Make yellow pages request
3.1.1	Provide payment instrument
3.2	initiate transaction
3.3	Place order
3.4	Make advance payment
3.4.1	Payment Transaction (3)
3.5	Confirm request
3.6	END ITERATION
4	Revise journey (Pre-journey Information (3))
5	WHILE driving
5.1	Get route guidance (Route Guidance & Navigation (2.3))
5.2	End Iteration

Figure 24 — Sequence diagram for On-trip Traveller Information

7.2 Traffic Management

The information classes identified in 6.3 were developed to meet the message and information contexts of traffic management and information centres. Thus they are highly relevant to this clause. Therefore the elaboration in this clause produces pairs of diagrams for each use case (e.g. Figures 25 and 26). There is one sequence diagram and one class diagram, the latter showing the key classes and parameter information classes which occur in the former diagram. The class diagram partitions the classes by package. In order to avoid cluttering the class diagrams it is usual to associate a parameter information class with a key class in only one package. There is always a key class with which each information class (parameter) can be associated.

7.2.1   Traffic and Pollution Measurement and Control

The abstract operations for Traffic and Pollution Measurement and Control in ISO/TR 14813 Part 2 are provided by the Roadway Class and the Event Class. This leads to the following key classes defined in 6.1.

— Local Control Group

— Roadway Group

— Violation

The following new information classes are required:

— Movement: This information class is invented to describe a stream of traffic and to record measurements about the associated traffic flow. The stream measured might be over a particular manoeuvre, or over a more loosely specified route beginning in a specified road element and ending in a specified road element. It is associated with the Local Control Group class.

— Parking: This information class is invented to record measurements about parking operations provided by Parking actors. It is associated with the Roadway Group class.

— Pollution: This information class is invented to record and process measurements about pollution. It is associated with the Incident class.

The following new interface classes are required:

— Roadside Peripheral: This interface class is invented to interface various signs, detectors and transceivers to TICS.

— Roadside Sensor: This interface class is invented to interface various detectors and transceivers to TICS. It is a subclass of Roadside Peripheral.

— Vehicle Sensor: This interface class is invented to interface special Automatic Vehicle Identification equipment to TICS. It is a subclass of Roadside Sensor.

The sequence diagram is shown in Figure 25. The main logic is a continuing iteration whereby Traffic is measured at the primitive level by sensors and then these measurements are integrated and aggregated in stages by objects of the Local Control Group class and the Roadway Group class to develop the strategic traffic measurements. In parallel with these transactions any violation of regulations by individual vehicles is detected and acted upon.

There are some less frequent maintenance transactions performed, dealing with reference geographic data, operator data display and processing violations. These are placed outside the main loop.

Comments on some of the interactions of the sequence diagram in Figure 25 are given below.

Objects of the interface classes Roadside Sensor and Vehicle Sensor interface between sensor hardware and an object of the Local Control Group class. They invoke two operations in the Local Control Group class:

— Local Control Group**.**apply traffic regulations ([411-], [412-], [414-])

— Local Control Group**.**update sensor measurements ([411-], [412-])

In addition an operation in the Pollution class is invoked to derive the area pollution:

— Pollution**.**update pollution data ([414-])

Annex A contains documentation on each of the parameters, which can also be identified in Figures 11 to 19.
If the operation, Local Control Group**.**apply traffic regulations, determines that an infringement has occurred then the following operations are invoked:

— Violation**.**create ([411-], [412-], [414-])

— Vehicle Interface**.**warn driver ([6132])

Objects of the Local Control Group class invoke operations in an object of the Roadway Group to process measurements at the higher level:

— Roadway Group**.**integrate measurements ([41--])

— Roadway Group**.**update current data ([412-], [413-])

— Movement**.**update measurements ([412-])

The Pollution class updates its higher level measurements:

— Pollution**.**update current data ([414-])

At the end of the iteration any adjustment to the attributes of objects of the Local Control Group or Sensor class is requested:

— Local Control Group**.**update control data ([51--])

— Roadside Sensor**.**update control data (…)

— Roadside Peripheral**.**update control data (…)

The above operations are just two of numerous examples of missing parameters, with no requisite data elements in draft ISO 14827.

Traffic operators may select and display data:

— Roadway Group**.**support operator access ([4---])

The final stage is used to process any violation and notify the conformance agency:

— Violation**.**process violation ([81--])

— Operating Interface**.**report violation ([81--])

The elaboration of the classes of the Roadway and Events packages developed in the above process is summarised in Figure 26, with the key classes denoted by double rectangles. Associations already shown in diagrams in clause 5 may not be included.

7.2.2 Performance Evaluation

The abstract operations for Performance Evaluation in ISO/TR 14813 Part 2 are provided by the Roadway Class, the Transport Class and the Event Class. This leads to the following key classes defined in previous clauses.

— Roadway Group

— Parking

— O-D Route

— Incident

— Pollution

— Probe

The sequence of object interactions for the Performance Evaluation use case is shown in Figure 27. The main part is a continuing low frequency iteration whereby a wide range of performance indicators are gathered and assessed. Actions to modify the active control strategies may be taken following this analysis, and the derived performance data is stored for long term reference.

A maintenance transaction keeps the reference geographic data current.

The first part of the iteration is to gather all the relevant current data on which network performance will be assessed. Thus the transactions are dependent on those of Traffic and Pollution Measurement and Control. The relevant data associated with other key classes is retrieved by the operations:

— Incident**.**access incident data ([42--])

— Probe**.**access route travel time data ([5211])

— Pollution**.**access pollution data ([414-])

— O-D Route**.**access travel data ([63--], ([64--])

— O-D Route**.**access route data ([412-])

— Parking**.**access parking data ([713-])

The key computational operation is "analyse data" of the Roadway Group class. Note this analysis would be carried out at the individual object level (corresponding to a region analysis) and at the static (class) level (corresponding to a global analysis across regions).

The remaining operations of the loop are responsible for storing the performance statistical data for this period for long term reference:

— Roadway Group.update performance data ([94--])

— Roadway Group.update traffic control data ([51--])

— Roadway Group.update long term data ([4-], [5---], [94--])

— Incident.update long term data ([3---])

— Pollution.update long term data ([414-])

— O-D Route.update long term data ([521-])

⸺ Parking.update long term data ([713-])

The elaboration of the classes of the architecture is summarised in Figure 28, with the key classes denoted by double rectangles.

7.2.3   Performance Prediction

The abstract operations for Performance Evaluation in ISO/TR 14813 Part 2 are provided by the Roadway Class, the Transport Class and the Event Class. This leads to the following key classes defined in previous clauses.

⸺ Roadway Group

⸺ O-D Route

⸺ Incident

The sequence of object interactions for the use case is shown in Figure 29. The iteration uses the Performance Evaluation transactions.

Preceding the main computation the incident data is retrieved and the performance data exchanged between Roadway Group objects:

⸺ Incident**.**access predicted incidents ([5213], [5214])

⸺ RoadwayGroup**.**exchange data ([51--], [521-])

The key computational operation is:

⸺ Roadway Group**.**predict network performance ([522-])

Note this analysis would be carried out at the individual object level (corresponding to a region analysis) and at the static (class) level (corresponding to a global analysis across regions).

The remaining operations of the loop are responsible for distributing the prediction data:

⸺ O-D Route**.**update prediction data ([522-])

⸺ Roadway Group**.**exchange predictions ([522-])

The elaboration of the classes of the architecture in the above process is summarised in Figure 30, with the key classes denoted by double rectangles.

7.2.4   Traffic Control

The abstract operations for Traffic Control in ISO/TR 14813 Part 2 are provided by the Roadway Class. This leads to the following key classes defined in previous clauses.

⸺ Roadway Group

⸺ Local Control Group

⸺ Incident

⸺ Parking

The following new information class is required:

— Control Plan: This information class is invented to maintain the traffic control strategy and operational parameters which can be implemented over the roadway network contained by one or more Roadway Groups. It is associated with the Roadway Group control class.

The following new interface class is required:

— Special Vehicle Interface: This information class is invented to interface special vehicle drivers to TICS.

The sequence of object interactions for the Traffic Control use case is shown in Figure 31. Information is provided to Operators.

— Operating Interface**.**operator data output ([41--])

Traffic Operators can override control assynchronously:

— Roadway Group**.**update control strategy ([51--])

The main part of the sequence is a continuing low frequency iteration with an inner higher frequency iteration. The sequence depends on the transactions of Performance Evaluation and Performance Prediction. The low frequency transactions then support changes to the current control strategy:

— Control Plan**.**compute plan ([3---], [4---], [51--])

— Roadway Group**.**update incident strategy ([51--])

— Local Control Group**.**update control data ([51--])

— Parking**.**update control data (...)

— Operating Interface**.**operator data output (...)

The control loop may invoke the transactions of Infrastructure Maintenance Management to perform infrastructure changes.

Conformant or autonomous control transactions use the operation:

— Local Control Group**.** generate control parameters for peripherals (...)

High frequency control transactions involving the Roadside Peripherals are based on the operations:

— Local Control Group**.**request priority ([211-])

— Local Control Group**.**update rail traffic data (…)

— Roadside Peripheral**.**update control data (...)

— Operating Interface**.**notify rail (…)

The elaboration of the classes of the architecture in the above process is summarised in Figure 32, with the key classes denoted by double rectangles.

7.2.5   Incident Management

The abstract operations for Incident Management in ISO/TR 14813 Part 2 are provided by the Roadway Class and the Event Class. This leads to the following key classes defined in previous clauses.

— Roadway Group

— Incident

— Pollution

— Emergency

The following new control class is required

— Commercial Vehicle Tour: This control class is invented to maintain and execute the plan for a commercial vehicle tour.

The following new information class is required

— Incident Response: This information class is invented to maintain response plans to be used in incident management.

The sequence of object interactions for the Incident Management use case is shown in Figure 33. Operators asynchronously develop the Incident Response plans:

— Incident Response**.**create ([531-], [9614])

The next part is a regular iteration beginning with the transactions of Traffic and Pollution Measurement and Control. Then the other sources of information provide additional data using the generic operation:

— Roadway Group**.**update incident data ([2240], [414-], [44--], [3---], [532-], [542-])

Once all incident data has been gathered it is analysed:

— Roadway Group**.**data fusion (...)

If this analysis and reasoning requires action, the following transactions apply:

— Incident**.**create ([2240], [3---], [44--], [532-], [54--])

— Incident Response**.**match incident ([2240], [3---], [44--], [53--])

— Incident**.**update response data ([531-])

Then the Traffic Control cycle is exercised to put the response into effect. If other responses are required an Emergency object is created:

— Emergency**.**create([44--])

Finally any traffic control recommendations are sent to strategic peers:

— Roadway Group**.**exchange data ([51--])

The elaboration of the classes of the architecture in the above process is summarised in Figure 34, with the key classes denoted by double rectangles.

7.2.6   Demand Management

The abstract operations for Demand Management in ISO/TR 14813 Part 2 are provided by the Roadway Class, the Transport Class and the Payment Class. This leads to the following key classes defined in previous clauses.

— Roadway Group

— O-D Route

— Parking

— Public Transport Schedule

— Tariff

The following new information class is required

— Demand Plan: This information class is invented to maintain the demand management strategy and parameters which can be implemented over the roadway network contained by one or more Roadway Groups. It is associated with the Roadway Group control class.

The sequence of object interactions for the Demand Management use case is shown in Figure 35. The operator maintains the demand response component of control plans by asynchronous interactions.

— Demand Plan.update demand policy data(…)

The main management transactions are executed periodically. This is based on the Performance Prediction transactions and recent traffic messages:

— O-D Route.access travel data ([61--])

— Roadway Group.predict demand (…)

This is followed by transactions which determine the action to be taken including Operator overrides.

— Demand Plan.compute plan([3---], [4---], [52--], [61--], [7---])

— Roadway Group.update demand strategy(…)

Transactions which might be executed subsequently are:

— Parking.request to cater to demand(...)

— Operating Interface.operator data output (...)

— Tarrif.request to cater to demand(...)

— Operating Interface.operator data output (...)

— Public Transport Schedule.request service change(...)

— Operating Interface.operator data output (...)

The parameters for the operations are not addressed in ISO 14827.

The elaboration of the classes of the architecture in the above process is summarised in Figure 36, with the key classes denoted by double rectangles.

7.2.7 Transport Planning Support

The abstract operations for Transportation Planning Support in ISO/TR 14813 Part 2 are provided by the Roadway Class, the Transport Class, and the Event Class. This leads to the following key classes defined in previous clauses.

— Roadway Group

— Parking

— Control Plan

— Probe

— O-D Route

— Public Transport Schedule

— Commercial Vehicle Tour

— Incident Response

— Pollution

The following new information classes are required

— Emergency Vehicle: This class is invented to maintain information about those vehicles used in emergency operations

— Commercial Vehicle: This class is invented to maintain information about those vehicles used in commercial operations

The sequence of object interactions for the Transport Planning Support use case is shown in Figure 37. A planning session is typically based on Performance Evaluation. Then current and historical data relevant to the particular planning task is accessed:

— Emergency Vehicle**.**access fleet operational data (...)

— Commercial Vehicle Tour**.**access fleet operational data ([73--])

— Probe**.**access route travel time data ([52--])

— Parking**.**access parking data ([713-])

— Pollution**.**access pollution data ([414-])

— Public Transport Schedule**.**access public transport operational data ([222-], [72--])

— O-D Route**.**access travel data ([62--])

— O-D Route**.**access route data ([41--])

The key computational operation is "decision support" of the Roadway Group class. Note this analysis would be carried out at the individual object level (corresponding to a region analysis) and at the static (class) level (corresponding to a global analysis across regions).

The remaining operations of the loop are responsible for making any new strategy:

— Control Plan**.**create ([51--])

— Demand Plan**.**create (…)

— Incident Response**.**create ([531-])

The elaboration of the classes of the architecture in the above process is summarised in Figure 38, with the key classes denoted by double rectangles.

7.2.8   Infrastructure Maintenance and Management

The abstract operations for Infrastructure Maintenance and Management in ISO/TR 14813 Part 2 are provided by the Roadway Class and the Event Class. This leads to the following key classes defined in previous clauses.

— Roadway Group

— Incident

The sequence of object interactions for the Infrastructure Maintenance and Management use case is shown in Figure 39.

A transaction involves the development of the maintenance plan based on network geographic data held in map information classes associated with the Roadway Group. Future or immediate incidents are notified. Operators are instructed on actions required:

— Roadway Group**.**schedule maintenance ([3---])

— Incident**.**create ([3---])

— Operating Interface**.**instruct operator(…)

The elaboration of the classes of the architecture in the above process is summarised in Figure 40, with the key classes denoted by double rectangles.

7.2.9   Package Classes for Traffic Management

This clause summarises the architecture elaboration for Traffic Management at the package level. The class diagrams in this sub-clause bring together all the operations and information class associations identified in 7.2 for each package. The operations listed for each key class are required in one or more Traffic Management use case. Similarly the information classes occur in object interactions involving classes of the particular package. The generalised class is used to imply any sub-class of that class in order to avoid clutter.

Only three packages have a significant role in Traffic Management:

— Roadway (Figure 41)

— Events (Figure 42)

— Transport (Figure 43)

Note the Vehicles package is about vehicle operation and safety.

Again it should be noted that the package architectures in Figures 41 to 43 are incomplete for several reasons.

— The elaboration is based on only one of the eight use case diagrams

— Information classes (and parameters) are restricted to those defined in draft ISO 14827.

Furthermore there are information dependencies which span other use case. For example, the Probe key class has no operation to generate objects in the information class [52—] travelTime. The Vehicle Charges use cases would give rise to such operations. For this reason the Resource key class does not appear in Figure 41.

Figure 25 — Sequence diagram for Traffic and Pollution Measurement and Control

Traffic & Pollution Measurement & Control

	Description
1	Update map data
1.1	...
2	D
2.1	Update parking status
2.2	Vehicles, pedestrians, etc. activate sensors
2.3	Unusual vehicle movement
2.4	Send individual vehicle data
2.4.1	IF regulation violated
2.4.1.1	Record violation
2.4.1.1.1	Notify driver
2.4.1.2	End Selection
2.5	Sensors send primitive traffic measurements
2.6	Pollution Measurements
2.7	IF end of control period
2.7.1	Integrate measurements over sensors, time and space
...	Update aggregate data
2.7.1.1	...
2.7.1.1.1	Update aggregate pollution data
2.7.1.1.2	Update control parameters
2.7.2	Update sign & sensor parameters
2.7.2.1	...
2.7.2.2	END SELECTION
2.8	END ITERATION
3	Display data
4	Process violations
4.1	Report to conformance agency

Figure 26 — Packages, control and information classes for Traffic and Pollution and Measurement and Control

Performance Evaluation

	Description
1	Update map data
2	FOR each control period
2.1	Update current data
2.2	Get roadway network data
2.3	Get network data
2.4	Get network data
2.5	Get network data
2.6	...
2.7	...
2.8	Analyse current data wrt long term data and other network data
2.9	Evaluate control and incidents
2.10	Update traffic control data
2.11	Update historical data
2.11.1	Update historical data
2.11.2	...
2.11.3	...
2.11.4	...
2.12	END ITERATION

Figure 27 — Sequence diagram for Performance Evaluation

Roadway

[132-] roadComponent

[131-] travelledWay

[4----] trafficUsage

Roadway Group
___
analyse data
update long term data
update map data
update performance data
update traffic control data

[5---] trafficManagement

[94--] performanceMonitor

[713-] parkingSupply

[5211] currentTravelTime

Parking
___
access parking data
update long term data

Probe
___
access route travel time data

Transport

[521-] influencingFactors

[412-] trafficFlow

O-D Route
___
access route data
access travel data
update long term data

[64--] ptJourney

[63--] privateJourney

Events

Incident
___
access incident data
update long term data

[42--] trafficDelays

[3---] effectsOnOperations

Pollution
___
access pollution data
update long term data

[414-] pollution

Figure 28 — Packages, control and information classes for Performance Evaluation

Performance Prediction

	Description
1	FOR each control period
1.1	Update current data
1.2	Get incident data
1.3	Exchange data
1.4	Predict network performance
1.5	Update prediction data
1.6	Exchange predictions
1.7	END ITERATION

O-D Route   Roadway Group   Incident

Performance Evaluation

access predicted incidents ([5213], [5214])

exchange data ([51--], [521-])

predict network performance ([522-])

update prediction data ([5225])

exchange predictions ([522-])
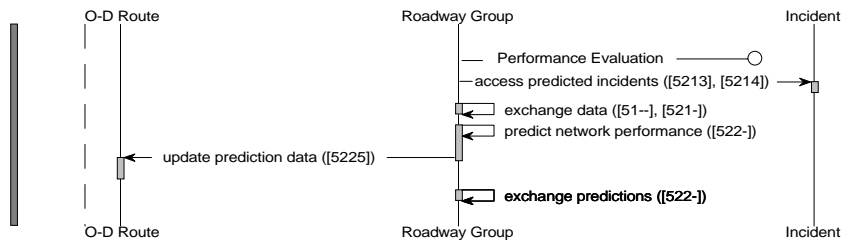
Figure 29 — Sequence diagram for Performance Prediction

Roadway

Roadway Group

exchange data
exchange predictions
predict network performance

[51--] trafficControl

[52--] travelTime

Events

Incident

access predicted incidents

[5214] supplyChanges

[5213] demandChanges

Transport

O-D Route

update prediction data

[5225] routeTimes
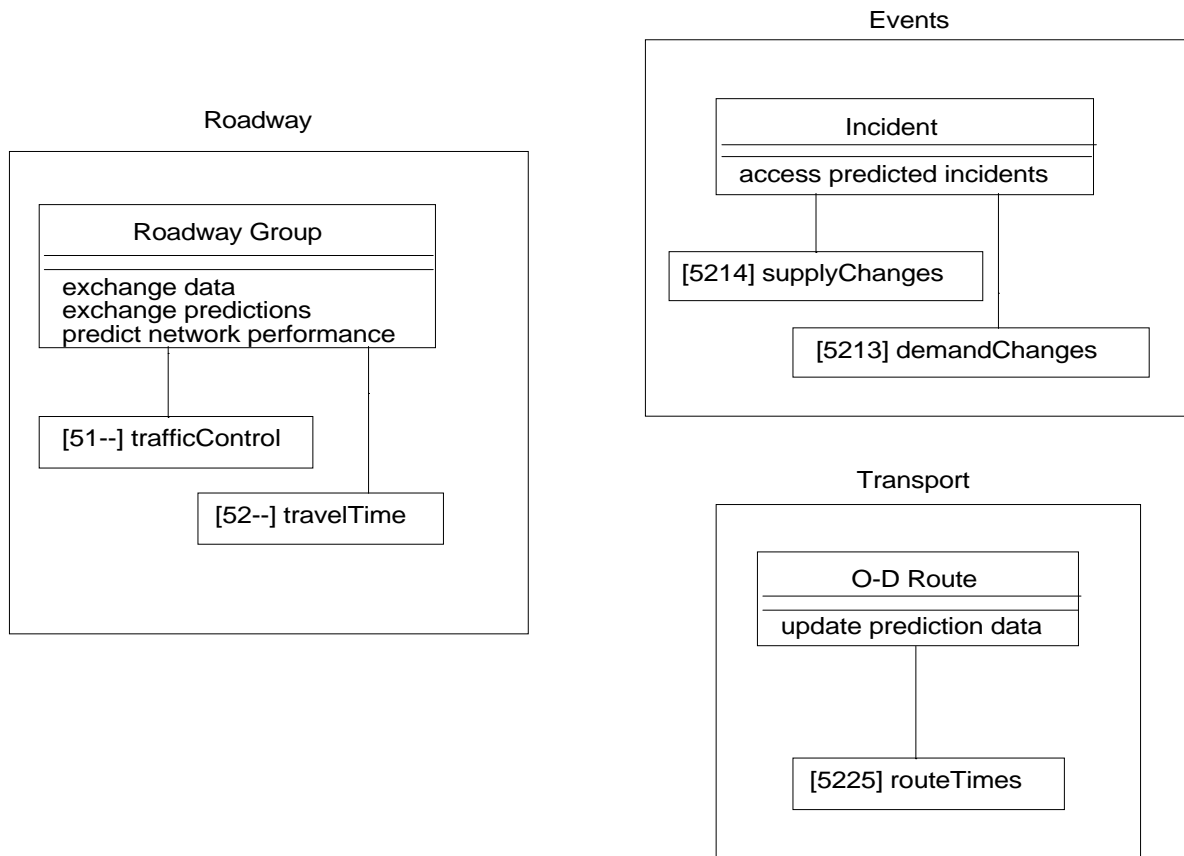
Figure 30 — Packages, control and information classes for Performance Prediction
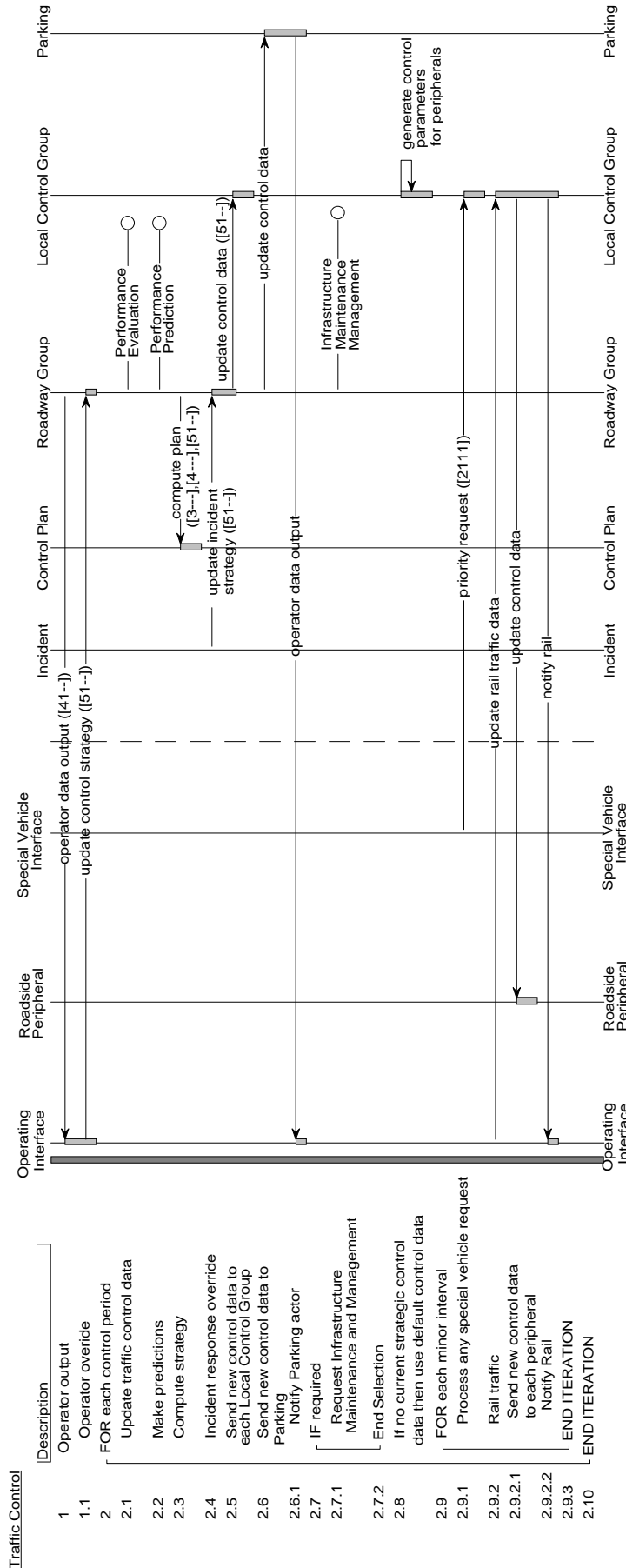
Figure 31 —Sequence diagram for Traffic Control

Traffic Control

	Description
1	Operator output
1.1	Operator overide
2	FOR each control period
2.1	Update traffic control data
2.2	Make predictions
2.3	Compute strategy
2.4	Incident response override
2.5	Send new control data to each Local Control Group
2.6	Send new control data to Parking
2.6.1	Notify Parking actor
2.7	IF required
2.7.1	Request Infrastructure Maintenance and Management
2.7.2	End Selection
2.8	If no current strategic control data then use default control data
2.9	FOR each minor interval
2.9.1	Process any special vehicle request
2.9.2	Rail traffic
2.9.2.1	Send new control data to each peripheral
2.9.2.2	Notify Rail
2.9.3	END ITERATION
2.10	END ITERATION

Lifelines: Operating Interface, Roadside Peripheral, Special Vehicle Interface, Incident, Control Plan, Roadway Group, Local Control Group, Parking

Messages: operator data output ([41--]); update control strategy ([51--]); compute plan ([3--],[4--],[51--]); update incident strategy ([51--]); update control data ([51--]); Performance Evaluation; Performance Prediction; update control data; operator data output; Infrastructure Maintenance Management; generate control parameters for peripherals; update rail traffic data; priority request ([2111]); update control data; notify rail

Figure 32 — Packages, control and information classes for Traffic Control

Incident Management

	Description
1	Develop incident responses
2	DO
2.1	Integrate measurements over sensors, time and space
2.2	Incident reports and information from actors
2.3	…
2.4	Emergency notification
2.5	Hazard Notification
2.6	Analyse and reason over all available data
2.7	END ITERATION
3	If analysis and reasoning suggests likely incident
3.1	Create incident identified by the data fusion process
3.2	Select response
3.3	Operator provides specific response
3.4	Revise traffic control
3.5	Infrastructure Maintenance and Management Control traffic
3.6	IF new incident
3.7	Incident alert
3.7.1	
3.7.2	END SELECTION
3.8	Send data to Strategic Peers
3.9	End Selection

Figure 33 — Sequence diagram for Incident management
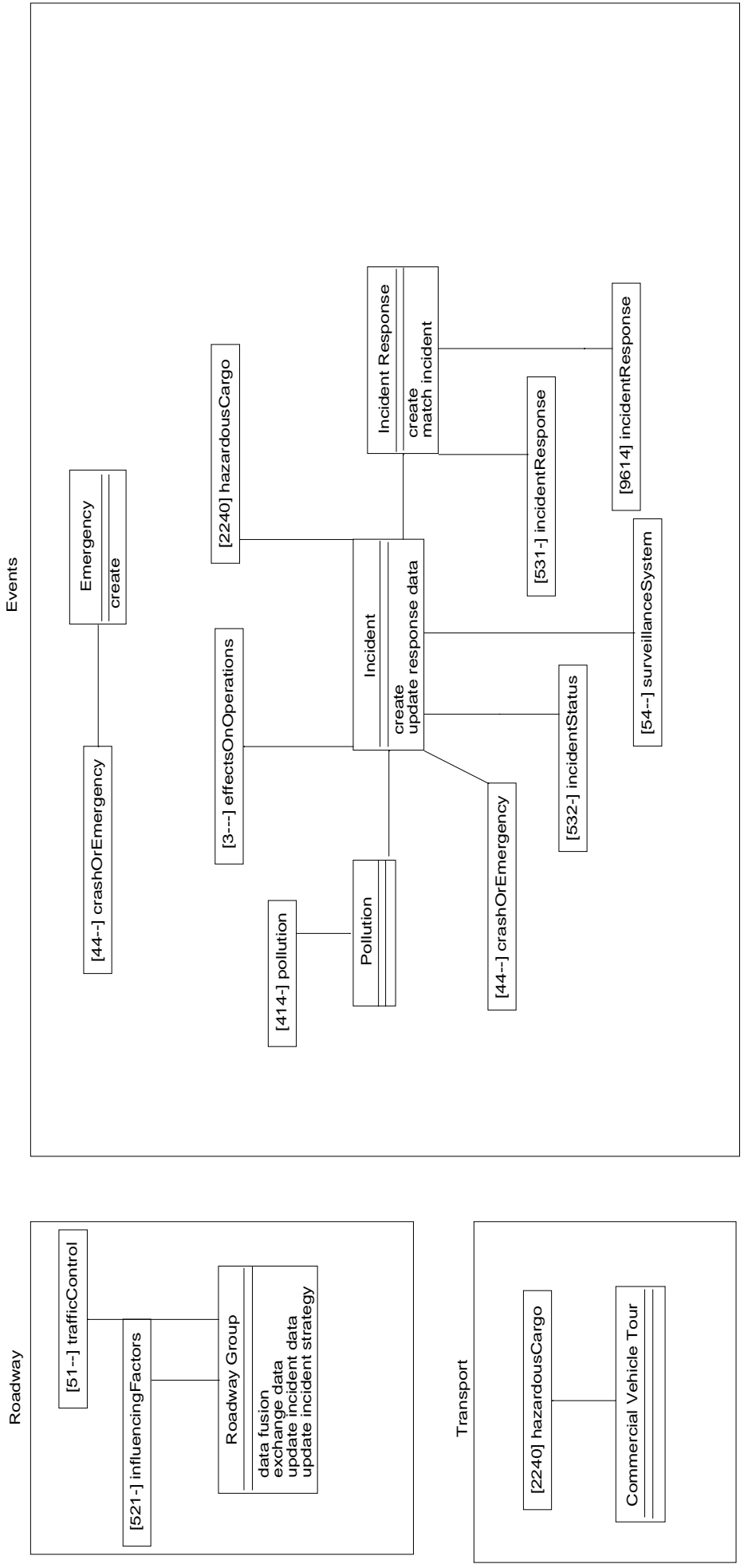
Figure 34 — Packages, control and information classes for Incident Management

Demand Management

	Description
1	Planner inputs any new demand policy
2	FOR each period
2.1	Get network data
2.2	Make predictions
2.3	Use current data and prediction data to forecast demand
2.4	Compute strategy
2.5	Operator overrides for demand control
2.6	Recommend changes to parking
2.6.1	...
2.7	Recommend changes to toll
2.7.1	...
2.8	Recommend changes to public transport
2.8.1	...
2.9	END ITERATION

Figure 35 — Sequence diagram for Demand Management

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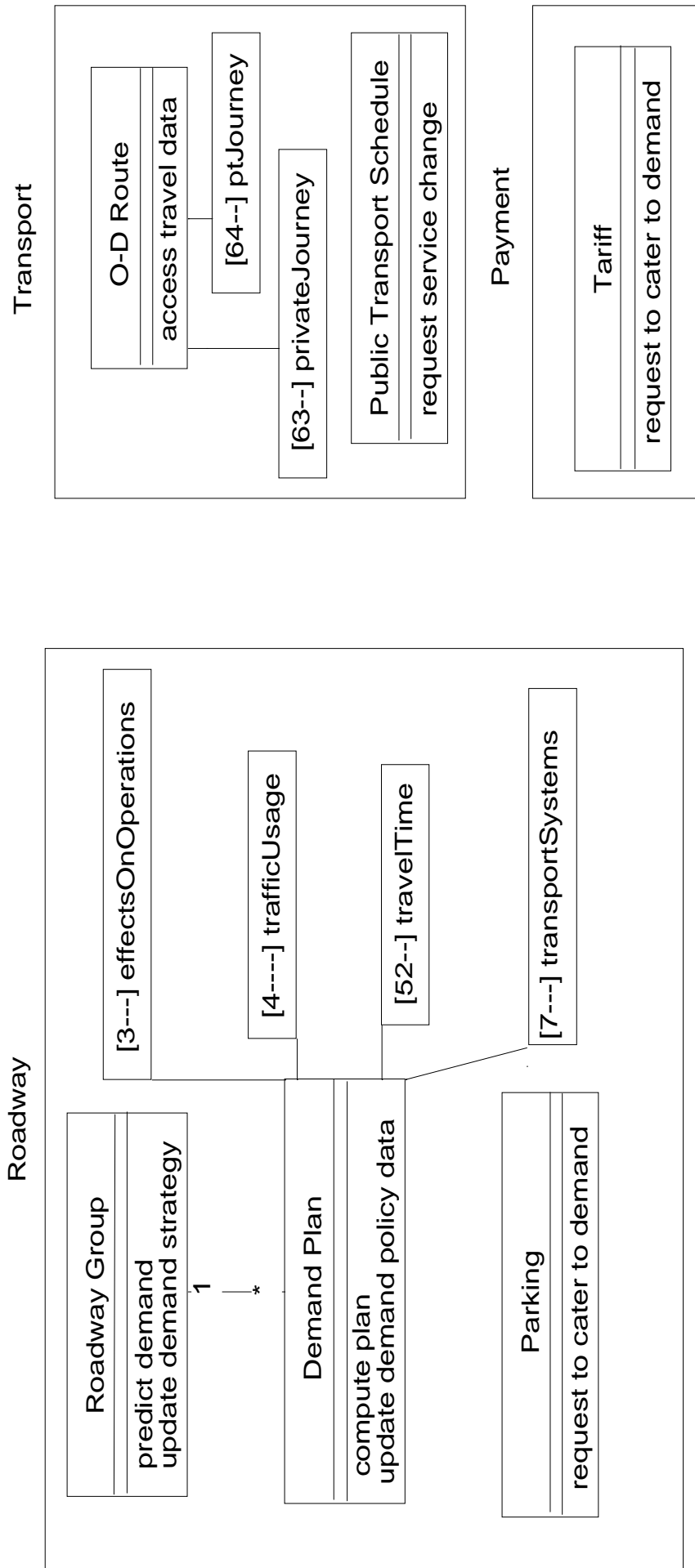
Figure 36 — Packages, control and information classes for Demand Management
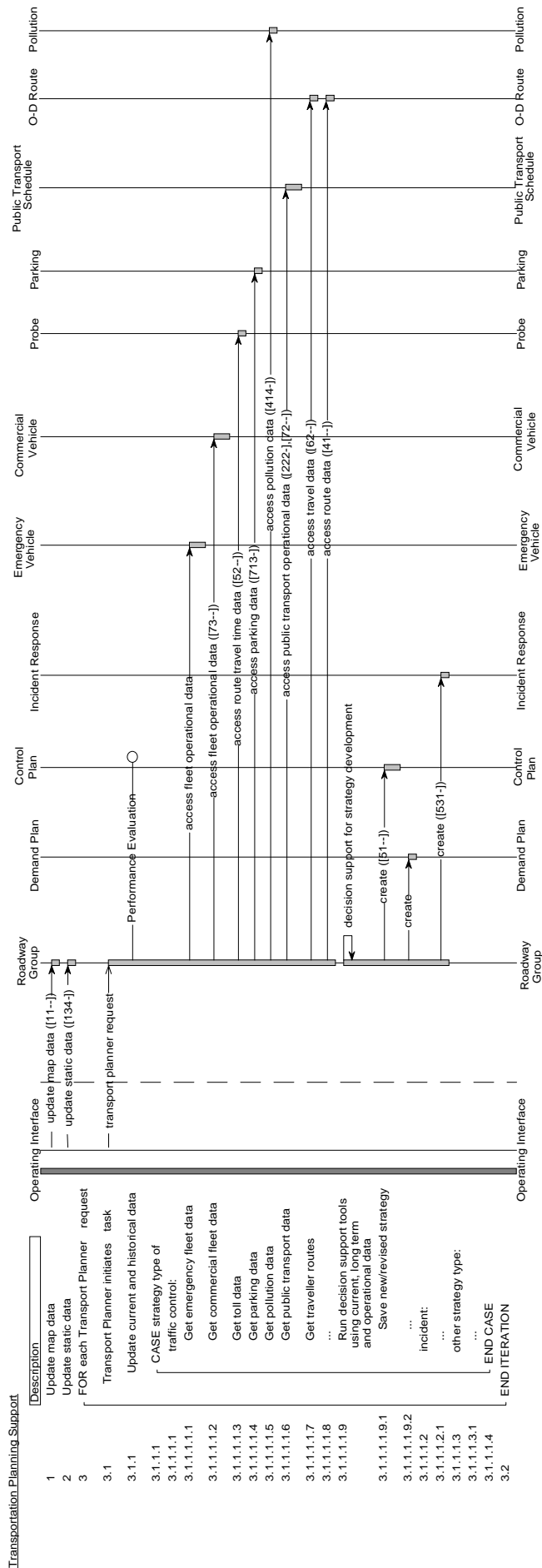
Figure 37 — Sequence diagram for Transportation Planning Support
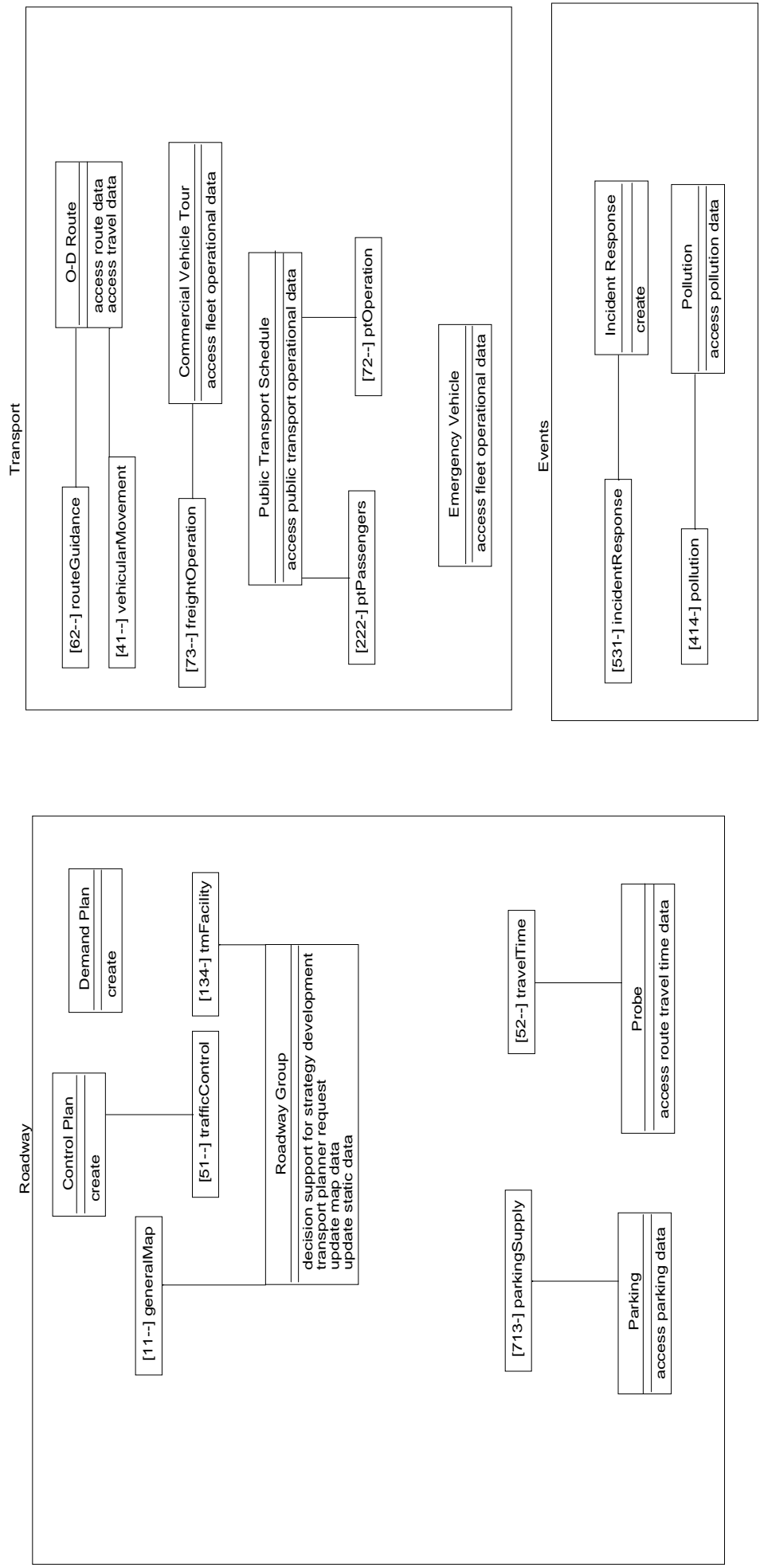
Figure 38 — Packages, control and information classes for Transportation Planning Support

Infrastructure Maintenance Management

Description		Operating Interface	Roadway Group	Incident
1	Do as required			
1.1	Schedule maintenance			
1.1.1	establish incident			
1.2	Instruct operators			
1.3	End Iteration			
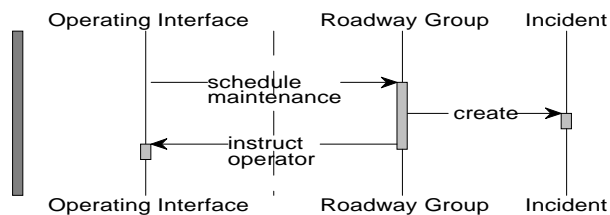
Figure 39 — Sequence diagram for Infrastructure Maintenance Management

Roadway

Roadway Group
schedule maintenance

1

*

[3---] effectsOnOperations

Events

Incident
create
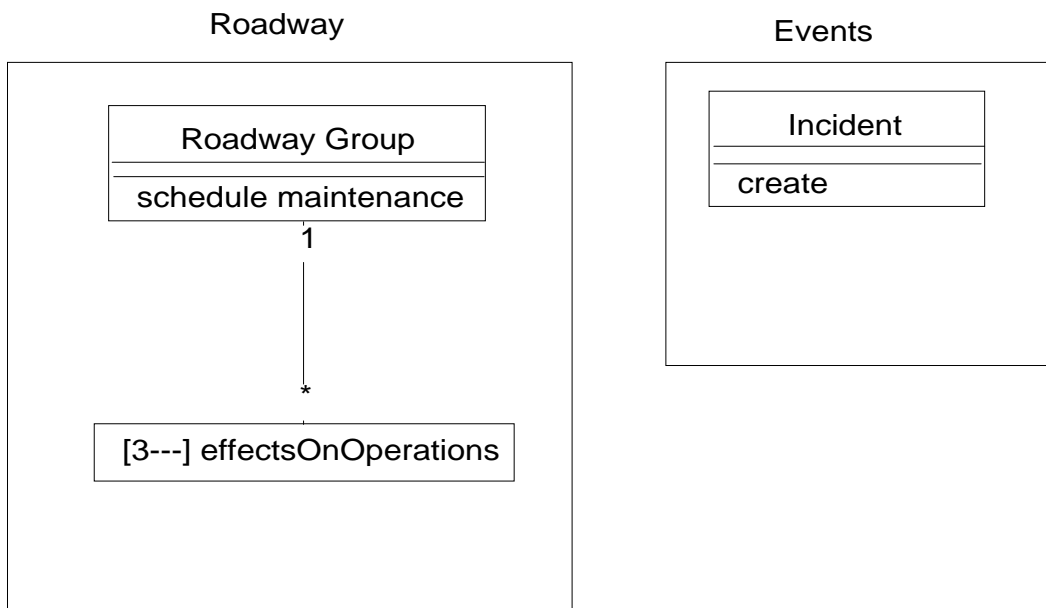
Figure 40 — Packages, control and information classes for Infrastructure Maintenance and Management
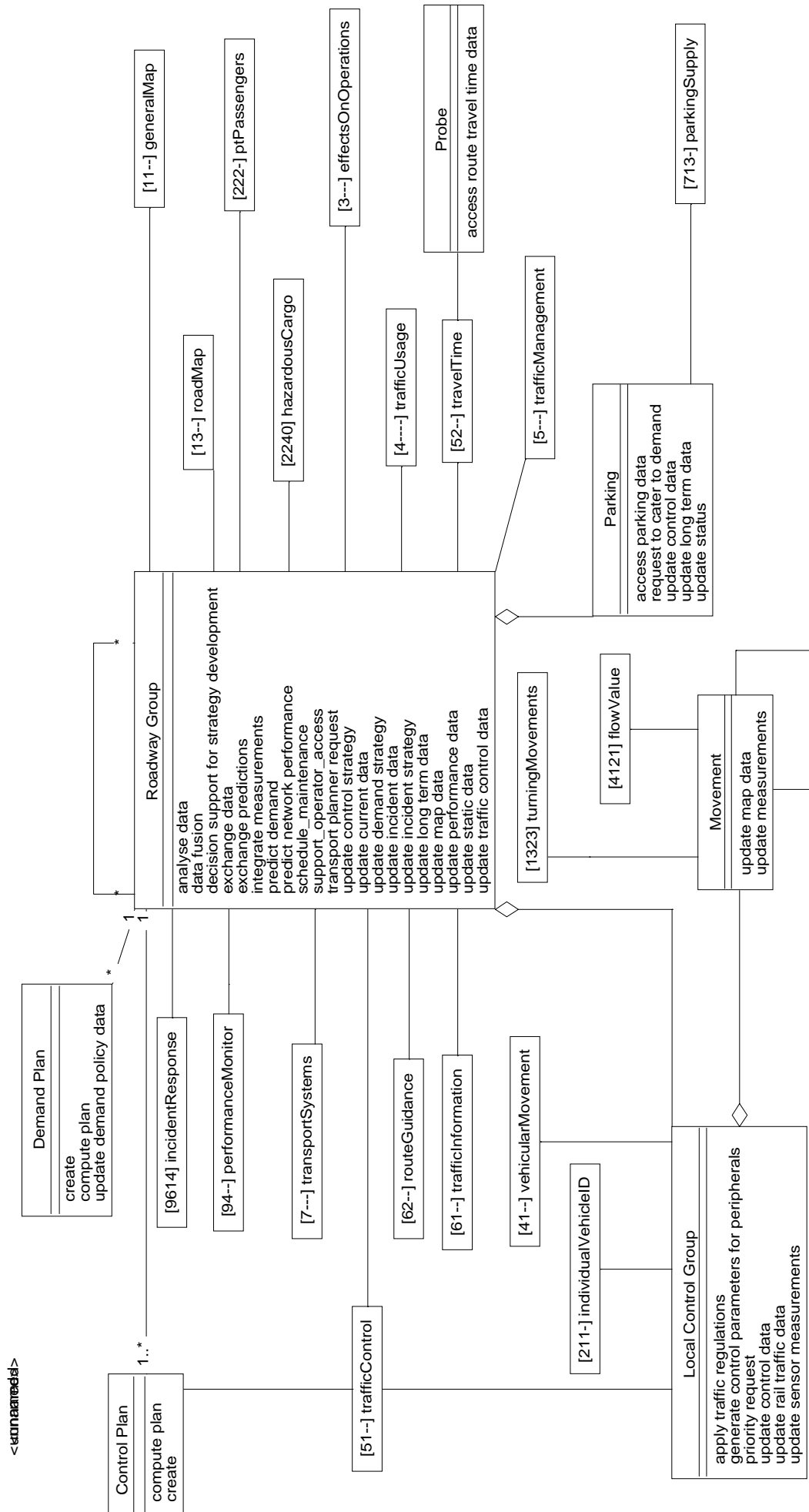
Figure 41 — Roadway package class operations and information class associations for Traffic Management
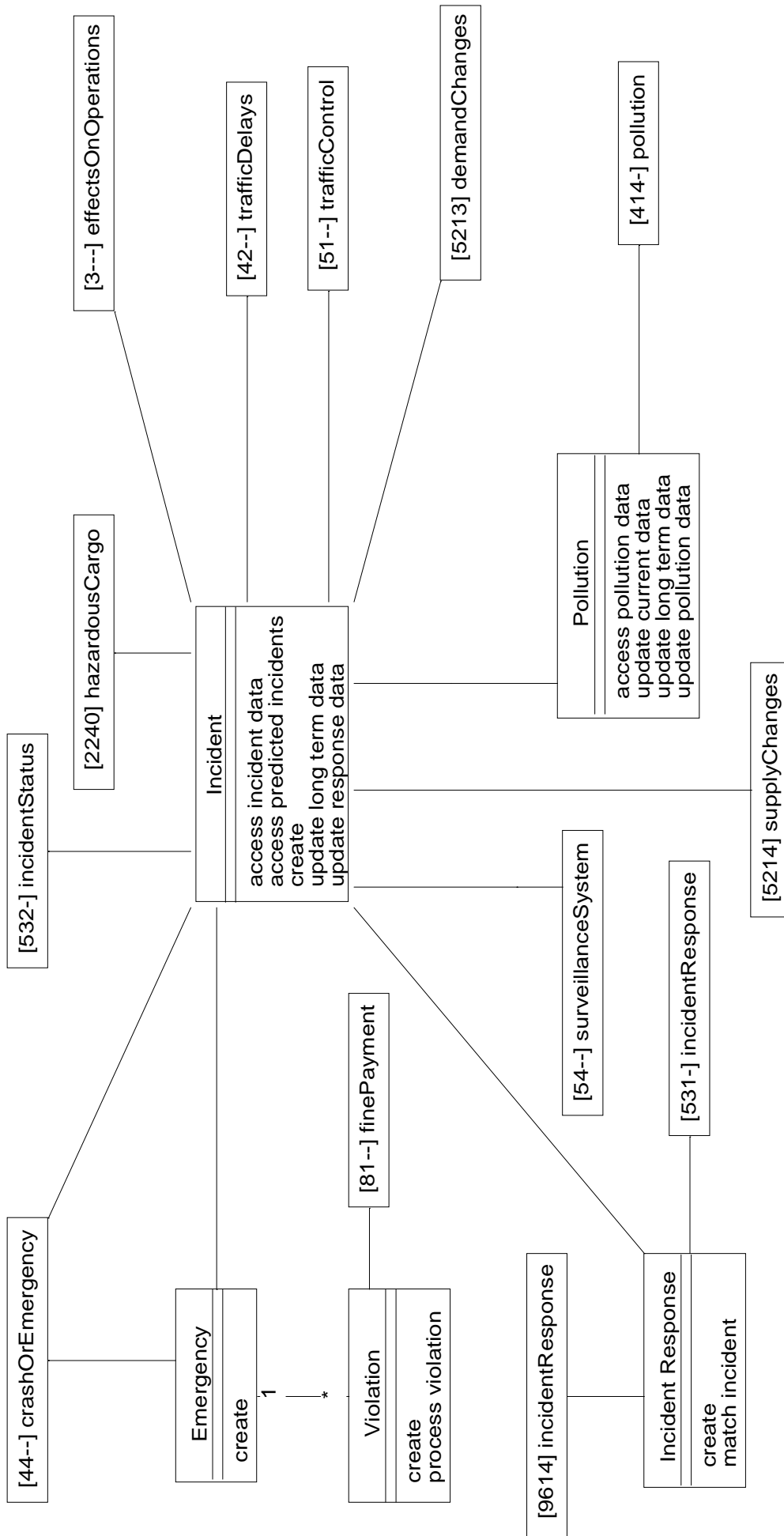
Figure 42 — Events package class operations and information class associations for Traffic Management

```
                                    ┌─────────────────────────────┐
                                    │          O-D Route          │
                                    ├─────────────────────────────┤        ┌──────────────────────┐
┌──────────────────────┐           │  access route data          │────────│ [63--] privateJourney │
│  [412-] trafficFlow   │───────────│  access travel data          │        └──────────────────────┘
└──────────────────────┘           │  update long term data       │        ┌──────────────────────┐
                                    │  update prediction data      │────────│  [64--] ptJourney     │
                                    └─────────────────────────────┘        └──────────────────────┘

      ┌──────────────────────┐    ┌──────────────────────────┐    ┌──────────────────────────┐
      │  [5225] routeTimes    │   │ [521-] influencingFactors │    │ [61--] trafficInformation │
      └──────────────────────┘    └──────────────────────────┘    └──────────────────────────┘
```

Public Transport Schedule

access public transport operational data
request service change

[222-] ptPassengers

[72--] ptOperation

Commercial Vehicle Tour

access fleet operational data

[2240] hazardousCargo

[73--] freightOperation

Emergency Vehicle

access fleet operational data

Figure 43 — Transport package class operations and information class associations for Traffic Management

7.3 Vehicle

7.3.1 Vehicle Status

The abstract operations for Vehicle Status in ISO/TR 14813 Part 2 are provided by the Vehicle Class, the Roadway Class and the Event Class. This leads to the following key classes defined in previous clauses.

— Vehicle

— Emergency

— Local Control Group

The following new interface class is required

— In-Vehicle Sensor: This interface class is invented to interface various types of sensors which are used on-board a vehicle.

The sequence diagram for one iteration is shown in Figure 44. The first stage monitors status from the vehicle:

— Vehicle**.**monitor driver (…)

— Vehicle**.**monitor vehicle operation (…)

— Vehicle**.**monitor roadway environment (…)

— Vehicle**.**monitor inter-vehicle dynamics (…)

The next stage collects data from the roadway system:

— Local Control Group**.**access collision avoidance data (…)

The next stage conducts the safety analysis and alerts the driver if necessary:

— Vehicle**.**analyse safety (…)

— Vehicle Interface**.**alert driver (…)

The final stage conducts the automated responses for collision avoidance:

— Vehicle**.**override default control mode (…)

— Vehicle Interface**.**get location (…)

— Emergency**.**create (…)

7.3.2 Vehicle Operation

The abstract operations for Vehicle Operation in ISO/TR 14813 Part 2 are provided by the Vehicle Class.

The sequence diagram is shown in Figure 45. The Driver's mode request results in the selection of one of the following macro operations:

— Vehicle.operate in manual mode (…)

— Vehicle**.**control vehicle actuators (…)

— Vehicle**.**control vehicle on automated highway (…)

Vehicle Status

	Description
1	Monitor status
2	"
3	"
4	"
5	Get external collision avoidance data
6	Analyse safety
7	IF necessary
7.1	Advise driver
7.2	END SELECTION
8	Analyse dynamics and context
9	IF necessary
9.1	Execute automatic control for emergency
9.2	END SELECTION
10	IF necessary
10.1	Get location
10.2	Request emergency assistance
10.3	END SELECTION
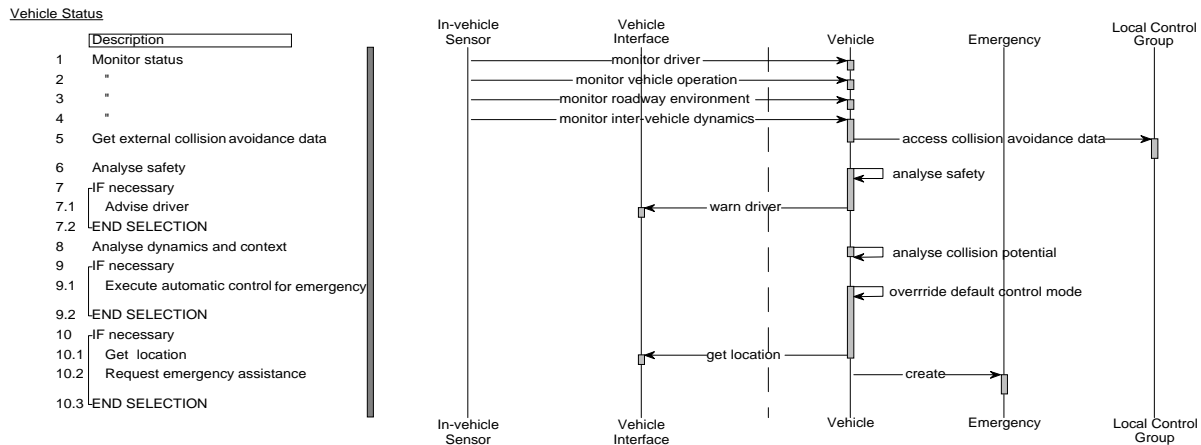
Figure 44 — Sequence diagram for Vehicle Status

Vehicle Operation

	Description
1	Request vehicle operational mode
2	CASE control mode of
2.1	Manual control:
2.1.1	Operate with manual control as default
2.2	Automatic vehicle control:
2.2.1	Operate uner automatic control with manual override
2.3	Automated highway:
2.3.1	Operate under automated highway protocol
3	END CASE
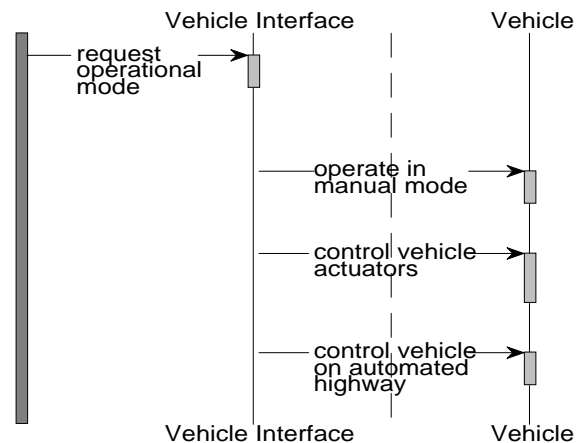
Figure 45 — Sequence diagram for Vehicle Operation

7.4 Commercial Vehicle

7.4.1 Order and Shipment

The abstract operations for Order and Shipment in ISO/TR 14813 Part 2 are provided by the Transport Class. This leads to the following key classes defined in previous clauses.

— Forwarder

— Journey

— Trip

The following new control and information class is required

— Goods Item: This class is invented to record journey planning and control the tracing of freight items.

The sequence diagram for the elements freight shipment is shown in Figure 46. The first transaction supports the selection of a forwarder from a TICS database:

— Forwarder.select forwarder(…)

The main logic is designed to support the tracing of freight. This begins with the creation of an Goods Item object:

— Goods Item.create (…)

The journey details (which have been arranged externally) are then entered into the TICS database:

— Journey.create (…)

— Journey.insert goods([223-])

Trip details are entered:

— Trip.create (…)

involving interaction with the Carrier actor

— Operating Interface.freight booking (…)

and inserting the trip details in the journey.

— Journey.insert trip(…)

As the freight movement progresses the trips are logged:

— Trip.log trip (…)

This permits the tracing of freight:

— Goods Item.trace([223-])

7.4.2 Commercial Vehicle Tour Planning

The abstract operations for Commercial Vehicle Tour Planning in ISO/TR 14813 Part 2 are provided by the Transport Class. This leads to the following key classes defined in previous clauses.

— Goods Item

— Journey

— Trip

The sequence diagram for one journey planning exercise is shown in Figure 47.The following new control and information class is required

— Freight Complement: This class is invented to register goods items in optimised cargo complements for commercial vehicles.

The first stage consists of registering goods items:

— Goods Item.log arrival ([2230])

The main stage is to arrange freight complements for tours by iterating over all goods items awaiting shipment:

— Goods Item**.**iterate over goods items ([2230])

— accessing the next trip for each goods item

— Goods Item**.**iterate over trips ([2230])

— Trip**.**access current trip ([2230])

— establishing a new tour if necessary

— Freight Complement**.**create (…)

— Journey**.**create (…)

— and building up the freight complement and journey list:

— Journey**.**insert trip (…)

— Freight Complement**.**update (…)

— Trip.update trip data (…)

The remainder of this sequence is accomplished for each freight complement by the transactions of Route Guidance and Navigation (see Figure 21 at line 2.1), followed by transactions of Commercial Vehicle Administrative Processes (7.4.3):

7.4.3   Commercial Vehicle Administrative Processes

The abstract operations for Commercial Vehicle Administrative Processes ISO/TR 14813 Part 2 are provided by the Transport Class and the Payment Class. This leads to the following key classes defined in previous clauses.

— Commercial Vehicle

— Carrier

— Journey

— Journey Schedule

The following new control and information classes are required

— Commercial Vehicle Driver: An information class used to maintain data about commercial drivers.

— Commercial Vehicle Tour: This class is invented to control journey planning and execution for commercial vehicles. It is a specialisation of Journey.

— Tax or Fee: An information class which maintains the various charges which are incurred for use of Roadway Resources.

The sequence diagram for one commercial vehicle tour administrative exercise is shown in Figure 48. The first stage is for clearance:

— Commercial Vehicle Tour**.**add driver and carrier ([221-])

— Carrier**.**clear carrier (…)

— Commercial Vehicle**.**clear vehicle ([2111])

— Commercial Vehicle Driver**.**clear driver ([221-])

followed by the conformance agency checks:

— Operating Interface**.**conformance agency check (…)

The second stage is for pre-payment:

— Commercial Vehicle Tour**.**update credit identity ([2214])

— Journey**.**iterate over trips (…)

— Tax or Fee**.**access segment charges (…)

— Journey Schedule**.**update time confirmation and price (…)

followed by the transactions of Journey Payment.

7.4.4   Commercial Vehicle Road Operation

The abstract operations for Commercial Vehicle Road Operation in ISO/TR 14813 Part 2 are provided by the Transport Class, the Roadway Class and the Event Class. This leads to the following key classes defined in previous clauses.

— Resource

— Commercial Vehicle Tour

— Commercial Vehicle

— Violation

The sequence diagram for the different stages of vehicle operation during a commercial vehicle tour is shown in Figure 49. The first stage is to initialise the vehicle interface from data already associated with an object of the Commercial Vehicle Tour class:

— Commercial Vehicle Tour**.**initiate vehicle interface (…)

The next stage comprises the iteration which monitors the state of the vehicle and its cargo:

— In-vehicle sensor**.**monitor vehicle and cargo ([214-])

— Commercial Vehicle Tour**.**update vehicle and cargo data (…)

The next stage comprises the iteration which allows the Carrier Operator to instruct the driver:

— Commercial Vehicle Tour**.**interrogate on-board data([214-])

— Commercial Vehicle Tour**.**update driver instructions([6620])

— Special Vehicle Interface**.**driver action request ([6620])

The next stage is about route guidance and other information using On-trip Traveller Information (Figure 24 line 3).

The next stage is the iteration repeated for each resource usage:

— Resource**.**recognise vehicle([41--])

— Commercial Vehicle**.**classify vehicle([41-])

— Resource**.**clear vehicle([211-])

— Special Vehicle Interface**.**interrogate on-board data (…)

— Commercial Vehicle Tour**.**access trip data (…)

— Commercial Vehicle Tour**.**command vehicle ([612-])

— Special Vehicle Interface**.**request driver action ([612-])

— Violation.create {[412-])

— Commercial Vehicle Tour**.**log trip segment (…)

The final stage is used to process any violation and notify the conformance agency:

— Violation.process violation ([811-])

— Operating Interface**.**report violation (([811-])

Figure 46 — Sequence diagram for Order and Shipment

Order and Shipment

	Description
1	Select Forwarder
2	Place shipment order (external transaction between Consignor and Forwarder)
2.1	Forwarder creates goodsshipment record
2.1.1	Create journey
2.1.2	Associate goods and journey
2.1.2.1	For each trip in journey
2.1.2.1.1	Trip details and documentation
2.1.2.1.1.1	Book with carrier
2.1.2.1.2	Insert trip in journey
2.1.2.1.3	End Iteration
3	Trip (external transaction)
3.1	Log trip
4	Trace goods
4.1	...

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Commercial Vehicle Tour Planning

	Description
1	Register goods item
2	Assemble tour complements
2.1	For each contracted item
2.1.1	Get current trip for goods item
2.1.1.1	….
2.1.2	IF necessary
2.1.2.1	Establish new tour
2.1.2.1.1	…
2.1.2.2	End Selection
2.1.3	Add derived trip to selected tour journey
2.1.3.1	…
2.1.4	Log goods item
2.1.5	End Iteration
3	For each tour
3.1	Identify journey
3.1.1	Establish journey conditions and generate itinerary (line 2.1)
3.1.2	Administrative Processes
3.2	End Iteration

Figure 47 — Sequence diagram for Commercial Vehicle Tour Planning

Figure 48 — Sequence diagram for Commercial Vehicle Administrative Processes

	Commercial Vehicle Road Operation	
	Description	
1	Initialise vehicle interface	
2	For monitor cycle	
2.1	Maintain vehicle dynamic data	
2.1.1	Update	
2.2	End Iteration	
3	For operator interrogation	
3.1	Request vehicle operational data	
3.2	Provide driver instructions	
3.2.1	Display	
3.3	End Iteration	
4	Route guidance etc. (3)	
5	For each resource used	
5.1	Vehicle in range	
5.2	Notify vehicle presence	
5.3	Classify vehicle	
5.4	Process clearance	
5.4.1	Interrogate vehicle	
5.4.2	Access trip administrative data	
5.4.3	Operator intervention	
5.5	If exception	
5.5.1	Request driver action	
5.5.2	Initiate violation actions	
5.5.3	End Selection	
5.6	Log trip component	
5.7	End Iteration	
6	Process violations	
6.1	Report to conformance agency	

Figure 49 — Sequence diagram for Commercial Vehicle Road Operation

7.5 Public Transport

7.5.1 Route and Schedule Planning

The abstract operations for Route and Schedule Planning in ISO/TR 14813 Part 2 are provided by the Transport Class. This leads to the following key classes defined in previous clauses.

— Public Transport Route

— Public Transport Schedule

— Roadway Group

— O-D Route

The sequence diagram is shown in Figure 50. The first stage maintains the geographic database:

— Public Transport Route**.**update map data ([121-])

The remainder of the sequence is an iteration conducted for each route. There are two cases, the first for maintenance of an existing route:

— Public Transport Schedule**.**request service change (…)

— Public Transport Schedule**.**update schedule (…)

— Special Vehicle Interface**.**access vehicle and passenger data([222-],[722-])

— Public Transport Route**.**access route([121-])

— O-D Route**.**access current conditions ([611-])

The second case is for route planning:

— Public Transport Route**.**create([121-])

— Public Transport Route**.**update route([121-])

— Public Transport Schedule**.**integrate vehicle and passenger data (…)

— O-D Route**.**access route data ([522-],[7---])

— Public Transport Schedule**.**update schedule (…)

The remaining logic is to generate and publish the timetable:

— Public Transport Schedule**.**generate timetable (…)

— Travel Terminal**.**publish timetable ([7211])

7.5.2 Fixed Route Public Transport

The abstract operations for Fixed Route Public Transport in ISO/TR 14813 Part 2 are provided by the Transport Class and the Roadway Class. This leads to the following key classes defined in previous clauses.

— Public Transport Schedule

— Roadway Group

The sequence diagram for operational maintenance of fixed route services is shown in Figure 51. The first stage consists of accumulating all operational data and updating the schedule:

— Public Transport Schedule**.**update intermodal connection data (…)

— Public Transport Schedule**.**update schedule (…)

— Roadway Group**.**access prediction data([522-])

— Roadway Group**.**access public transport priority data(…)

— Special Vehicle Interface**.**access vehicle and passenger data([222-])

— Roadway Group**.**priority request (…)

The next stage accomodates operator overrides::

— Public Transport Schedule**.**update schedule (…)

— Roadway Group**.**priority request (…)

The final stages are to instruct drivers and to support traveller information enquiries:

— Special Vehicle Interface**.**update driver instructions(…)

— Public Transport Schedule**.**access public transport running data ([72--])

7.5.3   Demand Responsive Public Transport

The abstract operations for Demand Responsive Public Transport in ISO/TR 14813 Part 2 are provided by the Transport Class. This leads to the following key classes defined in previous clauses.

— Journey

The following new control and information classes are required:

— Demand Responsive Vehicle: This class is used for dynamic dispatching of the fleet.

— Demand Responsive Vehicle Itinerary: This class is used for dynamic scheduling of the fleet.

The sequence diagram for a reservation request is shown in Figure 52. The first stage is to support traveller information ad hoc enquiries:

— Demand Responsive Vehicle Itinerary**.**reservation enquiry (…)

The main stage supports fleet scheduling and vehicle allocation:

— Demand Responsive Vehicle Itinerary**.**make reservation (…)

— Special Vehicle Interface**.**interrogate on-board data(…)

The last operation involves the Location Data Source actor. If a new vehicle has to be dispatched:

— Demand Responsive Vehicle**.**deploy (…)

— Special Vehicle Interface**.**update driver instructions(…)

The operator may override the dispatch decision:

— Operating Interface**.**operator data output(…)

— Demand Responsive Vehicle Itinerary**.**operator assignment (…)

The scheduling decision is finalised:

— Demand Responsive Vehicle**.**update passenger data (…)

— Special Vehicle Interface**.**update driver instructions(…)

with route guidance being provided through Route Guidance and Navigation (Figure 21 line 2.2).

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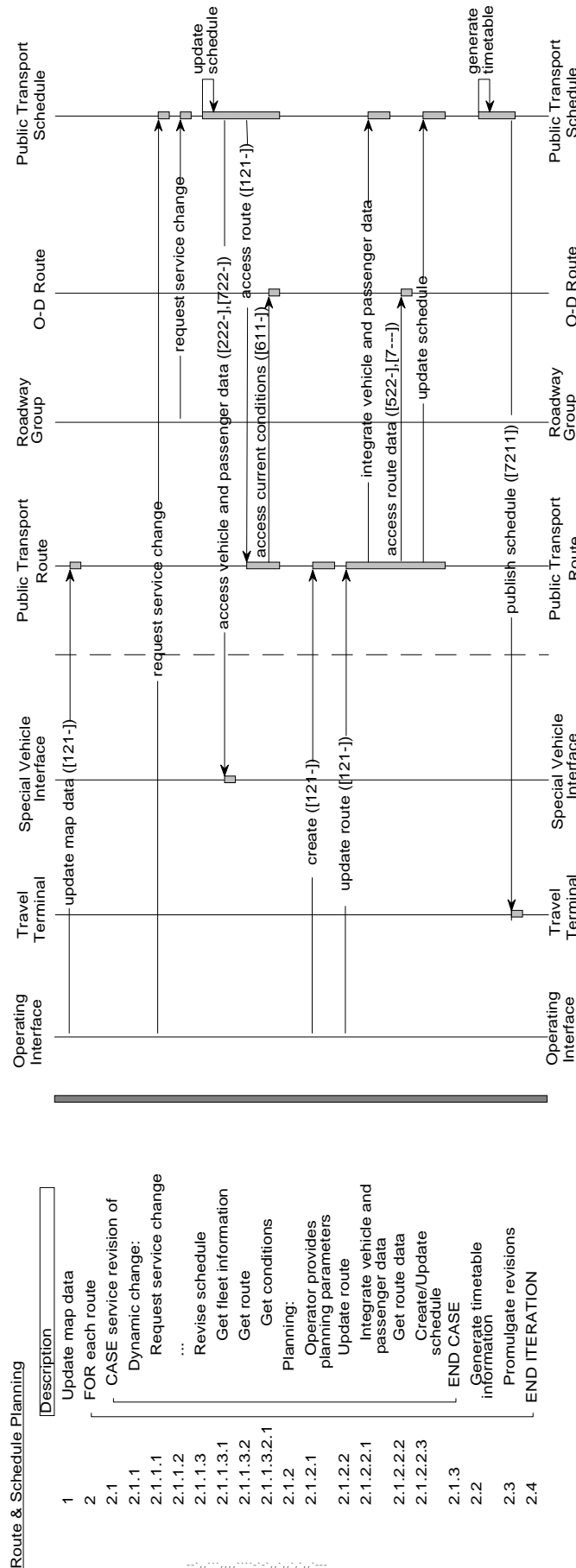
Figure 50 — Sequence diagram for Route and Schedule Planning

Route & Schedule Planning

	Description
1	Update map data
2	FOR each route
2.1	CASE service revision of
2.1.1	Dynamic change:
2.1.1.1	Request service change
2.1.1.2	...
2.1.1.3	Revise schedule
2.1.1.3.1	Get fleet information
2.1.1.3.2	Get route
2.1.1.3.2.1	Get conditions
2.1.2	Planning:
2.1.2.1	Operator provides planning parameters
2.1.2.2	Update route
2.1.2.2.1	Integrate vehicle and passenger data
2.1.2.2.2	Get route data
2.1.2.2.3	Create/Update schedule
2.1.3	END CASE
2.2	Generate timetable information
2.3	Promulgate revisions
2.4	END ITERATION

Figure 51 — Sequence diagram for Fixed Route Public Transport

Fixed Route Public Transport

	Description
1	FOR each revision
1.1	Intermodal inputs
1.2	Make estimates and variations
1.2.1	Get network performance data
1.2.2	Get priority data
1.2.3	Get vehicle running data
1.3	Request traffic priority
1.4	Operator overrides
1.4.1	Request traffic priority
1.5	Give driver instructions
1.6	Inform traveller
1.7	END ITERATION
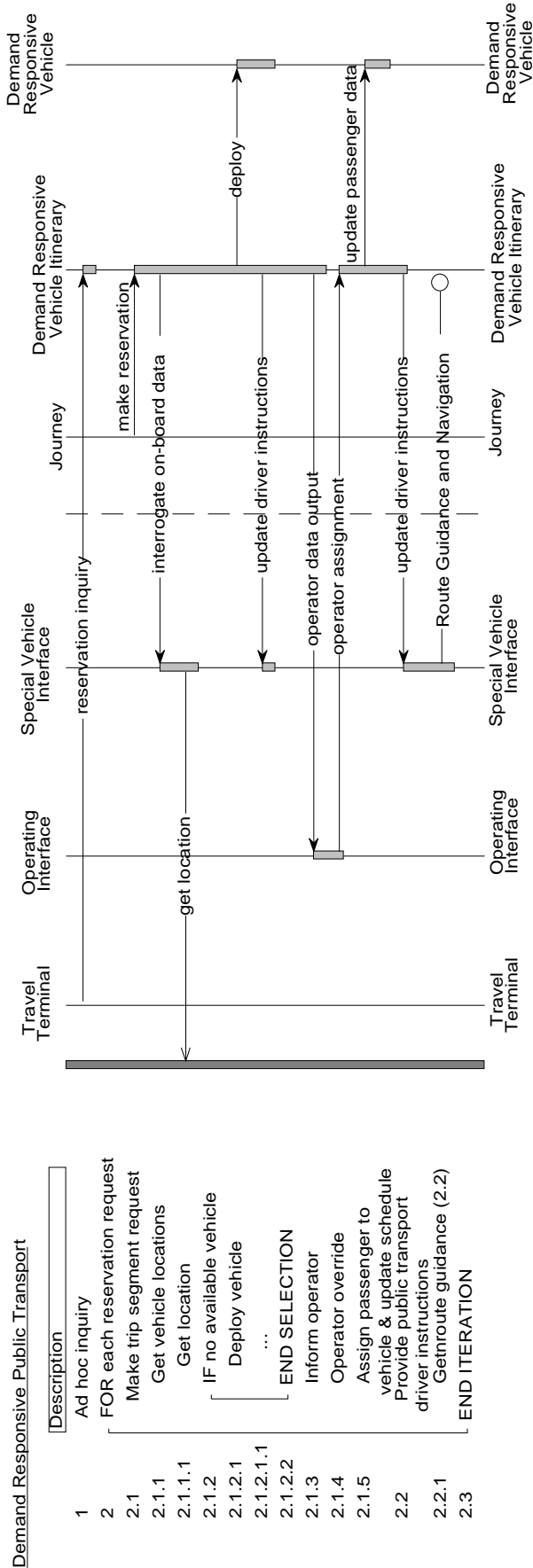
Figure 52 — Sequence Diagram for Demand Responsive Public Transport

Demand Responsive Public Transport

	Description
1	Ad hoc inquiry
2	FOR each reservation request
2.1	Make trip segment request
2.1.1	Get vehicle locations
2.1.1.1	Get location
2.1.2	IF no available vehicle
2.1.2.1	Deploy vehicle
2.1.2.1.1	...
2.1.2.2	END SELECTION
2.1.3	Inform operator
2.1.4	Operator override
2.1.5	Assign passenger to vehicle & update schedule
2.2	Provide public transport driver instructions
2.2.1	Getnroute guidance (2.2)
2.3	END ITERATION

7.6 Emergency

7.6.1 Emergency Notification and Personal Security

The abstract operations for Emergency Notification and Personal Security in ISO/TR 14813 Part 2 are provided by the Event Class. This leads to the following key class defined in previous clauses.

— Emergency

The sequence diagram for one notification is shown in Figure 53. The first stage is to validate the Traveller's journey request:

— Travel Terminal**.**sense security violation (…)

— Travel Terminal**.**security request (…)

These operations may involve the Location Data Source actor.

An emergency object is created:

— Emergency**.**create (…)

and the Emergency Resources Allocation transactions (Figure 54 line 2.2) invoked.

Finally the request is acknowledged:

— Travel Terminal**.**acknowledge (…)

7.6.2 Emergency Resources Allocation

The abstract operations for Emergency Resources Allocation in ISO/TR 14813 Part 2 are provided by the Event Class. This leads to the following key classes defined in previous clauses.

— Emergency

— Roadway Group

— Emergency Vehicle

The following new information class is required

— Emergency Response: This information class is invented to maintain response plans to be used in emergency management.

The sequence diagram is shown in Figure 54. The first stage involves the maintenance and planning operations:

— Emergency**.**update map data ([131-])

— Emergency Response**.**create ([5313])

The main stage registers an emergency and determine if a response is required:

— Emergency**.**create ([44--])

— Emergency**.**incident or emergency message ([54--])

— Emergency**.**data fusion (…)

— Emergency**.**assess status (…)

— Travel Terminal**.**acknowledge (…)

The second part of the main stage determines the response, allowing operator override:

— Emergency Response**.**match emergency ([44--],[5313])

— Emergency**.**update response plan ([5313])

Resources are deployed by the transactions of Emergency Vehicle Management (7.6.3). The incident is notified if necessary:

— Roadway Group**.**update incident data[44--])

The final stage is to integrate the state of current emergenies:

— Emergency**.**exchange data (…)

7.6.3   Emergency Vehicle Management

The abstract operations for Emergency Vehicle Management in ISO/TR 14813 Part 2 are provided by the Transport Class and the Roadway Class. This leads to the following key classes defined in previous clauses.

— Emergency

— Emergency Response

— Emergency Vehicle

— Roadway Group

The sequence diagram is shown in Figure 55. The first stage allows a response plan to be applied:

— Emergency**.**apply response plan (…)

— Emergency Response**.**access response plan ([5313])

— Operating Interface**.**operator data output (…)

— Emergency Vehicle**.**deploy (…)

— Special Vehicle Interface**.**update driver instructions(…)

Once the vehicles are committed the transactions of Route Guidance and Navigation (Figure 21 line 2.1) are used and then any traffic priority requested:

— Roadway Group**.**priority request(…)

The final part of the sequence is to iteratively assess the status of the emergency:

— Emergency**.**assess status (…)

— Special Vehicle Interface**.**track vehicle and status (…)

This operation may involve the Location Data Source actor.

Emergency Notification and Personal Security

	Description
1	Secure area violation sensed
	OR
2	Traveller initiates emergency request
3	IF mobile
3.1	Get emergency location
3.2	END SELECTION
4	Activate emergency
4.1	Process emergency (line 2.2)
5	Acnowledge traveller

Travel Terminal
Emergency
Emergency Resources Allocation
Emergency
Travel Terminal

sense security violation
create
acknowledge
security request
request location
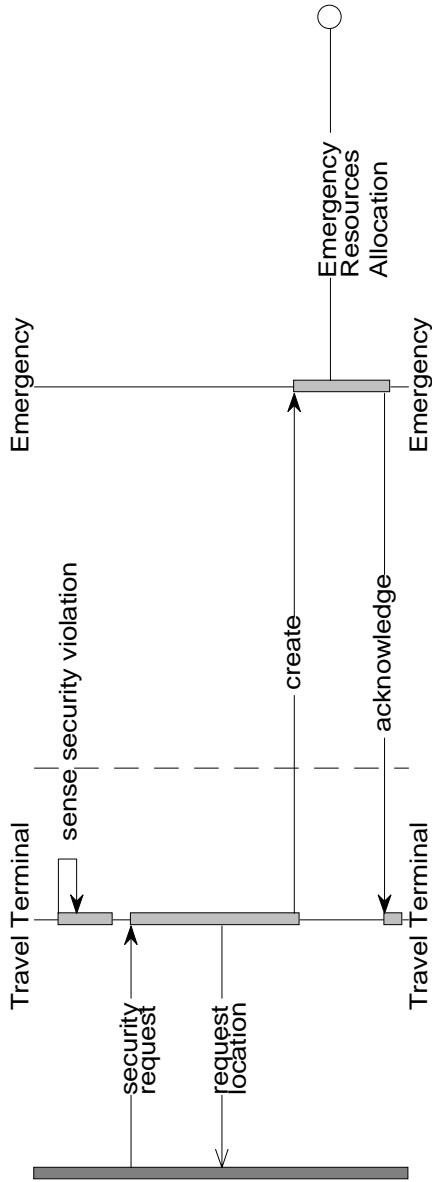
Figure 53 — Sequence diagram for Emergency Notification and Personal Security

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Not for Resale

Emergency Resources Allocation

	Description
1	Update map data
2	Develop emergency response
3	FOR each emergency notification
3.1	Emergency notification
3.1.1	...
3.1.2	...
3.1.3	...
3.2	Do data fusion
3.3	Recognise emergency
3.4	Acknowlege
3.5	Select response
3.6	Operator provides specific response
3.6.1	Make vehicle allocation
3.7	Notify traffic control
3.8	END ITERATION
4	Exchange data

Figure 54 — Sequence diagram for Emergency Resources Allocation
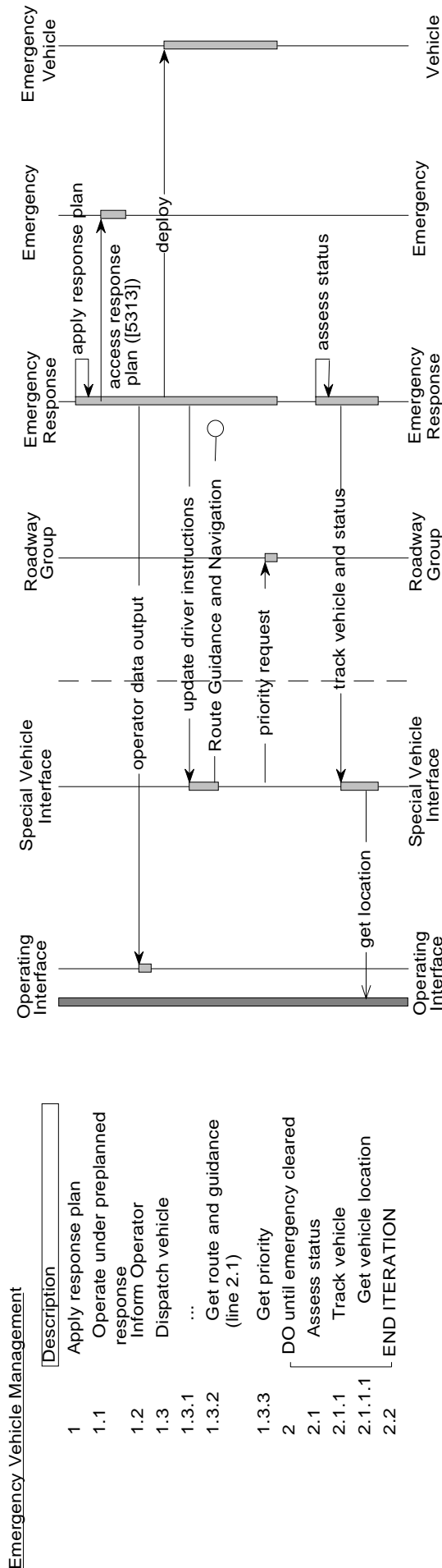
Figure 55 — Sequence diagram for Emergency Vehicle Management

Emergency Vehicle Management

	Description
1	Apply response plan
1.1	Operate under preplanned response
1.2	Inform Operator
1.3	Dispatch vehicle
1.3.1	...
1.3.2	Get route and guidance (line 2.1)
1.3.3	Get priority
2	DO until emergency cleared
2.1	Assess status
2.1.1	Track vehicle
2.1.1.1	Get vehicle location
2.2	END ITERATION

7.7 Electronic Payment

7.7.1   Payment Means

The abstract operations for Payment Means in ISO/TR 14813 Part 2 are provided by the Roadway Class. This leads to the following key classes defined in previous clauses.

⸺   Resource

The sequence diagram is shown in Figure 56. There are two independent stages. The first stage consists of the standard transactions for priming an electronic purse:

⸺   Travel Terminal**.**read payment card/tag ([2214])

⸺   Travel Terminal**.**accept cash/credit (…)

This is followed by a message to the Collection Agent actor. The second stage is for establishing credit for use of Resources:

⸺   Travel Terminal**.**accept cash/credit (…)

⸺   Resource**.**validate user credit (…)

This is followed by a message to the Clearing Agent actor.

⸺   Operating Interface**.**register user credit (…)

7.7.2   Fare Collection

The abstract operations for Fare Collection in ISO/TR 14813 Part 2 are provided by the Payment Class. This leads to the following key classes defined in previous clauses.

⸺   Billing Record

The sequence diagram is shown in Figure 57. Most of the interactions are in the interface classes:

⸺   In-vehicle sensor**.**detect passenger embark/disembark (…)

⸺   Special Vehicle Interface**.**count passengers (…)

⸺   Travel Terminal**.**read payment card/tag ([2214])

⸺   Billing Record**.**create([2214])

This is followed by the Payment Transaction (Figure 59 line 4.3).

7.7.3   Vehicle Charges

The abstract operations for Vehicle Charges in ISO/TR 14813 Part 2 are provided by the Roadway Class and the Payment Class. This leads to the following key classes defined in previous clauses.

⸺   Resource

⸺   Billing Record

The sequence diagram for one journey planning exercise is shown in Figure 58. The first stage is to establish the payment means:

⸺ Vehicle Interface. read payment card/tag ([2214])

The next stage involves recognising a vehicle at the resource:

⸺ Vehicle Sensor**.**specific actor in range

⸺ Resource**.**recognise vehicle([411-])

followed by retrieving the identification and payment means from the interface objects:

⸺ Vehicle Interface**.**access payment identification ([2214])

⸺ Vehicle Sensor**.**access vehicle identification ([4111])

If necessary the driver is warned:

⸺ Vehicle Interface**.**warn driver ([6132])

then the payment process begins:

⸺ Billing Record**.**create([4112],[2214])

followed by the Payment Transaction (Figure 59 line 2).

7.7.4   Payment Transaction

The abstract operations for Payment Transaction in ISO/TR 14813 Part 2 are provided by the Payment Class and the Event Class. This leads to the following key classes defined in previous clauses.

⸺   Resource

⸺   Billing Record

⸺   Tariff

⸺   Probe

⸺   Violation

The following new information class is required

⸺   Advance Payment: This information class is invented to apply advance payments made for Resource use.

The sequence diagram comprising all the possible stages is shown in Figure 59. The first stage is a maintenance stage for tariffs:

⸺   Tariff**.**update tariff ([715-])

If the transactions are being invoked at the completion of a Resource use, e.g. Vehicle Charges (7.7.3), the Billing Record object has to be selected, Probe data recorded, and any invalid use acted upon:

⸺   Billing Record**.**select ([2214])

⸺   Probe**.**update resource use statistics (…)

⸺   Violation**.**create([211-])

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The next stage computes charges in various circumstances:

— Billing Record**.**enter completion details ([2214])

— Tariff**.**calculate charges (…)

— Advance Payment**.**reconcile[2214])

if credit

— Billing Record**.**record creditor amount (…)

if debit

— Travel Terminal**.**debit request (…)

which results in an electronic purse calculation or the acceptance of cash or token. Again violations are processed:

— Violation**.**create([2214])

Advance payments are processed:

— Advance Payment**.**create ([2214])

Periodically all payments are reconciled and request sent to the Clearing Operator agents:

— Billing Record**.**reconcile collected fees (…)

— Operating Interface**.**request funds transfer ([8210],[8300],[8400],[8500])

The final stage is used to process any violation and notify the conformance agency:

— Violation.process violation (…)

— Operating Interface**.**report violation (([811-])

Figure 56 — Sequence diagram for Payment Means

Payment Means

	Description
1	IF pre-payment means
1.1	Provide payment instrument
1.2	Provide cash/credit
1.3	Collection agent transaction
1.4	End Selection
2	IF post-payment means
2.1	Provide credit identification
2.2	Validate credit
2.2.1	Send user/issuer data to Clearing Operator
2.3	End Selection
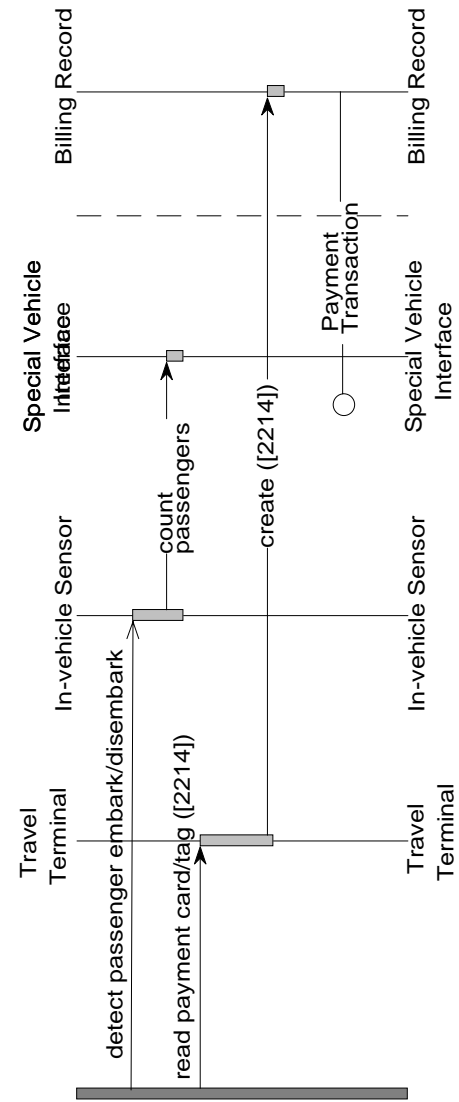
Fare Collection

	Description
1	FOR each passenger
1.1	Count passengers
1.1.1	...
1.2	Initiate payment
1.3	IF credit
1.3.1	Establish credit
1.3.2	End Selection
1.4	Payment transaction (line)
1.5	END ITERATION

Figure 57 — Sequence diagram for Fare Collection

Vehicle Charges

	Description
1	Provide payment instrument
2	Detect vehicle
2.1	Notify
3	Get payment identification
4	Get vehicle identification data
5	IF payment identification invalid
5.1	Warn driver
5.2	END SELECTION
6	IF vehicle starting use of resource
6.1	Create billing record
6.2	END SELECTION
7	ELSE
7.1	Payment transaction (line 2)
7.2	END
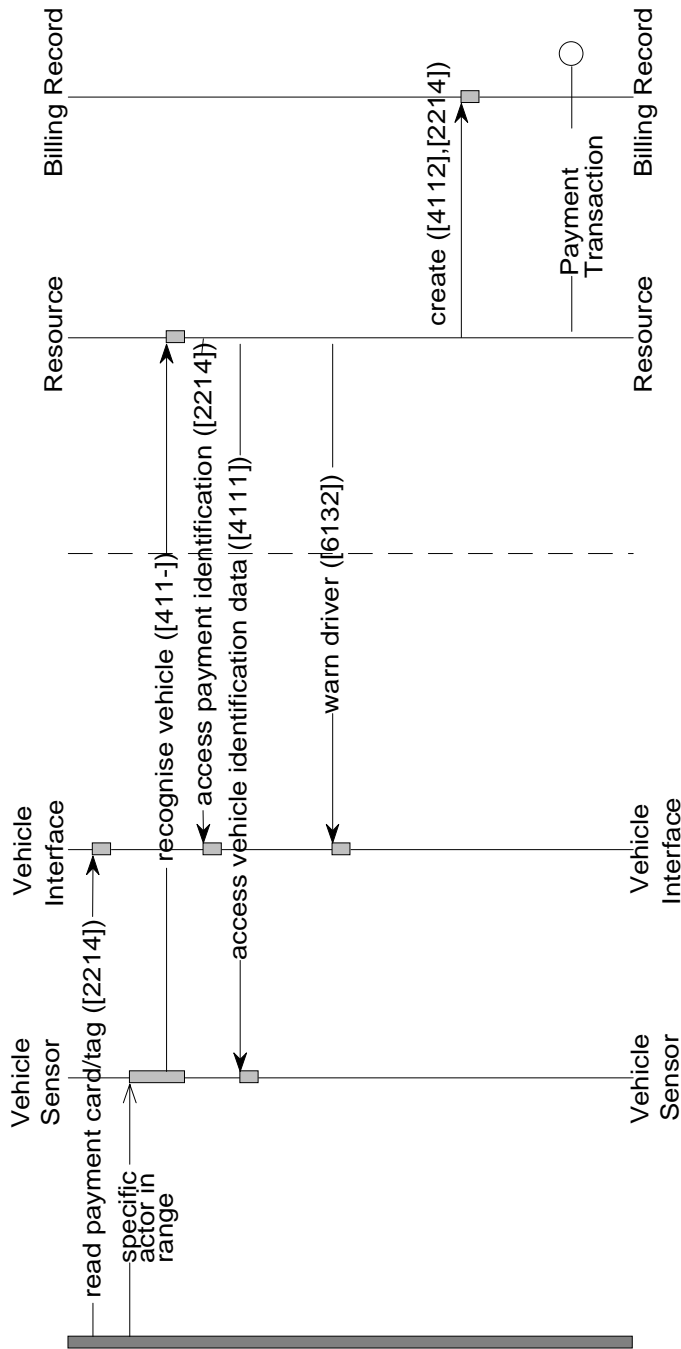
Figure 58 — Sequence diagram for Vehicle Charges

Payment Transaction

	Description
1	Maintain fare and charges schedules
2	(1) IF traveller is completing resource use
2.1	Select old billing record
2.2	Record probe statistic
2.3	END SELECTION
3	IF billing record for invalid identifier
3.1	Notify violation
3.2	END SELECTION
4	ELSE
4.1	Complete billing record
4.2	Compute outstanding charges
4.3	(2) IF payment already made
4.3.1	Reconcile agsainst advance payment
4.3.2	END SELECTION
4.4	ELSE
4.4.1	(3) CASE payment mode of
4.4.1.1	Post-payment
4.4.1.1.1	Record creditor amount
4.4.1.2	Pre-payment
4.4.1.2.1	Notify debit
4.4.1.2.2	Debit request
4.4.1.2.2.1	Debit card/cash/token
4.4.1.2.3	If debit failed
4.4.1.2.3.1	Notify violation
4.4.1.2.3.2	End Selection
4.4.2	END CASE
4.4.3	IF making advance payment
4.4.3.1	Create payment record
4.4.3.2	END SELECTION
4.4.4	END SELECTION
4.5	END SELECTION
5	IF periodicr funds transfer
5.1	List payments
5.2	Request clearing operator
5.3	END SELECTION
6	Process violations
6.1	Report to conformance agency

Lifelines: Operating Interface — Travel Terminal — Resource — Billing Record — Advance Payment — Tariff — Violation — Probe

Messages: update tariff ([715-]); select ([2214]); update resource use statistics; create ([211-]); enter completion details; calculate charges; reconcile ([2214]); record creditor amount; debit user; debit request; collect fee; create ([2214]); create ([2214]); reconcile collected fees; report violation ([811-]); request funds transfer ([8210], [8300], [8400],[8500]); process violation

Figure 59 — Sequence diagram for Payment Transaction

7.8 Safety

7.8.1 Safety Enhancement for Vulnerable Road Users

The abstract operations for Safety Enhancement for Vulnerable Road Users in ISO/TR 14813 Part 2 are provided by the Roadway Class and the Vehicle Class. This leads to the following key classes defined in previous clauses.

⎯ Local Control Group

⎯ Vehicle

The sequence diagram is shown in Figure 60. It is a continual iteration. In the first stage the movements of vehicles and pedestrians are continually monitored and appropriate warnings conveyed:

⎯ Local Control Group**.**identify vulnerable (…)

⎯ Vehicle Interface**.**warn driver ([612-])

⎯ Roadside Peripheral**.**safety warning (…)

Another stage focuses on vulnerable vehicles:

⎯ Vehicle**.**monitor vulnerable vehilces(…)

⎯ Vehicle Interface**.**warn driver ([612-])

Safety Enhancement for Vulnerable Road Users

	Description
1	DO WHILE TRUE
1.1	Vehicles, peestrians activate sensors
1.2	Identify vulnerable pedestrian
1.3	Notify driver
1.4	Notify vulnerable
1.5	END Iteration
2	DO WHILE TRUE
2.1	Recognise vulnerable vehicle
2.2	Notify driver
2.3	END Iteration
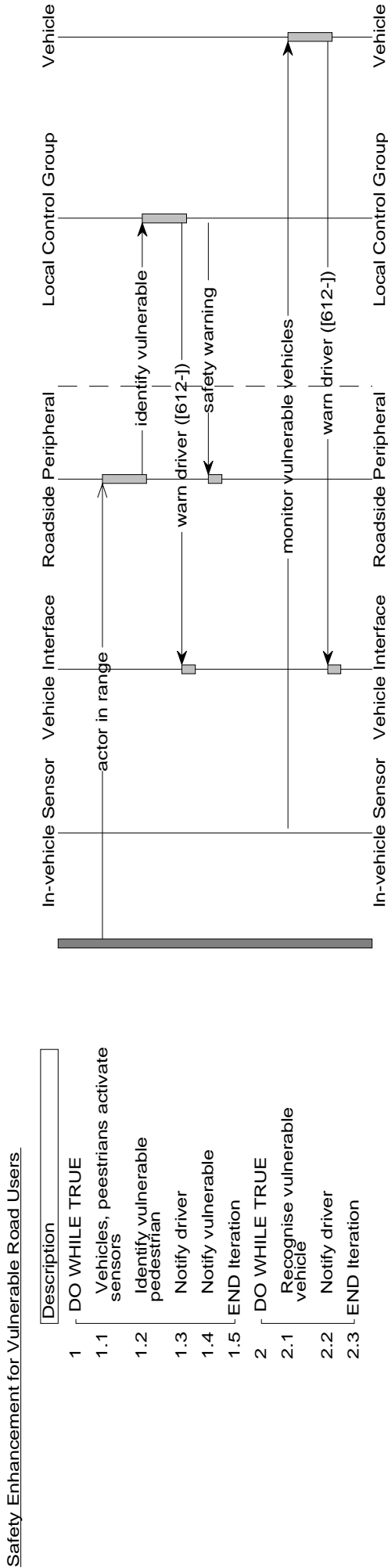
Figure 60 — Sequence diagram for Safety Enhancement for Vulnerable Road Users

8   Elaboration of the Packages

This clause summarises the packages by developing a class diagram containing the key classes of the package and their associations. The operations of each class are then listed . In 8.7 a matrix relating classes to their involvement in sequence diagrams (hence use case) is given.

8.1 Roadway

The class diagram for the key classes of the Roadway package is shown in Figure 61.
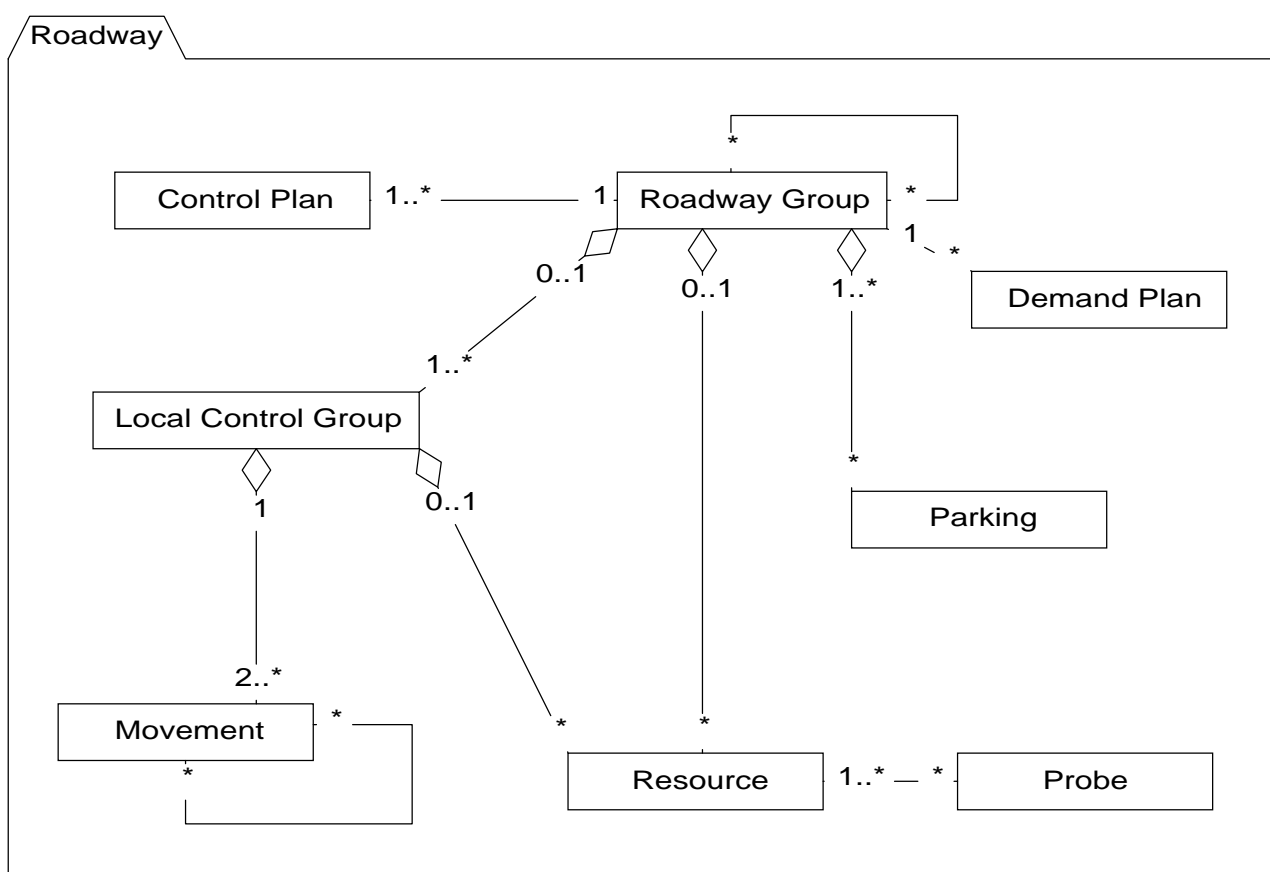
Figure 61 — Key classes of the Roadway package

Control Plan

This class has the following operations:

  os+[3)] create

  o+ compute plan

Demand Plan

---

3)   os+ denotes a static operation (see ISO 14813 Part 4)

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This class has the following operations:
 os+ create

 o+ compute plan

 o+ update demand policy data

Local Control Group

This class has the following operations:
 o+[4] access collision avoidance data

 o+ apply traffic regulations

 o+ generate control parameters for peripherals

 o+ identify vulnerable

 o+ priority request

 o+ update control data

 o+ update rail traffic data

 o+ update sensor measurements

Movement

This class has the following operations:
 o+ update map data

 o+ update measurements

Parking

This class has the following operations:
 o+ access parking data

 o+ make reservation

 o+ request to cater to demand

 o+ update control data

 o+ update long term data

 o+ update status

Probe

This class has the following operations:
 os+ access route travel time data

 o+ aggregate statistics

 o+ update resource use statistics

---

[4] o+ denotes an instance (object) operation (see ISO 14813 Part 4).

Resource

This class has the following operations:
- o+ clear vehicle
- o+ command vehicle
- os+ create
- o+ debit user
- o+ recognise vehicle
- o+ validate user credit

Roadway Group

This class has the following operations:
- o+ access prediction data
- o+ access public transport priority data
- o+ access traffic data
- o+ analyse data
- o+ data fusion
- o+ decision support for strategy development
- os+ exchange data
- o+ exchange predictions
- o+ integrate measurements
- o+ predict demand
- os+ predict network performance
- o+ priority request
- o+ schedule maintenance
- os+ compute strategy
- o+ support operator access
- o+ transport planner request
- o+ update control strategy
- o+ update current data
- o+ update demand strategy
- o+ update incident data
- o+ update incident strategy
- o+ update long term data
- o+ update map data
- o+ update performance data
- o+ update static data
- o+ update traffic control data

8.2 Transport

The class diagram for some of the key classes of the Transport package is shown in Figure 62. More key classes of the Transport package are shown in association with the Vehicles package.
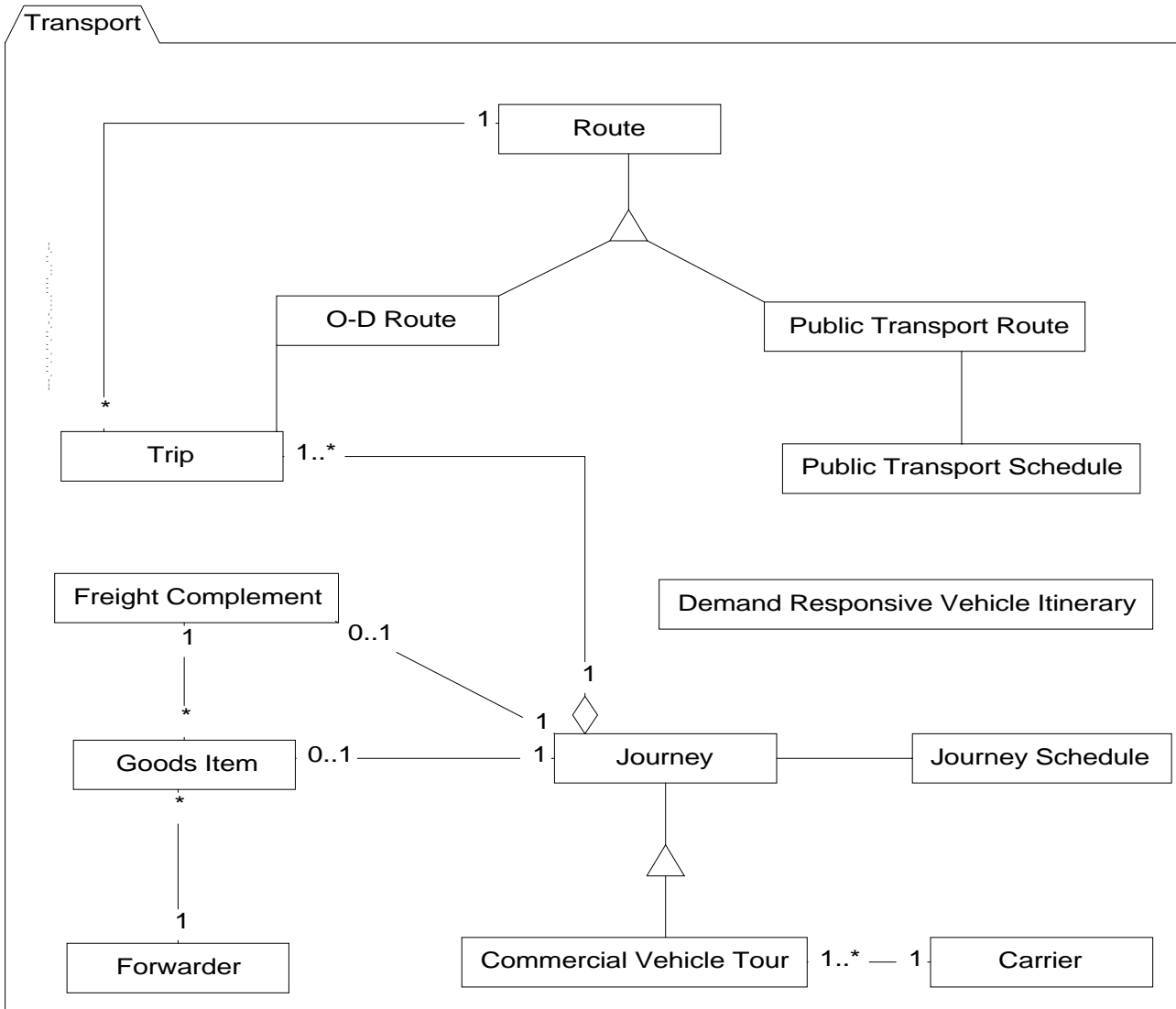
Figure 62 — Key classes of the Transport package

Carrier

This class has the following operations:

   o+ clear carrier

Commercial Vehicle Tour

This class has the following operations:

os+ access fleet operational data

o+ access trip data

o+ add driver and carrier

o+ initialise vehicle interface

o+ interrogate on-board data

o+ log trip segment

o+ update credit identity

o+ update driver instructions

o+ update vehicle & cargo data

Demand Responsive Vehicle Itinerary

This class has the following operations:
  os+ make reservation

  o+ operator assignment

  os+ reservation inquiry

Forwarder

This class has the following operations:
  os+ select forwarder

Freight Complement

This class has the following operations:
  os+ create

  o+ update

Goods Item

This class has the following operations:
  os+ create

  os+ iterate over goods items

  o+ log arrival

  o+ trace

Journey

This class has the following operations:
  o+ commit

  os+ create

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o+ insert goods

o+ insert trip

o+ iterate over trips

o+ select

o+ trace goods

os+ update map data

Journey Schedule

This class has the following operations:

o+ access schedule

o+ access segment and cost

os+ create

o+ update time, confirmation & price

o+ validate

O-D Route

This class has the following operations:

o+ access advisory data

o+ access current conditions

o+ access route conditions

o+ access route data

o+ access route definition

os+ access travel data

o+ exchange data

o+ generate advice

o+ update effects data

o+ update long term data

o+ update map data

o+ update prediction data

o+ update travel data

Trip

This class has the following operations:

o+ access current trip

o+ access route

o+ access route guidance

os+ create

    o+ generate route & guidance

    o+ log trip

    o+ update trip data

Public Transport Route

This class has the following operations:

    o+ access route

    os+ create

    o+ update map data

    o+ update route

Public Transport Schedule

This class has the following operations:

    os+ access public transport operational data

    o+ access public transport running data

    o+ generate timetable

    os+ integrate vehicle and passenger data

    o+ request service change

    o+ update intermodal connection data

    o+ update schedule

8.3 Vehicles

The class diagram for the key classes of the Vehicles package is shown in Figure 63.

Commercial Vehicle

This class has the following operations:

    os+ access fleet operational data

    os+ classify vehicle

    o+ clear vehicle

    o+ log trip segment

Commercial Vehicle Driver

This class has the following operations:

    o+ clear driver

Demand Responsive Vehicle

This class has the following operations:

Public Transport Vehicle...

o+ update passenger data

Special Vehicle...

o+ access fleet operational data
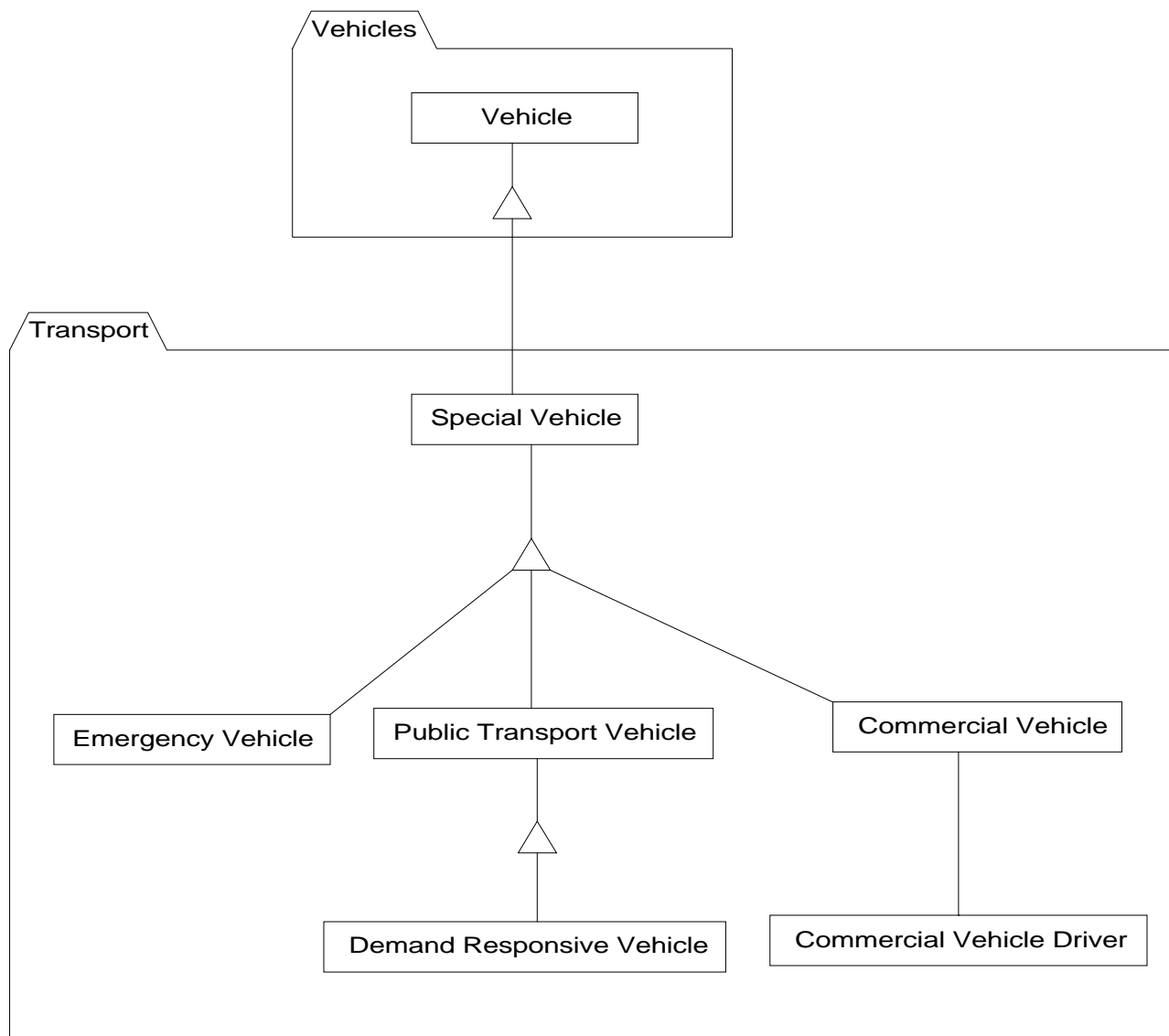
os+ deploy

Figure 63 — Key classes of the Vehicle package

Emergency Vehicle

This class has the following operations:

Special Vehicle...

 o+ access fleet operational data

os+ deploy

Public Transport Vehicle

This class has the following operations:
   o+ update passenger data

Special Vehicle

This class has the following operations:
   o+ access fleet operational data

   os+ deploy

8.4 Events

The class diagram for the key classes of the Events package is shown in Figure 64.
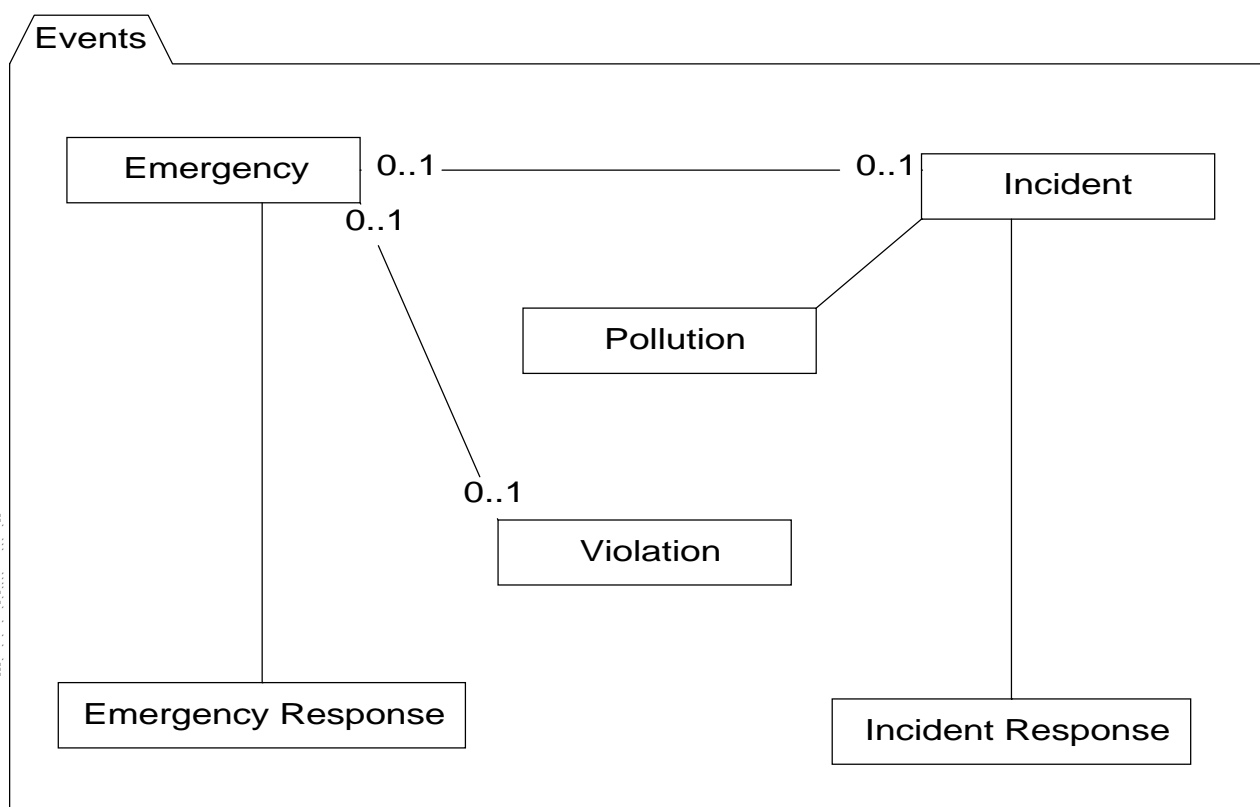
Figure 64 — Key classes of the Events package

Emergency

This class has the following operations:

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os+ access fleet operational data

o+ apply response plan

o+ assess status

os+ create

o+ data fusion

o+ exchange data

os+ incident or emergency message

os+ update map data

o+ update response plan

Emergency Response

This class has the following operations:

o+ access response plan

os+ create

o+ match emergency

Incident

This class has the following operations:

os+ access incident data

os+ access predicted incidents

os+ create

o+ update long term data

o+ update response data

Incident Response

This class has the following operations:

os+ create

os+ match incident

Pollution

This class has the following operations:

o+ access pollution data

o+ update current data

o+ update long term data

o+ update pollution data

Violation

This class has the following operations:

os+ create

os+ process violation

8.5 Payment

The class diagram for the key classes of the Payment package is shown in Figure 65.
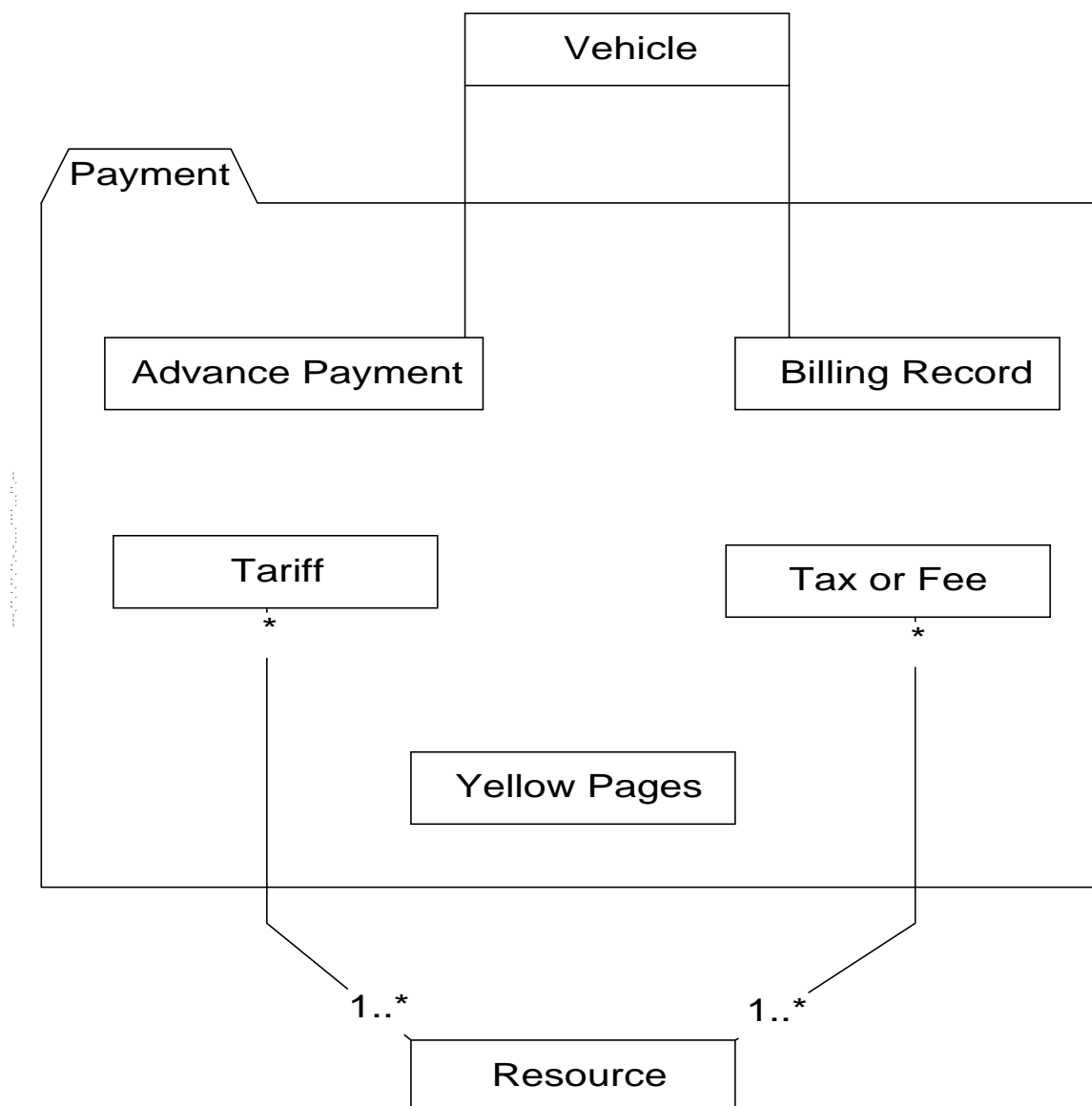
Figure 65 — Key classes of the Payment package

Advance Payment

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This class has the following operations:

   os+ create

   o+ reconcile

Billing Record

This class has the following operations:

   os+ create

   o+ enter completion details

   os+ reconcile collected fees

   o+ record creditor amount

   os+ select

Tariff

This class has the following operations:

   o+ calculate charges

   os+ create

   o+ request to cater to demand

   o+ update tariff

Tax or Fee

This class has the following operations:

   o+ access segment charges

Yellow Pages

This class has the following operations:

   o+ construct yp service

   o+ update general information

   o+ update yp service

   o+ yp transaction

8.6 Interfaces

The class diagram for the key classes of the interface packages is shown in Figure 66.
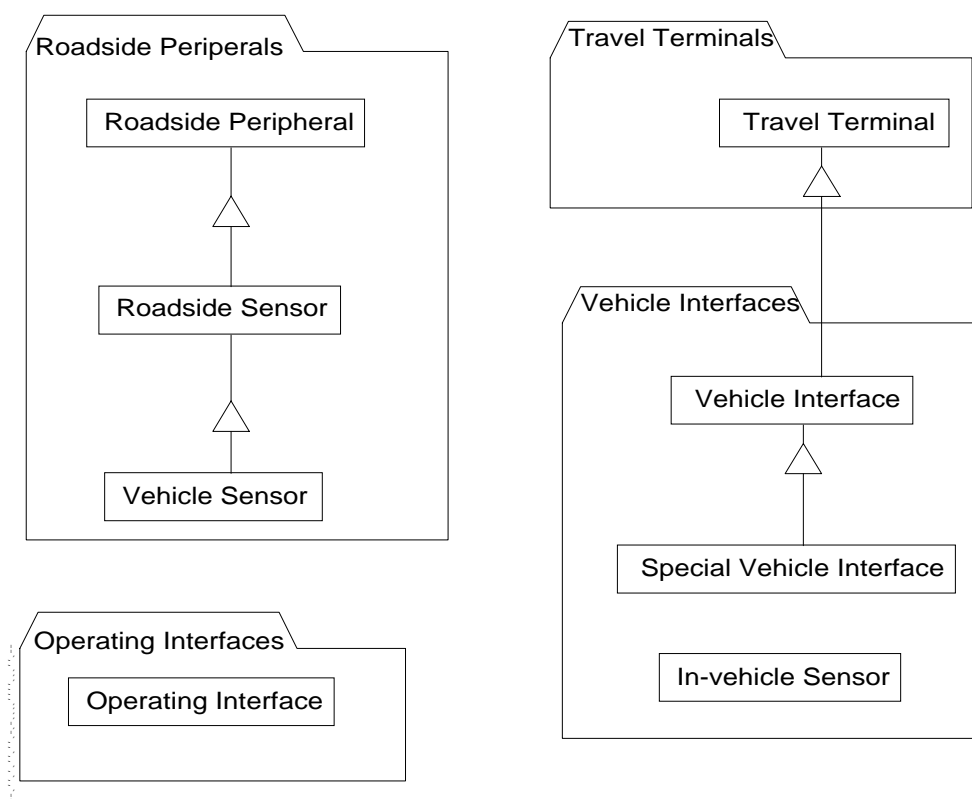
Figure 66 — Key classes of the interface packages

In-vehicle Sensor

This class has the following operations:
- o+ detect passenger embark/disembark
- o+ monitor vehicle and cargo

Operating Interface

This class has the following operations:
- o+ conformance agency check
- o+ freight booking
- o+ instruct operator
- o+ make intermodal reservation
- o+ make parking reservation
- o+ make ridesharing reservation
- o+ notify rail
- o+ operator data output

o+ register user credit card

o+ report violation

o+ request funds transfer

o+ yp service order

Roadside Peripheral

This class has the following operations:

o+ safety warning

o+ update control data

Roadside Sensor

This class has the following operations:

o+ actor in range

Roadside Peripheral

Special Vehicle Interface

This class has the following operations:

o+ access vehicle and passenger data

o+ count passengers

o+ driver action request

o+ interrogate on-board data

o+ track vehicle and status

o+ update driver instructions

Vehicle Interface

Travel Terminal

This class has the following operations:

o+ accept cash/credit

o+ acknowledge

o+ commit to route & schedule

o+ confirm

o+ confirm yp request

o+ debit request

o+ initiate journey request

o+ provide yp advertisement

o+ publish schedule

o+ read payment card/tag

o+ security request

o+ sense security violation

o+ update journey request

o+ yp request

Vehicle Interface

This class has the following operations:

o+ access payment identification

o+ enter route parameters

o+ get location

o+ request operational mode

o+ warn driver

  Travel Terminal

Vehicle Sensor

This class has the following operations:

o+ access vehicle identification data

o+ specific actor in range

  Roadside Sensor

8.7 Class-Sequence Diagram Matrix

The following clauses detail where classes have been used in a diagram.

8.7.1   Matrix for Key Control and Information Classes

This matrix lists the Class name, followed by Sequence Diagrams (Use Cases).

Advance Payment
  Payment Transaction

Billing Record
  Fare Collection

  Journey Payment

  On-trip Traveller Information

  Payment Transaction

  Vehicle Charges

Carrier
  Commercial Vehicle Administrative Processes

Commercial Vehicle
   Commercial Vehicle Administrative Processes

   Commercial Vehicle Road Operation

   Transportation Planning Support

Commercial Vehicle Driver
   Commercial Vehicle Administrative Processes

Commercial Vehicle Tour
   Commercial Vehicle Administrative Processes

   Commercial Vehicle Road Operation

   Incident Management

Control Plan
   Traffic Control

   Transportation Planning Support

Demand Plan
   Demand Management

   Transportation Planning Support

Demand Responsive Vehicle
   Demand Responsive Public Transport

Demand Responsive Vehicle Itinerary
   Demand Responsive Public Transport

Emergency
   Emergency Notification and Personal Security

   Emergency Resources Allocation

   Emergency Vehicle Management

   Incident Management

   Vehicle Status

Emergency Response
   Emergency Resources Allocation

   Emergency Vehicle Management

Emergency Vehicle
    Emergency Resources Allocation
    Emergency Vehicle Management
    Transportation Planning Support

Forwarder
    Order and Shipment

Freight Complement
    Commercial Vehicle Tour Planning

Goods Item
    Commercial Vehicle Tour Planning
    Order and Shipment

Incident
    Incident Management
    Performance Evaluation
    Performance Prediction
    Route Guidance and Navigation
    Traffic Control

Incident Response
    Incident Management
    Transportation Planning Support

Journey
    Commercial Vehicle Administrative Processes
    Commercial Vehicle Tour Planning
    Demand Responsive Public Transport
    Journey Payment
    Journey Schedule
    Order and Shipment
    Pre-journey Information
    Route Guidance and Navigation

Journey Schedule
    Commercial Vehicle Administrative Processes
    Journey Payment
    Journey Schedule

Pre-journey Information

Local Control Group
Safety Enhancement for Vulnerable Road Users
Traffic & Pollution Measurement & Control
Traffic Control
Vehicle Status

Movement
Traffic & Pollution Measurement & Control

O-D Route
Demand Management
Performance Evaluation
Performance Prediction
Pre-journey Information
Route Guidance and Navigation
Route and Schedule Planning
Transportation Planning Support

Parking
Demand Management
Performance Evaluation
Traffic & Pollution Measurement & Control
Traffic Control
Transportation Planning Support

Pollution
Incident Management
Performance Evaluation
Traffic & Pollution Measurement & Control
Transportation Planning Support

Probe
Payment Transaction
Performance Evaluation
Route Guidance and Navigation
Transportation Planning Support

Public Transport Route
  Route & Schedule Planning

Public Transport Schedule
  Demand Management

  Fixed Route Public Transport

  Pre-journey Information

  Route & Schedule Planning

  Route Guidance and Navigation

  Transportation Planning Support

Resource
  Commercial Vehicle Road Operation

  Payment Means

  Payment Transaction

  Vehicle Charges

Roadway Group
  Demand Management

  Emergency Resources Allocation

  Emergency Vehicle Management

  Fixed Route Public Transport

  Incident Management

  Infrastructure Maintenance Management

  Performance Evaluation

  Performance Prediction

  Route & Schedule Planning

  Route Guidance and Navigation

  Traffic & Pollution Measurement & Control

  Traffic Control

  Transportation Planning Support

Tariff
  Demand Management

  Payment Transaction

Tax or Fee
  Commercial Vehicle Administrative Processes

Trip

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    Commercial Vehicle Tour Planning

    Journey Schedule

    Order and Shipment

    Pre-journey Information

    Route Guidance and Navigation

Vehicle

    Safety Enhancement for Vulnerable Road Users

    Vehicle Operation

    Vehicle Status

Violation

    Commercial Vehicle Road Operation

    Payment Transaction

    Traffic & Pollution Measurement & Control

Yellow Pages

    On-trip Traveller Information

8.7.2 Matrix for Interface Classes

This matrix lists the Class name, followed by Sequence Diagrams (Use Cases).

In-vehicle Sensor

    Commercial Vehicle Road Operation

    Fare Collection

    Safety Enhancement for Vulnerable Road Users

    Vehicle Status

Operating Interface

    Commercial Vehicle Administrative Processes

    Commercial Vehicle Road Operation

    Commercial Vehicle Tour Planning

    Demand Management

    Demand Responsive Public Transport

    Emergency Resources Allocation

    Emergency Vehicle Management

    Fixed Route Public Transport

    Incident Management

    Infrastructure Maintenance Management

Journey Schedule

On-trip Traveller Information

Order and Shipment

Payment Means

Payment Transaction

Performance Evaluation

Route & Schedule Planning

Route Guidance and Navigation

Traffic & Pollution Measurement & Control

Traffic Control

Transportation Planning Support

Roadside Peripheral

Safety Enhancement for Vulnerable Road Users

Traffic & Pollution Measurement & Control

Traffic Control

Roadside Sensor

Traffic & Pollution Measurement & Control

Special Vehicle Interface

Commercial Vehicle Road Operation

Demand Responsive Public Transport

Emergency Resources Allocation

Emergency Vehicle Management

Fare Collection

Fixed Route Public Transport

Route & Schedule Planning

Traffic Control

Travel Terminal

Demand Responsive Public Transport

Emergency Notification and Personal Security

Emergency Resources Allocation

Fare Collection

Fixed Route Public Transport

Journey Payment

On-trip Traveller Information

Order and Shipment

Payment Means

Payment Transaction

Pre-journey Information

Route & Schedule Planning

Route Guidance and Navigation

Vehicle Interface

On-trip Traveller Information

Route Guidance and Navigation

Safety Enhancement for Vulnerable Road Users

Traffic & Pollution Measurement & Control

Vehicle Charges

Vehicle Operation

Vehicle Status

Vehicle Sensor

Commercial Vehicle Road Operation

Traffic & Pollution Measurement & Control

Vehicle Charges

9 Package Interfaces

The control and information classes defined in 8.1 to 8.5 interact with the actors through interface classes identified in 8.6. The collaboration between the interface classes and the other classes is documented in the following clauses.

Each clause contains a diagram with a collaboration linkage shown between each class for which there is a corresponding message in the sequence diagrams of clause 7. There may be multiple messages between each class pair. The direction of the message from the originator is shown by arrow and the message is identified by a label of the form

Sequence Diagram:operation name

where the class of the operation can be derived by following the arrow direction on the diagram. For example, in Figure 67, there is a message from the interface class Special Vehicle Interface to the Roadway Group class:

Emergency Vehicle Management:priority request(...).
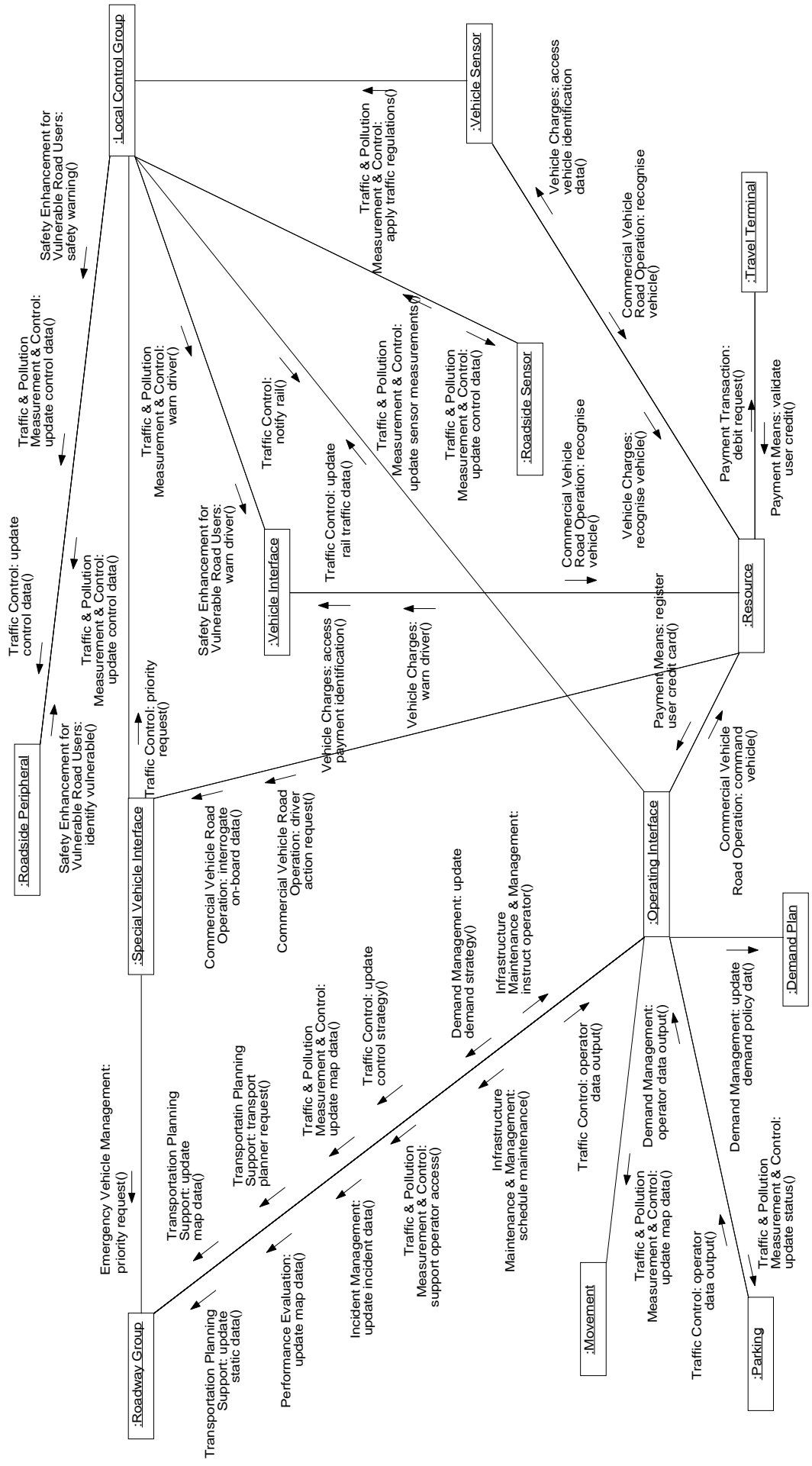
Figure 67 — Roadway Package Interfaces

9.1 Roadway Interfaces

The collaboration between the Roadway classes and the Interface classes is documented in Figure 67. The number of message types between collaborating pairs is summarised in Table 10.

Table 10 — Matrix count of Roadway class Interface class collaborations

	Roadway Group	Local Control Group	Resource	Demand Plan	Movement	Parking
Operating Interface	12	2	2	1	1	3
Vehicle Interface		2	3			
Special Vehicle Interface	1	1	2			
Roadside Peripheral		4				
Roadside Sensor		2				
Vehicle Sensor		1	3			
Travel Terminal			2			
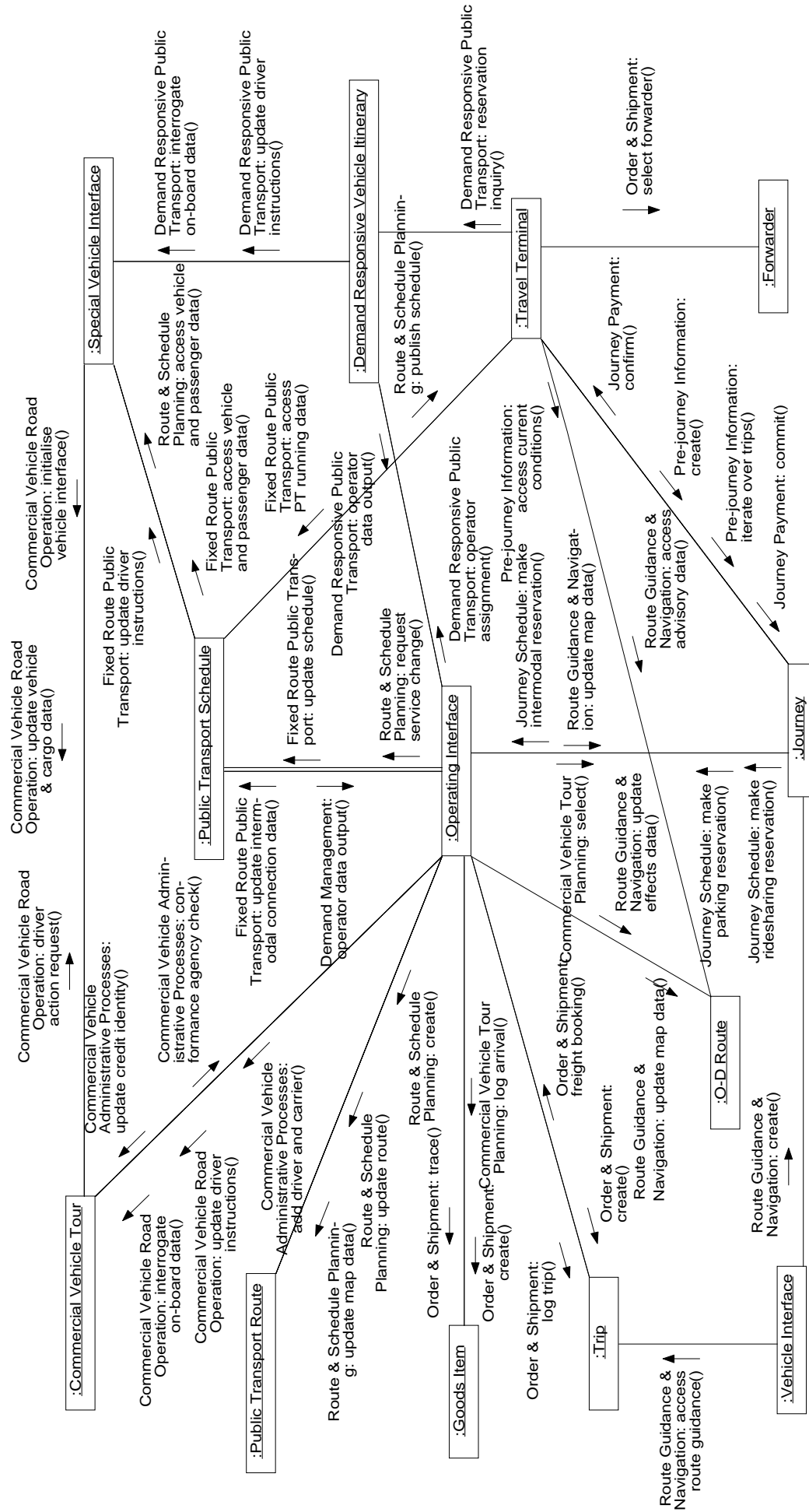
Figure 68 — Transport Package Interfaces

9.2 Transport Interfaces

The collaboration between the Transport classes and the Interface classes is documented in Figure 68. The number of message types between collaborating pairs is summarised in Table 11.

Table 11 — Matrix count of Transport class Interface class collaborations

	Operating Interface	Vehicle Interface	Special Vehicle Interface	Travel Terminal
Commercial Vehicle Tour	5		3	
Public Transport Route	3			
Goods Item	3			
Trip	3	1		
O-D Route	2			2
Journey	5	1		4
Forwarder				1
Demand Responsive Vehicle Itinerary	2		2	1
Public Transport Schedule	4		3	2

9.3 Vehicle Interfaces

The collaboration between the Vehicles classes and the Interface classes is documented in Figure 69. The number of message types between collaborating pairs is summarised in Table 12.

Table 12 — Matrix count of Vehicles class Interface class collaborations

	In-vehicle Sensor	Vehicle Interface
Vehicle	5	6
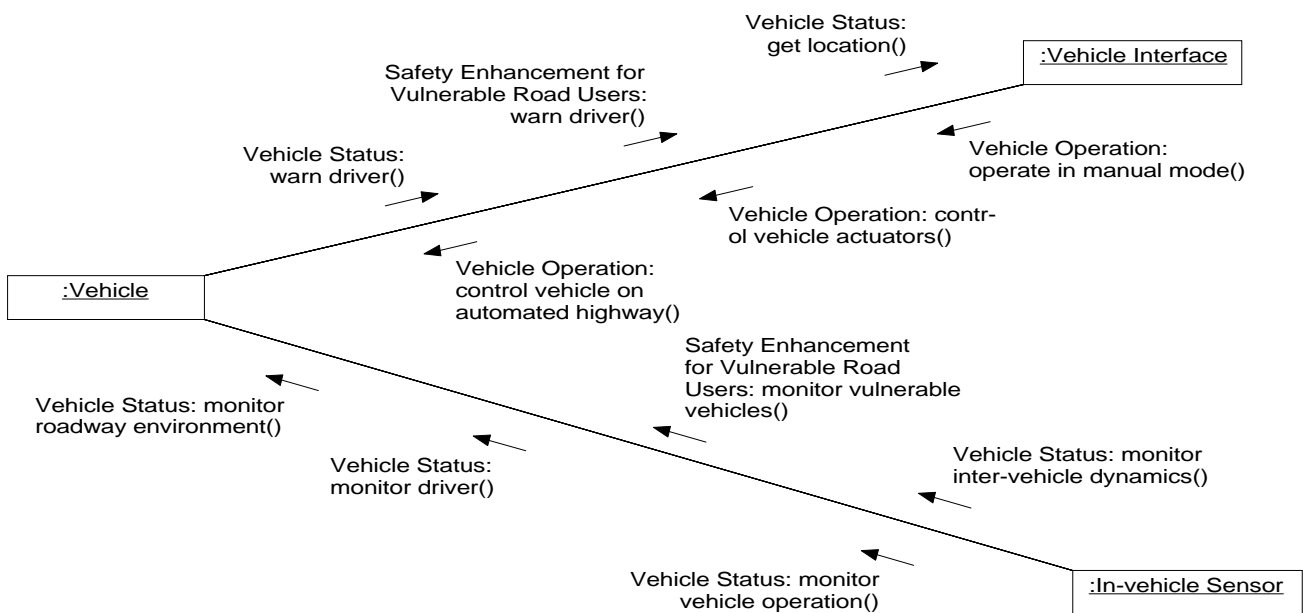
Figure 69 — Vehicle Package Interfaces

9.4 Events Interfaces

The collaboration between the Events classes and the Interface classes is documented in Figure 70. The number of message types between collaborating pairs is summarised in Table 13.

Table 13 — Matrix count of Events class Interface class collaborations

|	Operating Interface	Special Vehicle Interface	Roadside Sensor	Travel Terminal
Incident Response	1			
Incident				
Emergency Response	1		3	
Emergency	4	2		4
Violation	3			
Pollution			1	
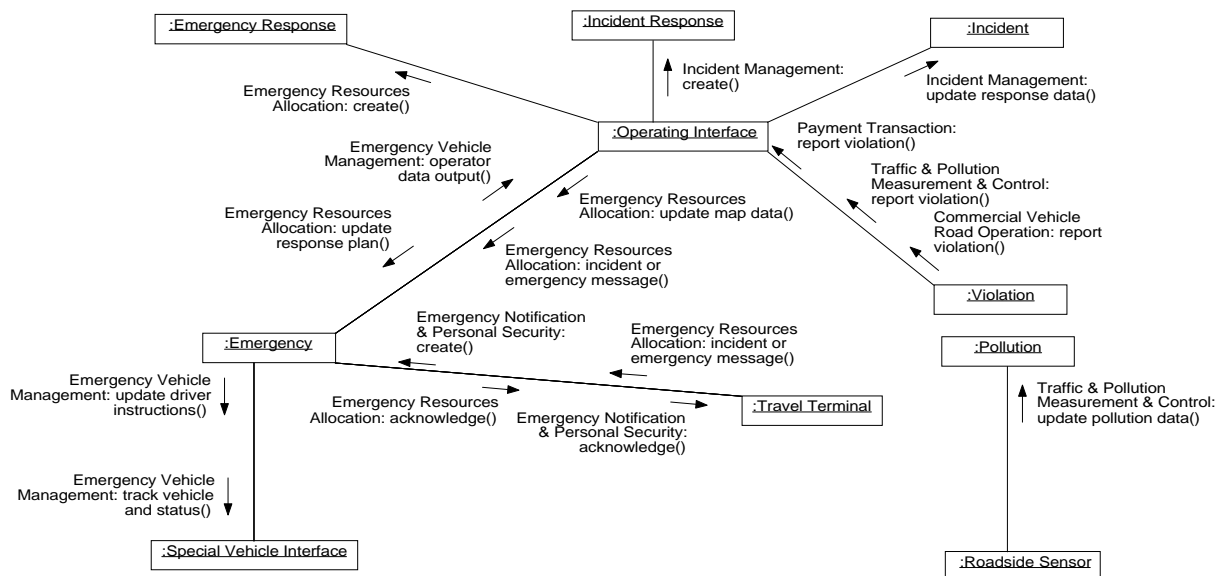
Figure 70 — Events Package Interfaces

9.5 Payment Interfaces

The collaboration between the Payment classes and the Interface classes is documented in Figure 71. The number of message types between collaborating pairs is summarised in Table 14.

Table 14 — Matrix count of Payment class Interface class collaborations

	Operating Interface	Travel Terminal
Yellow Pages	4	3
Billing Record	1	1
Tariff	2	
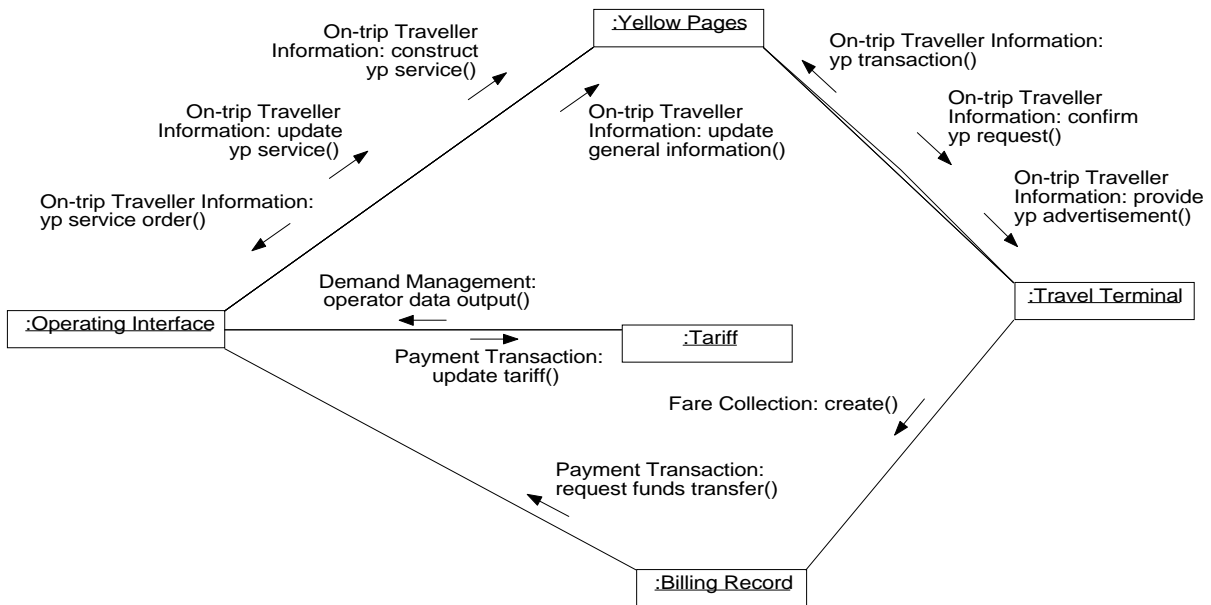
Figure 71 — Payment Package Interfaces

10 Dependencies between Packages

The control and information classes defined in 8.1 to 8.5 interact as shown in the sequence diagrams of Clause 7. The collaboration between the classes of the various packages is documented in the following clauses.

Each clause contains a diagram with a collaboration linkage shown between each pair of classes in different packages for which there is a corresponding message in the sequence diagrams of clause 7. There may be multiple messages between each class pair. The direction of the message from the originator is shown by arrow and the message is identified by a label of the form

Sequence Diagram:operation name

where the class of the operation can be derived by following the arrow direction on the diagram. For example, in Figure 72, there is a message from the class O-D Route of the Transport package to the Probe class of the Roadway package:

Route Guidance & Navigation:access route travel time(...).

10.1 Roadway - Transport Collaboration

The collaboration between the Roadway classes and the Transport classes is documented in Figure 72. The number of message types between collaborating pairs is summarised in Table 15.

Table 15 — Matrix count of Roadway class Transport class collaborations

	Roadway Group	Resource	Probe
O-D Route	8		1
Commercial Vehicle Tour	1	1	
Emergency Vehicle	1		
Commercial Vehicle	1	1	
Public Transport Schedule	6		

10.2 Roadway - Vehicles Collaboration

The collaboration between the Roadway classes and the Vehicles classes is documented in Figure 73.

10.3 Roadway - Events Collaboration

The collaboration between the Roadway classes and the Events classes is documented in Figure 74. The number of message types between collaborating pairs is summarised in Table 16.

:Probe

:O-D Route

Route Guidance &
Navigation: access route
travel time data()

Transportation Planning
Support: access
route data()

Route Guidance &
Navigation: access
prediction data()

Performance Evaluation:
access route data()

Transportation Planning
Support: access
travel data()

Route Guidance &
Navigation: access
traffic data()

:Emergency Vehicle

Performance Evaluation:
update long term data()

Demand Management: access
travel data()

Transportation Plannning
Support: access fleet
operational data()

Performance Evaluation:
access travel data()

Route & Schedule
Planning: request
service change()

Demand Management:
request service change()

Transportation Planning
Support: access public
transport operational
data()

:Roadway Group

Fixed Route Public Trans-
port: priority request()

Fixed Route Public
Transport: access public
transport priority data()

Fixed Route Public
Transport: access
prediction data()

:Public Transport Schedule

Transportation Planning
Support: access fleet
operational data()

Commercial Vehicle
Road Operation: classify
vehicle()

:Commercial Vehicle

Incident Management:
update incident data()

:Resource

:Commercial Vehicle Tour

Commercial Vehicle
Road Operation: log
trip segment()

Figure 72 — Roadway - Transport Collaborations

Vehicle Status: access c-
ollision avoidance data()

:Local Control Group

:Vehicle

Figure 73 — Roadway - Vehicles Collaborations
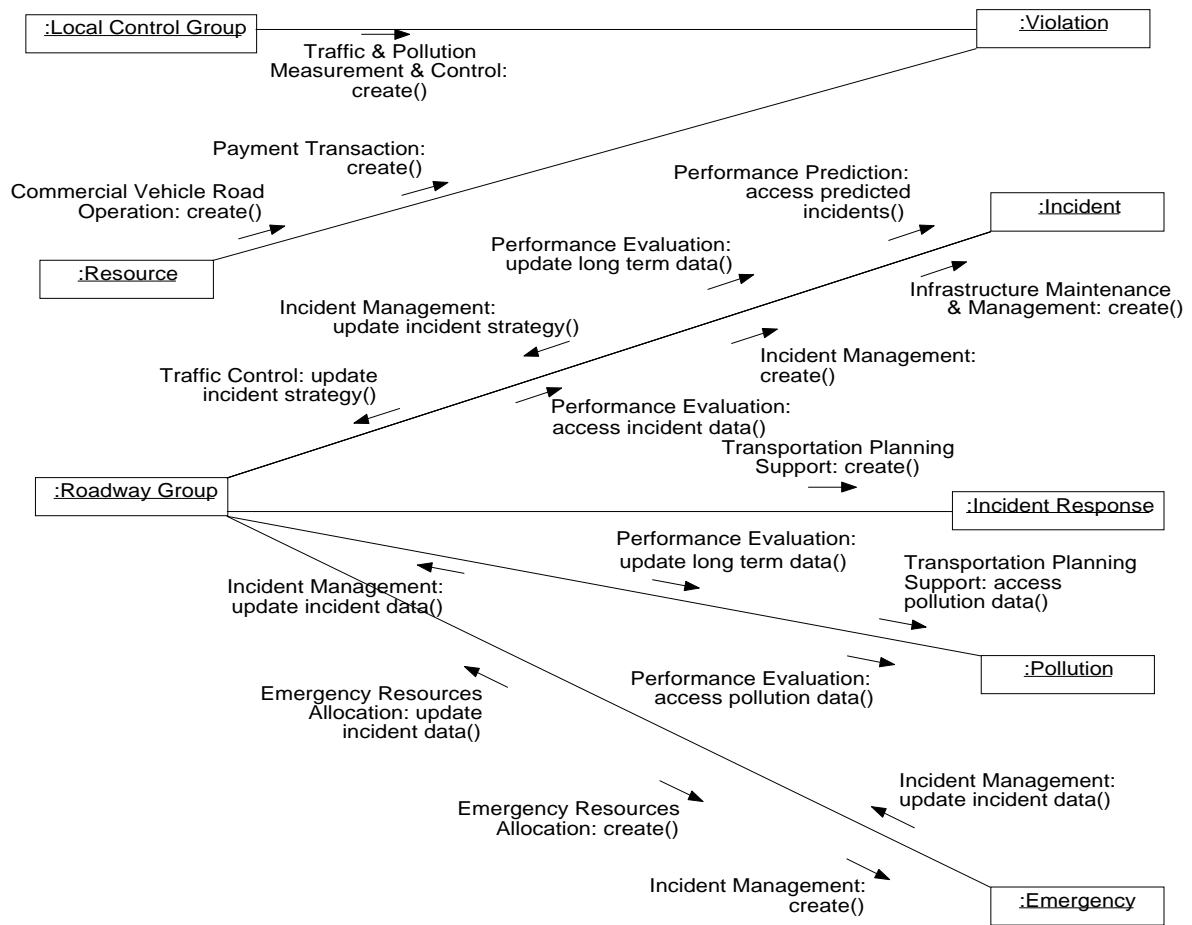
Figure 74 — Roadway - Events Collaborations

Table 16 — Matrix count of Roadway class Events class collaborations

	Local Control Group	Resource	Roadway Group
Violation	1	2	1
Incident			7
Incident Response			1
Pollution			4
Emergency			4

10.4 Roadway - Payment Collaboration

The collaboration between the Roadway classes and the Payment classes is documented in Figure 75. The number of message types between collaborating pairs is summarised in Table 17.
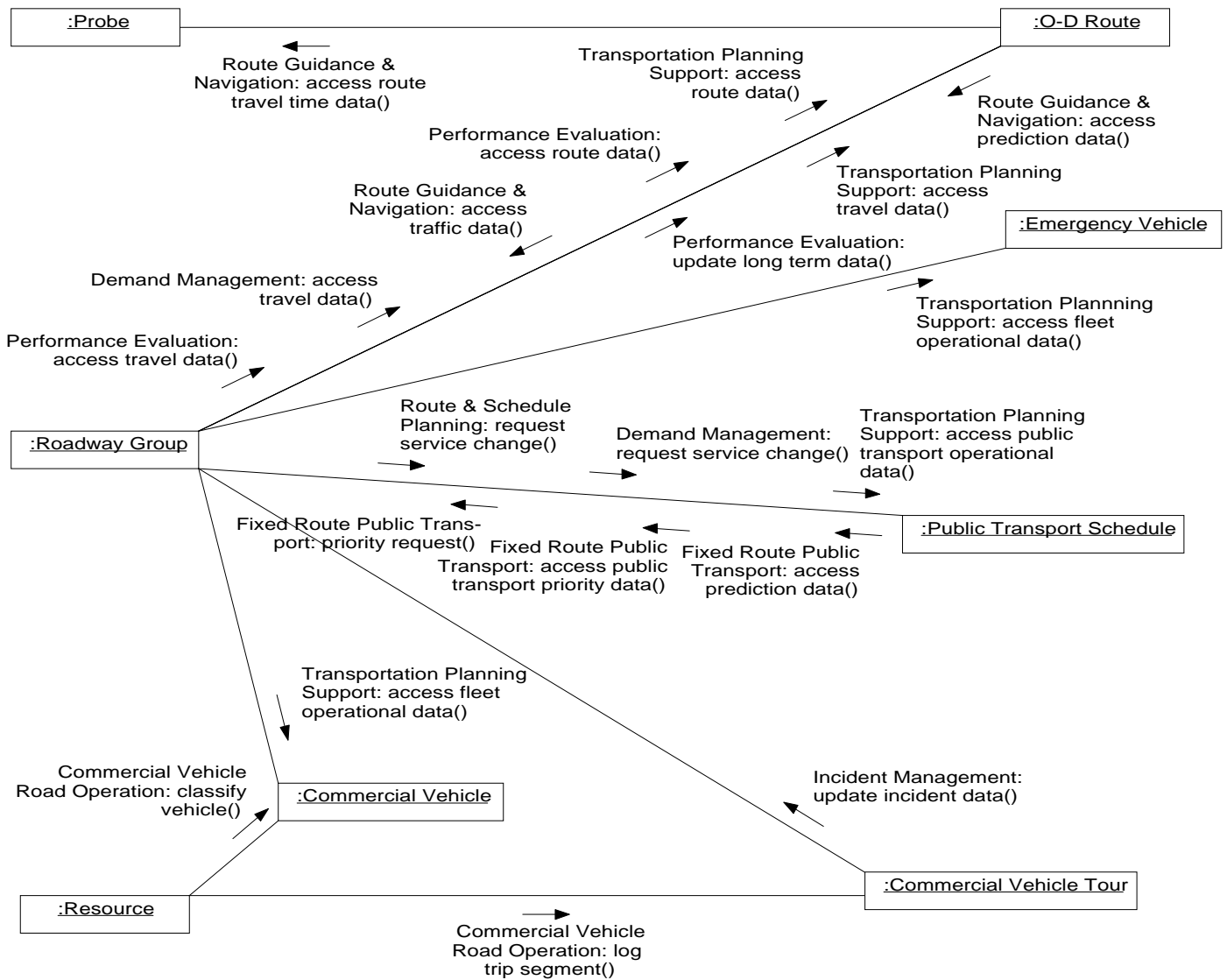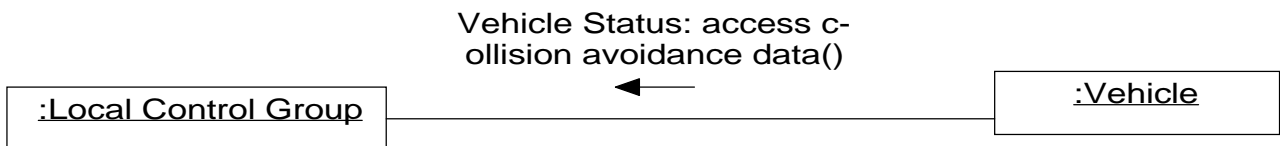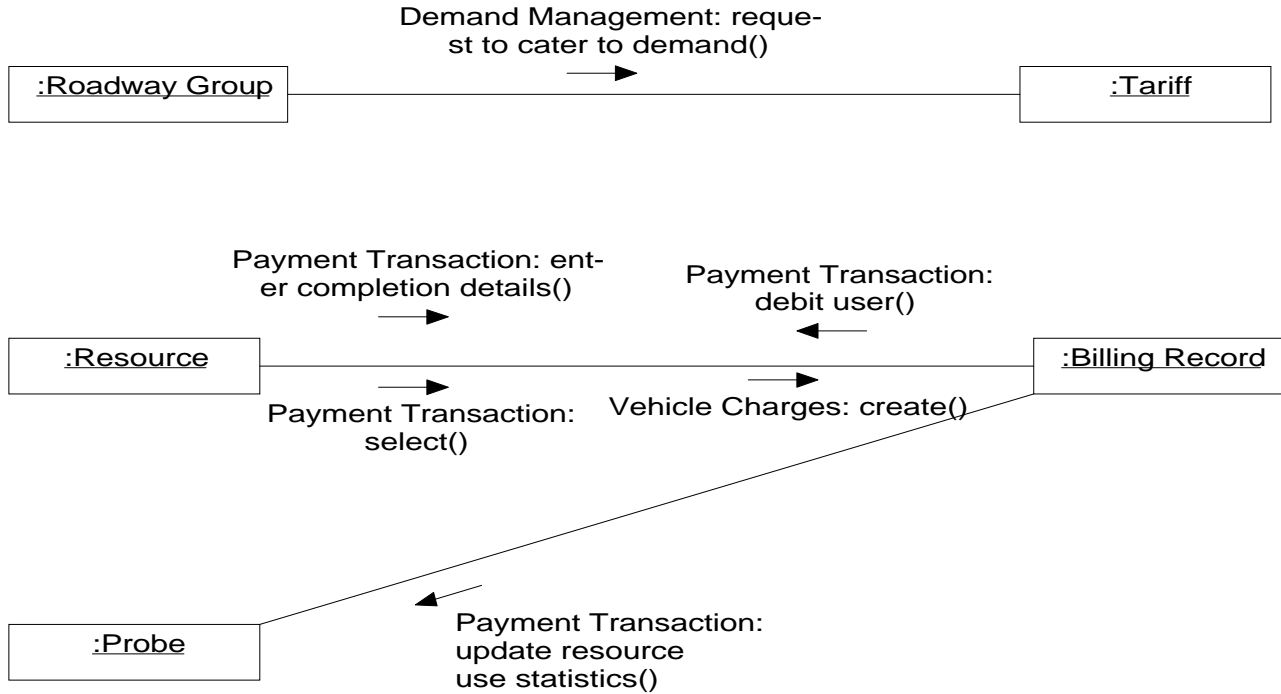

Figure 75 — Roadway - Payment Collaborations

Table 17 — Matrix count of Roadway class Payment class collaborations

	Probe	Resource	Roadway Group
Tariff			1
Billing Record		4	1

10.5 Transport - Events Collaboration

The collaboration between the Transport classes and the Events classes is documented in Figure 76.
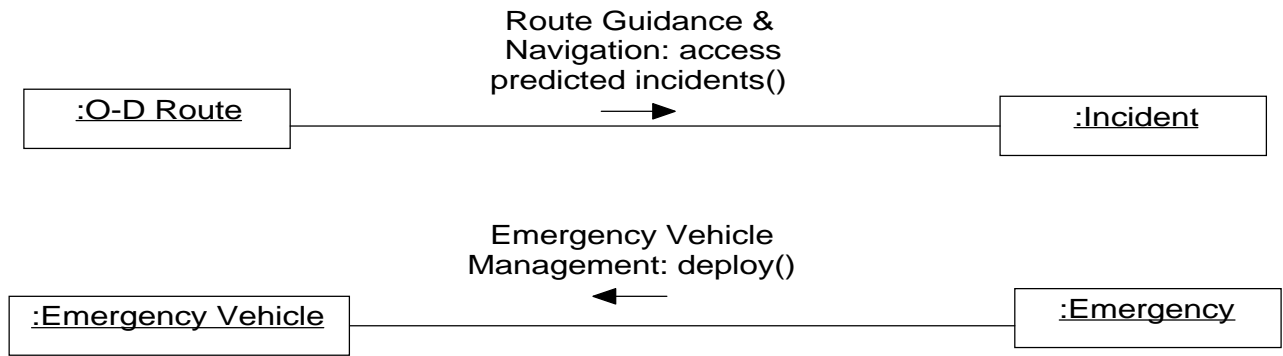
Figure 76 — Transport - Events Collaborations

10.6 Transport - Payment Collaboration

The collaboration between the Transport classes and the Payment classes is documented in Figure 77.

Figure 77 — Transport - Payment Collaborations

10.7 Vehicles - Events Collaboration

The collaboration between the Vehicles classes and the Events classes is documented in Figure 78.

Figure 78 — Vehicles - Events Collaborations

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Annex A
(informative)

Management and Information Centres Information Classes

The draft standard ISO 14827 **Message Format and Information Contexts for Traffic Management and Information Centres (TMIC)** h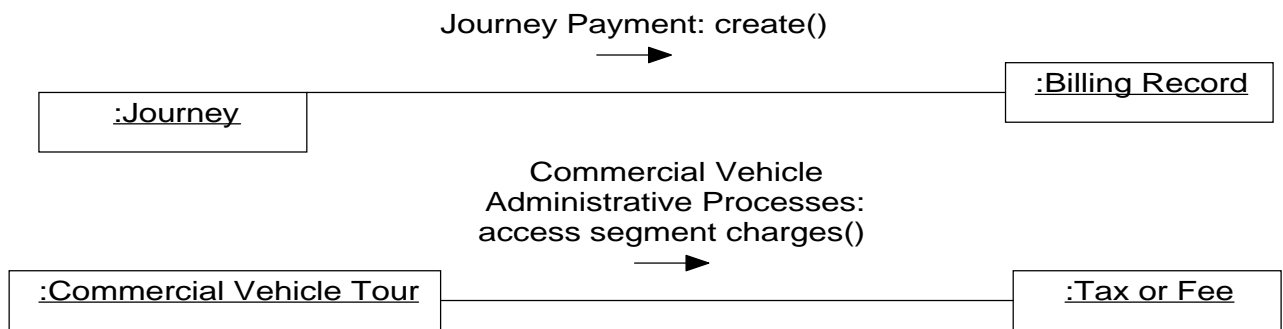as been used to derive an aggregation hierarchy of information classes used in classes and sequence diagrams pertinent to Traffic Management and Traveller Information classes. A data dictionary for these classes is given in this Annex. It is divided into nine clauses according to the tree defined in Figure A.1.

ISO 14827 is under revision by TC204/WG9 and the definitions given here are based on draft N173H, (1998-01-08). The descriptions of the data elements provided in N173H have been copied verbatim into this dictionary, except that the description is usually introduced with the words "This information class shall consists of...". The terminology used in N173H is not consistent with the object-oriented model and so terms such as "file" and "list" occur. The reader will have to translate these terms into appropriate object-oriented terms, (e.g. file and list might correspond to the members of a class, or to the attributes of a complex object).

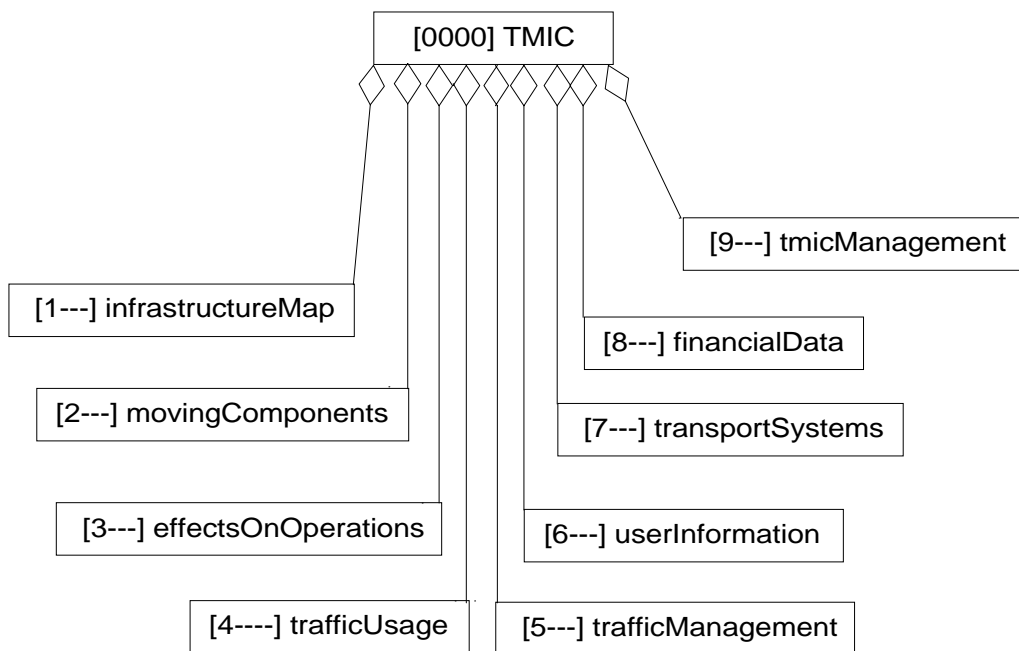In Figure A.1 the class [0000] TMIC is a virtual base class to define global attributes.

Figure A.1 — The top level of the naming tree for the information classes defined in the data dictionary

A.1 Infrastructure Map

[1---] infrastructureMap

These are maps of the static physical network. The units used at this level may be specified in DC[13].

Attributes:

name/address [[1---] infrastructureMap.] The name/address of the group responsible for the information class.

[11--] generalMap This aggregate information class shall consist of a layered map of a region, including its transport system. This base map describes all relevant geographic features of the region. It is desirably a digital, GIS - layered map in GDF format based on the work of TC204/WG3. The version (or revision or edition) is covered by the obligatory DC[14b]. All the map layers described elsewhere in [1---] are uniquely linked to the map. The contents of the map should be acceptable to all the traffic and transport operators using the system. The map can be formally authenticated by users, employing the DC[15] facility. The map publisher (or assembler or producer) is uniquely specified by mandatory attribute A1, and each layer publisher by attribute A2.

Attributes:

map name/ID [[11--] generalMap.] Identifying

region name/ID [[11--] generalMap.] Identifying

[111-] layer The map layer publisher (or assembler or producer) is uniquely specified by mandatory attribute.

Attributes:

layerID [[111-] layer.] Administrative.

publisher [[111-] layer.] Administrative.

[12--] transportMap These are facilities operated by the relevant service provider.

[121-] ptRoute This information class shall consist of a map layer of pt routes and stations. This is a map layer of pt routes, bus stops, train stations, access links, facilities for the handicapped, etc., with particular emphasis on road-based routes. pt schedules are covered in [721-].

Attributes:

ease of use of station [[121-] ptRoute.] Definitional Attribute.

fare structure [[121-] ptRoute.] Definitional Attribute.

link travel time [[121-] ptRoute.] Definitional attribute. Should be considered for both light and congested conditions and for both normal and handicapped travellers.

time for passenger to traverse station [[121-] ptRoute.] Definitional attribute. The transfer process associated with Definitional attribute is described in [75--].

transit type [[121-] ptRoute.] Identifying attribute. Will cover whether heavy rail, light rail, bus, etc.

[122-] transportNode

[1221] parkingFacility This information class shall consist of a map layer of parking facilities. This is a map layer locating car parks and parking stations.   The supply of available spaces is covered in [7131].

Attributes:

usage fees [[1221] parkingFacility.] Definitional attribute.

[1222] freightTerminal This information class shall consist of a map layer of freight terminals. The supply of available spaces is covered in [7133].

Attributes:

usage fees [[1222] freightTerminal.] Definitional attribute.

[1223] rideSharePickup   This information class shall conist of a map layer of ride-share pick-up points. This is a map layer of nominated pick-up points in an endorsed ride-share (car-pooling) system.

Attributes:

organiser's name/ID [[1223] rideSharePickup.] Identifying attribute.

ride-share rules [[1223] rideSharePickup.] Definitional attribute.

[1224] ptStation   This information class shall consist of a map layer of pt stations. This map layer will often be incorporated into [121-]. Station includes any pt passenger access point.

Attributes:

station ID [[1224] ptStation.] Identifying 1

station access parameters [[1224] ptStation.] Definitional attribute

[13--] roadMap

[131-] travelledWay   Road (or link, although link often involves direction) includes bridges, ferries, and tunnels. Routine operating characteristics are covered in [132-], as all roads are considered to be comprised of operating lanes.Short-term closures would be initially noted in [132-]. However, [1311] will subsequently be updated if an entire road closes, is blocked, becomes impassable, or reopens.

Attributes:

chainage [[131-] travelledWay.]

classification/type [[131-] travelledWay.] Identifying 2

name/ID [[131-] travelledWay.] Identifying 1

[1311] roadLayer   This information class shall consist of a map layer of the road network, its links and nodes, and their connectivity. This layer gives the location of the road network. It also gives the distance (chainage) along the road, from some defined but arbitrary datum, which is used often used to locate road features.

Attributes:

link average travel time [[1311] roadLayer.] Definitional attribute.

[1312] pathLayer   This information class shall consist of a map layer of independent paths. This layer gives the independent paths, usually restricted to pedestrians, bicycles and similar vehicles. Various jurisdictions will use attribute Definitional attribute differently.

Attributes:

cross-section [[1312] pathLayer.] Definitional attribute.

surfacing [[1312] pathLayer.] Definitional attribute.

user restrictions [[1312] pathLayer.] Definitional attribute.

[1313] emergency Route This information class shall consist of a map layer of emergency routes, for pre-agreed emergencies. This is a map layer that gives routes for defined emergencies such as snow, flood, fire, and blocked one-way routes.

[132-] roadComponent

[1321] laneLayer This information class shall consist of a map layer of the location and geometry of a nominated length of lanes, medians, islands, shoulders, and kerb-side paths. This layer includes road shoulders and on- and off- ramps. This layer gives operating characteristics - other than those in [1322] & [512] - of each lane. It gives the lane data, including lane-marking and lane width.

Attributes:

HOV limits [[1321] laneLayer.] Definitional attribute.

behavioural limits [[1321] laneLayer.] Definitional attribute. Covers such items as restrictions on overtaking, horn usage, etc.

classification [[1321] laneLayer.] Identifying attribute. Includes such designations as emergency lane.

dimensional restraints [[1321] laneLayer.] Definitional attribute. Helps to indicate whether the shoulders are trafficable in an emergency [1313].

direction of traffic flow [[1321] laneLayer.] Definitional attribute.

esa limits [[1321] laneLayer.] Definitional attribute.

flow capacity [[1321] laneLayer.] Definitional attribute. Directly reflects the effects of a full or partial lane closure due to events in [32],or due to a road closure - [1311].

hazards [[1321] laneLayer.] Definitional attribute.

lane marking [[1321] laneLayer.] Definitional attribute.

lane width [[1321] laneLayer.] Definitional attribute. Helps to indicate whether the shoulders are trafficable in an emergency [1313].

mass limits [[1321] laneLayer.] Definitional attribute.

name/ID [[1321] laneLayer.] Identifying attribute.

other limits [[1321] laneLayer.] Definitional attribute.

parking rules [[1321] laneLayer.] Definitional attribute.

safe operating speed [[1321] laneLayer.] Definitional attribute.

speed limit [[1321] laneLayer.] Definitional attribute.

surfacing [[1321] laneLayer.] Definitional attribute. Helps to indicate whether the shoulders are trafficable in an emergency [1313].

type [[1321] laneLayer.] Definitional attribute.

vehicle-type limits [[1321] laneLayer.] Definitional attribute. Includes lanes for express vehicles, high occupancy vehicles, slow vehicles, overtaking vehicles, trailers or specified vehicle types, using [211-212].

[1322] intersectionGeometry This information class shall consist of a map layer of the location and geometry of lanes and channelisation islands, for a nominated intersection. This layer gives geometric details of the individual lanes through and within an intersection. Intersections are also called nodes & junctions.

Attributes:

behavioural limits [[1322] intersectionGeometry.] Definitional attribute.

dimensional restraints [[1322] intersectionGeometry.] Definitional attribute.

direction of traffic flow [[1322] intersectionGeometry.] Definitional attribute.

hazards [[1322] intersectionGeometry.] Definitional attribute.

mass limits [[1322] intersectionGeometry.] Definitional attribute.

name/ID [[1322] intersectionGeometry.] Identifying attribute.

node ID [[1322] intersectionGeometry.] Administrative attribute.

other limits [[1322] intersectionGeometry.] Definitional attribute.

surfacing [[1322] intersectionGeometry.] Definitional attribute.

type [[1322] intersectionGeometry.] Identifying attribute.

vehicle-type limits [[1322] intersectionGeometry.] Definitional attribute.

[1323] turningMovements This information class shall consist of a map layer of the individual turning movements for each entry lane, for a nominated intersection. This layer gives details of the individual turning movements (or streams or manoeuvres) within an intersection.   There is usually more than one movement per entry or exit lane.

Attributes:

average time to traverse the movement [[1323] turningMovements.] Definitional attribute. The sum of the average delay at control device and the actual time to travel through the movement.

laneID [[1323] turningMovements.] Administrative attribute.

name/ID [[1323] turningMovements.] Identifying attribute.

nodeID [[1323] turningMovements.] Identification 1

saturation volume per unit of green time [[1323] turningMovements.] Definitional attribute. Volume is the number of vehicles, flow is the rate at which they pass a point.

type [[1323] turningMovements.] Identifying attribute.

[1324] drawingLayer This information class shall consist of a map layer showing the associated engineering drawings. This layer gives cross-links to the land title, planning, road reservation, and engineering drawings for the road, including data on utility services and vertical levels.

Attributes:

drawing number [[1324] drawingLayer.] Identifying 1

[133-] roadFacility This information class shall consist of a map layer of roadside-related service facilities. These map layers cover all the traffic management facilities.

Attributes:

name/ID [[133-] roadFacility.] Identifying attribute.

[1331] roadsidePublicFacility This is a map layer of all public facilities such as toilets, tourist aids, rest areas, emergency call facilities [443], emergency assembly areas, and rescue points (e.g. helipads), and the dedicated lanes serving them. Commercial services are in [135-].

[1332] roadmanagementDepot This is a map layer of all road maintenance depots and the dedicated lanes serving them.

[1333] serviceFacility This is a map layer of toll booths, customs points, etc. and any dedicated lanes providing non-public access to them.

[134-] tmFacility This information class shall consist of a map layer of facilities. These map layers cover all the traffic management facilities.

Attributes:

name/ID [[134-] tmFacility.] Identifying 1

[1341] tmStaticDeviceNetwork This information class shall consist of a map layer of tm facilities. This is a map-layer of fixed, stand-alone signs. The operational effect of the sign is covered in [5133].

[1342] tmSystemDevice This informatin class shall consist of a map layer of tm facilities. This is a map layer of tm devices actively connected to the tm system and located near the road. The attributes include an ID for each device. The operational effect of the device is covered in [5134].

[1343] environmentalMonitor This information class shall consist of a map layer of tm facilities. This is a map layer of devices monitoring the roadside environment.

[1344] automatedHighway This information class shall consist of a map layer of tm facilities. This is a map layer of automated highway devices (US ITS program).

[1345] userCommunication This information class shall consist of a map layer of the communications facilities presented to the user. This map layer covers the transmitters and receivers of tm messages.

[1346] communicationNetwork   This information class shall consist of a map layer of the communications network supporting [1165].   This map layer covers the associated communications links installed within the transport reservation and supporting [1342].

[135-] commercialService

Attributes:

name/ID [[135-] commercialService.] Identifying 1

[1351] roadsideServices This information class shall consist of a map layer of each commercial service, using a pre-agreed list. This is a map layer of relevant commercial ventures, such as fuel sellers, accessible from the transport facility.

[1352] yellowPages This information class shall consist of a map layer of each entry, in a manner specified by Yellow Pages. These are map layers linked to the local yellow pages listing commercial businesses, and will often contain more data than [1351].

[1353] InformationProvider This information class shall consist of a map layer of each information provider, using a pre-agreed list. This is a map layer of the various providers of tm information.

A.2 Moving Components

[2---] movingComponents

Attributes:

name/address [[2---] movingComponents.] The name/address of the group responsible for the information class.

[21--] vehicles This data may also be collected by Agencies within the system.

Attributes:

vehicle ID [[21--] vehicles.] Identification 1

[211-] individualVehicleID

[2111] vehicleLicence This information class shall link a detected vehicle ID to other attributes (a file produced by others). a. Vehicle ID itself is a data object and can be detected by a range of devices. The ID may be permanent or temporary. A permanent vehicle ID is commonly called a vehicle registration or vehicle licence. b. Compared to the vehicle ID discussed in a, [2111] is a complex object as it is a file linking the vehicle ID to official vehicle records, and thus to data on the characteristics of the vehicle in terms of class (or type) [2112], mass [2113], and dimension [2114], possibly to engine (VIN) numbers, and other attributes such as colour and body type.Most jurisdictions have classification schemes defining motorcycles, cars, small trucks, large trucks, etc. Often, a vehicle will be classified according to a number of different schemes. c. There is also a link to vehicle ownership and, possibly, to the driver licence data in [221-].

Attributes:

vehicle attributes [[2111] vehicleLicence.] Definitional attribute. including those in [2112] to [2116]

vehicle characteristics [[2111] vehicleLicence.] Definitional attribute.

vehicle ownership [[2111] vehicleLicence.] Definitional attribute.

vehicle type [[2111] vehicleLicence.] Definitional attribute.

[2112] vehicle AVI This information class shall link a detected vehicle AVI ID to other attributes (a file produced by others). Tolling and AVI organisations may have other files linking their vehicle ID to specific customer data.

Attributes:

customer data [[2112] vehicle AVI.] Representational 1

vehicle licence [2111] [[2112] vehicle AVI.] Representational 2

[2113] vehicleLadenMass This information class shall consist of the mass measured in [4111]. This refers to the laden mass of the vehicle. The unladen mass would be included in [2114]. The item may also cover axle masses.

Attributes:

comparison [[2113] vehicleLadenMass.] Definitional attribute. a comparison with the maximum permitted masses in [2111] and [2117],

possibility of a prosecution [[2113] vehicleLadenMass.] Definitional attribute.   the need for a prosecution to be initiated in [613-].

[2114] vehicleDimension This information class shall consist of a dimension measured in [4111] or reported by operators. This includes length, width, height, unladen mass and, typically, the number of axles and engine power.

Attributes:

comparison [[2114] vehicleDimension.] Definitional attribute. comparison with the maximum permitted dimensions in [2111] and [2117

need for a prosecution [[2114] vehicleDimension.] Definitional attribute. the need for a prosecution to be initiated in [613-].

[2115] unusualVehicle This information class shall consist of a list of vehicles identified using the vehicle ID [2111] and exempt from meeting specified requirements in Definitional attribute = [2113] and Definitional attribute = [2114]. This covers vehicles which are outside the standard classification in [2112] or the unladen properties in [2114] , but have been given a special or temporary permit to operate.

Attributes:

[2113] [[2115] unusualVehicle.]

[2114] [[2115] unusualVehicle.]

[2116] exceptionalVehicle This information class shall consist of a list of vehicles identified using the vehicle ID [2111] and exempt from meeting specified requirements in Definitional attribute = [2113] and Definitional attribute = [2114]. This covers vehicles whose laden mass or configuration takes them outside the limits in [2113] and [2114], but have been given a special permit to operate, often only over a specific route.

Attributes:

[2113] [[2116] exceptionalVehicle.]

[2114] [[2116] exceptionalVehicle.]

[2117] vehicleRouteLimit This information class shall consist of a map-layer derived from [1311] and showing those links and nodes on which a vehicle cannot operate due to its attributes. This lists routes [1311] that nominated vehicles [2111-2] cannot use.

Attributes:

dimension [[2117] vehicleRouteLimit.] Definitional attribute. [2114]

freight [[2117] vehicleRouteLimit.] Definitional attribute. [224-]

mass [[2117] vehicleRouteLimit.] Definitional attribute. [2113]

occupancy [[2117] vehicleRouteLimit.] Definitional attribute. [71--]

type [[2117] vehicleRouteLimit.] Definitional attribute. [2111]

[212-] governmentID This information class shall consist of (a list of) the vehicles that an Agency wishes to have identified in the manner indicated. The label is established by entering the vehicle ID [2111] into a P file supplied by the Agency. This lists the various fleets using the system.

[2121] vip This information class shall consist of a supplied list of the IDs of vehicles [2111] requiring VIP treatment.

[2122] taxi This information class shall consist of a supplied list of taxi IDs, linked to industry lists.

[2123] bus This information class shall consist of a supplied list of the IDs of buses. Other pt vehicles are covered in [2129].

[2124] truck This information class shall consist of a supplied list of the IDs of trucks. Trucks are also called commercial vehicles and in this item the term covers all vehicles in managed fleets, and not necessarily vehicles classified as trucks in [2112].This is a list supplied by a truck company or operator or fleet manager to permit its special needs and features to be addressed. The list comprises the IDs of the trucks and other fleet vehicles and can be supplemented by data in [211].

[2125] policeVehicle This information class shall consist of a supplied list of the IDs of police vehicles.

[2126] emergencyVehicle This information class shall consist of a supplied list of the IDs of emergency service vehicles.

[2127] recreationalVehicle This information class shall consist of a supplied list of the IDs of caravans, campers, and off-road vehicles, if they require special IDs in the local system.

[2128] operationalVehicle This information class shall consist of a supplied list of the IDs of vehicles used by the operating agency - such as patrol vehicles - and which may have special privileges.

[2129] ptFixedTrackVehicle   This information class shall consist of a supplied list of the IDs of pt vehicles operating on a fixed track. Buses are covered by [2123].

[213-] policeListing This information class shall consist of a list of the vehicles that an Agency wishes to have identified in the manner indicated. The label is established by entering the vehicle ID [2111] into a P file supplied by the Agency. This is a list of vehicle IDs supplied by the police.

[2131] stolenVehicle

[2132] criminalsVehicle

[2133] dangerousVehicle

[214-] vehicleCondition

[2141] engineStatus This information class shall consist of data on engine status, with the specific definition supplied by others. It is linked to the general [2111] or specific [2121 - 2129] vehicle ID. This provides for data on engine performance provided by in-vehicle or roadside monitoring devices

[2142] snowTyres This information class shall consist of a list of devices to handle snow conditions which have been noted as being fitted to the vehicle, identified by its vehicle ID [2111]. This indicates whether the vehicle is equipped for snowy conditions - {3114], [3143] & [3223] - particularly with chains or studded tyres. Advice on using snow tyres is given in [671-].

[22--] transportedObjects

[221-] driverLicence This information class shall consist of a list supplied from the driving licence file.

[2211] nameAndAddress This information class shall consist of basic personal data about a driver in files supplied by others, particularly name and address. It is linked to the driver's ID [221-]. This is a list supplied from the driving licence file.

Attributes:

address [[2211] nameAndAddress.] Definitional attribute.

name [[2211] nameAndAddress.] Definitional attribute.

[2212] licenceClass This information class shall consist of limits placed on the time, duration, manner, or vehicle [2111] that can be driven by the driver. This places conditions on how and what the driver can drive.

Attributes:

duration [[2212] licenceClass.] Definitional attribute.

manner [[2212] licenceClass.] Definitional attribute.

time [[2212] licenceClass.] Definitional attribute.

vehicle [[2212] licenceClass.]

[2213] governmentID This information class shall consist of other government IDs, such as passport numbers, linked to the driver ID [221-], in a file supplied by others. As supplied for a specific purpose, e.g passport number

[2214] commercialID   This information class shall consist of commercial IDs, such as credit card numbers, linked to an existing ID such as the driver [221-] or passenger [2222] ID. As supplied for a specific purpose, e.g. credit card number

[222-] ptPassengers

[2221] passengerNumbers This information class shall consist of the number of passengers in a pt vehicle, linked to the vehicle ID [2123] & [2129]. This is a supplied list of passenger numbers.

[2222] passengerData This information class shall consist of passenger attributes. This is a supplied, an optional, list of data on the passengers and their trip.

Attributes:

destination [[2222] passengerData.] Definitional attribute.

origin [[2222] passengerData.] Definitional attribute.

personal ID [[2222] passengerData.]

ticket ID [[2222] passengerData.]

[2230] cargoData This information class shall consist of description of freight linked to the vehicle ID [2111]. This is a supplied list of freight carried - e.g. the loading documents for the current trip. These documents are often available in computer-readable form, usually in EDIFACT. Although shown in bold font, this data may also be collected by Agencies within the system.

Attributes:

commercial documentation [[2230] cargoData.]

legal documentation [[2230] cargoData.]

type of freight being carried [[2230] cargoData.] Definitional attribute.

value [[2230] cargoData.] Definitional attribute.

[2240] hazardousCargo This information class shall consist of a report of the hazardous cargo being carried in terms of International Standard XXXX, linked to the vehicle ID [2111]. This is a list supplied by others and usually reflecting legal requirements for the reporting of the movement of hazardous cargo. The data could be used for prosecution.

[225-] specialObject

[2251] emergencyObject This information class shall consist of a list of the IDs of the people or cargo in the particular category being carried, linked where possible to the vehicle ID [2111]. This is a list supplied by others of emergency passengers or cargo, such as sick people in ambulances, or blood supplies.

[2252] illegalObject This information class shall consist of a list of the IDs of the people or cargo in the particular category being carried, linked where possible to the vehicle ID [2111]. This is a list supplied by others of illegal passengers or cargo, such as people or property wanted by the police.

A.3 Effects on Operations

[3---] effectsOnOperations

This information class excludes traffic events.

Attributes:

name/address [[3---] effectsOnOperations.] The name/address of the group responsible for the information class.

[31--] externalToRoad This covers all external emergencies. These and other alerts and alarms are listed in [3163].

[311-] generalWeather This information class shall consist of components defined according to WMO standards. These are routine weather reports of current (present) weather and forecasts supplied by standard weather sources. Forecasts are indicated using message element characteristics [3c] and[3d]. The area covered is indicated using [1111]. Maximum and minimum values and their times of occurrence may also be recorded. See also [311-] where exceptional events are reported. These cover emergencies away from the system but with the potential to impact on travel on the system. This data may also be collected by Actors.   These are routine weather reports of current (present) weather and forecasts supplied by standard weather sources. Forecasts are indicated using message element characteristics [3c] and[3d]. The area covered is indicated using[1111]. Maximum and minimum values and their times of. occurrence may also be recorded. See also [311-] where exceptional events are reported. These cover emergencies away from the system but with the potential to impact on travel on the system. Although shown in bold font, this data may also be collected by Agencies within the system.

Attributes:

quantity [[311-] generalWeather.] Definitional attribute. quantity defined in WMO 8, M

[3111] weatherType Representation is by quantity defined in WMO 8, 4 Weather type includes cloud cover and type.

[3112] airTemperature Representation is by quantity defined in WMO 8, 1

[3113] surfaceTemperature Representation is by quantity defined in WMO 8, 7 This includes solar radiation.

[3114] windSpeed Representation is by quantity defined in WMO 8, 5.1&3

[3115] windDirection Representation is by quantity defined in WMO 8, 5.2

[3116] humidity Representation is by quantity defined in WMO 8, 2

[3117] atmosphericPressure Representation is by quantity defined in WMO 8, 3

[3118] rainfall Representation is by quantity defined in WMO 8, 6 This includes hail and freezing rain.

[3119] snowfall Representation is by quantity defined in WMO 8, 6.2

[311A] visibility The localised effect is in [3229].

[312-] backgroundEffect These are routine weather reports of current (present) weather and forecasts supplied by standard weather sources. Forecasts are indicated using message element characteristics [3c] and[3d]. The area covered is indicated using [1111]. Maximum and minimum values and their times of occurrence may also be recorded. See also [311-] where exceptional events are reported. These cover emergencies away from the system but with the potential to impact on travel on the system.

[3121] backgroundPollution This information class shall consist of measurements in a pre-agreed format, of region-wide pollution. This gives the background (ambient) air pollution for the region and is uses in conjunction with [4141].

[3122] backgroundNoise This information class shall consist of measurements in a pre-agreed format, of ambient noise. This gives the background (ambient) noise for the region and is used in conjunction with [4144].

[313-] naturalEvent This class shall consist of components which are located according to [113-] and defined according to pre- agreed regional notification, warning, alerting, and response plans. These are routine weather reports of current (present) weather and forecasts supplied by standard weather sources. Forecasts are indicated using message element characteristics [3c] and[3d]. The area covered is indicated using [1111]. Maximum and minimum values and their times of occurrence may also be recorded. See also [311-] where exceptional events are reported.

[3131] earthquake Typical attributes would include the type of seismometer, seismic coefficient, SI value, X, Y & Z acceleration.

[3132] tidalWave This includes tsunami.

[3133] eruption

[3134] volcanicAsh This is a special case of [3133].

[3135] fire This includes smoke.

[3136] insectsOrBirds This includes swarms of insects and flocks of birds.

[314-] localWeather This information class shall consist of components defined according to WMO standards, emphasising their extreme nature. This covers weather extremes, relative to the routine weather reporting in [311-]. These are events external to the road and not near the roadside and which are reported in a pre-agreed format. These use the. WMOvii definitions

Attributes:

prediction [[314-] localWeather.] Definitional attribute. Prediction of effect on driving.

[3141] dustStorm This uses the WMO definition and includes sandstorms.

[3142] severeWind This includes blizzards and the extremes of [3114].

[3143] flood This may lead to [3217] or [3224].

[3144] snowStorm

[3145] fogAndSmog This includes smoke, haze, dust, sand, haze, mist and fog.

[3146] hailAndSleet

 [3147] thunderStorm

 [3148] heavyRain

[315-] roadsideIncidents This is an information class. These are events near the roadside and which are reported in a pre-agreed format, including an estimate of their effect on traffic

Attributes:

effect [[315-] roadsideIncidents.] Definitional attribute. Effect on lane capacity and safe speed.

media response [[315-] roadsideIncidents.] Definitional attribute.

process [[315-] roadsideIncidents.] Definitional attribute. Process for rectifying the consequences.

response [[315-] roadsideIncidents.] Definitional attribute. Traffic management response

[3151] roadsideFire

[3152] landSlide This includes mudslides.

[3153] snowSlide Or avalanche.

[3154] gasLeak

[3155] radioactiveLeak

[316-] serviceFailure This is an information class. These are events near the roadside and which are reported in a pre-agreed format, including an estimate of their effect on traffic

Attributes:

effect [[316-] serviceFailure.] Definitional attribute. Effect on lane capacity and safe speed.

media response [[316-] serviceFailure.] Definitional attribute.

process [[316-] serviceFailure.] Definitional attribute. Process for rectifying the consequences.

response [[316-] serviceFailure.] Definitional attribute. Traffic management response

[3161] powerFailure

[3162] majorEmergency This covers events not covered elsewhere in [311] and which may impact on transport operations. It is often associated with a Mayday message other than as in [3166].

[3163] publicThreat Includes bomb and demolition threats.

[3164] industrialAction Includes strikes.

[3165] facilitiesClosed Covers situations where essential roadside services area unavailable.

[3166] alertsAndAlarms This information class shall consist of a list of all alerts and alarms issued for the region by others. This lists any alerts, alarms, and mayday messages issued for the region by others - many may be used in [31--].

[32--] atRoad

[321-] objectsOnRoad This information class shall consist of components which are located according to[113-] and defined according to pre-agreed regional notification, warning, alerting, and response plans for each of these events. These are events on the road and which are reported in a pre-agreed format, including an estimate of their effect on traffic.

Attributes:

effect on lane capacity and safe speed [[321-] objectsOnRoad.] Definitional attribute.

media response [[321-] objectsOnRoad.] Definitional attribute.

process for rectifying the consequences [[321-] objectsOnRoad.] Definitional attribute.

traffic management response [[321-] objectsOnRoad.] Definitional attribute.

[3211] unauthorisedPedestrian   Includes mobs, spectators & pedestrians crossing the road and children playing on the road.

[3212] animal

[3213] fallenFreight This includes liquids spilt from a container on a vehicle.

[3214] fallenRock

[3215] fallenTree

[3216] fallenUtilityLines

[3217] waterFlow This could derive from events in [3143]. Stationary water is covered in [3224].

[3218] chemicalOrOilSpill This includes fuel and oil spillages.

[322-] roadSurface This information class shall consist of components which are located according to[113-] and defined according to pre-agreed regional notification, warning, alerting, and response plans for each of these events. These are natural events on the road and which are reported in a pre-agreed format, including an estimate of their effect on traffic.

Attributes:

effect on lane capacity and safe speed [[322-] roadSurface.] Definitional attribute.

media response [[322-] roadSurface.] Definitional attribute.

process for rectifying the consequences [[322-] roadSurface.] Definitional attribute.

traffic management response [[322-] roadSurface.] Definitional attribute.

[3221] iceySurface This includes the effects of frost, hail and freezing rain [3118].

Attributes:

effect on lane capacity and safe speed [[3221] iceySurface.] Definitional attribute.

media response [[3221] iceySurface.] Definitional attribute.

process for rectifying the consequences [[3221] iceySurface.] Definitional attribute.

traffic management response [[3221] iceySurface.] Definitional attribute.

[3222] blackIce

[3223] snowySurface This may be the result of either a storm [3114], slide [3143], or avalanche [3134].

[3224] waterOnRoad This is for puddles, rather than the flow in [3217].

[3225] leavesOnRoad

[3226] mudOnRoad This includes mud from truck tyres.

[3227] surfaceEnhancement This covers unschedulable work such as gritting or salting icy surfaces [4133], or clearing snow. See [3243] for scheduled work

[3228] looseStones This covers both chippings from road surfacing operations and unsurfaced roads.

[3229] visualRange This includes the visibility distance, as influenced by such weather events [311-] as particulates, mist/fog [3145], rain and snow. The overall effect is in [314A].

[323-] roadStructure This information class shall consist of components which are located according to[113-] and defined according to pre-agreed regional notification, warning, alerting, and response plans for each of these events. These are reports on detrimental developments in the condition of the road. These are natural events on the road and which are reported in a pre-agreed format, including an estimate of their effect on traffic.

Attributes:

effect on lane capacity and safe speed [[323-] roadStructure.] Definitional attribute.

media response [[323-] roadStructure.] Definitional attribute.

process for rectifying the consequences [[323-] roadStructure.] Definitional attribute.

traffic management response [[323-] roadStructure.] Definitional attribute.

[3231] washOut

Attributes:

effect on lane capacity and safe speed [[3231] washOut.] Definitional attribute.

media response [[3231] washOut.] Definitional attribute.

process for rectifying the consequences [[3231] washOut.] Definitional attribute.

traffic management response [[3231] washOut.] Definitional attribute.

[3232] roadSubsidence

[3233] unexplainedDamage

[3234] bridgeFailure

[3235] tunnelBlockage This can include a vehicle fire [4236].

[324-] roadMaintenance This information class shall consist of a definition of the work. This covers the influence of scheduled road maintenance operations on the operation of the traffic system. These are schedules as to how the planned work will impact on the operating parameters in [1132]. They may relate to the temporary controls in [424.].

Attributes:

ID [[324-] roadMaintenance.] Identifying attribute. ID of work team

nomination [[324-] roadMaintenance.] Definitional attribute. A nomination of any new hazards to which drivers should be alerted.

prediction [[324-] roadMaintenance.] Definitional attribute. A prediction of its direct effect on traffic system by nominating changes to that part's attributes.

specification [[324-] roadMaintenance.] Definitional attribute. A specification of the time and duration, and location of the scheduled roadwork using [1131 &[1141], including effects of weather

[3241] unfixedDeterioration This allows for the influence of expected deterioration on the operating parameters in [1133].

[3242] inspectionWork This covers scheduled technical inspections of the road.

[3243] surfaceEnhancement This covers such scheduled activities as spraying a new bitumen surface on a road. Unscheduled work in this category is covered in [3227] and more major work in [3225].

[3244] surfaceClearing This includes snow-clearing.

[3245] rubbishRemoval

[3246] lineMarking

[3247] vergeMaintenance This covers grass mowing and maintenance of the landscaping.

[3248] trafficSignWork

[3249] tmMaintenance

[324A] cleaningFacilities

[324B] icePrevention

[325-] roadWork This information class shall consist of a definition of the work. These are schedules as to how the planned work will impact on the operating parameters in [1132]. They may relate to the temporary controls in [424-].

Attributes:

ID [[325-] roadWork.] Identifying attribute. ID of work team

nomination [[325-] roadWork.] Definitional attribute. A nomination of any new hazards to which drivers should be alerted.

prediction [[325-] roadWork.] Definitional attribute. A prediction of its direct effect on traffic system by nominating changes to that part's attributes.

specification [[325-] roadWork.] Definitional attribute. A specification of the time and duration, and location of the scheduled roadwork using [1131 &[1141], including effects of weather

[3251] pavementWork This also covers bridges and work beyond {3243}.

[3252] trenchWork

[3253] shoulderWork

[3254] overheadWork

[3255] adjacentConstruction This covers roadwork beside a carriageway which will influence traffic flow.

[3256] tunnelWork

[3257] bridgeWork

[3258] emergencyRestoration

[3259] tmWork

A.4 Traffic Usage

[4----] trafficUsage

Attributes:

name/address [[4----] trafficUsage.] The name/address of the group responsible for the information class.

[41--] vehicularMovement This data will apply at a defined [113] point in a traffic lane in a link or within an intersection.

[411-] trafficPresence This covers all aspects of traffic flow. Extra data comes from [822]. The data objects may also contains data aggregated over time or location.

[4111] vehicleTmPresence This information class shall consist of the map location of a vehicle. This can include data in [822]. It covers vehicles of all types detected by any tm (traffic management) means - commonly inductive loops, light beams, and CCTV.The detection may be (a) of the vehicle as a bulk giving location, or (b) of the extremities of the vehicle to give critical dimensions.The time at which the detection occurs is usually critical, and is covered by DC[3a]. Many detectors are at fixed locations and so the device ID - [1142] - will be sufficient to locate the vehicle.A vehicle ID - [2111] - can be detected and transmitted at the same time. This combined data can be used for prosecution. Pedestrians are covered in [4119].

traffic flow [[4111] vehicleTmPresence.] Definitional attribute. The traffic flow at nominated lane locations, calculated as the time rate at which vehicle presences are detected at the location, over a nominated time period, and distinguishing between nominated vehicle types [2112].

[4112] aviPresence This information class covers vehicles with active (avi = automatic vehicle identification) devices. The time at which the detection occurs is usually critical, and is covered by DC[3a]. Vehicle and driver IDs - [2111] & [221-] - can be detected and transmitted at the same time.

Attributes:

driverLicence [[4112] aviPresence.]

time [[4112] aviPresence.]

traffic flow [[4112] aviPresence.] Definitional attribute. The traffic flow at nominated lane locations, calculated as the time rate at which vehicle presences are detected at the location, over a nominated time period, and distinguishing between nominated vehicle types [2112].

vehicleLicence [[4112] aviPresence.]

[4113] vehicleDimension   This information class shall consist of the dimensions of a vehicle at a nominated location, possibly linked to the vehicle ID. See the note(b) for [4111].

[4114] laneOccupancy   This information class shall consist of the sum of the actual lengths of each vehicle in a lane length, divided by the lane length. This is the percentage of the lane length occupied by vehicles. A linked term is "concentration", which is the occupancy ratio divided by the average vehicle length. It is not related to the occupancy of the vehicle [711-].

[4115] vehicleHeadway   This information class shall consist of the spacing, in time or distance, between two successive vehicles at a nominated location. This is the time or distance between the same point on two successive vehicles in a traffic lane. Gap is the spacing between vehicles and is the headway less vehicle length (for distance) or {vehicle length}/speed (for time). They can be deduced from [4111] measurements, and can be used in [4227]. Headways are often reported as average values over a length or a time.

[412-] trafficFlow

[4121] flowValue   This information class shall consist of the vehicle flow at a nominated location over a nominated time. Combining files [4111] and [4112] will give the traffic flow, composition, and direction in a nominated lane at a nominated location. The flow along the link can be defined as the flow at the end of the link.

[4122] flowComposition   This information class shall be determined by combining attributes [4111] and [4112] will give the traffic flow, composition, and direction in a nominated lane at a nominated location. The flow along the link can be defined as the flow at the end of the link. Based on data from [211 & 212]. It is usually the percentage of trucks in the traffic stream.

[4123] axleNumbers   This information class shall consist of the number of axles that have passed a nominated location in a nominated time. These are usually counted by an in-pavement sensor.

[4124] vehicleMass   This information class shall consist of the ID of a vehicle at a nominated location. This may be measured by an in-pavement sensor or supplied by standard forms from weighbridges or shippers. It is usually measured in tonne. The data can be used for prosecution in conjunction with [2113] or to determine a vehicle with an abnormal but permissible load [2116] if it adheres to a specific route. Weight is another term for mass.

Attributes:

mass [[4124] vehicleMass.] Definitional attribute.

signal [[4124] vehicleMass.] Definitional attribute. A signal if the mass exceeds that permitted at that location.

[4125] esaCount   This information class shall consist of the esas of a vehicle at a nominated location. This will usually be measured by in-pavement sensors. esa = equivalent standard axles.

[4126] pedestrianFlow   This information class shall consist of the pedestrian flow at nominated locations, calculated as the time rate at which pedestrians are detected at the location, over a nominated time period. This is the number of pedestrians using a crossing or path.

[413-] averageSpeed   This is the speed of all vehicles of a defined type, averaged over either a defined time or a defined length.

[4131] vehicleSpeed   This information class shall consit of the measured vehicle speed at a nominated location. This is the instantaneous (or point) speed of an individual vehicle. For two-way lanes, this can also be used to give vehicle direction. The data can be used for prosecution.

[4132] speedDistribution   This information class shall consist of a nominated statistical description (such as means and variances) of a set of nominated measured speeds (such as time mean speed & space mean speed). This describes the statistical distribution of vehicle speeds, typically in terms of both the speed type and the statistical parameters describing the measurements. The two main speed types are space mean speed (the average speed of all vehicles in a defined length of road at a given time) and time mean speed (the average speed of vehicles passing a given point in a defined period of time).   The statistical parameters might be the mean (or average speed) and standard deviation of the measurements.

[4133] linkSpeed   This information class shall consist of measured vehicle speed over a road link between intersections, when not influenced by intersection delays [425].   This describes the average speed along a link. A link is the length of road between intersection nodes.

[4134] routeSpeed   This information class shall consist of measured vehicle speed from origin to destination, calculated as travel time divided by route length. This describes the average speed along a route and is the sum of all the link times and the node times, divided by the route distance (the sum of all the link distances).

[414-] pollution   This information class shall consist of components defined according to a pre-agreed report format. Covers unwanted emissions from vehicles, but also includes background levels in the absence of traffic. Although shown in bold font, this data may also be collected by Agencies within the system.

Attributes:

location of the reading [[414-] pollution.] Definitional attribute.

quantum of pollutant [[414-] pollution.] Definitional attribute.

time of the reading [[414-] pollution.] Definitional attribute.

[4141] exhaustFumes information class

[4142] waterRunoff information class

[4143] surfaceSalinity information class

[4144] noiseGeneration information class

[42--] trafficDelays

[421-] congestionDelays

[4211] queuedLength   This information class shall consit of measured queue lengths in nominated lanes. This length is given per traffic lane. It is usually obtained from either a presence detector on the lane, or from CCTV.

[4212] congestionCause This information class shall consit of a report in pre-agreed format. "Cause" includes high flows, and the events in [422-] and [423-].

Attributes:

causes [[4212] congestionCause.] Definitional attribute. Describing the causes of the congestion.

estimate of duration [[4212] congestionCause.] Definitional attribute.

[4213] observerInput information class This includes input from such groups as motor-club observers and spotter aircraft.

Attributes:

causes [[4213] observerInput.] Definitional attribute. Describing the causes of the congestion.

estimate of duration [[4213] observerInput.] Definitional attribute.

[4214] actualDelay This information class shall consit of a report giving the actual delay due to the congestion. This accumulates the actual delay caused by the congestion.

[4215] degreeOfCongestion This information class shall consit of a report using a pre-agreed measure to quantitatively rate congestion. This is a locally agreed measure of congestion, often displayed on signs or used in broadcasts.

[422-] externalCause This information class shall consist of a pre-agreed report. This covers traffic delays caused by traffic or by scheduled events. Other unscheduled delays are covered in [32--], particularly in [3211].

Attributes:

estimated duration [[422-] externalCause.] Definitional attribute. Estimated duration of the reduction.

increased flows [[422-] externalCause.] Definitional attribute.

measures required [[422-] externalCause.] Definitional attribute. Measures required to minimise the impact of the event.

reduction in operating [[422-] externalCause.] Definitional attribute. Any reduction in operating characteristics of any lane - particularly capacity and speed.

specific congestion cause [[422-] externalCause.] Definitional attribute.

[4221] trafficGenerator information class

[4222] paradeOnRoad information class

[4223] overflowOntoRoad information class

[4224] publicDisturbance information class

[4225] emergencyAlert information class

[4226] surpriseCongestion information class

[423-] vehicularCause This information class shall consist of a pre-agreed report. This can be combined with vehicle ID data in [2111].

Attributes:

estimated duration [[423-] vehicularCause.] Definitional attribute. Estimated duration of the reduction.

increased flows [[423-] vehicularCause.] Definitional attribute.

measures required [[423-] vehicularCause.] Definitional attribute. Measures required to minimise the impact of the event.

reduction in operating [[423-] vehicularCause.] Definitional attribute. Any reduction in operating characteristics of any lane - particularly capacity and speed.

specific congestion cause [[423-] vehicularCause.] Definitional attribute.

[4231] roadCrash This information class covers delays caused by road crashes, and derived from the effect of [441-] on other traffic.

[4232] oversizeVehicle This information class covers congestion caused by a vehicle which is too large to permit normal traffic operations. Vehicle length can be detected by [4111].

[4233] slowVehicle information class

[4234] stoppedVehicle This information class covers a vehicle stopped in an operating lane. It could illegally parked or abandoned, or stopped after skidding or being otherwise out-of-control, or the driver could be ill. Disabled vehicles are covered in [4235].

[4235] disabledVehicle information class Vehicles disabled as a result of a crash are covered by [44--], and their delaying effect in [4239].

[4236] burningVehicle information class

[4237] vehicleConvoy information class

[4238] cyclistsAbreast information class This may be reported or detected from detector data [4114]

[4239] gawkingDrivers information class These are the delays caused by the crashes reported in [44--] for the time specified in [4441].

[424-] temporarySpeedLimit

[4241] scheduledSpeedDrop information class These are temporary changes in the local speed limit. They may stem from the activities in [324-5].

Attributes:

authorisation [[4241] scheduledSpeedDrop.] Definitional attribute.

duration [[4241] scheduledSpeedDrop.] Definitional attribute.

extent [[4241] scheduledSpeedDrop.] Definitional attribute.

speed limit [[4241] scheduledSpeedDrop.] Definitional attribute. The new speed limit.

[4242] unscheduledSpeedDrop information class These are temporary changes in the local speed limit. They may stem from the activities in [324-5].

Attributes:

cause [[4242] unscheduledSpeedDrop.] Definitional attribute.

duration [[4242] unscheduledSpeedDrop.] Definitional attribute.

extent [[4242] unscheduledSpeedDrop.] Definitional attribute.

speed limit [[4242] unscheduledSpeedDrop.] Definitional attribute. The new speed limit.

[4243] temporaryControl   information class These are usually temporary traffic signals or flagmen operating at construction sites and may stem from the activities in [324-5].

Attributes:

authorisation [[4243] temporaryControl.] Definitional attribute.

delay [[4243] temporaryControl.]   Definitional attribute. The average delay introduced by the temporary control device.

[425-] controlDelays

[4251] requiredStop These are delays caused by traffic signals and statutory stops [511]. If the vehicle is being tracked in real time, the traffic signal delay would be the actual delay - otherwise it is the average delay experienced by vehicles at that signal.

Attributes:

delay at sign [[4251] requiredStop.] Definitional attribute. The average delay at each stop and give-way sign.

delay at signal [[4251] requiredStop.] Definitional attribute. The average (or actual) delay at a traffic signal.

[4252] geometricDelay This information class shall consit of the delay caused by the indirect path a vehicle is required to follow to pass through an intersection. These are delays due to the geometry of an intersection - e. g. at a roundabout

[4253] ferryDelay   This information class shall consist of the delay caused by intermittent ferry operations, linked to time of day. These are delays caused by ferry schedules.

[4254] bridgeOpening   This information class shall consist of delay caused by intermittent bridge openings, linked to time of day. These are delays caused by bridge openings to accommodate shipping.

[4255] tmFailure This information class shall consist of delay caused by the failure of tm devices, and not covered by direct changes to their operating characteristics. These are delays not covered by the adjustments to operating conditions made via [923-].

[43--] driverBehaviour

[431-] undesirableDriving These are detected vehicle behaviours which indicate unsafe driving. Many of the entries will be defined by others such as WG14.

[4311] vehicleClearance This information class shall consist of instances when a vehicle exceeds a nominated clearance limit at a nominated location, and possibly the vehicle ID.

[4312] dangerousSpeed This information class shall consist of instances when a vehicle exceeds a nominated safe speed at a nominated location, and possibly the vehicle ID.

[4313] looseLoad This information class shall consist of instances when a vehicle's load is loose, detected at a nominated location, together with the vehicle ID.

[432-] illegalBehaviour

[4321] illegalSpeed This information class shall consist of instances when a vehicle violates a traffic law at a nominated location, and commonly the vehicle ID. This is partly based on [4131].

[4322] trafficViolation This information class shall consist of instances when a vehicle violates a traffic law at a nominated location, and commonly the vehicle ID. This covers violations of signals, signs, parking restrictions, etc.

[4323] policePursuit This is data supplied by the police on pursuits that they are undertaking.

Attributes:

classification [[4323] policePursuit.] Definitional attribute. A preagreed pursuit classification.

pursuit vehicles [[4323] policePursuit.] Definitional attribute. The IDs of the pursuit vehicles.

route [[4323] policePursuit.] Definitional attribute. Estimated route.

[4324] securityCheck This information class shall consist of the location, duration and type of any security check point or cordon. This covers the activities of Agencies stopping traffic for inspection

[4325] attackOnVehicle This information class shall consist of the location and type, in pre-agreed format, of the attack. This covers reported, threatening attacks.

[44--] crashOrEmergency These would all be based on pre-agreed forms. These measures are aggregated in [944-].

[441-] crashSeverity This class shall consist of a report on a crash in a pre-agreed format. This would be based on a pre-agreed crash-report form. See note in [442].

Attributes:

action [[441-] crashSeverity.] Definitional attribute. Any required follow-up action.

location [[441-] crashSeverity.] Definitional attribute.

people [[441-] crashSeverity.] Identifying attribute. The IDs of the people/cargo/ptsystem involved.

type [[441-] crashSeverity.] Definitional attribute. The type and characteristics of the crash.

vehicles [[441-] crashSeverity.] Identifying attribute. The IDs of the vehicles involved.

[4411] fatalityCrash information class

[4412] injuryCrash information class

[4413] propertyDamageOnly information class

[442-] crashType This class shall consist of a report on a crash in a pre-agreed format. This is for vehicles that crash. Vehicles that break-down or roll-over without other impacts are - covered by [4235]. These use pre-agreed (often standard) crash reporting forms. Each entry here and in [441] is usually a cell in a single larger matrix (or form).

Attributes:

action [[442-] crashType.] Definitional attribute. Any required follow-up action.

location [[442-] crashType.] Definitional attribute.

people [[442-] crashType.] Identifying attribute. The IDs of the people/cargo/ptsystem involved.

type [[442-] crashType.] Definitional attribute. The type and characteristics of the crash.

vehicles [[442-] crashType.] Identifying attribute. The IDs of the vehicles involved.

[4421] headonCrash information class

[4422] nearsideCrash information class

[4423] offsideCrash information class

[4424] rearendCrash information class

[4425] roadsideCrash information class

[4426] pedestrianInCrash information class

[443-] crashDelay

[4431] crashTime This lists the time of the crash, the lanes affected and whether closed or slowed, and when the lanes are expected to be cleared

Attributes:

influence [[4431] crashTime.] Definitional attribute. An estimate of the time interval during which it will influence traffic operations.

time [[4431] crashTime.] Definitional attribute. The time at which the crash occurred.

[4432] crashExtent This information class shall consist of for the crash event in [441-2]. This lists the extent of the crash in terms of the number and description of the vehicles and people involved. The vehicles involved are identified using [21], and any hazardous cargo using [224]. [441] & [442] are used to define the individual damage.

Attributes:

delay [[4432] crashExtent.] Definitional attribute. The time delay to pt passengers.

freight damage [[4432] crashExtent.]

Definitional attribute. The value of freight damaged.

number injured [[4432] crashExtent.] Definitional attribute. The number of people injured at each severity level.

number vehicles [[4432] crashExtent.] Definitional attribute. The number of vehicles involved at each damage level.

[4433] crashCause This information class shall consit of, for each crash event in [441-2], a list assigning one or more causes from a pre-agreed list. This lists the processes being used to remove injured people, clear damaged vehicles, restore traffic facilities, and return the lanes to service.

[4434] crashRemoval This information class shall consit of, for each crash event in [441-2], a set of responses and needs to clear the crash, from a pre-agreed list. This estimates the cause of the crash.

[444-] emergencyCall

[4441] notificationByCall This information class shall consist of a list of emergency calls by pre-agreed type, time, and location. This covers the incoming message, which can be from either a human observer, a deduction from sensors, or from other Agencies (such as the police). The pre-agreed list of emergency responses will include those linked to [422-], [423-], [431-] & [44--].

[4442] investigationOfCall This information class shall consist of a list of pre-agreed responses to each emergency call in [4431], including the time of execution of each response. This covers the immediate action as a result of the message.   It may develop into further actions covered by [4443] or [531-].

A.5 Traffic Management

[5---] trafficManagement

This covers traffic management.

Attributes:

name/address [[5---] trafficManagement.] The name/address of the group responsible for the information class.

[51--] trafficControl This covers traffic control

[511-] intersectionControl

[5111] signalPriority This information class shall consist of a list of the IDs of vehicles to be given priority at nominated traffic signals. The vehicle types receiving priority are defined via [211-212].

[5112] signalPlan This information class shall consist of pre-agreed, adjustable operating parameters for a nominated location. Defines the control algorithm to be used gives the saturation flow for each lane, probably taken as an attribute from [1132].

[5113] controlTiming   This information class shall consist of pre-agreed, adjustable operating parameters for a nominated location. Gives the timing for cycles, phase splits, offsets.

[5114] trafficActuation   This information class shall consist of pre-agreed, adjustable operating parameters for a nominated location. The actuation is by through flow & turners, and for partial or full co-ordination of signal sets. The actuation algorithms may be defined.

[5115] rampMeter This information class shall consist of pre-agreed, adjustable operating parameters for a nominated location. The ramp metering algorithm is defined.

[5116] levelCrossing   This information class shall consist of pre-agreed, adjustable operating parameters for a nominated location. This covers the interface requirements with the pt system.

[5117] priorityRules   This information class shall consist of pre-agreed, adjustable operating parameters for a nominated location. This covers the application of priority rules to the intersection and covers roundabouts. See also [5133].

[512-] laneControl This class shall consist of messages from a pre-agreed set, adjusting lane-use signals.

[5121] laneRestriction information class This includes lane closure.

[5122] laneEnd information class These relate to variations in the location at which a lane starts or ends, as in a response to a lane blockage.

[5123] laneStart information class These relate to variations in the location at which a lane starts or ends, as in a response to a lane blockage.

[5124] directionControl information class Typical controls would be that a lane or road operates two-way, one-way, or is closed.

[5125] speedControl information class This includes variable mandatory speed signs.

[513-] driverInstruction

[5131] policeControl   This information class shall consist of messages from a pre-agreed set, instructing drivers how and where to drive. Covers situations where police direct the traffic.

[5132] operatorControl   This information class shall consist of messages from a pre-agreed set, instructing drivers how and where to drive. This covers situations where people responsible for operating the traffic system direct the traffic.

[5133] fixedSign This information class shall consist of messages from a pre-agreed set, instructing drivers how and where to drive. This covers messages to drivers via static - painted - signs and pavement markings. Their location is in [1141].

[5134] variableMessageSign This information class shall consist of messages from a pre-agreed set, instructing drivers how and where to drive. This covers messages to drivers via variable message signs. Their location is in [1142].

[5135] inVehicleReceivers   This information class shall consist of messages from a pre-agreed set, instructing drivers how and where to drive. This covers messages to drivers via in-vehicle receivers, such as car radios and VICS equipment.

[5136] drivingRegulations   This information class shall consist of the formal traffic regulations for the nominated jurisdiction. This covers the local formal traffic regulations (or laws, or rules).

[5137] mediaMessages This information class shall consist of a catalogue of media messages likely to affect driver behaviour. This covers messages in the general media.

[52--] travelTime This covers current and predicted traffic conditions.

[521-] influencingFactors

[5211] currentTravelTime This information class shall consist of the route times - [4134] - for vehicles which have just completed their journeys. This is the current route time, which is the sum of all the link times ([link length [1131] / link speed [4133]) and node times [425], i.e route length [1131] / route speed [4134].

[5212] flowCycles This information class shall consist of a statistical analysis of previous flows at nominated locations and times. This covers the expected cyclical variations in flow, such as am and pm peaks, work days vs weekends and holidays on link times over the prediction period.

[5213] demandChanges This information class shall consist of known changes in travel demand at defined locations, based in part on [111-] & [4221]. This covers the known changes in traffic demand on link times over the prediction period. These could be permanent land use changes or special events.

[5214] supplyChanges This information class shall consist of known changes in travel supply at defined locations, based in part on [111-], [422-] & [423-]. This covers the known changes in traffic supply on link times over the prediction period. . These could be permanent land use changes or special events.

[5215] adviceFeedback This information class shall consist of estimates of the percentage of drivers likely to accept the advice offered in [611-], at each relevant node. This covers the percentage of drivers taking trip advice [621] on link times over the prediction period.

[5216] tollCollection This information class shall consist of estimates of the effect that toll collecting will have on traffic times.

[522-] trafficPrediction This covers predicted travel times.

[5221] trafficModel This information class shall consist of the operating file for the model used to predict traffic flows, based on a knowledge of transport supply [5213] and demand [5214] and the network operating characteristics.

[5222] flowExtrapolation This information class shall consist of the operating file for the model used to predict traffic flows, based on a knowledge of transport supply [5213] and demand [5214] and the network operating characteristics.

[5223] linkTimes This information class shall consist of times to travel on nominated links, based on a consideration of default values, the output of [5221] and [5222], and modified by [5215]. This will be based on a consideration of default travel time values, values predicted from a traffic model based on predicted conditions [5211], and historical trends adjusted for local changes, for both normal and handicapped travellers.

[5224] nodeTimes This information class shall consist of average times to pass through a nominated node, based on the flows in [5223] and the delays in [4251]. This will be based on a consideration of default travel time values, values predicted from a traffic model based on predicted conditions [5211], and historical trends adjusted for local changes, for both normal and handicapped travellers.

[5225] routeTimes This information class shall consist of times to travel nominated routes, by aggregating the relevant times in [5223] and [5224]. This layer is an addition of [5222] and [5223] over a route.

[53--] responsePlans These response (or action) plans are for events in [3, 423 & 44].

[531-] incidentResponse

[5311] operatorResponse This information class shall consist of pre-agreed responses by a nominated agency to a signal from [42--], [43--], or [44--]. These are responses by the named Agency operating to a pre- agreed response procedure

[5312] policeResponse This information class shall consist of pre-agreed responses by a nominated agency to a signal from [42--], [43--], or [44--]. These are responses by the named Agency operating to a pre- agreed response procedure

[5313] emergencyResponse This information class shall consist of pre-agreed responses by a nominated agency to a signal from [42--], [43--], or [44--]. The resulting message is in [65--].

[5314] otherAgencies This information class shall consist of pre-agreed responses by a nominated agency to a signal from [42--], [43--], or [44--]. These are responses by the named Agency operating to a pre- agreed response procedure

[5315] driverResponse This information class shall consist of unstructured reports from drivers on their actions. This is a response by members of the public.

[532-] incidentStatus This information class shall consist of reports on the status of an incident listed in [531-],using pre-agreed responses wherever possible. This gives the current status of the incident, using pre-agreed reports as far as possible

[5321] congestionStatus information class

[5322] driverStatus information class

[5323] crashStatus information class This would include [444-].

[54--] surveillanceSystem

[541-] machineSurveillance This information class shall consist of instructions to operate nominated parts of the surveillance system, using pre-agreed instructions.

[542-] observerReport This information class shall consist of messages of observations from the public.

[5421] solicitedObservation   This information class shall consist of solicited observations using pre-agreed instructions.

[5422] unsolicitedObservation This information class shall consist of unstructured reports from random observers.

A.6 User Information

[6---] userInformation

This information class is partly based on the output of [522] and is partly completed by others. The messages are conveyed to drivers by the various media listed in [513] and located in [1141-4], and to intending drivers and managers by the various public and private services such as TV, radio, fax, e-mail and telephone.

Attributes:

name/address [[6---] userInformation.] The name/address of the group responsible for the information class.

[61--] trafficInformation

[611-] trafficMessages This information class shall consist of advice to nominated areas or drivers, in a pre-agreed format, by listed media. This gives advice to drivers.

[6111] tmMessage information class

[6112] inVehicleMessage information class

[6113] policeMessage information class

[6114] mediaMessage information class

[612-] trafficCommands This information class shall consist of instructions to drivers in nominated areas or to specific drivers, in a pre-agreed format, by listed media. This gives instructions to drivers.

[6121] tmCommand information class

[6122] inVehicleCommand information class

[6123] policeCommand information class

[6124] mediaCommand information class

[613-] enforcementActivity

[6131] policePresence This information class shall consist of records of drivers detected committing illegal acts, using [61--] trafficInformation

established police documentation. This records the prosecution process. Other input comes from [2113], [2114], [224-], [4117], [4131], [413-], [432-], [4433] & [513-].

[6132] prosecutionMessage This information class shall consist of notifications to specific drivers that they are being prosecuted or fined for nominated driving offences. This tells a driver of a traffic prosecution. The next step after prosecution may be a fine [811].

[62--] routeGuidance

[621-] suggestedRoute This information class shall consist of instructions on the best route to take between two nominated points, consistent with the relevant listed criterion or a default criterion. This gives a driver a route to a given destination which meets defined criteria.

[6211] quickestRoute information class This suggests the quickest route to drivers.

[6212] shortestRoute information class This suggests the shortest route to drivers.

[6213] scenicRoute information class This suggests the most scenic route to drivers.

[6214] nominatedRoute information class This suggests a route via nominated points.

[6220] detour This information class shall consist of instructions on the best route to take between two nominated points, consistent with the relevant listed criterion or a default criterion. This covers a changed route due to the unavailablity of part of the desired route. The default criterion for choosing the new route is commonly the quickest route.

[6230] diversion This information class shall consist of instructions on the best route to take between two nominated points, consistent with the relevant listed criterion or a default criterion. This covers a changed route due to the unsuitability of the vehicle for at least part of the desired route.

[6240] parkingGuidance This information class shall consist of instructions on the best route to take between two nominated points, consistent with the relevant listed criterion or a default criterion. This guides to a parking station with vacancies.

[63--] privateJourney This information class shall consist of: A private trip is any road-based trip, other than by pt.

[6310] routePlan This information class shall consist of intended route plans, filed by specific travellers. The route plan comes from [621-].

[6320] tripPlan This information class shall consist of intended trip purpose, filed by specific travellers. This gives the trip purpose.

[64--] ptJourney

[6410] ptRoutePlan This information class shall consist of intended route plans, filed by specific travellers. This gives a suggested route on pt.

[6420] routeProgress This gives instantaneous position location to a pt traveller.

Attributes:

comparisons [[6420] routeProgress.] Definitional attribute. Comparisons with the published schedule.

route [[6420] routeProgress.] Definitional attribute. The route used by a nominated pt vehicle.

times [[6420] routeProgress.] Definitional attribute. Arrival and departure times.

[65--] generalMessage

[6510] emergencyMessage   This information class shall consist of messages in a pre-agreed format, including ones arising from the events in [3---], [4---] & [531-]. This gives messages, alerts and alarms about an emergency, usually as an outcome of [5313].

[6520] publicRelations This information class shall consist of unstructured messages. This covers public relations messages.

[66--] fleetMessages   This information class shall consist of messages in a format defined by the relevant agency.

[6610] ptMessages This information class shall consist of: This provides messages from pt managers to their drivers.

[6620] freightMessages   This information class shall consist of: This provides messages from freight managers to their drivers.

[67--] vehicleMessage   This information class shall consist of messages in a format defined by the relevant agency.

[6710] tyreMessage This information class shall consist of: This would include advice on using snow tyres or chains [2142].

[6720] engineMessage   This information class shall consist of: This would include instructions to turn engines off.

[6730] transmitterMessage This information class shall consist of: This would include advice to switch off radios and mobile phones.

A.7 Transport Systems

[7---] transportSystems

Attributes:

name/address [[7---] transportSystems.] The name/address of the group responsible for the information class.

[71--] roadUsers

[7110] carOccupancy This information class shall consist of the number of people in a vehicle, related to the vehicle ID. This relates to the number of people in the vehicle, and not to lane occupancy [4113].

[7120] rideSharing This information class shall consist of messages in a format defined by the service operator. This gives ride-sharing supply and demand data in a pre-agreed format.

[713-] parkingSupply This information class shall consist of the number of vacant parking spaces for the particular vehicle type in a nominated parking place. The location of the facility is given in [1122]. This item gives the remaining spaces in a specific carparks, covers prebooking of sites, and the cost of the available spaces.

[7131] carParking information class

[7132] busParking information class

[7133] truckParking information class

[714-] serviceAreaSupply

[7141] externalParking   This information class shall consist of the number of vacant parking and service spaces at a nominated service facility. This gives data on parking occupancy in roadside service (or rest) areas.

[7142] internalFacilities   This information class shall consist of the spare service capacity at the nominated service facility. This gives data on the spare service capacity of the facility.

[7150] tollCharges   This information class shall consist of the toll imposed at a nominated location or length. This gives data on toll charges.

[72--] ptOperation   This gives data on pt operations in a pre-agreed format and data structure.   These measures are aggregated in [945-].

[721-] ptSchedules

[7211] publishedScedule   This information class shall consist of the time at which a pt vehicle is scheduled to arrive at a nominated location. This covers scheduled arrival times at stations. Stations are located in [1121].

[7212] revisedScedule   This information class shall consist of the time at which a pt vehicle is scheduled to arrive at a nominated location, adjusted in the light of its performance to date on the current trip.

[722-] ptActuals

[7221] vehicleTimes   This information class shall consist of the time at which a pt vehicle actually arrives at a nominated location.   This covers actual arrival times at stops

[7222] accessTimes   This information class shall consist of the time being taken by passengers to transfer between modes at nominated pt access points. This covers access times between modes

[7230] ptSurveillance   This information class shall consist of reports in a format defined by the pt agency. This covers data received from TV surveillance within vehicles.

[73--] freightOperation   This gives data on freight operations in a pre-agreed format and data structure. The type of freight carried is given in [223].

[7310] freightSchedules   This information class shall consist of the time at which a freight vehicle is scheduled to arrive at a nominated location. This covers scheduled arrival times at delivery stops.

[7320] freightActuals   This information class shall consist of the time at which a freight vehicle actually arrives at a nominated location. This covers actual arrival times at stops

[74--] taxiOperation   This gives data on taxi operations in a pre-agreed format and data structure

[7410] dispatchEstimate   This information class shall consist of the time at which a taxi is scheduled to arrive at a nominated location.   This covers estimated arrival times at pick-up points.

[7420] taxiActuals   This information class shall consist of the time at which a taxi actually arrives at a nominated location. This covers actual arrival times at a pick-up point.

[7500] transfers   This information class shall consist of the time and location at which a transported object wishes to transfer from one nominated vehicle to another. This gives data on transfers to, within, and from the pt system in a pre-agreed format and data structure. The transfers are made at locations in [1121].

A.8 Financial Data

[8---] financialData

Attributes:

name/address [[8---] financialData.]

The name/address of the group responsible for the information class.

[81--] finePayment

Attributes:

ID [[81--] finePayment.] Definitional attribute. ID of the person fined

fine [[81--] finePayment.] Definitional attribute. Magnitude of the fine

recipient [[81--] finePayment.] Definitional attribute. The recipient of the cash

status [[81--] finePayment.] Definitional attribute. The status of the fine.

type [[81--] finePayment.] Definitional attribute. Type of fine.

[811-] trafficFines

[8111] parkingFines   information class This covers financial transfers for fines.

[8112] speedingFines   information class This covers speeding fines.

[8113] massFines   information class This covers over-load fines.

[8114] dimensionalFines information class This covers over-dimensional fines.

[8115] freightFines information class This covers freight fines.

[8120] otherFines information class This covers other fines than those in [811].

[82--] tollCollection

[8210] tollFees This information class shall consist of a list of the amount of toll fees being transferred from a nominated tollgate to a nominated account. This covers financial transfers for tolls, using a pre-agreed format

[8220] tollGateTraffic This information class shall consist of a list of the traffic flows measured at nominated toll points. This captures the traffic count data from the toll process at locations in [1135] for use in [411].

[8300] parkingFees This information class shall consist of a list of the amount of parking fees being transferred from a collection point to a nominated account. This covers financial transfers from car-parking fees.

[8400] ptFares This information class shall consist of a list of the amount of fares being transferred from a collection point to a nominated account. This covers financial transfers from pt fares.

[8500] otherTransfers This information class shall consist of a list of defined charges being transferred from one nominated agency to another. This covers financial transfers for public transport fares, yellow pages purchases, ride-sharing fees, & costs arising from DC[7]

A.9 TMIC Management

[9---] tmicManagement

Attributes:

name/address [[9---] tmicManagement.] The name/address of the group responsible for the information class.

[91--] tmicToTmic

[9110] service This information class shall consist of pre-agreed data transfer process between nominated tmics. This covers data supplied by one tmic to another, and not covered elsewhere in this [91--].

[9120] changeOfControl This information class shall consist of pre-agreed signal for transferring the control of a nominated element between nominated tmics. This covers transfers of control of parts of a system from one tmic to another.

[92--] systemOperation This information class shall consist of a list of repairs, in pre-agreed format, that are needed or have been undertaken, on a nominated device. This records any repairs needed or completed, flowing from [93--] or routine maintenance.

[921-] systemStatus This information class shall consist of pre-agreed status reports for nominated devices and programs. These are generally in a yes/no format. More subtle changes are covered in [923-].

[9211] hardwareStatus information class This gives the current hardware status in terms of functionality, operating mode and stage, contents and displays.

[9212] softwareStatus information class This gives current software system status in terms of functionality, default values, algorithm parameters, and current messages and displays.

[9220] systemRepairs This information class shall consist of a list of repairs, in pre-agreed format, that are needed or have been undertaken, on a nominated device. This records any repairs needed or completed, flowing from [93--] or routine maintenance.

[9230] operatingCondition This information class shall consist of condition measures, in a pre-agreed format, for a nominated device or system. This gives the current system operating characteristics, such as throughput and down-time and will often need to be fed into [424-] and [425-]. Changes in operational status are covered in [921-].

[93--] errorInformation This information class shall consist of error messages, in a pre-agreed format, for a nominated device or system.

Attributes:

advice [[93--] errorInformation.] Definitional attribute. Advice on how any consequences of these errors are to be rectified.

[9310] systemErrors information class This lists errors or faults detected in the system.

[9320] messageErrors information class This lists errors detected in messages from the system.

[94--] performanceMonitor This reports performance against pre-agreed performance indicators.

[9410] systemEfficiency This information class shall consist of efficiency measures, in a pre-agreed format, for a nominated activity. Efficiency is output divided by input.

[9420] systemEffectiveness This information class shall consist of effectiveness measures, in a pre-agreed format, for a nominated activity. Effectiveness is the extent to which actual outputs matched desired outputs, usually as reflected in a system strategy.

[9430] totalDelay This information class shall consist of the total delay caused by the system, in a pre-agreed format, and over a nominated time period. This is an aggregation of measures in [42].

[9440] totalCrashes This information class shall consist of the total number of crashes in the system, in a pre-agreed format, and over a nominated time period. This is an aggregation of measures in [44].

[9450] passengerThroughput This information class shall consist of the total number of passengers using the system, in a pre-agreed format, and over a nominated time period. This is an aggregation of measures in [75].

[9460] otherStatistics information class This contains data not in the adjacent categories

[9470] archivalData This information class shall consist of data to be archived off-site. This contains data to be archived.

[95--] tmicToExternal This information class shall consist of messages to and from external agencies, often in a pre-agreed format. This covers messages from the TMIC to other agencies

[9510] policeService information class

[9520] emergencyServices information class

[9530] otherAgencies information class

[96--] externalToTmic This covers messages from the other agencies to a TMIC. No expansion on the detail in the definitions is needed.

[961-] policeData

[9611] trafficControl This information class shall consist of data in pre-agreed format on traffic control messages being given by the police. For use in [513-].

[9612] trafficViolation This information class shall consist of data in a pre-agreed format on traffic violations detected by police. For use in [4322].

[9613] policePursuit This information class shall consist of data in a pre-agreed format on pursuits being conducted by the police. For use in [4323].

[9614] incidentResponse This information class shall consist of data in a pre-agreed format giving the response to a nominated incident. For use with [5312].

[9615] securityCheck This information class shall consist of data in a pre-agreed format on security checks conducted by the police or others. For use in [4324].

[962-] emergencyServices

[9621] emergencyNotification This information class shall consist of data concerning emergencies, often in a pre-agreed format. For use in [3---].

[9622] emergencyResponse This information class shall consist of data in a pre-agreed format giving the response to a nominated incident. For use with [5313].

[963-] transportIdentifiers

[9631] driverIDs This information class shall consist of driver IDs linked to driver data, in a pre-agreed format. For use in [221-].

[9632] vehicleIDs This information class shall consist of vehicle IDs linked to vehicle data, in a pre-agreed format. For use in [2111] & [2112].

[9633] freightIDs This information class shall consist of freight IDs linked to freight data, in a pre-agreed format. For use on [2230-2250]

[9634] exceptionalIDs This information class shall consist of special vehicles and vehicles exempted from meeting nominated regulations, linked to the vehicle ID. For use in [2116], [212-] & [213-].

[9635] commercialIDs This information class shall consist of peoples' commercial IDs, possibly linked to [9631]. For use in [2213].

[9640] mapProducer This information class shall consist of the producer's commercial IDs. For use in [1---].

[965-] ptOperator

[9651] ptAccess This information class shall consist of access data for a pt access point. For [1224]

[9652] ptRoutes This information class shall consist of route data for pt. For [121-].

[9653] ptSchedules This information class shall consist of pt schedules. For use in [721-].

[9654] vehiclePerformance This information class shall consist of pt vehicle performance data. For use in [2141].

[9655] passengerData This information class shall consist of pt passenger data. For use in [222-] & [225-].

[9656] vehicleProgress This information class shall consist of progress of nominated vehicles. For use in [642-] & [722-].

[9657] ptSurveillance This information class shall consist of messages on surveillance. For use in [723-].

[966-] parkingOperator

[9661] parkingLocation This information class shall consist of maps locating parking facilities. For use in [1122].

[9662] parkingAvailability This information class shall consist of messages on vacant parking spaces. For use in [713-].

[967-] freightOperator

[9671] freightFacilities This information class shall consist of maps locating freight terminals. For use in [1123].

[9672] freightVehicles This information class shall consist of freight vehicle performance data. For use in [2141].

[9673] freightSchedules This information class shall consist of freight schedules. For use in [731-].

[9674] freightProgress This information class shall consist of progress of nominated freight vehicles. For use in [732].

[9675] cargoData This information class shall consist of cargo data linked to vehicle ID. For use in [223-], [224-] & [225-].

[968-] environmentalData information class

[9681] weatherService This information class shall consist of weather data.   For use in [311-], [313-] & [314-].

[9682] pollutionMonitor This information class shall consist of pollution data. For use in [413-].

[969-] otherParticipants

[9691] rideShare This information class shall consist of a. maps locating rideshare pick-up points b. direct advice to ridesharers a. For use in [1233] b. For use in [712-].

[9692] roadsideService This information class shall consist of maps locating roadside commercial services. For use in [135-].

[9693] yellowPages This information class shall consist of maps locating services in the region. For use in [1352].

[9694] tollOperator This information class shall consist of data on toll charges at nominated locations. For use in [715-].

[9695] otherMessages This information class shall consist of unstructured messages.

Bibliography

[1]   Unified Modeling Language, UML Semantics, Version 1.1, 1 September 1997. Available on the Internet: <http://www.rational.com/uml>

NOTE   At the time of the technical development of the TICS Reference Architecture, UML Version 1.1 was evolving. The software tool used in this effort provided one available presentation for UML diagrams. Since then UML Version 1.3 has been formalized and subsequently submitted to ISO under a Publicly Available Specification Procedure. UML Version 1.3 is being balloted as Draft International Standard ISO/IEC 19501.

[2]   The Unified Modeling Language User Guide, Booch G., Rumbaugh J., Jacobson I., Addison Wesley, 1999, ISBN 0201571684

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