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TITLE

ARKTRANS

The multimodal ITS framework architecture

Version 6

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ABSTRACT

ARKTRANS is the Norwegian ITS framework architecture. ARKTRANS is multimodal. This means that the specifications are common to all transport modes (road, sea, rail and air). The specifications also are harmonised across freight and person transport. By providing such coordinated and harmonised specifications and a holistic approach, ARKTRANS provides a generic and simplified view upon the transport sector that will contribute to new and improved ITS solutions. The transport sector is specified at different abstraction levels and by means of different viewpoints:

- A Reference Model divides the transport sector into domains with defined responsibilities
- For each domain, the generic roles of the associated stakeholders and related objects are defined
- A functional view specifies and structures the functionality needed within each domain
- A process view describes how the functionality in the domains interact in processes
- An information view defines the information that is exchanged
- A communication view defines the technical implementations of the information exchange

ARKTRANS is the result of a comprehensive study of all transport modes. The first version of ARKTRANS was established in a research project co-funded by the Research Council of Norway. The pursuance of the work is ensured by ITS Norway, based on funding from the Norwegian Ministry of Transport and Communications. See www.arktrans.no for more information.

KEYWORDS	ENGLISH	NORWEGIAN
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	Freight and passenger transport	Gods- og passasjertransport

Preface

ARKTRANS is the Norwegian framework architecture for multimodal ITS. ARKTRANS covers all transport modes (sea, rail, road and air) as well as freight and passenger transport.

The work on ARKTRANS was initiated by Norwegian transport authorities. A pilot study was done in 2001. A research project, co-funded by the Research Council of Norway, was started in January 2002 and ended in 2004. Since then, ITS Norway has been responsible for further development of ARKTRANS based upon founding from the Norwegian Ministry of Transport and Communications and government departments for transport.

During the lifetime of ARKTRANS several parties have participated in and contributed to the work. We will especially like to mention: the Norwegian Public Road Administration, the Norwegian Coastal Administration, Avinor (the Norwegian civil aviation administration), the Norwegian National Rail Administration, the Norwegian State Railways, the Federation of Norwegian Transport Companies, Norwegian Hauler's Association, CargoNet, Norsk Reiseinformasjon, Trafikanten in Oslo and Akershus, Trafikanten in Møre og Romsdal, SAS Braathens AS, and the FARGIS Forum. They have all contributed to the work by providing input, by participating in work groups, and by commenting on preliminary results. The work would have been impossible without their contributions.

SINTEF has been responsible for the coordination and the established the architecture. Several versions of ARKTRANS have been issued. The current version is number 6. For more information see www.arktrans.no or www.its-norway.no.

ARKTRANS is used in several national and European projects that have provided input to the work on further refinement of the framework, among others

- MultiRIT – national research project (multimodal travel information services)
- INTRANS - national research project (intelligent goods)
- D2D - EU FP 5 (intermodal transport chains for freight transport)
- MarNIS - EU FP 6 (maritime safety and efficiency)
- FreightWise - EU FP 6 (co-modal freight transport))
- SMARTFREIGHT - EU FP 7 (smart urban freight distribution).

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Abbreviations

ACID	Atomicity, Consistency, Isolation, and Durability
AIS	Automatic identification System
API	Application Programming Interface
ATA	Actual Time of Arrival
ATC	Automated Traffic Control
ATD	Actual Time of Departure
ATM	Automated Teller Machine
ATP	Actual Transport Preferences
B2B	Business-to-Business
BCF	Business Collaboration Framework
BOD	Business Object Document
BPEL	Business Process Execution Language
BPEL4WS	Business Process Execution Language for Web Services
BPML	Business Process Modelling Language
BPSS	Business Process Specification Schema
BTP	Business Transaction Protocol
CEFACT	Centre for Trade Facilitation and Electronic Business
CEN	The European Committee for Standardization
COTS	Commercial Off-The-Shelf
CPP	Collaboration Protocol Profile
CPPA	Collaboration-Protocol Profile and Agreement Specification
D2D	Door-to-Door
DAML-S	DARPA Agent Mark up Language for Services
DBMS	DataBase Management System
DDA	Disability Discrimination Act
DFD	Data Flow Diagrams
ebMS	ebXML Messaging Specification
ebXML	Electronic Business using eXtensible Markup Language
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange For Administration, Commerce, and Transport
EDS	Electronic Data Systems
EMS	Emergency Medical Services
ER-diagram	Entity-Relationship diagram
ETA	Estimated Time of Arrival
ETD	Estimated Time of departure

EU	European Union
GSM	Global System for Mobile Communications
GTP	General Transport Preferences
IATA	International Air Transport Association
ICF	International Classification of Functioning
ICT	Information and Communication Technology
ID	Identity/Identifier
IIOP	Internet InterOperability Protocol
ISO	International Standards Organization
ITS	Intelligent Transport Systems and services
JAR-OPS	Joint Aviation Requirements Operation
LAN	Local Area Network
LE	Large Enterprise
MFAG	Medical First Aid Guide
MIG	Message Implementation Guidelines
MIME	Multipurpose Internet Mail Extensions
MS	Message Service
MSH	Message Service Handler
NCSU	North Carolina State University
NOIE	National Office for the Information Economy
NTS	Network and Traffic Status
OAGi	Open Applications Group
OAGIS	Open Applications Group Integration Specification
OASIS	Organization for the Advancement of Structured Information Standards
PT	Public Transport
RFID	Radio Frequency Identification
RMI	Remote Method Invocation
RM-ODP	Open Distributed Processing – Reference Model
RPC	Remote Procedure Call
RUP	Rational Unified Process
SAML	Security Assertion Markup Language
SME	Small & Medium Enterprise
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SQL	Structured Query Language

SSIM	Standard Schedules Information Manual
TC	Technical Committee
TCC	Traffic Control Central
TEP	Transport Execution Plan
TES	Transport Execution Status
TIC	Traffic Information Central
TIS	Transport Item Status
TOP	Transport Operation Plan
TRIDENT	Transport Intermodal Data sharing and Exchange NeTworks
TRIM	Transport Reference Information Model
TRP	Transport Routing & Packaging
UD	Universal Design
UDDI	Universal Description, Discovery and Integration
UIC	Union Internationale des Chemins de Fer (International Union of Railways)
ULD	Unit Load Device
UML	Unified Modelling Language
UMTS	Universal Mobile Telecommunications System
UN	United Nations
VHF	Very High Frequency
VIP	Very Important Person
VTS	Vessel Traffic Services
W3C	World-Wide-Web Consortium
WHO	World health Organization
WS	Web-services
WSCI	Web Service Choreography Interface
WSCL	Web Service Conversation Language
WSDL	Web-services Definition Language
WSEL	Web service Endpoint Language
WS-I	Web Service Interoperability Organization
WWW	World-Wide-Web
XACML	eXtensible Access Control Markup Language
XML	Extensible Markup Language

1 Introduction

ARKTRANS is the Norwegian framework architecture for multimodal ITS. ARKTRANS covers all transport modes (sea, rail, road and air) as well as freight and passenger transport.

ARKTRANS is the result of a comprehensive study of the whole transport sector and all transport modes. The first version of ARKTRANS was established in a research project co-funded by the Research Council of Norway. The pursuance of the work is ensured by ITS Norway, based on funding from the Norwegian Ministry of Transport and Communications.

Information about ARKTRANS can be found on www.arktrans.no.

1.1 Background and motivation

The current traffic situation is dominated by severe problems mainly related to road transport, e.g. congestions, a high number of casualties, and air pollution. Increased use of other transport modes, preferably rail and sea, will improve the situation [1, 2]. However, most departure and destination points are not located next to ports or rail terminals, and door-to-door transport operations involving sea or rail transport require intermodal transport chains.

Intermodal transport involves many actors, and the establishment and management require a considerable amount of coordination and information exchange. It is the belief that such transport can become more competitive by means of ITS, which in this case is interoperable ICT solutions [3]. Planning, as well as coordination and information exchange, and detection and handling of deviations and incidents can be automated or supported in a more efficient way. Delays in one part of a transport chain may for example be reported in time and enable corrective actions in the remaining chain.

ITS solutions also support the operation of the transport means, the traffic management and the interactions between traffic management and the transport means. On-board assistance and support will in combination with pro-active and adaptive traffic management and infrastructure systems improve the safety and efficiency.

Openness and interoperability are prerequisites for optimal effects of ITS. The different parts of the transport sector must be able to interact in an efficient way and to utilise and re-use information established by others. The transport companies may for example benefit from reliable traffic information from traffic management centres; and the actors involved in transport chains will benefit from well defined information flows that are harmonised across all transport modes. ARKTRANS arranges for such solutions by providing common concepts and specifications, and by providing well defined interfaces for information exchange. Such interfaces also arrange for the establishment of new value chains and ICT services related to the transport sector.

1.1.1 Multimodality

ARKTRANS is multimodal framework architecture in the sense that it is common and harmonized for all the transport modes, i.e. road, sea, air and rail. There are of course differences between the transport modes. However, the similarities are more conspicuous, especially at a conceptual and logical level. Thus, the ARKTRANS approach is to harmonise and coordinate whatever can be harmonised and coordinated into a common framework architecture.

An alternative to the ARKTRANS approach is to establish separate architectures for each transport mode and define interfaces between them. However, it is our belief that such an approach will complicate the establishment of optimal intermodal solutions. Empirically, interfaces or gateways for such complex solutions will require a lot of effort, and they may also cause problems due to differences in semantics. By establishing a common multimodal framework architecture, ITS solutions that support intermodal transport are more likely to be established. System interoperability, efficient information flows, coordination across transport modes, etc. can be supported by common concepts and specifications that bridge the current gaps in semantics and arrange for interoperability and efficiency.

1.1.2 Harmonisation of freight and passenger transport

In addition to being multimodal and harmonised across all transport modes, ARKTRANS also harmonises freight and passenger transport. Such a harmonisation is, as far as we know, not done in other ITS frameworks, but many similarities between freight and passenger transport legitimate a closer coordination. Freight and passenger transport are to a large extent performed by the same types of Transport Means, on the same Transportation Networks, and a freight item and a travelling person are quite equal from a conceptual point of view. Their journeys through the Transportation Network have start and stop locations, they have demands with respect to how to be handled by the transport service providers, they are in transit at terminals, etc. The main difference is that people usually are able to move between the different Transport Means by themselves. There are also similarities with respect to the provision of the transport services. The operators of both freight and person transport must plan their use of resources, their routes, and their handling of the items/persons to be transported.

1.2 The purpose of the ARKTRANS framework architecture

ARKTRANS is a *framework architecture*. A framework architecture is in this case a generic specification of solutions for the transport sector. The intention is to support the establishment of ITS (requirement specifications and system architectures) through the provision of generic specifications that

- Provide a holistic and mode-independent understanding of the transport sector, responsibilities, relations and dependencies included.
- Define multimodal terminology and concepts (semantics) for the transport sector.
- Support the specification and implementation of ITS solutions that are in compliance with a common and holistic view of the transport sector. To do this ARKTRANS
    - Can be used as a starting point for ITS specifications. The content of ARKTRANS can be used as a check list for planning and discussions, or as a starting point and inspiration for more detailed specifications.
    - Can be used directly in ITS specifications. Parts of ARKTRANS can be adopted as they are into specifications of ITS solutions. The service oriented parts of the architecture can for example arrange for interoperability between systems.
    - Provides specifications with an assured quality (they are discussed with stakeholders from all transport modes and refinements have been done based on use in relevant projects).
    - Arranges for intermodal solutions and services by providing a holistic, multimodal and structured view upon the transport sector
- Support analysis and simplifications of transport solutions through provision of different abstraction levels or views on the transport sector. By means of these specifications
    - The context in which the solutions shall operate can be defined.
    - The relevant abstraction levels can be used to “hide” irrelevant details when they are not needed.
    - Gaps and shortcomings can be identified in a holistic context.

1.3 Reduction of complexity

The transport sector is very comprehensive. A large number of actors are involved in many different activities, and they coordinate their activities in several ways. Due to this complexity, it has been a challenge to establish good and generic solutions. ARKTRANS aims to reduce this complex view upon the transport sector to arrange for new and generic solutions by means of:

- A harmonised and generic view upon

- o All transport modes as well as freight and person transport.
- o The variety of transport services and transport operations.
- A division of the transport sector according to responsibilities and focuses.
- A top down approach that
  - o Ensures a holistic view upon the solutions.
  - o Specifies the transport sector at different complexity levels.

1.3.1 Generic view upon the transport sector

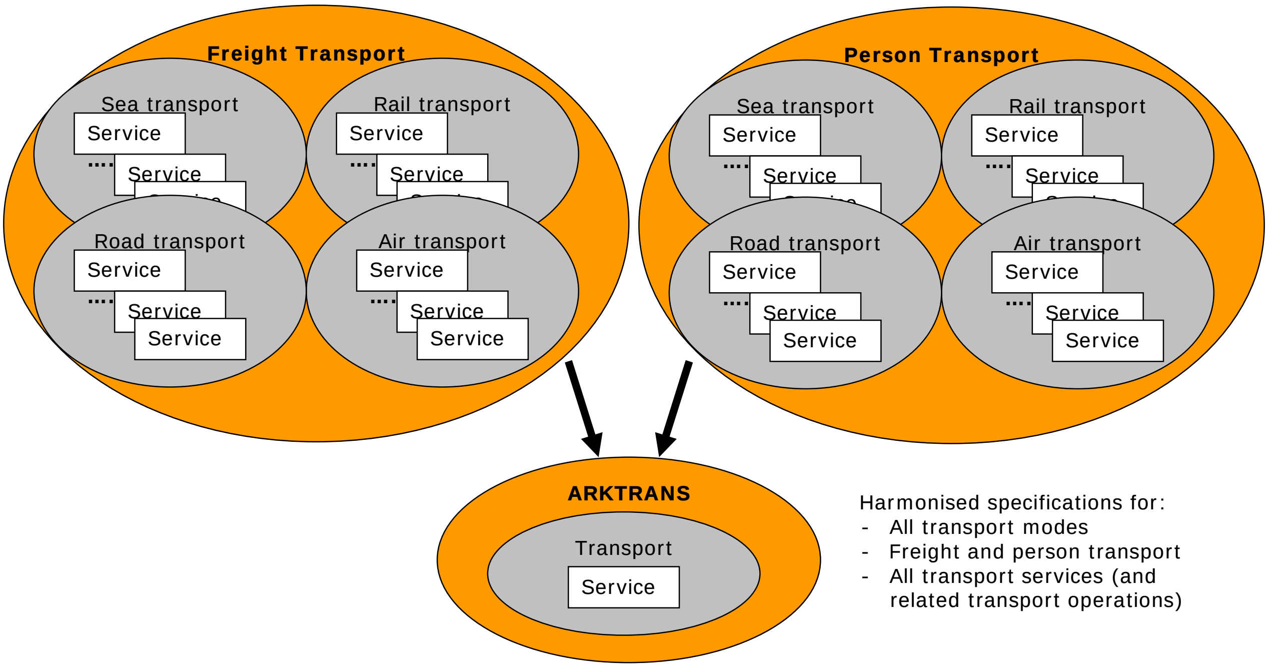


Figure 1 ARKTRANS simplifies the transport sector

To cope with the complexity of the transport sector, ARKTRANS aims to define the sector in a generic way that hides local and modal variations. In that way, the large number of solutions do not have to be specified (e.g. variants for each transport mode, passenger transport and freight transport). When the work on ARKTRANS started, there was uncertainty about the ability to make such generic specifications. However, it has been proved that a harmonisation of transport modes and transport types (freight transport and person transport) is feasible. All transport modes and types are from a conceptual and logical point of view similar, and they can be described by means of common specifications. This approach simplifies the specification and arranges for common solutions and interoperability.

A large variety of transport services are provided by public transport operators, forwarders, freight companies, terminal operators, etc. These services have to be planned; information about available services must be published to potential customers; the customers must be supported in transport planning, service booking and follow up; and the associated transport operations (e.g. transport, handling at terminals, document handling, storage, etc.) must be managed and executed. The transport services, as well as the planning and management of the associated transport operations, can be specified in a generic way. This service harmonisation approach reduces the complexity even more.

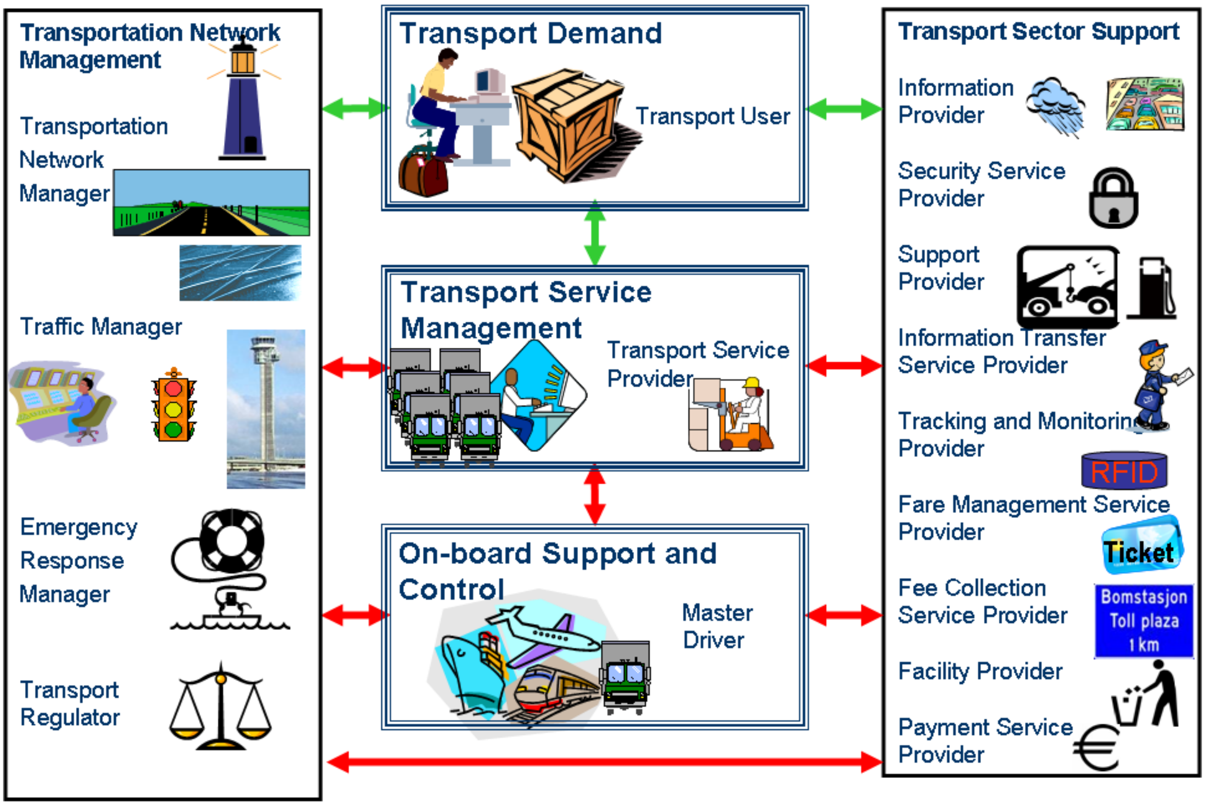
1.3.2 A subdivision of the transport sector

ARKTRANS copes with the wide scope of the transport sector by dividing it into manageable domains. However, unlike other frameworks, the division is not according to functions, e.g. freight transport, which may involve interactions between a many different types of stakeholders.

ARKTRANS, on the other hand, divides the transport sector into domains addressing responsibilities. Just a limited number of stakeholder types, or roles as they are called in ARKTRANS, relate to each domain, and one role relates to just one domain.

Figure 2 The transport sector is divided into domains

Figure 2 shows a popular version of the ARKTRANS Reference Model, which illustrates the



overall decomposition of the transport sector and the main roles related to the domains. To fulfil their responsibilities the roles must interact with other roles, indicated by the arrows in the figure.

- The Transport User in the Transport Demand books or requests transport services from Transport Service Providers in the Transport Service Management domain.
- The Transport Service Management domain is responsible for the provision of transport services like mobility and terminal services to the Transport User. This also includes the execution of the required transport operations.
- The On-board Support and Control domain is responsible for the operation of the Transport Means. This is done according to regulations and traffic management provided by the Transportation Network Management.
- The Transportation Network Management domain represents responsibilities that arrange for safe, efficient and environmental friendly transport through regulation enforcement, traffic management, transportation network infrastructure management, and emergency management.
- The Transport Sector Support domain provides generic services to different parts of the transport sector, e.g. different types of information services.

With respect to intermodal transport, it is important that the Transport User can operate in the same way independent of the transport mode. Transport booking and follow up, along with traffic information, should be exchanged in the same way, as indicated by the green arrows in the Figure. The red arrows, however, may be implemented in different ways depending on the transport mode. The traffic management interactions with the transport means will for example be different in different modes, but the conceptual specification of traffic management (the required activities, etc.) is in ARKTRANS the same for all modes.

1.3.3 A top down approach

To provide a holistic specification of the transport sector, and to cope with the details of the transport sector, ARKTRANS has a top down approach. The transport sector is specified at different complexity levels and from different viewpoints.

At the top level, the ARKTRANS Reference Model divides the transport sector into manageable domains and provides an overall and holistic depiction of the sector, as illustrated by the simplified version of the model in Figure 2. The main responsibilities and focuses are addressed, but details and complexity are hidden. The Reference Model is crucial as it is used as a point of reference and defines the structuring of the more detailed parts of the ARKTRANS framework. By linking the more detailed parts of ARKTRANS to the Reference Model, the overall context is clear when solutions are specified.

The detailed parts of ARKTRANS are organised into viewpoints that specify different aspects of the logical solutions, as illustrated in Figure 3 and described in 1.4.

1.4 The ARKTRANS content

This section provides an overview over the ARKTRANS content and how it is established.

1.4.1 A layered approach

The content of ARKTRANS is organised into different abstraction layers and different viewpoints, inspired by both the ISO RM-ODP framework [4], which identifies a wide set of relevant viewpoints, and the Converge guidelines for transport system architectures, which operates with a more limited number of what they call architectures [5]. ARKTRANS has selected the viewpoints needed from either framework.

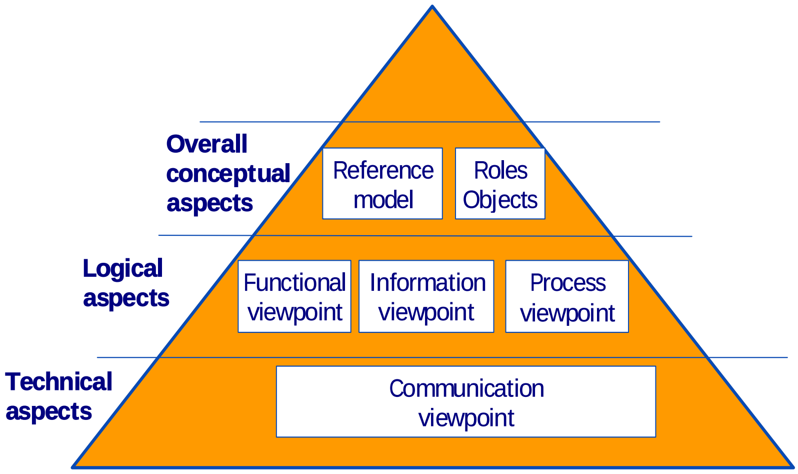


Figure 3 The ARKTRANS content

The content of ARKTRANS addresses, as illustrated in Figure 3, different aspects:

- The overall conceptual aspects
  - The ARKTRANS Reference Model. The model organises the transport sector into domains to cope with the comprehensiveness of the transport sector. It also defines the overall structure of the ARKTRANS framework architecture.
  - The generic roles of stakeholders in the transport sector. Each role represents a unique set of responsibilities, and relates to just one domain of the Reference Model.
  - The generic objects in the transport sector. They represent physical items or systems representing abilities.
- The logical aspects
  - The functional viewpoint decomposes the domains of the Reference Model into functional hierarchies, which provide structure and terminology for the overall

functions and activities. These functions or activities contribute to the fulfilment of responsibilities associated to the roles.
  - The process viewpoint describes how the activities of the roles are combined to work processes. The required interactions between roles are identified.
  - The information viewpoint defines the required information objects, their attributes and relations. The information objects are further used in a service oriented architecture (SOA), which arranges for the interactions identified in the process viewpoint.
- The technical aspects
  - The communication viewpoint specifies the implementation of the services defined in the information viewpoint.

1.4.2 The ARKTRANS building blocks

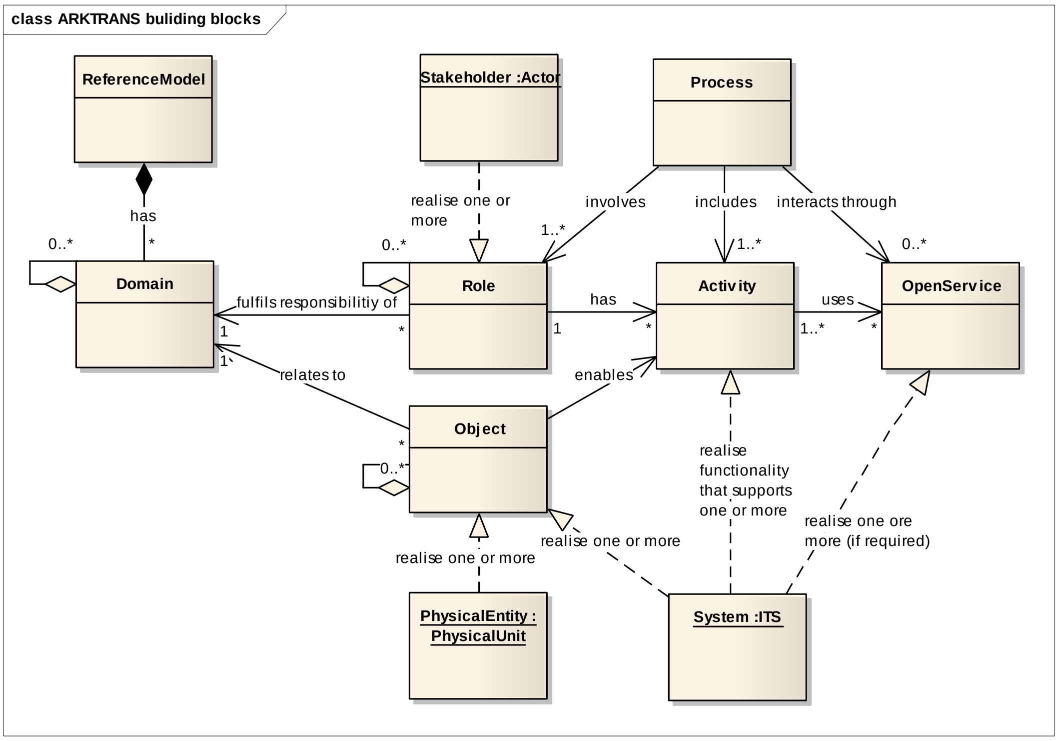


Figure 4 The ARKTRANS building blocks

Figure 4 shows the building blocks used to specify ARKTRANS:

- Stakeholders like organisations, businesses and people realise one or more Roles. A Role may consist of other Roles.
- The Reference Model consists of Domains representing a set of responsibilities which are fulfilled by one or more Roles. One Domain may be decomposed into other Domains.
- One Role relates to just one Domain.
- Physical Entities and Systems are referred by means of generic Objects representing generic abilities. An Object may consist of other Objects.
- One Object is related to just one Domain.
- A Role has to execute one or more Activities to fulfil its responsibilities.
- An Activity may interact with other Activities by means of Open Services.
- A Process involves the Activities of one or more Role and how these Activities interact by means of Open Services.
- Systems may realise functionality that supports the Activities and the interactions by means of Open Services.

- Parts of the functionality required in a Domain may be realised by means of an Object. An Object represents a physical units and a system. The same physical element or systems may cover Objects.

1.4.3 Input to ARKTRANS

ARKTRANS must be generic and multimodal. Several projects have contributed with input. In some cases the input is directly included into ARKTRANS. In other cases the input verifies that the existing content of ARKTRANS is correct, or the input has to be evaluated and processed further to represent multimodal and generic knowledge.

Several projects have used ARKTRANS and provided input to the refinement of ARKTRANS, among other:

- The D2D project (EU 5FP project on intermodal freight transport chains) went on in parallel with the establishment of the first version of ARKTRANS. Thus, many of the overall concepts (e.g. Reference Model and roles) were tested towards the needs identified by D2D.
- The MultiRIT project (national research project on multimodal travel information services) has provided valuable input related to person transport and travel information services. The content of the Reference Model, the roles, the functional viewpoint and the process viewpoint have been verified and adjusted thanks to MultiRIT. In addition MultiRIT has provided new content to the information and communication viewpoints (information and service models for travel information).
- The INTRANS project (national research project on intelligent goods) has used ARKTRANS as a starting point for conceptual work and has so far contributed to confirmations of role and object specifications.
- The MarNIS project (EU FP6 project on maritime safety and efficiency) used ARKTRANS as a starting point for the work on a maritime architecture. This work verified that ARKTRANS also supports maritime transport. MarNIS has also provided input to the role definitions.
- In the Freightwise project (EU 6FP project on co-modal freight transport) ARKTRANS has been used as the starting point for a innovative thinking with respect to new and improved services for planning and management of co-modal freight transport chains. Freightwise has provided valuable input to the functional viewpoint, and may in the future also contribute to specifications that support freight transport in the information and communication viewpoints.
- In the SMARTFREIGHT project (EU 7FP) ARKTRANS has been the starting point for the specification of traffic management toward individual freight vehicles in urban areas. Such traffic management is not common in road transport, but due to the multimodal approach, this is supported by ARKTRANS. SMARTFREIGHT has so far contributed to improvements of the functional and the process viewpoints.

Due to the dependency of input from projects working on practical solutions, parts of ARKTRANS are more mature than other parts. There are for example so far no service definitions for freight transport. Hopefully the Freightwise project and the upcoming eFreight project (EU 7FP) will contribute to this.

1.4.4 The establishment method

The work on ARKTRANS has been challenging for many reasons. The list below describes how these challenges are met:

1. Involvement, input and comments from stakeholders in the transport sector have been a prerequisite for the result. Two-ways communication with the stakeholders is achieved through

- o Dissemination activities. The work on ARKTRANS and the use of ARKTRANS is published at conferences and at meetings.
- o Working groups. Stakeholders from relevant parts of the transport sector have been participating in the working groups, which have established the viewpoints. There have been representatives from all transport modes in the working groups.
- o Use of ARKTRANS in national and European projects.

2. The wide scope and the complexity of the transport sector is handled by means of several strategies
    - o Results from related work are used as a starting point, especially the KAREN framework [6], the US architecture [7] and the architecture work in ISO [8, 9].
    - o Harmonisation across transport modes, person and freight transport, and different transport services to bridge between differences in terminology, working procedures, etc. (see 1.3.1). This has arranged for simplified specifications.
    - o Organisation of the transport sector is into manageable domains with specific responsibilities and focuses (see 1.3.2).
    - o Realisation details for the inner parts of systems are not addressed. Common understanding and interoperability are focused upon.
3. Conceptual and logical specifications that arrange for a common understanding and new and improved services are established by means of:
    - o Software engineering methods and specification.
    - o Use of existing and intermediate versions of ARKTRANS in transport related projects (see 1.4.3). In that way knowledge and experience are gained and used as input to a continuous and iterative improvement process.

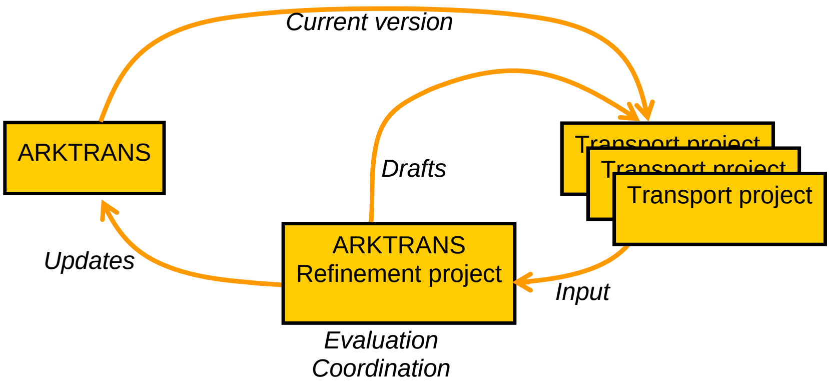


Figure 5 The ARKTRANS refinement process

As illustrated in Figure 5, the ARKTRANS refinement process is based on input from transport projects that are using ARKTRANS. An ARKTRANS refinement project is responsible for the evaluation of the input and for the actual updates. The methods used vary. In some projects the collaboration with the ARKTRANS refinement project is formalised and a method inspired by action research is used as described in [10]. In other cases the collaboration is more ad hoc.

1.5 The content of this report

The content and the status of the different parts of this report are listed below:

- Norwegian and English summaries are provided in Chapter 2 and 3.
- Chapter 4 defines the Reference Model. The model is complete, and at the moment we do not see the need for any updates.
- Chapter 5 defines the roles of the stakeholders and the physical objects in the transport sector. The specifications are complete, but there may be updates in the future due to needs identified in transport related projects.

- Chapters 6, 7, 8, 9 and 10, the functional view, specify the functionality required by the domains of the Reference Model. The specifications are to a large extent complete, but there may be updates in the future due to needs identified in transport related projects.
- Chapter 11 is the process view. The processes may be carried out in many ways, and the main intention is to identify the required interactions. New knowledge may identify needs for updates.
- Chapter 12 is the information view and describes conceptual information models and service models for travel information. New models will be added in the future, among others based on work currently going on in European projects dealing with freight transport and traffic management.
- Chapter 13 describes technical solutions that arrange for interoperability between ITS solutions. Web-service definitions for exchange of travel information and the provision of travel plans are defined, but these are not included in this report. They can be found on the Web-site. More solutions will be added later, based on input from ongoing projects.
- Chapter 14 contains a description of some terms that are important to the overall understanding of ARKTRANS.

1.6 Changes in this version

This version of ARKTRANS has major changes from the previous version. There are changes in all parts, and a detailed description will be too extensive. The main changes are:

- The Reference Model is changed.
  - The Terminal Management domain is removed as the other domains cover the terminal (or a Transfer Node as it now is called). See description in 4.3.1.
  - The Service Management domain is re-named to Transport Sector Support, and its position in the Reference Model is also changed.
  - The Transport Network Management domain is renamed to Transportations Network Management. The “Transportation Network” denotes the network that arrange for transport in general. See the description of the transport and transportation terms in 14.57.
  - For the same reason as above, the Transport Network Infrastructure Management domain is renamed to Transportation Network Infrastructure Management, and the Transport Network Utilisation domain is renamed to Transportation Network Utilisation.
- The roles and objects are updated. At the top level (superior roles), as few roles as possible are related to each domain of the Reference Model. Some major roles have new names:
  - Transport Service Provider is used instead of Transporter
  - Transport Regulator is used instead of Authority
  - Transportation Network User is used instead of Driver/Master
- The functional view is updated
  - The functionality is illustrated as UML use cases attached to roles
  - Most of the functions have new names. These names are also used on activities in the process view.
  - New functionality is added.
  - The Transport Service Management domain is organised into sub-functions representing provision of transport service; transport operation management; transport operation execution and transport business management.
- The behaviour view is now called process view to reflect that processes are addressed.
  - The process diagrams are organised into a hierarchy with different abstraction levels.
  - The process diagrams are updated and many more process diagrams are added
- The information view contains new and updated models related to travel information.
- In the communication view, WSDL (Web-service Definition Language) specifications are available for a selection of Web-services.

2 Norwegian summary

ARKTRANS er det nasjonale rammeverket for multimodal ITS og dekker både gods- og persontransport. Denne rapporten, ARKTRANS versjon 6.0, beskriver rammeverket slik det forelå etter første halvår av 2009.

2.1 Bakgrunn

Etatene for de fire transportformene vei, sjø, bane og luft, representert ved Statens Vegvesen ved Vegdirektoratet, Kystverket, Jernbaneverket, NSB AS og Avinor AS hadde før oppstarten av ARKTRANS etablert et godt samarbeid om multimodal transporttelematikk etter initiativ fra Samferdselsdepartementet. Det ble etablert en såkalt Nettverksgruppe med representanter fra de fem institusjonene og Samferdselsdepartementet. Nettverksgruppen i Norge var samordnet med en nordisk nettverksgruppe og arbeidsgruppe for transporttelematikk nedsatt av Nordisk Ministerråd og Nordisk Embetsmannskomité for Transport (NET).

Nettverksgruppen så at de fire etatene så vel som transportutøverne og transportbrukerne har sammenfallende behov og utfordringer knyttet til bruk av IKT [11]. Det er et stort potensial for synergieffekt av et nært og praktisk samarbeid på tvers av ulike roller og ulike transportmodi. Det var imidlertid, før oppstarten av Nettverksgruppen, gjort lite for å få til en samordning. På initiativ fra Nettverksgruppen ble temaet behandlet i samarbeid med fagpersoner fra forskningssiden. Det var en felles oppfatning om at den mest effektive angrepsmåten var å starte arbeidet med en arkitektur for transportområdet. ARKTRANS Forprosjekt startet opp høsten 2000 [12]. Forprosjektet resulterte så i oppstarten av et forskningsrådsprosjekt i 2002. Deltakere i forskningsrådsprosjektet var Staten Vegvesen ved Vegdirektoratet, Kystverket, Jernbaneverket, Avinor AS, NSB AS, Ergo Group, Telenor FOU og Transportbedriftenes Landsforening. Hovedprosjektet ble ledet av SINTEF. I tillegg kom en større referansegruppe som ga et uvurderlig bidrag til spesifikasjonen av ARKTRANS.

Eierskapet til ARKTRANS er etter forskningsrådsprosjektets slutt ivaretatt av ITS Norge.

2.2 Problemstillinger

ARKTRANS Forprosjekt frembrakte god oversikt over relevante problemstillinger samt innsikt i nasjonale og internasjonale resultater og aktiviteter som er av betydning for det videre arbeidet med en multimodal systemarkitektur. Blant annet kan vi nevne følgende forhold som gjør at forbedringspotensialet er stort:

1. Det er i stor grad den samme informasjonen og de samme tjenestene som etterspørres av myndighet, tjenesteyter og bruker - uavhengig av transportmodus, men det er dårlig samordning av systemer og lite effektiv informasjonsflyt:
    - Informasjon kan ikke sendes elektronisk mellom aktører og transportformer. Samme informasjon må registreres manuelt mange ganger i løpet av en transportkjede, både hos brukere, transportutøvere og myndigheter.
    - Feilregistreringer oppstår på grunn av gjentagne manuelle registreringer, ulik terminologi og dårlig samordnede systemer.
    - Håndteringen av farlig gods er for dårlig. Det er liten eller ingen overlevering av relevant informasjon fra en transportmodus til en annen, og mellom aktører.
    - Sporing av gods, farlig gods inkludert, gjøres i liten grad og ikke i det hele tatt på tvers av transportmodi og aktører
    - Kontroll med transport som utføres av en kjede med utøvere er dårlig. Statusinformasjon er svært lite tilgjengelig underveis.
2. Informasjon som kan forbedre sikkerhet og effektivitet er ikke tilgjengelig, eller den utnyttes dårlig ved planlegging og gjennomføring av transport, for eksempel:

- Informasjon om meteorologiske forhold, tilstanden til transportnettet (veier, farleder, baner, korridorer) og forhold ved trafikken (kødannelser, ulykker, osv.) er til en viss grad tilgjengelig, men etablering og dynamisk oppdatering av slik informasjon kan bedres i vesentlig grad, og informasjonen må formidles og presenteres på måter som egner seg for de ulike aktørene og den jobben de utfører (for eksempel værprognoser på kart til flåteoperatører som planlegger ruter, bruk av informasjon om trafikkforhold, værforhold og forhold ved transportnettet ved rute- og tidsplanlegging, melding om gjeldende værforhold og forhold ved trafikken og transportnettet via talemeldinger til førere av transportmidler, osv.) .
- Ruteinformasjon og trafikkdata (avgangs- og ankomsttider, forsinkelser, forventet ankomst, osv.) som formidles gjelder i stor grad kun for én aktør eller én transportform. Informasjon fra ulike transportutøvere og ulike transportformer kan ikke kombineres slik at det gis et samlet bilde av transportoppdrag (person eller gods) som omfatter flere etapper og flere transportutøvere/transportmodi.

3. Flere aktører er involvert i både gods- og persontransport, og det er mange av de samme problemstillingene knyttet til begge former for transport. Gode løsninger for en av transportformene bør derfor kunne utnyttes av den andre. Blant annet kan vi nevne at følgende likhetstrekk ikke er utnyttet til effektivisering og samordning
   - Problematikken rundt flåtestyring og planlegging er lik for mange former for godstransport og persontransport. Bestillinger skal mottas, bruk av personell og ressurser skal planlegges, ruter skal velges, tidsplaner legges, osv.
   - Behovet for førerstøtte og kjøretøykontroll er sammenfallende, blant annet vil man underveis i transporten ha behov for informasjon om trafikkforhold, meteorologiske forhold og forhold ved transportnettet, og man vil overvåke viktige forhold ved transportmiddelet. ARKTRANS innser dog at det på dette området er mange modale, internasjonale standarder som man *må* forholde seg til innenfor hver transportmodus.
   - Operatører må ofte forholde seg til ulike administrative systemer mot gods- og persontrafikk, selv om de selv benytter samme transportmiddel og/eller terminal for å avvikle denne transporten.

2.3 Hensikten med ARKTRANS

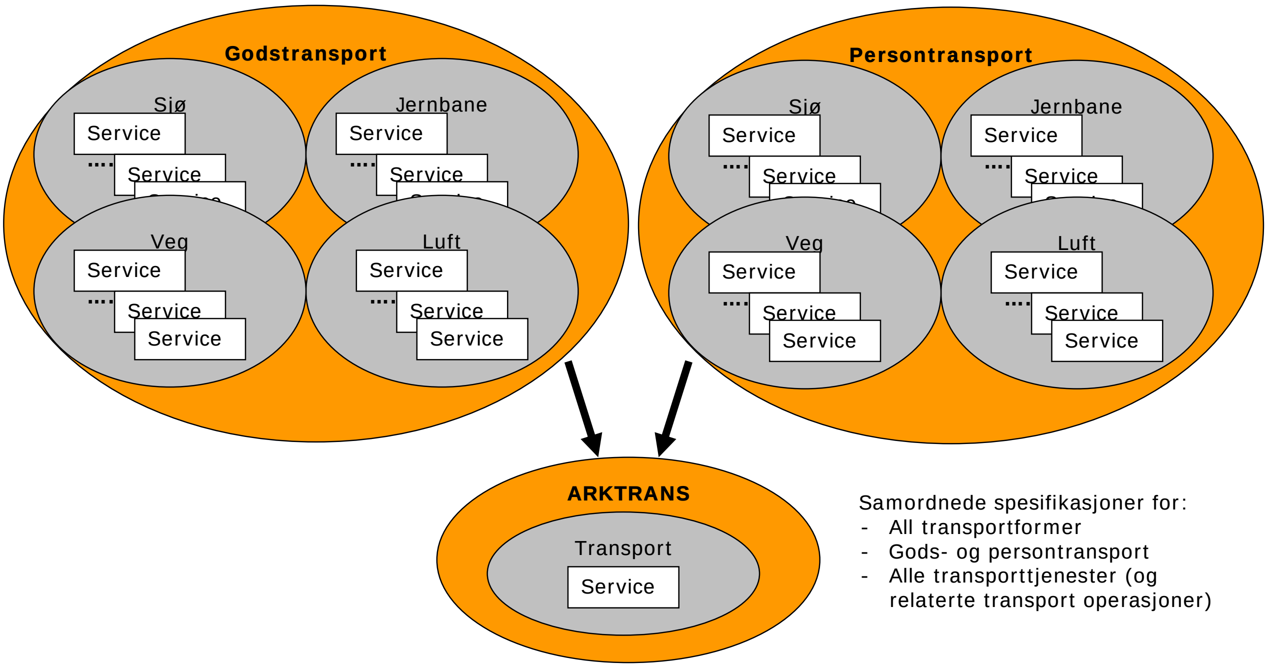
ARKTRANS skal støtte etablering av ITS ved hjelp av spesifikasjoner som

- Gir en helhetlig forståelse av transportsektoren, ansvarsområder, relasjoner og avhengigheter inkludert. Dette gjøres ved hjelp av spesifikasjoner som er uavhengig av transportform.
- Definerer multimodale termer og konsepter for transportsektoren (semantikk)
- Støtter spesifikasjon og implementering av ITS som passer inn i et helhetlig bilde av transportsektoren. Dette gjøres ved at ARKTRANS
  - Kan være et utgangspunkt for ITS spesifikasjoner. Innholdet i ARKTRANS kan fungere som sjekkliste ved planlegging og i diskusjoner eller som utgangspunkt og inspirasjon ved spesifikasjoner
  - Kan benyttes direkte i spesifikasjoner.
  - Tilbyr spesifikasjoner som er kvalitetssikret gjennom diskusjoner på tvers av transportformer og prosjekter.
  - Legger til rette for intermodale løsninger
- Støtter analyser og forenklinger ved å tilby ulike abstraksjonsnivå og synsvinkler
  - Irrelevante detaljer kan skjules etter behov
  - Mangler kan identifiseres

2.4 ARKTRANS reduserer kompleksitet

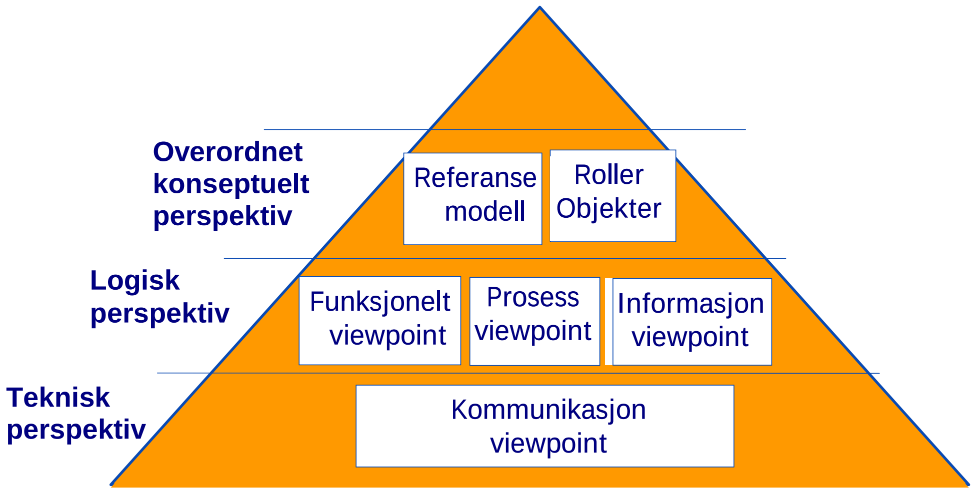
Transportsektoren er bred og kompleks med mange aktører og aktiviteter. Samhandlingen skjer på mange ulike måter. ARKTRANS har angrepet denne kompleksiteten ved å:

- Samordne spesifikasjonene for alle transportformer (vei, sjø, bane og luft), gods- og persontransport og alle transporttjenester og transport operasjoner. Denne samordningen gjør at ARKTRANS kan beskrive transportsektoren på en generell måte som bidrar til felles forståelse.
- Dele transportsektoren inn i områder avhengig av ansvars- og fokusområder (se beskrivelsen av referansemodellen under)
- En top-down tilnærming med ulike kompleksitets- og detaljeringsnivå



Figur 6 ARKTRANS forenkler transportsektoren gjennom samordning

2.5 Innholdet i ARKTRANS



Figur 7 Innholdet i ARKTRANS

Figur 7 viser innholdet i ARKTRANS. Ulike perspektiver på transportområdet er beskrevet. Et overordnet konseptuelt perspektiv gir en overordnet beskrivelse av hele transportområdet. En *referansemodell* deler transportområdet inn i delområder og avgrenser omfanget av arkitekturen.

Hvert delområde forholder seg til aktører og organisasjoner, som fyller gitte *roller*, og *objekter* representerer fysiske enheter og systemet (for eksempel godsenheter, transportnette, utstyr, osv.).

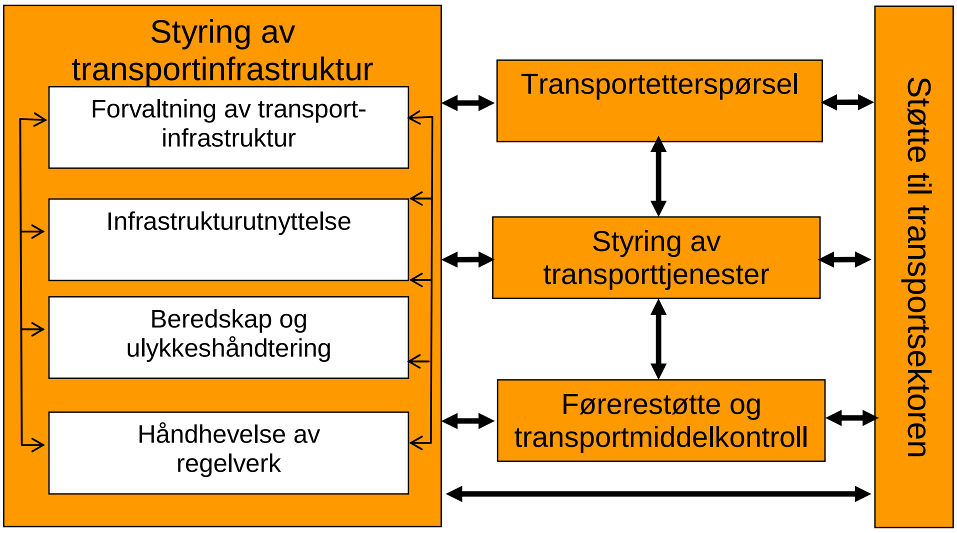
Et logisk perspektiv spesifiserer nødvendig funksjonalitet og hvilken informasjon det er behov for. Det beskrives også hvordan de ulike delene av transportområdet arbeider sammen i prosesser, inkludert hvilke informasjonsflyter som er nødvendige. Det er lagt vekt på at spesifikasjonene skal være teknologiuavhengige. De skal gjelde for skiftende teknologier.

Et teknisk perspektiv beskriver hvordan løsningene skal realiseres.

Innspill til arbeidet er hentet inn i ulike arbeidsgrupper hvor representanter fra alle transportformene har jobbet sammen og fra prosjekter som har benyttet ARKTRANS.

Gjennom studier av relaterte arbeider og tilbakemeldinger fra internasjonale kontakter er det klart at ARKTRANS i internasjonal sammenheng i er unik. Det eksisterer ingen andre rammeverk som samordner transportformene på en tilsvarende måte.

2.5.1 Referansemodell og roller



Figur 8 - ARKTRANS Referansemodell

Referansemodellen i Figur 8 er strengt rollesentrert. En rolle er kun relatert til ett av områdene i modellen. Norske rollebegreper er angitt i tabellene i Annex E. Tankekart i Annex A gir en oversikt over rollene.

Delområdene i referansemodellen har veldefinerte mål og ansvarsområder:

- *Transportetterspørsel* støtter transportbrukerne eller de som representerer disse (reisebyrå, speditører, osv.) ved planlegging, bestilling og oppføling av både person- og godstransport.
- *Styring av transporttjenester* støtter operatører og andre (bl.a. terminaler) som tilbyr transporttjenester. Kundekontakt, styring og gjennomføring av transportoperasjoner støttes for både person- og godstransport. Ruter, timetabeller, ressursbruk osv. håndteres. Transportoperasjonene overvåkes, og transportbrukerne informeres om status.
- *Førerstøtte og transportmiddelkontroll* skjer lokalt på selve transportmiddelet. Besetningen støttes (navigasjon, relevant informasjon om trafikkforhold, osv.), og fører, last, passasjerer og selve transportmiddelet overvåkes. Aksjoner tas dersom avvik eller hendelser oppstår.
- *Styring av transportinfrastruktur* håndterer forhold knyttet til selve transportnettet (veier, farleder, jernbanelinjer, luftkorridorer, signaleringsutstyr) og fokus er på tilrettelegging, sikker og effektiv trafikkavvikling på dette nettet.

- *Støtte til transportsektoren er* generelle tjenester som også benyttes av transportsektoren. Dette er for eksempel informasjonstjenester som meteorologiske informasjon, støttetjenester som tauing av skip, betalingsformidling, sporingstjenester, osv.

Delområdene i referansemodellen kommuniserer med hverandre og utveksler informasjon og tjenester. Funksjonalitet i to delområder kan f.eks. representere hver sin side i en forretningsprosess. Området Transportetterspørsel kan f.eks. bestille transporttjenester, mens den andre siden, representert ved området Styring av transporttjenester, vil motta og prosessere ordren. Funksjonalitet i et av delområdene kan også være basis for funksjonalitet i andre delområder. Sporingsinformasjon som etableres av teknologi på transportmiddelet (området Førerstøtte og transportmiddelkontroll) kan f.eks. støtte operatørens sporing av transportmiddelet i delområdet Styring av transporttjenester. Videre kan slik sporingsinformasjon oversendes transportbrukeren i området Transportetterspørsel i form av oppdatert statusinformasjon.

2.5.2 Funksjonelt viewpoint

Delområdene i referansemodellen defineres videre ved hjelp av funksjonell dekomponering. Strukturen er dokumentert i form av ”hjernekart” som viser hvordan de ulike funksjonene er brutt ned og organisert, se Annex B. Hver funksjon er knyttet til en rolle. I tillegg er den ulike funksjonaliteten tekstlig beskrevet i denne rapporten.

2.5.3 Prosessviewpoint

Prosessmodeller beskriver hvordan funksjonene i praksis benyttes og samarbeider. Prosessene identifiserer informasjon som flyter mellom de ulike delene av referansemodellen. Scenarioene er beskrevet ved hjelp av UML aktivitetsdiagrammer i ”svømmebaner” (eng. swim lanes).

2.5.4 Informasjonsviewpoint

Den informasjonen som deles mellom områdene i referansemodellen er beskrevet ved hjelp av konseptuelle informasjonsmodeller. Informasjonselementene er videre satt sammen til modeller som representerer tjenestegrensesnitt.

2.5.5 Tekniske aspekter

Tekniske aspekter knyttet til utveksling av informasjon er beskrevet.

2.6 Mer informasjon

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3 English summary

ARKTRANS is the Norwegian framework architecture for multimodal ITS supporting freight and passenger transport. The work on ARKTRANS is a joint effort by representatives from the transport sector, among others the Public Road Administration, the Norwegian State Railways, the National Rail Administration, Avinor, and the Norwegian Costal Administration. The work is co-funded by the Research Council of Norway and the Norwegian Ministry of Transport and Communications. Links are established to relevant national and international activities to achieve maximum input. The work on further refinement of ARKTRANS is managed by ITS Norway.

3.1 Motivation and background

Norwegian transport authorities clearly saw that the stakeholders in the transport sector to a large extent had identical needs and challenges. These needs and challenges also were the same across all transport modes, person transport and freight transport. There were also shortcomings related to intermodal transport. Thus, ARKTRANS is multimodal. That means common to all transport modes. By providing common specifications, including common concepts and terminology, ARKTRANS shall support more efficient intermodal transport.

ARKTRANS also provide specifications that are coordinated and harmonised across freight and person transport. Freight and passengers are conceptually handled in the same way.

3.2 Results

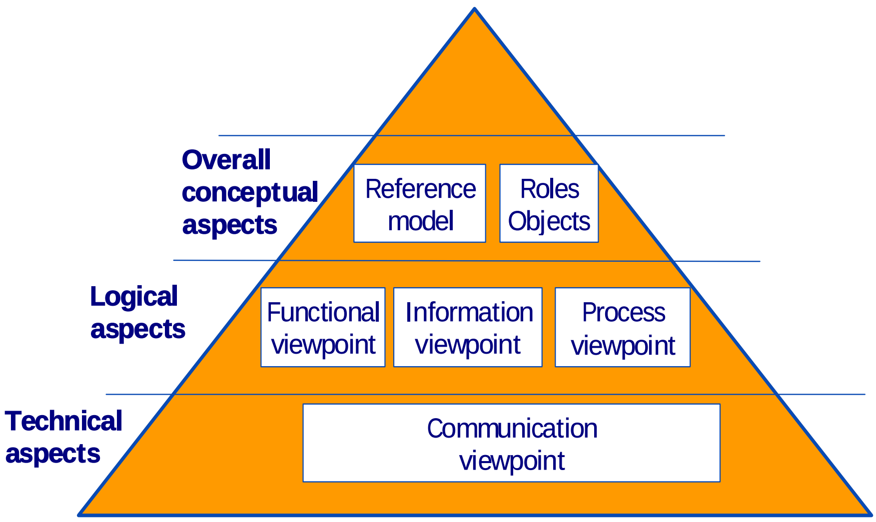

Figure 9 The ARKTRANS content

The content of ARKTRANS is shown in Figure 9.

3.2.1 Reference Model

The ARKTRANS Reference Model divides the transport sector into five manageable domains.

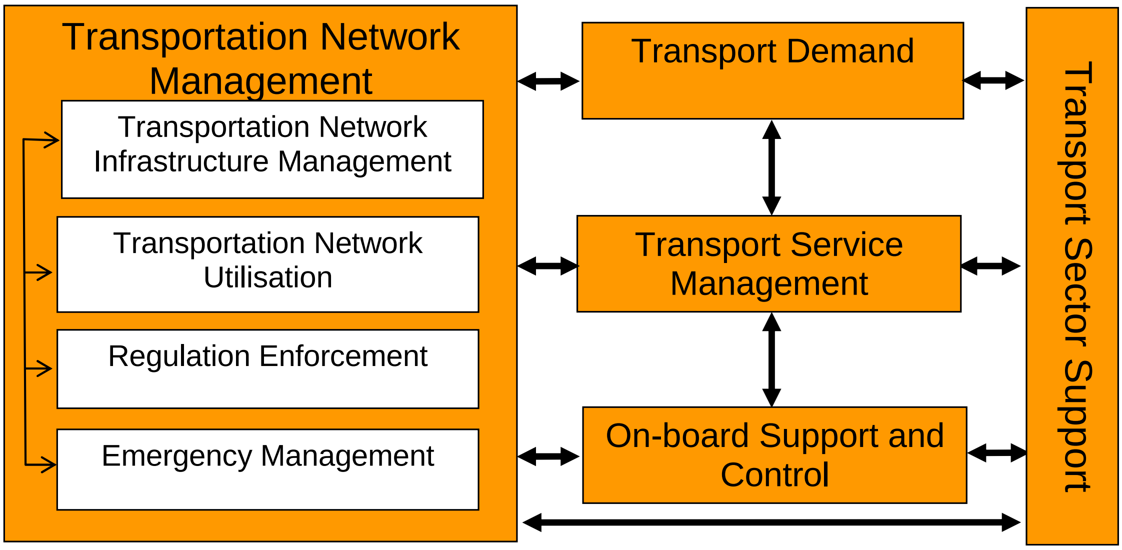

Figure 10 ARKTRANS Reference Model and upper level functional decomposition of Transportation Network Management

Each DOMAIN has well defined objectives and responsibilities:

- The Transport Demand domain supports the transport demands for both freight and passenger transport. This involves pre-trip preparation and planning as well as transport order initiation and follow-up of simple as well as more complex transport chains.
- The Transport Service Management domain provides transport services to the Transport Demand domain. This includes transport operations management and execution for both freight and passenger transport.
- The On-board Support and Control domain supports the operation of Transport Means e.g. navigation, adaptation to traffic situation, etc. On-board incident handling is also an important issue.
- The Transportation Network Management domain provides functionality related to the Transportation Network (roads, fairways, railroads, lanes, etc) and the safety and efficiency of the traffic flow. This encompasses functionality that supports optimal Transportation Network utilisation by means of traffic management, Transportation Network infrastructure management, emergency management and regulation enforcement.
- The Transport Sector Support domain provides supportive services to the other domains.

The domains interact with each other. The functionalities in two domains may represent the two sides in a business-to-business interaction. E.g. the Transport Demand domain will order transport services, while the other side represented by the Transport Service Management domain will accept and process the orders. Functionality provided by one may also be the basis for functionality in other domains. E.g. tracking information collected by tracking technology on-board the Transport Means (Transport Execution Support and Control) may support management and tracking of fleet resources in the Transport Service Management domain. Further on, such tracking information can be passed to the Transport Demand domain and provide the transport user (a consignor, consignee, etc.) with status information and tracking information for the cargo on its way towards its destination.

3.2.2 Roles and objects

ARKTRANS defines a set of roles, and one role relates to just one domain in the Reference Model. A Transport User (e.g. a consignor who wants to send some cargo) is for example related to the Transport Demand domain. A Transport Service Provider (e.g. a freight carrier company) is supported by functionality in the Transport Service Management domain. A Transportation Network User (e.g. a driver) is supported by the On-board Support and Control domain. Traffic Managers and Transportation Regulators operate through the Transportation Network

Management domain. An overview of the roles in ARKTRANS is provided in mind maps in Annex A.

ARKTRANS also defines a set of objects. Objects are general terms representing physical entities (physical elements/units or technical solutions) related to transport. An object represents abilities. The use of generic objects makes it easier to make references to these abilities in a generic way, independent of technology and implementation.

3.2.3 Functional viewpoint

The functional viewpoint specifies the functionality related to the domains of the Reference Model. The breakdown structure of the functionality is depicted in the mind maps in Annex B. Each function is related to a role.

3.2.4 Process viewpoint

The process viewpoint specifies how the transport sector is working with respect to interactions between functions and roles.

3.2.5 Information viewpoint

The information view specifies information that is shared between the domains of the Reference Model. Conceptual information models are described as well as models specifying service interfaces.

3.2.6 Communication viewpoint

The technical realisations of the service interfaces are specified.

3.3 More information

Further development of ARKTRANS is managed by ITS Norway.

WEB-pages: http://www.arktrans.no/

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4 ARKTRANS Reference Model

The transport sector is so extensive and complex that a division into manageable domains is a necessity. The ARKTRANS Reference Model defines these domains and visualises their overall need for interoperability. Each domain is a responsibility domain with specific responsibilities.

By its simplicity, the Reference Model is an overall conceptual model of the transport sector and transport issues. It is possible to remember the shape and the content of the model, and it is easy to map activities, projects, systems and stakeholders into the model. Thus, the model simplifies the communication about transport issues.

It is also important that the Reference Model is independent of organisational issues as well as the physical realisation of the ITS solutions. The model is stable and lasts through changes in how the transport sector is organised, use of technology, etc.

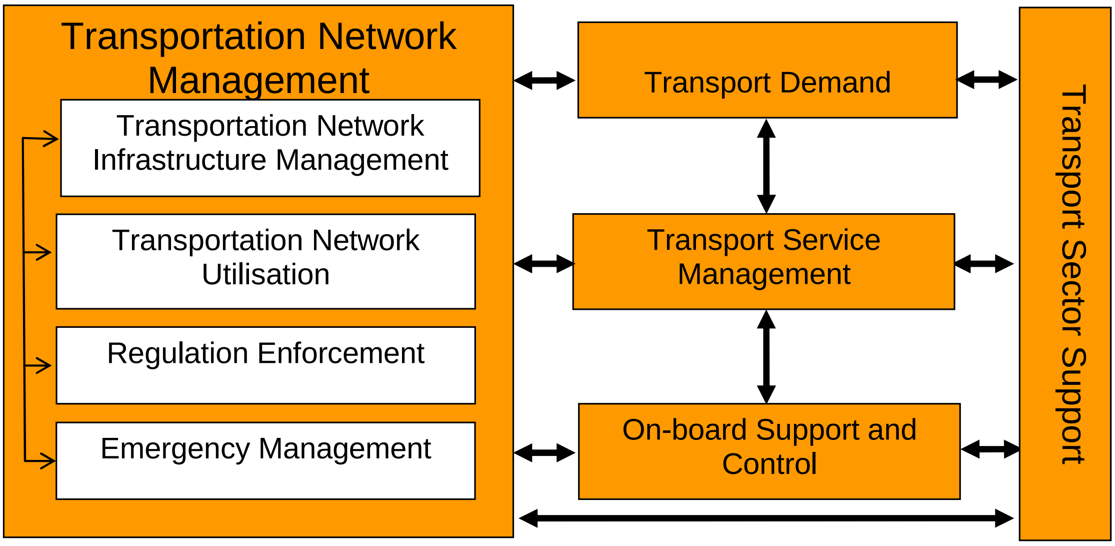


Figure 11 The ARKTRANS Reference Model

The Reference Model is the basis for the internal structure of the ARKTRANS framework description provided by this report. A defined set of roles and objects associated to the domains are specified in Chapter 5. The domains and their relations are further specified in the logical aspects of the ARKTRANS; the functionality provided by the domains is further specified in the functional view of ARKTRANS (Chapter 6, 7, 8, 9 and 10); the interactions between the domains are described in the process view (Chapter 11); and some of the information elements, which are exchanged in the interactions, are defined in the Information view (Chapter 12).

4.1 The domains of the ARKTRANS Reference Model

The Reference Model divides the transport sector into manageable domains and defines necessary interactions as shown in Figure 11. Each domain relates to:

- A defined set of roles and objects – as specified in Chapter 5
- Responsibilities defined by means of the related roles.
- Functionality – as specified in the functional views of ARKTRANS in Chapter 6, 7, 8, 9 and 10.

4.1.1 Transportation Network Management

The Transportation Network Management domain addresses the society's need for sustainable transport, i.e. safety, efficiency, security and environmental protection. The need for mobility and the needs of the individual users of the Transportation Network infrastructure have to be balanced against the best of the society.

The Transportation Network is the infrastructure provided by roads, fairways, railways, air corridors and Transfer Nodes. A Transfer Node is in this context a location or area where goods and passengers enter, leave or transfer between Transport Means. The Transportation Network arrange for mobility in general. (The term transport, and not transportation, is used about the specific transport services offered by transport companies and others and the mobility demands of the users of these transport services.)

A wide spectre of tasks must be supported related to the Transportation Network, such as the management of the physical infrastructure; traffic management during normal and abnormal traffic situations; emergency management; and regulation enforcement. Responsibilities of this part of the transport sector are as follows:

- To arrange for the safety and security of persons; property and environment that are involved in or affected by transport
- To arrange for the availability of public transport services

4.1.1.1 Transportation Network Infrastructure Management

The Transportation Network Infrastructure Management domain provides functionality required by those who are responsible for the physical Transportation Network infrastructure, the physical infrastructure of Transfer Nodes such as terminals and stations infrastructures included. The domain has the following responsibilities towards the other parts of the Reference Model:

- To plan and establish Transportation Network infrastructures (Transportation Network Resources and Transportation Network Equipment included) that optimise the benefits of investments and provide the required capacities and qualities
- To establish and manage information about the Transportation Network infrastructure.
- To ensure proper operation of the Transportation Network infrastructure, including the Transportation Network Resources, Transportation Network Equipment and required navigation aids.
    - To monitor the state and the capacity of the Transportation Network infrastructure
    - To do strategic and tactical planning of infrastructure maintenance and improvements
    - To mange deviations and continuous operation of the infrastructure
- To operate the Transportation Network infrastructure according to instructions received from the Transportation Network Utilisation domain.

The management of the actual maintenance and the improvements of the infrastructure are however not within the scope of ARKTRANS.

4.1.1.2 Transportation Network Utilisation

The Transportation Network Utilisation domain supports the use and utilisation of the physical Transportation Network infrastructure, Transfer Nodes included. The responsibilities of this domain are as follows:

- To do strategic and tactical traffic and transportation planning
    - To clarify the rules and regulations with respect to the traffic management.
    - To ensure the availability of supportive services to Transport Means
    - To provide guidelines or requirements for public transport with respect to capacities, routes, services, fees, etc. (Public transport will however be established and operated as a part of the Transport Service Management domain)
- To manage the traffic in the Transportation Network infrastructure (the flow of Transport Means in general as well as the behaviour of individual Transport Means) in order to optimise safety, efficiency, security and environmental protection:
    - To plan how to handle normal and abnormal traffic situations and extraordinary transport operations
    - To arrange for traffic that is in conformance with laws and regulations.

- To manage and provide traffic information
- To manage the access to and use of Transportation Network Sections
- To handle foreseen and occurred deviations and incidents in a way that minimise the threats to safety, environment, security, efficiency and property.
- To register deviations, accidents and incidents.

- To manage the assignment and use of Transportation Network Resources
- To provide supportive services to the Transport Means that are using the Transportation Network to arrange for safe and efficient traffic flow and manoeuvring.

4.1.1.3 Regulation Enforcement

The Regulation Enforcement domain provides functionality required by transport regulators. The overall functions are to a large extent generic and common to several regulators, but the area in which they work will vary. These functions include decision-making (based on the laws), operative control as well as the establishment and maintenance of directories holding relevant information. The domain has the following responsibilities:

- To manage registries, licences, fee collection and statistics with transport related information enabling regulation enforcement
- To make transport related decisions
    - To inspect and issue certificates and licenses according to rules and regulations
    - To establish fare policies
    - To take decisions on regulations (based on the laws)
- To supervise and control in order to detect rule and regulation violations;
- To prevent undesirable situations and unlawfulness
    - To provide information to the public about rules and regulation;
    - To provide qualified advice to individual actors on desired behaviour;
    - To intervene (in accordance with laws and regulations) to prevent undesirable situations and unlawfulness;
- To enforce the laws and regulations
    - To register and handle regulation offences
    - To handle rule or regulation violations.
    - To manage statistics

4.1.1.4 Emergency Management

The Emergency Management domain provides functionality required by those responsible for emergency response related to transport. The responsibilities towards the other parts of the Reference Model are:

- To manage information about incidents, accidents and pollution related to transport, and to derive knowledge about safety and environmental threats.
- To establish emergency and pollution preparedness plans.
- To provide guidelines and requirements for emergency preparedness, pollution control, and pollution preparedness;
- To support search and rescue operations.
- To support pollution response operations.
- To support salvage operations.
- To support the investigation of accidents, pollution and incidents.

4.1.2 Transport Demand

The Transport Demand domain supports transport preparation and planning, transport booking, and follow-up for freight as well as passenger transport. The aim is to support the Transport User, which may be both the party who wants to travel or to send goods and the party who is organising the transport on behalf of this Transport User (travel agency, forwarding agent, logistics provider). They both need much of the same functionality.

The Transport Items (passengers or goods to be transported) and the transport chains are defined. The transport chains may include several legs served by different transport modes. Transport services are requested from the Transport Service Management domain and followed up.

The responsibilities of the domain are:

- To support preparation, planning and identification of relevant transport chains and services
- To define the Transport Item properties
- To support the ordering of the required transport services
- To support the establishment of a Transport Execution Plan (TEP)
- To support the execution of the transport chain (information exchange towards the transport service providers and authorities as well as coordination)
- To support the follow up of the transport chain and corrective actions in case of deviations
- To capture experience gained so that it can be reused

4.1.3 Transport Service Management

This domain addresses the management and provision of transport services to the Transport Demand domain. Such services may for example be provided by transport companies or terminals. A service may for example be transport along predefined and scheduled routes; ad hoc routes based on actual demands; document handling services; and terminal services like loading, unloading and transhipment.

The provision of transport services is planned and managed based on actual and foreseen demands and information about the Transportation Network infrastructure and traffic conditions provided by the Transportation Network Management domain. The planning includes decisions about routes, schedules, service types and use of resources.

The execution of the transport operations (movement of passenger/goods, cargo handling, document handling, etc.) is monitored and controlled. The latter may involve interactions with the On-board Support and Control domain. The exchange of information with the Transport Demand domain shall support effective coordination and accomplishment of the whole transport chain (managed in the Transport Demand domain). This may include transport and terminal operations managed by several Transport Service Providers (transport companies, terminals, etc.).

Responsibilities of this part of the transport sector are:

- To provide transport Services to the Transport Demand domain according to orders and regulations
    - To plan the transport services to be provided
    - To publish information about the transport services
    - To support booking of transport services
    - To provide status information that may support the management of the transport chain
- To manage ongoing transport operations
    - To find the most optimal routes and schedules and the most optimal use of resources.
    - To support efficient, safe, secure and environmentally friendly execution of the transport operations.
- To accomplish the required information exchange with authorities
- To support the execution of the transport operation
    - To handle the Load Items (cargo or passengers) according to regulations and agreements, dangerous goods included.
    - To report status and deviations related to transport operation (delays, problems, etc.)
    - To report Load Item status (damage, condition, loaded, unloaded, etc.).

4.1.4 On-board Support and Control

The On-board Support and Control domain addresses the navigation, integration of Transport Means and Transportation Network Users (pedestrians and cyclists included) in the traffic and safety issues related to the operation of the Transport Means. Adaptation to traffic situation, traffic regulations, Transportation Network conditions, security and efficiency are emphasized. On-board equipment provides information and supports safety and the operation of the Transport Means. The Transport Means' driver and the operation of the Transport Means may also be monitored.

Responsibilities of this part of the transport sector are:

- To control the operation of the Transport Means in such a way that dangerous situations can be detected and if possible avoided.
- To monitor the Transport Means and the operation of it in such a way that dangerous situations can be detected and if possible avoided.
- To monitor the Load Items in such a way that damage and irregular or dangerous situations can be detected and if possible avoided.
- To inform the Transportation Network Management domain about dangerous or irregular situations.
- To promote safety and efficiency by providing information and support to the persons onboard in case of dangerous or irregular situations.

4.1.5 Transport Sector Support

The Transport Sector Support domain provides information and supportive services to the other parts of the Reference Model (but the services do not represent core transport or traffic activities – they are covered elsewhere in the Reference Model). Several types of services may be offered to the other domains.

Responsibilities of this part of the Reference Model are:

- To provide generic information services about the transport sector. This may for example be information about transport services, resources, infrastructure, environment, etc.
- To provide services that support efficient information exchange between the parties in the transport sector. This may for example be gateways or hubs for reception, transformation and distribution of information.
- To provide generic services to the transport sector. This may for example be fee collection services, directory management, travel product retailing, etc.
- To provide services that support the operation and administration of Transport Means (e.g. assistance provision, supply services, certificate issuer, etc.)
- To provide services and equipment that support incident and emergency handling (e.g. oil protection equipment, salvage services, etc.)

4.2 Interactions between the domains

ARKTRANS defines a set of roles defined by multimodal terms, see Chapter 5, and each domain in the Reference Model has a relation towards a set of these roles. E.g. a Transport User is supported by functionality provided by the Transport Demand domain, a Transport Service Provider (e.g. a freight carrier company or terminal operators) is supported by functionality in the Transport Service Management domain, a Driver is supported by the On-board Support and Control domain and Authorities operate through the Transportation Network Management domain.

The domains interact with each other. They exchange information and provide services to each other. Those responsible for the cargo transport and handling in the transport companies (the Transport Service Management domain) may for example have to report to the Authorities in the Transportation Network Management domain. The functionalities in two domains may also represent two parties in a business-to-business interaction. E.g. the Transport Demand domain will order transport services, while the other party represented by the Transport Service Management domain will accept and process the orders.

Functionality provided by one domain may also be the basis for functionality in other domains. E.g. tracking information collected by tracking technology on-board the Transport Means (On-board Support and Control) may support the management and tracking of fleet resources in the Transport Service Management domain. Further on, such tracking information can be passed to the Transport Demand domain and provide the Transport User (a consignor, consignee, etc.) with status and tracking information for the cargo.

4.3 ARKTRANS deployment

ARKTRANS may be deployed in many ways. The conceptual and logical aspects of ARKTRANS provide a holistic view upon the responsibilities, activities and relations in the transport sector by means of a top-down approach. These specifications can be used when solutions of services are planned, developed and purchased. The technical aspects of ARKTRANS provide specifications that arrange for interoperability between systems.

4.3.1 Transfer Nodes

The Transfer Node term is in ARKTRANS used about goods terminals, public transport terminals (e.g. bus terminals, airports, ferry terminals, etc.) and public transport stops like stations, bus stops, etc. Conceptually they are all alike – they arrange for goods or passengers to enter, leave or change between Transport Means.

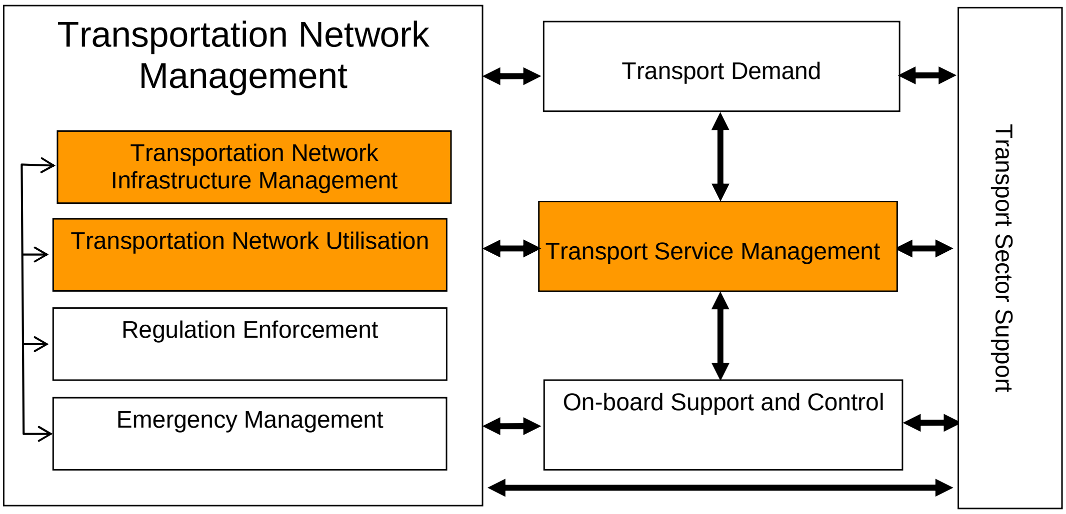


Figure 12 A Transfer Node may relate to several parts of the Reference Model

The responsibilities of and activities at a Transfer Node may, depending on the type of Transfer Node, be related to the different parts of the ARKTRANS Reference Model:

- The Transportation Network Infrastructure Management domain is responsible for the planning and the continuous operation of the physical infrastructure at the Transfer Node (terminal areas, platforms, transfer/transhipment area, etc.) and also the operation of the equipment related to this infrastructure (signalling systems, etc.).
- The Transportation Network Utilisation domain is responsible for the management of the traffic in the area of the Transfer Node (utilisation of the Transfer Node infrastructure, entry/exit control, etc.), and for provision of information about the Transfer Node (information about facilities, services, opening hours, etc.).
- The Transportation Network Utilisation domain is also responsible for the provision of services to the Transport Means that are visiting the Transfer Node (towing, follow me

cars, etc.), and for the allocation of Transportation Network Resources (e.g. stop points) to Transport Means

- The Transport Service Management domain is responsible for the provision of terminal services (e.g. handling services) to the Transport User. This includes the overall management of the terminal operations, including management of terminal equipment and personnel, task allocation, the actual execution of the terminal operations (e.g. loading, unloading, transhipment, storage, etc.) and the follow up of these operations.

In additions there may also be other activities related to a Transfer Node, but these are not included in the Transfer Node concept:

- The Regulation Enforcement domain is responsible for the activities like customs control, immigration control. etc.
- The Transport Sector Support domain is responsible for the provision of services like the tug boats, supplies, etc.

4.3.2 Functionality in ITS solutions

Each domain of the Reference Model encompasses functionality that may be combined into systems and services that are used by the stakeholders in the transport sector. The functional views in Chapters 6, 7, 8, 9 and 10 describe the building blocks for such systems and services.

ARKTRANS may be used as a functionality “shopping list”:

- When requirements to ITS are specified. The required functionality can be specified by referring to the content of the functional views, or they can be used as check lists when specifying or discussing with end users.
- When ITS is developed. The preferred functionality can be chosen from the architecture, and the system can be specified by referring to the architecture.
- When an ITS is to be purchased. The functionality provided by available systems can be compared against the functionality specified in the architecture.

4.3.3 Transport related work processes

Transport related activities may be simple tasks involving one single stakeholder or complex processes involving a large number of stakeholders. The latter can be described as work processes composed of activities ordered along a time axis. The activities may be carried out by different stakeholders; they may be performed sequentially as well as in parallel; and there may be interactions (information flows) between the activities.

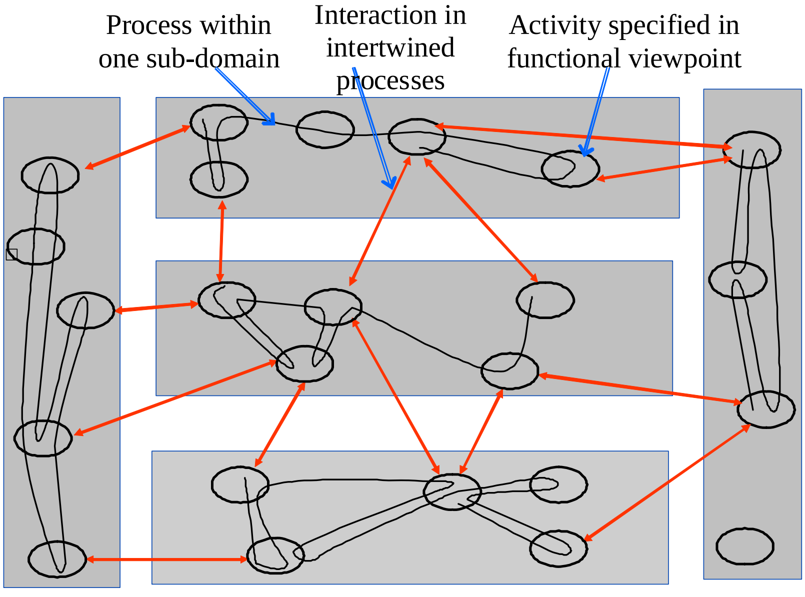


Figure 13 Intertwined processes (just an illustration - not a real case)

Figure 13 illustrates that activities in the different parts of the Reference Model may work together and exchange information. Activities (ovals) within the same part of the Reference Model (squares) may together accomplish a work process (indicated by the curved lines). These processes may again be a part of a larger process that also includes activities in other parts of the Reference Model. Thus, interactions (straight lines with arrows in each end) between the different parts of the Reference Model are required.

ARKTRANS specifies the functionality required by the activities. The activities are generic building blocks in transport related work processes (the processes may however also encompass activities not covered by ARKTRANS, e.g. manual activities and activities supported by non-transport systems). A transport process may involve activities from several parts of the Reference Model, and several transport processes may also be intertwined. The process view in Chapter 11 illustrates a number of such processes. The following actions may for example take place within the processes (the sequence of actions carried out may vary and is not considered in the list below):

- In the Transport Demand domain
  - The establishment of the transport chain is initiated based on a transport demand
  - Transport service information is received, and the transport chain is established by means of interactions with the Transport Service Management domain
  - Information services from the Transport Sector Support domain provide information that may influence on the selection of transport modes and routes e.g. meteorological services and rout planning services.
  - Status reports are received from Transport Service Management domain
  - If required, service providers, e.g. transport companies and terminal operators, are informed about changes in the Transport Execution Plan
- In the Transport Service Management domain
  - The relations towards the Transport User in the Transport Demand domain are handled. Orders are received and the status on ongoing operations is reported.
  - The transport operations are planned and managed.
    - The required resources are allocated; the route is planned, etc.
    - The required information is submitted to the workers and to the Transport Means in the On-board Support and Control domain
    - The on-going transport operations are monitored and if relevant controlled
  - The transport tasks are executed (loading, unloading, document handling, etc.) and status information is registered. (The driving/navigation operation is however a part of the On-board Support and Control domain)
  - The required transport related information is submitted to transport regulators in the Transportation Network Management domain.
- In the On-board Support and Control domain
  - The driver receives dynamic information about the traffic situation and Transportation Network condition from the Transportation Network Management domain.
  - The driver responds to traffic management measures and may interact with the traffic management part of the Transportation Network Management domain.
  - The required traffic related information is submitted to transport regulators in the Transportation Network Management domain, e.g. information about dangerous cargo.
- In the Transportation Network Management domain
  - Traffic management measures (the Transportation Network Utilisation domain) are taken towards Transport Means (the On-board Support and Control domain)
  - Tasks like customs clearance (Regulation Enforcement domain) are accomplished and reports are handled according to regulations
  - Incidents and emergencies are handled (Emergency Management domain)

- In the Transport Sector Support domain
  - Information requests are responded upon
  - Assistance services are provided to Transport Means, e.g. towing services.

4.3.4 Interoperability

ITS solutions should be able to interact with other ITS solutions. For some application areas the ARKTRANS information view specifies how interoperability can be achieved:

- Common conceptual information models are the basis for the interoperability. These models define the syntax as well as the semantics of information elements used in interactions between the transport systems.
- The information elements in the information models are used as building blocks in service models. The service models define open interfaces for information exchange. (The technical realisation of the interfaces, which enable information exchange between the domains of the Reference Model, are specified in the communication view of ARKTRANS.)

5 ARKTRANS roles and objects

Roles and objects are general names for stakeholders and physical elements/systems in the transport sector.

5.1 ARKTRANS roles

A stakeholder may be a person, a team, an organisation or an institute and can be defined by means of one or more *responsibilities* (which are generic and organisation unspecific). ARKTRANS focuses on the generic responsibilities related to the transport sector. A role is used as a generic term that implements a particular set of (related) responsibilities. By means of such generic roles, the large variety of stakeholders in the transport sector can be handled in a generic way in the architecture description.

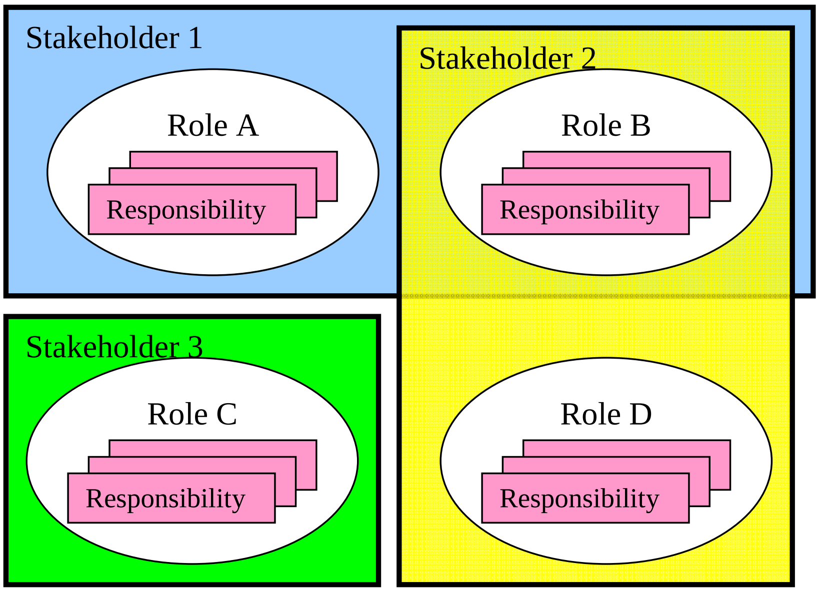


Figure 14 ARKTRANS uses roles instead of stakeholders

It is important to notice that:

- One responsibility belongs to just one role.
- One stakeholder can fulfil one or more roles.
- A role represents all stakeholders with the same set of responsibilities. The Transport Service Provider role represents for example all providers of transport related services, such as carriers, terminal operators, warehouse operators, etc.
- One role belongs to just one domain of the Reference Model. (Figure 15 shows the overall roles related to the domains of the Reference Model.)
- Stakeholders that implement multiple roles can be handled by focusing on each role separately. From the Transport User's point of view a forwarder has the Transport Service Provider role as the forwarder receives the booking (the Transport User may not know whether the forwarder is the real carrier or just a forwarder). However, whenever the forwarder books transport services on behalf of a Transport User, the forwarder will have the Transport User role (see 5.3.1 for more information).

Roles support dynamic changes and organisational structure diversities

- Roles are independent of organisational issues and will persist through organisational changes (stakeholders may change, organisational differences in different countries, etc.);
- A stakeholder can dynamically change its set of roles at any time. In crisis a stakeholder may for example have to adopt roles on a rather semi-permanent basis;

- Roles support changing levels of automation. A role may for example be implemented by human beings, systems or by both at the same time. In any case the provider of a service can be referred to by means of the same roles, e.g. the Information Provider role.

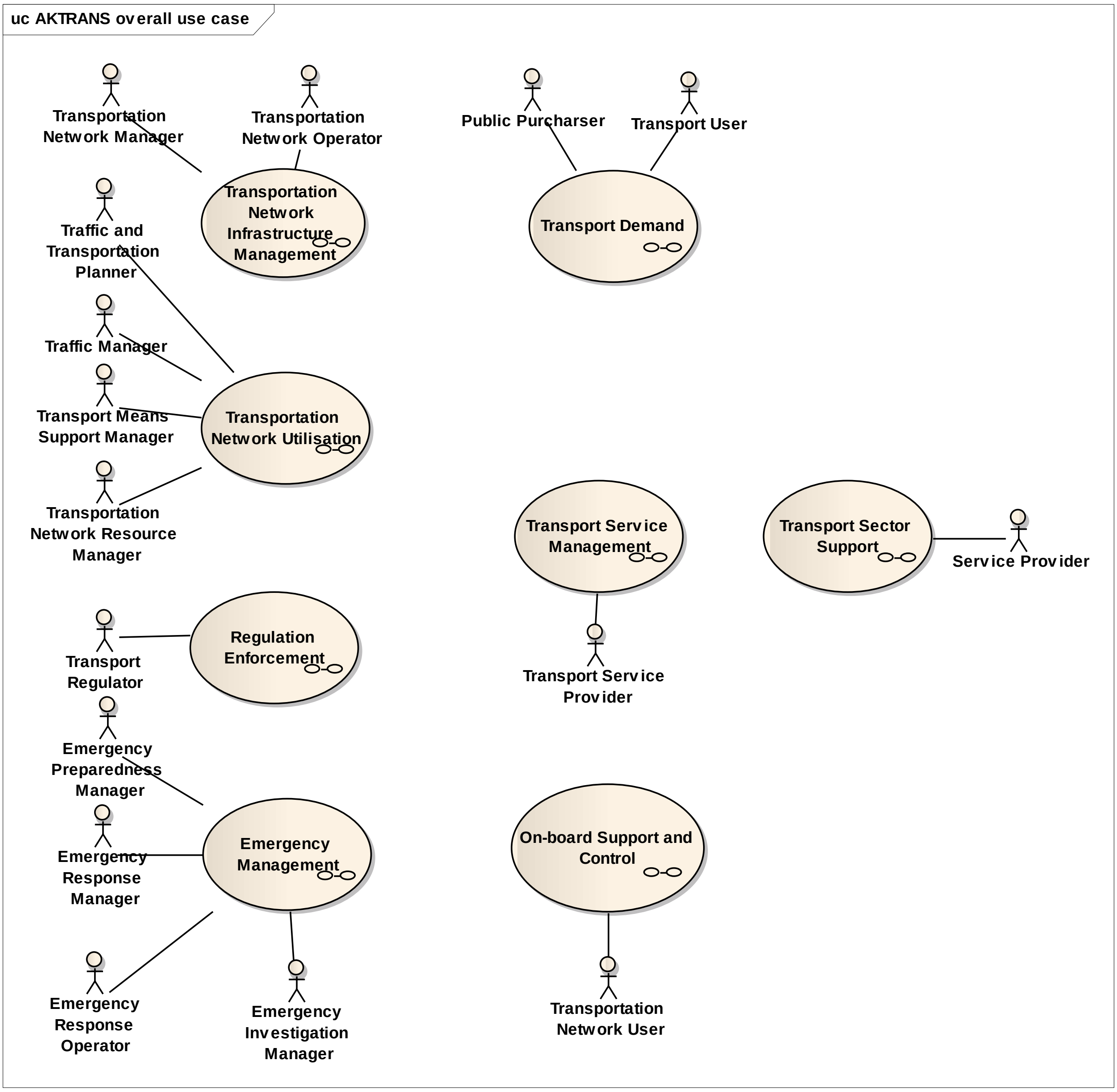


Figure 15 The overall roles related to the domains of the Reference model

The roles in the tables below are generic terms valid across all the transport modes and in many cases also common for both freight and personnel transport. The s*uperior roles* are overall and these will be used when all the *detailed roles* can be handled in a generic way. The detailed roles are refinements of the superior roles. A detailed role may be a superior role specified elsewhere in the table. In such cased the role term is printed in *italic*. In Annex E the roles are further described by means of Norwegian terms and examples from the respective transport modes.

5.1.1 Roles related to Transportation Network Management

The Transportation Network Management domain relates to a wide spectre of roles. Thus, this domain is further decomposed into four domains (see Chapter 6):

- Transportation Network Infrastructure Management
- Transportation Network Utilisation
- Emergency Management
- Regulation Enforcement

5.1.1.1 Roles related to Transportation Network Infrastructure Management

English		Description
Superior roles	**Detailed roles**	
Transportation Network Manager		Responsible for • The physical Transportation Network infrastructure (operative planning, establishment, operation, maintenance, etc.). Safety, efficiency and protection of the environment are emphasised. Such a Transportation Network infrastructure may be a collection of transport links and Transfer Nodes and may include several sub-infrastructures (that are managed by Transportation Network Operators). • The management of information about the physical Transportation Network.
	Transportation Network Information Manager	Responsible for • Management of information about the physical Transportation Network.
	Transportation Network Planner	Responsible for • The strategic planning of the Transportation Network infrastructure and related equipment. The quality must be according to regulations. • Contracts with the Transportation Network Operator.
	Transportation Network Quality Manager	Responsible for the quality of the Transportation Network. This includes • Quality requirements with respect to service level, safety (e.g. infrastructure safety measures, the availability of emergency equipment), security (e.g. infrastructure that takes care of the security issues such as security checks, access control, etc.) and environmental protection. • Improvement plans. • Establishment and follow-up of the contracts for continuous operation and maintenance with Transportation Network Operator • The fulfilment of the quality requirements.
Transportation Network Operator		Responsible for the fulfilment of the instructions from the Transportation Network Quality Manager for • The daily operation of the physical Transportation Network infrastructure • The daily operation of equipment related to the infrastructure (installation, operation and maintenance) • Improvements

5.1.1.2 Roles related to Transportation Network Utilisation

English		Description
Superior roles	**Detailed roles**	
Traffic and Transportation Planner		Responsible for • Strategically and tactical planning of traffic and transportation issues in an area.
	Traffic Planner	Responsible for local traffic planning.
	Traffic Support Planner	Responsible for • The availability for Transport Means assistance services. Such services may for example be the provision of tugs, pilot services, etc.
	Transportation	Responsible for

English		Description
Superior roles	**Detailed roles**	
	Planner	• The overall planning of transportation and traffic flow in an area.
Traffic Manager		Responsible for • The best possible traffic flow during normal and abnormal traffic situations (Network and Traffic Status – NTS) through efficient traffic management and incident handling. • Provision of information about the traffic situation (Network and Traffic Status – NTS) and the Transport Means supporting facilities and services.
	Traffic Control Manager	Responsible for • Monitoring and controlling the traffic flow or individual Transport Means, e.g. by controlling the infrastructure and by guidance or orders given to the Transport Means. • The registration of information about the traffic and Transportation Network conditions.
	Traffic Information Manager	Responsible for • Management of Network and Traffic Status information and provision of such information.
Transport Means Support Manager		Responsible for • The provision of supportive services to Transport Means using the infrastructure. This may be just overall management of the availability and capacity (the actual services may be provided by the Transport Sector Support domain). Such supportive services may for example be services related to: Waste reception; manoeuvring support (e.g. provision of tug boats, pilots, lens men, shunting locomotives, follow me cars); and infrastructure access (e.g. bridge and lock operators)
Transportation Network Resource Manager		Responsible for • The assignment of Transportation Network Resources to Transport Means.

5.1.1.3 Roles related to Regulation Enforcement

English		Description
Superior roles	**Detailed roles**	

Transport Regulator		Responsible by or under national law for regulation, enforcement of laws, administrative provision and international agreements with respect to traffic and transport. The will at least be to:
		• Provide general information to the public and to individual actors about rules and regulation and desired behaviour;
		• Take care of a national information collection and processing;
		• Decide on regulations
		• Enforce laws and regulations by means of:
		  • Inspections and certification;
		  • Supervision of the actual behaviour of individual actors in order to detect law and regulation violations;
		  • Handling of law or regulation violations (investigations included)
		• Provide information to and cooperate with other authorities (national and international)

	Agricultural Authority	Responsible for the execution of the laws concerning the admittance of agricultural products.
	Armed Forces Authority	Responsible for the enforcement of regulations and laws applicable to Transport Means and their presence in territorial areas.
	Cargo and Transport Inspection Authority	Responsible for enforcement of rules and regulations on how cargo is stowed and transported.
	Civil Law Authority	Responsible for policing in case of violation of civil laws and regulations. Takes the necessary measures or actions to achieve compliance with laws, rules and regulations for the management of transport and traffic. If any violations of laws and regulations are detected, sufficient data for identification and prosecution initiation of the offenders is needed.

English		Description
Superior roles	**Detailed roles**	
	Clearance Authority	Responsible for the entry/exit clearances of Transport Means before entry/exit to/from territorial areas, ports, etc. The clearance process may also involve coordination with other authorities.
	Customs Authority	Responsible for the levying of duties and taxes on imported goods from foreign countries and the control over the export and import of goods such as controls over prohibited goods. Receives customs declarations and verifies that the transport is according to rules and regulations with respect to export and import. Issues customs clearances.
	Emergency Authority	Responsible for the policy and organisation of emergency preparedness and emergency response related to traffic and transport. Also responsible for and emergency response decisions (termination of emergency response operations, etc.)
	Environmental Authority	Responsible for protection and preservation of the environment. This includes the establishment of rules and regulations with respect to pollution control; and the availability of strategic plans and resources for pollution prevention, detection and combat.
	Fare Authority	Responsible for • Policy and guidelines with respect to fare schemes for an area. Fares are also decided upon. • The interoperability of fare system, including strategy with respect to products, interoperability between providers of transport services (PT transport) and the fare interoperability management implemented by the Fare Management Interoperability Provider.
	Fee Collection Authority	Responsible for fee collection.
	HAZMAT Authority	Responsible for regulating and monitoring of the transportation of dangerous or polluting cargo and competent authority as for the classification of such cargo. This includes the availability of one or more points of notification for dangerous or polluting cargo, and the availability of solutions and routines that support the exchange of information about such cargo.
	Health Authority	Responsible for the enforcement of regulations and laws applicable to entrance of people or objects that may cause a health risk.
	Immigration Authority	Responsible for the enforcement of regulations and laws applicable to persons requesting to enter a country or territory.
	Information Centre Authority	Responsible for collection and distribution of information on behalf of Transport Regulators. This should be done by means of a single point of contact - provided by an Authority Information Transfer Provider (see Transport Sector Support roles).
	Legislative Authority	Responsible for establishment of laws and regulations for transport and traffic.
	Licence Authority	Responsible for issuing licences and certificates to persons or companies/organisations based on qualifications of personnel and fulfilment to laws and regulations.
	Privacy Regulatory Authority	Responsible for controlling the activities of other companies or organisations to ensure privacy. Whenever required, responsible for instructing other parties in privacy issues.
	Prosecution Authority	Responsible for the prosecution in case of illegal behaviour in traffic and transport.
	Registrar Authority	Responsible for assigning unique identifiers for stakeholders, components, applications, products and messages. For electronic ticketing see ISO/DIS 24014-1.
	Safety Regulatory Authority	Responsible for controlling the activities of other companies or organisations to ensure safety. Responsible for instructing other parties in safety issues.
	Security Authority	Responsible for security issues related to transport of passenger and cargo.
	Statistics Authority	Responsible for the systematic collection of data and facts and establishment of statistics related to traffic and transport.
	Traffic Authority	Responsible for traffic regulations.

<table>
<tr><th colspan="2">English</th><th rowspan="2">Description</th></tr>
<tr><th>Superior roles</th><th>Detailed roles</th></tr>
<tr><td rowspan="5"></td><td>Transport Means Inspection Authority</td><td>Responsible for inspection of Transport Means, crew and cargo to ensure that the required certificates are in place and adherence to safety regulations (see Registry Authorities for Transport Means in general).</td></tr>
<tr><td>Transport Means Regulatory Authority</td><td>Responsible for approval and certification and registration of Transport Means. Construction, design, equipment and manning requirements are considered to ensure adherence to safety regulations. (For inspection of Transport Means in traffic – see Transport Means Inspection Authority)</td></tr>
<tr><td>Transport Means Security Authority</td><td>Responsible for security issues related to Transport Means and their use of the Transportation Network.</td></tr>
<tr><td>Transportation Network Authority</td><td>Responsible for making decisions on the usability of the Transportation Network Infrastructure. May decide to put restrictions on the traffic in parts of the infrastructure (for all or specific Transport Means).</td></tr>
<tr><td>Veterinary Authority</td><td>Responsible for entrance/exit of animals and animal products and the well-being of animals.</td></tr>
</table>

5.1.1.4 Roles related to Emergency Management

<table>
<tr><th colspan="2">English</th><th rowspan="2">Description</th></tr>
<tr><th>Superior roles</th><th>Detailed roles</th></tr>
<tr><td>Emergency Investigation Manager</td><td></td><td>Responsible for finding the cause of the emergency.</td></tr>
<tr><td rowspan="4">Emergency Preparedness Manager</td><td></td><td>Responsible for: the emergency preparedness, including
• The availability of the required preparedness and emergency response plans
• The availability of required services and actors that can be assigned the required responsibilities
• Agreements and procedures that ensures the required coordination and collaboration between actors involved</td></tr>
<tr><td>Preparedness Coordination Manager</td><td>Responsible for the coordination of emergency preparedness in an area
• The provisioning of preparedness plan guidelines.
• The availability of emergency preparedness plan(s), including the follow-up and coordination of plans established by others in the responsibility area.
• The coordination of the required education and training actions.</td></tr>
<tr><td>Pollution Preparedness Manager</td><td>Responsible for: the pollution preparedness for a specific area, including
• The establishment of emergency response plans.
• The availability of required services and actors
• Agreements and procedures that ensure the required coordination and collaboration between actors involved in pollution response.
• Education and training of personnel.</td></tr>
<tr><td>Search and Rescue Preparedness Manager</td><td>Responsible for: the search and rescue preparedness for a specific area, including
• The establishment and of the required response plans
• The availability of required services and actors
• Agreements and procedures that ensures the required coordination and collaboration between actors involved in search and rescue operations
• Education and training of personnel.</td></tr>
<tr><td rowspan="3">Emergency Response Manager</td><td></td><td>Responsible for
• The overall management and coordination of such emergency response operations including operative planning, allocation of resources, assignment of responsibilities and tasks, etc.
• Regional and/or international coordination of such operations.
• Investigation support to authorities in case of accidents and incidents.</td></tr>
<tr><td>Pollution Response Manager</td><td>Responsible for pollution response management in case of pollution</td></tr>
<tr><td>Salvage Operation Manager</td><td>Responsible for the management of salvage operations (directed towards properties – Transport Means, cargo, etc.).</td></tr>
</table>

English		Description
Superior roles	**Detailed roles**	
	Search and Rescue Manger	Responsible for the management of operations to save lives and health of persons in distress.
Emergency Response Operator	On Site Coordinator	Responsible for the coordination of activities at the emergency site.
	Search and Rescue Unit	Responsible for search and rescue activities.

5.1.2 Roles related to Transport Demand

English		Description
Superior roles	**Detailed roles**	
Public Purchaser		Responsible for • The availability of transport services needed by the society, even though such services may not be business profitable. • Evaluation of the needs for transport services • The establishment of contracts with the Transport Service Providers assumed to be the best with respect to quality of services and costs. The contract usually is for a specific area or between specific destinations, and there are requirements with respect to capacities and frequencies.
Transport User		Responsible for • Defining the transport demand (either freight transport or personnel transport) • Finding the best transport alternative • Transport planning • The required transport follow up and re-planning.
	Cargo owner	The owner of the cargo that is to be transported.
	Consignee	The receiver of cargo.
	Consignor	The sender of cargo.
	Supply Chain Party	May be manufacturer, wholesaler, retailer or end customer
	Transport Organiser	Organises the transport.
	Traveller	See below
Traveller		Responsible for • The planning, preparation and accomplishment of the travel. May use a set of different transport modes, scheduled and non-scheduled transport services included.
	Crew in Transit	Crew that are not on duty. However, being on-board a Transport Means such crew has another role than ordinary passengers.
	On-demand Transport Passenger	Traveller travelling as a passenger on non-scheduled transport services.
	Scheduled Transport Passenger	Traveller travelling as a passenger on scheduled transport services.

5.1.3 Roles related to Transport Service Management

English		Description
Superior roles	**Detailed roles**	
Transport Service Provider		Responsible for • The provision of transport services to a Transport User. The services that are provided may be transport from one point to another, terminal services, document handling services, etc. See 5.3.1 for more details. • The management and execution of the required transport operations.

English		Description
Superior roles	**Detailed roles**	
	Transport Business Manager	Responsible for • Transport resources (e.g. Transport Means, crew, load units, trucks, etc), including their condition and qualifications. • Gathering of information for administrative purposes • Providing business related information to other parties, e.g. statistics and information for fee collection.
	Transport Operation Manager	Responsible for • Decision on how to fulfil the transport demand by means of one or more transport operations, e.g. transport from one point to another; Load Item handling (e.g. at terminal); warehouse operations; document handling related to Load Items (e.g. customs), etc. • The planning of the transport operations (resource utilisation, time schedule, etc.). that can be carried out according to rules and regulations • The management of ongoing transport operations, including monitoring and follow up of the transport operations carried out by the Transport Operation Worker and the use of Transport Means (in On-board Support and Control). • Reporting related to transport operations (e.g. to authorities); etc. (if not done by the On-board Support and Control domain)
	Transport Service Manager	See below
	Transport Operation Worker	See below
Transport Service Manager		Responsible for the • The planning of the services to be provided, including: price policy (if not committed to the guidelines of the Fare Authority); • The publishing of information about available transport services • The customer relations (i.e. contact with the Transport Users). This includes: Formal agreements with customers; transport service provision; status reporting, etc. • The delegation of responsibilities for the fulfilment of transport needs to the Transport Operation Managers.
	Customer Relation Manager	Responsible for • All contact towards customers (i.e. Transport Users). This includes: Information provision about the services provided, contract and booking handling and yield management.
	Transport Service Planner	Responsible for • Strategically, tactical and operational planning related to the provision of transport services. This also includes the use of abilities and resources operated by one or more Transport Operation Managers.
Transport Operation Worker		Responsible for • The execution of the actual transport operation and the related handling of the Load Items (loading, unloading, delivery, pick-up, document handling, etc.) according to instructions from the Transport Operation Manager and according to laws and regulations. (The actual operation of Transport Means is however the responsibility of the Transportation Network User). • Status reporting to the Transport Operation Manager.
	Case Handler	Responsible for • The handling of miscellaneous cases.
	Counter Staff	Responsible for • Provides counter services at for example terminals.
	Document Handler	Responsible for • Document handling, e.g. customs declaration
	Emergency Team Personnel	Responsible for • Handling of emergencies.

English		Description
Superior roles	**Detailed roles**	
	Load Item Handler	Responsible for • The handling of Load Items at Transfer Nodes. This may be cargo, baggage or passenger handlers, e.g. terminal worker doing terminal operations like loading, unloading, packing, splitting, and transhipment; warehouse workers; dedicated passenger managers on-board Transport Means transporting passengers; Those who operates terminal equipment; etc.
	Passenger Manager	Responsible for • The handling of the passengers, e.g. hotel/catering services on board the Transport Means.
	Safety Surveyor	Responsible for • The handling of safety issues including the control of Transport Means, cargo; certificates; etc.
	Security Surveyor	Responsible for • The actual handling of security issues including the control of Transport Means, people and cargo; the reception of security notifications and certification; and monitoring and enforcement of certificates.
	Transport Product Validator	Responsible for • The provision of transport product validation (actuates the ticket) and/or controls.

5.1.4 Roles related to On-board Support and Control

English		Description
Superior roles	**Detailed roles**	
Transportation Network User		Responsible for integration in the traffic in compliance with laws and regulations and for safety issues related to behaviour and operation of Transport Means.
	Safety and Traffic Related Crew	See below
	Pedestrian	Responsible for safe walking
	Cyclist	Responsible for safe cycling.
Safety and Traffic Related Crew		Responsible for the safety, security and traffic related operation of the Transport Means (The tasks related to the on-board commercial handling of cargo and passengers are however the responsibility of the Transport Operation Worker in the Transport Service Management domain).
	Master	The highest authority over the Transport Means responsible for • Safety on-board, security and environmental protection • The state of the Transport Means and the crew with respect to qualifications and licences. • The navigation of the Transport Means • The operation of the Transport Means. • The compliance with the traffic regulations and traffic management measures.
	Driver	Responsible for • Steering and control of the Transport Means according to the instructions from the Master.
	Chief	Responsible of • The operation of the engine according to instructions from the Master.
	First Officer	Responsible of • Assisting the Master according to instructions from the Master.
	Navigator	Responsible the • Maintenance of navigational instruments and equipment and, with respect to navigation according to instructions from the Master.
	People on duty	Crew with misc. responsibilities related to safety and traffic issues. Acts according to instructions from the Master.

5.1.5 Roles related to Transport Sector Support

English		Description
Superior roles	**Detailed roles**	
Service Provider		Responsible for the provision of services to stakeholders in the transport sector.
	Facility Provider	*See below*
	Fare Management Interoperability Provider	Responsible for the fare interoperability between two or more Fare Management Service Providers. If the fare policy with respect to the transport products to be provided is a subject to public authorities, this role operates according to the instructions provided by the public Fare Authority. For electronic ticketing see ISO/DIS 24014-1
	Fare Management Service Provider	See below.
	Fee Collection Service Provider	Responsible for collection of fees related to Transport Means and their use of the Transportation Network and other infrastructure (tolling, parking charging, etc.)
	Information Service Provider	See below
	Information Transfer Service Provider	See below
	Payment Service Provider	Responsible for financial transactions between parties (but not payment information provision).
	Payment Information Provider	Responsible for the transmission of payment information between parties (but not payment information provision).
	Tracking and Monitoring Provider	Responsible for provision of tracking information
	Travel Service Provider	Provides services like accommodation, guided tours, etc.
	Security Service Provider	Responsible for services related to physical security.
	Support Provider	See below
Facility Provider		Responsible for provision of physical equipment and facilities to the transport sector
	Pollution Response Facility Provider	Responsible for provision of facilities that can be used in pollution response operations, e.g. oil lenses and other equipment.
	Rescue Facility Provider	Responsible for provision of facilities that can be used in emergency situations (for rescue of persons, e.g. equipment, lifeboats, etc.
	Quarantine Service Provider	Responsible for provision of quarantine services.
	Search Facility Provider	Responsible for provision of facilities that can be used in emergency situations, e.g. helicopters.
	Waste Disposal Facility Provider	Responsible for provision of waste disposal services and facilities to Transport Means.
Fare Management Service Provider		Responsible for providing operational services that enables the distribution and use of fare products (issued as electronic or paper tickets) in a transport environment.
	Application Owner	Related to electronic ticketing. Responsible for the definition of an application stored on an electronic ticketing medium. See ISO/DIS 24014-1.
	Application Retailer	Related to electronic ticketing. Responsible for retailing and termination of an application to be run on electronic ticketing medium. See ISO/DIS 24014-1.
	Collection and Forwarding Provider	Related to electronic ticketing. Responsible for the facilitation of data interchange related to the fare management.

English		Description
Superior roles	**Detailed roles**	
	Product Owner	Responsible for a fare product (issued as electronic or paper tickets) that can be provided to the Transport User/Traveller, including the pricing, usage rules and the commercial rules. Also responsible for clearing and for reporting with respect to usage towards the Transport Service Providers. Operates on behalf of a Fare Authority (in case the product is subsidies by authorities) or one or more Transport Service Providers. For electronic ticketing - see ISO/DIS 24014-1.
	Product Retailer	Responsible for retailing and termination of fare products (issued as electronic or paper tickets). The role may be possessed by a ticket trader or by ticket issuing equipment. For electronic ticketing - see ISO/DIS 24014-1.
Information Service Provider		Responsible for the provision of information services, e.g. portals, directories and on demand services providing access to relevant information or other service providers.
	Environmental Condition Information Provider	Responsible for provision of information about the environment.
	Environmental Resource Information Provider	Responsible for the provision of information about vulnerable areas, recreation areas, specific environmental resources like bird habitats, and resources that may be used in emergency situations (oil retention equipment, landing areas, etc.).
	Geodata Provider	Responsible for the provision of maps and information that can be included into maps.
	Meteorological and Hydrological Information Provider	Responsible for provision of information about meteorological and hydrological conditions (observations and prognosis).
	Prediction Provider	Responsible for provision of model-based predictions (e.g. drift models, survivability models, etc.)
	Traffic Situation Information Provider	Responsible for provision of information about the Network and Traffic Status (NTS). This may be dynamic traffic information and statistical traffic information about traffic flow, such as traffic density, speed and delay; dynamic information about abnormal and unplanned conditions in the Transportation Network (slippery road, turbulence, high waves, obstructions, restricted view, air pollution, oil spill, etc.); and generic information about routes and navigation, e.g. normal routes, alternative routes and route diversions (in case of obstructions), notice to mariners, etc.
	Transportation Network Information Provider	Responsible for provision of information about the Transportation Network infrastructure. This includes information about • Topology • Regulations and situations due to Transportation Network conditions, e.g. closed roads, platooning, speed limitations, quality, restrictions, constraints, etc. • Transfer Nodes for public transport. This may be small bus stops as well as large passenger terminals. • Transfer Nodes for goods.
	Travel Information Provider	See below
Information Transfer Service Provider		Responsible for provision of generic information transfer services. This may include information collection, storage, converting, distribution, forwarding, etc. (but not the actual processing of the information content). The information distribution/forwarding is limited to those entitled to the information.
	Authority Information Transfer Provider	Responsible for provision of a single point of contact for information reporting to local, national, or European Transport Regulators to fulfil regulatory requirements. The European contact point facilitates exchange of information and provision of reference data (certificates, etc.) between national Transport Regulators in different states.

English		Description
Superior roles	Detailed roles	
	Commercial Information Transfer Provider	Responsible for provision of a single point of contact for information reporting to commercial stakeholders and local Authority Information Transfer Providers. Facilitates reporting of information to a number of commercial actors, e.g. actors at a terminal.
	Communication Provider	Responsible for providing real-time communication services between parties. May also take part in the communication, e.g. by broadcasts of information, etc.
	Gateway Provider	Responsible for provision of gateway functionality. This includes the transformation between information formats and information exchange protocols.
	Information Security Provider	Responsible for the provision of information security services related to the provision of electronic services (including certification, auditing, monitoring and operation of the security).
Support Provider		
	Bunkering Service Provider	Responsible for provision of bunkering services.
	Classification Service Provider	Responsible for establishment and application of technical requirements for design, construction and survey of Transport Means and other objects. Responsible for issuing of certificates of safety, construction, etc.
	Insurance Provider	Responsible for the provision of insurance services.
	Surveillance Provider	Responsible for provision of specialist services related to inspections of Transport Means, cargo, objects or items and for reporting the findings.
	Mooring Service Provider	Responsible for the provision of mooring crew, i.e. persons taking care of the lines of a ship to bring them ashore and secure them to bollards.
	Supply Provider	Responsible for provision of supplies (consumables, spare parts, etc.)
	Salvage Service Provider	Responsible for provision of salvage services (salvage of Transport Means or other objects – not persons)
	Towing Service Provider	Responsible for provision of Transport Means towing services.
	Repair Service Provider	Responsible for provision of repair services.
Travel Information Provider		Responsible for the provision of travel information services to the Transport User or others. This may be travel planning services or additional information related to the travel plan.
	Door-to-door Travel Plan Provider	Responsible for the provision of door to door travel planning services. A combination of scheduled and non-scheduled transport is supported.
	Non-scheduled Travel Plan Provider	Responsible for the provision of travel planning services for non-scheduled transport, e.g. driving car, walking and using bike.
	Scheduled Transport Travel Plan Provider	Responsible for the provision of travel planning services for scheduled transport.
	Tourist Information Provider	Responsible for the provision of tourist information.

5.2 ARKTRANS objects

Object are general terms representing physical entities (physical elements/units) or technical solutions related to transport. An object represents abilities. The use of generic objects makes it easier to make references to these abilities in a generic way, independent of technology and implementation. In real life, one physical system may implement the abilities addressed by several objects. We state the following reasons for using objects in ARKTRANS:

- Objects make it easier to make references to units (equipment, technical solutions, resources, units, etc.) and systems representing a specific functionality in a generic way.
- Objects are common names used across all the transport modes on objects representing the same functionality or purpose. E.g.: The Transport Means object is for example used

instead of car, vessel, bus, train, etc., and the object name Transportation Network is used instead of road, fairway, railroad, and air corridor.

- ARKTRANS should as far as possible be independent of technological changes. By using objects, the functionality provided by technical solutions that can be handled in a generic way (the realisation is irrelevant). E.g. the Communication Equipment object may be used instead of a specific GSM cellular phone.

One object is related to one of the sub-domains in the Reference Model, but may also interact with other domains.

The objects in the tables below are generic terms valid across all the transport modes and in many cases also common for both freight and personnel transport. The s*uperior objects* are overall and these will be used when all the *detailed objects* can be handled in a generic way. The detailed objects are refinements of superior objects. A detailed object may be a superior object specified elsewhere in the table. In such cased the term is printed in *italic*. In Annex E the objects are further described by means of Norwegian terms and modal examples.

5.2.1 Objects related to Transportation Network Management

The Transportation Network Management domain relates to a wide spectre of roles. Thus, this is further decomposed into four domains (see Chapter 5.3):

- Transportation Network Infrastructure Management
- Transportation Network Utilisation
- Emergency Management
- Regulation Enforcement

5.2.1.1 Objects related to Transportation Network Infrastructure Management

Superior object names	Detailed object names	Description
Terminal Area		A Transportation Network Resource that may have to be booked by the Transport Service Management domain. An area of the Transfer Node assigned specific tasks.
	Manoeuvring Area	An area for manoeuvring of Transport Means that are visiting the Transfer Node, e.g. to and from and between Stop Points. The area is under the supervision of the Transfer Node.
	Ramp Area	An area assigned loading/unloading and boarding/disembarking activities.
	Service Area	Area in which maintenance operations can be performed, equipment or supplies can be loaded or unloaded, or other services can be provided.
	Transhipment Area	An area assigned transhipment of Load Items.
	Transit Area	An area in which Load Items are waiting for further transport.
Transfer Node		The part of the Transportation Network infrastructure where passenger can enter or leave or change Transport Means or where cargo can be loaded, unloaded, stored and transferred between Transport Means. Also an area where services can be performed. Can be considered as a Transportation Network: Has a physical infrastructure; may have traffic management; may have Transportation Network sections – e.g. security areas; may have Transportation Network resources – e.g. stop points and terminal areas.
	Access Point	Entry point for Transfer Node
	Freight Handling Transfer Node	A Transfer Node that arrange for freight transport.
	Junction Transfer Node	A Transfer Node where passengers or Load Items can be transferred from one Transport Means to another.
	Passenger Transfer Node	A Transfer Node that arrange for passenger transport.
	Ro-Ro Transfer Node	A Transfer Node that arrange for ro-ro transport (ferry terminal included).
Transportation Network	Physical infrastructure that makes movement of vehicle, goods and people possible.	
	Checkpoint	A point where information about the traffic in general or individual Transport Means are registered. May be used to: Register the presence of Transport Means; collect information about Transport Means; or pass information to

Superior object names	Detailed object names	Description
		Transport Means. (The information collected may for example be used to detect (unauthorised) entry or traffic monitoring)
	Transfer Node	*See above*
	Transport Link	A part of the infrastructure that enables transport between Transfer Nodes and Transportation Network Resources.
	Transportation Network Equipment	*See below*
	Transportation Network Resource	*See below*
	Transportation Network Section	Limited part of the Transportation Network with specific supervision or access restrictions. May be defined by means of a number of entry and exit points or a set of coordinates
Transportation Network Equipment	An integrated part of the Transportation Network (located along, over, under, or at specific points in the Transportation Network). The equipment is available without any booking. Can be used to support, monitor and/or control behaviour or situations. The equipment may exchange information with systems or other equipment, and there may be several strategies for signalling, communication and information dissemination. The same physical equipment may serve as several object types.	
	Access Control Equipment	Monitors and checks the access to Transportation Network Sections or Transportation Network Resources.
	Communication Facilitating Equipment	Equipment localised in, along or close to the Transportation Network infrastructure enabling information exchange with Transport Means.
	Information Equipment	Equipment for dissemination of information to those using the Transportation Network.
	Resources Management Equipment	Interacts with systems or equipment connected to Transportation Network Resources. Manages the resource allocation and, if movable resources, the movement of resources.
	Security Equipment	Monitoring and scanning equipment in general.
	Signalling Equipment	System controlling the traffic signals
	Traffic Control Equipment	Provides mechanisms for control of traffic flow or Transport Means (to control or influence on their behaviour).
	Traffic Monitoring Equipment	Monitors traffic flow or the movement of individual Transport Means and provides information about the traffic in general (amount of traffic, speed) and/or individual Transport Means and their behaviour.
	Traffic Regulation Equipment	Provides mechanisms for traffic regulation (to affect the generic traffic flow and behaviour in the traffic)
	Transport Means Handling Equipment	Provides mechanisms for Transport Means handling, e.g. weighing, manoeuvring, etc.
	Transportation Network Condition Monitoring Equipment	Monitors Transportation Network conditions, e.g. weather conditions that may affect the Transportation Network conditions and environmental condition (pollution).
Transportation Network Resource	A resource in the Transportation Network to which the access is managed according to some strategy, for example first come first served; or booking of timeslots (may have to be booked by the Transport Service Management domain). Supervision may be relevant, e.g. to detect unauthorised access/use	
	Loading and unloading area	Area where Transport Means may stop for loading or unloading outside Transfer Nodes
	Parking Area	Area in which Transport Means may park.
	Stop Point	Location at a Transfer Node at which Transport Means stops.
	Terminal Area	See above
	Waiting Area	Area where Transport Means can wait. May be used due to specific Network and Traffic Statuses or while waiting for other Transportation Network Resources.

5.2.1.2 Objects related to Transportation Network Utilisation

Not defined

5.2.1.3 Objects related to Emergency Management

Superior object names	Detailed object names	Description

Superior object names	Detailed object names	Description
Emergency Equipment		Equipment used in emergency situations, e.g. fire alarm within a tunnel, phones for emergency calls, etc.

5.2.1.4 Objects related to Regulation Enforcement

Not defined

5.2.2 Objects related to Transport Demand

Superior object names	Detailed object names	Description
Goods Item		The goods contained in a Transport Item.
	Thermo Load	
	Environmental Affected Load	Cargo that is or may be affected by its surroundings. Requires clean surroundings.
	Non-floating bulk	
	Floating bulk	
	Special Cargo	See below
	General Cargo	
	Project Cargo	
Load Unit		A unit on or in which goods are transported. The load unit is not a part of the Transport Means. However, it must be possible for Transport Means to carry them.
	Container	
	Pallet	
Luggage		Luggage (of a Traveller) transported by a Transport Service Provider
	Animals	Animal.
	Normal Luggage	Normal luggage
	Unhandy luggage	Luggage needing special handling/treatment.
On-Transport Item Equipment		Equipment that can be attached to a Transport Item enabling identification, monitoring, tracking, etc. May also facilitate “intelligent items”, i.e. ability to take decisions based on situational awareness.
	Identification Equipment	Identifies Transport Item
	Monitoring Equipment	Monitors Transport Items, e.g. goods items, passengers, load units, etc. by means of misc. technologies, e.g. sensors or video. Provides information about the state.
	Security Equipment	Equipment that may prevent thefts or other criminal acts as well as equipment that may support the police or the owner in case of thefts (e.g. tracking equipment).
	Tracking Equipment	Equipment that provides tracking information (e.g. tracking of Transport Item).
Special Cargo		Cargo that requires special treatment.
	Animals	
	Dangerous Cargo	
	Food	
	Human Remains	
	Valuables	
Trade Unit		Trade Unit (with goods).
	Can	
	Carton	
Transport Item		The item to be transported by a Transport Service Provider. A Transport Item may contain other Transport Items, and so on.
	Goods Item	See above
	Load Unit	
	Luggage	See above
	Passenger	Person to be transported
	Trade Unit	See above

5.2.3 Objects related to Transport Service Management

Superior object names	Detailed object names	Description
Load Item		The items being transported. May be goods or load units.
Load Item Scanning Equipment		Equipment that registers and forwards information about Load Item from the On-Load Item Equipment (id, content, etc.)
On-Load Item Equipment		Equipment that can be attached to a Load Item (e.g. goods, or load units, load area of Transport Means) to facilitate identification, monitoring and tracking.
	Identification Equipment	Identifies Load Item
	Monitoring Equipment	Monitors Load Items, e.g. goods items, passengers, load units, load area of Transport Means, etc. by means of misc. technologies, e.g. sensors or video. Provides information about the state.
	Positioning Equipment	Provides position information.
	Security Equipment	Equipment that may prevent thefts or other criminal acts as well as equipment that may support the police or the owner in case of thefts (e.g. tracking equipment).
	Tracking Equipment	Equipment that provides tracking information (e.g. tracking of Load Item).
Terminal Equipment		A resource used in the transport operation. May have to be booked. The equipment may exchange information with systems or equipment
	Loading and Unloading Equipment	Used in loading and unloading operations.
	Passenger Handling Equipment	Resources that have to be allocated to the terminal operations like passenger handling.
Transport Worker Support Equipment		Equipment that supports the Transport Operation Worker in the execution of the transport operation and transport operation tasks. May for example provide information about operation and tasks and facilitate status reporting.

5.2.4 Objects related to On-board Support and Control

Superior object names	Detailed object names	Description
Transport Means		Transport Means transports people or goods, in the air, on roads, on rails or water bound.
	Emergency Transport Means	Transport Means used for emergency purposes.
	Freight Transport Means	Transport Means used for freight transport.
	Green Transport Means	Transport Means fulfilling environmental requirements
	Private Transport Means	
	Service Providing Transport Means	Provides services to other Transport Means in such a way that they can carry out their transport operations in a safe and efficient way.
	Transport Means for Passengers	
On-Board Equipment		Equipment on-board the Transport Means. (In addition generic equipment from the Transport Sector Support domain may also be on-board, e.g. tracking and monitoring equipment)
	ATC Equipment	On-board equipment supporting Automated Traffic Control (ATC)
	Equipment for Driver Control	Monitors the mode and behaviour of the Transport Means' driver. May intervene to avoid emergency situations.
	Equipment for Driver Support	Laptops, PDAs or other equipment that provides access to information systems or other solutions useful to the Transport Means' driver. May support the Transport Means' driver with respect to the accomplishment of the driving operation and in emergency situations.

Superior object names	Detailed object names	Description
	Equipment for Environmental Issues	Monitors the Transport Means and the operation of the Transport Means. May intervene to avoid damage and emergency situations.
	Equipment for Transport Means Monitoring and Control	Monitors the Transport Means. May intervene to avoid damage and emergency situations.
	Navigation Support Equipment	Equipment that supports the navigation process.
	Speed recorder	
	Trip recorder	

5.2.5 Objects related to Transport Sector Support

Superior object names	Detailed object names	Description
Communication Equipment		Provides mechanisms that enable communication with other systems, e.g. systems located outside the Transport Means, e.g. along the Transportation Network, in other Transport Means, or elsewhere.
Item Scanning Equipment		Equipment that registers and forwards information about Item from the On-Item Equipment (id, content, etc.)
On-Item Equipment		Equipment that can be attached to an Item to enable identification, monitoring, tracking, etc. May also facilitate “intelligent items”, i.e. ability to take decisions based on situational awareness
	Identification Equipment	Equipment enabling identification of Item, equipment or transport means
	Monitoring Equipment	Equipment enabling monitoring of Items or the surroundings of Items by means of misc. technologies. Provides information about the state
	Positioning Equipment	Provides position information.
	Security Equipment	Equipment that supports (enables) prevention of thefts or other criminal acts as well as equipment that may support the police or the owner in case of thefts.
	Tracking Equipment	Equipment that provides tracking information (e.g. tracking of Item).
Payment Equipment		Provides payment facilities
	Fee Equipment for Registered Payments	Equipment for collection of payment and registration of payment information
	Equipment for Non-registered Payment	Provides payment facilities for anonymous payment - no payment information is registered
Ticket Equipment		Equipment that issues and handles tickets.
	Ticket Machine	Provides payment facilities and issues tickets.
	Validation Machine	Registers payment information
	Medium Access Device	A device with the necessary facilities (hardware or software) to communicate with the Customer medium (e.g. for validation).
	Customer medium	Medium that enabled fare management.

5.3 Deployment of roles and objects

This section provides some examples that hopefully are clarifying with respect to the use of roles and objects related to specific issues.

5.3.1 Transport chain

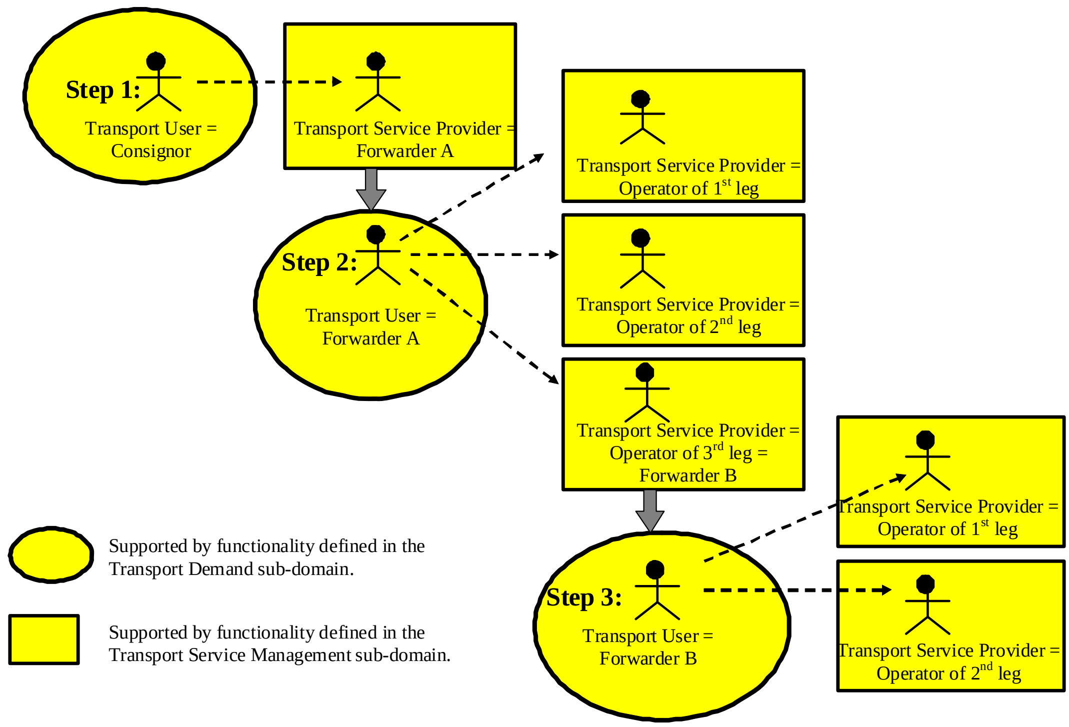


Figure 16 Transport Chain Establishment and Roles

A stakeholder may possess several roles and may, depending on the role, relate to different domains of the Reference Model. Figure 16 illustrates the establishment of a freight transport chain and the roles of the stakeholders involved:

- Step 1: The consignor is a Transport User. The Transport User orders transport services from a Transport Service Provider (Forwarder A). The Transport User does not have to know whether the Transport Service Provider is an operator or a forwarder.
- Step 2: Forwarder A orders transport services from several Transport Service Providers. Forwarder A has the Transport User role. As in step 1, one of the Transport Service Providers is a forwarder B (Forwarder B). Two Transport Service Providers are operators.
- Step 3: Forwarder B is the Transport User and orders Transport Services from subsequent Transport Service Providers.

The role of the forwarders will depend on whom they relate to:

- On reception of an order from a Transport User, the forwarders are Transport Service Providers (the Transport Service Management domain). It is irrelevant to the Transport User whether a Transport Service Provider is an operator or a forwarder.
- Whenever a forwarder orders transport services from a Transport Service Provider (on behalf of the Transport User), the forwarder is a Transport User (Transport Demand domain).

Similarly, the role of a travel agency will also depend on whom they relate to. However, a travel agency is usually not to be blamed if the transport is not carried out as planned. Thus, a travel agency will book on behalf of the traveller (the original Transport User) when they book transport services from Transport Service Provider

5.3.2 Fare management

ISO/DIS 24014-1 describes the standardised architecture of interoperable fare management systems. ARKTRANS looks at interoperable fare management as a part of the larger transport sector. This implies some extensions and differences compared to ISO/DIS 24014-1:

- In ARKTRANS, interoperable fare management is made generic with respect to the ticket medium. Electronic as well as paper tickets are covered by the same parts of the architecture descriptions.
- In ARKTRANS, interoperable fare management is put into a wider context.
    - The policy making roles are defined and reflect that the fare policy may be decided upon by authorities or by one or more commercial Transport Service Providers.
    - The purchase of fare products is just one of many actions taken by the Traveller. In that way transport demands, purchase of fare products, transport execution, etc. can be looked upon in a more complete way.
    - In a similar way, in ARKTRANS the provision of transport services against the use of a fare product is just a minor part of the total scope of transport company tasks.
- Generic issues, that are not specific to fare management, are in ARKTRANS described outside the scope of fare management. This count for roles and functionality related to the security and registrar functions.

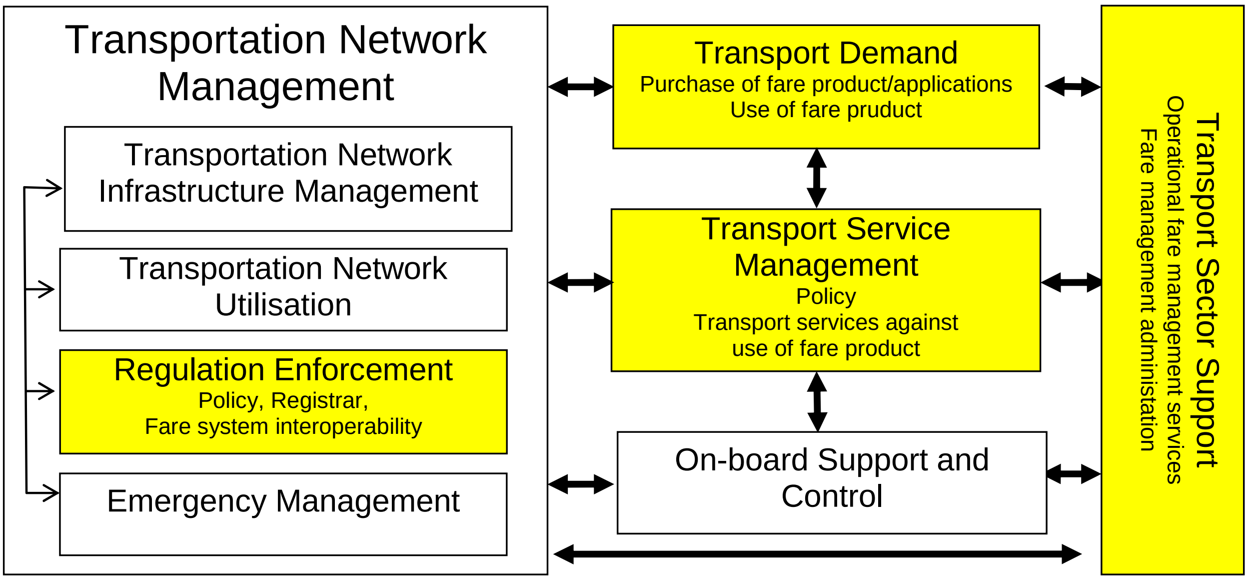


Figure 17 domains of relevance to fare management

The domains marked yellow in Figure 17 are of relevance to fare management, and ARKTRANS defines the associated roles. For some of these roles, relations can be drawn towards the entities of the ISO/DIS 24014-1:

- Different roles may be responsible for the fare policy depending on the involvement of public government:
    - The Fare Authority role (the Regulation Enforcement) is responsible for the fare policy for transport services subsidies by authorities. For such transport services the Fare Authority will, for the area they cover, provide fare scheme guidelines. Fares are also decided upon. There is no corresponding entity in ISO/DIS 24014-1
    - The Fare Authority role is also responsible for the interoperability of the fare systems. There is no corresponding entity in ISO/DIS 24014-1
    - One or more stakeholders possessing the Transport Service Provider role (Transport Service Management domain) may be responsible for the fare policy for transport services that are not subsidies by authorities. There is no corresponding entity in ISO/DIS 24014-1.
- Many of the roles related to fare management are in ARKTRANS considered as Service Provider roles (Transport Sector Support domain) as they provide services to different types of stakeholders (travellers, authorities, transport companies, etc.):
    - The Fare Management Service Provider is the overall role responsible for the provision of fare management operational services. The role can be used instead of

the detailed roles listed below when operational details are not required. The Fare Management Service Provider role is decomposed into:

- The Application Owner role, which is in accordance with the Application Owner entity in ISO/DIS 24014-1.
- The Application Retailer, which is in accordance with the Application Retailer entity in ISO/DIS 24014-1.
- The Product Owner role, which is in accordance with the Product Owner entity in ISO/DIS 24014-1.
- The Product Retailer role, which is in accordance with the Product Retailer entity in ISO/DIS 24014-1.
- The Collection and Forwarding Provider role, which is in accordance with the Collection and Forwarding entity in ISO/DIS 24014-1.

  - The Fare Management Interoperability Provider is responsible for the fare interoperability between two or more Fare Management Service Providers. A stakeholder possessing this role operates according to the instructions provided by the policy making roles mentioned above. The role is in accordance with the IFM management entity in ISO/DIS 24014-1.
  - The Information Security Provider role is generic as security management is of relevance to more areas than fare management. The role is in accordance with the Security Manager entity in ISO/DIS 24014-1.

- Within the transport sector, many different types of customers may buy different types of services. Thus, ARKTRANS distinguishes between the different types of customers by means of specific roles. For fare products, the customer is the Transport User role or the detailed Traveller role (Transport Demand domain). These roles in ARKTRANS are in accordance with the Customer entity in ISO/DIS 24014-1.
- The transport is provided by a transport company, the Transport Service Provider role (Transport Service Management domain) in ARKTRANS. This role is in accordance with the Service Operator entity in ISO/DIS 24014-1.
- The Registrar Authority role (Regulation Enforcement) in ARKTRANS is generic as the assignment of unique identifications to entities is of relevance to more areas than fare management. The role is in accordance with the Registrar entity in ISO/DIS 24014-1.

6 Functional view, Transportation Network Management

The Transportation Network Management domain focuses on the Transportation Networks (roads, fairways, railroads, air corridors, Transfer Nodes, etc.); the traffic and Transport Means in the Transportation Networks; emergency management; and regulation enforcement related to traffic and transport issues.

The traffic, constituted by the flow of Transport Means within the Transportation Network, is the outcome of freight and passenger transport. Such transport is crucial to our society, and the main objectives of this domain are to ensure the efficiency and safety of such transport. The infrastructure operation as well as the planning, monitoring and control of the traffic are emphasized. The traffic must be as efficient, safe and environmental friendly as possible.

The Transportation Network Management domain is comprehensive and includes a wide spectre of roles (see Chapter 5). Thus, it is further decomposed into 4 domains as illustrated in Figure 11 on page 32. The domains will interact with each other and with the other parts of the Reference Model. Some interactions, e.g. those towards the On-board Support and Control domain, mainly have a scope limited to one specific transport mode, and they will be according to conventions or standards for that mode. However, several interactions are required by all transport modes and should preferably be multimodal (i.e. equal for all transport modes), for example interactions with:

- The Transport Sector Support domain (e.g. meteorological services and statistics reporting)
- Emergency Management domain (e.g. emergency reporting)
- The Transport Demand domain (e.g. support to multimodal transport planning)

6.1 Transportation Network Infrastructure Management

The Transportation Network Infrastructure Management domain provides functionality required by those who are responsible for the physical Transportation Network infrastructure, the physical infrastructure of Transfer Nodes such as terminals and stations infrastructures included. The management of the actual maintenance and the improvements of the Transportation Network infrastructure are however not within the scope of ARKTRANS.

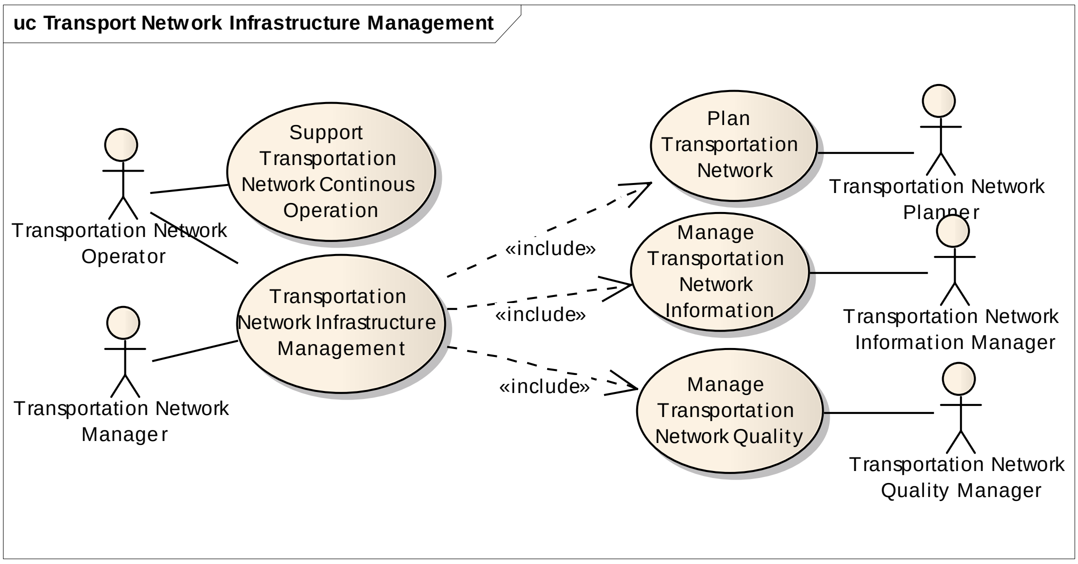


Figure 18 Use cases showing relations to Transportation Network Infrastructure roles

6.1.1 Plan Transportation Network

Decisions with respect to Transportation Network capacity and development (extensions and repairs) are taken, and Transportation Network establishments and improvements are planned. The environment, area resources and business activities are taken into consideration.

The work is assigned to Transportation Network Operators.

6.1.2 Manage Transportation Network Information

Information about the Transportation Network is established, verified, updated and made available to other functions. This includes both static and dynamic information about:

- Transportation Network geometry
- Transportation Network regulations, for example
  - Restrictions with respect to weight, width, height, speed, etc.
  - Access restrictions (green zones, etc.)
  - Suitability information (for different vehicle types, dangerous cargo, etc.)
  - Specific regulations due to Transportation Network conditions and events, e.g. closed roads, platooning, reduced speed, etc.
- Transportation Network condition and deviations, for example
  - Conditions caused by planned/foreseen activities/events (e.g. roadwork)
  - Conditions caused by unplanned/unforeseen events (e.g. due to weather)
  - Environmental conditions
  - Transportation Network Equipment status (e.g. signalling and communication equipment)

Information about conditions, deviations and regulations is received from 6.1.3.3 (current deviations) and 6.1.3.2 (upcoming conditions and deviations).

6.1.3 Manage Transportation Network Quality

The quality of the Transportation Network is managed. This includes the planning and follow up of continuous maintenance and improvements. The quality is evaluated with respect to safety, security and environmental protection. Corrective actions are suggested.

6.1.3.1 Identify Transportation Network Maintenance Needs

The quality is evaluated and needs with respect to maintenance are registered manually or automatically based on incoming reports, for example based on input from 6.1.3.3.

6.1.3.2 Manage Transportation Network Maintenance

Foreseen maintenance of the existing Transportation Network infrastructure is planned. Information about planned and on-going maintenance activities should be made available to other functions. Transportation Network Utilisation functions should for example consider this information when prognoses are made and when the traffic is controlled.

6.1.3.3 Register Deviation

The need for maintenance and improvement of faults as well as the need for continuous operation of the Transportation Network is registered.

This is the contact point for those who want to report about traffic network conditions (e.g. slippery road, restricted view, etc.) and upcoming or effectuated Transportation Network deviations due to incidents and accidents.

Authorities may also request measures (e.g. closure of roads, tunnels etc.).

6.1.3.4 Support Safety and Risk Analysis

The safety and the risks related to maintenance and continuous operation are evaluated and corrective actions may be suggested.

6.1.4 Support Transportation Network Continuous Operation

The continuous operation and maintenance of the Transportation Network is supported (e.g. clearing, salting, etc.). This includes both the physical Transportation Network infrastructure as well as the functionality of the Transportation Network, e.g. the functionality provided by the Transportation Network Equipment.

The use of the Transportation Network Equipment in traffic control is however managed by the Traffic Control functionality (see 6.2.2.3.5) and the safety management functionality (see 6.2.2.3.8.2) so that it contributes to efficient and safe traffic flow.

6.2 Transportation Network Utilisation

The Transportation Network Utilisation domain supports the use and utilisation of the physical Transportation Network infrastructure, Transfer Nodes included. This includes traffic and transport planning, traffic management, the availability of supportive services to the Transport Means in the Transportation Network, and Transportation Network Resource management.

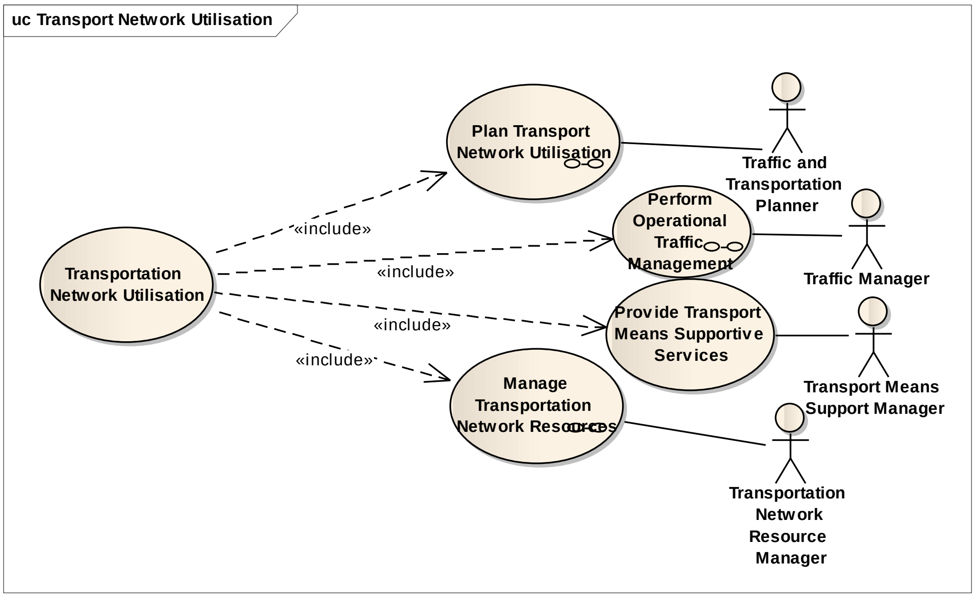


Figure 19 Use cases showing relations to Transportation Network Utilisation roles

6.2.1 Plan Transportation Network Utilisation

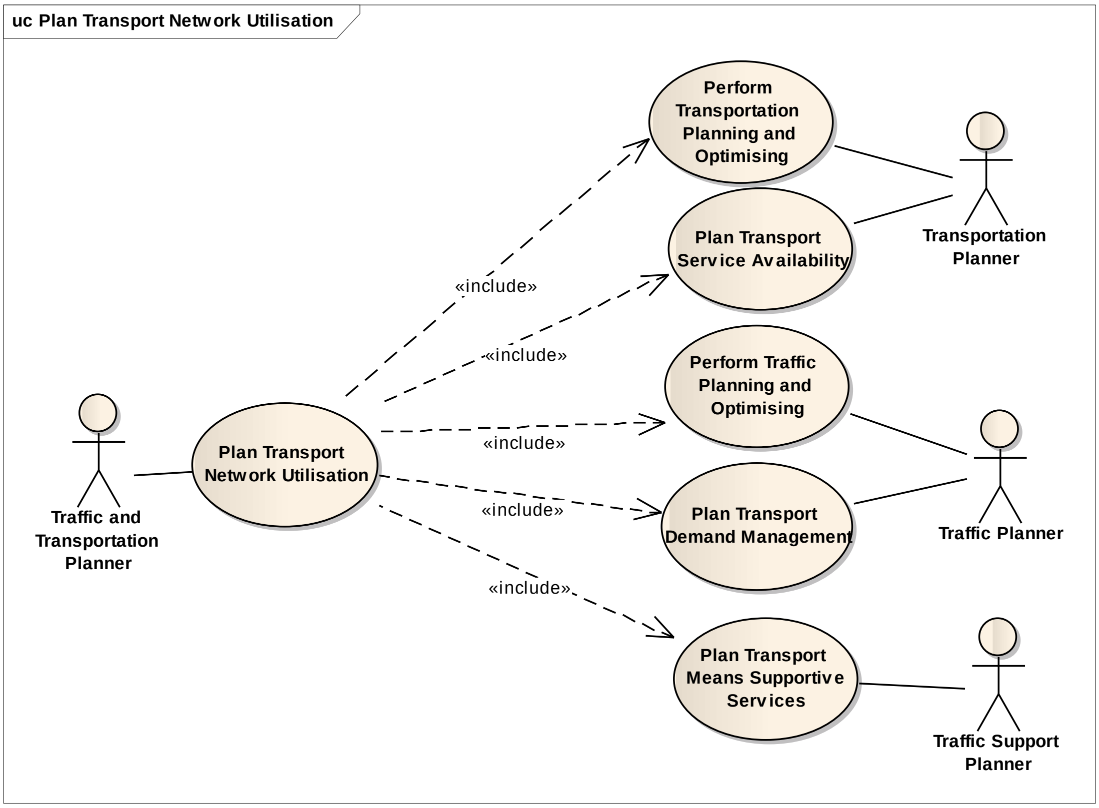


Figure 20 Use cases showing relations to roles

The Traffic and Transport Planner is responsible for strategic and tactical planning with respect to transport and traffic solutions and the provision of transport services that benefits the society. The needs of different actors (e.g. public transport and freight transport) have to be considered, and cooperation with authorities and others in the actual area and surrounding areas or regions may be required.

6.2.1.1 Perform Traffic Planning and Optimising

Prospective Transportation Networks or prospective traffic control strategies are planned and if possible tested by simulations. The traffic planning encompasses a restricted part of the Transportation Network and a single transport mode. Different solutions for the restricted part of the Transportation Network is considered, evaluated and planned.

6.2.1.1.1 Establish Statistical Traffic Information

Statistical information about the traffic is established.

6.2.1.1.2 Model Traffic

The traffic in the restricted part of the Transportation Network is modelled. Statistical information is used.

6.2.1.1.3 Evaluate Safety and Quality

The safety and the quality of the foreseen outcome of the suggested traffic plan are evaluated.

6.2.1.2 Perform Transportation Planning and Optimising

Prospective Transportation Networks or prospective traffic control strategies are planned and if possible tested by simulations. The transportation planning may encompass alternative routes and several transport modes. Different strategies and political issues may be tested and evaluated. Route planning across several transport modes should be considered.

6.2.1.2.1 Establish Statistical Transport Information

Statistical information about transport (public transport, freight transport, different transport modes, selected routes, etc.) is established.

6.2.1.2.2 Model Transport

The transport is modelled. Statistical information is used. Alternative routes and transport modes should be a part of the model.

6.2.1.2.3 Evaluate Safety and Quality

The safety and the quality of the foreseen outcome of the suggested transport plan are evaluated.

6.2.1.3 Plan Transport Demand Management

Strategies and plans for different types of overall demand management (influence on the traffic distribution and the choice of transport modes and Transport Means) are established. The demand management plans will be based on prognosis, and the objective is optimised according to strategic parameters (efficiency, safety, environment, mobility, etc.).

6.2.1.4 Plan Transport Means Supportive Services

Services and equipment that can support the individual Transport Means (tug boats, “follow me cars” on airports, etc.) are planned, and the availability of the required services and equipment is ensured.

6.2.1.5 Plan Transport Services Availability

The need for transport services that benefit the society is addressed. Such services are provided by the Transport Service Management domain, but the Transport Planner may influence on the availability of such transport services.

6.2.1.5.1 Prognosticate Transport Demand

The need for transport services, i.e. routes and capacity requirements, is estimated, and the transport services provided by the Transport Service Management domain are influenced to meet the route and capacity demands. Figures and capacities for such services are also required in transport models.

Call for tenders may be issued and evaluated if the required transport services are not profitable from a corporate economy point of view, and contracts may be entered with the Transport Service Providers providing the best services with respect to quality and costs. However, the establishment of such contracts and the ordering of the transport services are, according to ARKTRANS, done in the Transport Demand domain (see 7.1). Thus, the Transport Planner will switch to the Transport User/Public Purchaser role.

6.2.1.5.2 Prioritise and Schedule Traffic

In transport modes in which the Transportation Network capacity is restricted, the utilisation of the Transportation Network (tracks, air corridors, Transfer Node, etc.) must be planned. Resources and timeslots are assigned to the planned transport services.

6.2.2 Perform Operational Traffic Management

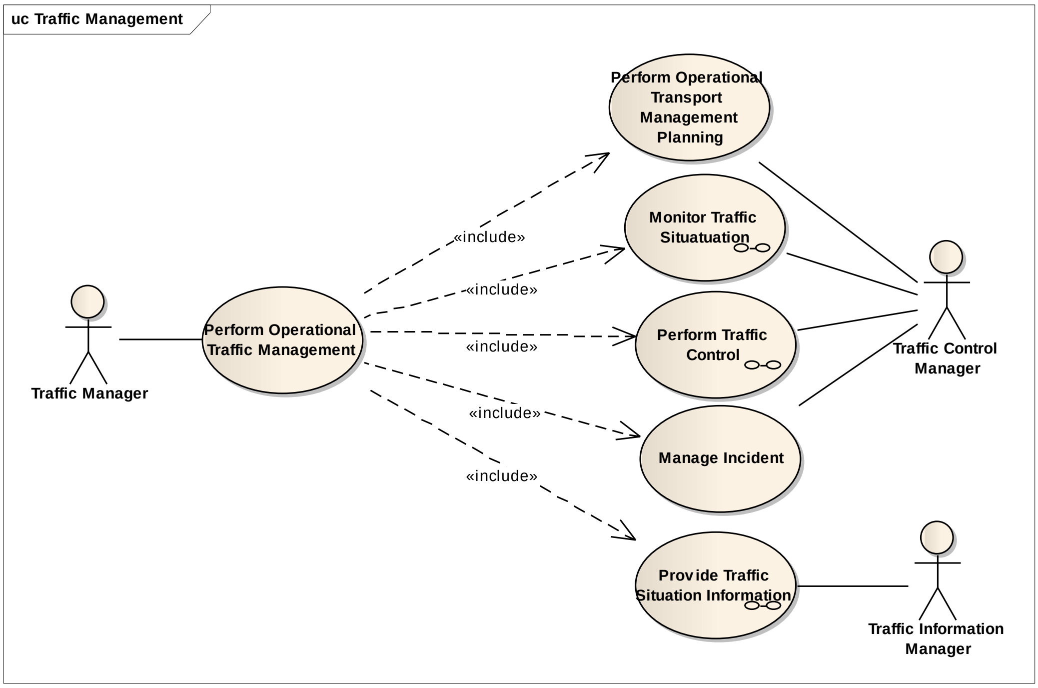


Figure 21 Use cases showing relations to roles

Ongoing traffic is managed based on information about the Network and Traffic Status (NTS).

6.2.2.1 Perform Operational Traffic Management Planning

Short term plans for the traffic management are made. Short term traffic control actions and strategies are decided upon based on information about events, traffic exceptions; current traffic; infrastructure conditions; and prognosis.

6.2.2.1.1 Register Traffic Exception

Occurrences, such as arrangements, state visits, transportation of broad cargo, high cargo, etc., that may cause exceptions from normal traffic flow are registered. The traffic problems caused by the occurrences must be considered and handled.

6.2.2.1.2 Administrate Entry and Exit Information

Information about estimated and actual arrivals to checkpoints is registered manually or automatically (based on incoming reports), and the information is made available to the traffic control.

Information about estimated time of arrival or departure (ETA/ETD) is received as well as information about specific issues, e.g. dangerous cargo.

6.2.2.1.3 Prepare Prognosis

Prognosis for the upcoming Network and Traffic Status and traffic types are based on information about the Transportation Network, historical information about traffic flow and Transportation Network conditions for the season, meteorological and environmental prognosis, and information about upcoming issues (known arrivals and departures, planned maintenance, known exceptions, etc.).The resulting prognosis will be used in traffic control planning.

6.2.2.1.4 Plan Traffic Control

Traffic control actions are planned based on information about expected traffic exceptions as well as Network and Traffic Status prognosis.

6.2.2.2 Monitor Traffic Situation

The ongoing traffic and the infrastructure conditions are monitored continuously to detect situations that may influence on safety and traffic flow. The quality of the information received is verified, and the importance of it is considered, and the information is processed according to guidelines.

Information about traffic and Transport Means behaviour is collected by means of many types of Transportation Network Equipment, and selected parts of the information are used to meet the needs of:

- Having an accurate and detailed overview of the current Network and Traffic Status across the network to enable effective traffic management and control.
- Maintaining empirical traffic data to give a sound basis to assess proposed traffic planning and development schemes and their likely impacts on traffic

The Transportation Network conditions are also monitored to support the traffic management. Abnormal and unplanned conditions that may influence on the traffic and the safety will get special attention.

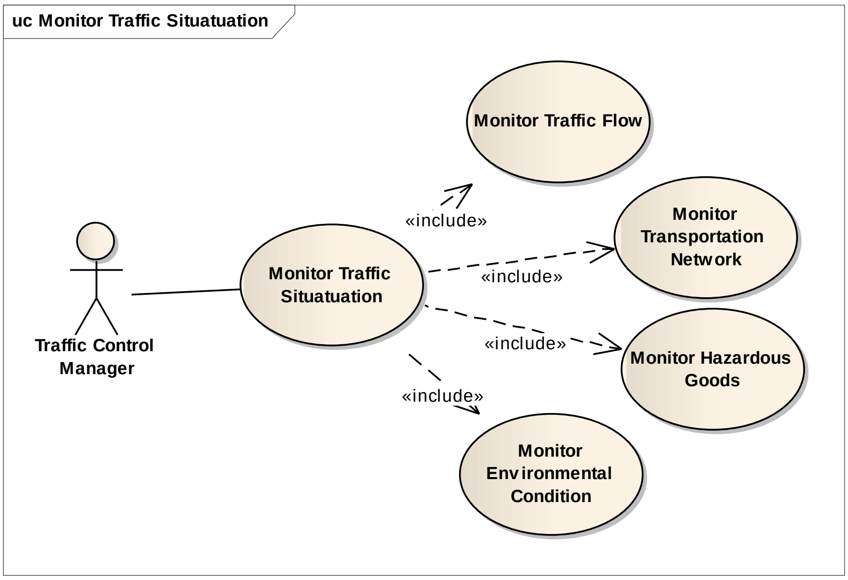


Figure 22 Use cases showing decomposition

6.2.2.2.1 Monitor Environmental Conditions

Meteorological conditions, pollution (dust, spill of harmful materials, etc.), noise, etc. are monitored to detect situations that may affect traffic flow or traffic safety (Received from 10.7.5).

6.2.2.2.2 Monitor Hazardous Goods

Transport operations involving dangerous cargo are monitored, and the monitoring contributes to awareness about the presence of hazardous materials in parts of the Transportation Network where such cargo may cause a safety risk in case of incidents or emergencies. Overall information about the hazardous cargo (identifying the type of dangerous cargo) should be available.

6.2.2.2.3 Monitor Traffic Flow

Information about traffic flow and Transport Means is continuously received from several sources. Different technologies can be used to collect the information. The information must be collected and stored in such a way that it can be provided to other functions such as traffic control, incident management, emergency preparedness and management, preparation of prognosis, and traffic planning and optimising. Specific attention is given to Transport Means assumed to represent a risk.

6.2.2.2.4 Monitor Transportation Network

Abnormal and unplanned Transportation Network conditions that may influence on the traffic flow and on the safety are monitored. The information may be provided to functions providing traffic control and traffic assessment. Conditions that may be monitored are

- Specific Transportation Network conditions due to environmental (e.g. meteorological) conditions (see 6.2.2.2.1)
- Obstructions (e.g. drifting objects, avalanche, potholes, etc.) Information about predicted progress may be received from 10.7.5.4.

6.2.2.3 Perform Traffic Control

The traffic is controlled and managed to achieve optimal efficiency and safety and to minimize the negative effects on the environment (pollution, noise, etc.). Traffic management measures are based on predefined schemes, or they are taken based on an assessment of the current Network and Traffic Status and the foreseen traffic development in short terms.

The traffic flow or the individual Transport Means are managed by means of automated systems, by Transportation Network Equipment and by individual contacts with the Transport Means. (The Transportation Network Equipment belongs to the Transportation Network Infrastructure Management domain, the traffic control decisions are a part of the Transportation Network Utilisation domain).

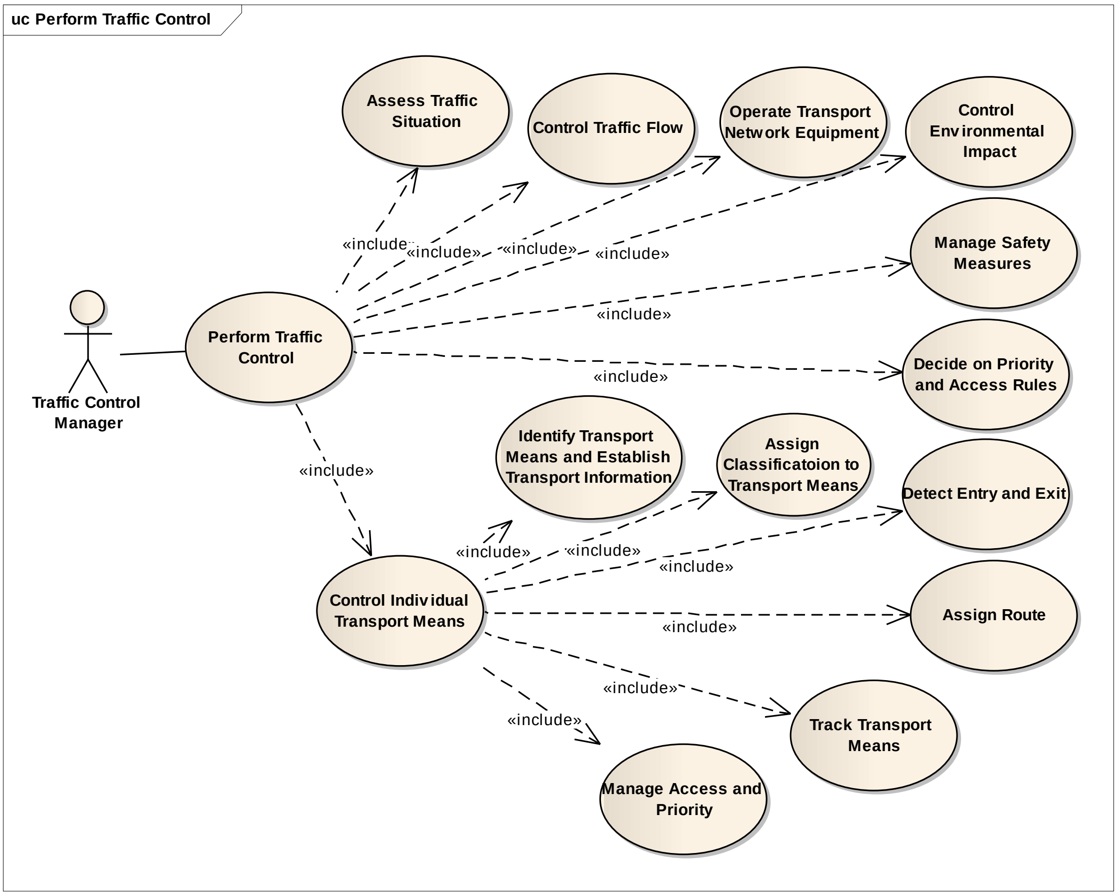


Figure 23 Use cases showing decomposition

6.2.2.3.1 Predict Traffic Flow

The short terms development of the traffic flow is predicted by means of for example empirical information, the current Network and Traffic Status and simulations. The results are used when traffic control decisions are made. For some transport modes intersecting movement of Transport Means must be managed.

6.2.2.3.2 Assess Traffic Situation

The Network and Traffic Status is assessed based on predictions of available information on:

- The Network and Traffic Status from the monitoring function (see 6.2.2.2)
- The Transportation Network information (speed limits, capacity, type (e.g. tunnel), and planned situations such as maintenance, reduced capacity, restrictions, etc.) from the Transportation Network Infrastructure Management area
- Expected traffic changes, and predicted development based on prognosis and empirical information
- Detection of potential dangerous situations

6.2.2.3.3 Control Environmental Impact

Environmental issues that should influence on the traffic control are identified, and actions may be taken towards individual Transport Means. Restrictions may for example be put on Transport Means with dangerous cargo and Transport Means that make a lot of noise with respect to routes and time period in which they may travel.

6.2.2.3.4 Control Traffic Flow

Based on the situation awareness established in 6.2.2.3.2 and (if available), decisions about traffic management measures are taken in compliance with the local polity. The aim is to affect the safety, the traffic flow, traffic density and environmental issues in a positive way.

Different traffic management measures may be taken by means of for example the Transportation Network Equipment. Signals, guidelines and information may be provided to control the behaviour. It is crucial to have an understanding of how the Transport Means might respond to the measures and information. Demands from for example Authorities must be handled, e.g. the priority or access of emergency cars.

6.2.2.3.5 Operate Transportation Network Equipment

The continuous operation of the Transportation Network Equipment is a part of the Transportation Network Infrastructure Management domain. The use of the equipment in traffic management is however a part of the Transportation Network Utilisation domain. Standardised procedures for traffic control and handling of different Network and Traffic Statuses, normal as well as abnormal variations, may be used. The equipment may also interact with the Transport Means to provide information or guidelines, or to influence on the operation of the Transport Means, for example by means of automatic traffic control (ATC). The equipment may for example:

- Assign or recommend routing
- Control the access to the Transportation Network Sections
- Assign or recommend speed or speed limits
- Promote better utilisation of the Transportation Network (e.g. tidal flow control)
- Provide relevant information
- Introduce restrictions
- Enforce regulations

6.2.2.3.6 Decide on Priority and Access Policy

The current traffic management policy with respect to priorities and access assignment must be decided. The policy will depend on the Network and Traffic Status.

6.2.2.3.7 Control Individual Transport Means

In addition to the generic management of the traffic flow, Transport Means are controlled in a mode individual way.

6.2.2.3.7.1 Assign Route

The Transport Means are assigned specific routes or duties that should be followed (however, for some transport modes the Master of the Transport Means may, on own responsibility, deviate from the assignment). The functionality is used for transport modes in which the usage of the Transportation Network is strictly regulated (air, rail and partly sea). For other transport modes, route guidance is provided as traffic information (see 6.2.2.4).

A routes is assigned to an individual vehicle depending on the available information about

- The entry, exit and presence detection and current position (see 6.2.2.3.7.5)
- Transport Means and transport operation information (see 6.2.2.3.7.2)
- The classification assigned (see 6.2.2.3.7.2)
- The current or foreseen Network and Traffic Status (see 6.2.2.3.2)
- The Transportation Network and its regulation and condition

Depending on the information mentioned above, the Transport Means may get more or less favourable routes. Environmental and safety issues are considered. Specific routes may for example be assigned to Transport Means with hazardous materials on-board and to Transport Means that make a lot of noise.

6.2.2.3.7.2 Assign Classification to Transport Means

Depending on the available information about the Transport Means (type of engine, construction, weight, the crew's ability to navigate in an area without a pilot) and the transport operation (passenger transport, type of cargo, percent of filling, delays, etc.) (established in 6.2.2.3.7.2) and the current or foreseen Network and Traffic Status (see 6.2.2.3.2), the Transport Means may be classified. The classification may be done according to many different strategies, e.g. depending on risk calculation, priority strategies, service level strategies, etc. This classification will influence on the traffic management measures taken towards the Transport Means.

Specific classifications may be requested for specific Transport Means. It is up to the policy of the traffic management system to allow this (e.g. for an extra fee).

6.2.2.3.7.3 Identify Transport Means and Establish Transport Information

Information about the transport properties are received from the On-board Support and Control domain. This may be

- Transport Means information:
  - The identity of the Transport Means
  - Overall information about the Transport Means, for example
    - ID
    - Nationality (e.g. flag state)
    - Weight and size
    - Construction (e.g. number of axles, hull, etc.)
    - Engine (e.g. Euro IV standard)
    - Fuel type
  - Overall information about the transport operation such as
    - Type of cargo on board (e.g. hazardous materials)
    - Loading factor (incentives may be provided to encourage full loads)
    - Cargo weight
  - Destination information
    - Route description
    - Arrival/departure locations (e.g. Transfer Node or specified loading bays)
    - Time schedule (e.g. assigned time slots)
- Trip information
  - Arrival information
  - Departure information
  - Available certificates
- Cargo information

6.2.2.3.7.4 Track Transport Means

The presence and position of the individual Transport Means are registered.

6.2.2.3.7.5 Manage Presence in Transportation Network Section

Information about entries and exits to Transportation Network Sections is registered to keep track of the presence of individual Transport Means. The entry and exit information is used for access management in 6.2.2.3.7.6.

The use of Transportation Network Resources (e.g. loading and unloading areas) is also registered and passed to the Transportation Network Resource Manager (see 6.2.3).

The detection of the Transport Means is based on information received from the tracking function (see 6.2.2.3.7.4).

6.2.2.3.7.6 Manage Access and Priority

The priority and the access to Transportation Network Sections are managed based on information about:

- The Transport Means and the classification assigned to it (see 6.2.2.3.7.2)
- The current priority and access policy (see 6.2.2.3.6)
- The Transport Means' position (see 6.2.2.3.7.4)
- The Transport Means' entry, exit and presence in Transportation Network Sections (see 6.2.2.3.7.5)
- The current or foreseen Network and Traffic Status
- A balancing of the need (e.g. public transport vs. freight distribution)

Access rights are assigned to the Transport means. Time slots for access may for example be assigned, and the Transport Means may be asked to wait until the Network and Traffic Status has improved. The Transport Means may also get advantages, e.g. priorities or access to specific lanes.

Depending on the assigned access rights, individual and location dependent traffic management measures can be taken. Illegal entries to Transportation Network Sections are detected.

6.2.2.3.8 Manage Safety Measures

The detection of incidents or accidents may trigger actions that prevent or minimise the negative effects (e.g. automatic train stop, closure of tunnels or bridges).

6.2.2.3.8.1 Handle Incident Triggered Transport Means Control

The required commands are transferred to the Transport Means (e.g. automatic train stop) based on pre-defined control strategies. Transportation Network equipment may be used to transfer the commands. (For road transport the function must be harmonised with work in CEN TC 278 and ISO TC 204).

6.2.2.3.8.2 Handle Incident Triggered Transportation Network Control

On detection of incidents that may influence on the safety, automatic control of the Transportation Network or Transportation Network Equipment is effectuated based on pre-defined control strategies. This may for example be automatic train stop, closure of tunnels or bridges. (For road transport the function must be harmonised with work in CEN TC 278 and ISO TC 204).

6.2.2.3.8.3 Provide Incident Warning

Incident warnings may become operative on detection of incidents that may influence on the safety. Warnings are provided to relevant stakeholders.

6.2.2.4 Provide Traffic Situation Information

Verified information about the Network and Traffic Status is crucial for the traffic management. However, the information should also be disseminated to the On-board Support and Control domain, the Transport Service Management domain and others. The information may be prognosis for the future as well as information based on real time observations or measurements. Thus, the information must contain meta information that reflects how the information is established (observation, measurement, calculated forecast, etc.).

The information is distributed to improve safety and to achieve efficiency in the traffic flow. Hopefully the information will be used in transport planning. The Network and Traffic Status information may be provided by means of many technologies and via several medias (notice to mariners, notice to airman, VHF communication, traffic messages, AIS, radio, Web, etc.). One or more types of traffic information may also be combined in a way that provides added value.

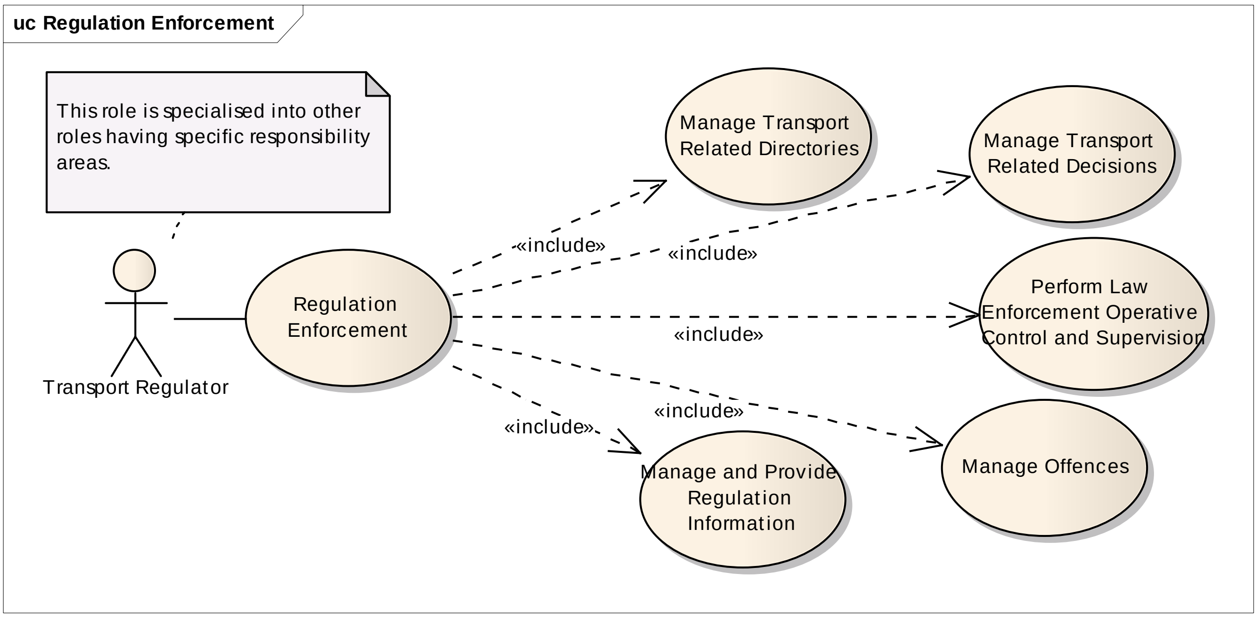


Figure 24 Use cases showing decomposition

6.2.2.4.1 Provide Incident and Accident Information

Information about incidents and accidents with respect to location, type of incident and effects on traffic is provided.

6.2.2.4.2 Provide Route and Navigation Information

The Transport Means may need information or route guidance to find their way or to find or follow the optimal route with respect to traffic flow and safety. Based on available information and needs, several types of route information may be provided such as:

- General route and navigation guidelines - normal routes
- Alternative routes and reasons for re-routing
- Route diversions (in case of obstructions) and reasons for re-routing.
- Personalised dynamic route guidance based on live, dynamic Network and Traffic Status information.

Expected travel times may be provided in all cases.

6.2.2.4.3 Provide Traffic Image

Information about the Transport Means in the area with respect to position, speed, direction, and the destination they are heading for is provided. This may be of importance to other Transport Means (especially for air and sea transport) when they plan their operations.

6.2.2.4.4 Provide Traffic Flow Information

Traffic Information is provided. This includes both dynamic and statistical traffic information. Dynamic information about the traffic flow may be information about:

- Traffic flow, such as traffic density, speed, journey times and delay.
- Abnormal traffic conditions such as congestion followed by information about
  - The length of queue
  - The likely duration
  - The estimated delay

- Reason for the abnormal condition (may be incident/accident, Transportation Network regulations or Transportation Network condition)
- Warnings

6.2.2.4.5 Provide Transportation Network Condition Information

Transportation Network Condition Information is provided. This is dynamic information about abnormal and unplanned conditions in the Transportation Network (slippery road, turbulence, high waves, obstructions, restricted view, air pollution, oil spill, etc.) due to situations that cannot be controlled (weather, incidents, accidents, etc.)

6.2.2.5 Manage Incident

Detection and response to incidents that may influence on the safety are managed automatically or according to formal procedures. Some incidents arise due to emergency situations. However, most incidents are normal variations that may require no - or just minor adjustments.

6.2.2.5.1 Detect and Verify Incident

Incidents or possible incidents may be detected due to monitoring (see 6.2.2.2). Automatic Incident Detection (AIC) may be supported as well as manual detection. Incidents may also be detected based on information received from misc. sources.

Some incidents may develop to emergency situations. However, most incidents are normal variations that may require no - or just minor adjustments.

Information about the incident is established, verified and stored in such a way that it can be used in incident handling and dissemination of information about incidents.

6.2.2.5.2 Assess and Handle Incident

Incidents are assessed and handled (automatically or manually) according to formal procedures. The handling may for example be delegation of responsibility to transportation network maintenance (reporting to 6.1.3.3); traffic control in general (see 6.2.2.3) or handling of safety measures (see 6.2.2.3.8); or Emergency Management (see 0).

In some cases other Transportation Networks must be notified (e.g. Transfer Nodes) so that they can contribute to the handling or prepare actions.

6.2.3 Manage Transportation Network Resources

The use of the Transportation Network Resources is planned and managed. These resources may be allocated to Transport Means or to Transport Operations (such resources are requested from the Transport Service Management and the On-board Support and Control domains). It may for example be required to book.

- Stop Points for Transport Means
- Loading and Unloading Area for loading/unloading outside Transfer Nodes (e.g. loading bay in cities) for loading and unloading of goods
- Ramp Areas in Transfer Nodes for Load Item handling like loading and unloading / boarding and disembarking
- Transhipment Areas in Transfer Nodes for transhipment of Load Items to and from storage services or transhipment of Load Items to, from and between Transport Means
- Transit Areas in Transfer Nodes where Load Items may wait/be stored while waiting for further transport

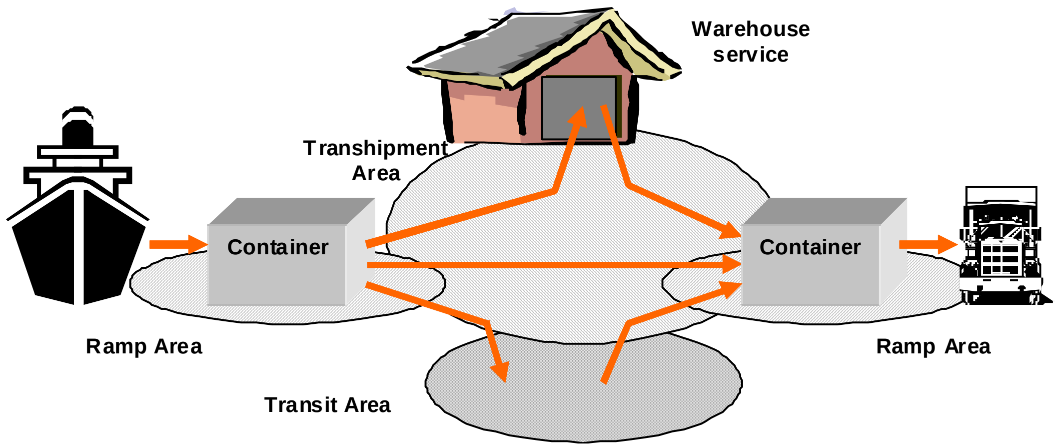


Figure 25 Use of Transportation Network Resources

6.2.3.1 Assign Transportation Network Resource

The rules for use of Transportation Network Resources (see 5.2.1.1) are established (e.g. first come – first served, booking of time slots, price level, fine for early arrival/late departure, etc.), and if required, the resources allocation is managed (assignment of timeslots for use).

In communication with the Transport Service Management domain:

- Information about properties of and access to Transportation Network Resources like for example loading bays is exchanged with the Transport Service Management domain (see 8.2.2.4 and 8.4.4) (e.g. time slots available, existing bookings).
- Bookings (re-bookings included) are handled

6.2.3.2 Monitor Transportation Network Resource Usage

The use of Transportation Network Resources is monitored based on entry and exit information received (from 6.2.2.3.7.5) and information registered during the use of the resource. The following functionality may be supported:

- The entry of Transport Means and/or Load Items is registered
- The access is checked, and illegal use is detected and handled according to local procedures (Load Items without a customs clearance can for example not enter areas for Load Items that have passed such control).
- Management of information about the use/content of the Transportation Network Resource. This may be an overview of Transport Means and/or Load Items:
  - o Their location;
  - o The duration of their use of the resource.

6.2.4 Provide Transport Means Supportive Services

Services that support the Transport Means are provided. This may be services that improve or support

- Safety (e.g. pilotage, towing services)
- Security (e.g. pilotage)
- Environmental protection (e.g. waste reception services)
- Manoeuvring and/or navigation (e.g. services provided by tug boats, shunting locomotives, follow me cars)
- Arrival and departure (e.g. mooring services, gate services, etc.)
- Access to Transportation Network sections (e.g. bridge or lock control services)

6.3 Regulation Enforcement

The Regulation Enforcement domain provides functionality required by authorities. Laws and regulations must be enforced, this includes decision-making (based on the laws), operative control as well as the establishment and maintenance of directories holding relevant information. Authorities may for example take decisions with respect to Transportation Network regulations.

The overall functions are to a large extent common to all authorities due to their role as a Transport Regulator (the area in which they work will however depend on the type of Transport Regulator).

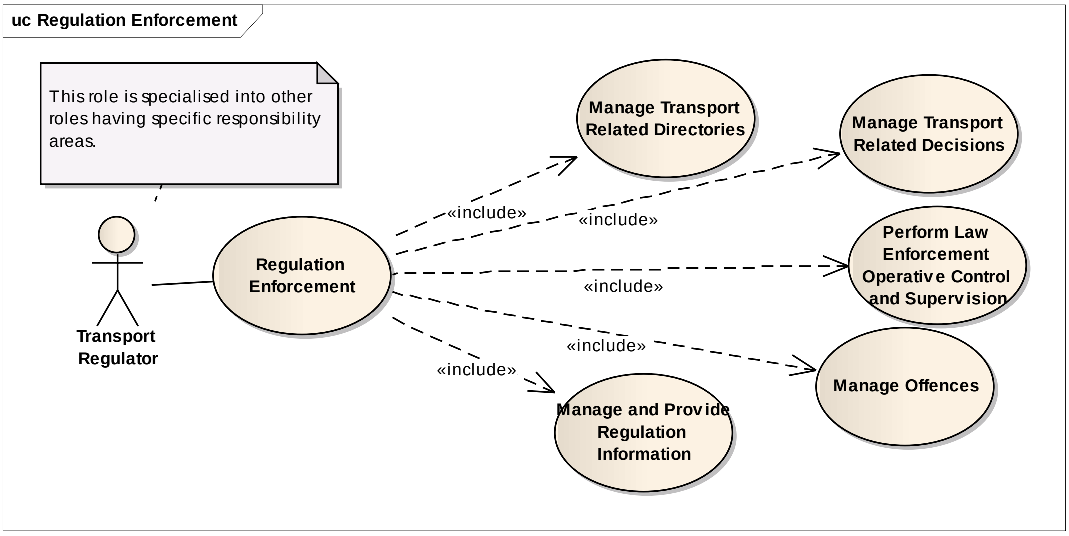


Figure 26 Use cases showing relations to Regulation Enforcement roles

6.3.1 Manage Transport Related Directories

6.3.1.1 Manage Transport Means Directory

Information about the Transport Means should be established, maintained and made available.

6.3.1.2 Manage Licence and Certificate Information

Information about licenses (that documents right to perform or provide certain activities) and certificates (that documents qualifications or abilities to provide certain services) are established, maintained and made available.

6.3.1.3 Manage Identifiers

Unique identifiers are assigned to entities and the identifiers are managed. The entities that are assigned identifiers may be organisations, components, applications, products, standardised messages, etc.

6.3.2 Manage Transport Related Decisions

Decision-making authorities take decisions on regulations related to traffic and transport.

6.3.2.1 Perform Fare Management

The overall fare policy is decided upon and the implications with respect to specific transport products are concluded. The pricing is decided upon.

The interoperability between the fare systems is managed. This includes the strategy with respect to products, interoperability between providers of transport services (PT transport) and the fare interoperability management.

6.3.2.2 Manage Traffic Regulation

Regulations related to the Transportation Network is decided upon and invoked.

6.3.2.3 Issue Licences and Certificates

Decisions on licenses and certificates (that documents qualifications or abilities to provide certain services) are taken.

6.3.3 Perform Law Enforcement Operative Control and Supervision

Functionality supporting supervision, registration and checking performed by Authorities (Police, Customs, etc.) – as a part of the enforcement of laws and regulations.

6.3.3.1 Manage Hazardous Goods Transport Information

Information about transport operations carrying dangerous materials is received and managed. Overall information about the type of cargo should be provided to traffic control and others that may need such information. In case of emergencies, the required information must be made available so that it can be submitted to other stakeholders according to predefined rules.

6.3.3.2 Manage Import and Immigration

The import of cargo as well as the immigration is managed according to immigration, health, veterinary and agricultural regulations.

For travellers, this includes passport and visa control.

6.3.3.3 Manage Customs

The import of goods and are managed according to customs regulations. Customs declarations are received and processed

6.3.3.4 Manage Clearances

The customs clearances of Transport Means entering a country are managed.

A customs clearance must have be received before cargo can enter domestic area.

6.3.3.5 Manage Incidents

Incidents that are of relevance to Transport Regulators are handled.

6.3.3.6 Manage Taxes

Demands for the payment of taxes are issued (defined by laws and regulations) and followed up.

6.3.3.7 Manage Statistics

Reception and management of different types of imposed statistics.

6.3.4 Manage Offences

Functionality supporting the handling of law or regulation offences.

6.3.4.1 Register Regulation Offence

Information about regulation offences is registered.

6.3.4.2 Support Offence Handling

6.3.5 Manage and Provide Regulation Information

Information about laws and regulations should be made available.

6.3.5.1 Manage Hazardous Goods Characteristics

Information about dangerous materials and international codes identifying such materials must be managed as well as with information about how the materials shall be made available in case of emergencies.

6.3.5.2 Perform Multimodal Hazardous Goods Mapping

The identification of hazardous materials should be coordinated across the transport modes.

6.4 Emergency Management

The Emergency Management domain provides functionality required by those responsible for emergency preparedness and response related to transport.

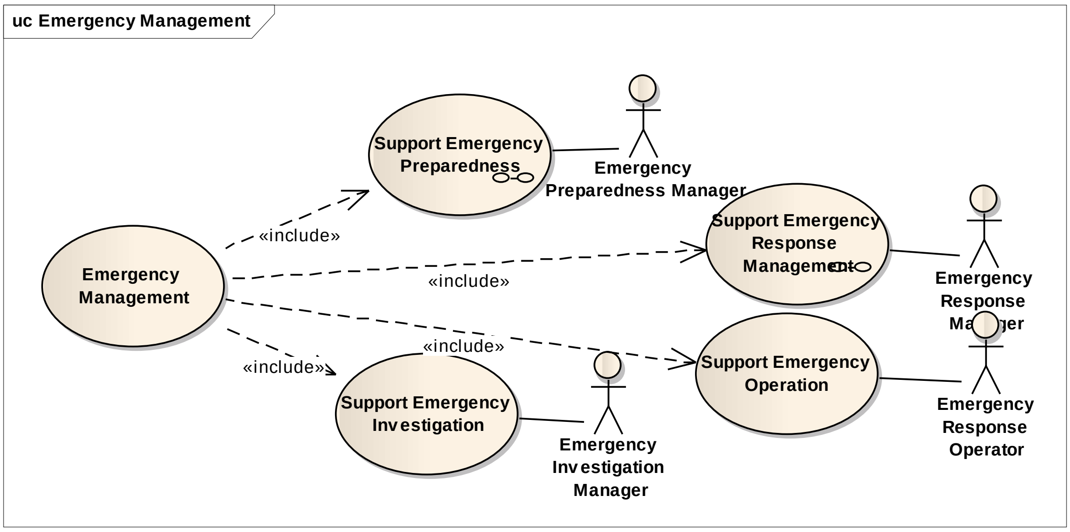


Figure 27 Use cases showing relations to Emergency Management roles

6.4.1 Support Emergency Preparedness

Plans and responsibilities in case of emergencies must be established.

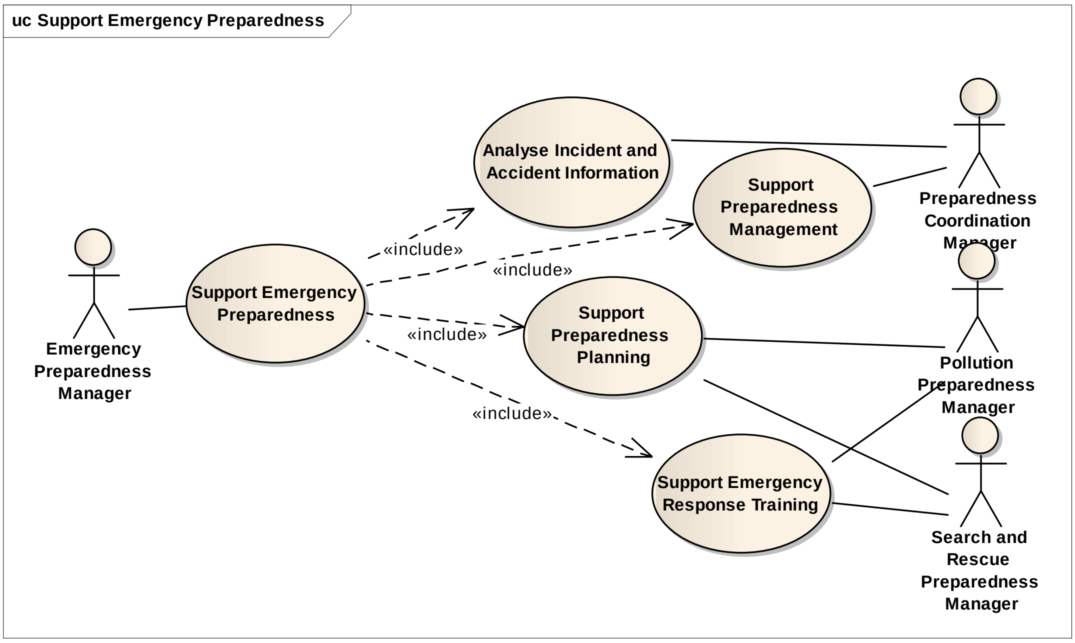


Figure 28 Use cases showing relations to roles

6.4.1.1 Analyse Incident and Accident Information

Historical information about incidents, accidents and pollution is used to produce statistics and to draw conclusions about causes and effects.

6.4.1.2 Support Preparedness Management

Guidelines for preparedness planning are defined, and the establishment of preparedness plans and organisations are coordinated and managed. Depending on the area this may include one or more plans. There may a hierarchy of responsibility areas with respect to the preparedness management.

6.4.1.3 Support Preparedness Planning

Preparedness plans are established.

6.4.1.4 Support Emergency Response Training

Emergency response training is supported.

6.4.2 Support Emergency Response Management

The management of upcoming or ongoing search and rescue and pollution response operations is supported. Required information is stored and used both during the operations and during investigations.

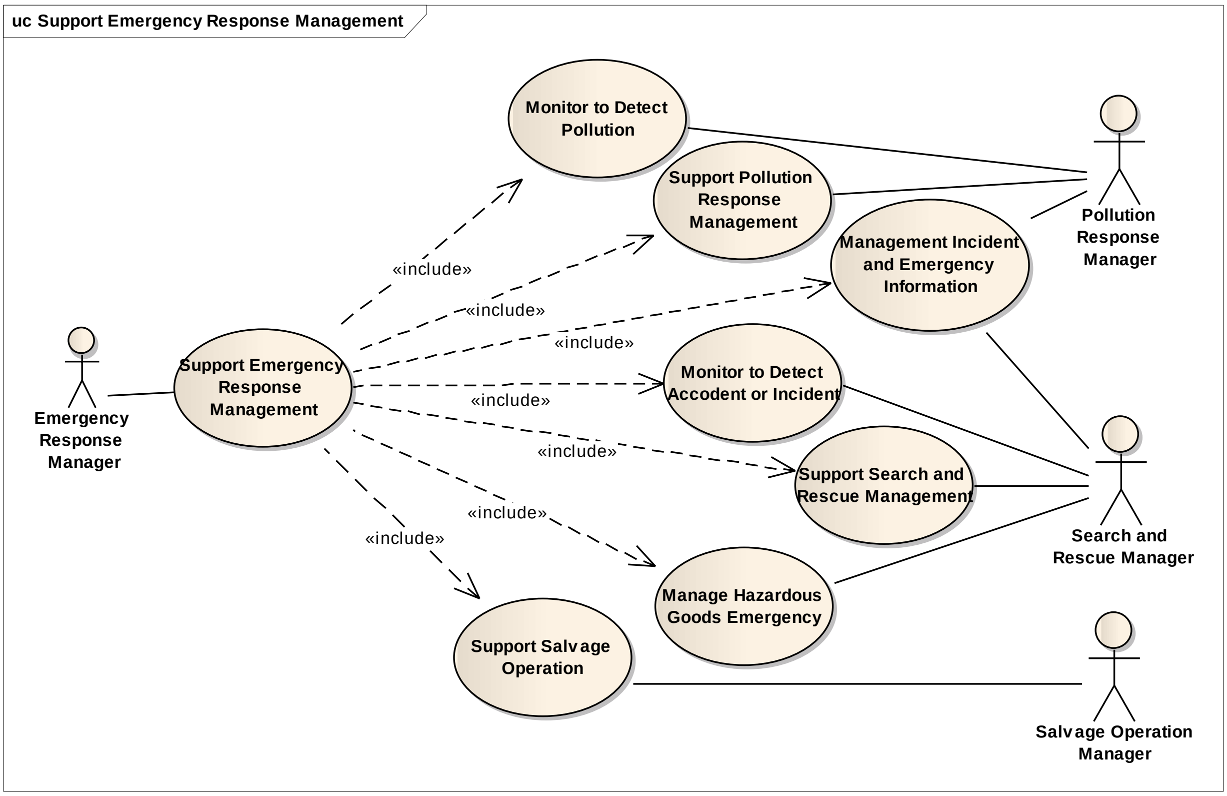


Figure 29 Use cases showing relations to roles

6.4.2.1 Monitor to Detect Pollution

The environment is monitored to detect pollution.

6.4.2.2 Monitor to Detect Accident or Incident

The traffic is monitored to detect emergencies or possible emergencies.

6.4.2.3 Management Incident and Emergency Information

Information about incidents, accidents and pollution is managed. The type of information may vary depending on the type of incident or accident.

The information may be used to support ongoing search and rescue operations and pollution prevention operations. The information may also be used during the investigation.

6.4.2.4 Support Search and Rescue Management

Relevant information such as information about people involved, the Transport Means involved, dangerous cargo involved, locations, emergency responsibilities, status, etc. is acquired. Situations in the future, e.g. drift of vessels or persons, may be simulated to support decisions concerning search and rescue.

The relevant actions are planned and instructions are provided according to continuous evaluations of the situation.

6.4.2.5 Support Pollution Response Management

Relevant information such as information about location, type of pollution, the extent of pollution, emergency responsibilities, status, etc. is acquired. Situations in the future, e.g. the propagation of an oil spill, may be simulated to support pollution response decisions.

The relevant actions are planned and instructions are provided according to continuous evaluations of the situation.

6.4.2.6 Manage Hazardous Goods Emergency

In case of emergencies involving dangerous cargo, information about the transport and the materials involved should be made available and distributed according to predefined planes.

6.4.2.7 Support Salvage Operation

The salvage of Transport Means or equipment is supported.

6.4.3 Support Emergency Operation

The emergency response operations are supported. This may include

- Support to on-site coordination
- Support to search mission
- Support to rescue mission
- Support to pollution combat

6.4.4 Support Emergency Investigation

Information about the emergency or incident is considered to

- To decide on the cause of the accident/incident
- To evaluate the cause to identify the safety problem
- To suggest actions or solutions that may prevent similar accidents or incidents.

It may not be known which Transport Means has caused the situation. The Transport Means may be identified by means of:

- Tracing back to the previous situations, e.g. the positions of a Transport Means or a Load Item (e.g. a load unit) at a given point of time, can be found. This information may for example be used to find possible sources of pollution (e.g. the source of an oil spill).

7 Functional view, Transport Demand

The Transport Demand domain harmonises travel planning (in personnel transport) and freight management. Transport preparation and planning is supported as well as the management of transport chains of variable complexity, where several transport modes may be involved.
The domain encompasses functionality needed by the Transport Users. The Transport Users may be consignors, consignees, cargo owner, travellers or Transport Organisator. The latter may be travel agencies and forwarding agents that organise the transport on behalf of a Transport User. However, then the Transport Organisator is to be considered as a Transport User, and this role will be used in the following.

The transport is booked from Transport Service Providers (the Transport Service Management domain) by means of a Transport Execution Plan (TEP). If detailed information about the transport is needed, like information about the services, routes and time schedules (always the case in person transport), an Itinerary is defined.

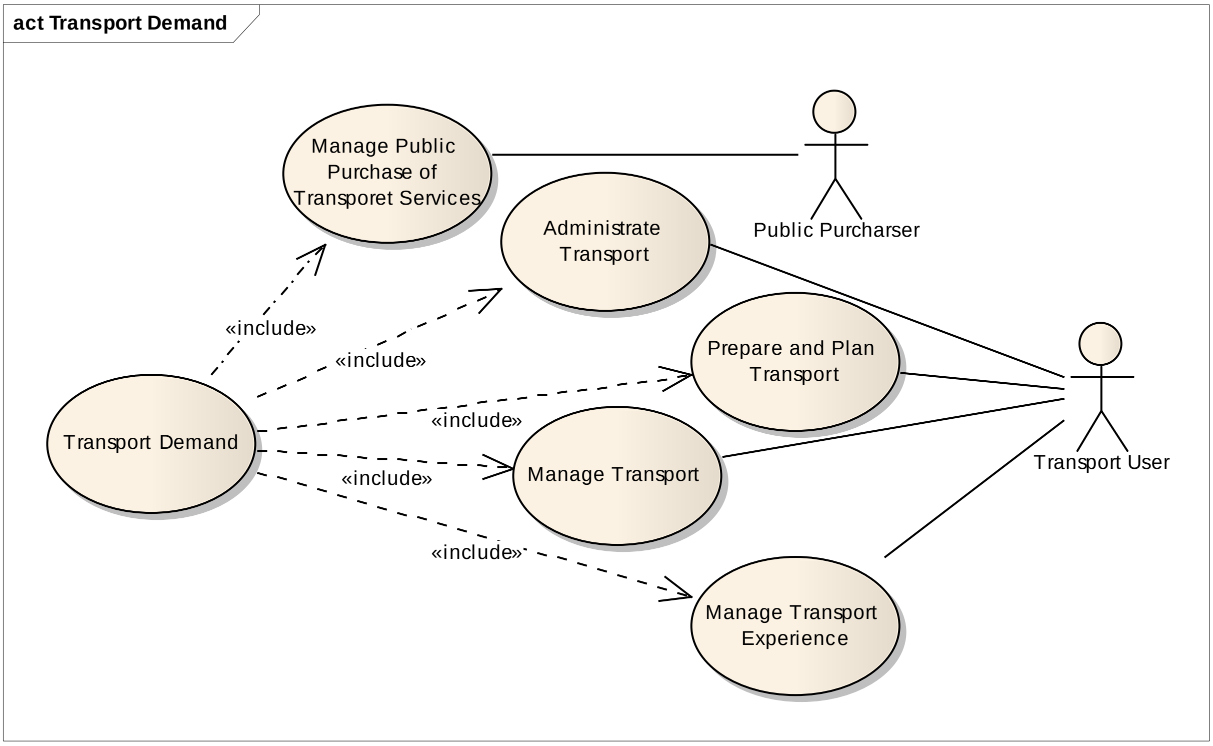


Figure 30 Use cases showing relations to Transport Demand roles

7.1 Manage Public Purchase of Transport Services

Needs for public transport are identified in the Transportation Network Utilisation domain (see 6.2.1.5). If the required transport services are not profitable from a corporate economy point of view, the state may decide to purchase the services. Call for tenders may be issued and evaluated, and contracts may be entered with the Transport Service Providers providing the best services with respect to quality and costs. The contract usually is for a specific area or between specific destinations, and there are requirements with respect to capacities and frequencies.

7.2 Administrate Transport

The transport demands of a Transport User are defined in a set of one or more TEPs. Whenever such a TEP is established, or whenever it has to be changed, formalities concerning effectuation or modification are handled.

The market is also monitored, and the long-term demand for transport related services are considered.

7.2.1 Manage Contract

A contract may be a standard contract or a special condition negotiated with a Transport Service Provider. For many TEPs the standard contract of the Transport Service Provider is adopted and standard fees and conditions are accepted.

7.2.1.1 Manage Contract Agreement

Negotiations or bids using portals are supported.

7.2.1.2 Manage Contract Information

Contract information must be established and stored in such a way that it can be processed automatically. Information about amendment conditions must for example be checked when a booking has to be changed (amendments must be made in accordance with the conditions specified in the contract).

A contract may address the transport of a number or quantum of Transport Items in a specific time span. Thus, the contract may be applicable for repeated transports operation, each described by means of a TEP. The number or quantum of Transport Items that are transported in each TEP has to be registered. The total number or quantum for all the TEPs has to be compared with the specifications in the contract.

7.2.2 Manage Transport Booking

Transport services are booked from Transport Service Providers. A transport service may for example be the movement of a Transport Item, loading, unloading, transhipment at Transfer Nodes, document handling, etc.

7.2.2.1 Manage Financial Transactions

Invoices are handled.

7.2.2.2 Manage Transport Booking Process

Transport services are booked by means of one or more TEPs. The bookings may be for a complete transport chain or for just a part of the chain. In the first case, the Transport User may not be aware of how the chain is to be decomposed into Journey Segments.

A Transport Service Provider will just get the TEP defining his part of the transport.

Joint booking (the booking of transport for more than one Transport Item in one booking) must be handled as well as joint loading (more than one piece of cargo into a load unit).

Preliminary bookings are used if several TEPs depend on each other. They may for example represent different segments of a journey. Firm bookings are usually not made until all preliminary bookings are confirmed. The follow-up of preliminary bookings must be supported. The Transport User must be notified if preliminary bookings are not confirmed, and in case of negative confirmations. In such cases alternative transport services must be selected. The Transport User must also be notified when all preliminary bookings have achieved positive confirmations. This should trigger firm bookings of the services.

In case of amendments, the old booking must be cancelled or updated (the consequences of amendments may be checked out by 7.2.2.3).

The fulfilment of the order is registered based on a final completion status report (e.g. proof of delivery) (see 7.4.1).

7.2.2.3 Consider Transport Amendment

A TEP amendment suggested by the Transport Service Provider (e.g. due to deviations), must be considered by the Transport User. The consistency of the complete Itinerary (which may include services defined in many TEPs) must be checked. A delay may for example affect the following Journey Segments. The Transport User must be allowed to accept or reject the amendments.

A TEP amendment suggested by the Transport User must be considered with respect to contractual issue. The legitimacy and consequences in case of amendments (extra costs, etc.) must be considered.

7.2.3 Manage Market Information

7.2.3.1 Manage Service Provider Information

Information about available service providers and their services must be provided in such a way that TEPs with the best-fitted services and service providers can be established. This also includes information about planned and actual deviations. This may be realised by local directories or by retrieval of information from external services.

7.2.3.2 Monitor Available Services

The spot market must be monitored and services selected.

7.2.3.3 Request Statistics

Transport Service Providers and Service Providers are asked for statistics showing services and transport operations delivered to the Transport User.

7.2.4 Manage Long Term Demand

Long-term needs are considered to support decisions about contracts and agreements towards Transport Service Providers, Service Providers, etc. This may also influence on preferences.

7.3 Prepare and Plan Transport

The Transport User has a transport need. The planning, preparation and booking of transport services are supported.

The *general transport preferences* (GTP) of the Transport User as well as the *actual transport preferences* (ATP) are used as to find relevant transport services and Transport Service Providers. The planning will result in a *transport execution plan* (TEP) defining the transport demand (see 14.68). The transport planning may be a complex process and several TEP alternatives may have to be considered. If needed by the Transport User, the Transport Service Provider may provide an *Itinerary* (see 14.25) which defines the execution of the transport.

7.3.1 Gather Information

The Transport User may gather information to be able to take better decision with respect to how and when to travel or how to send goods. The Transport User may have to use market information (see 7.2.3) and information from external sources to be able to take decisions.

Additional information about known transport alternatives can also be requested. The user should be able to expand the available information about the transport alternatives with the retrieved information.

The Transport User may also want gather additional information about the entries in an Itinerary.

7.3.1.1 Get Transport Service Information

Information about specific transport services are gathered from the Transport Service Management domain or others. This may be information such as

- Time tables (departures and arrivals)
- Trip patterns (Transfer Nodes that are visited, etc.)
- Specific trips
- Deviations and restrictions, additional services, etc.

7.3.1.2 Get Transportation Network Information

Information about Transportation Network infrastructure is gathered from the Transportation Network Infrastructure Management domain or the Transport Sector Support domain (as such information may be provided by misc. service providers). This may be several types of information, for example (see 5.2.1.1) information about:

- Transport Links and Transportation Network Sections
- Transportation Network Resources
- Transfer Nodes
- Transfer Node infrastructure, for example information about
    - Access Points
    - Stop Points.
    - Available services and facilities and accessibility.
    - Transfers

7.3.1.3 Get Traffic Information

Information about the Network and Traffic Status is gathered from the Transportation Network Utilisation domain. This may be information about

- Transportation Network Conditions
- Traffic flow, density, etc.
- Route recommendations
- Etc.

7.3.1.4 Get Generic Information

Information that may support transport preparation and planning are gathered by means of information services provided by the Transport Sector Support domain. This may for example be

- Meteorological information
- Travel plans and related travel information
- Other types of information related to traffic and transport

7.3.2 Define General Transport Preferences (GTP)

The general transport preferences (GTP) for a Transport User are defined. One Transport User may have several GTPs, each indicating preferences for different types of transport demands (e.g. business travel, pleasure travel, demands related to different types of cargo, etc.).

The GTPs are the basis for the actual transport preferences defined for each transport operation. A GTP may for example include the preferred Transport Service Providers and the associated customer numbers, preferred transport modes, criteria for selection of transport modes (e.g. costs, time schedules, environmental issues), requirements (e.g. environmental profile, restrictions with respect to additional cargo on the Transport Means, no tunnels, no smoker, seat by the aisle, vegetarian food, accessibility for disabled people, preferred payment, etc.).

7.3.3 Define Transport Demand

The requirements and relevant information related to a specific transport demand are defined. The information may be retrieved from internal data stores (e.g. in case a Transport User Agent may have received the information in an order from a Transport User) or the required information may be registered from scratch.

7.3.3.1 Define Actual Transport Preferences (ATP)

The actual transport preferences (ATP) for a specific transport operation are defined. An ATP specifies the overall transport requirements. The content may be retrieved from internal data stores (e.g. in case a Transport User Agent may have received the information in an order from a Transport User), it may be based on an old ATP, or it may be registered from scratch. Relevant information from the GTP (general transport preferences) associated with the transport is included.

The ATP may encompass requirements such as

- Departure/pick up, arrival/delivery and transit locations
- Desired departure/pick up and arrival/delivery times
- The Transport Items (Travellers or Cargo) to be transported
- Required transport services, for example
    - transport services – transport from one location to another
    - Handling services – loading and unloading
    - Document handling services
    - Agent services – preparations, etc.
    - Inspection services
    - Customs services
    - Maintenance services
- Preferred Transport Service Providers
- Criteria for optimising (costs, time, comfort, quality, contract references, environmental issues, etc.)
- Requirements concerning the ability to change the TEP (deadline for cancellation or changes, costs related to changes, etc.)
- Status report requirements

The ATP may be used in 7.2.2.2, 7.2.2.3 and 7.3.5.

7.3.3.2 Define Transport Item

Relevant information about the Transport Items to be transported (Passenger, Luggage, Load Item or Cargo) is established. The information may be retrieved from internal data stores (e.g. in case a Transport User Agent may have received the information from a Transport User), or it may be registered from scratch.

Transport Item Instructions that may contain guidelines for handling of the Transport Item (transport instructions, loading instructions, etc.) may be registered. However, the Transport Item type is in many cases sufficient information. The Transport Service Provider will know how to handle specific Transport Item types.

7.3.3.3 Define Waybill

The required Waybills are established and may cover one or more Transport Items (joint booking) that have the same destination. Joint loading (more than one piece of cargo into a load unit with one waybill) must also be handled.

A waybill contains an id, a reference to the Transport User and a specification of the Transport Items that are managed by the waybill. A waybill may also contain transport item instructions that will follow the Transport Items to ensure proper handling through the whole transport chain.

7.3.4 Find Transport Alternatives

Transport alternatives are identified:

- External services, e.g. travel planning services, may be used to find a transport service or a collection of transport services that fulfils the transport demand
- Information about transport services may be found by means of search engines
- Information about specific transport services may be gathered from the Transport Service Management domain or others. This may be information about
  - The type of service.
  - Time tables (departures and arrivals)
  - The locations at which the services are provided, e.g. trip patterns defining the Transfer Nodes that are visited.

7.3.5 Manage Transport Execution Plan

A Transport User's *Transport Execution Plan* (TEP) defines the requested transport as seen from the Transport User's point of view, and this TEP is the basis for the transport service booking (see 7.2.2.2) and follow up. The TEP definition process may be iterative:

- Alternative TEPs are identified (see 7.3.5.1)
- It may be necessary to verify the usability of existing TEPs (that are re-used) (see 7.3.5.2)
- The preferred TEP is selected (see 7.3.5.3)
- The TEP is updated and refined in an iterative process (see 7.3.6)
- Status report requirements are defined (see 7.3.5.4)

7.3.5.1 Find Transport Service Alternatives

TEP alternatives that fulfil the transport demand of the Transport User are found. Several strategies may be used:

- Search for relevant transport services. The ATP (see 7.3.3.1) and the Transport Items define the search requirements. The search may be supported by the Transport Sector Support domain.
- Re-use of known transport alternatives, e.g. TEPs used earlier or TEPs suggested by others are modified.
- Use of information from established contracts with Transport Service Providers

Each TEP alternative may refer to one or more transport services. The availability of the transport services may have to be verified (see 7.3.5.2). Additional information about the TEP alternatives may be gathered (see 7.3.1).

It may be necessary to repeat the search for relevant transport services, for example in case of deviations that affects the accomplishment of the transport operations.

7.3.5.2 Verify Transport Execution Plan Usability

The Transport User may want to verify the ability to accomplish the transport and that a TEP is according to the ATP. Disabled people may for example have to verify that existing TEPs fulfil accessibility requirements expressed in the ATP.

7.3.5.3 Define Transport Execution Plan

The TEP alternatives found in 7.3.5.1 are evaluated, and the best alternative becomes the Transport User's *Transport Execution Plan* (TEP). This TEP is the basis for the transport service booking (see 7.2.2.2) and follow up (see 7.4).

A TEP becomes operational when the Transport User is satisfied with the plan and the transport services that require booking are booked. A Transport User's TEP will define:

- The transport services to be provided and the associated Transport Service Providers. This is restricted to the services and the Transport Service Providers which the Transport User needs to know about.
- The service locations (e.g. start, end, transit location)
- Time schedules
- The Transport Items (Travellers or Cargo) addressed by the TEP (see 7.3.3.2)
- The status report requirements (see 7.3.5.4)

7.3.5.4 Define Required Status Reporting

The transport should be carried out according to the TEP. However, deviations may occur. Two types of status reporting may be required:

- The status of the transport operation. This may for example concern deviations like delays, cancellation, etc.
- For booked transport services, the Transport User should be able to request status reports concerning specific Transport Items, for example:
    - Deviation notifications about damage, loss, wrong condition (e.g. with respect to temperature)
    - Services status related to the stages that the services go through (e.g. started, ongoing or finalised); Transport Item tracking information; and service fulfilment status (e.g. proof of delivery or disrupted).

The Transport User should define the required status reports. The necessity of status reports may depend on the responsibility for the handling of deviations. A Transport Service Provider that is responsible for consecutive Journey Segments is probably also responsible for the handling of delays that may affects any of these Journey Segments. However, the Transport User may request a delay notification if the next Journey Segments is served by another Transport Service Provider.

The preferred way to receive the exception notifications should also be defined (automatic response to information system, SMS to mobile phone, etc.).

7.3.6 Manage Itinerary

An Itinerary defines the Journey Segments to be carried out. The Transport User may define a draft version of a Travel Plan and book transport services according to this plan. Each Transport Service Provider may return a detailed Itinerary containing one or more Journey Segments. (This will always be done in passenger transport. In freight transport however, the actual Itinerary for the goods may be of no relevance to the Transport User, but even in freight transport the Transport User may request an Itinerary).

An Itinerary is established during the booking process, but it may be updated during the whole transport process for several reasons:

- A TEP (covering one or more Journey Segments of the Itinerary) is changed due to a new agreement between the Transport User and the Transport Service Provider. Contractual issues must be checked (see 7.2.2.3) as there may be conditions related to such changes.
- One or more Journey Segments is changed (e.g. due to deviations) and the Transport Service Provider initiates an Itinerary update for the affected Journey Segments. The Transport User must verify whether the changes affect the consistency of the whole

Itinerary (the following Journey Segments – which may be delivered by another Transport Service Provider, etc.).

- The Itinerary is refined
  - Transport service details may be received from the Transport Service Provider (e.g. information about seats, meals on-board, etc). The required level of details depends on the needs of the Transport User. In personnel transport, the TEP is the itinerary, and route details must be included. The Itinerary for freight transport may however be absent or quite superficial with respect to the route (e.g. transit locations). In freight transport it is usually irrelevant to the Transport User how the actual transport is carried out (this is up to the provider of the transport service – e.g. the forwarder).
  - Additional information may be collected by the Transport User and entered into the Itinerary (see 7.3.1)

7.3.7 Manage Tender Request

A tender request can be issued based on transport preferences defined in the ATP (Actual Transport Preferences). The responses should be specified as TEP alternatives that can be compared with respect to costs, time schedules, etc.

Traditional tenders may not fit the needs related to some freight transports, e.g. fish transport. The whole value chain involving seller, buyer and Transport Service Providers may be so intertwined that you cannot have separate tenders for separate types of actors.

7.3.8 Request Transport Means Sharing

Travellers may share a Transport Means on a trip or on parts of a trip. Services that support the combining of such people shall help the travellers to find relevant people and Transport Means.

7.4 Manage Transport

The transport is accomplished according to the TEP and the Itinerary (if specified), and the progress is followed up by means of status information received from the Transport Service Providers.

7.4.1 Activate Transport Product

The transport product to be used (documented by means of a paper ticket or an eTicket or a waybill) has to be validated by the Transport Service Provider. After the validation the Transport User is entitled to use the transport service.

7.4.2 Receive Context Related Information

During the transport, the Transport User may get information that depends on the context, e.g. the current location, the status of the transport operation (e.g. delayed), etc.

7.4.3 Manage Transport Status

Status reports may be received for booked services. Depending on the request from the Transport User (see 7.3.5.4), as defined in the TEP, two types of status reporting may be received from the Transport Service Provider:

- The Transport Execution Status (TES) is the status of the transport service to be provided. The status may be one of two
  - Confirmation of “according to plan”.
  - Notification about deviations like delays, cancellations or change of delivery location. If changes in delivery time, an estimated time of delivery is provided.

- In case the TES reports about a deviation, Transport Item Statuses (TIS) for the affected Transport Items are provided to the Monitor Transport Items function in 7.4.4. The status report will inform about the Transport Item condition (e.g. damage, lost, values representing temperature, etc.); deviation description and status location.

If the transport service is not booked or exception notifications are not requested, the Transport User may also request status information on demand.

A TES that reports about deviations (e.g. delays) may be followed by an adjusted TEP (received in 7.3.6 and considered by the Transport User in 7.2.2.3). The Transport Service Provider may for example have booked the Transport User on the next plane due to a late arrival.

Deviations may be followed by claims. The submission of such claims is not supported by functionality specified in ARKTRANS. However, the status report may provide information that can document the reason for claims.

7.4.4 Monitor Transport Items

The Transport Item Status may be monitored in two ways:

- The Transport User may have monitoring equipment (On-Transport Item Equipment) attached to the Transport Items, and status information may be received directly from this equipment.
- Status information is received from the Transport Service Management domain.

In the latter case the Transport Service Provider will report depending on the instructions from the Transport User. This may be information about:

- The condition of the Transport Item (e.g. temperature, humidity, shock, etc.); in most cases the Transport User is just notified in case of deviations, e.g. exceeding threshold values.
- Possible security violations.
- The state (e.g. loaded, unloaded, delivered, etc.).

7.4.5 Track and Trace Transport

The Transport User may want to track the Transport Items. Tracking information can be obtained in different ways:

- Tracking information can be derived from the status information received from the Transport Service Providers (see 7.4.2).
- The Transport Service Providers may provide Transport Item tracking information on regular terms. This may be information about the current location of the Transport Item and status information with respect to the operations that are carried out (e.g. loaded, unloaded, in warehouse, etc.).
- The Transport Service Providers may provide tracking information for the Transport Means.
- The Transport Item may provide tracking information to the Transport User by means of attached tracking equipment. The information may flow via a provider of tracking services.

If relevant, the tracking history can be traced.

Different tracking and tracing technologies may be used. Some Transport Service Providers may be able to provide continuous tracking of Transport Items, while others may just be able to provide information about departures from or arrivals to checkpoints (e.g. Transfer Nodes).

7.4.6 Manage Transport Information Exchange

Required Transport Item reporting and information exchange related to transport are handled by the Transport User himself or booked as a transport service from a Transport Service Provider. In the latter case, the tasks must be defined as a transport service in the TEP and booked. The Transport Item reporting may for example be customs declaration.

7.5 Manage Transport Experience

On termination of a transport, experiences should be stored. This may be

- TEPs
- Data that can be used in statistics (deviations, etc.)
- Comments (typed in by the Transport User).

When required the Transport User may re-use TEPs, look at the experience information, generate statistics, etc.

8 Functional view, Transport Service Management

The Transport Service Management domain provides transport services to the Transport User in the Transport Demand domain. A Transport User may for example request a service like transport from A to B and related sub-services, e.g. loading, unloading and customs declaration. The Transport Execution Plan (TEP), which is negotiated with the Transport User during the booking process, defines the requested transport services and the contractual conditions (see description of the TEP in 14.68). The transport operations required for the provision of these services are planned and followed up. If required, an Itinerary, which specifies the detailed route of the Transport Items, is returned to the Transport User.

The Transport Service Provider may, depending on the TEP, be responsible for a total transport from A to B; just simple operations like unloading or loading; or the transport for a part of the distance (other Service Provider will be responsible for the other parts). The Transport Service Provider will however, in any case, just be aware of his part of the transport chain. The management of the total transport, including the coordination of the services delivered by different Service Providers, is the responsibility of the Transport Demand domain.

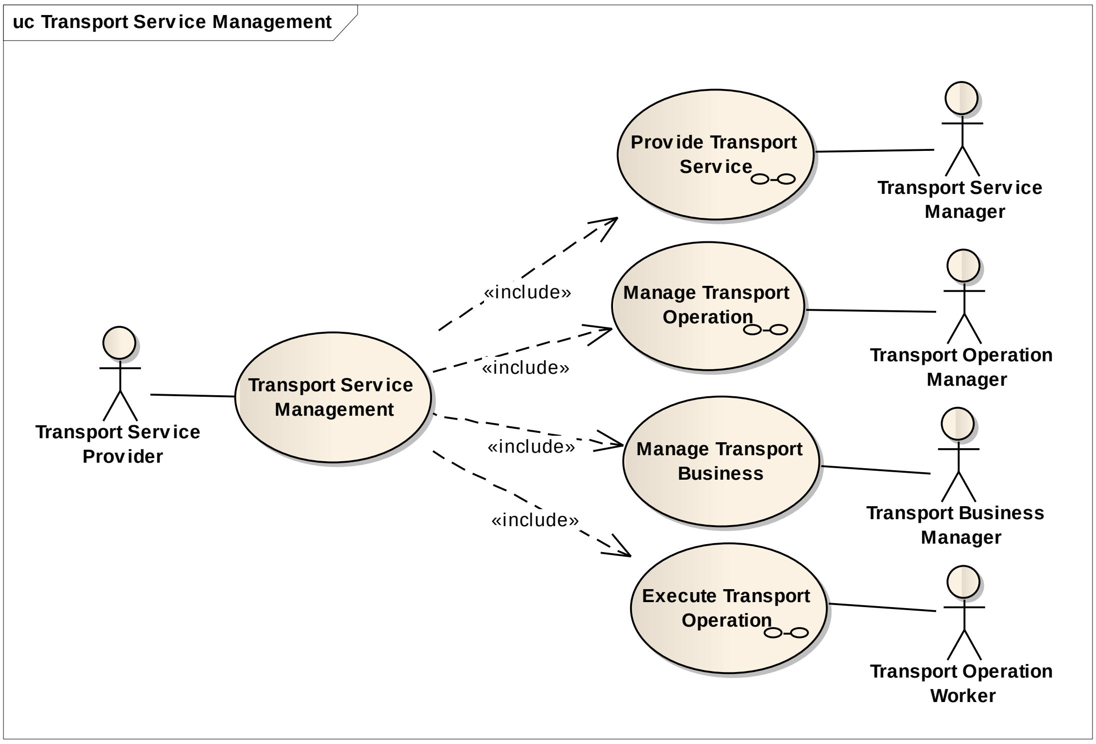


Figure 31 Use cases showing relations to Transport Service Management roles

To facilitate a structured specification, the Transport Service Management domain is decomposed into sub-domains. Thus, the Transport Service Provider role is divided into sub-roles with responsibilities as described in 5.1.3 and illustrated in Figure 31.

Figure 32 illustrates their main focuses. The Transport Service Manager receives the Transport Execution Plan (TEP) that defines the Transport Items and the transport service needs from the Transport User. The Transport Operation Manager will, based on the information in the TEP, establish Transport Operation Plans (TOPs) that define how the transport operations are to be carried out. The Transport Operation Worker will execute the tasks that fulfil the TOPs.

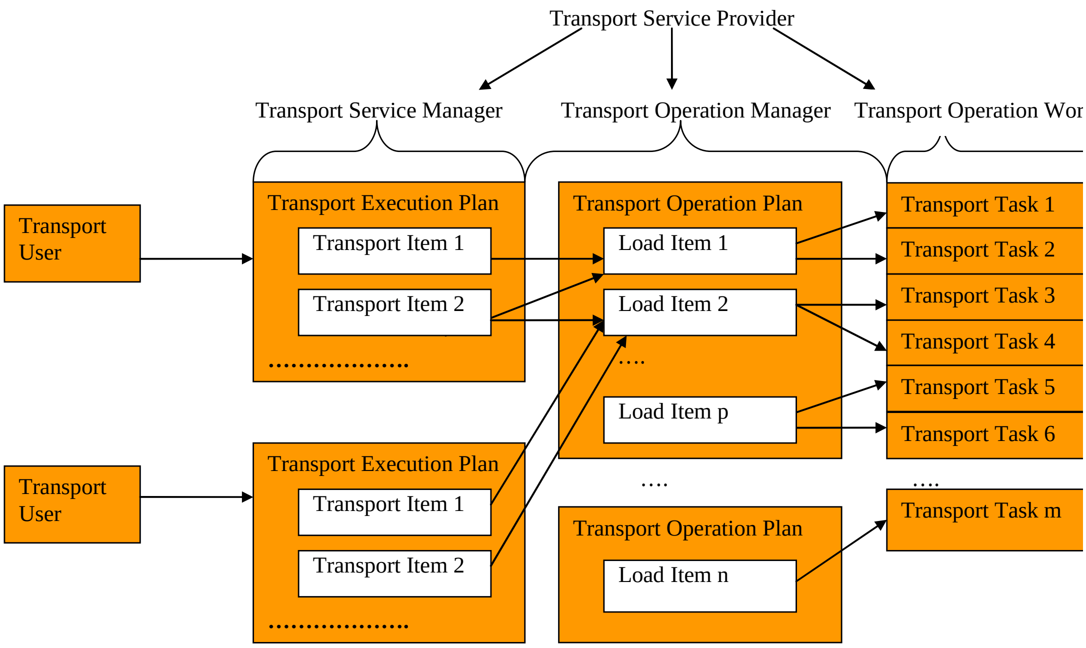


Figure 32 The TEP is the basis for the Transport Operation planning and execution

8.1 Provide Transport Service

Strategic and tactical plans for the service provision are made, information about the services is published to potential customers, and the contact with the customers is handled (contracts, bookings, provision of Itineraries, status reporting, etc.). The actual management of the required transport operation is however handed over to the Transport Operation Managers.

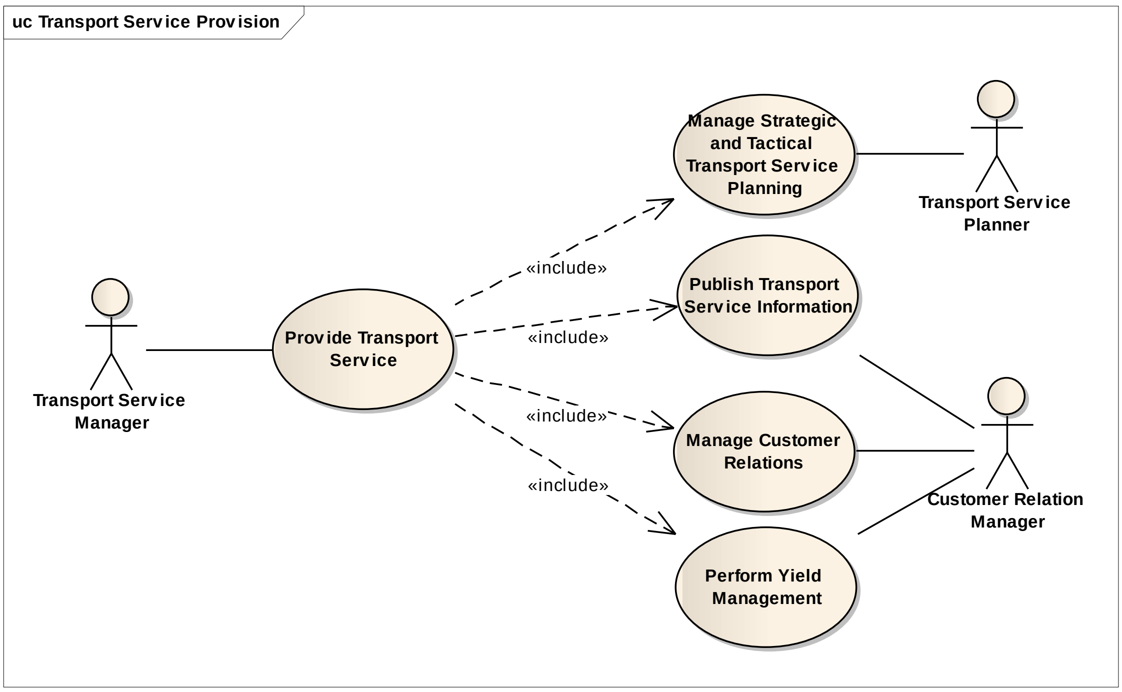


Figure 33 The Provide Transport Service use cases

8.1.1 Publish Transport Service Information

Information about the transport service is published through several market channels to relevant stakeholders and applications. The following information is relevant:

- Service type offered

- Time schedule
- Location information, e.g. route, Transfer Node, etc.
- Cost
- Capacity
- Deviation information (statistics, expected delays, etc.)
- Comments

8.1.2 Manage Customer Relations

The relation towards the individual Transport Users is managed. This includes:

- The contract and booking conditions are negotiated with the Transport User, and a TEP is established (see 14.68 for description of the TEP). The TEP defines the transport services that are to be provided.
- The actual Itinerary, which specifies details about how the transport is executed, may (if needed by the Transport User) be provided to Transport User
- Status information for the transport execution is provided to the Transport User

8.1.2.1 Manage Contract

Negotiations, establishment and maintenance of a contract between the Transport Service Manager and a customer (Transport User) that is requesting transport services are supported.

Different types of contracts may be used depending on the services that are to be offered and the type of customers that are served (freight/passengers transport, special transport, food transport, etc.).

- Standard contracts related to well defined services (e.g. the transport products in public transport)
- Specific contracts with specific customers concerning transport services and use of resources. In case of long-term contracts, information about orders and the execution of orders that are according to contracts must be registered.
- Contracts negotiated and established as framework agreements with authorities concerning transport services that benefit the society.
- Tenders

Information about the tenders and contracts has to be managed, e.g.:

- Customer information (in case of a special contract)
- Details about the Transport Items and/or passenger to be transported
- Locations
- The degree and status of a contract fulfilment

A contract can dependent on its content be changed, renegotiated, or cancelled, and these processes have to be supported by means of for example functionality that requests the required information (information required by the Transport Service Provider as well as information that is to be acquired due to regulations) in combination with functionality that supports the work flow.

8.1.2.2 Manage Transport Service Request

Transport service requests (e.g. quotations or more informal requests) are received from the Transport Demand domain. They may refer to existing contracts, or they may not refer to any contract at all. In the latter case a contract must be established, or a standard contract can be used.

Some requests may be handled automatically. Others may require manual handling. The fulfilment ability has to be considered depending on the certificates and licences of the Transport Service Provider and the traffic and network conditions. Requests that have to be rejected and the reason for the rejections should be logged. In that way knowledge about market demands can be used in strategic and tactical planning (see 8.1.4.1).

8.1.2.3 Manage Bookings

A booking is initiated by a Transport Execution Plan (TEP) from a Transport User – see 14.68. The contractual agreements are included in the TEP, or there may be a reference to an existing contract.

The content of the TEP may vary depending on the state of the contract negotiation and booking process. The Transport User may send preliminary or firm bookings to the Transport Service Manager. A preliminary booking will expire if it is not followed by a firm booking before the expiration date.

A booking (TEP) is sent to the Transport Operation Manager (see 8.2.1.4) who will respond by means of a confirmation (positive or negative).

The booking information (in the TEP) must be managed. In case of bookings related to a long-term contract, the extent of the booking must be registered in the contract information (see 8.1.2.1).

Depending on the contractual agreements, a Transport User may cancel or amend bookings, or amendments may be initiated by the Transport Service Provider (e.g. due to unforeseen problems such as cancellations, lack of capacity, etc.). In case of amendments, an updated TEP has to be provided to the Transport User.

Financial transactions related to bookings and contracts are not a part of ARKTRANS. However, such transactions are likely to be initiated, and there must be access to support for financial transactions.

8.1.2.4 Manage Itinerary Information

Some Transport Users may want a detailed specification of how the transport is to be executed and updates of this specification in case of changes. This is for example the case in person transport (where the Transport User needs an Itinerary), but also in freight transport some Transport Users will like to have information about how the transport is executed.

In addition to a positive confirmation on the TEP, the Transport Operation Manager may also provide an Itinerary (see 14.25 and 8.2.1.12) describing the transport services that fulfil the TEPs. This Itinerary can, if required, be provided to the Transport User.

The Itinerary may contain information about seat allocations, the detailed route, etc. In case of amendments, an updated Itinerary will also be provided by the Transport Operation Manager, and it may be forwarded to the Transport User.

8.1.2.5 Manage Status Information

Status information related to the transport service and the Transport Items is provided to the Transport User (see 7.4.2) on request or automatically according to requirements defined in the TEP. Two types of status reporting may be provided to the Transport User:

- The Transport Execution Status (TES) is the status of the transport service to be provided. The status may be one of two
  - Confirmation of “according to plan”.
  - Notification about deviations like delays, cancellations or change of delivery location. If changes in delivery time, an estimated time of delivery is provided.
- In case the TES reports about a deviation, Transport Item Statuses (TIS) for the affected Transport Items are provided. The status report will inform about the Transport Item condition (e.g. damage, lost, values representing temperature, etc.); describe deviations; and identify the status location.

8.1.2.6 Manage Claims

In case of damage, relevant information about the transport operation and the affected transport items is made available to support the decisions taken by those in charge.

8.1.2.7 Handle Ad Hoc Demand

Even for scheduled transport services that do not require booking (e.g. bus lines) there may be transport demands from individual Transport Users. A Transport Users may for example request a stop at a bus stop, either from on-board the Transport Means or waiting at a Transfer Node. The request has to be transmitted to the Transport Operation Manager (who will transmit it to the Transport Operation Worker, who may be the driver on-board the Transport Means).

8.1.3 Perform Yield Management

The prices and services that are to be offered, and the market channels that are to be used are decided upon. Transport services are offered through different market channels by means of the marketing function (see 8.1.1). Prices and capacities are set according to the yield management strategy (see 8.1.4.4).

8.1.4 Manage Strategic and Tactically Transport Service Planning

Transport Service Manager must make strategic plans for their position in the market and the services they are to offer. Tactical management plans for the operations must also be established. The following elements must be supported:

- Identification of customer's needs
- Planning of regular services as well as on-demand services (adjustments to the market, etc.)
- Yield management planning (to decide about price strategies, service packaging, sales strategies, etc.)
- Resource scheduling and backup planning
- Planning the use of third party service providers
- Optimising of services with respect to economy
- Configuration for deviation, incident and priority condition settings

8.1.4.1 Identify Transport Service Needs

Long-term contracts and information about Transport User's long-term transport service needs are considered.

Transport service requests that have not been fulfilled may be logged (see 8.1.2.1), and the information can be used to identify Transport User demands.

For long time planning, information about the market, statistics, political guidelines, new trends, and new regulations as well as changes in the competition and Transportation Network infrastructure are considered.

8.1.4.2 Decide Operation Strategies

Strategic decisions on how to provide transport services and how to handle special conditions are made. This may for example be related to

- Priorities of service requests
- The responsibility for the route planning on ad hoc transport operations
- How to handle deviations
- How to handle incidents

The consequences of the different strategies with respect to the efficiency of the transport services must also be considered. It may for example be relevant to adapt to the local traffic management policy (decided by the Transportation Network Management). Priority and access policies in cities may for example regulate the access to areas of cities dependent on type of engine (e.g. environmental friendly), type of cargo (e.g. dangerous cargo), type of transport operation (e.g. public transport), the load factor, planned destination, etc. The conditions for assignment of priorities and access, and the consequences with respect to the efficiency must be considered when strategies are decided upon. It may for example be advantageous to use environmental friendly transport means.

8.1.4.3 Plan Transport Service

The Transport Services to be provided are planned and defined. The operation strategies must be considered (see 8.1.4.2), and the capacity must be adjusted to the market. The foreseen needs for transport services as well as the planned services are used when the performance is planned. This includes planning of capacity, frequencies, schedules, use of resources, coordination with other services, etc.

Strategies with respect to over-booking and fulfilment of timetables are decided upon.

Several types of information are used as the basis for the planning, e.g. foreseen needs for transport services, empirical as well as static and dynamic information about the Network and Traffic Status.

8.1.4.3.1 Plan Scheduled Transport Service

Transport services with fixed schedules, routes and resource usage are planned, ensuring that the Transport Service Provider can provide the required services and qualities. The individual services as well as their synchronising with other services are planned.

Several types of information are used as the basis for the planning, e.g. foreseen needs for transport, and empirical, static and dynamic information about the Network and Traffic Status.

The planning may also be influenced by contracts that provide information about long-term needs for transport services. The Transport Service Provider may for example have entered contracts with Authorities concerning specific routes. Conditions with respect to route frequency, capacity, quality of service, etc. may be stated in the contracts.

8.1.4.3.2 Plan On-demand Transport Service

Transport services with no fixed schedules and routes are to be planned. This includes identification of service types and qualities.

Several types of information are used as the basis for the planning, e.g. foreseen needs for transport services, and empirical as well as static and dynamic information about the Network and Traffic Status.

8.1.4.4 Plan Yield Management

The strategies that enable the Transport Service Provider to realise optimum revenue from operation are established. The aim is to provide the right services to the right customer, in the right way, at the right time, for the right price.

The structure of the fares and prices, and parameters determining this structure, are decided on. The pre-defined fares and prices are to be determined and administrated.

The marketing and sales of the transport services are also planned and shaped. Integration with other transport services is to be included in the structures of the fares.

8.1.4.5 Schedule Resources

Long term schedules for resources (Transport Means, personnel, terminal areas, equipment, etc.) are made for foreseen transport operations. Most of the plans are made with respect to safety and economy. Allocation of resources has to be planned and optimised with respect to skills, licences and certificates, etc.

The long term plans will be used as a starting point for further planning by the Transport Operation Manager (see 8.2.1.5).

The actual management of the resources (condition, maintenance, training and education, etc.) is however the responsibility of the Transport Business Manager (see 8.3.1).

8.1.4.6 Plan Use of External Services

The Transport Service Provider may need services from third party service providers. The services may be requested on demand basis, or they may be controlled by long term contracts with Service Providers.

8.1.4.7 Plan Resource Backup

Backup resources (e.g. Transport Means, equipment and personnel) must be identified, and plans for replacement of personnel, Transport Means and other resources that may have to be withdrawn from operation are prepared. Plans for preparedness and use of assistant transport resources (in case of lack of capacity) are also handled by this function.

8.1.4.8 Optimise Plan

The transport services must be evaluated along several dimensions, such as costs, the price of services, and the utilization of resources such as Transport Means, infrastructure, equipment, areas, and manpower. It must be possible to check the power of plans, and decisions that may optimize the cost-benefit of the transport services should be supported.

8.2 Manage Transport Operation

The Transport Operation Manager receives information about transport service demands from the Transport Service Manager and will decide how to fulfil the demands, either by means of own resources, or by purchase of services from external Transport Service Providers. In the latter case, the Transport Operation Manager becomes a Transport User (see Transport Demand domain).

If the operation can be handled by means of own resources, the Transport Operation Manager will:

- Plan and prepare the transport operations that fulfil the transport needs defined in the TEPs. One TEP may request both a service and sub-services, e.g. transport and related sub-services such as loading, unloading and customs declaration, or one specific service may also indirectly imply this. The most optimal Transport Operation Plans (TOPs) are established.
- Manage the transport operations execution (carried out by the Transport Operation Worker).

It is important to notice that the Transport Items addressed by several TEPs may be handled by one Transport Operation. The Transport Items become Load Items (see 14.30) that may be included into other Load Items (e.g. containers).

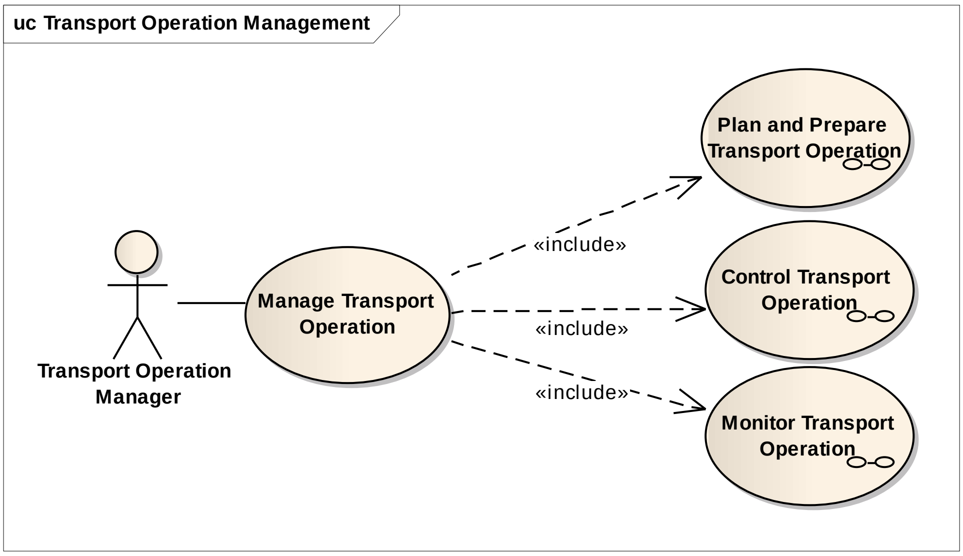


Figure 34 The Manage Transport Operation use cases

8.2.1 Plan and Prepare Transport Operation

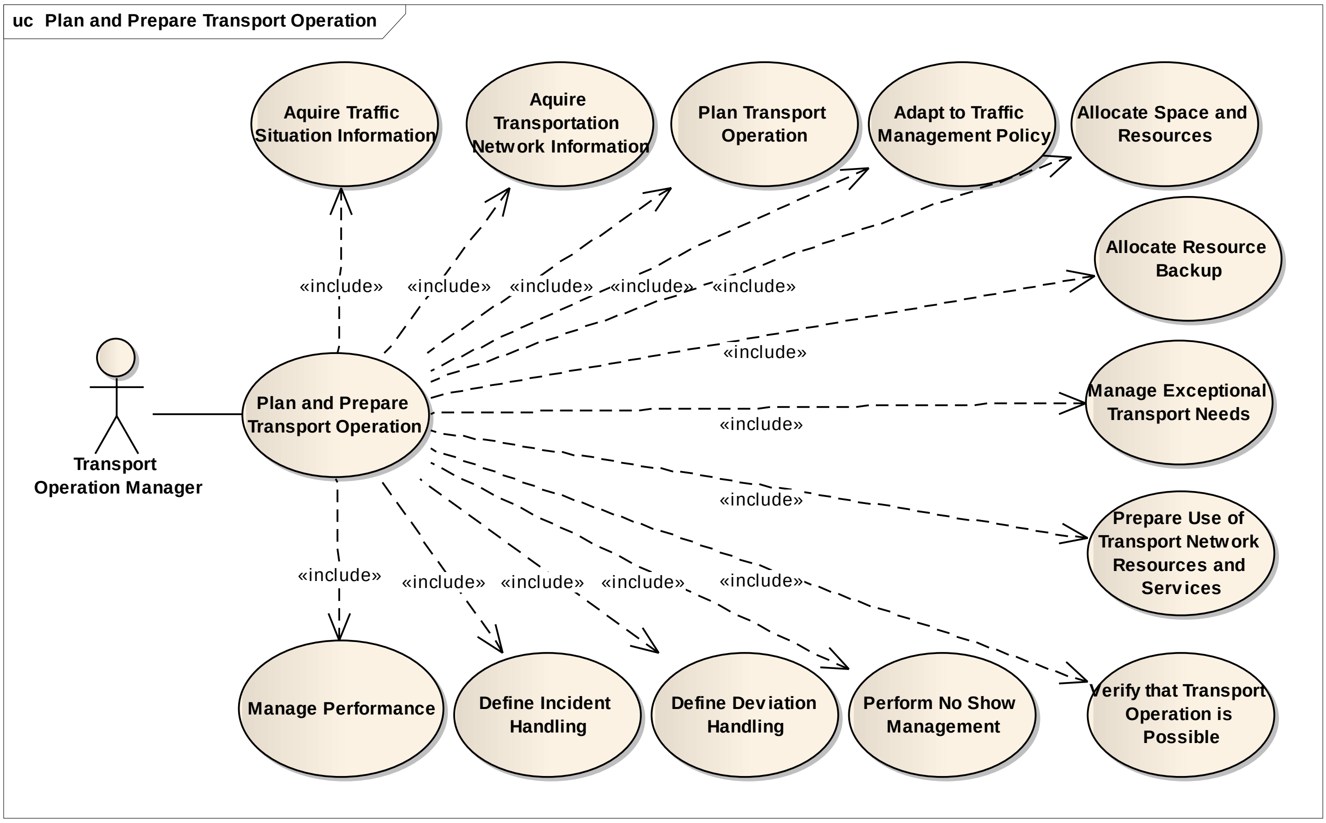


Figure 35 The Plan and Prepare Transport Operation use cases

Different types of transport operations are planned:

- Schedule services (for instance a bus in regular service)
- Ad hoc services (e.g. taxies, transport of freight from one location directly to another).
- Transport without a fixed schedule where the Transport Means is shared (for instance freight pooling, airport taxies)
- Operations related to scheduled services (e.g. stop on demand)

The planning also includes re-planning in case of deviations or amendments.

If the transport services requested by a Transport User cannot be fulfilled (neither by means of own resources or by booking of external resources or services), the Transport Service Manager is notified so that the Transport User can get a negative confirmation on the transport request.

If the transport services requested by a Transport User can be delivered, the transport operation planning will result in a Transport Operation Plan (TOP) (see 14.72) including an Operational Route Plan (see 14.35) and Safety and Security Instructions (see 14.43). The related Resource Plans (see 14.35) are updated.

8.2.1.1 Adapt to Traffic Management Policy

The Transportation Network Utilisation domain will manage the use of the Transportation Network according to a policy. The Transport Operation Manager must be aware of these policies (the access and priority conditions, etc.) and the consequences of the different decisions (e.g. type of Transport Means to be used, routes to be followed, etc.) with respect to the execution and the efficiency of the transport operations.

8.2.1.2 Acquire Traffic Situation Information

Information about historical, current and foreseen Network and Traffic Status are acquired from the Transportation Network Management domain. The information will be used both for planning and for operational purposes.

Traffic control information about traffic management measures (e.g. the planned slot time for specific Transport Means) is also acquired.

8.2.1.3 Acquire Transportation Network Information

Static as well as dynamic information about the Transportation Network is acquired from the Transportation Network Management domain and from empirical data about previous transport operations may also be used. The information will be used both for planning and for operational purposes.

8.2.1.4 Plan Transport Operation

In the planning process the Transport Operation Manager must consider:

1. Can the requested transport services be delivered? If the required transport cannot be delivered, a negative confirmation must be sent to the Transport Service Manager (who will inform the Transport User).
2. If yes: Can the required transport operations be carried out by means of own resources or should transport services be booked from external Transport Service Providers?
    - If the transport services have to be provided by external Transport Service Providers, the Transport Operation Manager becomes a Transport User that books these services (see the Transport Demand domain)
    - If the transport operations can to be carried out by means of own resources, the optimal organisation and execution have to be decided upon (see below).
    - If a combination of the two above is found to be useful, the transport request is partly fulfilled by means of operations managed by this Transport Operation Manager and partly by external service providers.

Those operations that are to be managed by the Transport Operation Manager have to be planned. The planning process must be based upon the strategic and tactically planning (see 8.1.4). The time scheduled and the resources to be used to carry out scheduled services (Transport Means, personnel, etc.) may for example be defined in advance. In other cases everything will have to be planned more or less from scratch.

The Transport Operation Plans (TOPs) are optimised and established based on information about:

- The transport service needs. The needs may be
  - Expressed in the TEPs (Transport Items and the required services) representing firm or preliminary bookings of immediate as well as foreseen transport demands. Preliminary bookings must be removed from the TOPs if they expire without a firm booking.
  - Internal transport needs (e.g. transport of empty load units or other resources - see Load Item p in Figure 32).
- Pick-up/departure and delivery/arrival locations and times schedules as well as existing plans for service provision (e.g. planned scheduled routes)
- Time limits for the transport and waiting time
- Special conditions
- The optimal organisation of Load Items (see 14.30). This may lead to TOPs specifying consolidation operations (loading Load Items into another Load Item, e.g. into a load unit or a loading area in a Transport Means) and splitting operations.
- Available resources (e.g. Transport Means, terminal equipment, personnel, load units, etc.), available space in resources (e.g. Transport Means and load units) and the capabilities (certificates, etc.) of these resources. The current location of the resources may also have to be considered (if non-scheduled).
- Issues that may affect the execution of the transport operations, such as
  - The current or expected Network and Traffic Status (see 8.2.1.2)
  - The Transportation Network information (see 8.2.1.3)
  - The traffic management policy in the relevant area (see 8.2.1.1)

Laws and regulations have to be considered. The total weight of the Transport Means, including Load Items must for example not exceed the limits for the Transport Means. If relevant, the distribution of the weight on-board the Transport Means must also be addressed. The weight and balance information is communicated to the On-board Support and Control domain.

The transport operation planning will result in a Transport Operation Plan (TOP) (see 14.72) which will include an Operational Route Plan (see 14.35) (if detailed route is to be provided) and Safety and Security Instructions (see 14.43).

8.2.1.5 Allocate Space and Resource

If all conditions can be satisfied (e.g. the fulfilment of requirements with respect to Handling Instructions, regulations, etc.), the use of resources is planned.

Individual Resource Plans (see 14.39) are established/updated accordingly (i.e. the working plans for the resources involved in the transport operation). The plans from the long term planning (see 8.1.4.5) can be used as a starting point. The workload for the personnel has to be considered. Resources that may be allocated are:

- Personnel (Transport Operation Workers)
- Terminal Equipment
- Transport Means

Space (or seats) is allocated to the Load Item - for example on a scheduled Transport Means, in a warehouse or in a Terminal Area. The allocations are entered into the Storage Plan (which is a part of the TOP).

Overbooking may be a strategy. Load Items that cannot be handled due to capacity problems may be put on waiting lists, and priorities may be assigned to them. Just before departure, available resources (due to “no show” or overcapacity) may be allocated to Load Items on waiting lists, and overbooking must be handled.

Space and resource allocations may be preliminary or firm, depending on the type of booking (see 8.1.2.1). When a preliminary booking expires, the resources allocated must be freed. Otherwise, the resource allocations must be made firm on reception of a related firm booking.

8.2.1.6 Allocate Resource Backup

Backup resources are allocated either as a stand in for resources that have to be withdrawn from operation or as a complement to account for missing capacity. After the booking, the resources will be a part of the resource pool managed by the Transport Operation Manager.

8.2.1.7 Manage Exceptional Transport Needs

Exceptional transport demands due to external activities (e.g. football games with many spectators) must be identified, and internal problems like lack of capacity, lack of resources or cancellations must also be accounted for. The coverage and capacity must be considered and adjusted, e.g. by allocation of backup resources (see 8.2.1.6). In such cases these resources will become a part of the resource pool managed by the Transport Operation Manager.

8.2.1.8 Prepare Use of Transportation Network Resources and Services

The Transport Operation Manager may have to use Transportation Network Resources and services that support the Transport Means. This may for example be

- Transportation Network Resources (provided by the Transportation Network Utilisation domain) such as Stop Points (e.g. gate, track, and quay) and Terminal Areas (see 6.2.3).
- Transport Means Support Services (provided by the Transportation Network Utilisation domain) such as tug boats (see 6.2.4)
- Misc. services (from the Transport Sector Support domain) such as water supply, fuelling services, etc.

The use of Transportation Network Resources, Transport Means Support Services and other generic services may have to be booked to ensure:

- Optimisation of area usage with respect to space allocation and throughput.
- Segregation control. Load Items must be managed according to regulations, e.g. food cannot be stored together with chemicals.

8.2.1.9 Verify that Transport Operation is Possible

If a transport operation puts special requirements to the Transportation Network infrastructure or Network and Traffic Status (e.g. due to broad or long cargo), it must be verified that the transport operation can be carried out. Exception requests may have to be sent to Transportation Network Utilisation domain (see 6.2.2.1.1). Route assignments, clearances, etc. are received to indicate feasibility as well as requirements with respect to the accomplishment of the transport.

8.2.1.10 Define Incident Handling

Situations that shall be considered as incidents and the actions that shall be taken in case of each type of incident are defined. This must be situations that can be detected by means of results from the transport operation monitoring (see 8.2.3).

8.2.1.11 Define Deviation Handling

Situations that shall be considered as deviations and the actions that shall be taken in case of each deviation are defined. This must be situations that can be detected by means of results from the transport operation monitoring (see 8.2.3).

8.2.1.12 Define Itinerary

The Itinerary for a Transport Item is established. The Itinerary will consist of one or more Journey Segments. Each segment will define how transport is to be carried out. The Journey Segments may be established in several ways depending on how the transport is carried out:

- The Transport Operation Manager will define the segments that cover the parts of the transport that are managed by him.
- Journey Segments provided by external Transport Service Providers are provided by these Transport Service Providers as an Itinerary for this part of the transport. In such cases the Transport Operation Manager is a Transport User that has booked the transport services. The Itineraries are provided to this Transport User (which is the Transport Operation Manager).

The final Itinerary for a Transport Item may be composed of Journey Segments defining own transport operations as well as Journey Segments from Travel Plans returned by external Transport Service Providers. The final itinerary is provided to the Transport User via the Transport Service Manager (see 8.1.2.4)

8.2.1.13 Manage Performance

The available capacity and the achievable performance have to be evaluated. The foreseen Network and Traffic Status has to be considered based on information received from the Transportation Network Management domain. Changes in the Network and Traffic Status and situations like overbooking, overcapacity, possible deviations from the schedule, etc. must also have to be evaluated. The necessity of re-planning is considered.

8.2.2 Control Transport Operation

The execution of the transport operations are managed in such a way that time schedules as well as quality and safety requirements are met. This counts for both scheduled and on-demand operations.

Information about the current situation with respect to resources used, the status of the transport operations, the Transportation Network and Network and Traffic Status, empirical data and schedules are used. Input from the Transport Operation Worker (see 8.4) and the On-board Support and Control domain, incidents and deviations uncovered by the Transport Operation Monitoring (see 8.2.3) are responded upon. Information exchange is supported.

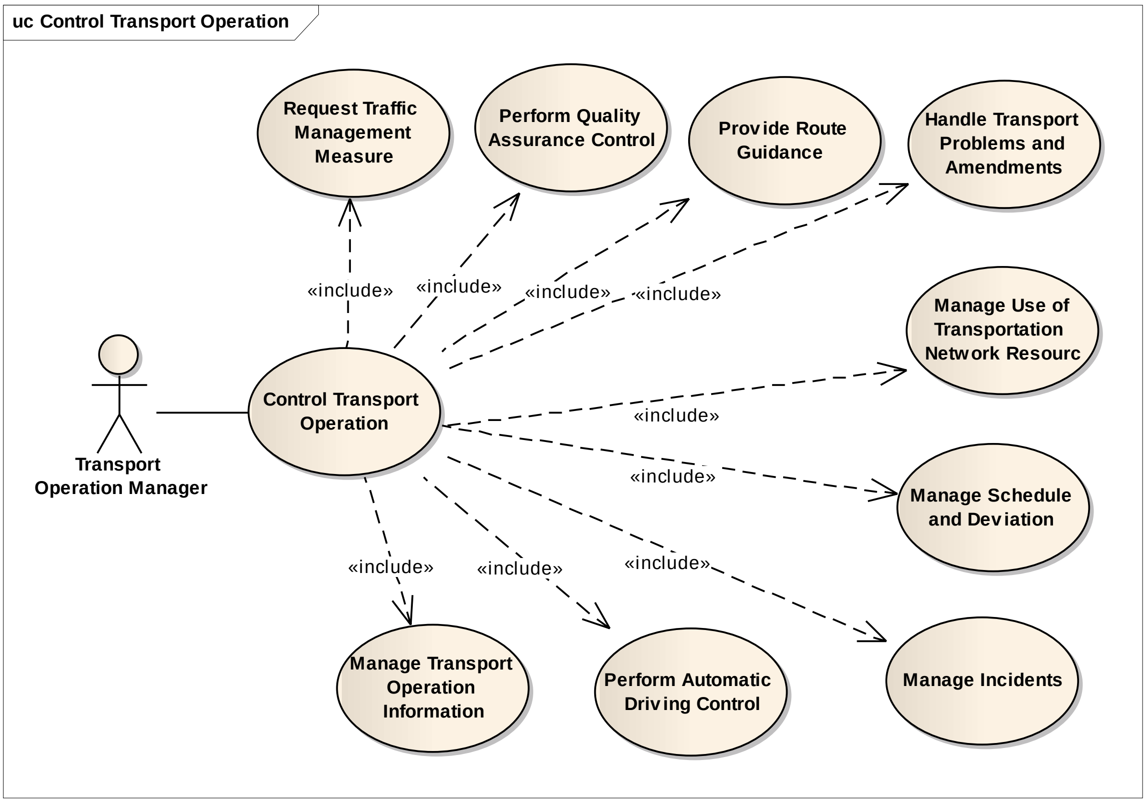


Figure 36 The Control Transport Operation use cases

8.2.2.1 Request Traffic Management Measures

The Transport Operation Manager may, on behalf of the Transport Means request individual traffic management measures, e.g. access to Transportation Network Sections, priorities, etc.

The Transportation Network Utilisation area will respond to the requests. Consents may be given unconditionally or in return for example extra fees.

8.2.2.2 Perform Quality Assurance Control

It has to be verified that all required routines are followed and that all required checks are carried out prior to the start of the transport operation. Such verification may be received from the Transport Operation Worker (see 8.4.1) and from the On-board Support and Control domain (see 9.1.3.1). If the required conditions are not satisfied, the start-up of the transport operation may be prohibited.

8.2.2.3 Provide Route Guidance

The navigation done in the On-board Support and Control domain is supported. The Operational Route Plan is provided. Information covering Network and Traffic Status and other relevant conditions may also be communicated to the Transport Means.

8.2.2.4 Manage Use of Transportation Network Resource

Transportation Network Resources like Terminal Areas may be used according to the Storage Plan part of the TOP (where optimal use of the area and segregation are considered). Based on information received from the Transportation Network Utilisation domain (see 6.2.3.2), the Transport Operation Manager may track the use of these areas:

- Entry control detection for Transport Means and Load Items.
- Information about the content of or activities in the Terminal Areas like overview of all Load Items in the area, e.g. their entrance/exit (unloading/loading); their location; the

duration of their stay in this area; etc. Such information can be used in the management of the transport operations.

8.2.2.5 Handle Transport Problems and Amendments

The Transport Operation Manager may receive reports about problems related to the transport operation. The problems must be handled. Some examples:

- Accidents, vehicle problems or need for assistance. May require re-planning (see 8.4.1) and other measures.
- Difficulties in finding locations along the route, or uncertain of which route to take. May require route guidance (see 8.2.2.3)
- Heavy route congestion or other abnormal network conditions. May require re-planning (see 8.2.1.2).
- Security concerns.

8.2.2.6 Manage Schedule and Deviation

The plan for the execution of the transport operation (i.e. the TOP with Operational Route Plan and the Safety and Security Instructions) is followed up. Input from the transport operation monitoring (see 8.2.3) enables both detection of current deviations and prediction of upcoming deviations. The input may concern deviations with respect to

- Compliance to regulations, e.g. resting hours. Such deviations are not directly about the Load Items and the transport operation, but they may for example affect the time schedule.
- Safety issues. Such deviations may not be directly related to the Load Items, but they may for example affect the ability to carry out the transport operation or the time schedule.
- The TOP (schedule, Load Item instructions, etc.)

Traffic issues and problems with Transport Means or Terminal Equipment may also cause deviations, for example delays. Corrective actions are considered. The Transport Operation Manager may for example respond by means of:

- Request for individual traffic management measures (see 8.2.2.1)
- Route guidance (see 8.2.2.3) or adjusted speed
- Allocation of backup resource (8.2.1.6)

If a deviation cannot be corrected, new transport operation planning may be required (see 8.2.1.4). It must be considered whether the TEPs are affected and whether the Transport Users has to be notified. If required, TEP updates are done by of the booking management functionality (see 8.1.2.3).

Status information related to the transport operations and the Load Items is managed and handed over to the information management function (see 8.2.4).

Depending on the incident settings (see 8.2.1.10), incidents may be detected. They are further processed in the incident management function (see 8.2.2.7).

8.2.2.7 Manage Incidents

Some incidents may require special actions not dealt with in ARKTRANS. However, the incident setting (see 8.2.1.10) indicates how specific incidents should be handled.

Incidents are also logged so that empirical information can be used for further planning.

8.2.2.8 Perform No Show Management

Information about Load Items that are boarded or loaded on the Transport Means is checked towards the TOPs. The no show of Load Items has to be managed (for example passengers that do not show up when luggage is loaded into the Transport Means in. air transport), e.g. by acceptance of other Load Items, by means of the Yield Management function or by correcting actions.

No shows may result in new plan and prepare operations.

8.2.3 Monitor Transport Operation

The transport operations are monitored. This may include:

- Tracking of Transport Means and, if relevant, Load Items. Several issues may be tracked
  - The geographic location
  - The tasks that are executed (e.g. loading, unloading, storage).
- The condition of equipment (e.g. the engine of Transport Means)
- The condition of Load Items (e.g. temperature).

Based on the tracking and condition information the status of the transport operation is evaluated with respect to:

- Compliance to regulations
- Safety
- The plans for the transport operation execution (schedule, Load Item instructions, etc.)

Depending on the incident condition settings (see 8.2.1.10) and the deviation conditions settings (see 8.2.1.11), these evaluations may trigger the Incident Management function (see 8.2.2.7) and/or the Schedule and Deviation Management function (see 8.2.2.6).

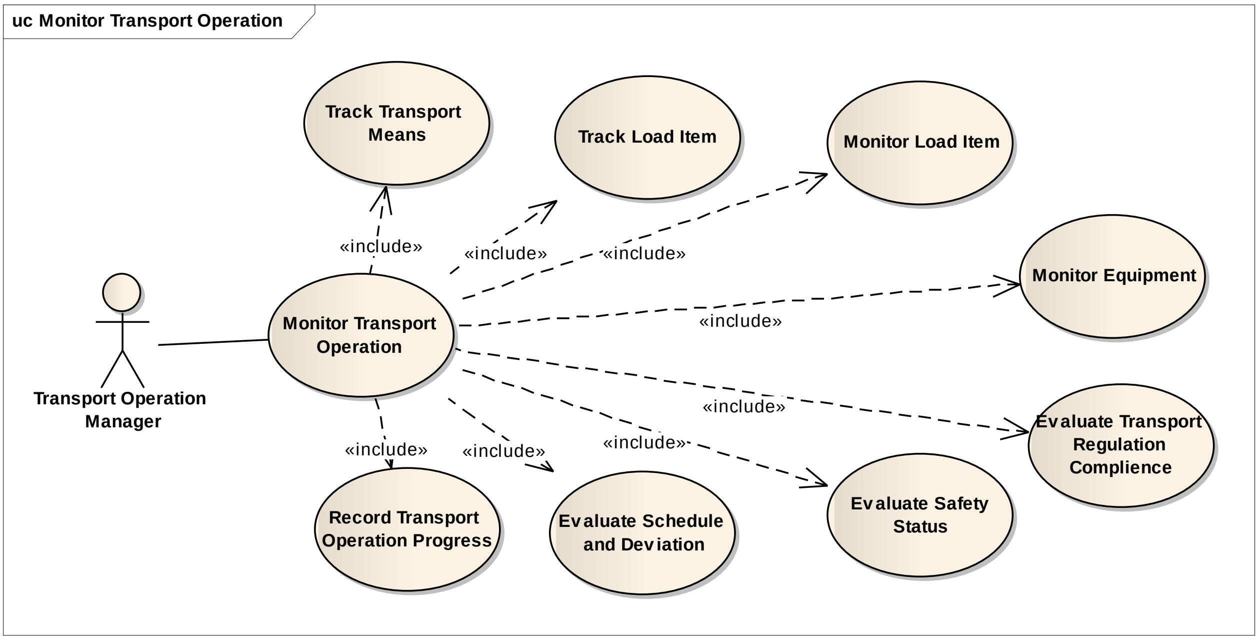


Figure 37 The Monitor Transport Operation use cases

8.2.3.1 Track Transport Means

The movement of the Transport Means may be tracked based on

- Information received from the generic tracking service (see 10.6.2).
- Entry/exit information for the Transportation Network Resources like Terminal Areas received from the Transportation Network Utilisation domain (see 6.2.3.2).

The information received may be

- Position of the vehicle
- Speed
- Direction
- Time stamp (for comparison with the schedule)

8.2.3.2 Track Load Item

Load Items (cargo or passengers) may be tracked based on
- Information received from the generic tracking service (see 10.6.2).
- Information from the Transport Means tracking (see 8.2.3.1)
- Information received from the Transportation Network Resource monitoring in the Transportation Network Utilisation domain (see 6.2.3.2)

8.2.3.3 Monitor Load Item

The Load Item is monitored with respect to:
- The status of the Load Item (cargo or passenger). Such information may be received from
  - The Transportation Network Resource monitoring in the Transportation Network Utilisation domain (see 6.2.3.2). For freight transport this includes information about whether it is loaded or unloaded. For passenger transport this includes information about whether they have entered or left the Transport Means and general conditions on-board the Transport Means (e.g. OK).
  - The Transport Operation Worker (see 8.4.3)
- The condition of the Load Item (e.g. temperature, humidity, pressure, etc.). Such information is received from the generic monitoring service in 10.6.

8.2.3.4 Monitor Equipment

The communication and the equipment on-board the Transport Means are monitored, and dysfunctions and errors may be detected.

8.2.3.5 Evaluate Transport Regulation Compliance

The transport operation is evaluates with respect to the compliance with the present regulations for transport and Transport Means behaviour. This may be done based on input from:
- The Transport Means tracking (see 8.2.3.1 and 8.2.3.2) may reveal illegal locations (e.g. illegal use of Transportation Network Segments)
- The schedule and deviation evaluation (see 8.2.3.7) may detect illegal behaviour (e.g. speed regulation violation or violation of resting hours).
- The monitoring of the Driver's behaviour (see 9.1.1)
- The Load Item monitoring function (see 8.2.3.3) may provide condition information that reveals an illegal situation (e.g. pollution emission).
- The equipment monitoring functions (see 8.2.3.4) may provide condition information that reveals an illegal situation (e.g. pollution emission).

Detected non-compliance with regulations is managed by the schedule and deviation management function (see 8.2.2.6).

8.2.3.6 Evaluate Safety Status

Potentially dangerous conditions are defined by the incident condition settings (see 8.2.1.10) and safety considerations in general. The safety status is evaluated based on input from:
- The monitoring of the Driver's behaviour (see 9.1.1)
- The safety status of the Transport Means (see 9.3.5)
- The Load Item monitoring function (see 8.2.3.3) may provide condition information that reveals a dangerous situation (e.g. gas leakage).
- The equipment monitoring functions (see 8.2.3.4) may provide condition information that reveals a dangerous situation (e.g. brake problem).
- The transport compliance evaluation (see 8.2.3.5) may reveal a dangerous situation (e.g. violation of resting hours)

Incidents that are detected are handled by the incident management function (see 8.2.2.7).

8.2.3.7 Evaluate Schedule and Deviation

Deviations are defined by the deviation conditions settings (see 8.2.1.11). The plans for the transport operation execution (see 8.2.1.4) are used as a reference. The deviations can be detected in a number of ways:

- The Transport Means and Load Item tracking (see 8.2.3.1 and 8.2.3.2) may provide information that reveals delays or other deviations (e.g. delay or wrong placing of Load Item).
- The Load Item monitoring (see 8.2.3.3) may provide information that reveals deviations (e.g. too high Load Item temperature).
- The equipment monitoring (see 8.2.3.4) may provide information that reveals deviations with respect to the operation of equipment on-board the Transport Means (e.g. engine problems).

8.2.3.8 Record Transport Operation Progress

The status of transport operation tasks are received and recorded. This includes tasks like Load Item loading, unloading, proof of delivery, invoicing, payment, and associated administrative functions. Electronic signatures can be used to verify the information.

8.2.4 Manage Transport Operation Information

Information about the Transport Operations is managed ahead of the transport operation, during the transport operation planning, during the transport operation execution, and when the transport is terminated. This includes the mapping between Transport Items, Load Items and Transport Operations (see Figure 32), and the management of status information (received from 8.2.2.6).

Based on the information about the Transport Items, relevant information can be retrieved, for example:

- The Load Item in which a Transport Item is included
- The transport operations that handle specific Load Items or Transport Items
- The Transport Items in a specific Load Item
- The Load Items and/or Transport Items addressed by a specific transport operation (e.g. load lists or passenger lists)
- The deviation settings for each Transport Item or Load Item
- The status related to Transport Items, Load Items or transport operations

Depending on the deviation settings (see 8.2.1.11), deviations are reported (to 8.1.2.5 – which may notify the Transport User).

The required information is provided to the Transport Operation Worker and to the On-board Support and Control domain.

Transport information may have to be reported to authorities or others (according to agreements and regulations), however, the On-board Support and Control domain may also do the actual reporting. Information that may have to be reported may be:

- Hazardous goods information on-board Transport Means
- Customs declarations for Transport Means
- Arrival and departure notification for Transport Means
- Loading list or passenger list
- Crew list

8.3 Manage Transport Business

By transport business management we mean all activities that affect the daily operation of the business that comprises the following:

- Management of resources such as personnel, Terminal Equipment, Transport Means, etc.
- Management of statistics and information about the execution of the transport operations

8.3.1 Manage Transport Resources

The maintenance and utilisation of the transport resources are managed. This includes resource status, maintenance operation planning, and resource disposition planning as well as the administration of the information the resources. Information about back-up resources is also managed.

8.3.1.1 Coordinate Maintenance

Maintenance of Transport Means and equipment is managed. The maintenance has to be planned and optimised with the basis in operative states as well as planned transport operations. Experience from different sorts of maintenance, and also known defects have to be considered. If suitable, the maintenance should be coordinated with planned maintenance of the Transportation Network.

8.3.1.2 Coordinate Education and Training

The education and the training of the personnel is managed and coordinated with planned transport operations.

8.3.1.3 Manage Certificates and Licences

Information about certificates (documenting qualifications of personnel, the quality of Transport Means and other equipment, or the ability to carry out certain operations) and licences (documenting the entitlement to carry out certain transport operations, e.g. transport of dangerous cargo) are established and managed.

Conditions related to the certificate types and licence types are also managed, e.g. conditions with respect to certain types of Transport Means or specific types of transport, e.g. food transport, animal transport, etc.

8.3.1.4 Manage Personnel Information

Personnel information is established and managed, including information regarding skills, availability, certificates, etc.

8.3.1.5 Manage Transport Means Information

Information about all Transport Means in the fleet is established and managed. This includes static information describing the Transport Means as well as more dynamic information about operative state, maintenance, economic transactions connected to the Transport Means, etc. Relevant parts of the information can be made available on board the Transport Means or it can be retrieved from the Transport Means, this according to present legislation. The information may be updated based on status reports received from the Transport Means (e.g. mileage).

Information about the overall capabilities according to the routes and the schedule is also a part of this function.

8.3.1.6 Manage Equipment Information

Information about equipment is established and managed. This includes static information as well as more dynamic information about operative state, maintenance, etc. The information may be updated based on status reports received from the Transport Means.

8.3.1.7 Manage Sub-contracting Information

Information about agreements with sub-contractors and information about the degree of fulfilment of the agreements are managed. The operations and resources that are delivered by sub-contractors are managed by means of the same functionality that manages operations and resources delivered by the Transport Operation Manager.

8.3.1.8 Manage Software

Software installed on equipment and on-board units (on Transport Means) are managed. This may include installation of new software and upgrading of existing (may be done remotely).

8.3.1.9 Evaluate Performance

The performance is to be evaluated based on collected information. The available capacity and the actual utilisation of the capacity are evaluated.

8.3.2 Administrate Statistics and Management Information

Statistics and management information is managed. This is information that supports the business management, e.g. strategic and tactic decisions. Some types of businesses also have to report statistics to authorities.

8.3.2.1 Record Payment

Information about payments related to bookings and transport operations is recorded.

8.3.2.2 Administrate Transport Statistics

Statistics about the transport tasks are established.

8.3.2.3 Administrate Customer Statistics

Statistics about the customers are established.

8.3.2.4 Report Statistics

Statistics are generated and reported according to present legislations.

8.4 Execute Transport Operation

The execution of transport operations concerning freight or passenger transport is supported. Information about the transport operation is established and made available to the Transport Operation Worker, and the execution of required activities is registered.

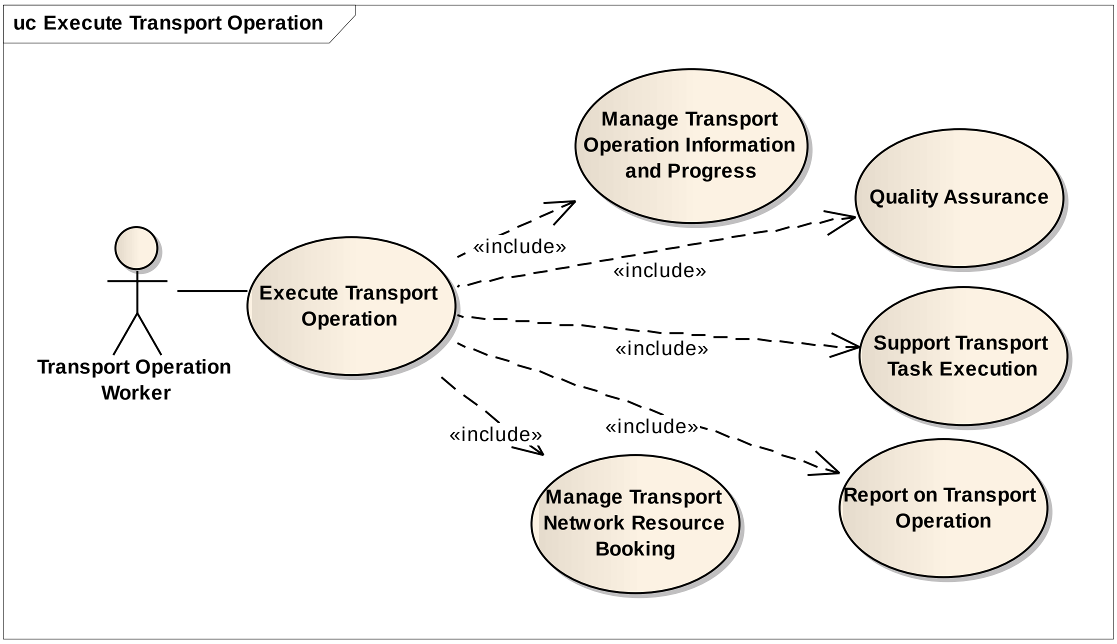


Figure 38 The Execute Transport Operation use cases

8.4.1 Manage Transport Operation Information and Progress

Transport operation information is received from the Transport Operation Manager, and the Transport Operation Worker may respond by issuing a positive or negative confirmation. A negative confirmation may for example be issued if information is missing or if any regulations are violated.

The transport operation information is established. This includes:

- Operational Route Plan – specifying the route for the specific transport operation (departure and arrival locations, time schedules, how to get between the locations, etc.).
- Transport Operation Plan – specifying the
  - Transport operation
  - The resources to be used
  - The Load Items that are to be handled and their handling instructions
  - Locations (departure/destination locations - coordinated with Operational Route Plan)
  - Operation guidelines for the operation (Storage Plan, etc.).
- Transport Documents

The status information is maintained according to input from the monitoring functions (see 10.6):

- Position of Transport Means
- Position of Load Item
- Handling activities (loading, unloading, delivery, etc.)
- Load Item or Load Item environment condition and deviations with respect to condition
- Security issues

8.4.2 Support Transport Task Execution

The transport operation is executed according to Transport Operation Plan, the Operational Route Plan and the Resource Plans). The transport operation is executed according to the TOP.

8.4.3 Report on Transport Operation

Relevant information is reported to the Transport Operation Manager, e.g.:

- Information about specific Load Items:

- Load Items position. (based on vehicle tracking or Load Item tracking)
- Load Item condition, deviations included (temperature, humidity, security, etc.)
- Information about incidents (e.g. damage reports)
- Proof of delivery. Electronic signatures can be used to verify for example the delivery.
- Information about the tasks that are executed (loaded, unloaded, delivery problems, etc.)

- Transport operation progress status:
  - Actual and expected times of arrival (ATA and ETA)
  - Actual and expected timed of departure (ATD and ETD)
  - Progress deviations (e.g. delays)
- Misc. requests
  - Need for assistance
  - Need for exception (e.g. with respect to guidelines or routines).

8.4.4 Manage Transportation Network Resource Bookings

The access to Transportation Network Resources (e.g. timeslots for access to loading and unloading areas) are managed through an interaction with the Transport Operation Manager (who may have pre-booked time slots) and/or the Transportation Network Resource Manager in the Transportation Network Utilisation domain (in case of new bookings and/or updates are required).

Timeslots for access are exchanged with the Transportation Network Resource Manager whenever there are deviations from original timeslots and when new timeslots have to be booked:

- In case of changes: Reference to old booking
- ETA (expected time of arrival)
- ETD (expected time of departure)
- Information about time slots will be received from the Transport Operation Manager and/or the Transportation Network Resource Manager.

9 Functional view, On-board Support and Control

The On-board Support and Control domain provides functionality that supports the actual mobility in the Transportation Network, including the operation of the Transport Means, the integration in the traffic and the conveying according to the planned transport operation.

Irregularities are handled in different ways depending on the situation and on the transport mode. The Transportation Network Management domain provides traffic management measures or takes other actions that may support or influence on the Transportation Network User.

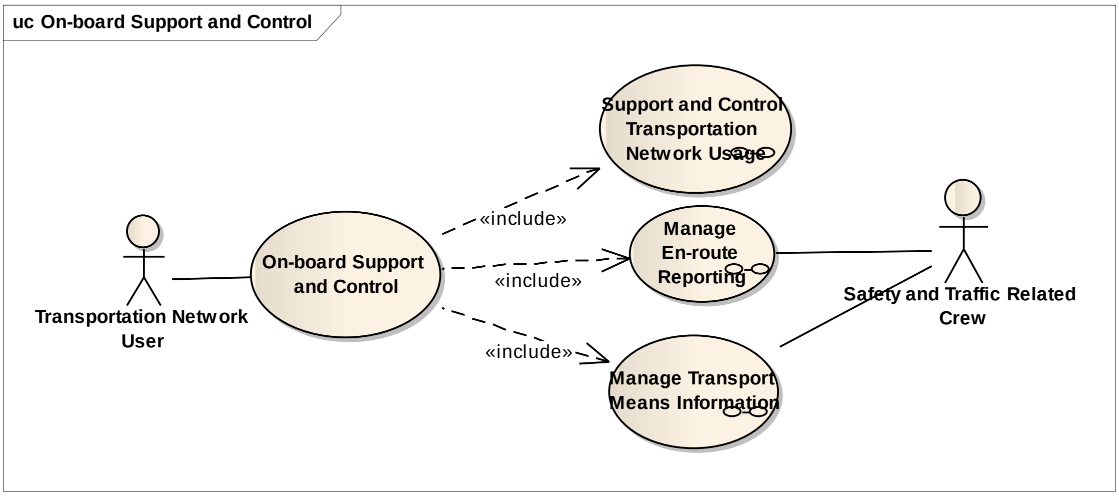


Figure 39 Use cases showing relations to On-board Support and Control roles

Despite of the on-board term, the Transport Network User role may in this context be a road user like a pedestrian or a cyclist. The role may of course also be played by the Safety and Traffic Related Crew on-board a Transport Means, Masters and Drivers included.

9.1 Support and Control Transportation Network Usage

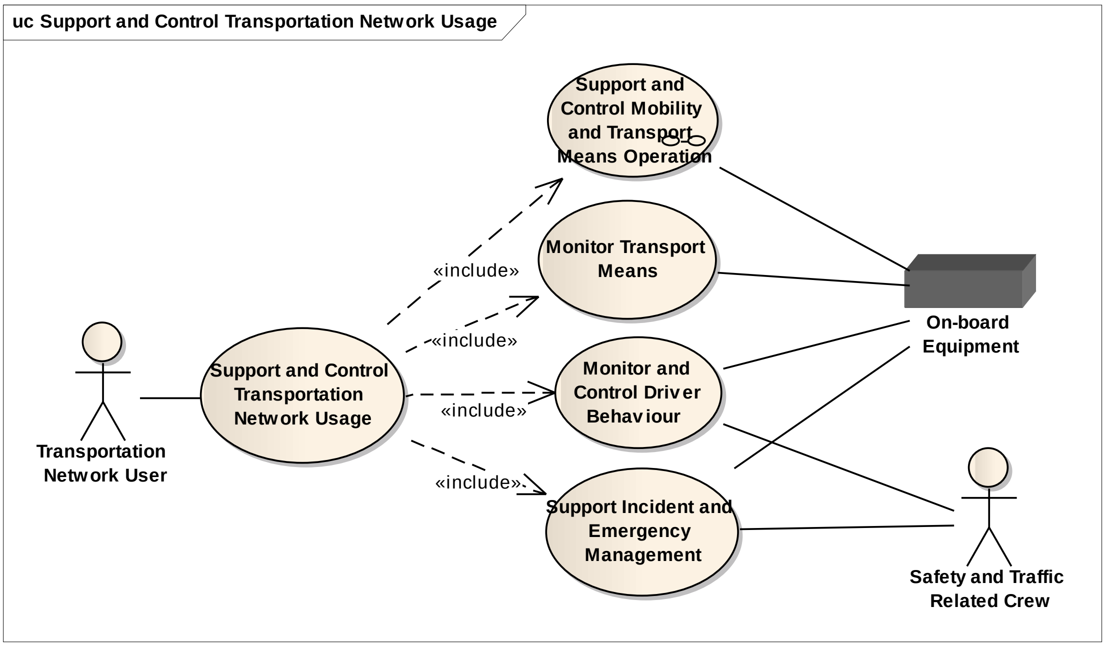


Figure 40 Operate Transport Means use cases showing relations to roles

The Transport Network User's mobility and integration in traffic is monitored and supported to achieve safe and efficient transport. This includes issues related to the operation of the Transport

Means as well as support to pedestrians and cyclists. On-Board Equipment may support the Transportation Network User.

9.1.1 Monitor and Control Driver Behaviour

The Transport Means' Driver and the Driver's actions are monitored and compared with a desired behaviour pattern. The Driver and/or the Transport Service Management domain will be notified in case of irregularities.

9.1.1.1 Monitor and Control Resting Hours

The resting hours are monitored and controlled for both for the Transport Means and the Transport Means' Driver. The monitoring ensures that all driving and all stops are logged. This information is compared with the regulations in force. When the Transport Means or the Driver is approaching the driving-hours limits, the Driver will be notified.

If a conflict with regulations is close or detected, the Transport Service Management domain (thus, the Fleet manager) may be notified by the Incident and Emergency Management function. Automatic stop of Transport Means may for example become operative (e.g. for rail transport) by means of the Automated Adaptation to Traffic Control (see 9.1.3.8.1).

9.1.1.2 Monitor and Control Watchfulness

The Driver's watchfulness is monitored. A dead man's control or monitoring of eye movements may be used for this purpose. The Transportation Network may also have built-in checkpoints to assist the monitoring. The Driver is given signals and has to respond to them. These signals are given at both fixed and random moments in time.

If the Driver does not respond, an alert will be given. In certain situations the Incident and Emergency Management function may also pass Driver state information to the Transport Service Management and the Transportation Network Management domains. If the Driver does not respond to the alert, automatic operations may become operative by means of the Automated Adaptation to Traffic Control (see 9.1.3.8.1).

9.1.1.3 Monitor and Control Regulation Violation

When a transport is carried out, appliance to regulations regarding the transport, the load, the Transport Means, the use of the Transportation Network are checked.

If rules or regulations are violated, the Transportation Network User is alerted, and the Transport Service Management domain may also be informed by the Incident and Emergency Management function (see 9.1.4) may also be invoked. Automated operation may be initiated by means of the Automated Adaptation to Traffic Control (see 9.1.3.8.1).

9.1.2 Monitor Transport Means

The operation of the Transport Means is monitored. Information about different aspects of the operation (speed, engine parameters, etc.) is collected as well as information about the movement of the Transport Means (tracking). Actions are taken in case of irregularities.

9.1.2.1 Monitor Transport Means Status

The status of the Transport Means, including speed, temperature and different control systems, engine parameters, emissions, etc. is monitored. Irregularities are communicated to the Support Incident and Emergency Management function (see 9.1.4). Status may also be reported to the Transport Service Management and Transportation Network Management domains according pre-defined policies.

9.1.2.2 Register Transport Means Tracking Information

The movement of the Transport Means are monitored and tracked. The tracking can be accomplished in several ways. The Transport Means may for example be equipped with "black boxes" which continuously logs the execution of the transport task, e.g. a speed recorder. The position of the Transport Means (and also other parameters such as speed) may also be communicated to specific recipients (e.g. the Transport Service Management domain) or broadcasted to its surroundings by the Manage En-Route Reporting function.

9.1.2.3 Monitor and Control Gas Leakage

The amount of gas in the Cargo compartment is monitored. If the amount exceeds the risk limit, the irregularities are communicated to the Emergency Management domain (see 9.1.4).

9.1.2.4 Monitor and Control Fire

The Transport Means is to have fire-monitoring equipment.

In case of fire detection, the Support Incident and Emergency Management function (see 9.1.4) is invoked.

9.1.2.5 Monitor and Control Noise

The noise within the Transport Means is monitored. In case of irregularities, this is communicated to the Support Incident and Emergency Management function (see 9.1.4).

9.1.2.6 Prevent Transport Means Theft

To be added.

9.1.3 Support and Control Mobility and Transport Means Operation

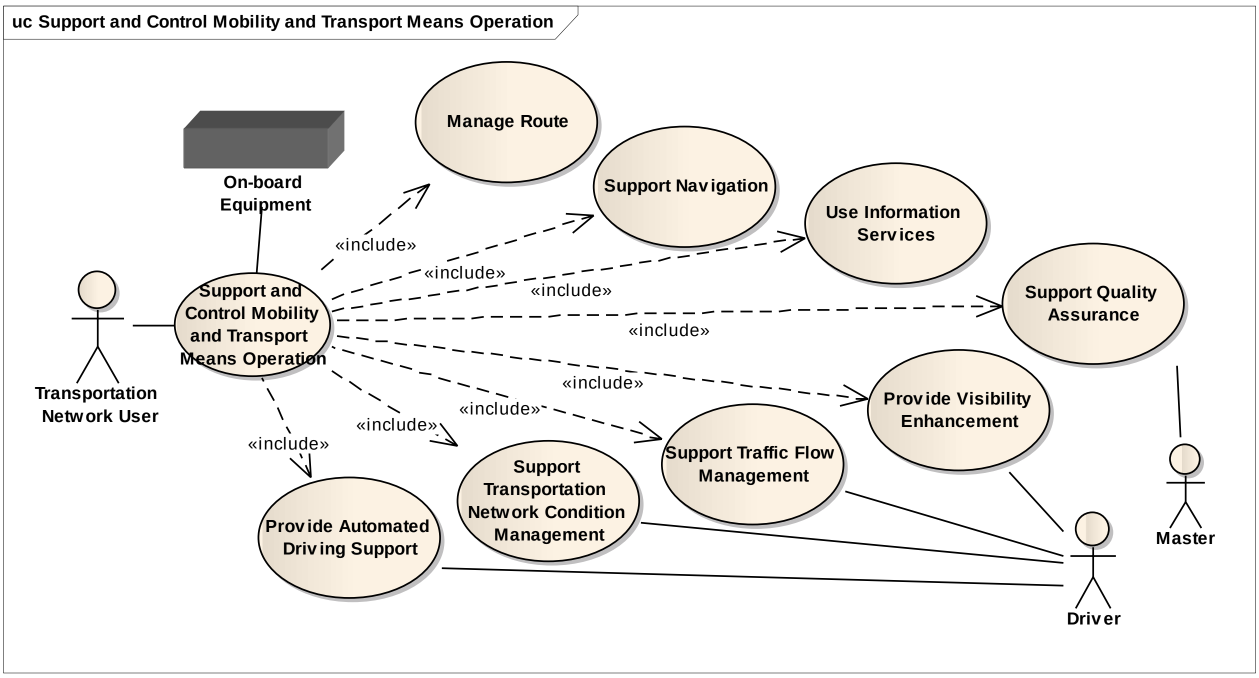


Figure 41 Use cases showing relations to roles

Safe and efficient mobility is supported through navigation support and support for Transport Means operation. The professional execution of freight and passenger transport operations is however supported by 8.4.

On-board equipment (which may be hand held equipment in case of pedestrians or cyclists) with two-way interfaces may be used. Information about irregularities detected by on-board monitoring functionality, as well as Transportation Network condition information from the Transportation Network Management domain is communicated to the Transport Network User.

On-board a Transport Mean the Master (the captain of the Transport Means) is responsible for route planning and navigation, but the Transport Network User role is used as pedestrians and cyclists also need such functionality (the Master role is however a part of the Transportation Network User role).

9.1.3.1 Support Quality Assurance

The Transport Means cannot enter the traffic without an approval of the compliance to laws and regulations. Thus, quality assurance is done prior to the start up.

- Predefined checklists may be used.
- The total weight of the Transport Means, including load, may be checked and registered. The distribution of the weight on-board the Transport Means may have to be checked both vertically and horizontally.
- The information about the trip, the load, the crew and their qualifications and the Transport Means is checked with respect to condition, qualifications, certificates, permissions, etc..
- Security deviations concerns may be checked and handled. If luggage is loaded, but the passenger is missing, the luggage may be unloaded.
- Transport documents and documents describing the transport operation should be read and understood, and this should be verified.

Quality verification or deviation information may be communicated to the quality assurance function in the Transport Service Management domain (see 8.2.2.2). This may for example be information about that the allowed weight is exceeded or if the weight distribution exceeds the limits for the Transport Means. The transport operation may be cancelled or postponed. The automated transport means operation (see 9.1.3.8.1) may also be invoked - to prevent the start up of the transport means until the quality control is passed.

9.1.3.2 Manage Route

The planned route is defined based on the transport operation to be executed. Several propositions for routes may be possible, and Transportation Network User may need routing information in a number of different circumstances, including whenever:

- The Transportation Network User is unfamiliar with the Transportation Network or with the precise location of the destination.
- The Transport Means is particularly wide, tall or heavy and information about the properties of the Transportation Network is required (restrictions, low or weak bridges, etc.).
- The delivery round contains many drop-off points and the optimal route may not be obvious.
- The transport operation requires a specified route or to visit delivery points in a set order; this could be for a number of different reasons including the delivery requirements, Transport Means restrictions or due to the goal of minimising fuel consumption.
- A Network and Traffic Status causes part of the Transportation Network to become unusable or highly congested.
- The traffic management policy in the area. There may for example be restrictions for certain transport operations due to environmental, safety (e.g. dangerous goods) of traffic reasons

The Transport Service Management domain (the Transport Operation Manager or the Transport operation Worker) establish an Operational Route Plan for the transport operation. The Transportation Network User may however have to re-define the route based on Network and Traffic Status information received from the Transportation Network Management domain and based on information received via information services. The Transportation Network Management domain may also assign a route to the Transportation Network User.

The chosen route may have to be communicated to the Transport Service Management. The route to be followed will be input to the navigation process.

9.1.3.3 Support Navigation

The navigation support may be provided by separate equipment or by separate systems, or the support may be done by integration of several tools. By means of the latter, several types of information (e.g. maps with dynamic information about Network and Traffic Status) may be combined. Such integration may simplify navigation and support decisions. Functionalities that may be provided are:

- Electronic maps may show the real-time position of other Transport Means as well as the position and movement of this Transport Means.
- Route planning and route definition may be supported. The planning may for example be based on the Operational Route Plan received from the Transport Service Management. Several propositions for routes may be suggested. The chosen route can be defined and if required it may be communicated to the Transport Service Management.
- A planned route can be simulated. In that way the navigation can be tested in advance.
- The Transportation Network User may be guided through the planned route. The accomplishment of the transport operation is, however, monitored as described in 8.4.3.
- Information about current position, deviations from the planned route, and status may be passed on to the Transportation Network User (and if needed also to the Transport Service Management).
- Information about the expected time of arrival can be provided.
- Information is collected (e.g. by means of the information services – see 9.1.3.4) and presented in an integrated way, e.g. on the map used for the navigation. This may for example be:
    - The current Network and Traffic Status (the density, incidents, accidents, condition in the Transportation Network)
    - The regulation of the Transportation Network, cordons, one-way driving, etc)
    - The current weather conditions
    - The current regulations
    - Notices to Transportation Network User
    - Information from the control functions and the monitoring functions

9.1.3.4 Use Information Services

The Transportation Network User may request several types of information, and on-board functions, e.g. Navigation Support, may also request such information. Information is collected and presented. This may for example be:

- Maps or map updates
- Meteorological conditions
- The current regulations
- Traffic Information - Dynamic traffic information and statistical traffic information about traffic flow, such as traffic density, speed and delay.
- Transportation Network Condition Information - Dynamic information about abnormal and unplanned conditions in the Transportation Network (slippery road, turbulence, high

waves, obstructions, restricted view, air pollution, oil spill, etc.) due to situations that cannot be controlled (weather, incidents, accidents, etc.).

- Dynamic Transportation Network Information - Dynamic information about situations in the Transportation Network infrastructure due to Transportation Network conditions and events as well as regulations valid in the Transportation Network, e.g. closed roads, platooning, speed limitations, quality, restrictions, constraints, general route and navigation guidelines about normal routes, alternative routes and route diversions (in case of obstructions).
- Physical Transportation Network Information - Static information about the Transportation Network
- Network and Traffic Status (NTS) Information - A total assessment of the situation in the Transportation Network that may affect safety and efficiency or just elements of such information.

9.1.3.5 Provide Visibility Enhancement

The function offers a better view upon the traffic by means of mechanisms such as simulations, use of radar, integration of information from hidden areas with radar, projection of pictures of the Transportation Network onto to Driver’s window etc.

The Driver’s view of the traffic as well as light and visibility conditions may be interpreted. If the view is considered too restricted, the Transport Means may change the lightning and also automatically flush windows and lights.

The Transportation Network may offer functions giving more/better lightning in case of bad lightning or visibility conditions.

9.1.3.6 Support Traffic Flow Management

The function supports the Transportation Network User in managing the Network and Traffic Status (the traffic flow and the actual Transportation Network conditions).

- Guidelines may be given based on information received from any of the other functions
- Warnings may be provided
- Safety operations may be handled
- Traffic management measures taken by the Transportation Network Utilisation domain may be handled

Available functionality, e.g. automated driving support – see 9.1.3.8, may be initiated to cope with situations. In dense traffic or if the traffic moves on very fluently, functionality integrated into the Transport Means (see 9.1.3.8.2) or collision avoidance (see 9.1.3.8.3) may for example be used.

9.1.3.7 Support Transportation Network Conditions Management

The function supports the Transport Means’ Driver in the movement of the Transport Means in case of abnormal, unplanned conditions in the Transportation Network (restricted view, slippery road or railway, high waves, etc.). Warnings may be provided and the Transport Means’ Driver may be supported in the handling of dangerous or difficult conditions.

9.1.3.8 Provide Automated Driving Support

In certain areas some sort of automated driving support may be mandatory or possible, and in certain situations it may be necessary to overrule the Transport Means’ Driver, or the Driver may want some assistance. The degree of automation and intervention may vary.

9.1.3.8.1 Provide Automated Transport Means Operation

The start up of the transport means may be prohibited until certain conditions are fulfilled, e.g. the conditions controlled in the quality assurance (see 9.1.3.1) or the alcohol lock on a vehicle has confirmed that the driver is OK.

Based on the defined route and the information received from the Transportation Network Management domain (traffic management, Transportation Network infrastructure information, etc.) the Transport Means may be operated automatically.

Automated operations must be of predefined types, and the automated operations must be carried out according to predefined specifications.

- Actions may be taken to prevent accidents or regulation violations, e.g. automatic train stop, automated speed adaptation, alcohol lock, etc.
- Actions may be taken due to incidents detected or due to information received from the Transportation Network Management domain.

The automated operations should be logged.

9.1.3.8.2 Support integration of Transport Means in Traffic

Information from the Transportation Network and other Transport Means is communicated to the Transport Means. This information and information collected by the Transport Means itself, is used to assist the Driver in the integration of the Transport Means in traffic. This integration is mainly correction of speed, breaking and support for keeping lanes and corridors.

9.1.3.8.3 Support Collision Avoidance (Støtte for avverging av kollisjon)

Services to assist in avoiding collisions are provided when the Transport Means is in motion and when the Transport Means is parking.

9.1.3.8.3.1 Longitudinal Collision Avoidance

This function measures of the Transport Means according to elements in the longitudinal direction to offer:

- Parking support, this includes sensors for estimation of the free distance in front of and behind the Transport Means, and also sensors in the transport leg and Transfer Node measuring the placement of the Transport Means
- Support for speed adjusting according to the present Network and Traffic Status
- Support for adjustable cruise control, the pattern of driving is adjusted to the Driver, the current placement in the Transportation Network, the Transport Means, the weight and also the freight and Travellers onboard, and the Transportation Network condition.
- Overruling of the Driver's speed, if speed is not adjusted manually and the Network and Traffic Status dictates that the speed should be changed to ensure flexible and/or safe accomplishment of the transport
- Automated emergency braking in case of an emergency situation in the traffic
- Support for putting the Transport Means forward in convoy. The leg to the Transport Means ahead and behind is automatically regulated and can be reduced compared with manually driving

Camera on the Transport Means, in the transport leg and Transfer Node, give visual support to the Driver. This is important when parking the Transport Means.

9.1.3.8.3.2 Lateral Collision Avoidance

This function measures the Transport Means according to elements in the lateral direction and supports the Driver in avoiding lateral collision with other Transport Means or other elements in the traffic. The function offers:

- Dynamic control of the Transport Means

- Support to the switch of transport lanes and also to keep the lane which the Transport Means is making use of
- Support for prioritising the Transport Means in determined and reserved transport lanes in the traffic
- Parking support

This function also makes use of cameras on the Transport Means, in the Transportation Network and at Transfer Nodes.

9.1.4 Support Incident and Emergency Management

Safety issues may be detected by means of information from the Transportation Network Utilisation domain, or incidents, irregularities and emergencies may be detected by the monitoring functions (see 9.1.2). Safety related information may be communicated to the Safety and Traffic Related Crew, or the Safety and Traffic Related Crew may detect and register such situations themselves. The safety and security instructions in the Transport Operation Plan (TOP) must also be considered.

The handling of incidents and emergencies (e.g. emergency brake, accidents, weight and balance issue, robbery, pollution response, fire response, etc.) is supported. Some situations may cause actions such as automatic operation of the Transport Means (e.g. train stop) by means of the Automated Adaptation to Traffic Control functionality (see 9.1.3.8.1).

In certain situations information about incidents and emergencies is reported to the Transport Service Management and Transportation Network Management domains.

9.2 Manage Transport Means Information

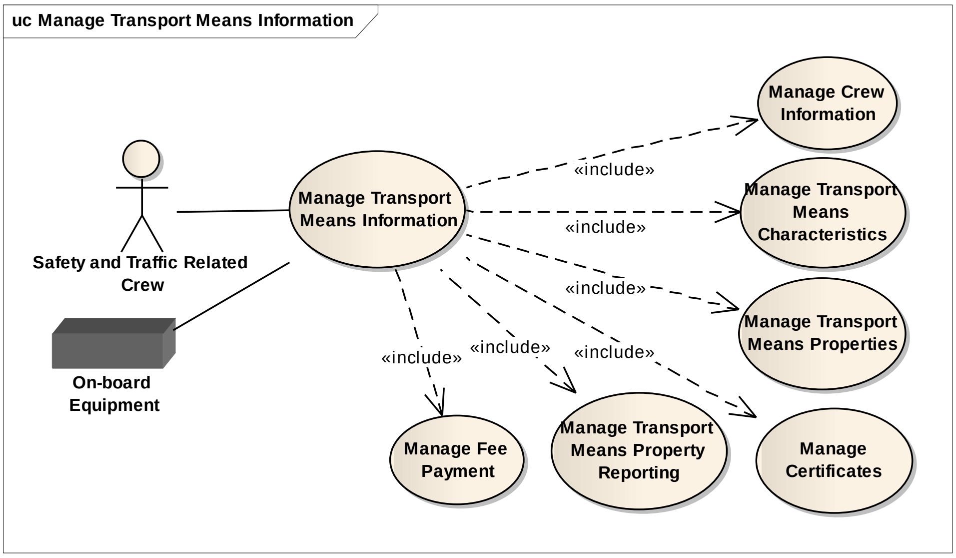


Figure 42 Use case decomposition

Information about Transport Means or transport operation is managed and reported to those entitled to such information. The submission of reports about traffic and Transportation Network conditions is also supported.

9.2.1 Manage Crew Information

Information about the crew of the Transport Means is established. This may be done on-board by several means (manually, smart card, etc.), or it may be done by information exchange with the Transport Service Management domain. The information identifies the actors responsible for the conveying of the Transport Means as well as their skills and preferences.

9.2.2 Manage Transport Means Characteristic

The type of Transport Means and the type of transport (type of load, load factor, etc.) that is carried out define the characteristics of the Transport Means:

These characteristics may influence on the traffic management measures towards the Transport Means, as the Classification assigned to the Transport Means (see 6.2.2.3.7.2).

9.2.3 Manage Transport Means Properties

The properties and status of Transport Means are registered and managed. This may include

- The identity of the Transport Means
- Speed and position (and direction)
- Classification (defining priority) currently assigned
- Overall information about the Transport Means such as
    - Vehicle weight when unladen
    - Number of axles
    - Vehicle engine (e.g. Euro IV standard)
    - Fuel type (e.g. diesel, bio-fuel)
    - Different control systems and engine parameters
    - Mileage
- Overall information about the transport operation such as
    - Type of cargo on board (e.g. hazardous materials)
    - Vehicle fill (incentives may be provided to encourage full loads)
    - Vehicle weight (laden)
    - Intended destinations (e.g. specified loading bays)
    - Loading bay data (e.g. time slots available, existing bookings)
    - Freight access regulations (the system should not violate these)
- Transport Means characteristics (see 9.2.2 - based on information listed above)
- Certificates (may be provided by the Transportation Network Utilisation domain or provided by Transport Operation Manager – see 6.2.2.3.7.2 and 6.2.2.3.7.6)

9.2.4 Manage Certificates

The certificates related to the Transport Means and crew are managed. Certificates providing priorities or access may be requested from the Transportation Network Management domain.

9.2.5 Manage Transport Means Reporting

Information about the properties of the Transport Means is reported to the Transportation Network Utilisation area and/or to the appropriate Transport Regulators (the Regulation Enforcement domain). The latter may be done via a single point of contact (see 10.8.2).

The properties may influence on the traffic management measures to be taken towards the Transport Means. Example of properties:

- The identity of the Transport Means
- Position
- Overall information about the Transport Means
    - Weight, dimensions and other relevant information about the construction (e.g. number of axles)
    - Type of engine (e.g. Euro IV standard)
    - Type of fuel (e.g. diesel, bio-fuel)
- Overall information about the transport operation such as
    - Type of cargo on board (e.g. hazardous materials)
    - Percentage of filling

- o Amount of cargo (e.g. weight)
- o Intended destinations (e.g. specified loading bays)

9.2.6 Manage Fee Payment

Before, during or after the transport, the required fee payments are performed, and information about the payment is registered. The payment may be manual, by credit card, electronic.

9.3 Manage En-Route Reporting

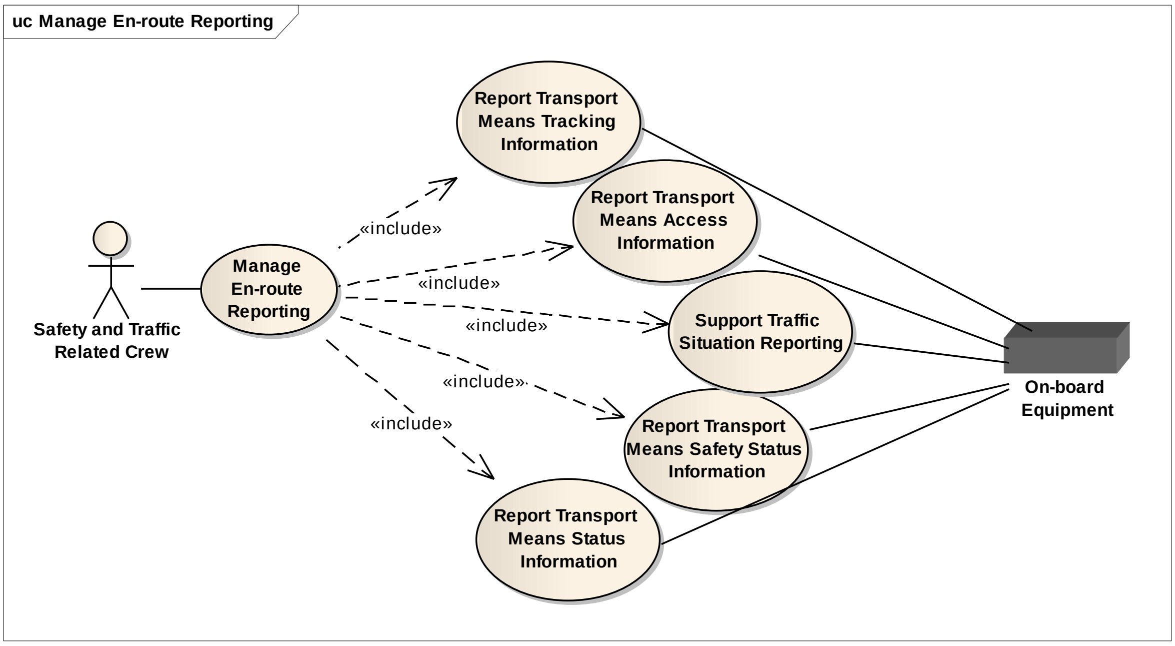


Figure 43 Use case decomposition

The Transport Means will report or publish information during the transport.

9.3.1 Report Transport Means Tracking Information

The tracking information registered in 9.1.2.2 is made available to those entitled to such information together with related information from 9.2.3 (Transport Means id, etc.).

9.3.2 Report Transport Means Access Information

Access certificate information (from 9.2.4) is reported as the Transport Means moves through the Transportation Network to document legal access to the Transportation Network Segments.

9.3.3 Support Traffic Situation Reporting

Information about meteorological conditions, environmental conditions and the Network and Traffic Status is reported to the Transportation Network Utilisation area or the Transport Service Management domain.

9.3.4 Report Transport Means Status Information

The status of the Transport Means (e.g. mileage, faults, etc.) is reported to the Transport Service Management domain.

9.3.5 Report Transport Means Safety Status Information

The status of the Transport Means (e.g. mileage, faults, etc.) is derived from the status monitoring (see 9.1.2.1).

The safety status of the Transport Means (parameters that may indicate that the Transport Means may have problems of any kind – e.g. fuel status, engine problems, etc.) is reported to the Transport Service Management domain and to the Transportation Network Utilisation. The latter may for example be of interest before the entrance of tunnels or other critical Transportation Network Sections.

10 Functional view, Transport Sector Support

The Transport Sector Support domain provides generic services to the other domains of the Reference Model, e.g. information services with variable content like Traffic Information, Transportation Network information, Transportation Network condition information, tourist information, etc. The services will be carried out and managed in different ways, and the specific service content will vary. ARKTRANS does not address how the services are established.

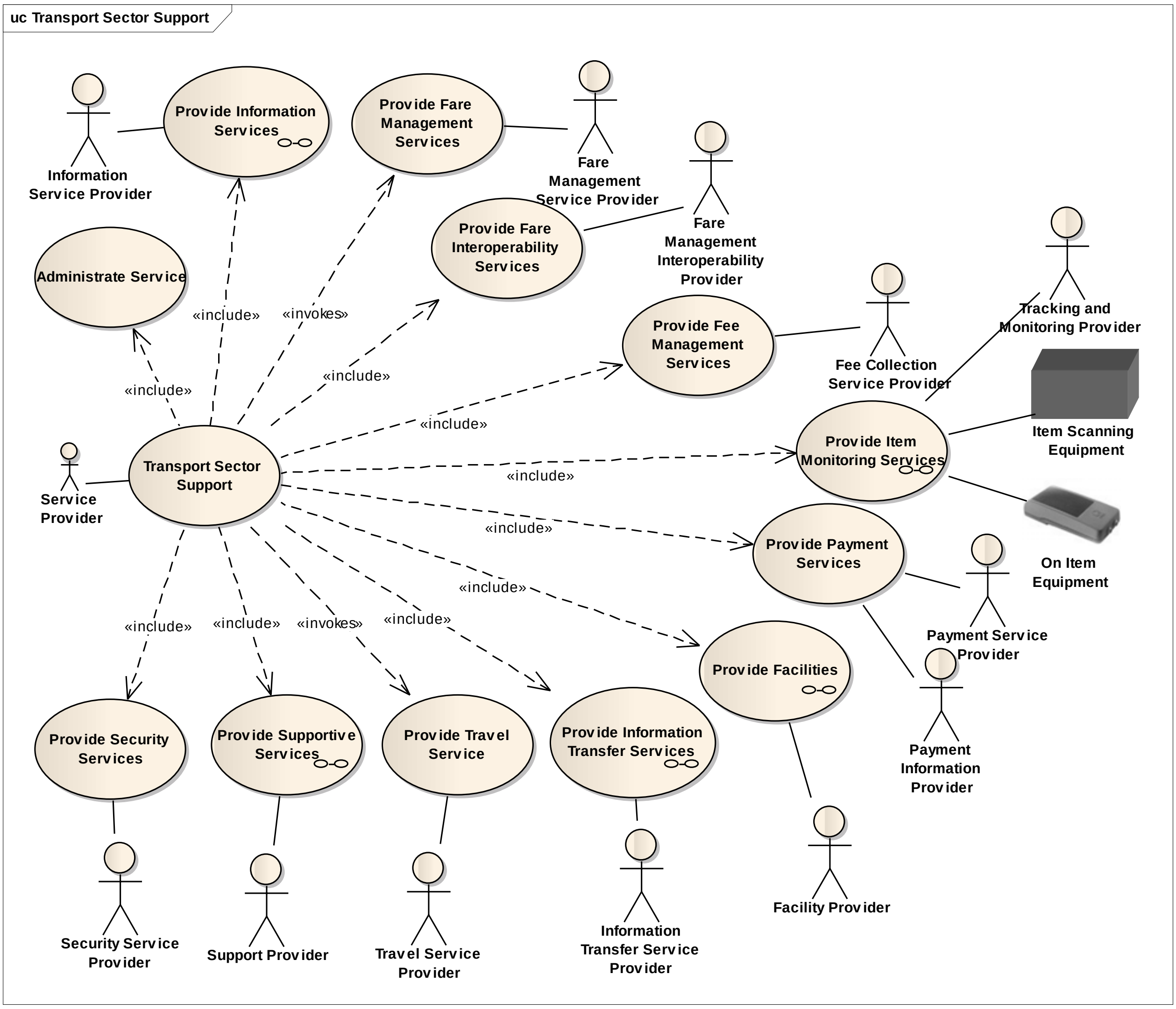


Figure 44 Use cases showing relations to Transport Sector Support roles

10.1 Administrate Service

The administrative and business related issues of service provision are handled. This may be:

- Customer management: Customer information is managed; including information about their preferences and needs.
- Booking management: Service bookings are received and managed. Amendments may also be received and processed.
- Service information management: Information about the service has to be established and maintained.
- Service information provision: Information about the services that are offered is made available. This may include directory services.

10.2 Provide Facilities

Misc. facilities are provided. This may be services
- Providing facilities supporting emergency response (facilities, equipment, etc.)
- Providing waste disposal facilities
- Providing quarantine facilities

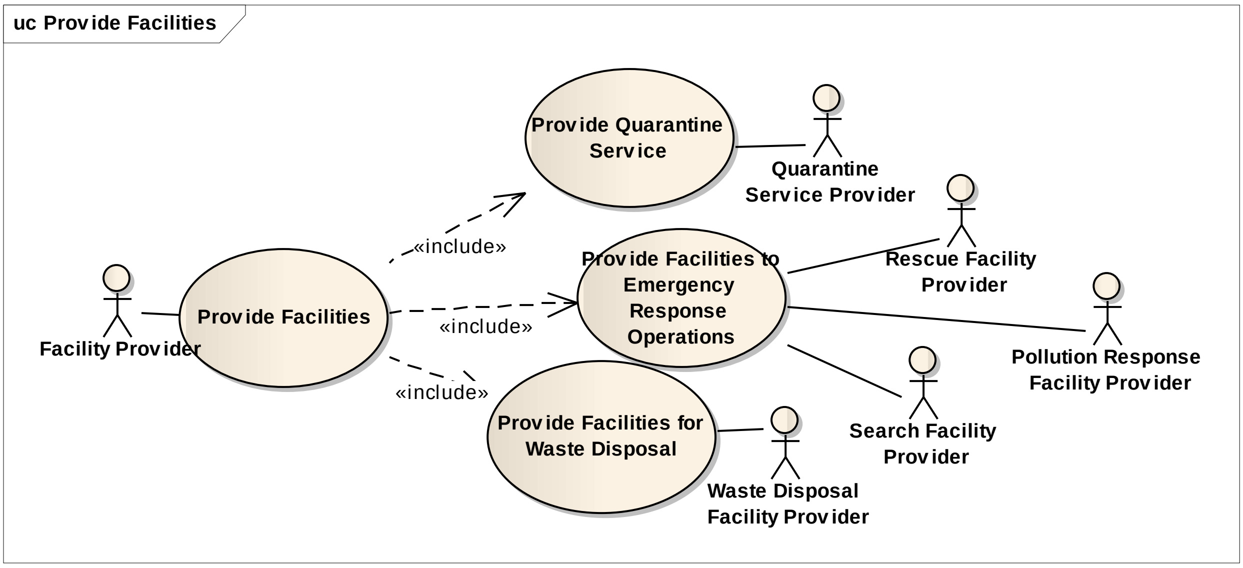


Figure 45 Use case decomposition

10.3 Provide Fare Management Services

Services dealing with the operational fare management are provided according to framework for electronic ticketing - see ISO/DIS 24014-1. This includes:
- Application management
- Product management

10.4 Provide Fare Interoperability Services

Fare interoperability is provided according to framework for electronic ticketing - see ISO/DIS 24014-1.

10.5 Provide Fee Management Services

To be described.

10.6 Provide Item Monitoring Services

Provides monitoring and reporting services related to an item. The item may be a goods item, a load unit or a loading area.

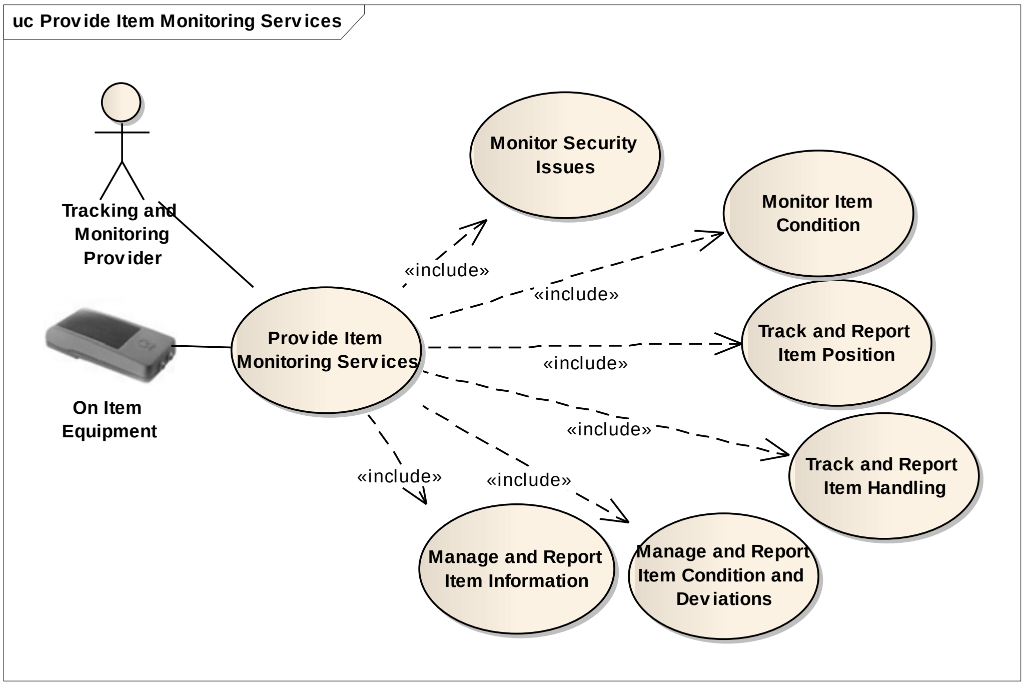


Figure 46 Use case decomposition

10.6.1 Monitor Item Condition

The state of the Item is monitored and registered. This may be:

- The temperature of the Item.
- The humidity of the Item
- Shocks inflicted to the Item
- Environmental issues (emissions, noise, etc.)
- Possible security violations. In case of no violations, this can be confirmed.

10.6.2 Track and Report Item Position

The position of an item is tracked and reported.

10.6.3 Track and Report Item Handling

The handling actions (loading, unloading, delivery, etc.) are tracked and reported.

10.6.4 Manage and Report Item Condition and Deviations

The monitoring done in 10.6.1 provides information about the condition of the item or in the area where the item is located. Deviations with respect to threshold values are detected.

The status related to the location and handling (see 10.6.2) is registered, e.g. loading, unloading, storage, etc.

10.6.5 Manage and Report Item Information

Item Information (see 14.22) about the item is managed and reported.

10.6.6 Monitor Security Issues

Possible security violations are detected. Alerts are provided in case of such violations. In case of no violations, it can be confirmed that the security has not been violated.

10.6.7 Prevent Load Item Theft

Provides mechanisms securing the freight onboard.

10.7 Provide Information Services

Many types of information should be made available. However, no matter what the content of the information is, there are certain needs for functionality such as directory services helping the user find the requested information and Service Providers.

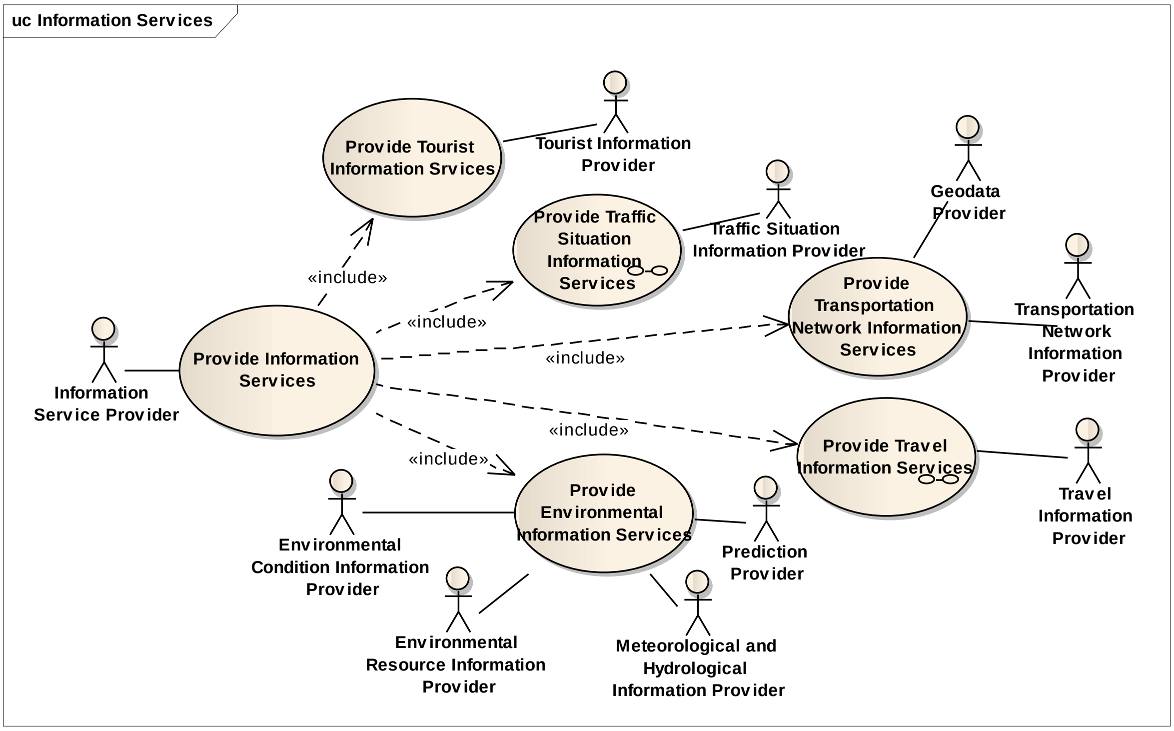


Figure 47 Use case decomposition and relations to Transport Sector Support roles

10.7.1 Provide Tourist Information Services

Different types of tourist information are provided.

10.7.2 Provide Traffic Situation Information Services

Information about the traffic, the transportation network conditions, events, incidents, etc. is provided to those needing such information.

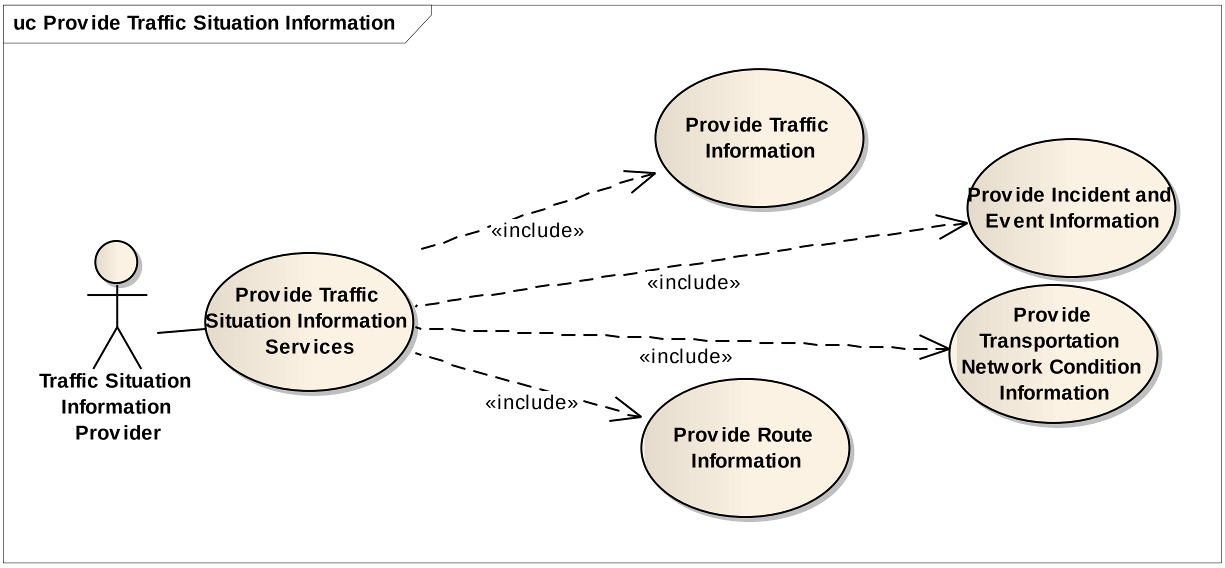


Figure 48 Use case decomposition

10.7.2.1 Provide Traffic Information

Traffic information such as traffic flow and traffic density, average speed, etc. is provided.

This may be real time observations, statistics or prognosis.

10.7.2.2 Provide Transportation Network Condition Information

Transportation Network Condition information is provided. This is dynamic information about abnormal and unplanned conditions in the transportation network that may affect the traffic (slippery road, turbulence, high waves, obstructions, restricted view, air pollution, oil spill, etc.) due to situations that cannot be controlled (weather, incidents, accidents, etc.)

10.7.2.3 Provide Incident and Event Information

Information about incidents, accidents and events that may affect the traffic flow is provided.

10.7.2.4 Provide Route Information

General route and navigation guidelines about normal routes, alternative routes and route diversions (in case of obstructions) are provided.

10.7.3 Provide Transportation Network Information Services

Information about the transportation network infrastructure is provided to those needing such information. This may be geodata or information provided in other forms, for example about:

- The physical Transportation Network consisting of Transport Links and Transportation Network Sections
- Regulations valid in the transportation network, e.g. closed roads, platooning, speed limitations, quality, restrictions, constraints, etc.
- Available Transfer Nodes
- Transfer Node infrastructure, for example information about
  - Access Points
  - Stop Points.
  - Available services and facilities and accessibility.
  - Transfers

10.7.4 Provide Travel Information Services

Travel information services are established, maintained and made available to the Transport User. The services are provided via some sort of user interface. Other services may be used to establish parts of the services or to collect the required information.

Travel information services may encourage people to change their habits towards more extensive use of public transport. Such services must meet the needs of both the society and the transport users. A transport user is in this context a person that plans to travel or a person that is travelling, either as a passenger or as a road user (driver, pedestrian or cyclist). There are different types of transport users, for example people going to work; tourists; disabled people; professional drivers; etc. They all have specific preferences that should be supported by new and improved travel information services.

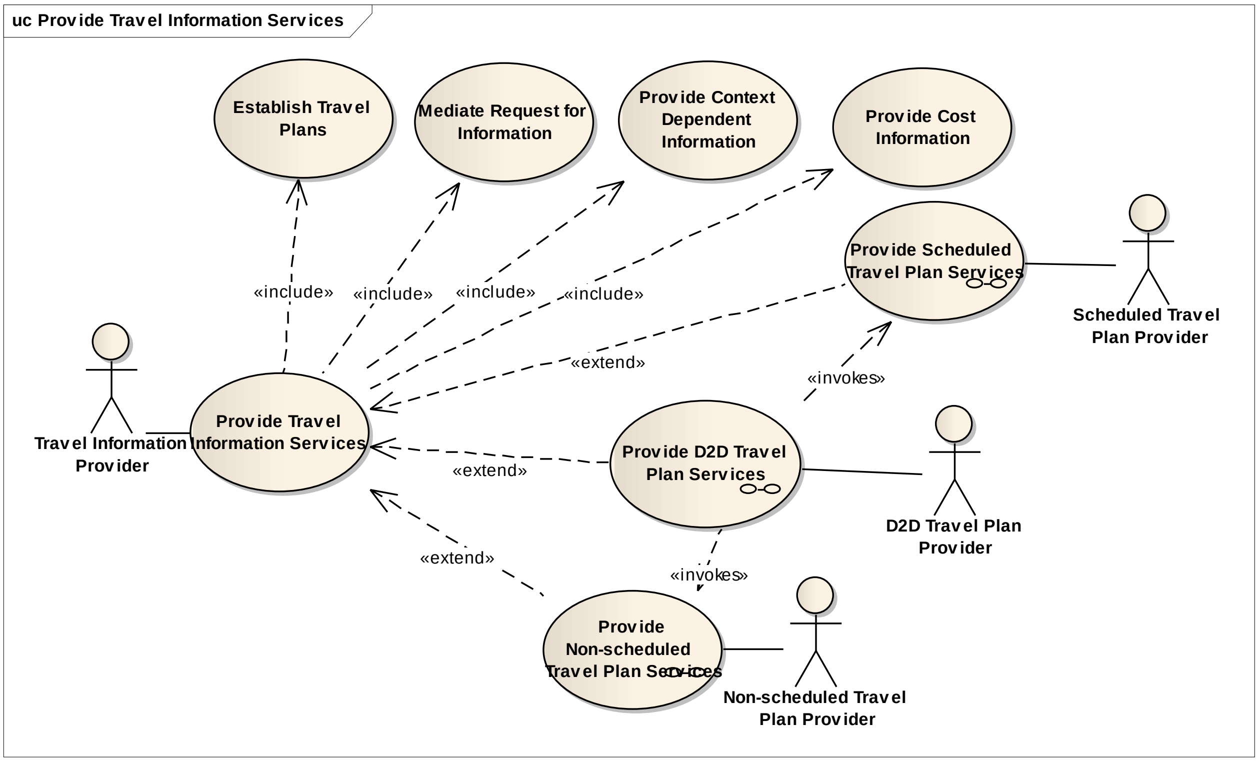


Figure 49 Use case decomposition and relations to roles

10.7.4.1 Provide Travel Information

Travel information is established and provided to the Transport User.

10.7.4.1.1 Establish Travel Plans

Travel plans that satisfy the transport demand are established by means of access to suitable travel planners. Additional information, e.g. about individual trips, can be collected and entered into the travel plans.

Multimodal travel information services should combine all transport modes and scheduled and non-scheduled transport (road use included) to find the best possible travel plans for the individual transport user. In general the travellers should get access to new and improved functionality that:

- Provides information about all relevant transport alternatives and makes it easy for the transport users to compare transport alternatives
- Supports all phases of the travelling process (planning and preparations, just before start and during the travel).

- Supports transport users that are not familiar with public transport (how to buy tickets, types of tickets, time tables, etc.).
- Supports special needs and preferences with respect to information. This may be needs related to comfort or ability to work during the travel, or it may be needs that are crucial for the ability to travel. Professional drivers as well as travelling persons must be supported.
- Provides information that makes the journey predictable, e.g. information about on-board facilities, accessibility, delays, status, estimated arrival time, etc.
- Support re-planning in case of deviations or changes in plans
- Supports adaptation to Network and Traffic Status (e.g. in case of congestion).

Dynamic information about status and deviations with respect to time schedules, next departure, estimated arrival, etc. is required by the users of public transport. Such information is to some extent provided by information boards at for example railway stations, airports and bus terminals, or via Web-pages and radio channels. However, dynamic information should be provided in a more individual and flexible way with respect to information content, when it is provided, and how it is provided (e.g. via cell phones). Access to dynamic information may for example allow people to adjust to the deviations, for example by finding other transport alternatives.

The travel process should be predictable. Information about the different transport alternatives and their qualities with respect to travelling times; waiting times; delays; services and facilities on-board and at stops (toilet, nursery, etc.); accessibility; etc. should be provided. Travellers should be able to compare the alternatives to select the one that is best for them. Accessibility information may be crucial. The access to services and facilities at terminals may for example very well be a key for deciding whether a journey by public transport is possible.

10.7.4.1.2 Mediate Travel Information Request

The Travel Information Provider receives requests for several types of information from the Transport User. The requests are processed, and the required information requests are forwarded to different Information Providers. When the required information is collected, the response is composed and provided to the Transport User.

The Transport User with specific preferences may have a transport execution plan that he wants to check towards these preferences. Information is collected to verify that the transport execution plan fulfils the requirements of the Transport User.

10.7.4.1.3 Provide Context Dependent Information

The Transport User may request context dependent information. Several strategies may be used to provide such information, for example:

- Context information is received from the Transport User (e.g. the location of the Transport User, transport service used, preferences, etc.), and information is provided according to this information.
- The systems providing the information may register the relevant context information themselves and provide relevant information to the Transport Users. On-board systems may for example register the location (by means of GPS) and these systems may also be informed about delays. Based on this context, relevant information is broadcasted to Transport Users on-board. In the same way, terminal information systems may be informed about delays and arrival times, and the information may be provided to Transport Users waiting for the bus.

10.7.4.2 Provide D2D Travel Plan Services

The Door-to-door Travel Planner calculates travel plans according to the request from the Travel Information provider. This may be done by means of centralised or de-centralised solutions.

Door-to-door travel information services may include public transport and the combination of public transport and road use (driving, walking, and cycling). They may for example provide information on how to get to the station by car; the park and ride facilities; the train leg of the journey; and how to walk to the final address. Multimodal travel information services should provide transport alternatives across all transport modes, also scheduled and non-scheduled transport.

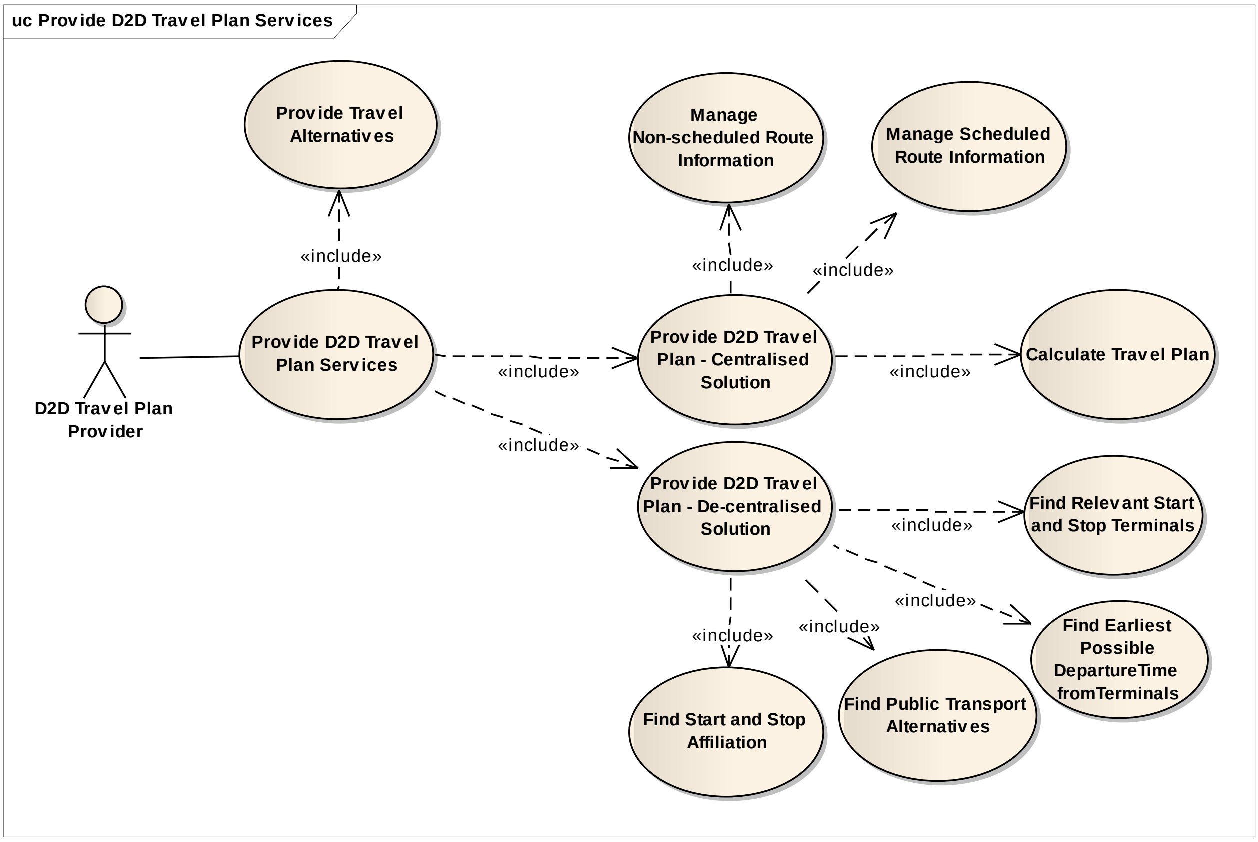


Figure 50 Use case decomposition

10.7.4.2.1 Provide Travel Alternatives

The calculated travel plans are provided to the Travel Information Provider.

The travel time may also be calculated, and the estimated time of arrival (ETA) may be provided.

10.7.4.2.2 Provide D2D Travel Plan – Centralised Solution

In a centralised solution all information that is required for the calculation of the travel plans are locally available.

10.7.4.2.2.1 Manage Non-scheduled Route Information

Non-scheduled route information is managed. This is information about the transportation network infrastructure, travel times and other properties that is of relevance to the travel planning.

10.7.4.2.2.2 Manage Scheduled Route Information

Route information is managed. This must consist of the routes of all relevant scheduled transport services.

10.7.4.2.2.3 Calculate Travel Plan

Based on the route information (scheduled and non-scheduled) the relevant route alternatives are calculated.

10.7.4.2.3 Provide D2D Travel Plan – De-centralised Solution

In a de-centralised solution the travel plans have to be calculated based on input from different travel planners.

10.7.4.2.3.1 Find Relevant Start and Stop Terminals

Assuming that public transport is to be used for a part of the route, the relevant terminals at each end of the journey have to be identified.

If there are specific requirements to the terminal (e.g. with respect to accessibility), requests for additional information may be required.

10.7.4.2.3.2 Find Earliest Possible Departure Time from Terminals

It will take time to get to the start terminals. Depending on the earliest start of the journey and the travel time to the relevant terminals, the earliest departure time for the public transport at the relevant start terminals are calculated.

10.7.4.2.3.3 Find Public Transport Alternative

The public transport alternatives from the start terminals to the possible stop terminals are calculated.

10.7.4.2.3.4 Find Start and Stop Affiliation

The routes to the start terminals and from the stop terminals to the destination are calculated.

10.7.4.3 Provide Scheduled Travel Plan Services

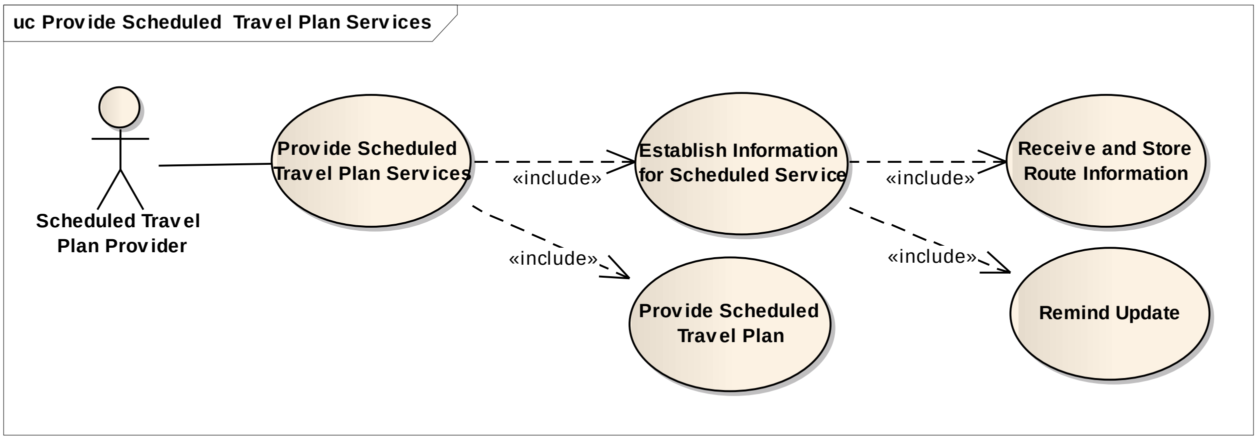


Figure 51 Use case decomposition

10.7.4.3.1 Establish Information for Scheduled Services

The data required for the travel planning is established.

10.7.4.3.1.1 Receive and Store Route Information

Information about all relevant routes are collected from the Transport Service Providers and managed.

10.7.4.3.1.2 Remind Update

If a Transport Service Provider does not provide route information according to agreements and regulations, the Transport Service provider is notified.

10.7.4.3.2 Provide Scheduled Travel Plan

The travel plan is calculated and provided.

The travel time may also be calculated, and the estimated time of arrival (ETA) is provided.

10.7.4.4 Provide Non-scheduled Travel Plan Services

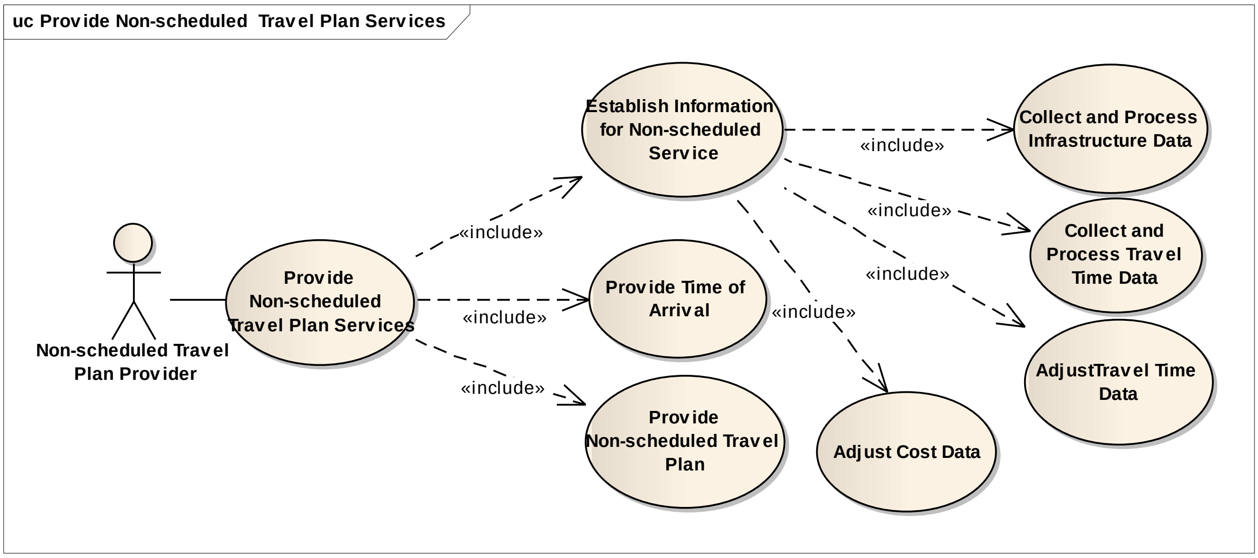


Figure 52 Use case decomposition

10.7.4.4.1 Establish Information for Non-scheduled Service

The data required for the travel planning is established.

10.7.4.4.1.1 Collect and Process Infrastructure Data

Information about the Transport Network Infrastructure is collected and managed. This also includes information about public transport Terminals (so that the link towards public transport can be handled).

10.7.4.4.1.2 Collect and Process Travel Time Data

Travel time data is collected and managed. Depending on the request, real time data or prognosis (e.g. statistics) should be used.

10.7.4.4.1.3 Adjust Travel Time Data

The travel time data is modified based on information about dynamic issues, e.g. meteorological issues, incidents and events and the transportation network condition.

10.7.4.4.1.4 Adjust Cost Data

Cost information is updated. Different types of costs may be relevant to match the preferences of the Transport User.

10.7.4.4.2 Provide Non-scheduled Travel Plan

Travel plans for a journey between two locations are calculated. Preferences are considered.

The travel time may also be calculated, and the estimated time of arrival (ETA) is provided.

10.7.4.5 Provide Cost Information

Information about the costs related to transport is provided.

10.7.5 Provide Environmental Information Services

Information about the environment is provided. This may be real time information (current status), statistical information or prognosis.

10.7.5.1 Provide Environmental Resource Information

Information about environmental resources (i.e. protected areas, vulnerable areas and potential treats to the environment) is established, maintained and made available.

10.7.5.2 Provide Environmental Condition Information

Information about environmental conditions (pollution, pollen, etc.) may be provided.

10.7.5.3 Provide Meteorological and Hydrological Services

Meteorological and hydrological information is provided.

10.7.5.4 Provide Predictions

Prognosis and predictions related to a specific situation (e.g. drift of vessel or oil spill) may be provided.

10.8 Provide Information Transfer Services

Different services may be provided related to electronic information exchange.

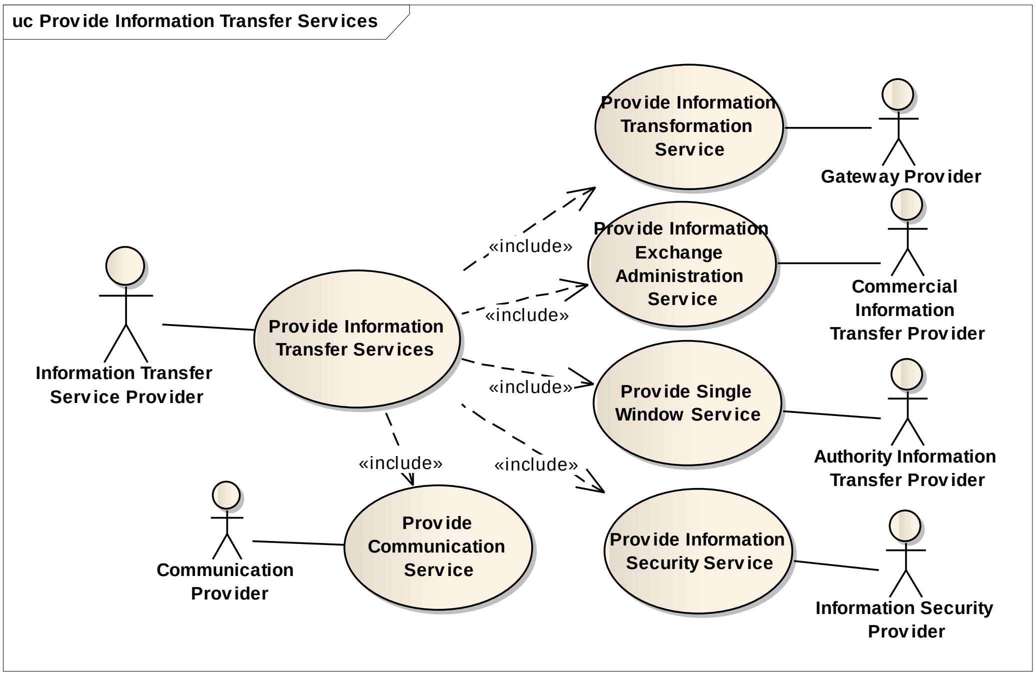


Figure 53 Use case decomposition and relations to roles

10.8.1 Provide Information Transformation Service

A transformation between different information formats is provided.

10.8.2 Provide Single Window Service

Information is received and delivered to one or more recipients according to pre-defined rules. The service provides a single point of contact for reporting/information exchange between stakeholders.

10.8.3 Provide Information Security Service

Services to ensure security are provided. This includes:
- Security keys management. This includes generation, registration, certification, deregistration, installation, storage, archiving, revocation, derivation and destruction of public and secret keying materiel in accordance with a security policy.
- Certification of organisations, components, applications, products, etc. with respect to information security.

10.9 Provide Payment Services

The following services are provided:
- Money transactions
- Payment information management

10.10 Provide Security Services

Services that ensure physical security are provided.

10.10.1 Security Monitoring

Monitoring of processes with respect to security is provided.

10.10.2 Security Certification

Certification of organisations, components, applications, products, etc. with respect to security is provided.

10.11 Provide Supportive Services

Misc. supply and assistance services are provided. This may be
- Repair services
- Salvage services
- Surveillance services
- Classification services
- Insurance services
- Manoeuvring support services (e.g. towing service)
- Services providing assistance to transport means at Transfer Nodes (e.g. mooring service)
- Supplies or bunkering

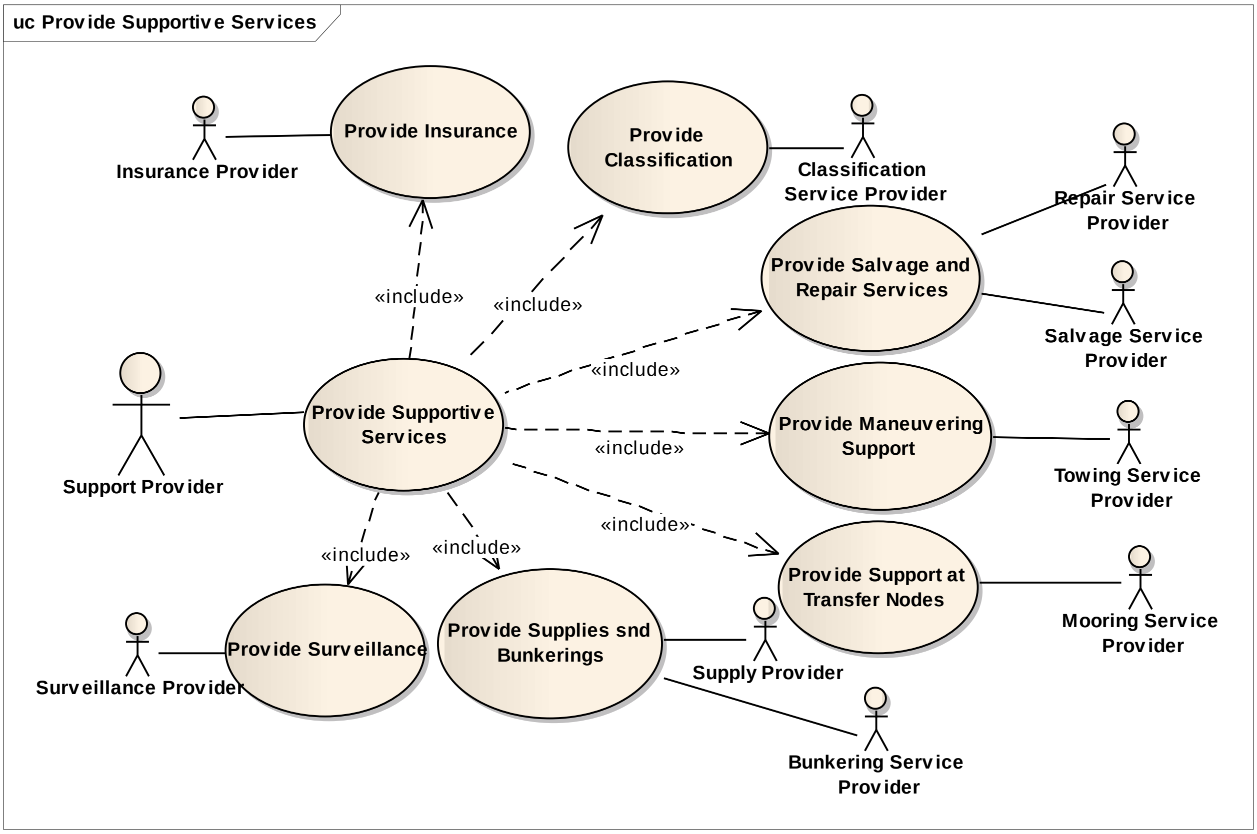


Figure 54 Use case decomposition and relations to roles

10.12 Provide Travel Service

Misc. services are provided to travellers, e.g. accommodation, restaurants, etc.

11 Process View

The domains of the Reference Model will interact during the planning and execution of transport operations. Information will flow between the functions represented by the use cases in the functional view (see Chapter 6, 7, 8, 9 and 10). In this chapter, this use cases are transformed to activities, and the activities and the related information flows are put together to processes. The processes are described by UML activity diagrams in swim lanes.

Figure 55 provides an overview of the main processes and illustrates the main interactions between the domains of the Reference Model. The process model is hierarchical. By browsing into the activities, more detailed are specified. In general the process diagrams can be read the following way:

- The activities are described by the use cases with similar names in the functional view
- There is one “swim lane” for each role involved.
- The solid-drawn arrows within one swim lane are control flows (*not* information flows). They represent the sequence in which the activities are executed.
- The interactions between the roles (i.e. between the swim lanes) are represented by information flows (dotted arrows).
- The information flows between activities within the same swim lane are in most cases *not* addressed. The information exchange is considered as an internal matter to the systems involved. In general we can assume that information received by one activity within a swim lane also will be available to the other activities in the same swim lane.
- The information flows that are realised by means of the open services specified by ARKTRANS are stereotyped with “ARKTRANS service”. These services are further defined in the Information view in 12.4.

It is important to bear in mind that the roles may be played by different stakeholders, and one stakeholder may also have more than one role. It is also important to notice that the processes are examples. The activities may be combined in other ways as well. The required interactions between the roles (i.e. between the swim lanes) are however to a large extent general.

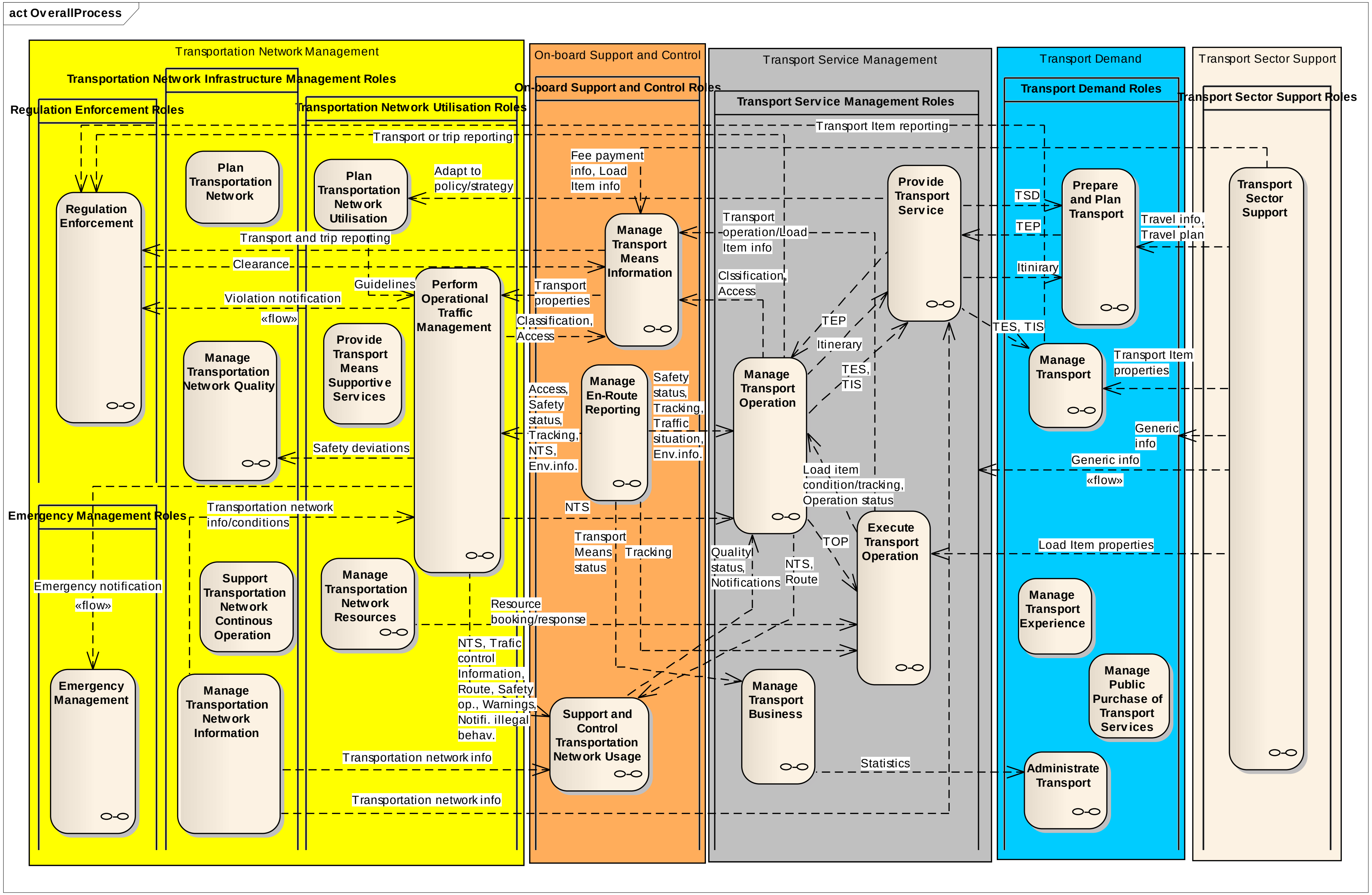
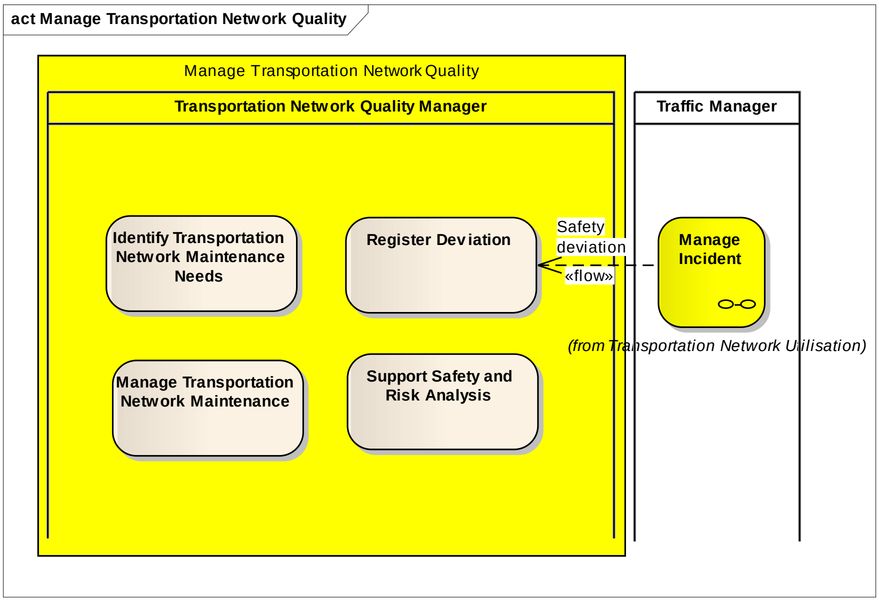


Figure 55 Overall information flows between the main processes in the domains of the Reference Model

11.1 Transportation Network Infrastructure Management processes

The process related to Transportation Network Infrastructure Management is illustrated below.

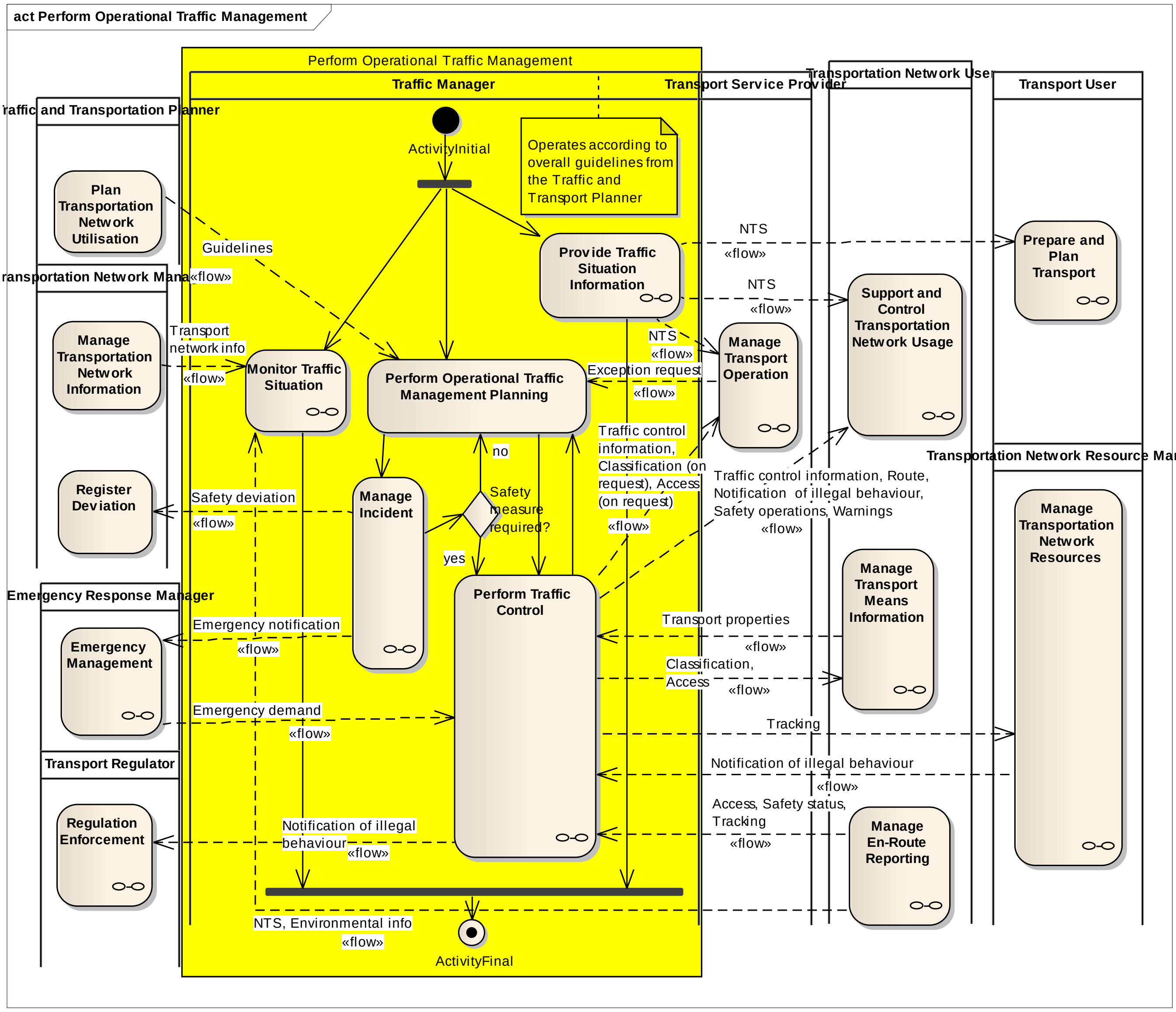
11.1.1 Manage Transportation Network Quality



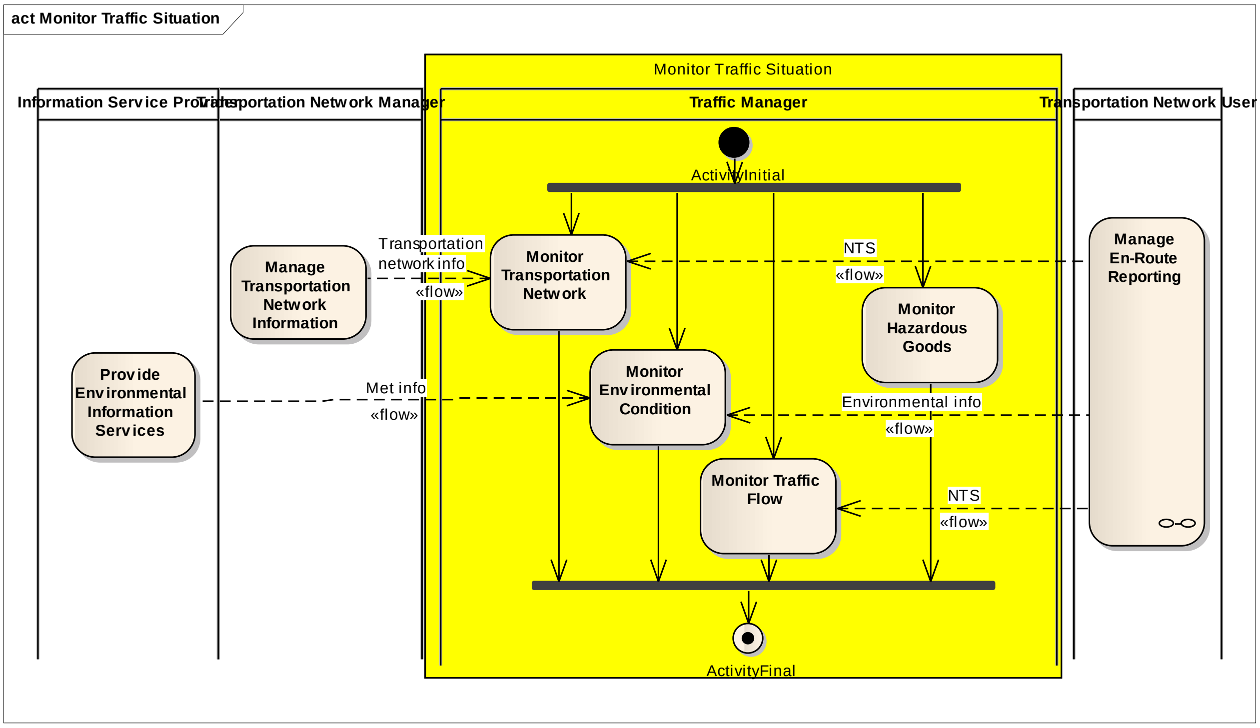
11.2 Transportation Network Utilisation processes

The processes related to Transportation Network Utilisation are illustrated below.

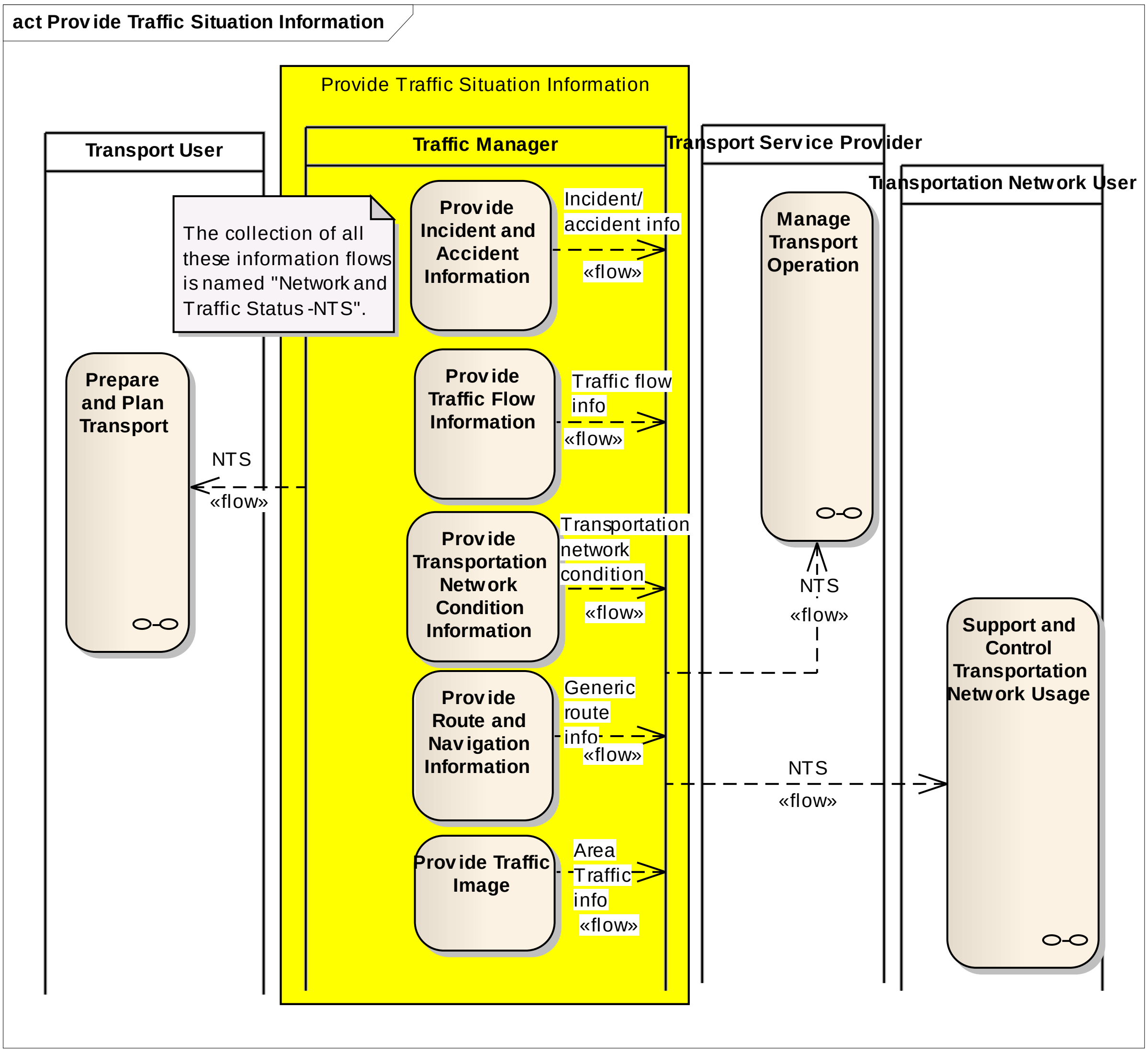
11.2.1 Perform Operational Traffic Management



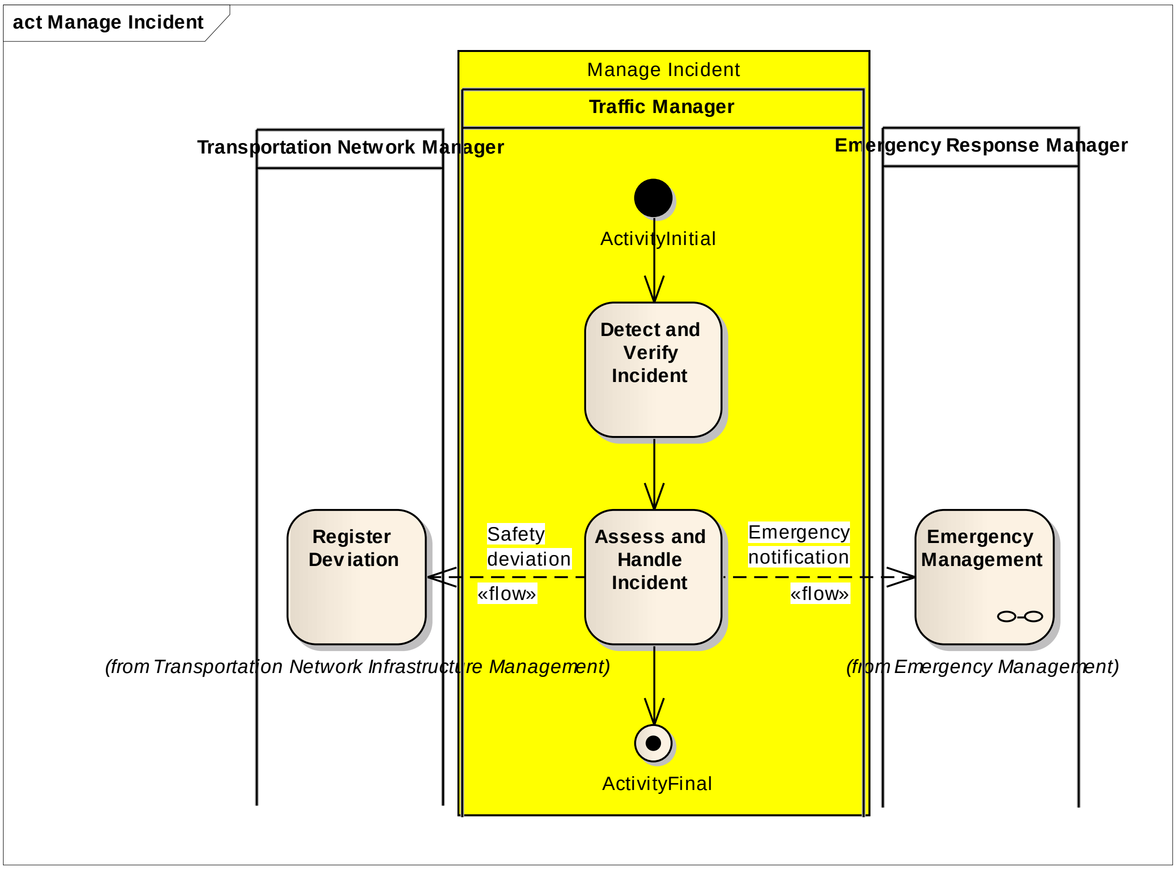
11.2.1.1 Monitor Traffic Situation



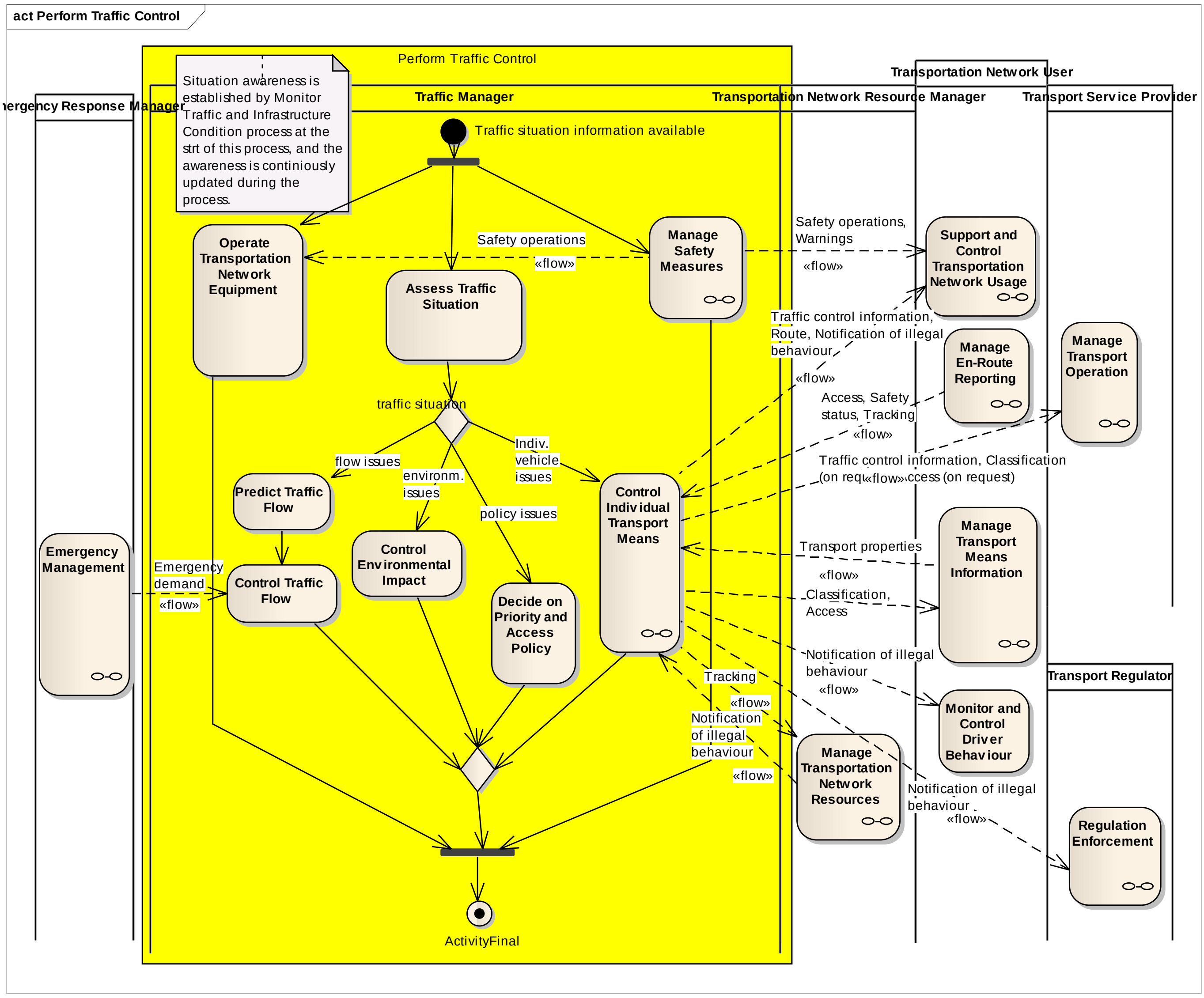
11.2.1.2 Provide Traffic Situation Information



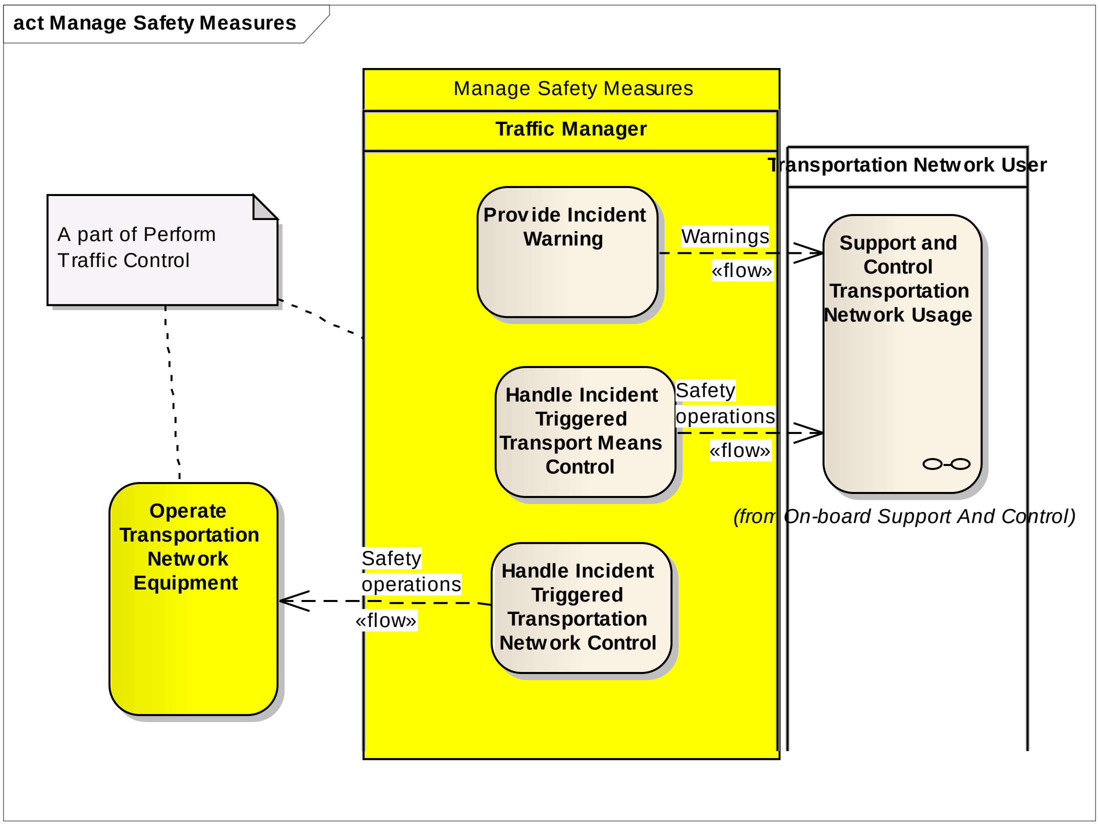
11.2.1.3 Manage Incident



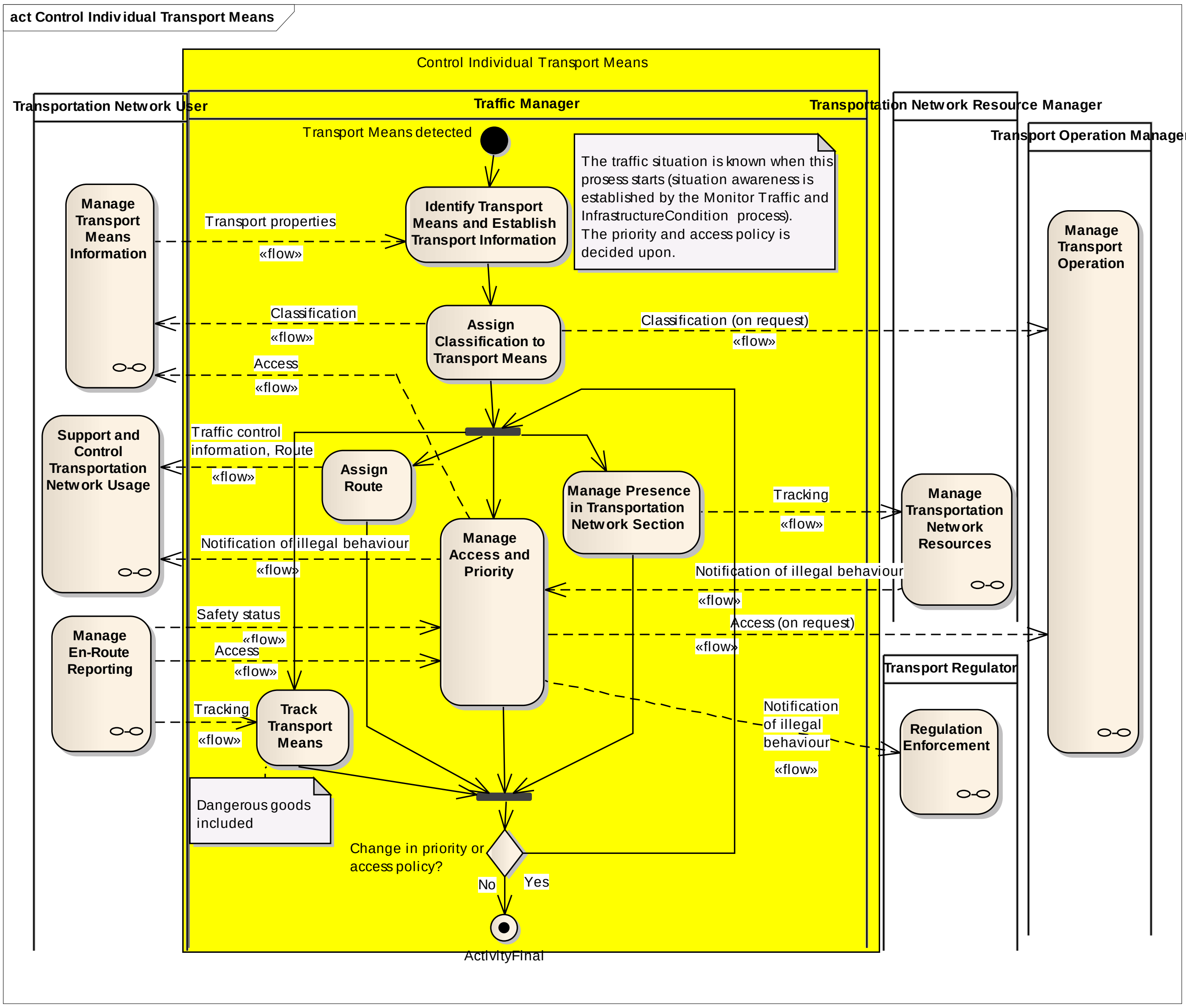
11.2.1.4 Perform Traffic Control



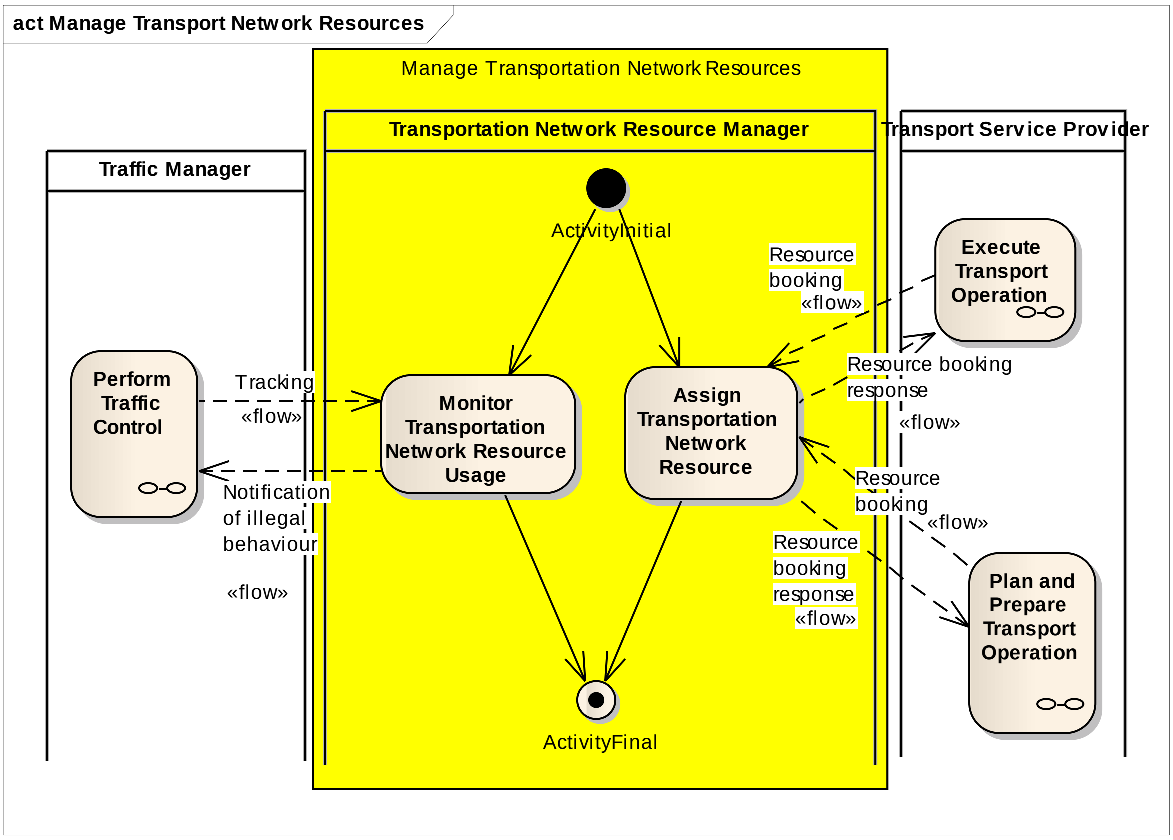
11.2.1.4.1 Manage Safety Measures



11.2.1.4.2 Control Individual Transport Means

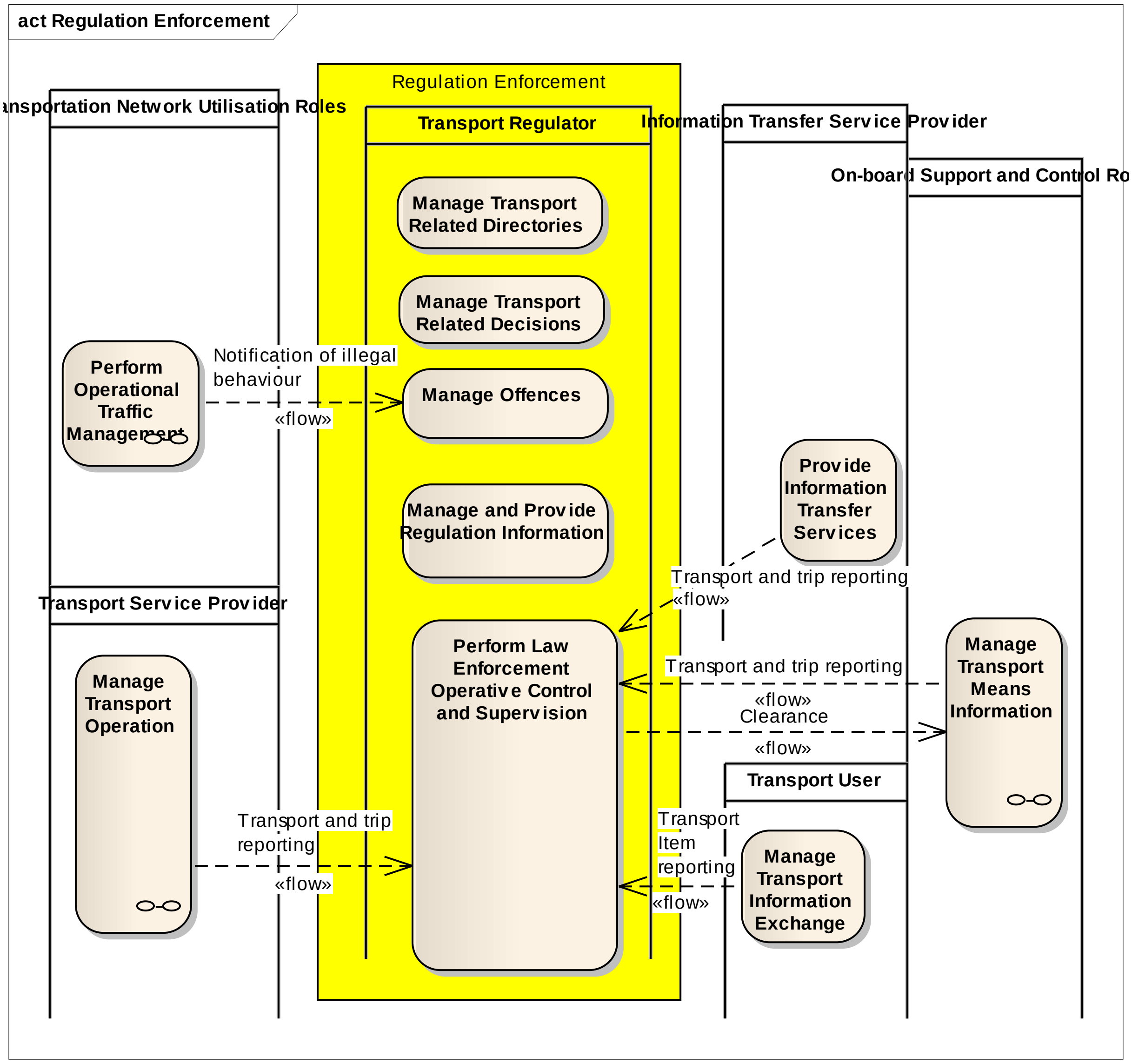


11.2.2 Manage Transport Network Resources



11.3 Regulation Enforcement processes

The process related to Regulation Enforcement is illustrated below.



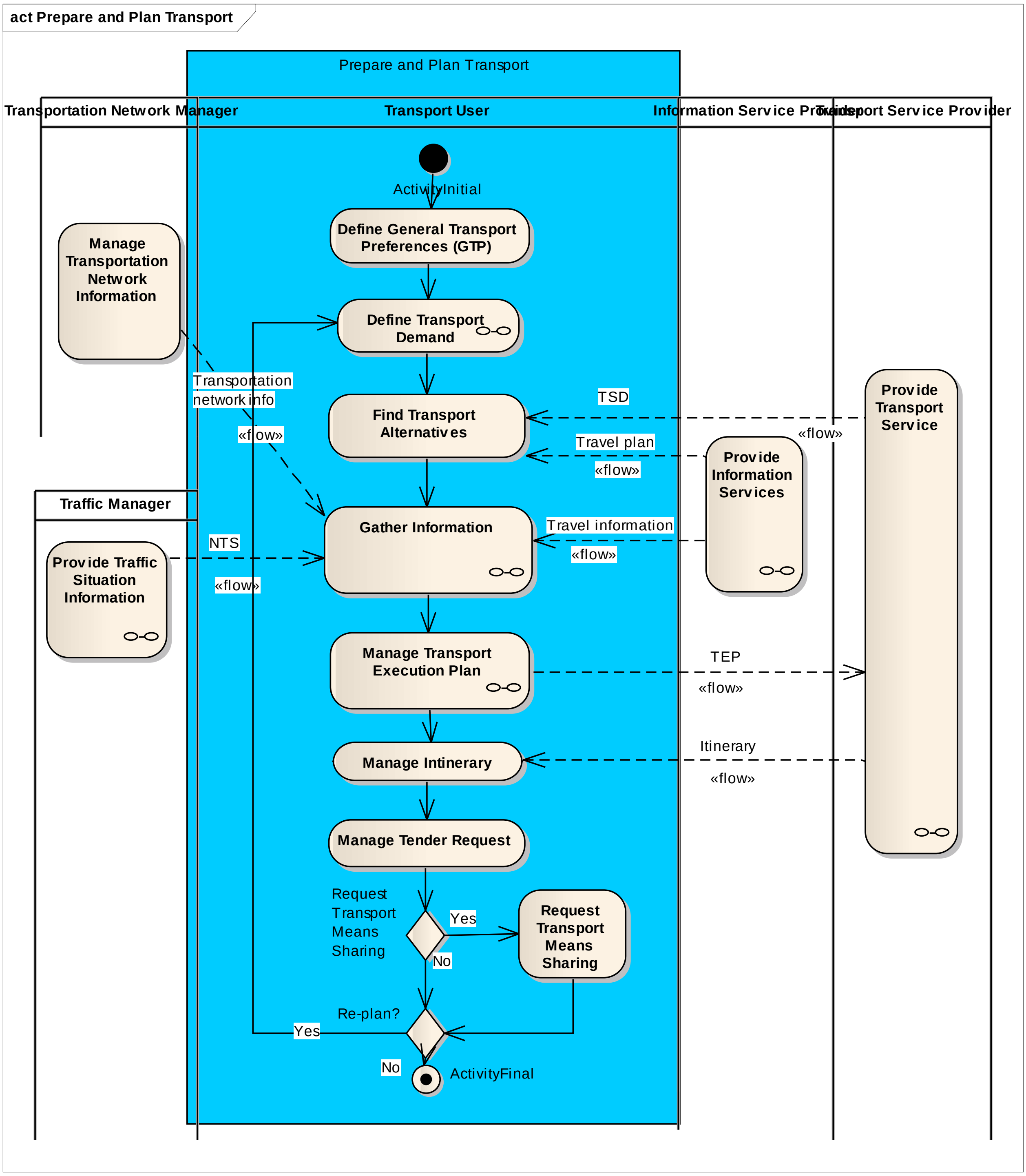
11.4 Emergency Management processes

No processes are described so far.

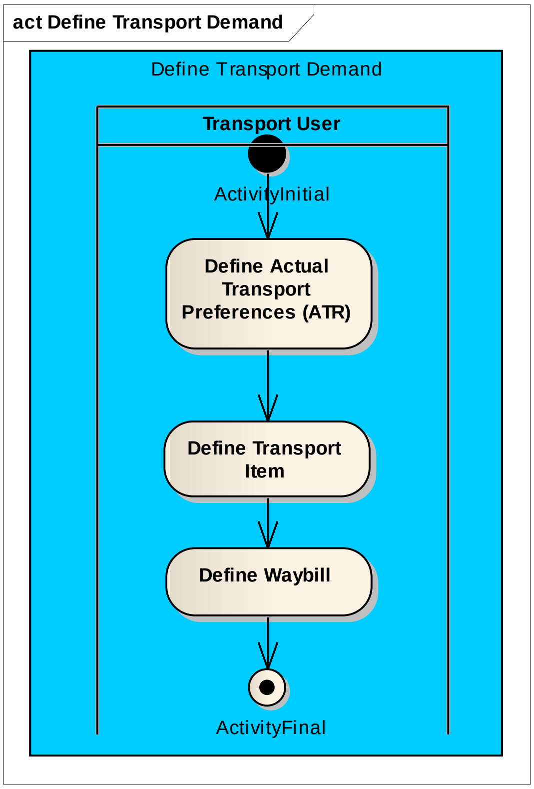
11.5 Transport Demand processes

Transport Users play an active role during the preparation and planning, and at the initiation of the transport. The processes related to Transport Demand are illustrated below.

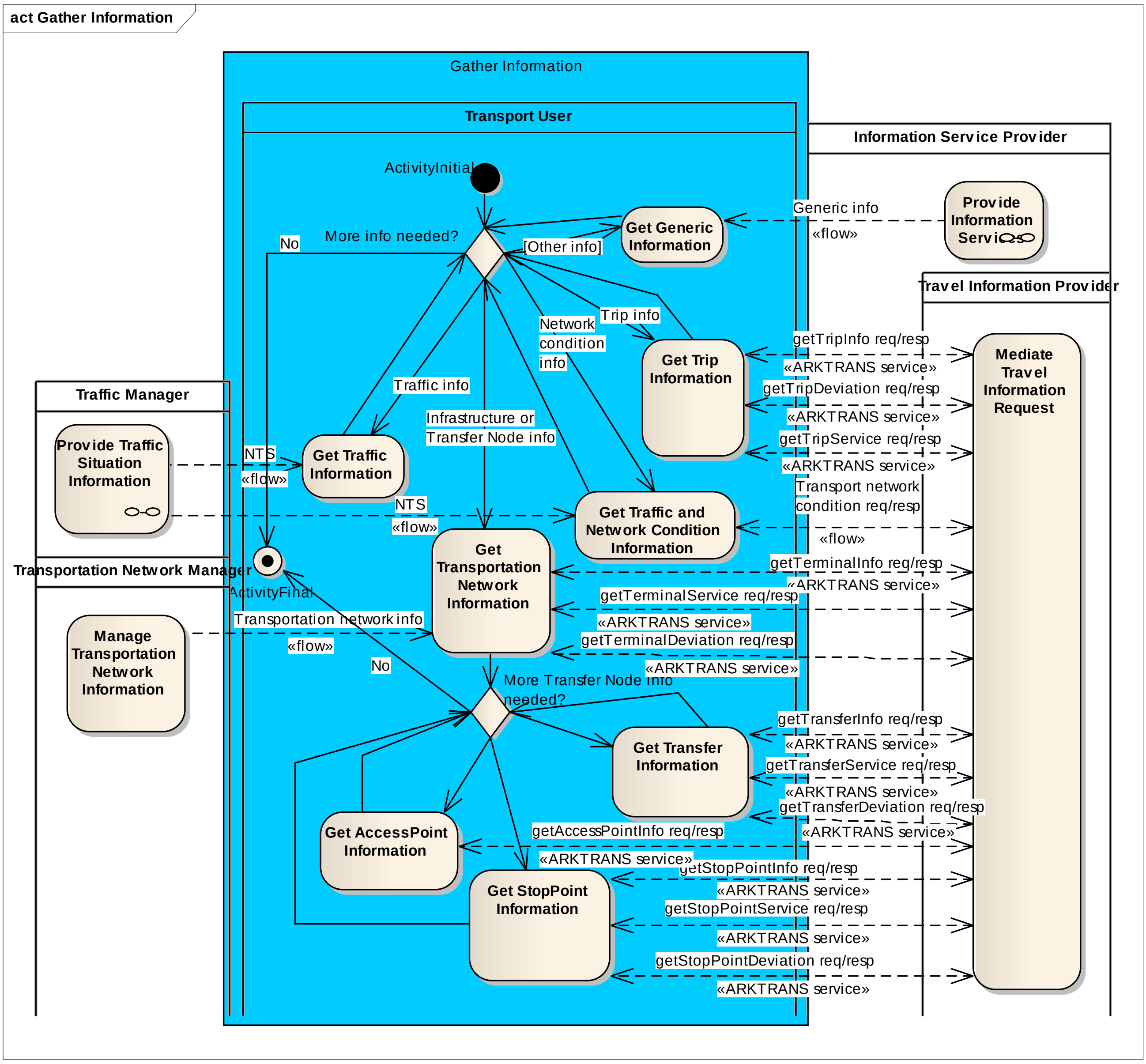
11.5.1 Prepare and Plan Transport



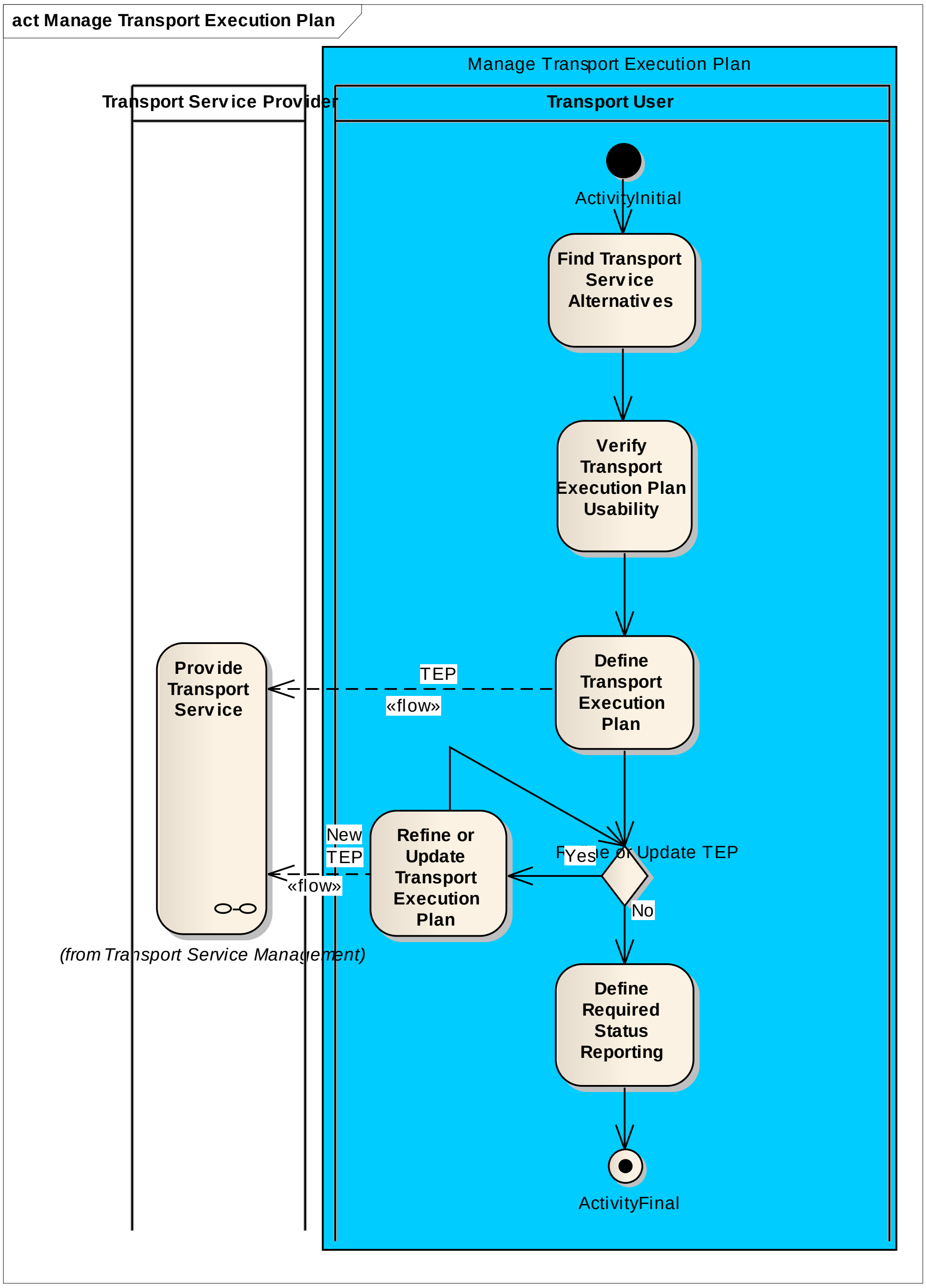
11.5.1.1 Define Transport Demand



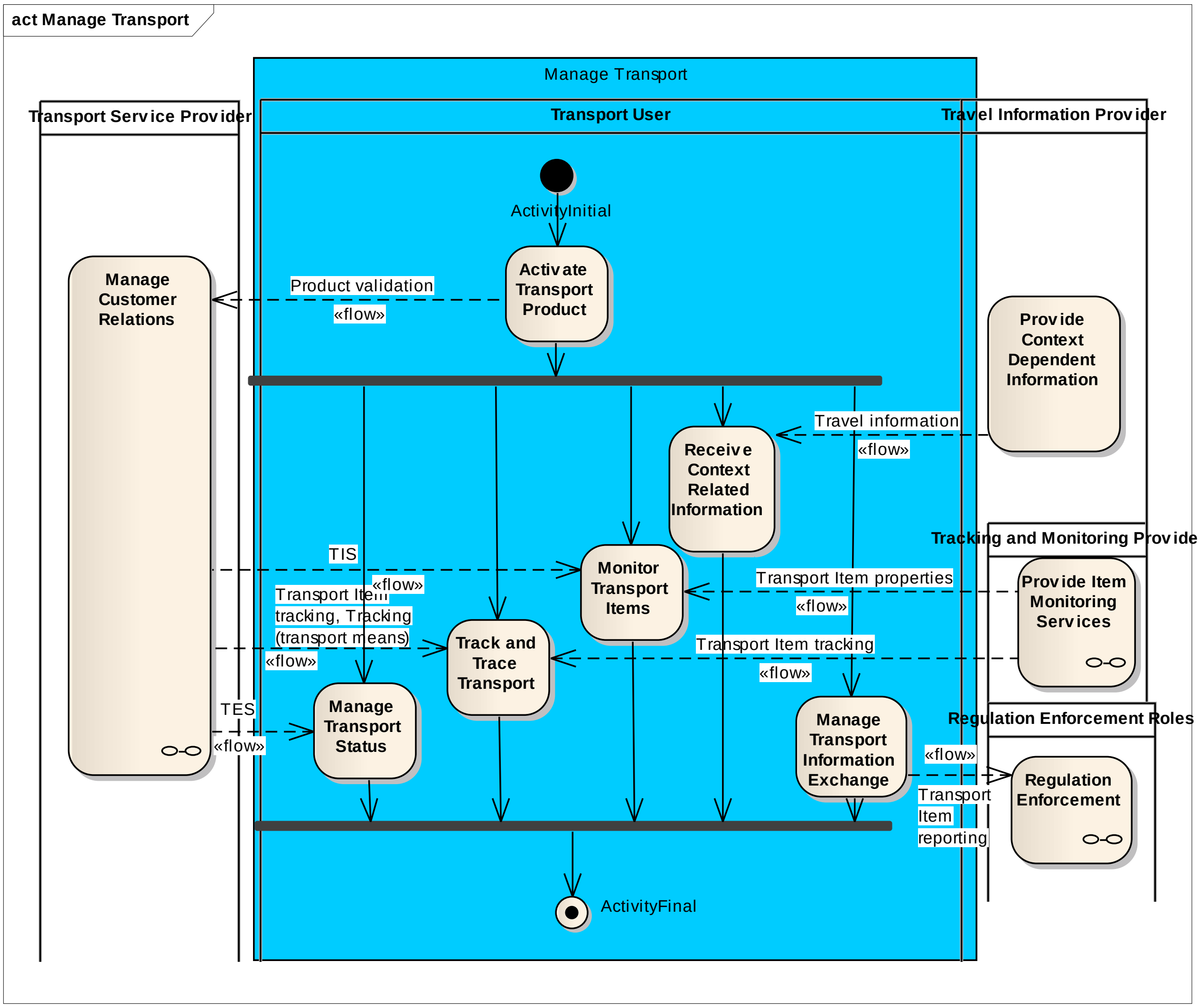
11.5.1.2 Gather Information



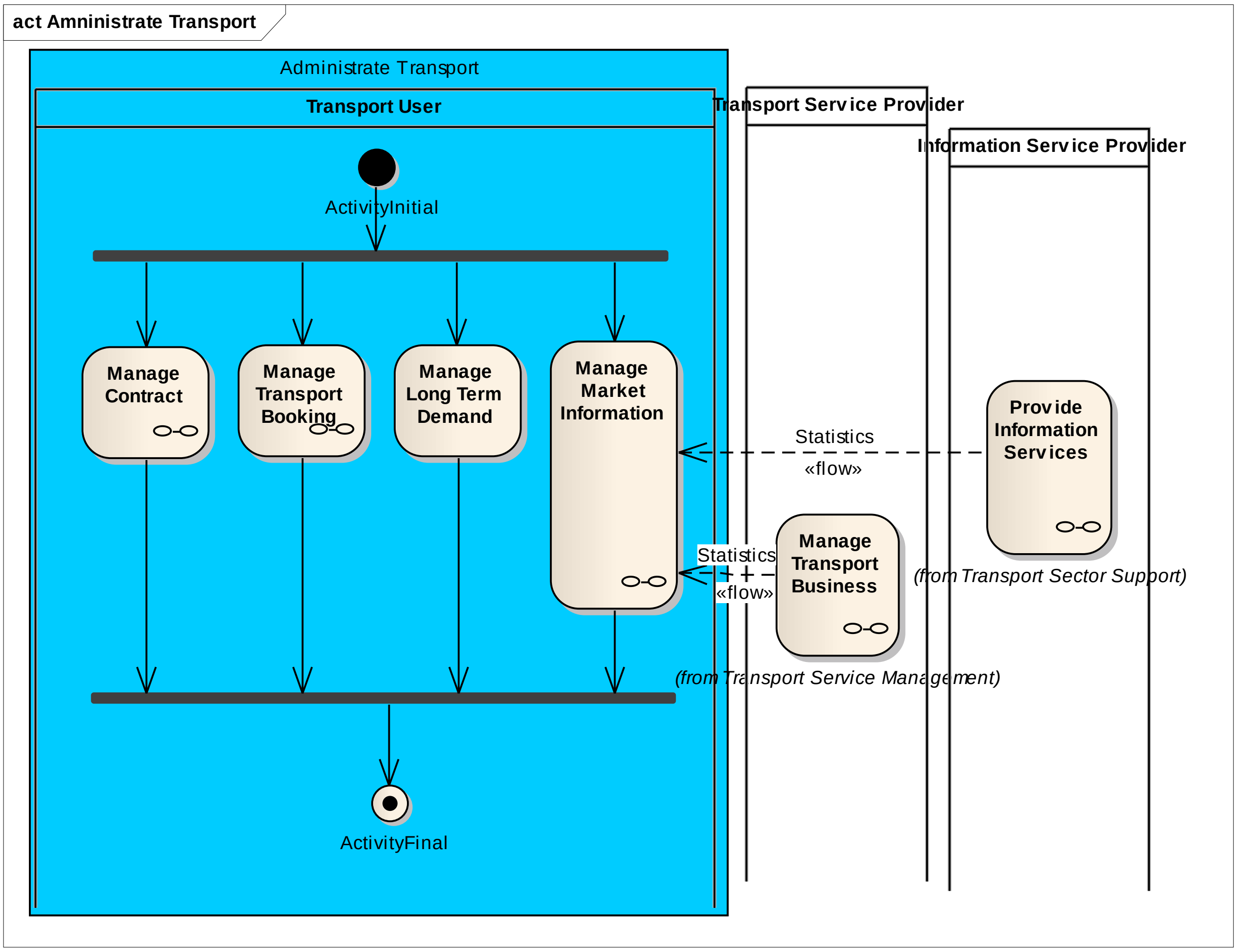
11.5.1.3 Manage Transport Execution Plan



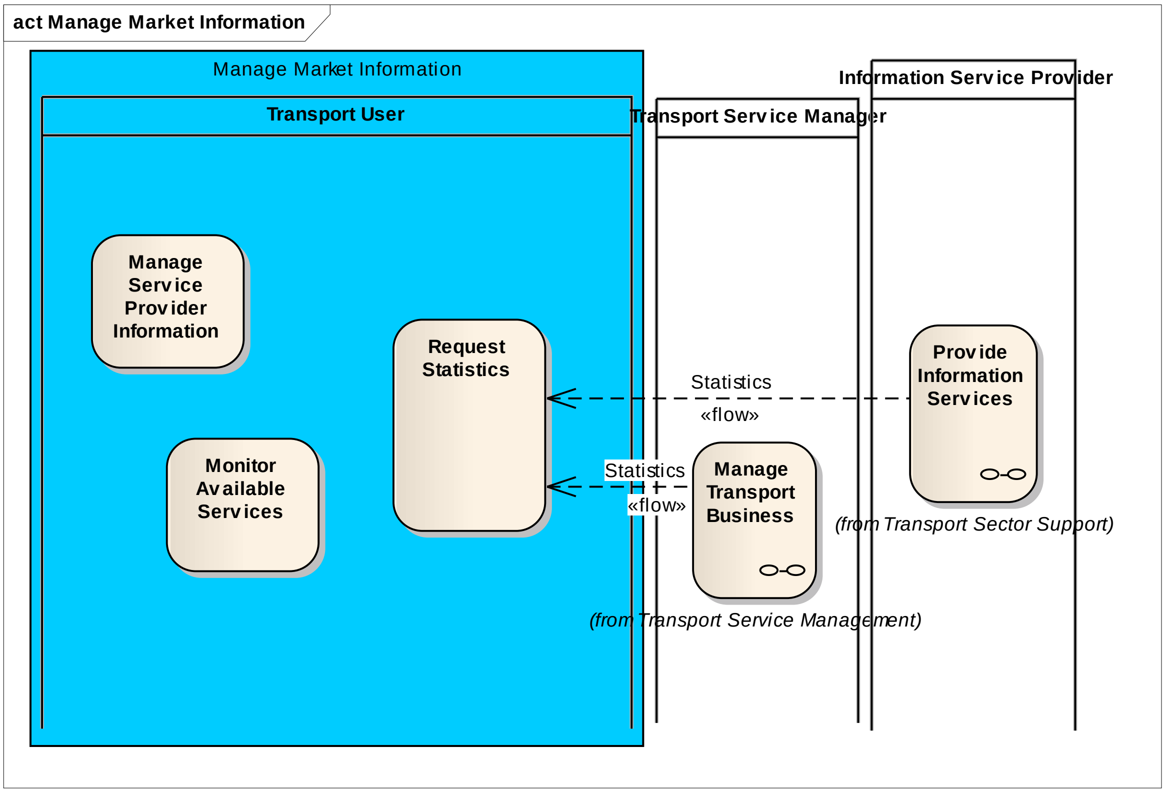
11.5.2 Manage Transport



11.5.3 Administrate Transport



11.5.3.1 Manage Market Information



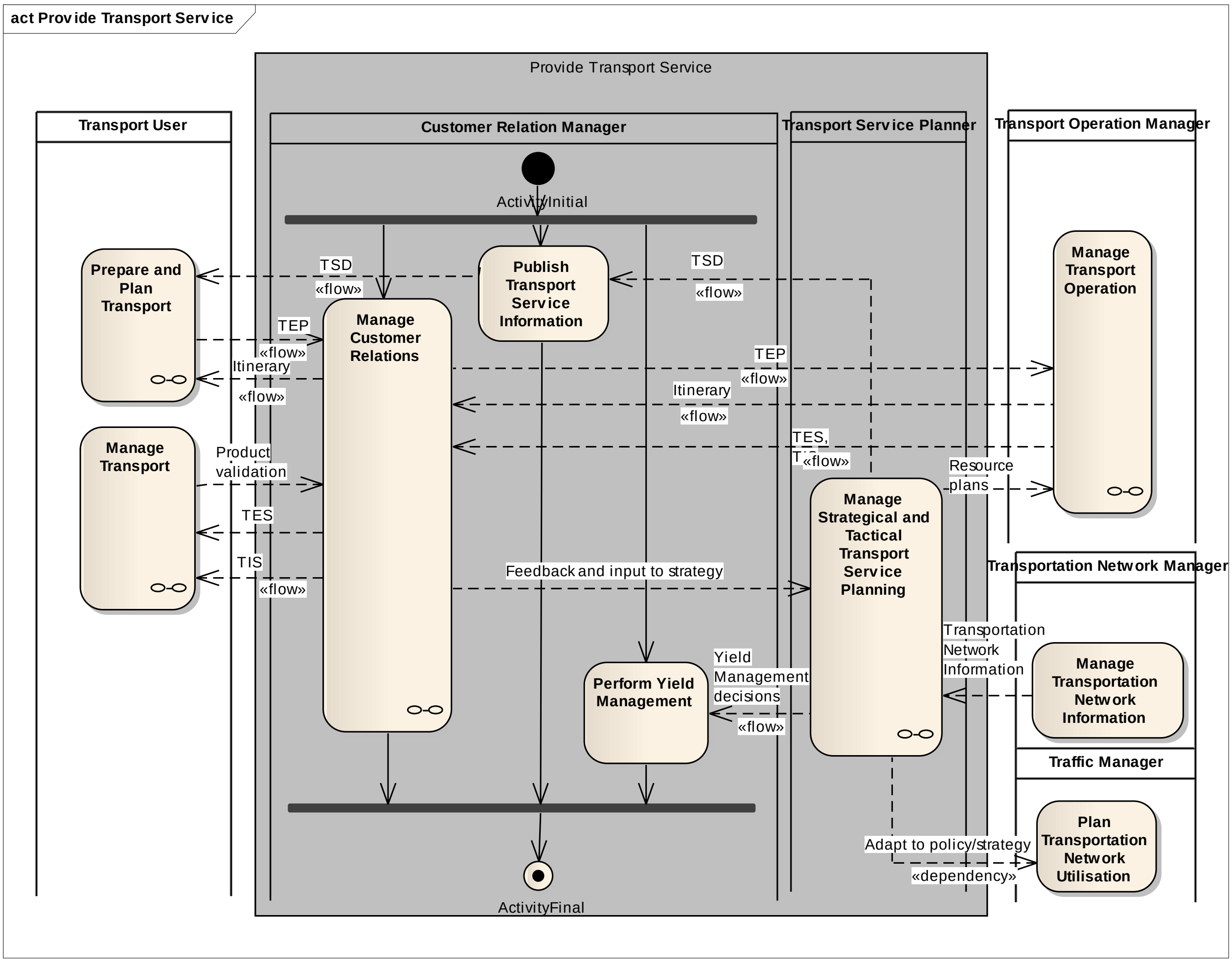
11.6 Transport Service Management processes

The activities of the Transport Service Provider include

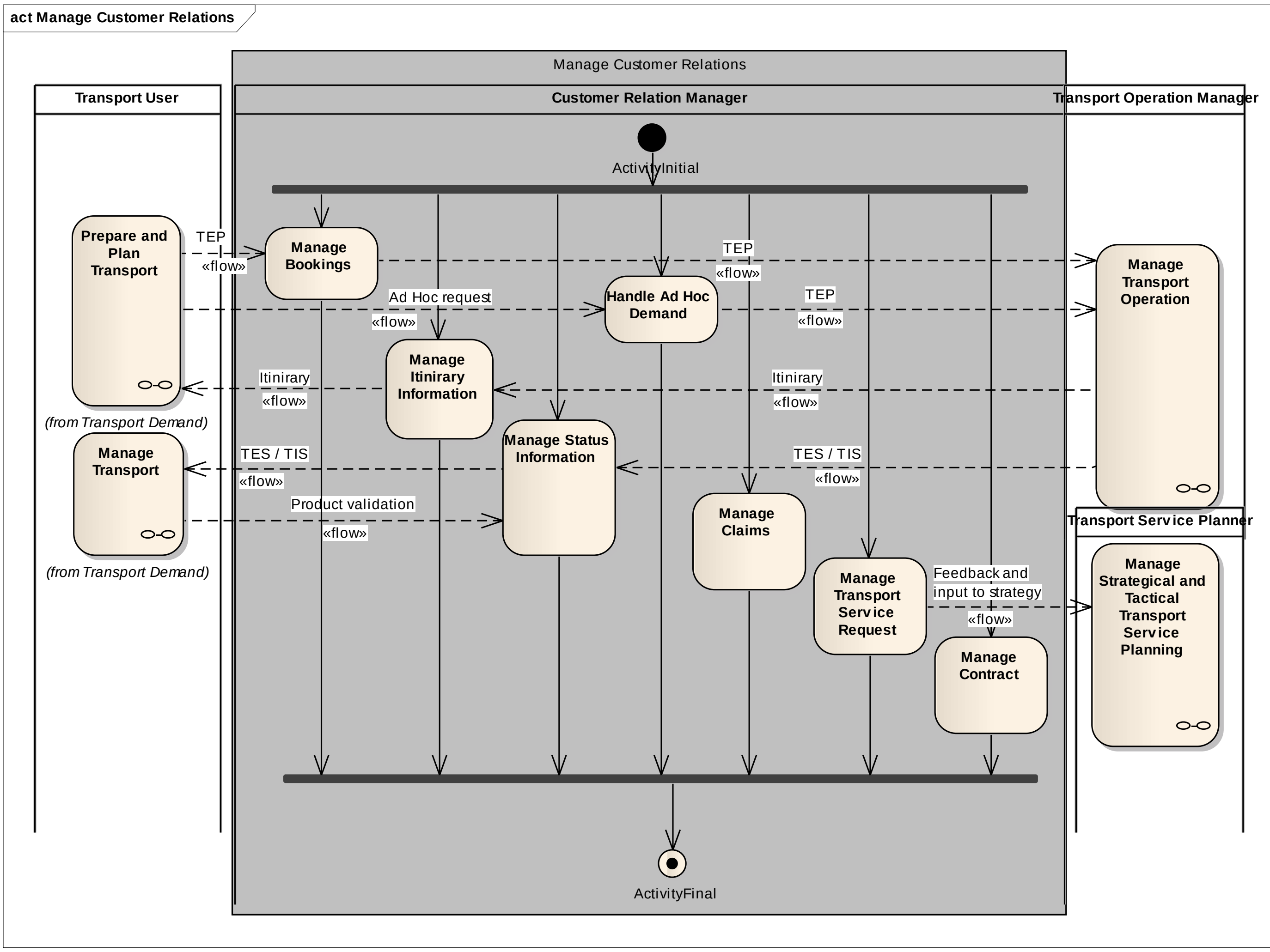
- The provision of transport services – strategic and tactical planning of the transport services and customer relations
- Transport operation management –operational planning, and management of ongoing transport operations.
- Transport operation execution – the actual execution of the transport operations
- Transport business management – the information and resource administration

The processes related to Transport Service Management are illustrated below.

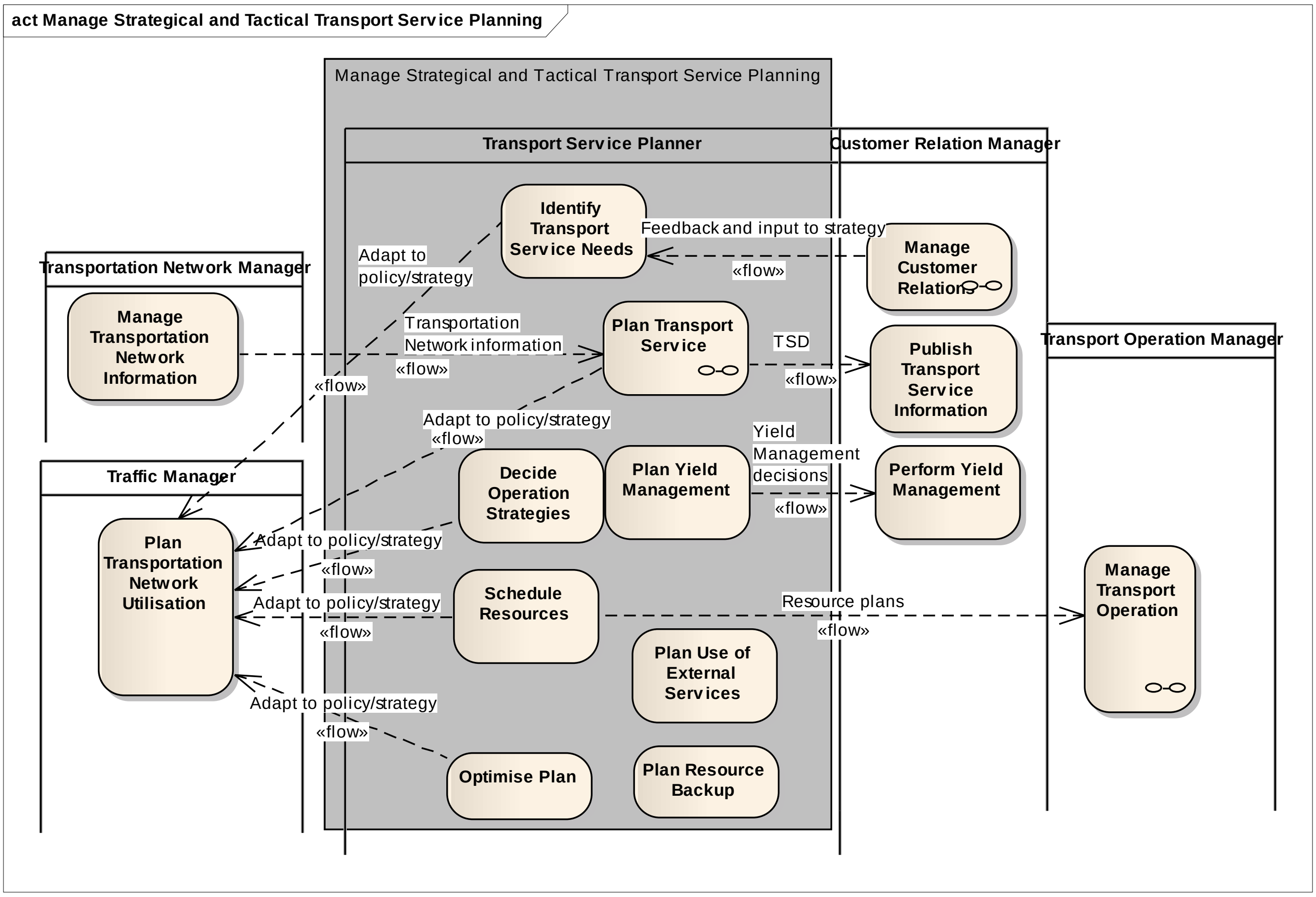
11.6.1 Provide Transport Service



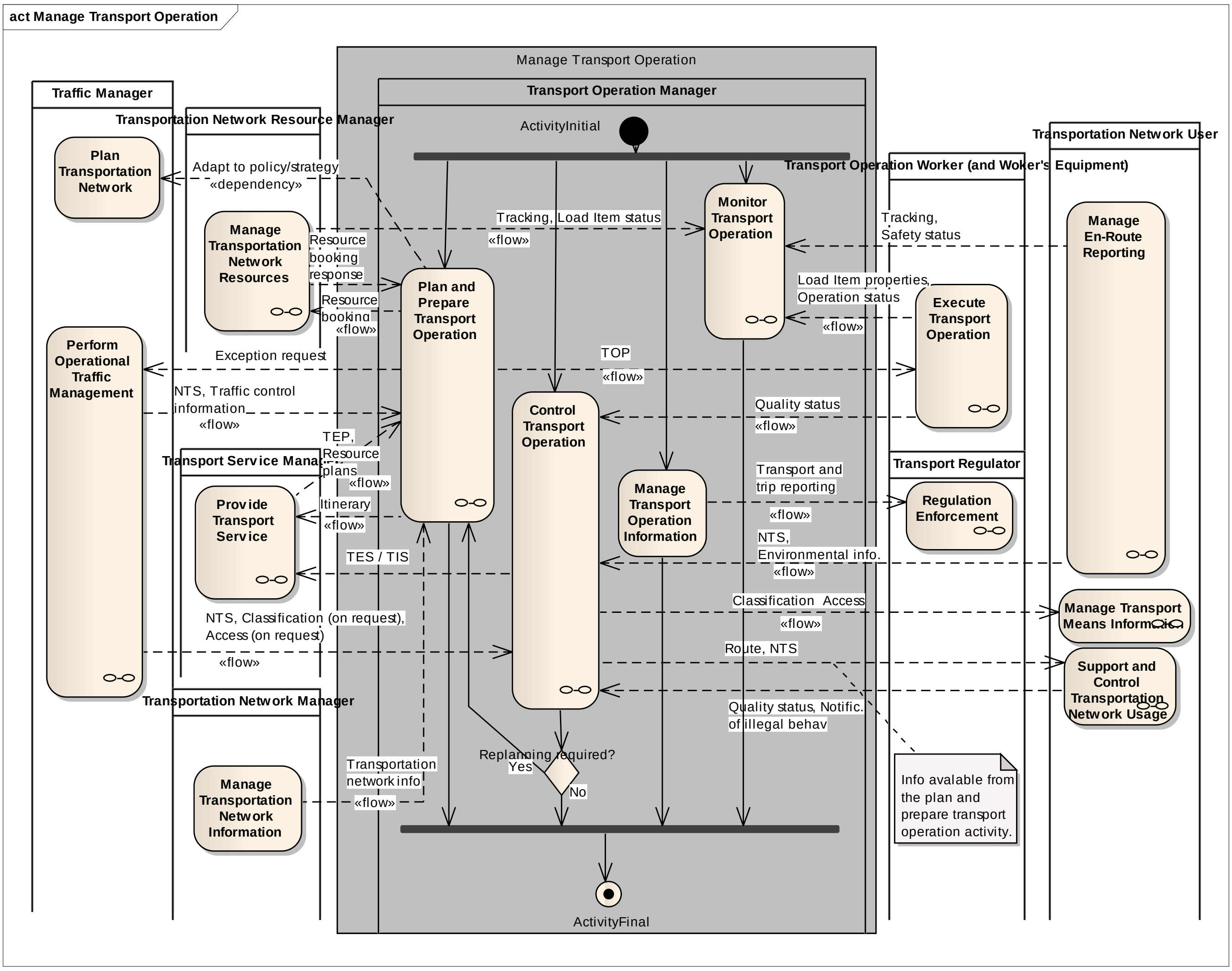
11.6.1.1 Manage Customer Relations



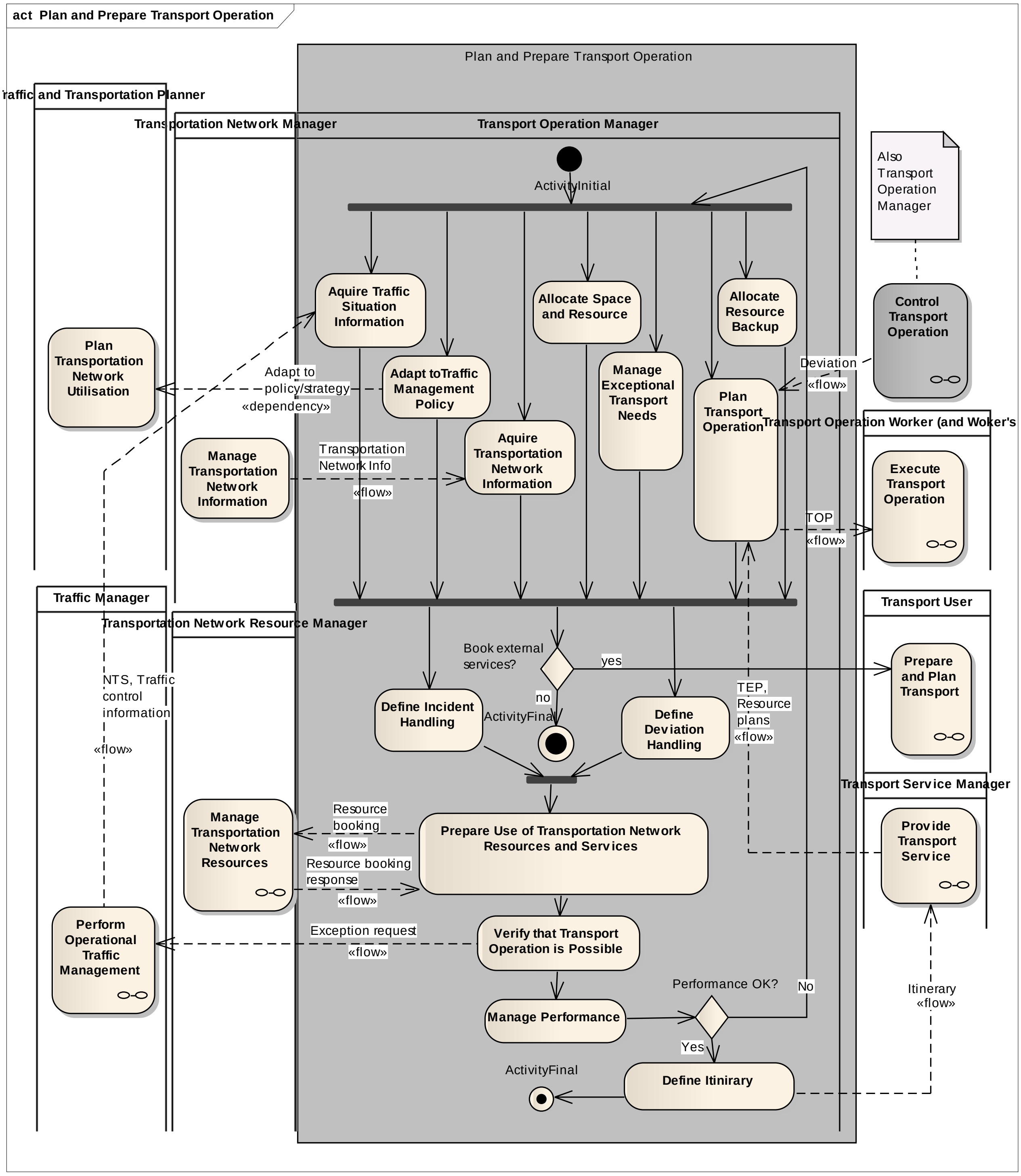
11.6.1.2 Manage Strategical and Tactical Transport Service Planning



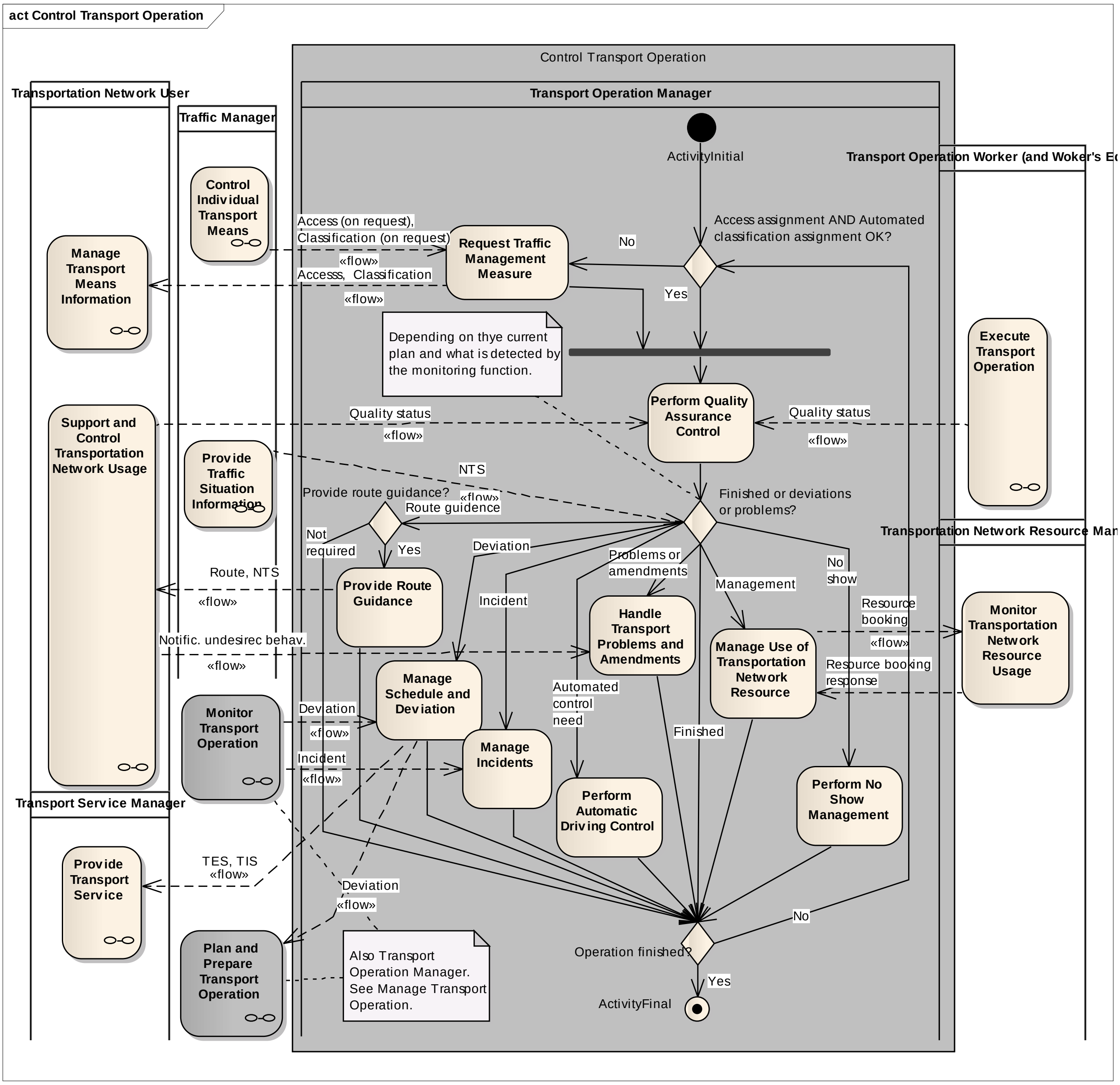
11.6.2 Manage Transport Operation



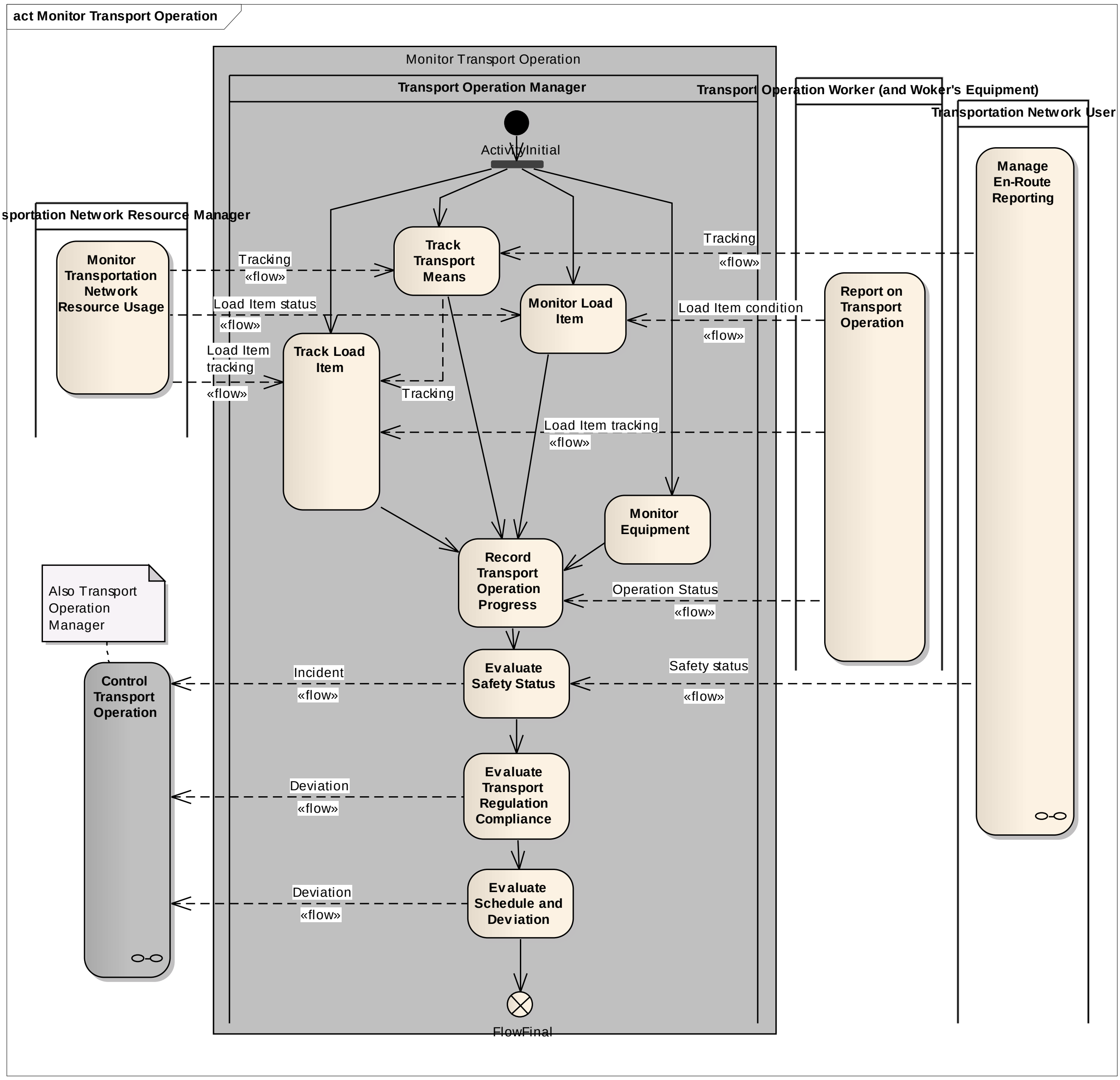
11.6.2.1 Plan and Prepare Transport Operation



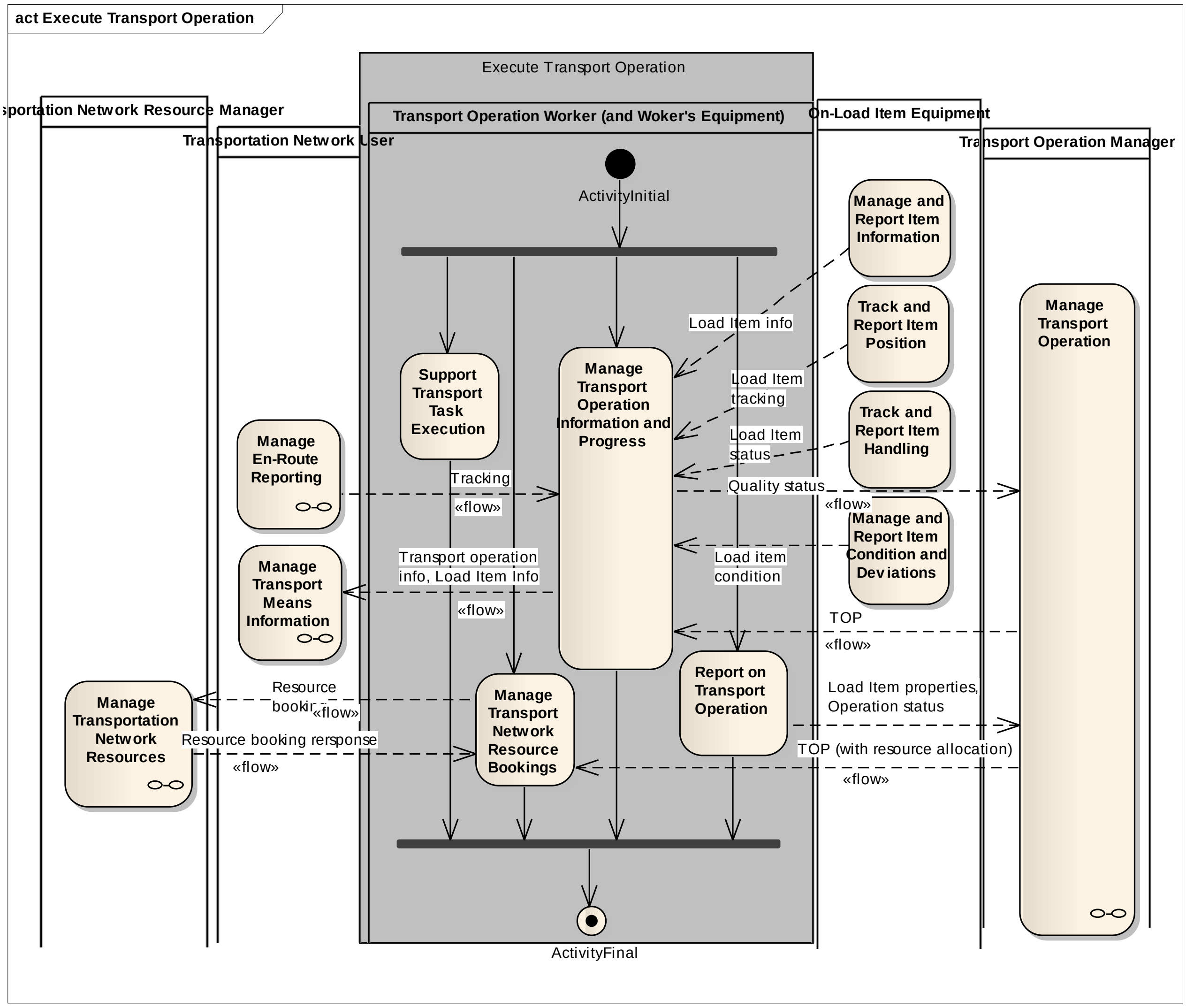
11.6.2.2 Control Transport Operation



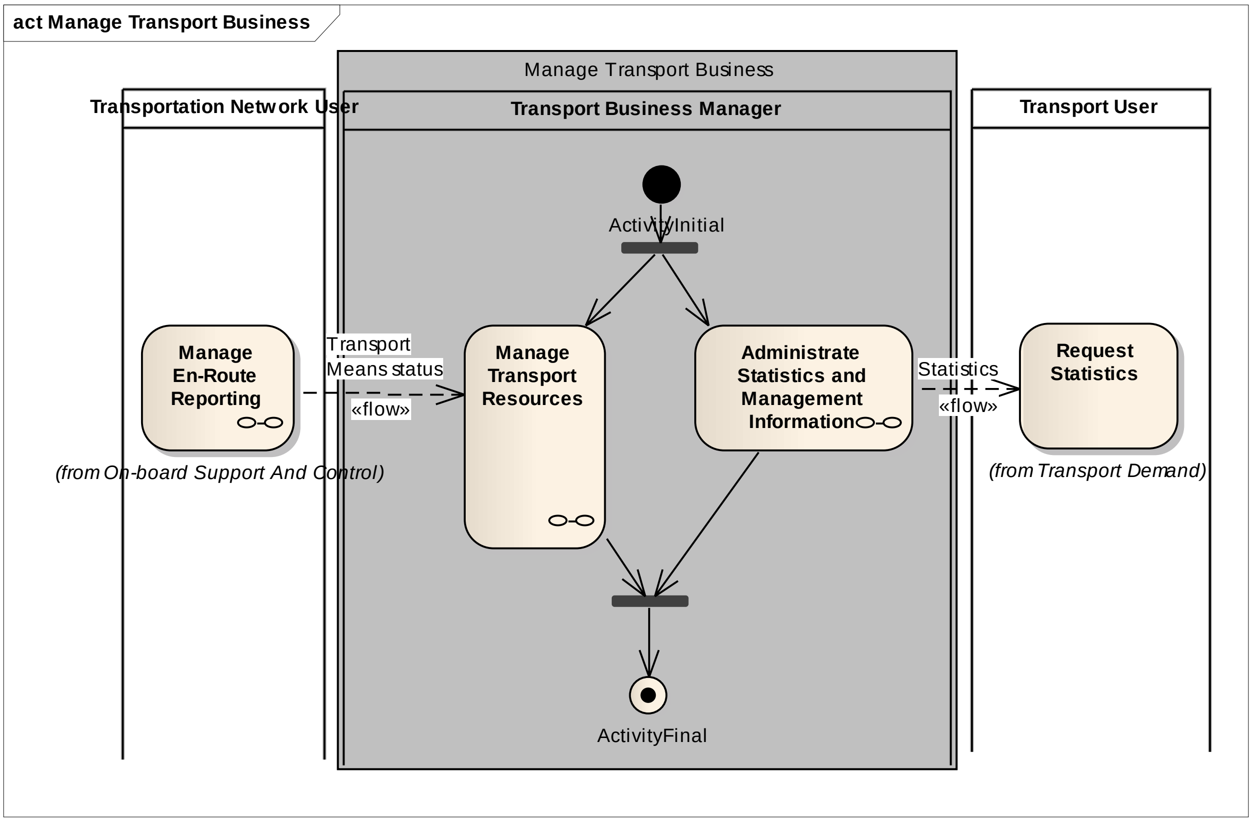
11.6.2.3 Monitor Transport Operation



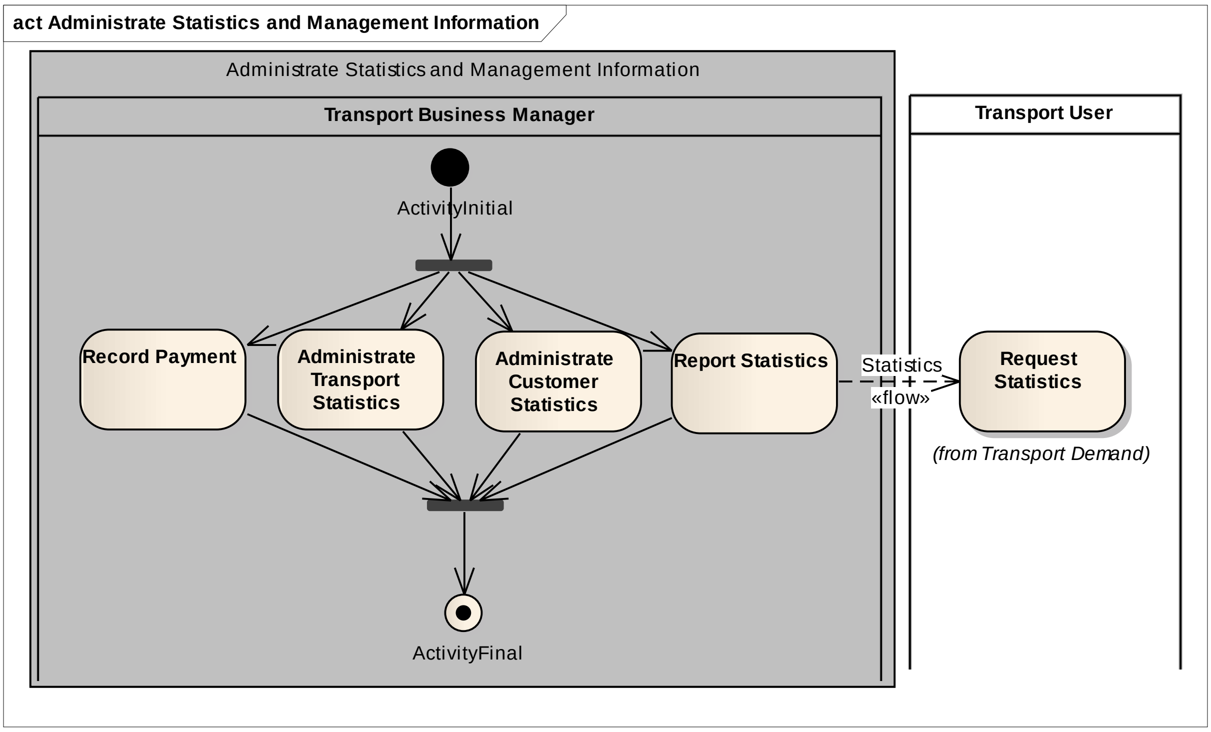
11.6.3 Execute Transport Operation



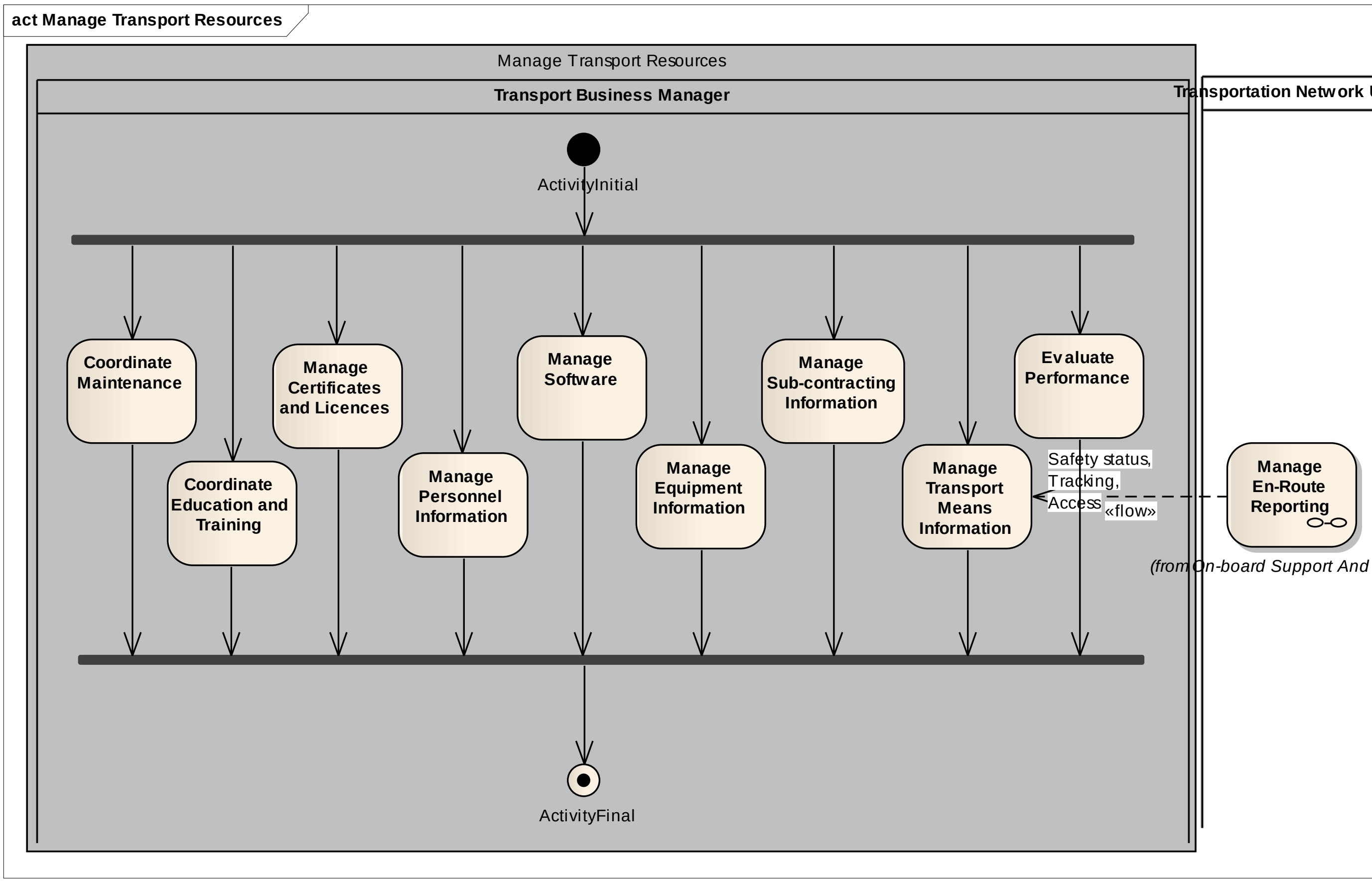
11.6.4 Manage Transport Business



11.6.4.1 Administrate Statistics and Management Information



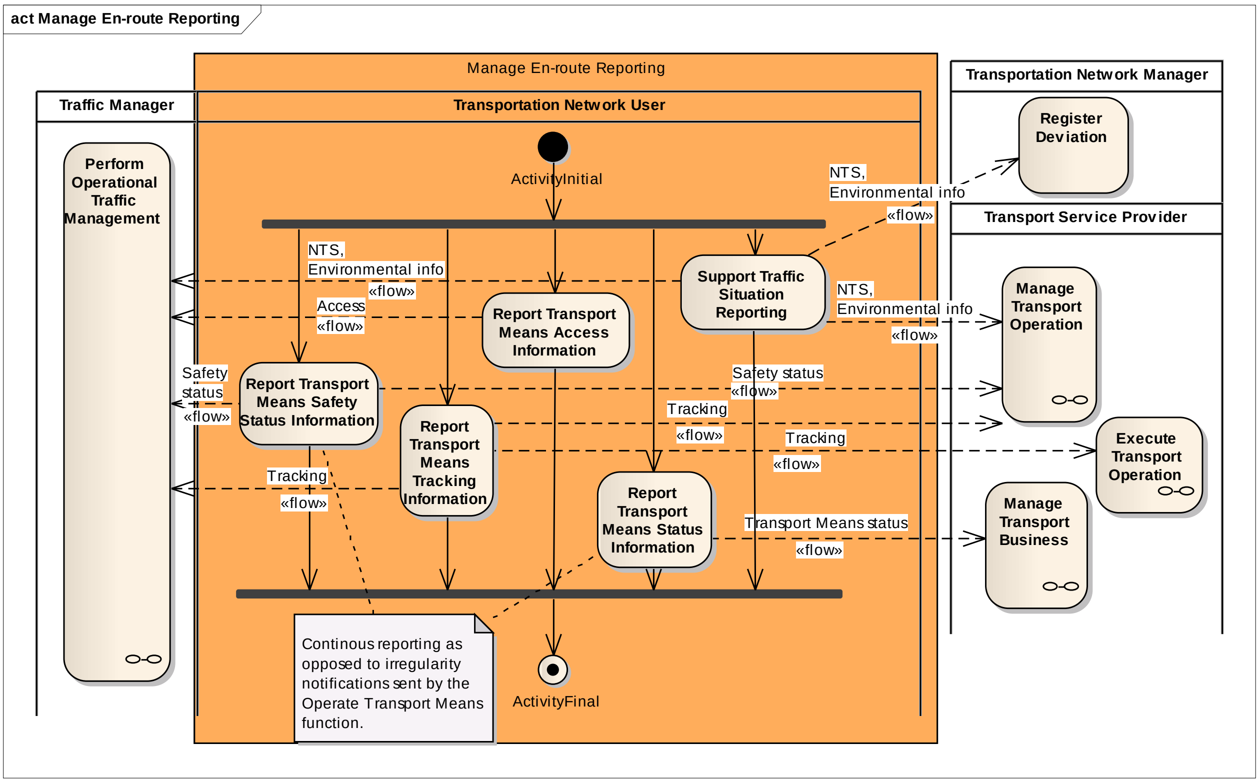
11.6.4.2 Manage Transport Resources



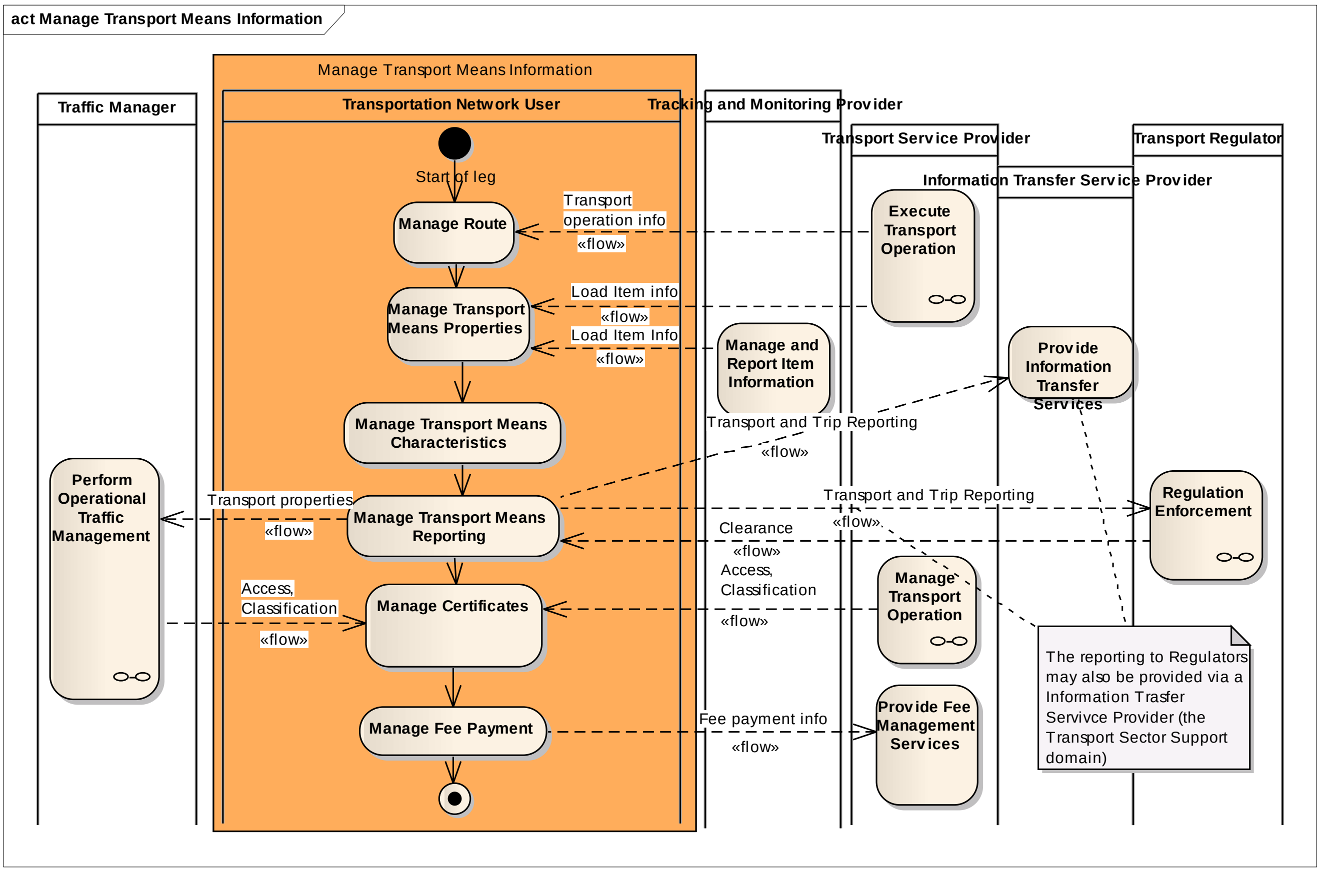
11.7 On-board Support and Control processes

The driving operation (to move the Transport Means as safely and efficiently as possible), the navigation (to find the destinations and to find the route), and reporting are supported.

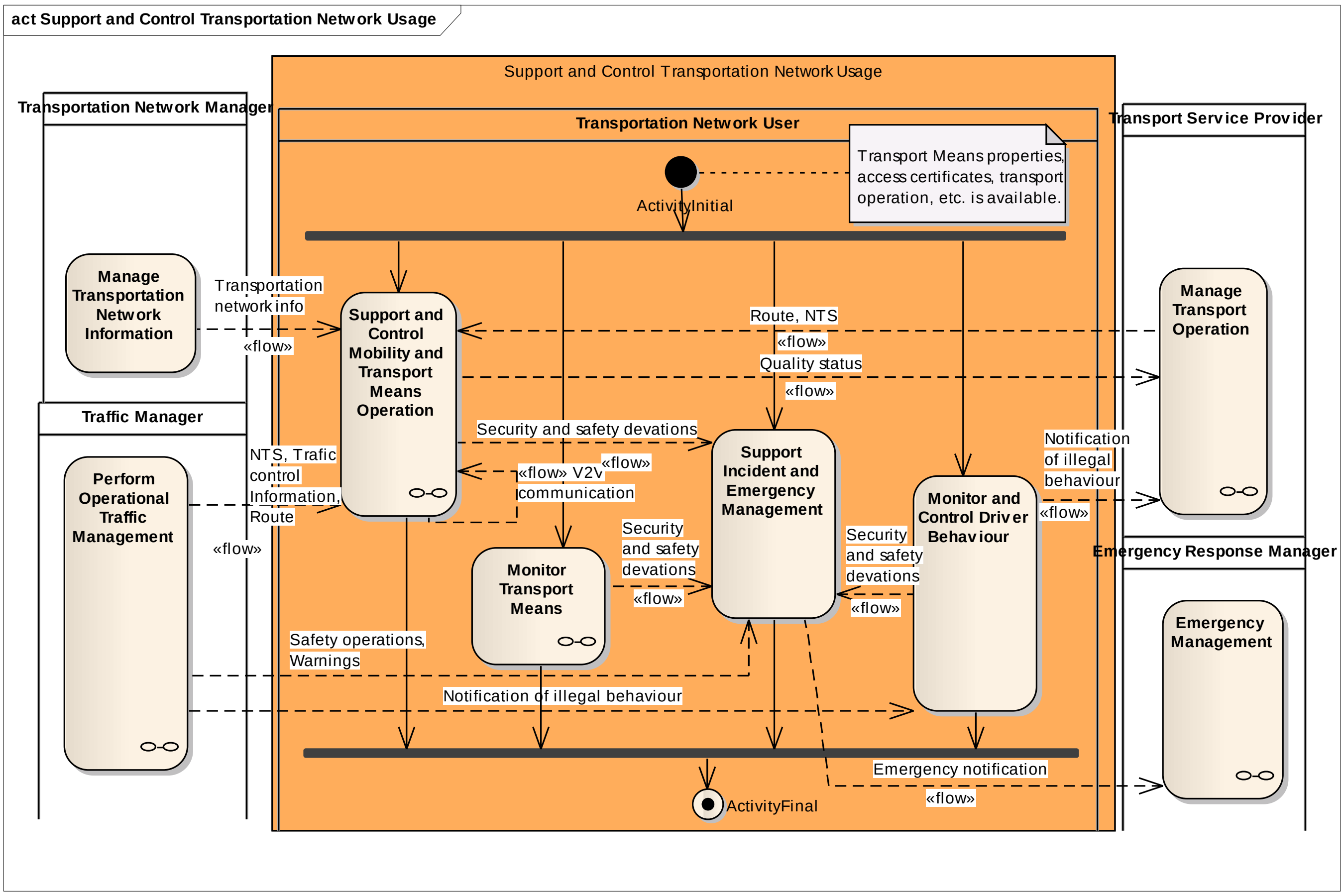
11.7.1 Manage En-route Reporting



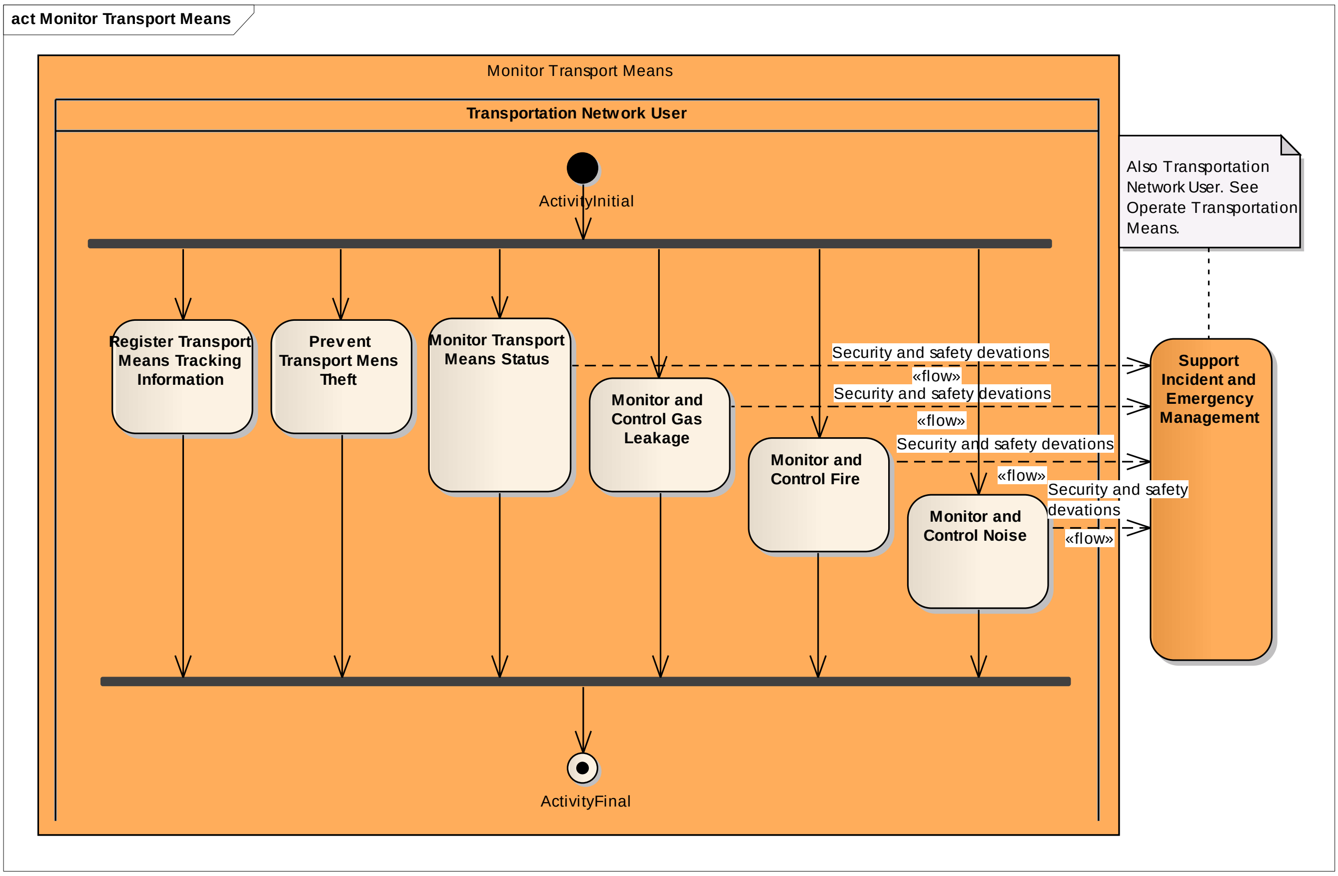
11.7.2 Manage Transport Means Information



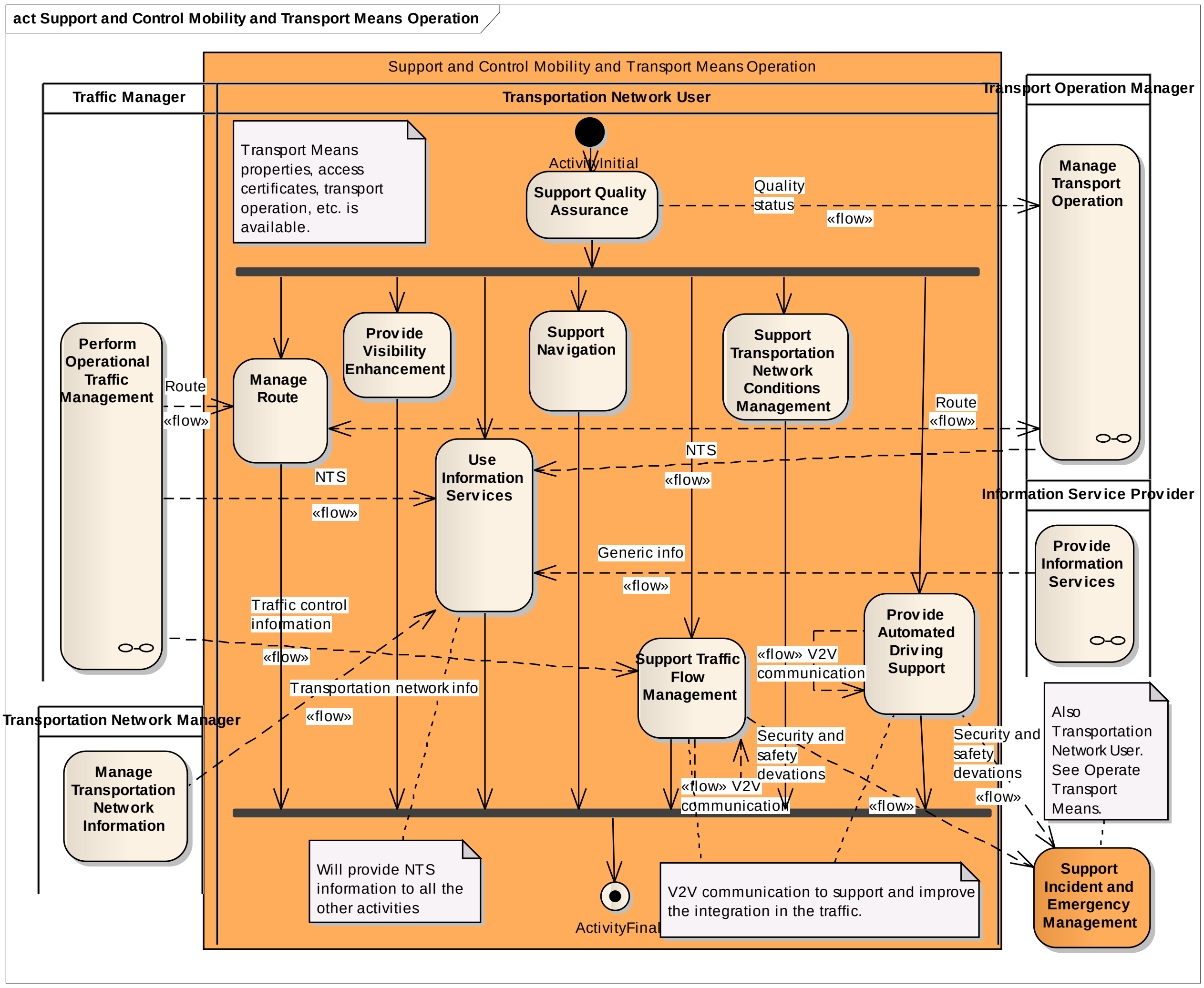
11.7.3 Support and Control Transportation Network Usage



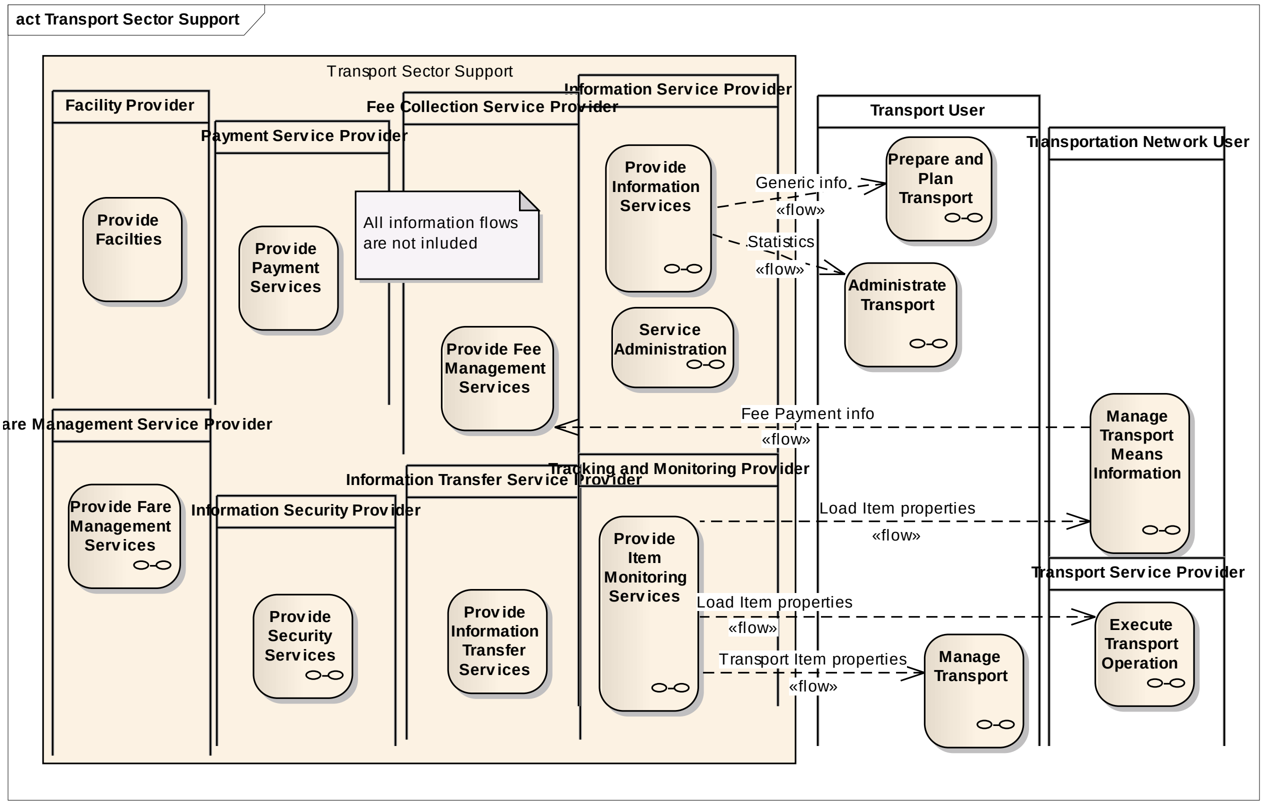
11.7.3.1 Monitor Transport Means



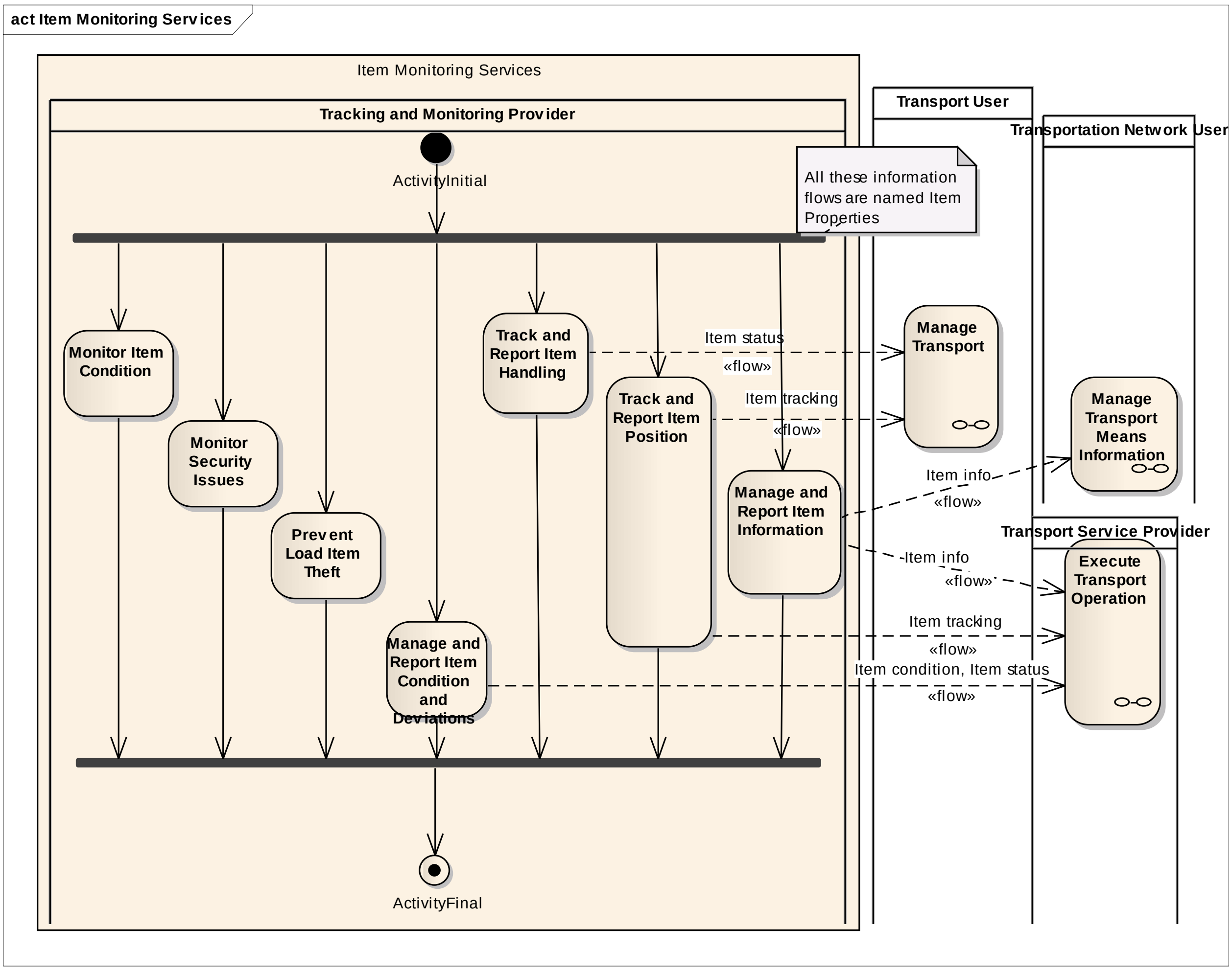
11.7.3.2 Support and Control Mobility and Transport Means Operation



11.8 Transport Sector Support processes

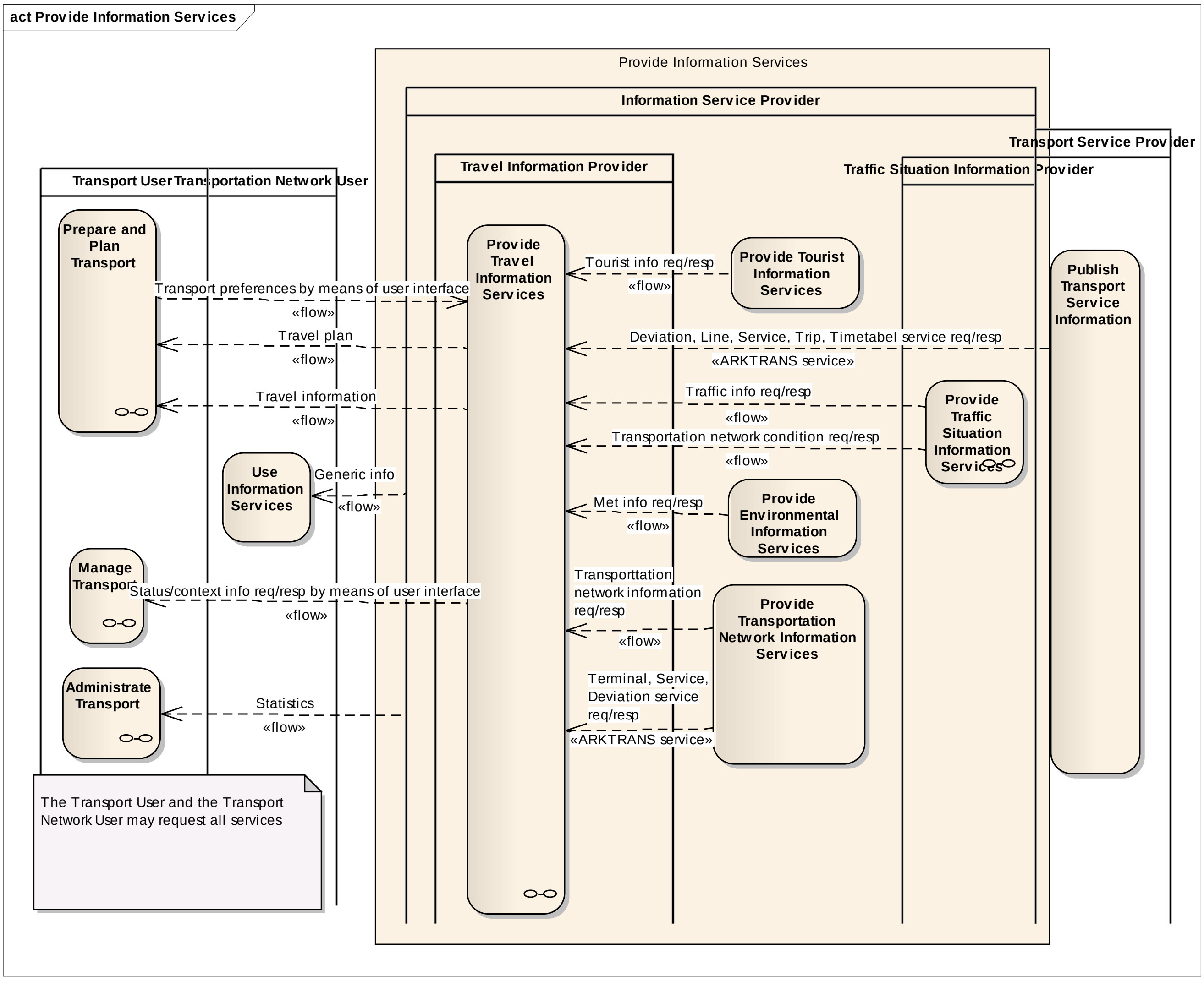


11.8.1 Provide Item Monitoring Services



11.8.2 Provide Information Services

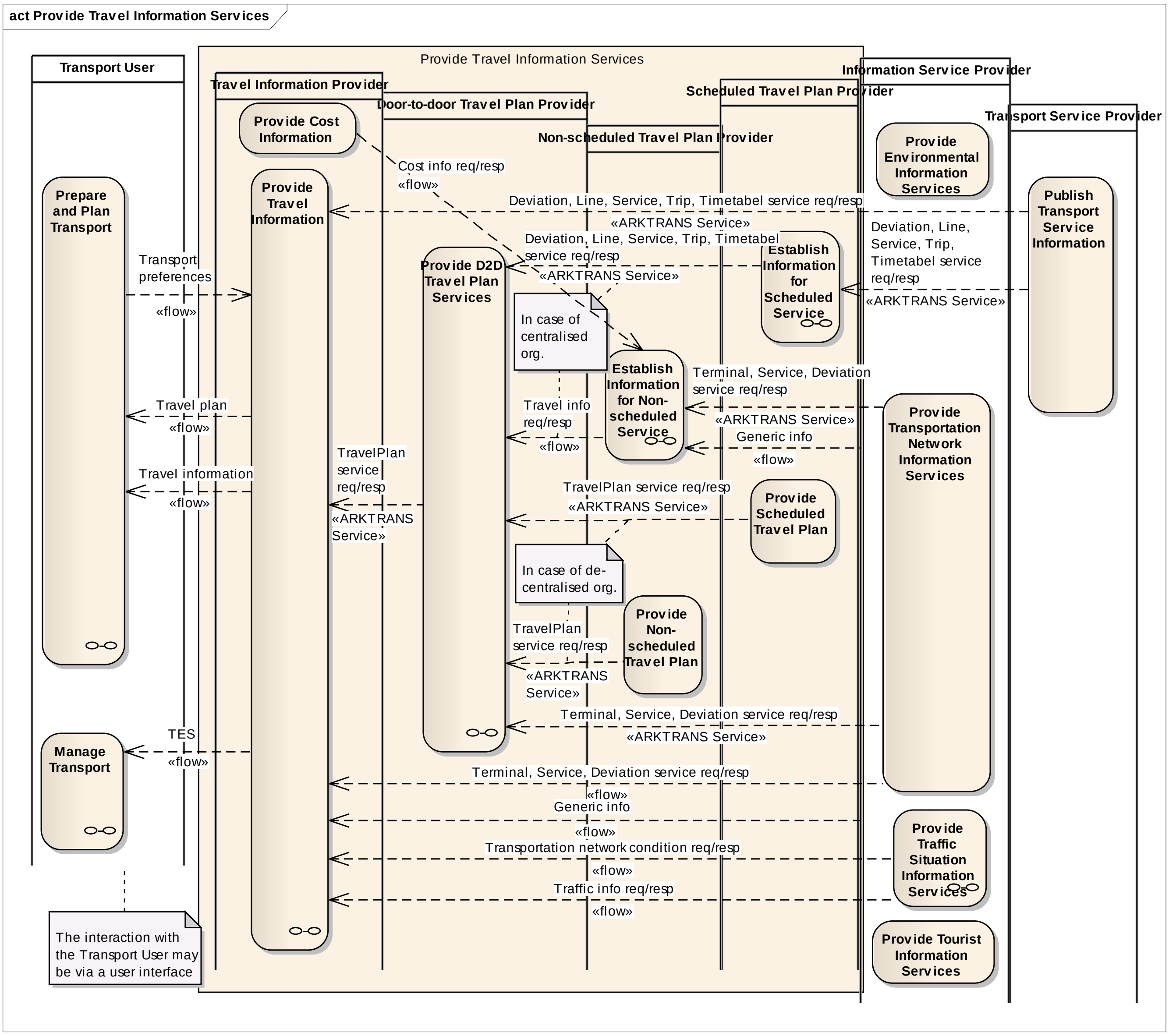
To provide travel information service, the Travel Information Provider has to collect information. A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with "ARKTRANS Service" – see Table 10 Services and operations.



11.8.2.1 Provide Travel Information Services

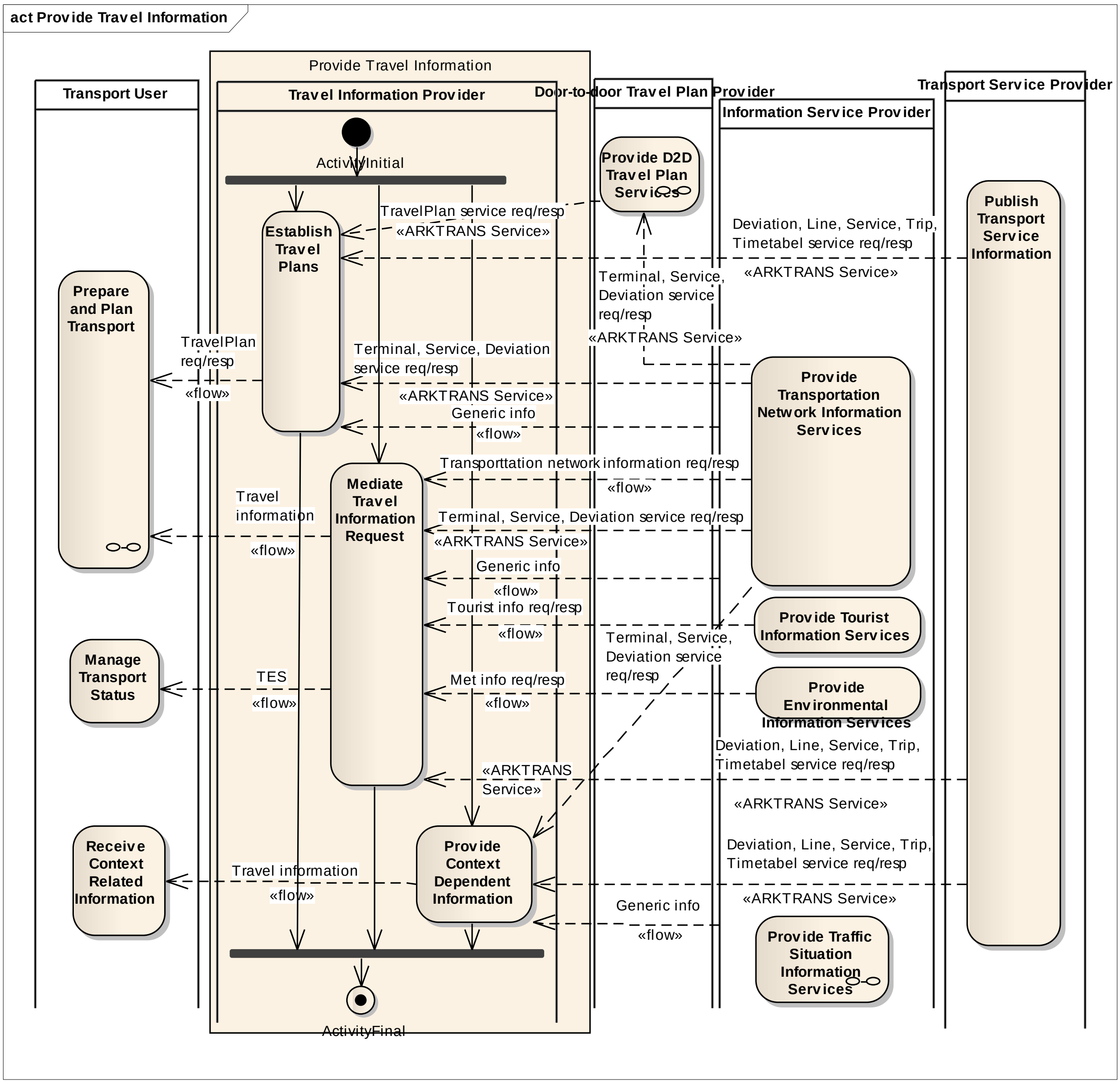
The Travel Information Provider will provide travel plans and travel information to the Transport User via a user interface. Travel plans are provided according to the travel preferences of the Transport User.

To establish the travel plan and the travel information, the Travel Information Provider has to interact with other service and information providers. A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with "ARKTRANS Service" – see Table 10 Services and operations.



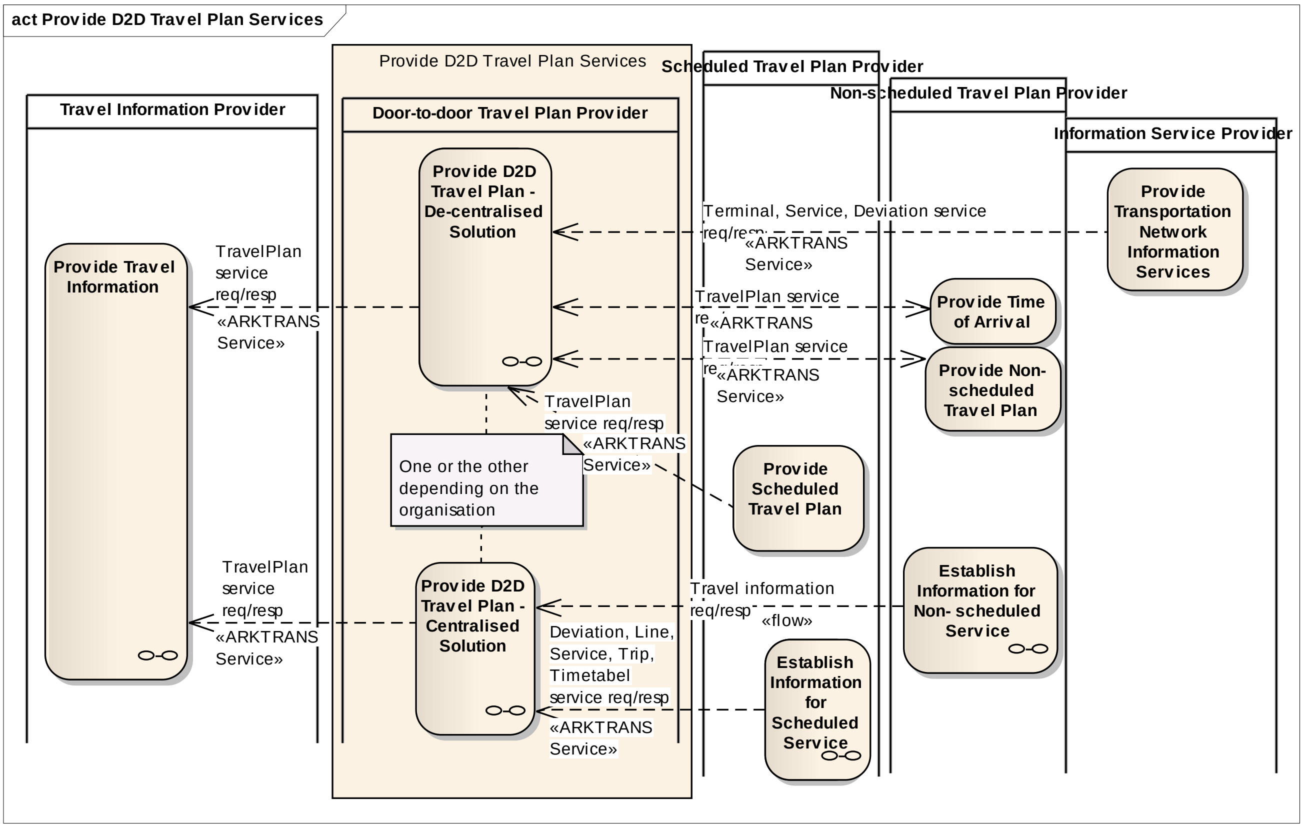
11.8.2.1.1 Provide Travel Information

To establish the travel plan and the travel information, the Travel Information Provider has to interact with other service and information providers. A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with "ARKTRANS Service" – see Table 10 Services and operations.



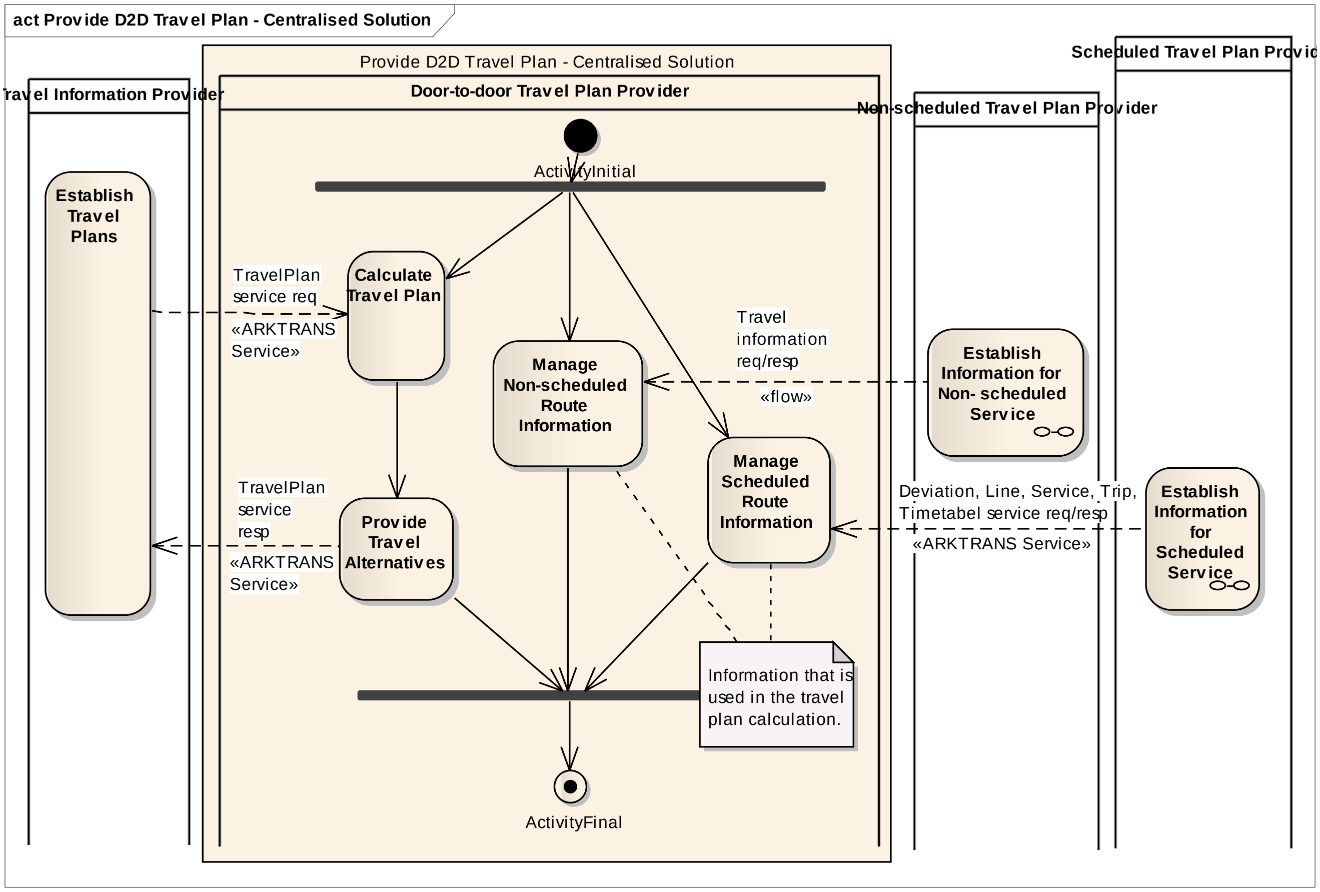
11.8.2.1.2 Provide D2D Travel Plan Services

A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with "ARKTRANS Service" – see Table 10 Services and operations.



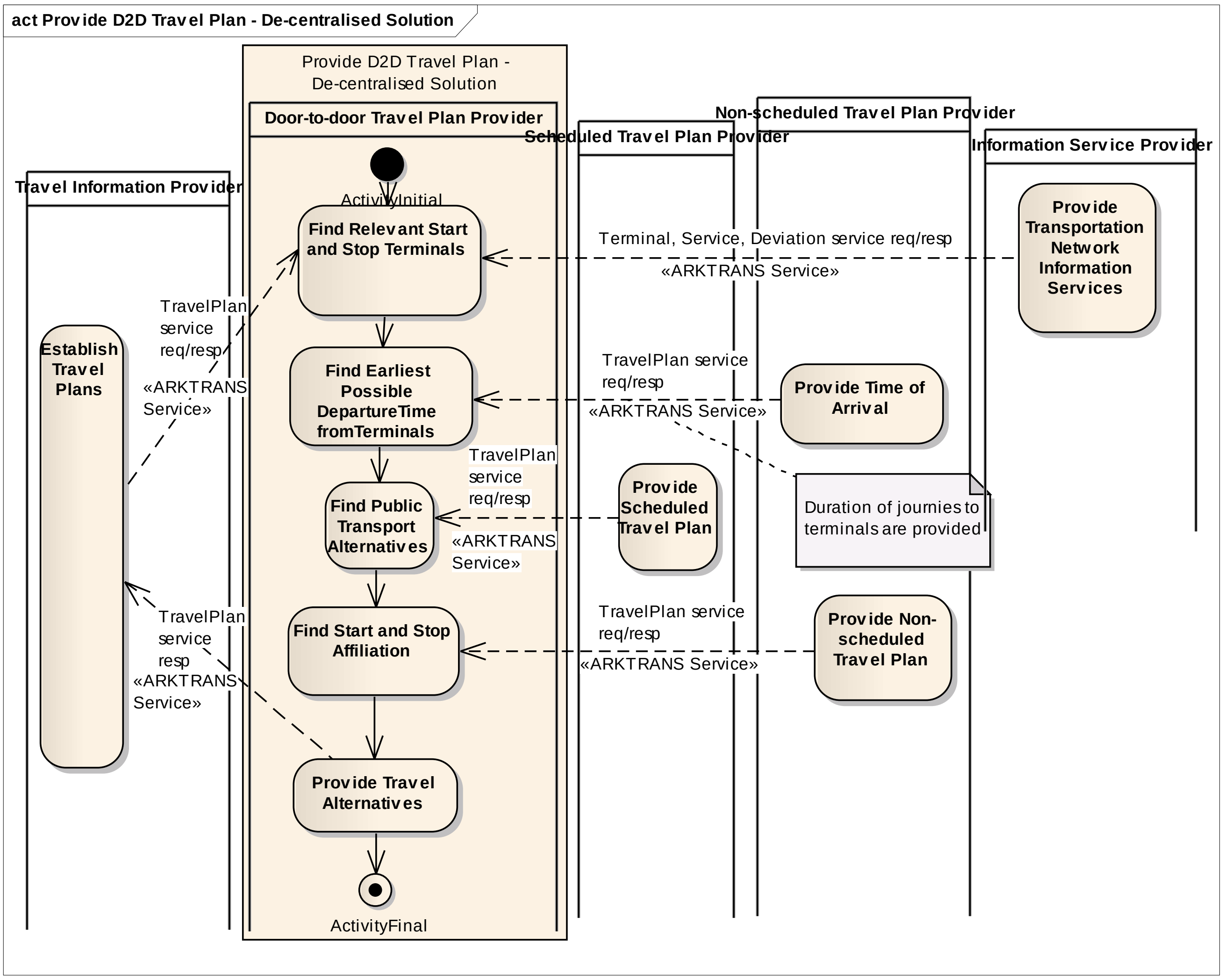
11.8.2.1.2.1 Provide D2D Travel Plan - Centralised Solution

A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with "ARKTRANS Service" – see Table 10 Services and operations.



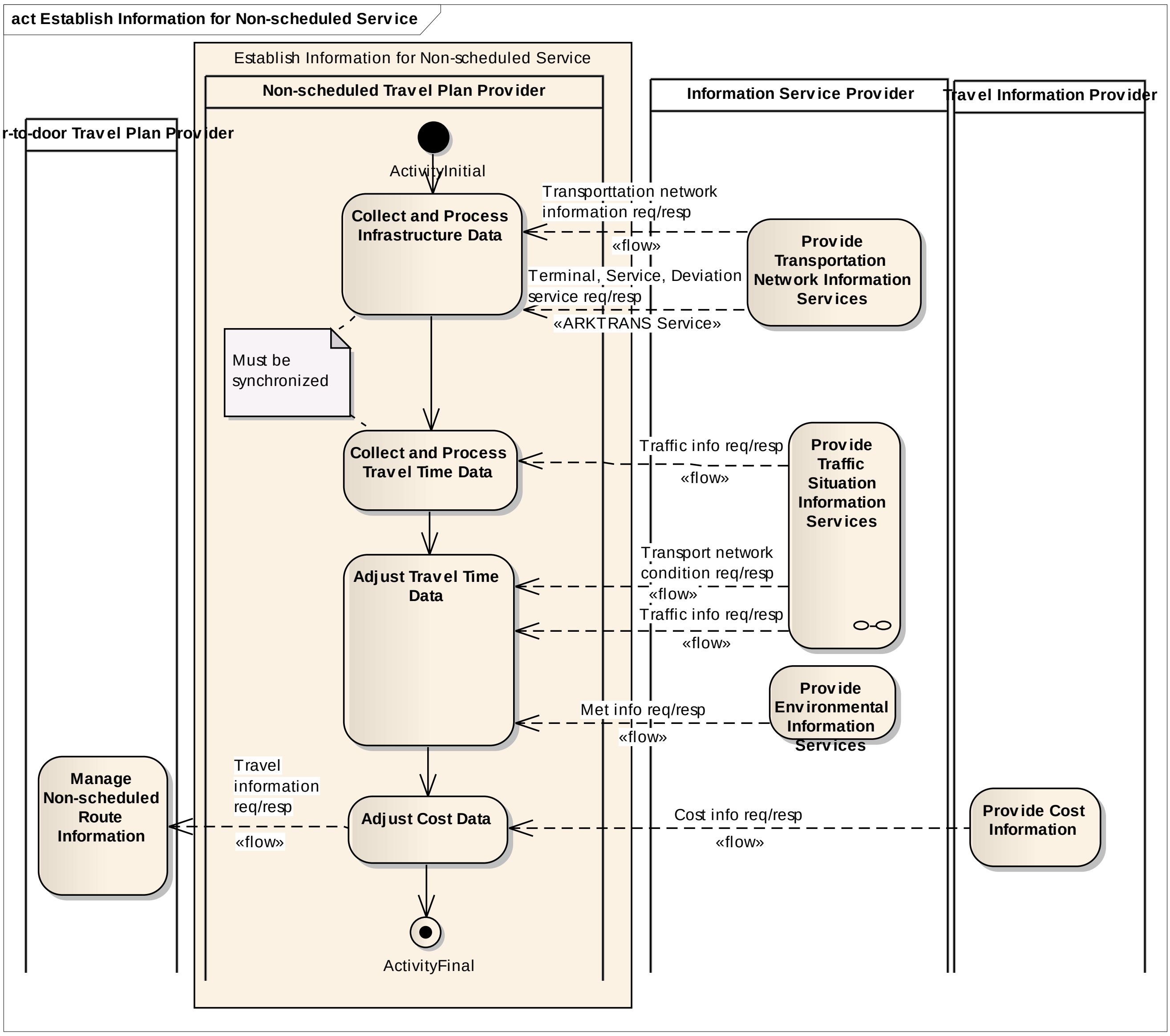
11.8.2.1.2.2 Provide D2D Travel Plan - De-centralised Solution

A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with “ARKTRANS Service” – see Table 10 Services and operations.



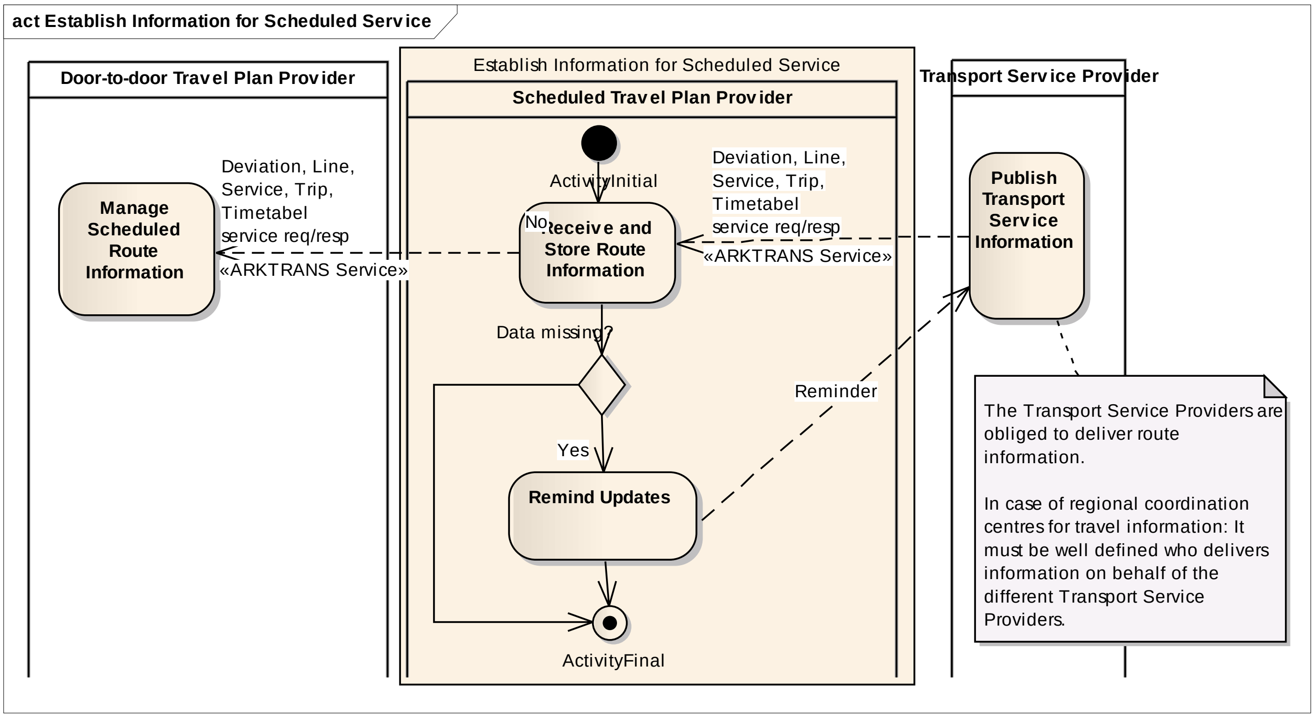
11.8.2.1.3 Establish Information for Non-scheduled Service

A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with “ARKTRANS Service” – see Table 10 Services and operations.

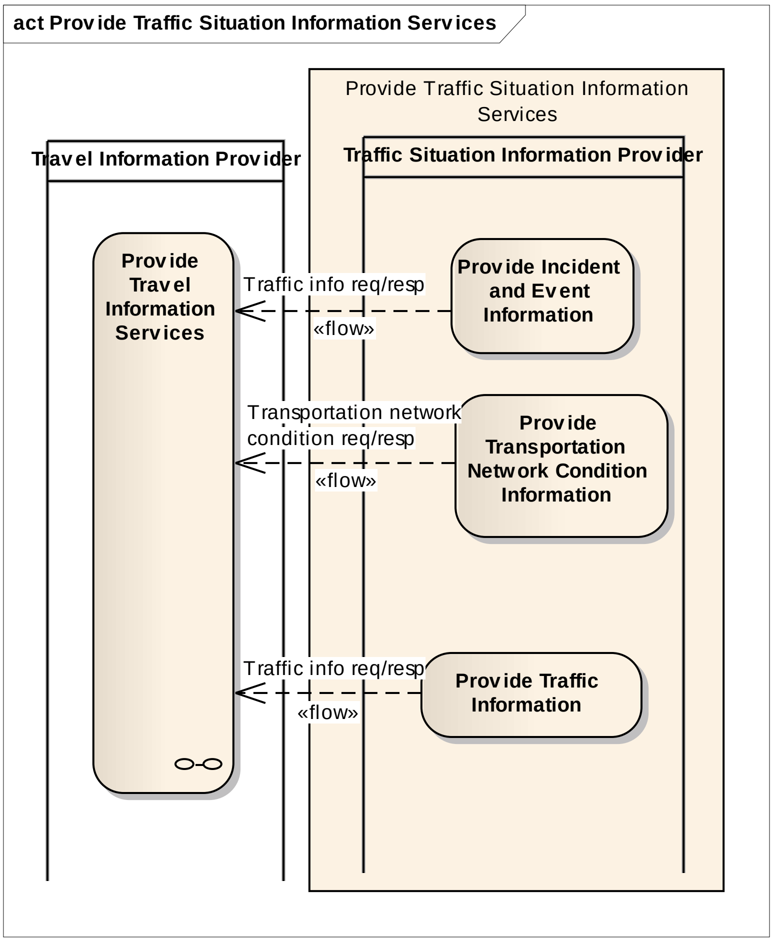


11.8.2.1.4 Establish Information for Scheduled Service

A part of the interaction will be done by means of open services specified in ARKTRANS (stereotyped with "ARKTRANS Service" – see Table 10 Services and operations.



11.8.2.2 Provide Traffic Situation Information Services



11.9 Interactions

As illustrated in the activity diagrams, information will flow between the domains of the Reference Mode. These interactions are listed in the table below, and the terminology used is further described in Chapter 14. Some of the information flows are in the diagrams stereotyped as ARKTRANS services. The implementation of these flows is described in 12.4.

Table 1 Interactions in the Activity diagrams

Interaction	Description
Access	See Chapter 14
Area Traffic Info	See Chapter 14 Part of Network and Traffic Status
Resource Booking	See Chapter 14
Resource Booking Response	See Chapter 14
Classification	See Chapter 14
Clearance	See Chapter 14
Deviation	See Chapter 14
Emergency Demand	See Chapter 14
Emergency Notification	See Chapter 14
Environmental Information. More detailed interactions: o Meteorological information	See Chapter 14
Exception Request	See Chapter 14
Generic Information. More detailed interactions: o Cost info o Travel time info o Misc context dependent info o Travel information / travel information services	See Chapter 14 See below for specification of Travel information services
Generic Route Information	See Chapter 14 Part of Network and Traffic Status
Guidelines	See Chapter 14
Incident	See Chapter 14
Incident and Accident Information	See Chapter 14 Part of Traffic Information
Item Properties. More detailed interactions: o Item information o Item status o Item tracking o Item condition	See Chapter 14
Itinerary	See Chapter 14
Irregularity Notification	See Chapter 14
Load Item Properties	Item Properties applied on a Load Item. See Chapter 14
Network and Traffic Status (NTS). More detailed interactions: o Traffic information o Transportation Network Condition o Generic Route Information o Area Traffic Information	See Chapter 14
Notification of illegal behaviour	See Chapter 14
Operation Status	See Chapter 14
Preference check	See Chapter 14
Product Notification of illegal behaviour	See Chapter 14
Quality Status	See Chapter 14
Resource Plan	See Chapter 14
Route	See Chapter 14
Safety Deviation	See Chapter 14
Safety Operation	See Chapter 14
Safety Status	See Chapter 14
Statistics	See Chapter 14
Tourist information	See Chapter 14

Tracking	See Chapter 14
Traffic Control Information	See Chapter 14
Traffic Information. More detailed interactions: o Incident and accident information o Traffic Flow information	See Chapter 14 Part of Network and Traffic Status
Transportation Network Condition	See Chapter 14 Part of Network and Traffic Status
Transportation Network Information	See Chapter 14
Transport and Trip Reporting	See Chapter 14
Transport Item Reporting	See Chapter 14
Transport Means Status	See Chapter 14
Transport Preferences	See Chapter 14
Transport Properties	See Chapter 14
Transport Item Reporting	See Chapter 14
Transport Item Properties	Item Properties applied on a Transport Item. See Chapter 14
Transport Item Status (TIS)	See Chapter 14
Transport Execution Plan (TEP)	See Chapter 14
Transport Execution Status (TES)	See Chapter 14
Transport Means Status	See Chapter 14
Transport Means Tracking	See Chapter 14
Transport Operation Information	See Chapter 14
Transport Operation Plan (TOP)	See Chapter 14
Travel information / Travel Information Services. More detailed interactions: o Access Point services o Deviation service o Line service o Service service o Stop Point services o Terminal service o Timetable services o Transfer services o Trip service o Relevant parts of Generic information	See Chapter 14 ARKTRANS services - see Table 10 Se above for specification of Generic information.
Travel Plan	See Chapter 14
Travel Plan service	See Table 10
Warnings	See Chapter 14
Yield Management Decision	See Chapter 14

12 Information View

The information view addresses the information that is exchanged between the stakeholders in the transport sector. The information is specified in a technology independent way, i.e. by means of UML class diagrams. The results are harmonised across all transport modes. The aim is to define open interfaces for information exchange by means of a model driven approach (MDA) [13].

The content of the information view depends on input from projects and activities that have specified and tested transport related information. The input must be generic and multimodal to be accepted. So far, information related to just a sub-set of the needs in the transport sector is specified. Currently there have been activities related to:

- Travel information services.
  The MultiRIT project has provided information models and service models that are included in this version of ARKTRANS
- Freight transport.
  The Freightwise project is working on information models for freight transport in collaboration with the ARKTRANS maintenance project. The work is however not fulfilled. Hopefully they can be included in the next version of ARKTRANS. In the meantime we will refer to the Freightwise work. The TRIM model, which was referred in the last version of ARKTRANS may be used, but is not included in this version as the expected results from Freightwise will replace TRIM.

The UML models in the information view are technology independent – CIMs (Computation Independent Models). They provide conceptual specifications of

- Information that may be useful for stakeholders in the transport sector by means of UML class diagrams (conceptual information models). The models define the generic and multimodal information elements and the relations and dependencies between them. These models are a common reference.
- The services to be exchanged (conceptual service models). They are composed of elements from the first and specify services that support interactions between stakeholders in the transport sector.

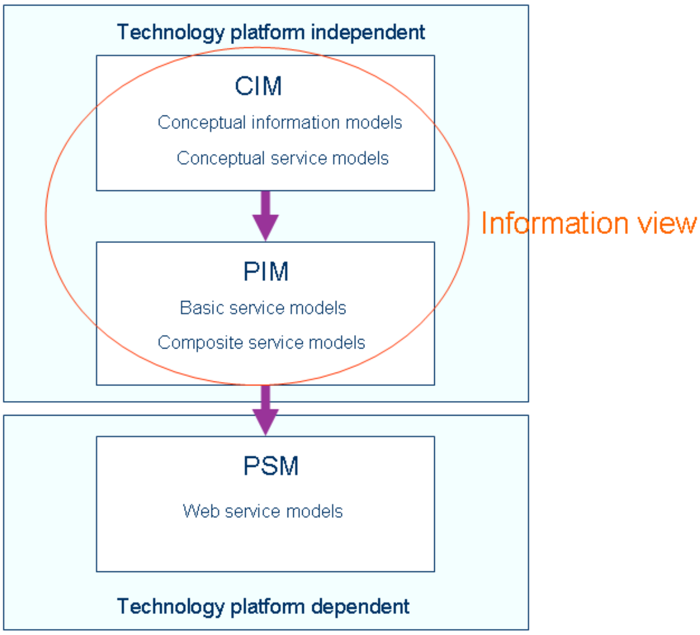


Figure 56 Model Driven Approach (MDA)

The conceptual service models are the basis for the PIMs (Platform Independent Models), which specifies the open interfaces. The resulting software models, transformed from the PIM, are called

PSM (Platform Specific Model). A PSM is directed towards an implementation by means of specific technology (platform) – see Chapter 13.

12.1 CIM – Conceptual information models for multimodal travel information

The CIMs for travel information are based on input from the MultiRIT project and arrange for the improvement and reconditioning of travel information services. Such services are crucial considering the addressed need for increased use of public transport. The work encompasses all transport modes (road, sea, rail and air) and is established as a joint effort by a wide spectre of Norwegian authorities and stakeholders who represent deep knowledge about route and travel information for road, sea, rail, and air transport. Thus, the results are harmonised across all transport modes. Representatives for people with disabilities are also consulted about needs related to the provision of information about accessibility.

12.1.1 Overall requirements

Travel planning and travel information services are emerging and offered by the transport companies themselves and by third party service providers. Good quality services require up to date information about time schedules, route patterns, and deviations. The travellers want timely information about status and deviations (delays etc.) with respect to time schedules, next departure, estimated arrival, etc. Information about services and facilities that can be provided on-board the Transport Means and at the Transfer Nodes (toilet, nursery, support for disabled people, shops, etc.) should also be available. Such information may be crucial when the best transport alternative is to be selected, and should be part of a travel information service.

The focus is *not* on the establishment of the travel planning and travel information end-user services that are to be delivered to the Transport Users. The focus is on the basis for such services, what basis must be provided for such services to be implemented and used. The service providers should be able to build new and improved services based on information received from a wide spectre of transport companies and terminals operators representing airports, railway stations, ferry terminals, bus stops, etc. Interoperability and information exchange according to well defined interfaces are crucial, trough which planned time schedules as well as real time information about deviations have to be provided. If such information is available in a standardised way, new and improved services may emerge.

Existing route information formats quite often include information that is of no importance to the Transport User, e.g. information used in fleet management and traffic control. Issues that are specific to one specific transport mode are often reflected, and an adaptation to other modes usually requires compromises. In ARKTRANS the focus must be on the information needed by the Transport User, such as time schedules and route patterns and information about services and facilities provided on-board, at stops, and at the terminals. In addition real time information about status and deviations is required. Information elements needed in new or improved services as well as in more traditional services (e.g. printed time tables) must be available. The information shall count for all transport modes (road, sea, rail and air), and a multimodal terminology is to be used.

All Transport Users should be supported. Travellers should be able to specify preferences and they should get accessibility information (see Annex F for description of disabilities and universal design).

Information about fares and fare zones is omitted, even though such information is of importance to the Transport User. Fares and fare zones are more or less independent of the routes, and many different zone systems may be used in parallel. Thus, fares and zones should be handled separately and linked to the route information to make a loose coupling.

Information about the terminals (bus stops, railway stations, airports, ferry terminals, etc.) and stop points must be available, and the terminals and stop points must have unique identifiers. In Norway, a national terminal register is being established, and the information provided by this register is to be harmonised with the information requirements stated by ARKTRANS.

12.1.2 Terminal CIM

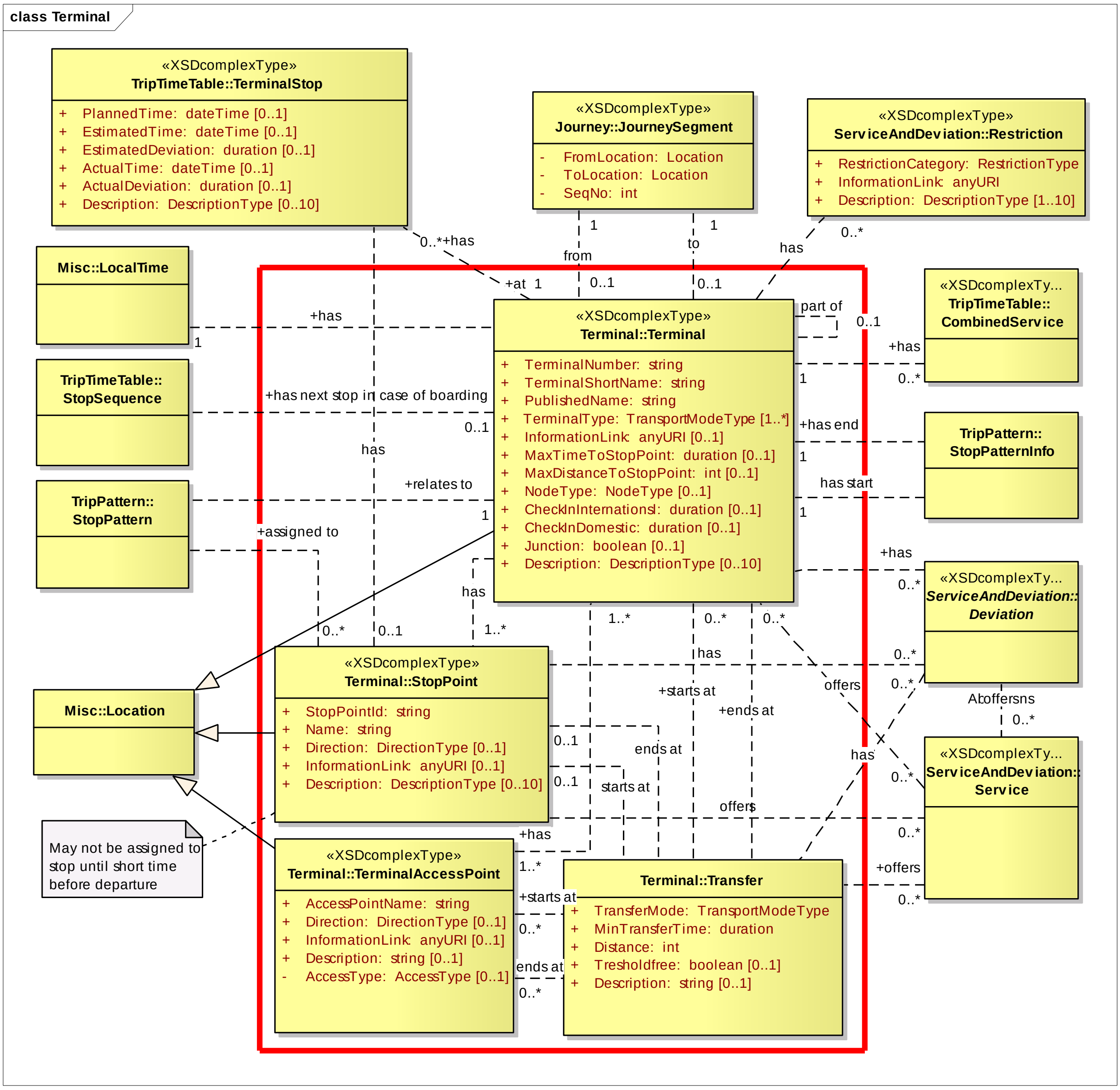


Figure 57 Terminal model

The terminal model is based on input from the MultiRIT project. In MultiRIT the transfer nodes were referred as terminals. Thus, in the following, the terminal term is used instead of the transfer node term. The model is now taken further to ISO for standardisation (ISO 19147 Transfer Nodes)

The terminal model is shown inside the square in the Figure. It specifies information required about terminals, stop points, terminal access points and transfers.

- Terminal represents all types of public transport stops: railway stations, simple bus stops along the road, bus terminals, airports, ferry berths, etc.

- Stop Point is the exact location where the transport means stops. This is the gate at an airport, the gate/track at a railway station, the location of the bus stop sign at a bus stop, etc.
- Terminal Access Point is the entrance to a terminal.
- Transfer is a transfer at a terminal or between terminals

The logical relations and dependencies are expressed in the diagram:

- Many terminals may be co-located. Thus, a Terminal may be a part of a superior Terminal that contains many Terminals.
- The Terminal has one or more Stop points
- A Terminal has one or more Terminal Access Points that may be the entrance of the terminal or another well recognised point at the terminal used as a waypoint during transfers. One Terminal Access Point may belong to more terminals, e.g. several co-located terminals.
- A Transfer may start at a Terminal, a Stop Point or a Terminal Access Point and end at another Terminal, Stop Point or Terminal Access Point.
  A sequence of transfers may also be required to come to the right location. The first may for example start at the first Stop Point and end at a Terminal Access Point. Then there may be successive transfers between different Terminal Access Points, and the last transfer may end at the final Stop Point.

Inheritance:

- A Terminal is a Location
- A Stop Point is a Location
- A Terminal access point is a Location

External relations are as follows:

- A Terminal has a Local time
- A Terminal Stop is related to one Terminal, and a Terminal Stop may also be assigned a Stop Point, but this may not happen until just before the stop.
- A Journey Segment may be between two Terminals
- There may be Combined Services related to a Terminal
- A Terminal, a Stop Point or a Transfer may have Deviations
- A Terminal, a Stop Point or a Transfer may offer Services
- There may be Restrictions associated to a Terminal
- A Trip Pattern (represented by the StopPatternInfo class) has one start and one end Terminal
- A Stop Pattern (representing one of the stops in a Trip Pattern) is related to one Terminal, and may also be assigned to a Stop Point.
- One stop (represented by the Stop Sequence class) may have restrictions concerning where alighting is allowed. If so, the next Terminal where alighting is allowed is identified.

12.1.3 Trip Pattern CIM

The Trip Pattern model is based on input from the MultiRIT project. In MultiRIT the term terminal is used instead of transfer node.

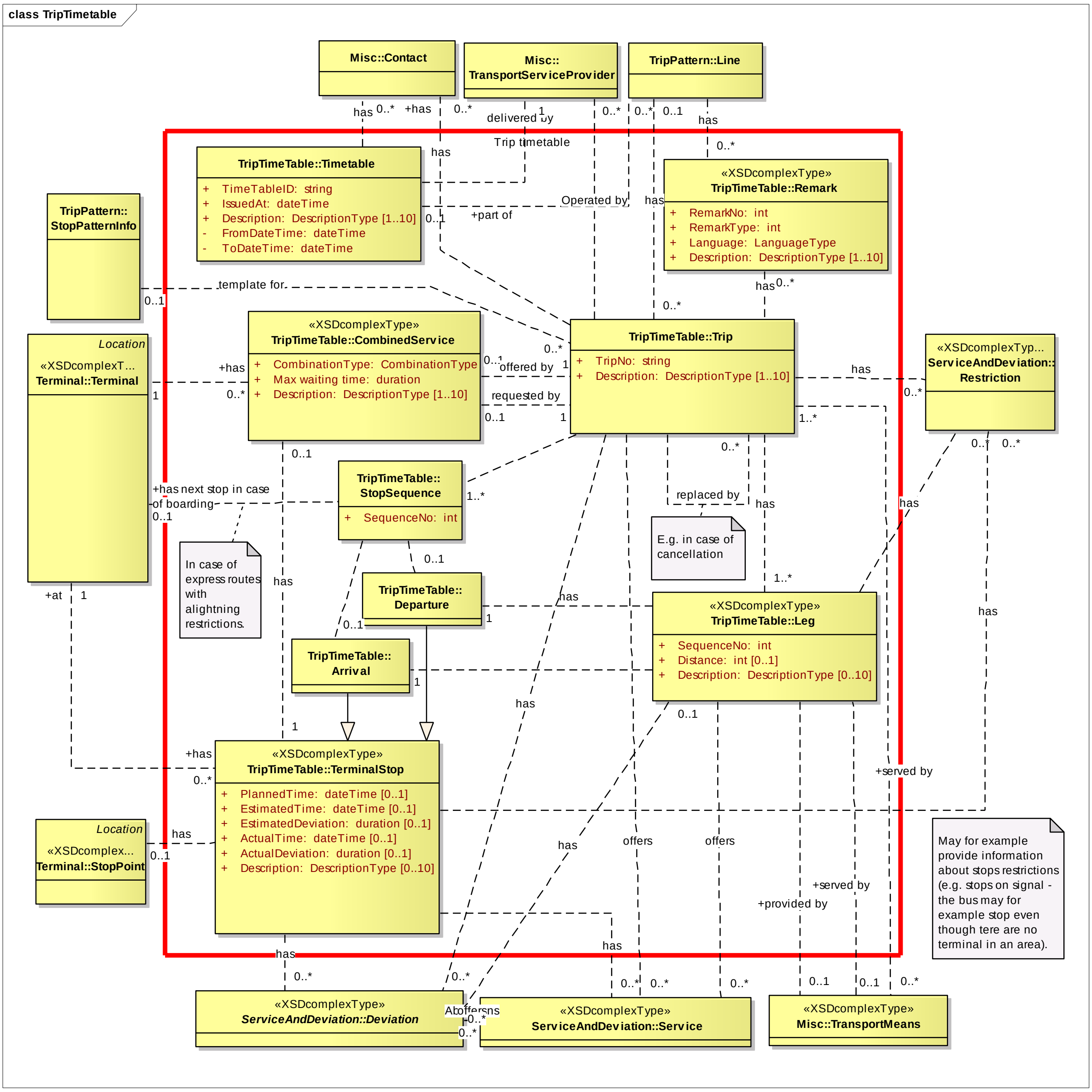


Figure 58 Trip pattern model

The trip pattern model is shown inside the square in Figure 58 and represents information about the pre-defined trip patterns of a line:

- A Line is a transport service that can be identified by means of a LineID of type LineReference consisting of:
  - A Network Id – the PTA (Public Transport Authority) responsible for the line, as defined in the eTicketing framework (ISO).
  - A Line Identifier - depends on the transport mode. May be:
    - The number used by the transport users (e.g. bus number, flight number, train number
    - An internal number that is not known to the transport user.
    - No value (for coastal liner)
  - Line Name – the published name. May for example indicate the start and the stop locations for the line, or another descriptive reference that refers to the route that the Line is serving
  - An Operator ID – the code of the Transport Service Provider as used in eTicketing

- A Line often has several route variants. One such route variant is represented by the StopPatternInfo class. The variants may for example represent different paths between the same stop or end points; different directions of for example a bus line; or variants representing different segments of a line, e.g. two segments of a line that runs through a city – from starting point to the city centre, and from the city centre to the final destination.
- A route variant may have several Time Schedule Patterns, which indicates the days and the start times for departures for trips serving the route variant.
- A route variant consists of a sequence of one or more Stop Patterns, representing the stops at terminals along the route. The arrival and the departure are provided relatively to the start time in the Time schedule pattern of the Trip pattern.
- A route variant consists of a sequence of one or more legs, represented by the Leg Patterns.
- One Leg Pattern stops and ends at specific terminals, represented by Stop Patterns.

External relations:

- A Timetable may include the route information for several Lines.
- A Contact may be responsible for a Line
- A Line will be operated by a Transport Service Provider (however, the actual trips that constitute the Line may be operated by other Transport Service Provider – see the Trip timetable model).
- A route variant (the StopPatternInfo class) may be the template for one or more Trips.
- A Line may be served by many Trips.
- A route variant (the StopPatternInfo class) starts and ends at Terminals.
- In the same way, Terminals and Stop points that are visited by the Trips may be related to and assigned to Stop Patterns.
- There may be Remarks associated to a Line.

Table 2 Examples of trip pattern attributes applied on transport modes

Transport mode	Line name (part of LineId) examples	StopPatternInfo attribute examples			Comments
		Trip pattern no	Variant no	Variant name	
Road	Examples: • Risvollan - Dronningens gt. • Dronningens gt. – Stavset • Stavset – Dronningens gt. • Dronningens gt. - Risvollan	Number	1 if just one pattern or first variant or higher sequence number	Name to be published in addition to Line name (if there is a need for a more detailed name). Examples: • Via St.Olavs hospital. • Stops at Stavset • Limited route • A • B	One or more Trips, identified by means of trip numbers will be related to each trip pattern.
Sea	Line name Examples: • Kystekspressen Trondheim – Kristiansund • Kystekspressen Kristiansund - Trondheim	Number	1 if just one pattern or first variant or higher sequence number	Name to be published in addition to Line name (if there is a need for a more detailed name). Example: • No call at Brekstad	One or more Trips, identified by means of trip numbers will be related to each trip pattern.
Rail	Line name	Number	1	Name to be published in addition to Line name (if there is a need for a more detailed name). Example: • Via Bodø	One or more Trips, identified by means of train number + date will be related to

Transport mode	Line name (part of LineId) examples	StopPatternInfo attribute examples			Comments
		Trip pattern no	Variant no	Variant name	
					each trip pattern.
Air	Flight name	Flight number	1	Name to be published in addition to Line name (if there is a need for a more detailed name)	One or more Trips, identified by means of flight number + date will be related to each trip pattern.

12.1.4 Timetable CIM

The timetable model is based on input from the MultiRIT project. In MultiRIT the term terminal is used instead of transfer node.

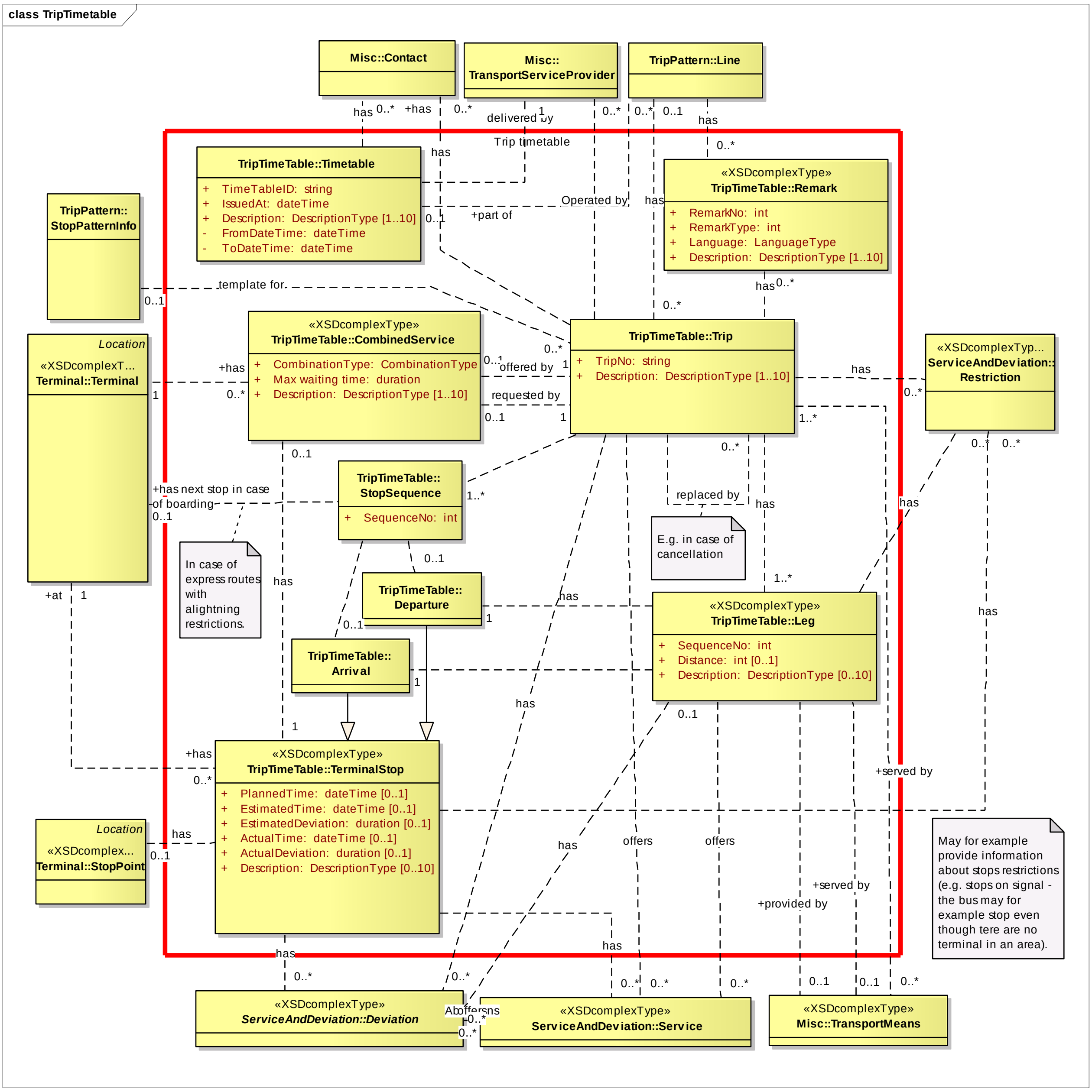


Figure 59 Timetable model

The trip timetable model is shown inside the square in the Figure. It specifies information about actual trips, e.g. their time schedule, terminal stops, services provided and deviations.

Inheritance:

- An Arrival is a Terminal Stop
- A Departure is a Terminal Stop

The logical relations and dependencies are expressed in the diagram:

- A Trip may be replaced by another Trip, for example if the Trip is cancelled due to engine problems or for other reasons. The new trip may stop at the same terminals, but the route may also be different from the original route. E.g. the ferry may have to go from another berth due to the weather.
- Arrivals and Departures to a terminal are considered as Terminal Stops with a planned time, an estimated time, an actual time, etc. However, some stops may not be dictated by a time schedule as they may not be check points in the route plan. Thus, the time attributes may have no values.
- The Departures/Arrivals of a Trip are carried out in a specific sequence, indicated by the Stop Sequence. For each visit to a terminal there may be just a Departure (the first stop in the sequence), just an Arrival (the last stop in the sequence), or both an Arrival and a Departure (the stops in between – if any).
- A Trip will consist of e sequence of Legs, each with a Departure and an Arrival.
- A Combined Service is offered by one Trip to another Trip.
- Through the inheritance of the Terminal Stop properties, an Arrival or a Departure may be related a Combined Services. This means that they may be related to an Arrival or a Departure of another Trip. This may for example be used to express that a connection can be provided despite of a short transfer time, or that the departure of a bus may depend on the arrival of another bus (the first bus may wait). A Combined Service may also be used to indicate a trough service (the same Transport Means will be used on both Trips, and the passenger will not have to change Transport Means).
- There may be Remarks related to a Trip.
- A Timetable will be valid for a certain time period.

External relations:

- A Timetable may include the route information for several Lines.
- A Timetable will be delivered by a Transport Service Provider (the Transport Service Provider operating the lines described in the timetable), and there may be a defined Contact related to the Timetable.
- A Trip may serve a Line according to a certain route variant (StopPatternInfo). Such Trips are named according to the line name, the trip pattern name and, if present, the variant name of the trip pattern. Some Trips may have no relations to a Line or a route variant. Such Trips are for example on-demand trips.
- A Trip is operated by a Transport Service Provider, and there may be a Contact for a Trip
- Terminal Stops are related to a Terminal, and a Terminal usually has several Terminal Stops. However, terminals that are not in operation will have no stops.
- A Terminal Stop is assigned a Stop point. This may be done when the route plan is established, or it may be done just before the stop at the Terminal. In the last case no Stop Point will be assigned to the Terminal Stop until just before the stop.
- The whole Trip may be served by a Transport Means
- The individual Legs may also served by specific Transport Means (if different Transport Means at different Legs of the Trip).
- In some cases a Leg may have accompanied transport where the actual transport is provided by another Transport Means, e.g. the leg may be served by a bus, but the complete bus may enter a ferry that provides the transport.

- A Combined Service is provided at a Terminal.
- There may be restrictions on alighting at some of the stops in the Stop Sequence. An express route may for example stop for passengers at local terminals. Depending on the entry point, a passenger may not be allowed to alight at specific locations (e.g. to avoid competition with local routes). The next stop in case of boarding will be the first Terminal where alighting is allowed, but not necessarily the next in the Stop Sequence.
- A Trip, a Leg and a Terminal Stop (i.e. an Arrival and a Departure) may offer Services.
- A Trip, a Leg and a Terminal Stop (i.e. an Arrival and a Departure) may have Deviations.
- A Trip, a Leg and a Terminal Stop (i.e. an Arrival and a Departure) may have Restrictions.

12.1.5 Service and Deviation CIM

The Service and Deviation model is based on input from the MultiRIT project. In MultiRIT the term terminal is used instead of transfer node. The model is now taken further to ISO for standardisation (ISO 19147 Transfer Nodes)

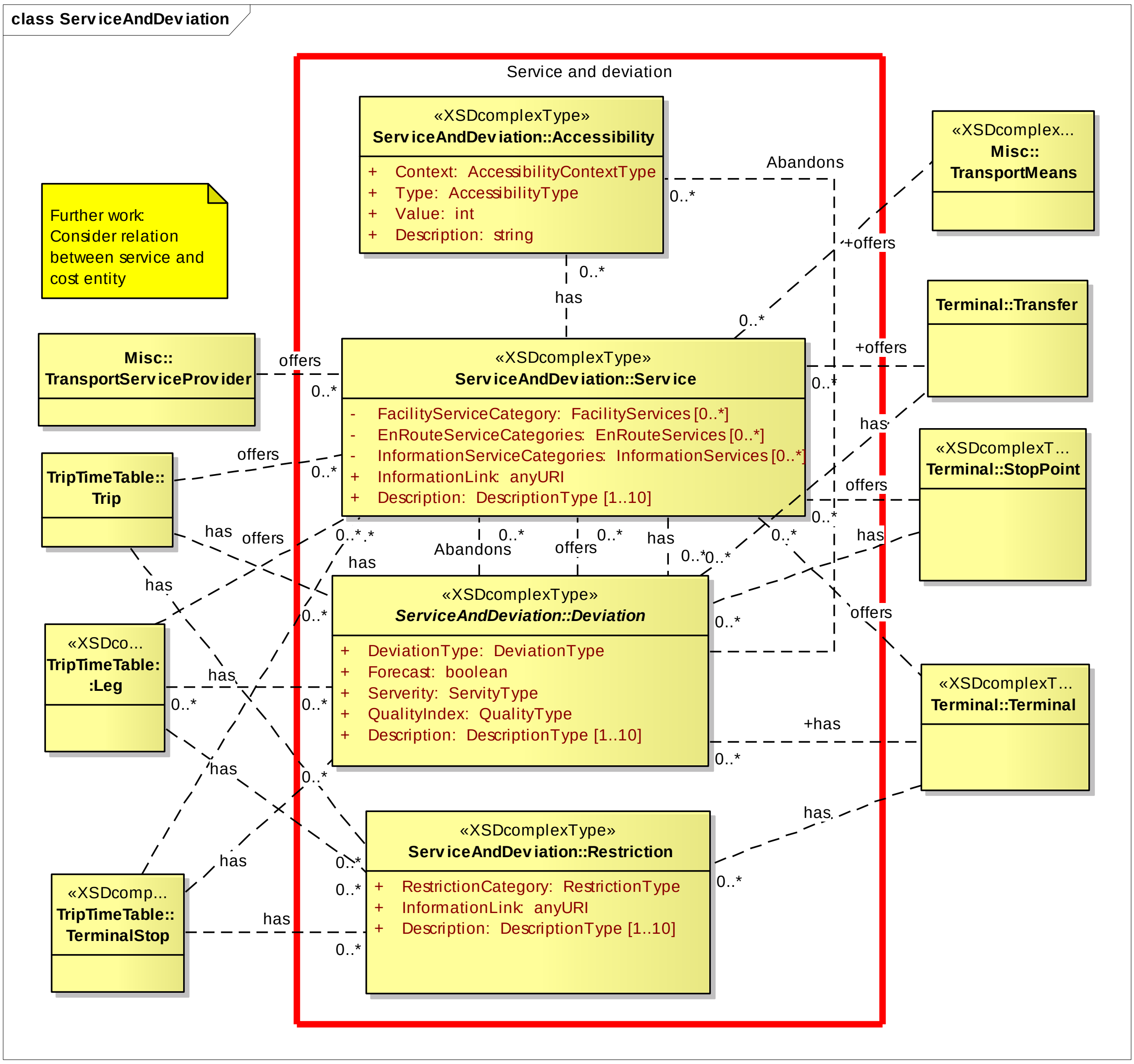


Figure 60 Service and deviation model

The service and deviation model is shown inside the square in the Figure. It specifies information required about services and deviations:

- A Service may be a service offered by persons or systems, or it may be the availability of a physical facility. The type of service is indicated by the ServiceCategoryType.
- A Service may have (i.e. be affected by) a Deviation. This means that a Service may be abandoned due to a Deviation, or a Service may be offered due to a Deviation.
- A Service may have associated Accessibilities.
- An Accessibility may be affected by deviation. An Accessibility may be abandoned due to a Deviation.
- A Restriction is of a certain type, defined by the RestrictionCategory.

External relations are as follows:

- A Service is offered by a Transport Service Provider
- During the transport, a Service may also be offered by a Trip in general, by specific Legs on a Trip, at Terminal Stops (i.e. at Arrivals and Departures), at Transfer, at Stop Points or at Terminals.
- The ability to provide a Service often depends on whether the Service can be offered by the Transport means used.
- A Deviation concerning a delay or an early arrival or departure affects a Terminal stop.
- A Deviation with respect to the availability of services and facilities may influence on a Leg, a complete Trip, a Terminal, a Stop Point and a Transfer.
- There may be Restrictions related to Trips, Legs, Terminal Stops (i.e. at Arrivals and Departures) and Terminals.

12.1.5.1 Services

A generic description of the services that are provided supports multimodal travel planning across several transport modes. By means of a standardised terminology representing the available service types, transport alternatives can be compared, and the door-to-door transport can be planned across all transport modes. The transport chain that satisfies the demands of the transport user can be chosen. By Service we mean

- Overall transport services
- En route services provided at terminals and on board transport means
- Information services at terminals and on board transport means
- Facilities at terminals and on board transport means

All services can be decomposed into a set of service categories that contain standardised service types. As stated by the attributes in Figure 60, a service has a service category and a service type attribute. For some of the services it may also be relevant to inform about the section in which the service is available, for example which part of a terminal or which part of a transport means (e.g. whereabouts facility on deck 3 of the ferry).

Services can be related to the actual transport, to arrivals and departures, to the terminals, and to transits. Some services just make sense related to parts of the transport chain (e.g. at terminals). Other services may be provided on both transport means and terminals. Services may be specified for the whole trip or for specific legs.

Overall transport services

The overall transport services describe the main types of transport services that are offered.

Table 3 Service categories and types for overall transport services

Service category	Service type
Route offers (Rutetilbud)	Predefined route (Rutegående transport) On demand (Behovsdefinert) On demand route (Behovsdefinert rute) Pre-booked space (Forhåndsbestilt plass) Space warranty (Plassgaranti)
Passenger transport (Passasjertransport)	
Luggage transport (Transport av reisegods)	Luggage check in (Bagasjeinnsjekking) Hand luggage only (Kun håndbagasje) Special luggage (Spesialbagasje) Luggage self service (Selvbetjening på bagasje)
Car transport (Biltransport)	
Freight transport (Godstransport)	Thermo transport (Termovarer) Controlled environment transport (Kontrollert transportmiljø) Bulk cargo transport (Bulktransport) Container transport (Containertransport) Ro-ro transport (Ro-ro transport) Dangerous cargo (Transport av farlig gods) Animal transport (Dyretransport)

En route services

The en route services describe the services that are offered to the transport user at terminals, on-board the transport means, at stops, and at transfers during the transport.

Table 4 Service categories and types for en route services

Service category	Service type	Relevance
Handling services (Håndteringstjenester)	Check in (Innsjekking) Customs (toll) Luggage check in (Bagasjeinnsjeking) Luggage security control (Sikkerhetskontroll av bagasje) Passenger security control (Sikkerhetskontroll av passasjerer)	At terminal During transport
Entertainment services (Underholdnings tjenester)	Children's entertainment (Underholdning for barn) Live music (Levende musikk) Movie (Film) Music channel (Musikkanal) News (Nyheter)	At terminal During transport
Payment services (Betalings-tjenester)	By phone (Via telefon) Cash (Kontanter) Credit card (Kredittkort) E-ticket (Elektronisk bilett)	At terminal During transport
Assistance provided (Assistanse tilbys)	Free transport of aids (Gratis hjelpemiddeltransport) Assistance to unaccompanied minors (Assistanse til barn som reiser alene) Assistance to sick people (Assistanse til syke) Luggage assistance (bagasjeassistanse) Assistance to disabled (Assistanse til funksjonshemmede) Assistance in security control (Assistanse i sikkerhetskontroll)	At terminal During transport At stops
Free offers (Gratistilbud)	Alcoholic beverages (Alkoholholdig drikke) Breakfast (Frokost) Cold meal (Kald mat) Dinner (Miiddag)	At terminal During transport

Service category	Service type	Relevance
	Lunch (Lunsj) Newspapers (Aviser) Non-alcoholic beverages (Alkoholfri drikke)	
Attendance (Betjening)	Cabin crew (Kabinpersonale) Conductor (Konduktør) Guard (Vakt)	At terminal During transport At stops

Facilities

The facilities describe physical installations that are offered to the transport users at terminals, and departures, on-board the transport means and at arrivals during the transport.

Table 5 Service categories and types for facilities

Service category	Service type	Relevance
Whereabouts facilities (Fasiliteter på oppholdssteder)	Lounge with refreshments (Lounge med forfriskninger) Smoking area (Røykeområde) Seating accommodation (Sitteplasser) Silence (Stille sone) Physical unit (Enhet) – e.g. terminal, transport means Waiting-room (Venterom) Shelter (Lehus) Security control area (Område for sikkerhetskontroll)	At terminal During transport
Local facilities (Fasiliteter i omgivelsene)	Parking garage (Parkeringshus) Short time parking area (Korttidsparkering) Car rental (Bilutleie) Long time parking area (Langtidsparkering) Cycle parking (Sykkelparkering) Car service (Biltjenester) Park and ride Taxi stop Kiss and ride	At terminal
Entry and exit facilities	Terminal access (Terminalinngang) Transport means access (Av- og på-stigning)	At terminal Terminal stops
Commercial facilities (Kommersielle fasiliteter)	Misc. (Diverse) Kiosk (Kiosk) Cloths (Klær) Bank (Bank) Pharmacy (Apotek) Food (Mat) Tax Free (Tax free) Books (Bøker) Gifts (Gaver)	At terminal During transport
Ticket sale facilities (Billettsalg-fasiliteter)	Attended ticket office (Bemannet billettkontor) E-ticket reader (Leser av e-bilett) Ticket machine (Bilettautomat)	At terminal During transport
Refreshment sale facilities (Fasiliteter for salg av forfriskninger)	Bar (Bar) Coffee or Tea (Kaffe og te) Fast food (Hurtigmat) Restaurant (Restaurant) Trolley (Trallsalg)	At terminal During transport
Facilities for	Nursery (Stellerom)	At terminal

Service category	Service type	Relevance
children (Fasiliteter for barn)	Playroom (Lekerom) Infant room (Spebarnsrom)	During transport
Misc. facilities (Diverse fasiliteter)	Cash dispenser (Minibank) Chapel (Kapell) Cloakroom (Bagasjeoppbevaring) Computer (Datamaskin) Desk (Arbeidsbord) Emergency telephone (nødtelefon) Fax (Fax) Internet access (Internettaksess) Library (Bibliotek) Lost property (Hittegods) Luggage space (Bagasjeplass) Luggage trolley (Bagasjetralle) Meeting point (Møteplass) Phone (Telefon) Physical training (Treningsfasiliteter) Power supply (Stikkontakt) Pram space (Barnevognsplass) Seats (Sittemuligheter) Swimming pool (Svømmebaseng) Table (Bord) Toilet (Toalett)	At terminal During transport
Accommodation (Innkvartering)	Allergy room (Allergirom) Single (Enmannsrom) Room adapted to disabled (Rom tilpasset funksjonshemmede) Shared (Rom dom deles med andre) Shared bath room (Felles baderom) Suite (Suite) With bath room (Med eget bad)	At terminal During transport

Information services

The information services are offered to the transport users at terminals and during the transport.

Table 6 Service categories and types for information services

Service category	Service type	Relevance
Travel information services	Arrival and departure information (Ankomst- og avgangstider) Dynamic arrival and departure information (Dynamiske ankomst- og avgangstider) Traffic information (Trafikkinformasjon) Contact information (Kontaktinformasjon) Route pattern (Rutenett) Time tables (Ruteplaner) Terminal information (Terminalinformasjon) Terminal map (Oversiktskart over Terminal) Transport means map (Oversiktskart over transportmiddel) Trip information (Turinformasjon)	At terminal During transport
Tourist information services (Turistinformasjons-tjenester)	Activity information (Aktivitetsinformasjon) Location information (Lokasjonsinformasjon) Accommodation information (Innkvarteringsinformasjon) Historic information (Historisk informasjon)	At terminal During transport

12.1.5.2 Restrictions

The restrictions are related to terminals, departures and arrivals, and to the transport.

Table 7 Restriction categories and types

Restriction category	Restriction type	Relevance
Stop restrictions (Begrensninger på stopp)	No alighting (Ingen avstigning) No boarding (Ingen påstigning) Stops on signal (Stopper på signal) Must be pre-booked (Må forhåndsbestilles)	Terminal stops
Transport restrictions (Begrensninger på transport)	Age restriction (Aldersbegrensning) Bikes prohibited (Forbud mot sykler) Check-in required (Innsjekking kreves) Must be pre-booked (Må har forhåndsbestilling) Must have space reservation (Obligatorisk plassreservering) Must have ticket (Må ha gyldig bilett ved påstigning) Pets prohibited (Forbud mot kjæledyr) Smoking prohibited (Røyking forbudt) Wheelchair restrictions (Restriksjoner på rullestol)	During transport
Access restrictions (Aksessrestriksjoner)	Must be entitled to admission (Må ha rett til adgang) Must have entrance card (Må ha adgangskort) Must have ticket (Må ha gyldig billett)	At terminal

12.1.5.3 Accessibilities

Accessibility defines the way a service is provided or the quality level of a service. Information about such accessibility is very important for some user groups. A lift may for example be available, but the physical conditions in the lift may influence on the usability.

The accessibilities are organised into contexts and types. There will be several types for each context. For each type there will be a value set defining the different levels of accessibility support.

In the table below the contexts and the types associated to each context is defined. The service categories related to each accessibility context is also defined. However, the results are so far preliminary, and further studies are needed.

Table 8 Accessibility categories and types and relations to service categories

Accessibility context	Accessibility type	Relevant to service categories
Accessibility for allergic people (Tilgjengelighet for allergikere)	Cleaning (Rengjøring) Mould (Mugg) Pets (Dyr) Pollen (Pollen) Smoking (Røyking)	Accommodation (Innkvartering) Commercial facilities (Bank, apotek og butikker) Local facilities (Fasiliteter i omgivelsene) Misc. facilities (Diverse fasiliteter) Whereabouts facilities (Fasiliteter på oppholdssteder)
Accessibility supported by lighting and contrast (Tilgjengelighet støttet ved lys og kontrast)	Contrasts (Kontraster) Lightening (Belysning)	Accommodation (Innkvartering) Commercial facilities (Bank, apotek og butikker) Facilities for children (Fasiliteter for barn) Local facilities (Fasiliteter i omgivelsene) Misc. facilities (Diverse fasiliteter) Refreshment sale facilities (Fasiliteter for salg av forfriskninger) Ticket sale facilities (Bilettsalgfasiliteter) Whereabouts facilities (Fasiliteter på oppholdssteder)
Information	Audio information (Lydinformasjon)) Marking (Merking)	Accommodation (Innkvartering) Commercial facilities (Bank, apotek og butikker)

Accessibility context	Accessibility type	Relevant to service categories
accessibility (Informasjons-tilgjengelighet)	Tactile information (Taktil informasjon) Visual information (Visuel informasjon)	Entry and exit facilities (Fasiliteter ved inngang) Facilities for children (Fasiliteter for barn) Local facilities (Fasiliteter i omgivelsene) Refreshment sale facilities (Fasiliteter for salg av forfriskninger) Ticket sale facilities (Bilettsalgfasiliteter) Travel information services Tourist information services (Turistinformasjons-tjenester)
Information means providing accessibility (Informasjonsmåte r)	Equipment for interactive information (Utstyr for interaktiv informasjon) Information desk (Informasjonsskranke) Information displays (informasjonsskjermer) Information handouts (Trykt informasjon) Information placards (Oppslag med informasjon) Internet access Maps Mobile services Route map (Rutekart) Signs and icons (Skilting og ikoner) Voice information (Informasjon over høyttaler)	Accommodation (Innkvartering) Commercial facilities (Bank, apotek og butikker) Entry and exit facilities (Fasiliteter ved inngang) Facilities for children (Fasiliteter for barn) Local facilities (Fasiliteter i omgivelsene) Refreshment sale facilities (Fasiliteter for salg av forfriskninger) Ticket sale facilities (Bilettsalgfasiliteter) Travel information services Tourist information services (Turistinformasjons-tjenester)
Machine accessibility (Automattilgjengel ighet)	Easy to find (Tilgjengelige) Usability (Brukbarhet)	Local facilities (Fasiliteter i omgivelsene) Misc. facilities (Diverse fasiliteter) Ticket sale facilities (Bilettsalgfasiliteter)
Misc. accessibility (Diverse tilgjengelighet)	Handicap toilet (Handikaptoalett) Seats adoption (Tilpassing av sittemuligheter)	Misc. facilities (Diverse fasiliteter)
Physical accessibility (Fysisk tilgjengelighet)	Broad wise gradient (Fallforhold) Doors (dører) Gradient (Stigning) Lane line (Ledelinje) Lift (Heis) Space requirement (Plassbehov) Surface (Overflate) Tactile marking (Taktil markering) Threshold (Nivåsprang) Waiting area / passages (Venterom/gang) Well arranged interior (Overskuelig innredning) Wheelchair area (Rullestolområde)	Accommodation (Innkvartering) Commercial facilities (Bank, apotek og butikker) Facilities for children (Fasiliteter for barn) Misc. facilities (Diverse fasiliteter) Local facilities (Fasiliteter i omgivelsene) Refreshment sale facilities (Fasiliteter for salg av forfriskninger) Ticket sale facilities (Bilettsalgfasiliteter) Whereabouts facilities (Fasiliteter på oppholdssteder)
Terminal entrance accessibility (Tilgjengelig adkomst til holdeplass)	Gradient (Stigning) Handicap parking (Handikapparkering) Lane line (Ledelinje) Tactile marking (Taktil markering) Threshold (Nivåsprang)	Entry and exit facilities (Fasiliteter ved inngang)
Transport means accessibility (Tilgjengelighet til transportmiddel)	Angle (Vinkel) Distance (Avstand) Grip (Håndtak ved rampene) Height level difference (Nivåforskjell) Lift (Heis) Wheelchair platform (Rullestolrampe)	Entry and exit facilities (Fasiliteter ved inngang)

12.1.5.4 Deviations

Deviations may occur related to the accomplishment of the transport represented by the trips and the legs, to the terminal, to specific terminal stops or to transfer. A deviation is temporary, and is defined as a deviation to the planned or normal situation. The table below also includes deviations that may not be reported to transport users, e.g. unlawful interferences, damages and security deviations.

Table 9 Deviation categories and types

Deviation category	Deviation type	Relevance
Time schedule deviation (Tidsavvik)	Delayed arrival (Forsinket ankomst) Delayed departure (Forsinket departure) Early arrival (For tidlig ankomst) Early departure (For tidlig avgang)	Route/travel information: Terminal stop
Transport execution deviation (Endring i transportgjennom-føringen)	Cancelled (Kansellert) Disrupted (Avbrutt) Transport mode altered (Endret transportmodus) Transport means replaced (Nytt transportmiddel) Reduced capacity (Redusert kapasitet) Re-routed (Ny rute)	Route/travel information: Trip/Leg
Stop deviation (Endring av stopp)	New stop (Nytt stopp) Stop omitted (Stopp fjernet)	Route/travel information: Terminal stop
Service deviation (Tjenesteavvik)	Reduced service (Redusert service) Increased service (Tilleggstjeneste) Reduced accessibility (Redusert tilgjengelighet)	Route/travel information: Terminal Trip/Leg Terminal stop Transfer
Unlawful interference (Lovbrudd)	Terrorism (terrorisme) Theft (Tyveri)	Transport management: Traffic control Fleet management Etc.
Damage (Skade)	Illness (Sykdom) Cargo damage (Skade på gods)	Transport management: Traffic control Fleet management Terminal operation Etc.
Security deviation (Sikkerhetsavvik)	Missing passenger Wrong or missing document (Manglende eller feil dokumentasjon) Wrong packing Dangerous cargo Unruly passenger	Transport management: Traffic control Fleet management Terminal operation Etc.

12.1.6 Preference CIM

The Preference model is based on input from the MultiRIT project.

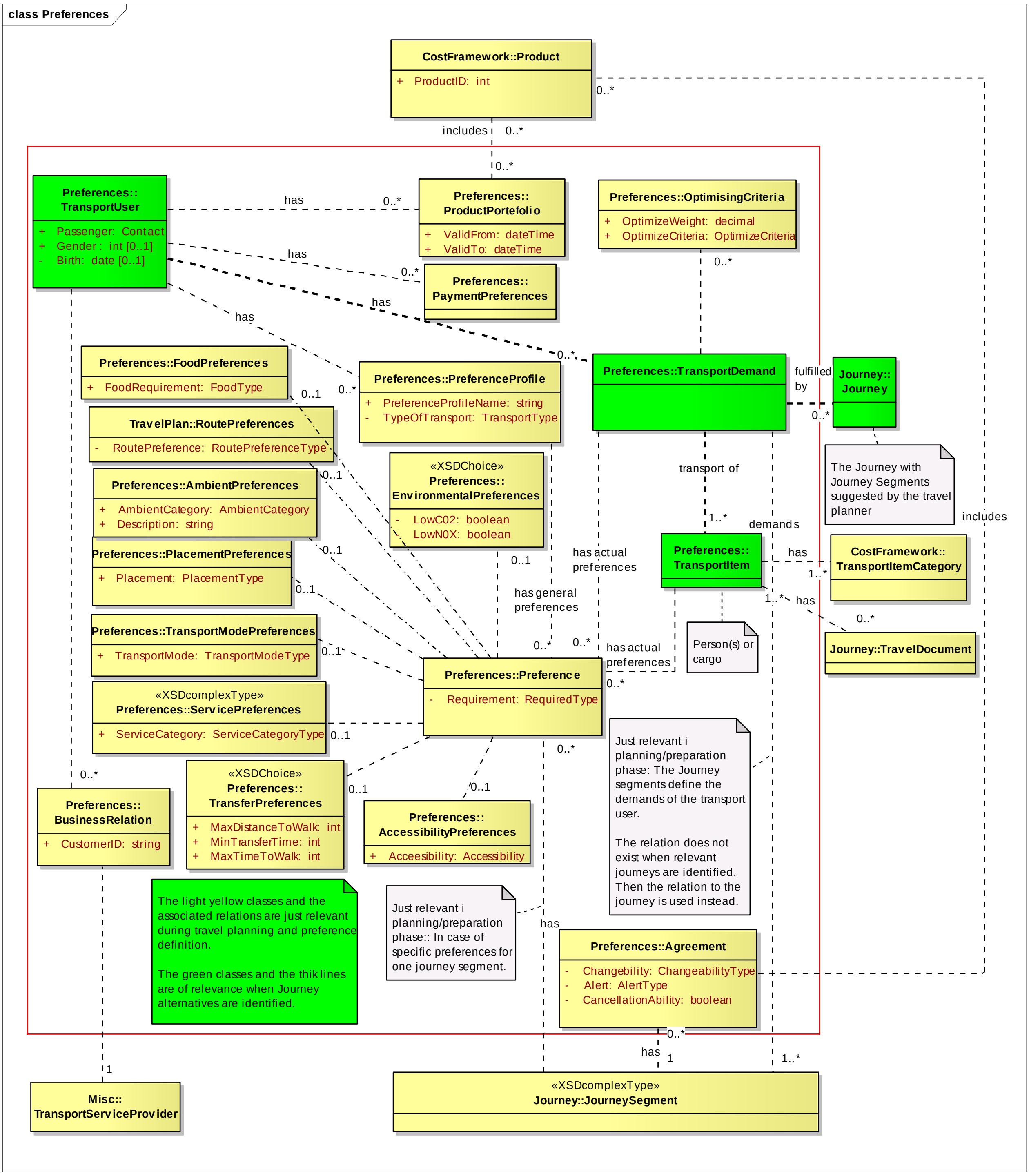


Figure 61 Preferences

The Preferences model is shown inside the square in the Figure and represents information about transport demands as seen from the Transport User. Several classes represent the general preferences and properties of the Transport User:

- A Transport User may have several Business Relations, and each Business Relation is related to a Transport Service Provider.
- A Transport User may also have Payment Preferences.

- A Transport User may have a Product Portfolio, i.e. transport Products (e.g. monthly tickets) that influences on the way he wants to travel.
- A Transport User may have several User Preference Profiles that specify the preferences with respect to different types of travel.
- A User Preference Profiles may contain Preference of several types (environmental issues, food during the travel, ambient condition, placement, transport modes, access to service, transfer and accessibility), and they all inherit the Requirement attribute which state the type – “must have”, “do not care”, “will not have”:
  - Environmental Preferences
  - Food Preferences
  - Transport Mode Preferences
  - Ambient Preferences (about the surroundings)
  - Service Preferences
  - Transfer Preferences
  - Accessibility Preferences

The Transport User has a Transport Demand:

- The Transport Demand is about transport of one or more Transport Items.
- There may be a set of actual Preferences related to the Transport in general. These actual Preferences may for example be established by means of the generic preferences from a User Preference Profile, or the actual Preferences may be established from scratch (the model does not consider how they are established)
- Each Transport Item may have also have actual Preferences that will overrule the actual Preferences stated for the complete Transport Demand.
- There may be Optimising Criteria related to the Transport Demand, i.e. criteria for optimising with respect to costs, time, preferences, quality, contract references, environmental issues, etc. (so far the criteria are not specified).
- A Transport Demand will consist of one or more Journey Segments, which define the desired from and to locations (more than one Journey Segment in case of desired via locations).
- There may be specific Preferences related to the individual Journey Segments.
- There may be Agreements (or requirements with respect to the agreement) between the Transport User and the Transport Service Provider. These requirements concerns contractual issues regarding flexibility in the transport service (with respect to cancellations, changes, etc.) and requirements with respect to status reporting to the Transport User.

The Transport Demand is submitted, and the response will contain information about Journeys that fulfil the demand.

12.1.7 Journey CIM

The Journey model is based on input from the MultiRIT project. In MultiRIT the term terminal is used instead of transfer node.

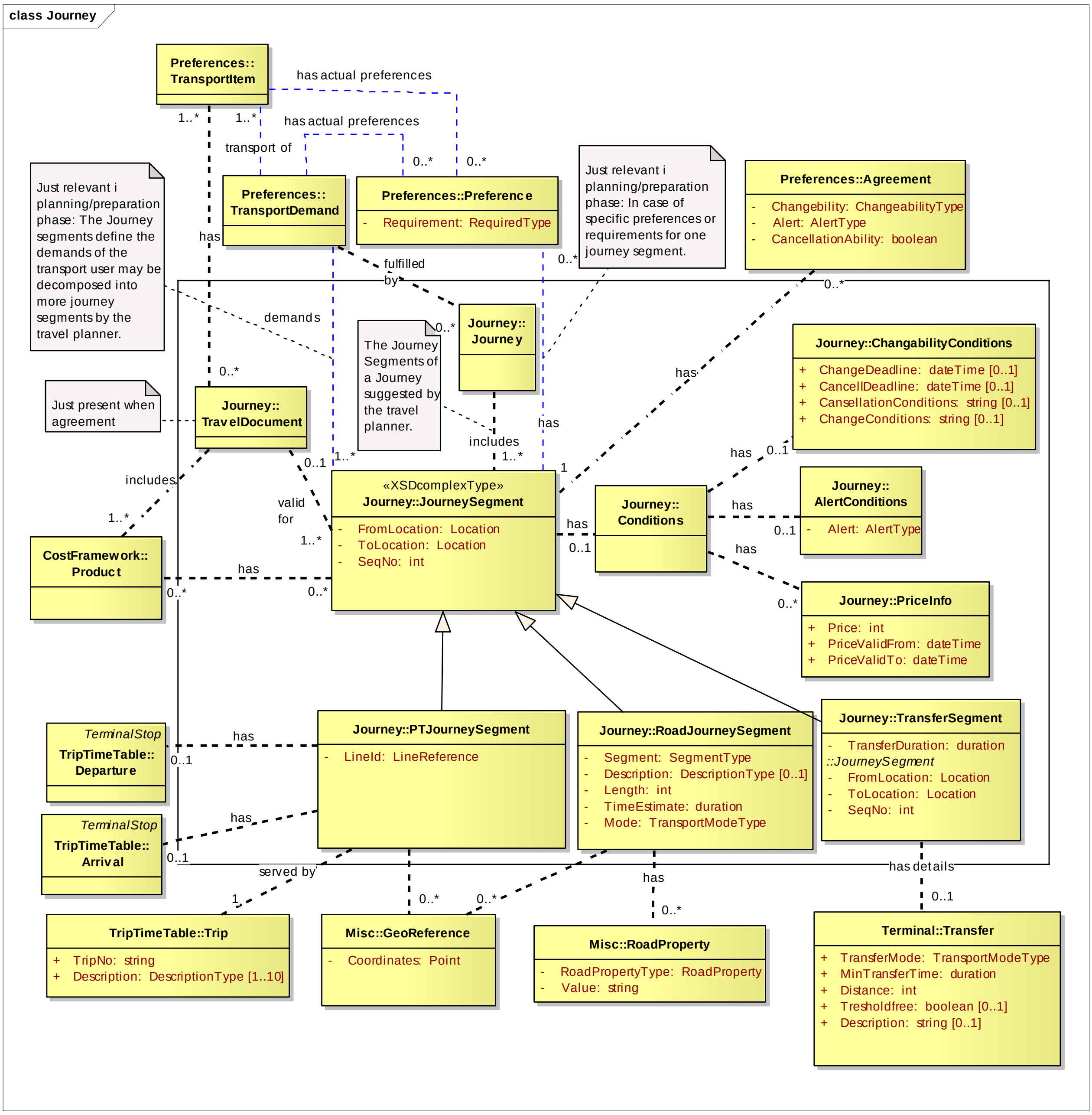


Figure 62 Journey

The Journey model is shown inside the square in the Figure. A request for relevant journeys will contain:

- A Transport Demand concerning one or more Transport Items.
- The Transport Demand in general as well as each Transport Item may have a set of Preferences.
- The Transport Demand may define one or more Journey Segments, and there may also be Preferences related to these Journey Segments.
- There may also be Agreement requirements related to the Journey Segments.

When relevant Journeys that fulfil a Transport Demand are found:

- The Transport Demand will be fulfilled by zero or more possible Journeys
- A Journey may be composed of one or more Journey Segments. The Journey Segments are specialisations: PT Journey Segments, Road Journey Segments and Transit Segments.
- There may be possible Agreements related to the Journey Segments

- A PT Journey Segment will have a Departure and an Arrival, and there will be a related Trip. The actual route may also be specified by means of Geo References.
- A Road Journey Segment will have a route that may be specified by means of Geo References, and the Road Properties are specified.
- A Transfer Segment may be further described by means of information about the actual Transfer.
- There may be Conditions related to each Journey Segment concerning the changeability of the bookings, conditions when the Transport User should be notified and the Price.
- The Journey Segment may be associated to a Product.

When the journey is booked or decided upon

- There may be one Agreement for each Journey Segment
- There will be a Travel Document associated with the Journey Segment.
- There will be Products associated with the Journey Segment.
- There will be Products associated with the Travel Document.

12.1.8 Other information model elements

These models are based on input from the MultiRIT project

Elements that do not belong to any of the other models are in the Misc model shown in the Figure below.

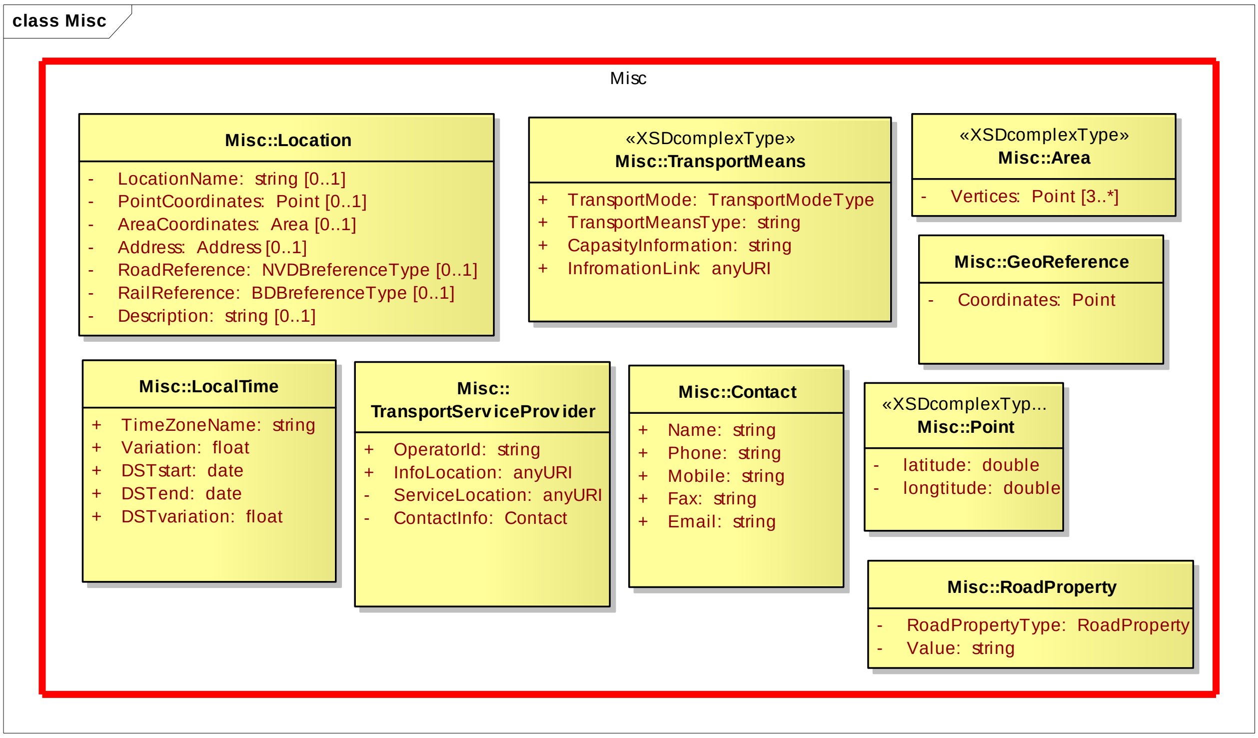


Figure 63 Other information model elements

12.1.9 Cost CIM

The Cost model is based on input from the MultiRIT project. The work is however very preliminary and further studies are required. In MultiRIT the term terminal is used instead of transfer node.

The current conceptual model for costs is based on the product concept from eTicketing [21].

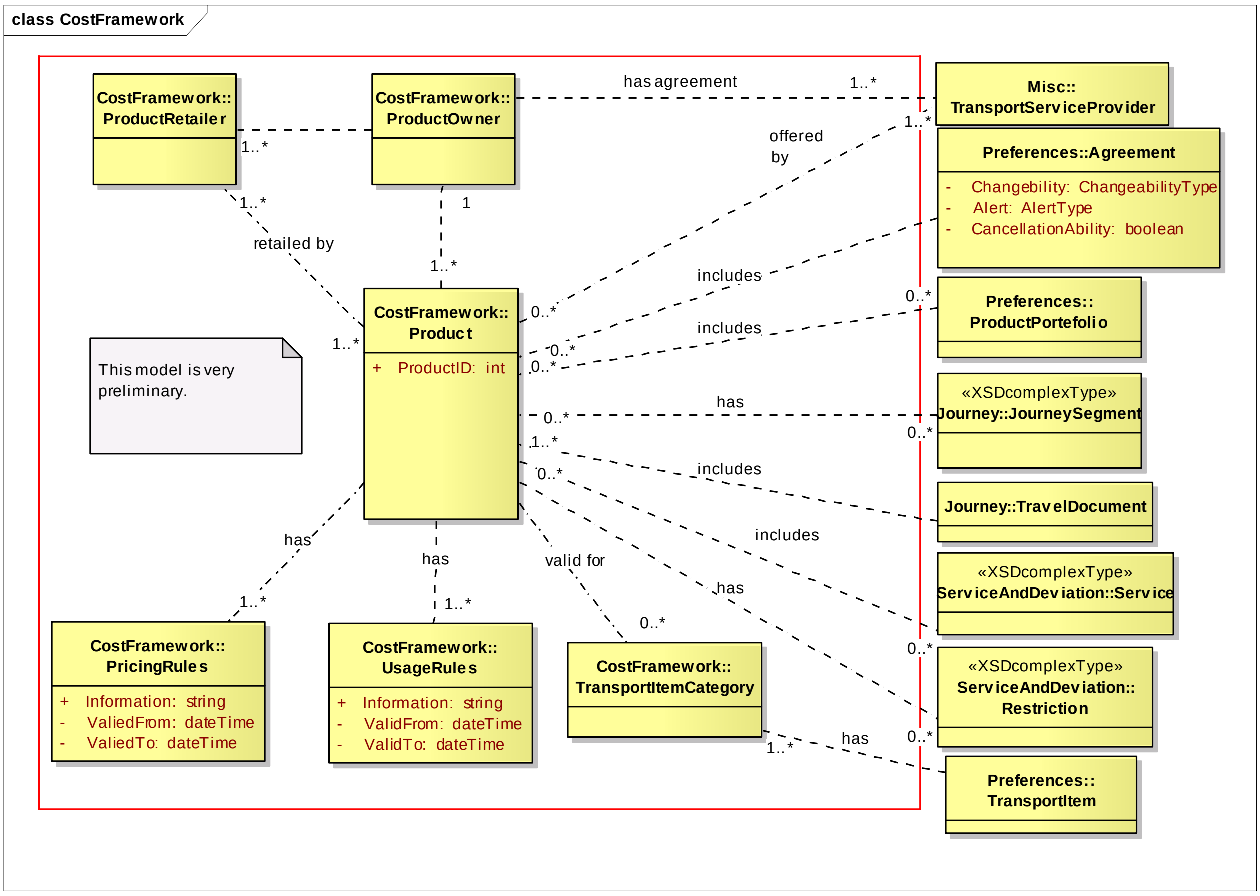


Figure 64 Cost (preliminary version)

The Cost model is shown inside the square in the Figure:

- A Product has a Product Owner
- A Product may have several Product Retailers
- A Product has a set of Pricing Rules
- A Product has a set of Usage Rules
- A Product is for a set of Transport Item Categories (i.e. traveller categories).
- A Product may be offered by one or more Transport Service Providers.
- An Agreement (with a Transport User) may refer to Agreements.
- A Product Portfolio (of a Transport User) may include several Products.
- Several Products may be available on a Journey Segment.
- A Transport Document may include several Products
- A Product may include several Services
- There may be Restrictions associated with a Product
- A Transport Item may have one or more Transport Item Categories. They should be harmonised with the eTicketing handbook.

12.2 CIM - Conceptual information models for freight transport

To be provided by the Freightwise project.

12.3 CIM - Conceptual information models for other areas

The ARKMIN project [22] established information models that also may be useful for other transport modes. ARKMIN can be found on http://www.fargisinfo.com/Arkmin/Arkmin/index.html. The models have not been further refined by the ARKTRANS project.

ARKMIN contains the following information models

- The ARKMIN Contingency sub model
- The ARKMIN Location sub model
- The ARKMIN Meteorological sub model
- The ARKMIN Navobj sub model
- The ARKMIN Tide sub model

12.4 CIM - Conceptual service models for travel information services

ARKTRANS addresses interoperability and information exchange between actors that provide information that may be used in travel information services and those who provide travel information services. The providers of information may be:

- Transport Service Providers such as transport companies. They may provide information about routes (time schedules, trip patterns, etc.), real time information about specific trips (e.g. deviations), information about the availability of services and facilities on-board and related accessibilities.
- Transport Service Providers such as terminal operators may provide information about transfers and the availability of services and facilities at the Transfer Nodes and related accessibilities.
- Traffic Managers may provide information about Network and Traffic Status.

The users of the information listed above may be traveller, or more likely Travel Information Service Providers who provide more or less complex travel information services to the Transport Users. (The Travel Information Service Providers role may of course be possessed by the transport companies themselves.)

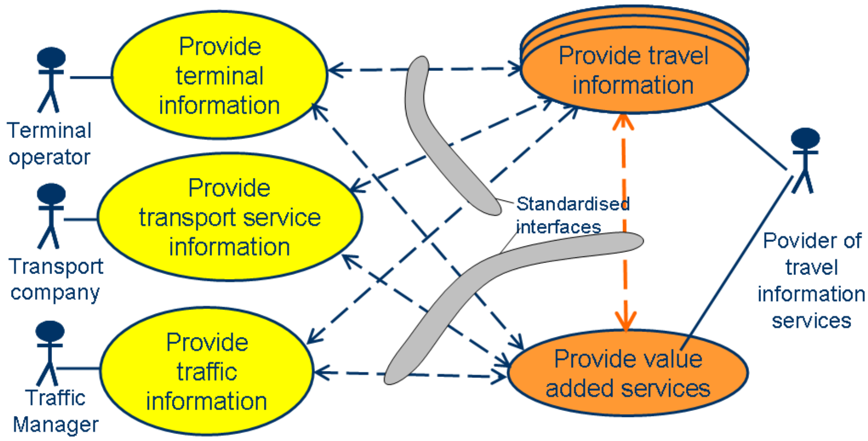


Figure 65 Standardised interfaces supports value chains and flexible organisation

Many types of information may be of relevance to the traveller. Based on knowledge about the needs of the transport user, the Travel Information Service Providers will collect and combine information form many sources to establish the services. Different services may be based upon the same information. New and value added services may also be established based on existing services in combination with new information.

Standardised multimodal interfaces must support the collection and provision of travel information and travel information services. In that way the information collection for the composition of travel information services can be more efficient and support the third-party travel information service providers in the establishment and provision of new and improved travel information services (see

Figure 65). Information representing all transport modes should be provided in the same way. Standardised interfaces towards the providers of travel information services should support the establishment of value added services.

Existing route information formats are not suited as standardised and multimodal interfaces. They quite often include information that is of no importance to the transport user, e.g. information used in fleet management and traffic control. Issues that are specific to one specific transport mode are often reflected, and an adaptation to other modes usually requires compromises. In the following service models, specified by the MultiRIT project, the focus is however on the information needed by the transport user, such as time schedules and route patterns and information about services and facilities provided on-board, at stops, and at the terminals. In addition dynamic information about status and deviations is required. Information elements needed in new or improved services as well as in more traditional services (e.g. printed time tables) must be available. The information must count for all transport modes (road, sea, rail and air). The services are modelled by means of UML class diagrams in the computation independent service models (see Figure 56), and the classes in the conceptual information models (see 12.1.1) are used as building blocks.

There are several operations related to each service. As far as possible, there is no or little overlap between the operations. Thus, it may be necessary to use several operations to get the required information. So far just operations of type request–response have been specified. However, many of the same information structures may also be used in one-way request operations (input to travel information providers) and push operations (output from travel information providers)

Table 10 Services and operations

Service	Operation	Request parameters	Response parameters	Comments
Deviation	getTerminalDeviation	Terminal reference	Terminal deviations	Provides deviation information (service and accessibility deviations included) for Terminals, Transfers, Stop Points and Trips
	getTransferDeviation	From terminal reference, To terminal reference	Transfer deviations	
	getStopPointDeviation	Stop point id, Terminal reference	Stop point deviations	
	getTripDeviation	Trip reference	Trip deviation	
	getArrivalDeviation	Terminal reference, Trip reference	Arrival deviation	
	getDepartureDeviation	Terminal reference, Trip reference	Departure deviation	
Line	getLineInfo	Line reference	Line	Provides details about line, stop pattern, name, etc.
Service	getTerminalService	Terminal reference	Terminal service info	Provides services information. Facilities are also considered as services. Information about accessibility is included.
	getTransferService	From terminal reference, To terminal reference	Transfer service info	
	getStopPointService	Stop point id, Terminal reference	Stop point service info	
	getTripService	Trip reference	Trip service info	

Terminal	getTerminalInfo	Terminal reference	Terminal information	Name, location etc. and access points
	getTerminalArrivals	From date time, To date time, Terminal reference	List of trips	List of arrivals at terminal
	getTerminalDepartures	From date time, To date time, Terminal reference	List of trips	List of departures at terminal
	getAccessPointInfo	Terminal reference	List of access point info	Access point info (location, etc.)
	getTerminals	Location, Radius	List of terminal info	Terminal info for terminals in area
	getTransferInfo	From location, To location	Transfer info	Transfers from a terminal (or a stop point or access point at the terminal) to access points or stop points at this terminal or to other terminals.
TimeTable	getLineTimetable	Line reference, From date time, To date time	Timetable	Timetable for one Line
	getNetworkTimetabel	Network id, From date time, To date time	Timetable	Timetable for all Lines administrated by a Public Transport Authority
TravelPlan	getTravelPlan	Preference info	List of journey info	Trips and routes that fulfil preferences
	getNextDeparture	Previous trip reference, From terminal; To terminal	PT Journey segment	Finds next departure
	getPreferences	User id, Preference profile name	Preference profile	Retrieves generic preference profile registered for that user
	updatePreferences	Preference info, User id, Preference profile name	Boolean (OK if true)	Register new or updates existing preferences
	getTravelTime	Preference info	Duration	Calculates and returns travel time.
Trip	getTripInfo	Trip reference	List of trip info	Overall Info for one Trip: Planned/actual route + Restrictions + combined services
	getTrips	Line reference, From date time, To date time	List of trip info	Overall Info on all Trips provided by one Public Transport Authority: Planned/actual route + Restrictions + combined services
	getLineTrips	Line reference, From date time, To date time	List of trip info	Overall Info on all Trips of a Line: Planned/actual route + Restrictions + combined services

The service models are depicted below. For information about the attributes, etc., see the conceptual information models in 12.1.1.

12.4.1 Line service CIM

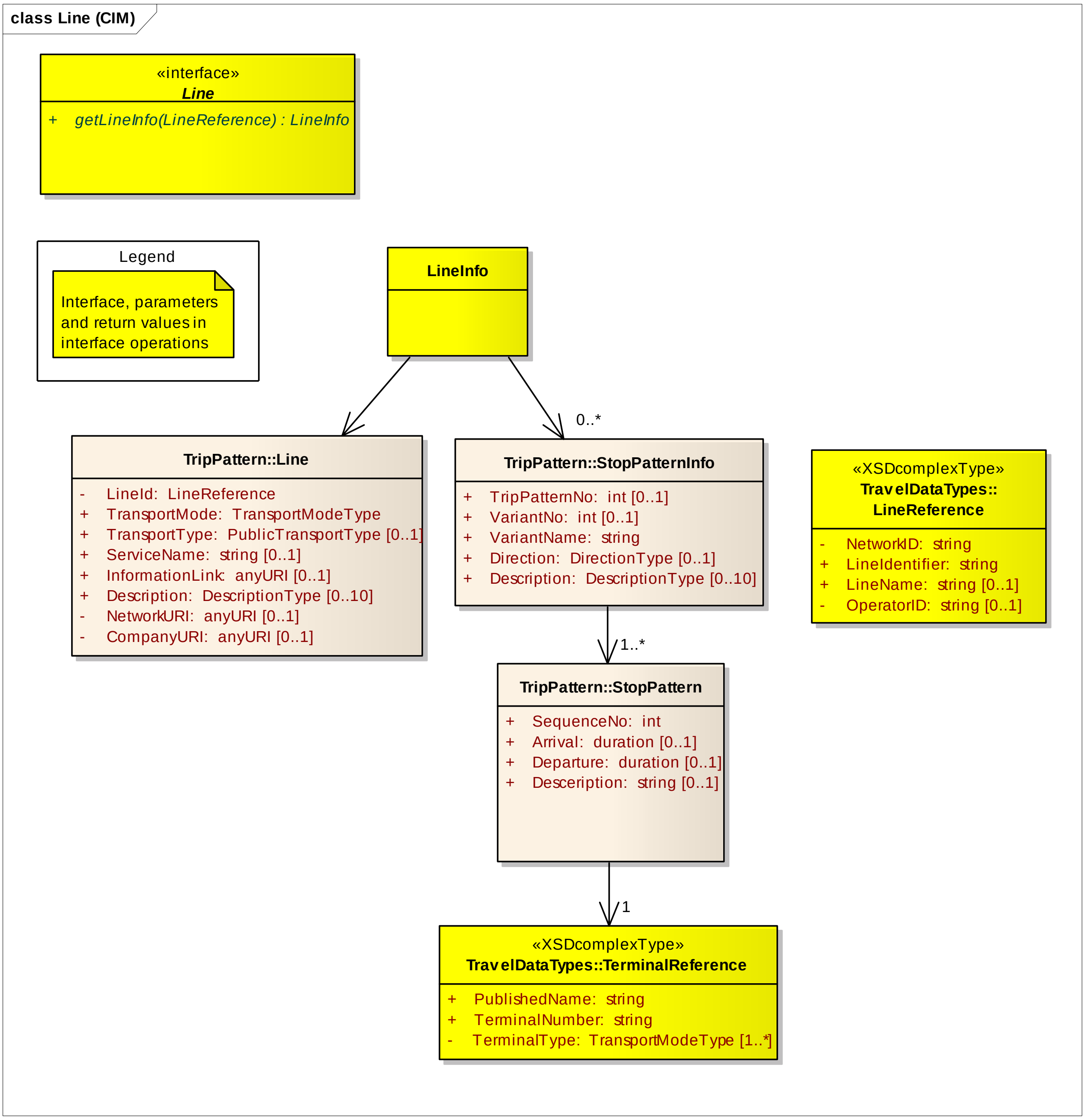


Figure 66 Line service model

12.4.2 Deviation service CIM

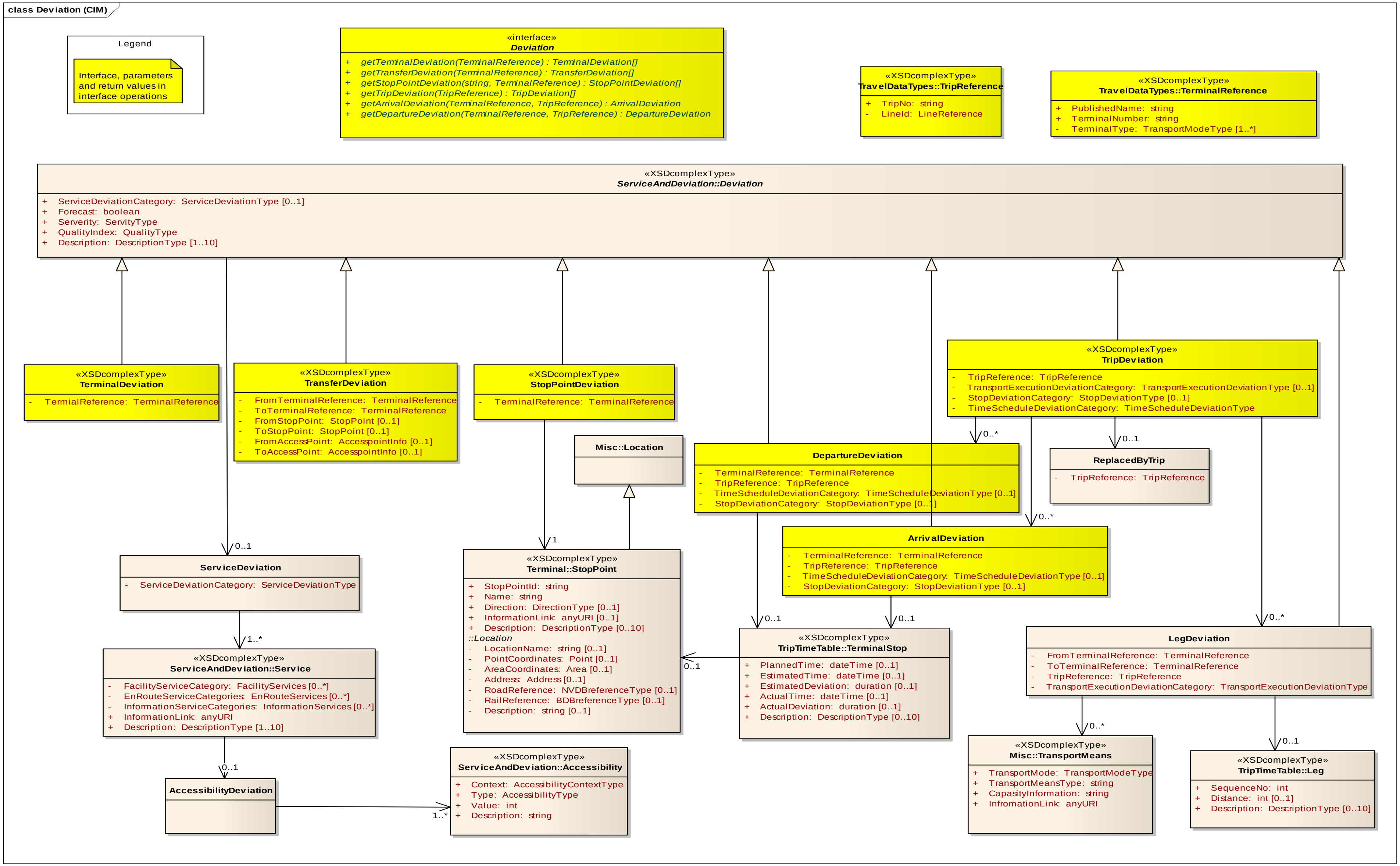


Figure 67 Deviation service model

12.4.3 Service service CIM

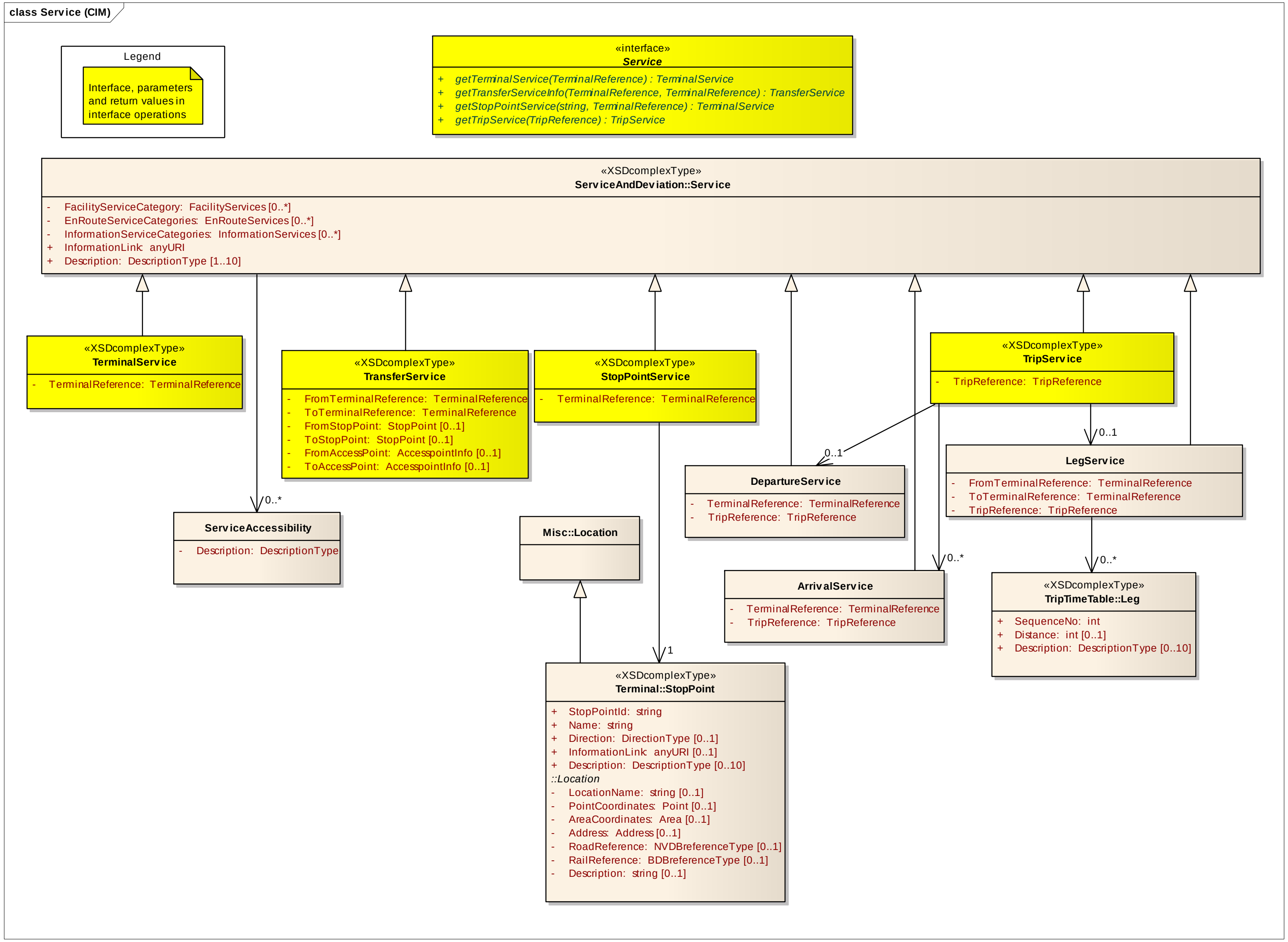


Figure 68 Service service model

12.4.4 Terminal service CIM

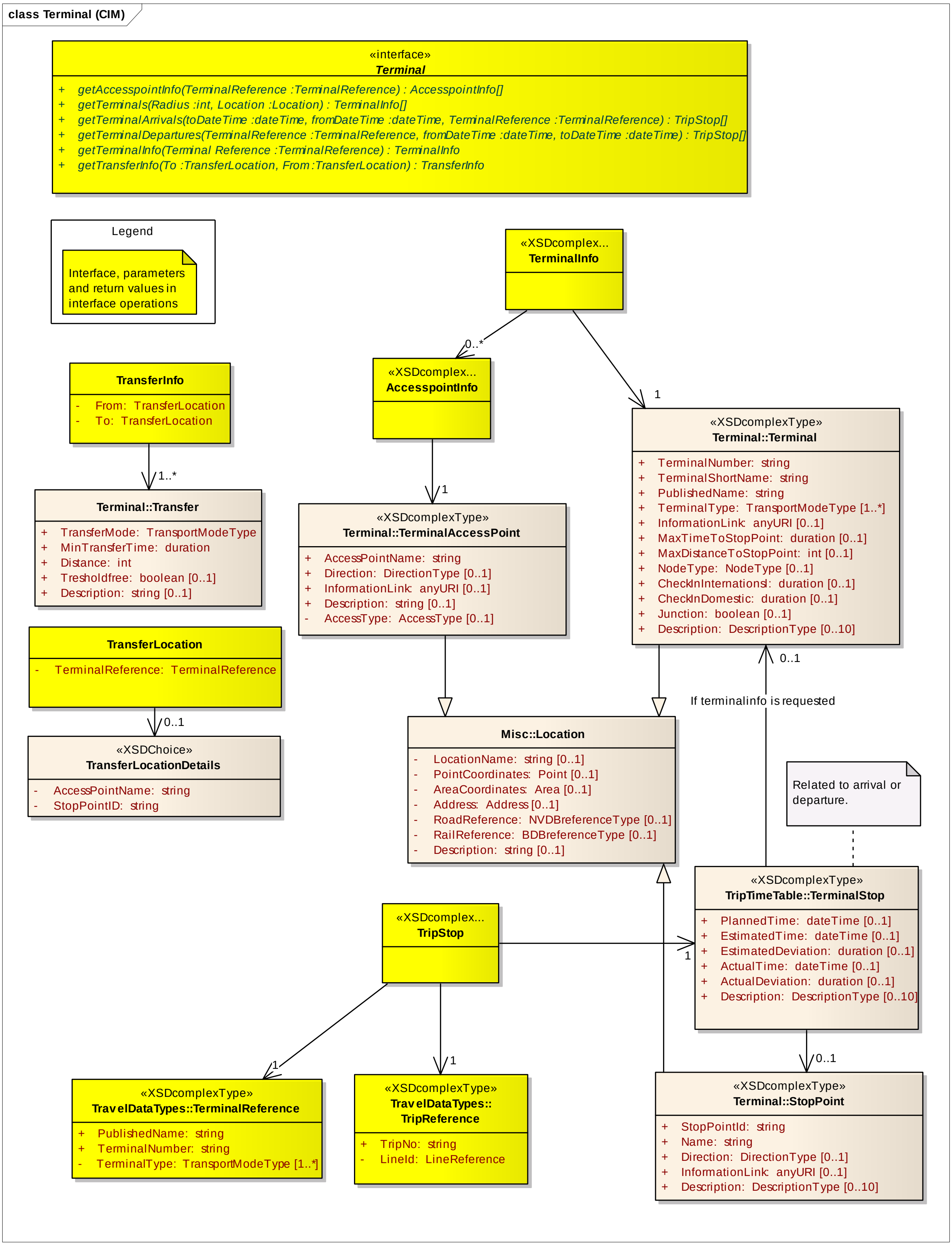


Figure 69 Terminal service model

12.4.5 Timetable service CIM

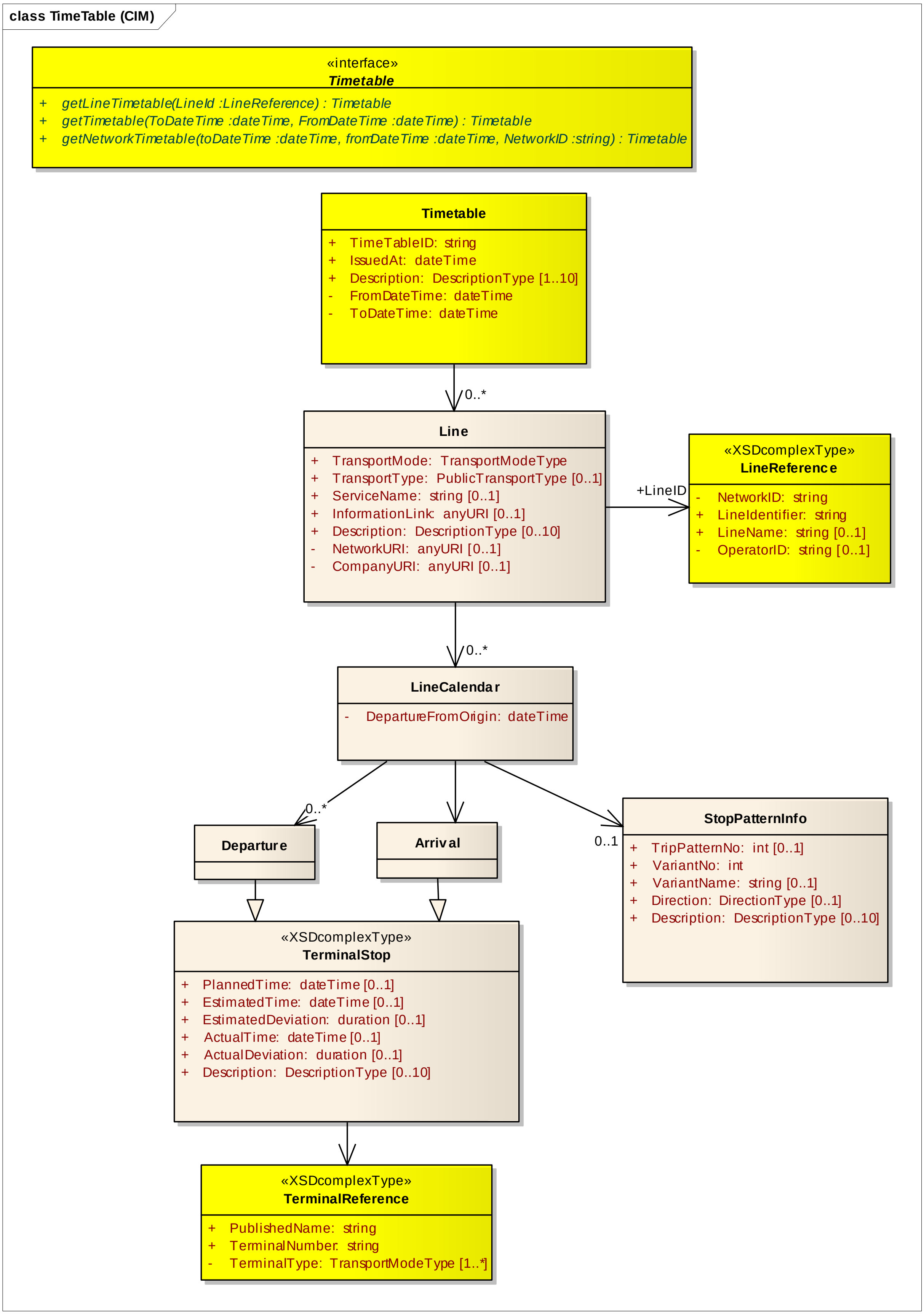


Figure 70 Timetable service model

12.4.6 TravelPlan service CIM

The travel plan service model is defined by the service models in Figure 71 and Figure 72.

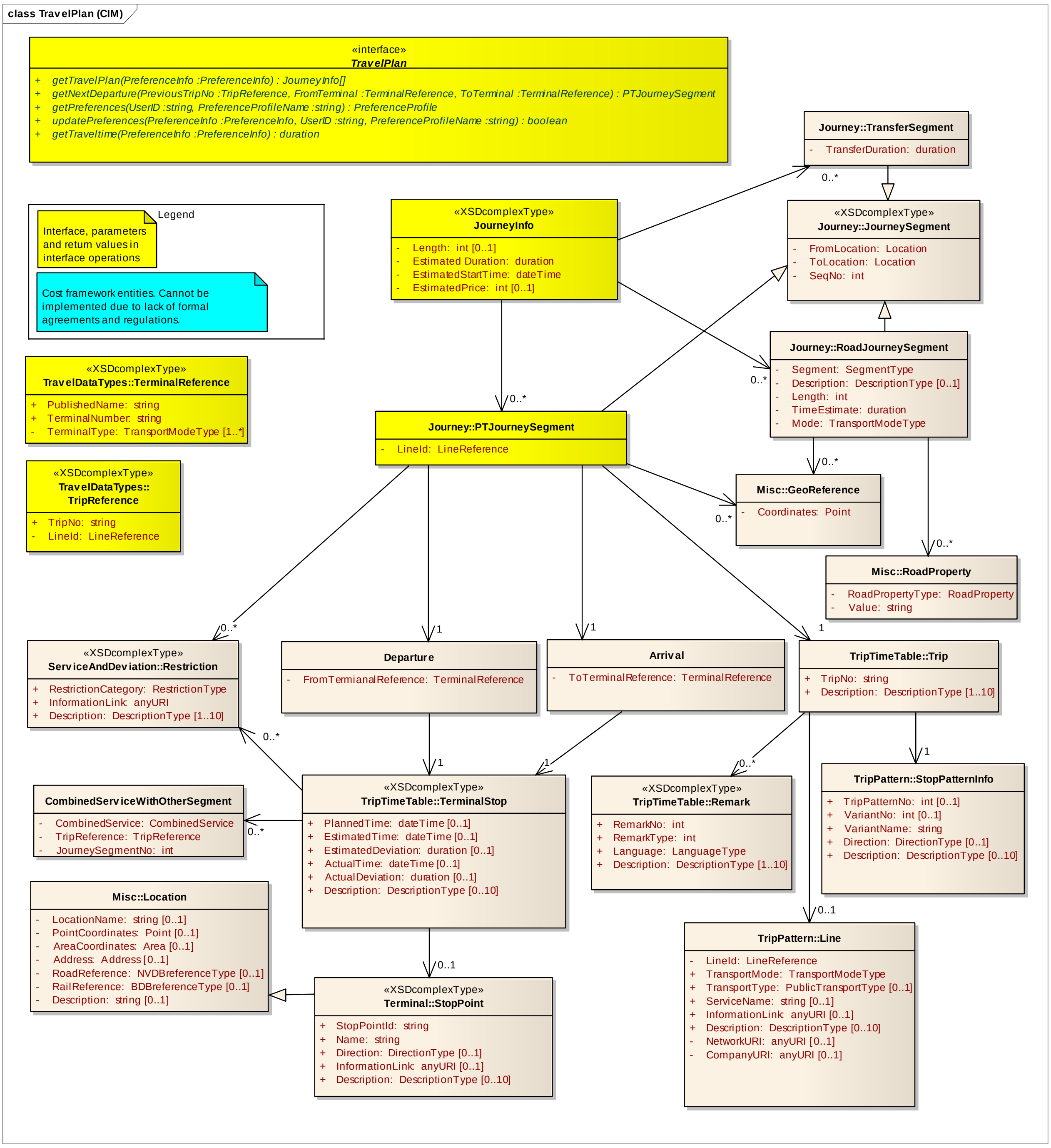


Figure 71 TravelPlan service model – part 1

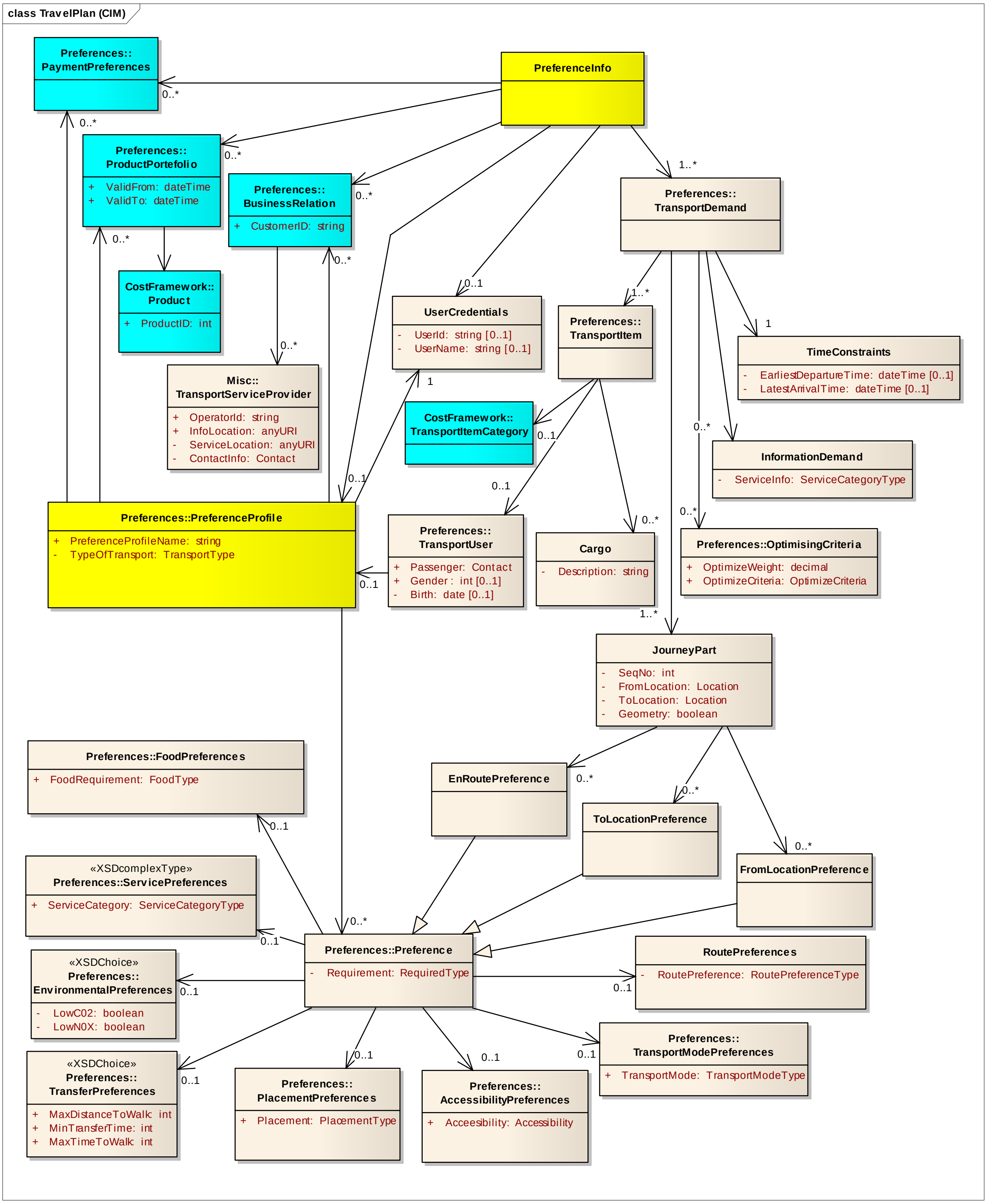


Figure 72 TravelPlan service model – part 2

12.4.7 Trip service CIM

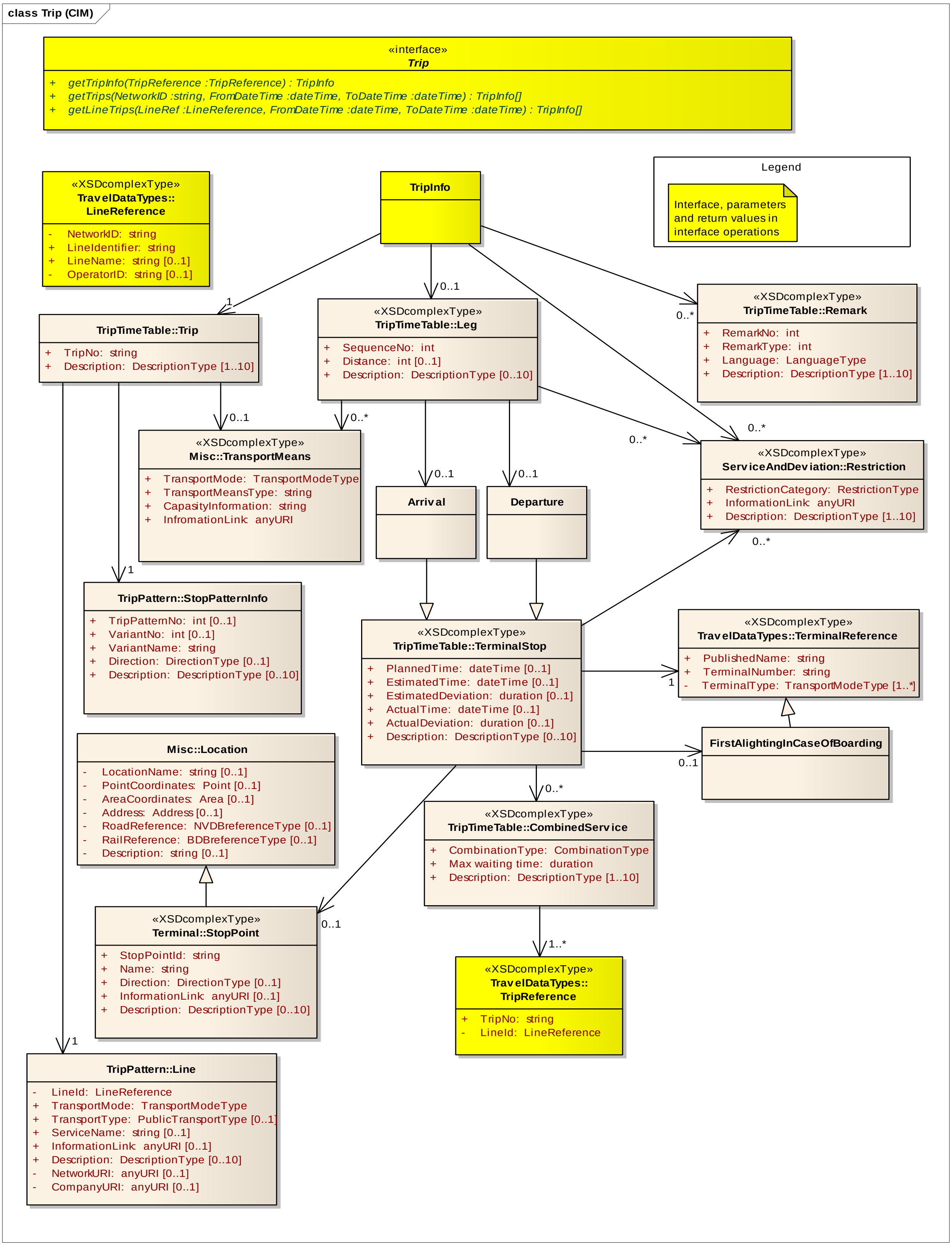


Figure 73 Trip service model

12.4.8 Sequence diagram example

The open services defined above can be used to collect information that can be combined into travel information services that are provided to the Transport User, as illustrated in the figure below.

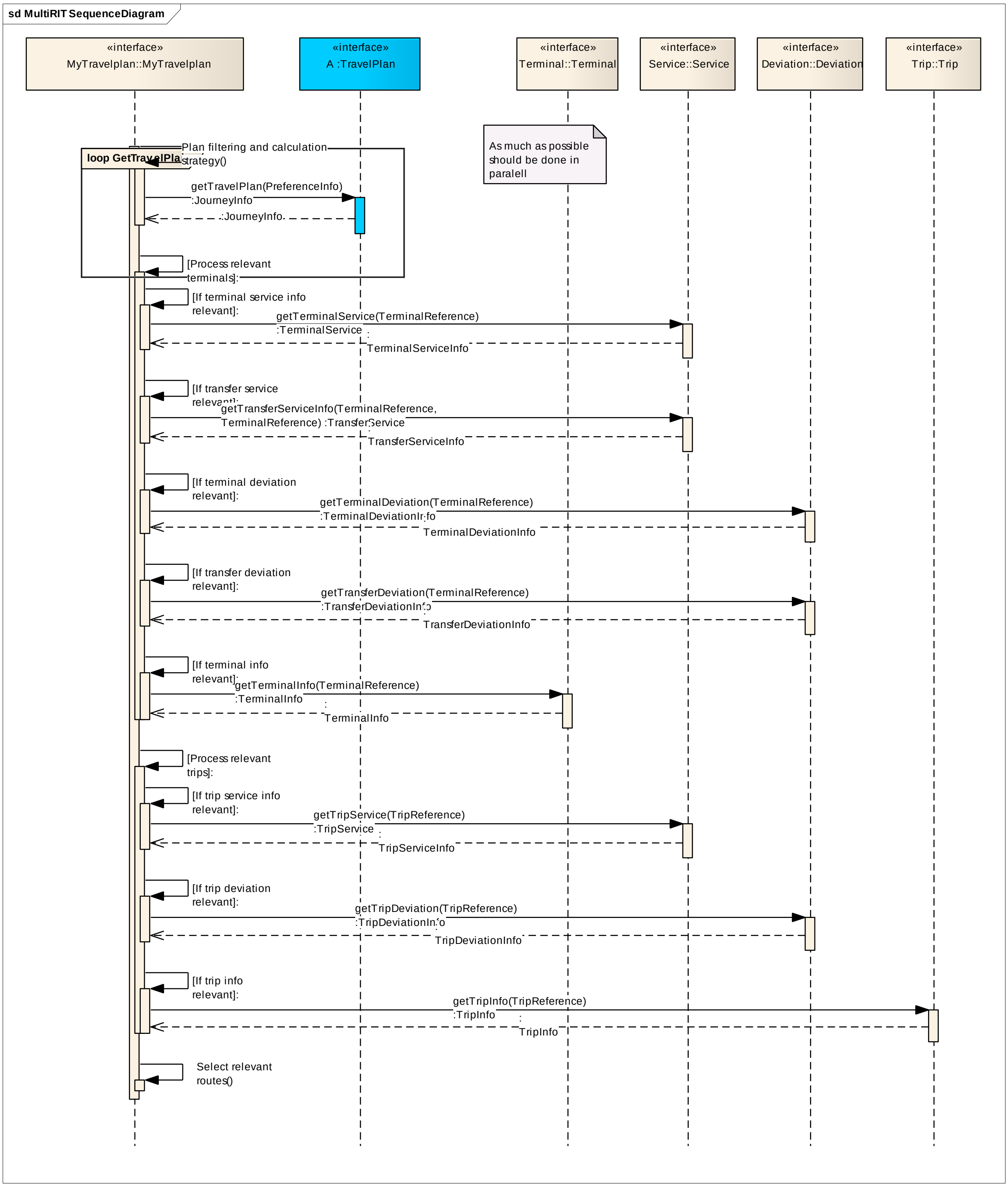


Figure 74 Sequence diagram example

12.5 PIM - Basic service models

The basic service models appear exactly as the conceptual service models. The difference is that the classes in the conceptual service models contain all relations to other classes that are present in any of the conceptual service models. To be able to successfully transform the basic service models into web service models (PSMs), all hidden and unneeded relations must be removed from each of the service models.

Since the conceptual service models and the basic service models actually depict the same information content we have not included diagrams showing the basic service models in this report.

13 Technical aspects

A loose integration of ITS solutions according to the SOA paradigm is preferred, mainly trough synchronous/asynchronous interactions realized by the now ubiquitous “web services” technology. The interactions have to be specified with respect to:

- Their information content. XML should be used
- If services are to be implemented: The services definition. WSDL is so far used
- Support for complex services supporting business processes/workflow, transactions, service descriptions, etc. So far there are no descriptions for such processes.
- The messaging solution. The best solutions for loosely coupled systems are currently probably:
  - o SOAP with Web-services (XML encoded messages according to WSDL specifications over SOAP)
  - o RESTFUL Web-services (XML encoded messages).

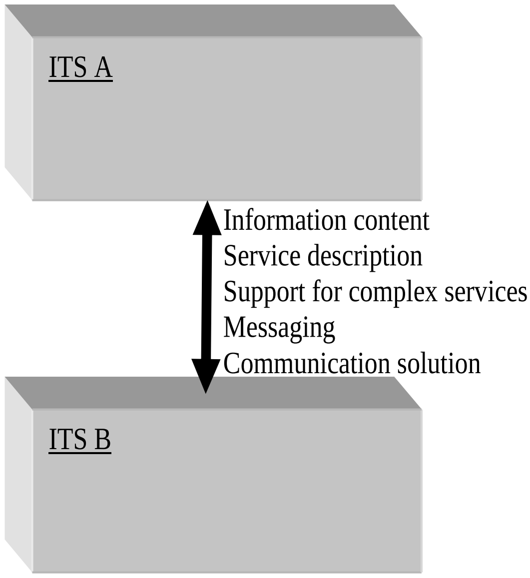


Figure 75 Loosely coupled systems

The communication solutions should be allowed to vary depending on the situation

13.1 Web service models

Based on the basic service models, a new set of models are created. These are referred to as web service models and in MDA terminology these models relate to what is called Platform Specific Models (PSM). In addition to the information described in the previous models (CIMs and PIMs) they prescribe how the travel information is formatted (XML), how it is being communicated (SOAP over HTTP) as well as technical details related to this.

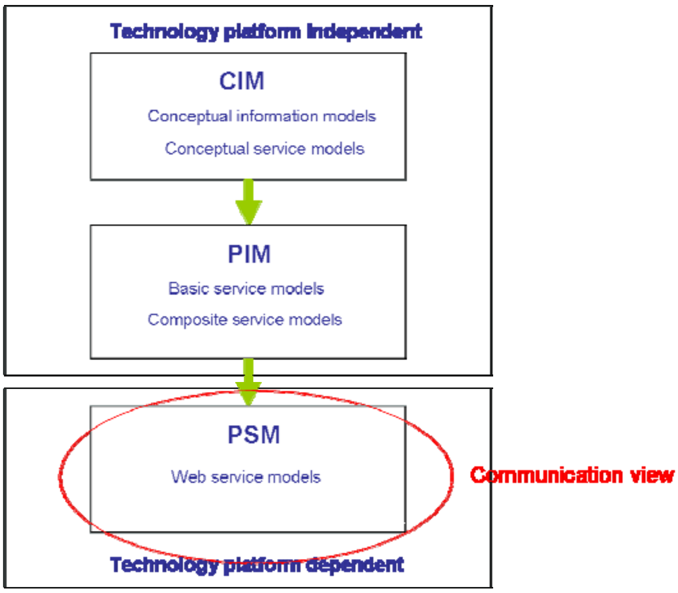


Figure 76 MDA - Communication view

The web service models are one step closer to the practical implementation of the travel information services. From these models WSDL (Web Service Definition Language) files can be generated. In addition to defining the web service interface according to the web service models, these files support automatic generation of skeleton code needed to communicate with the web services as well as code that may be used in the development of the web services themselves.

The technical aspects described in the web service models includes information about the actual services, what protocols to be used to transfer the information (bindings), information about the operations that are included in the web service (port types), information about the messages that are being distributed (messages) and the data types that are used in the messages (types). An excerpt from a web service model demonstrating the abovementioned components is depicted in Figure 77.

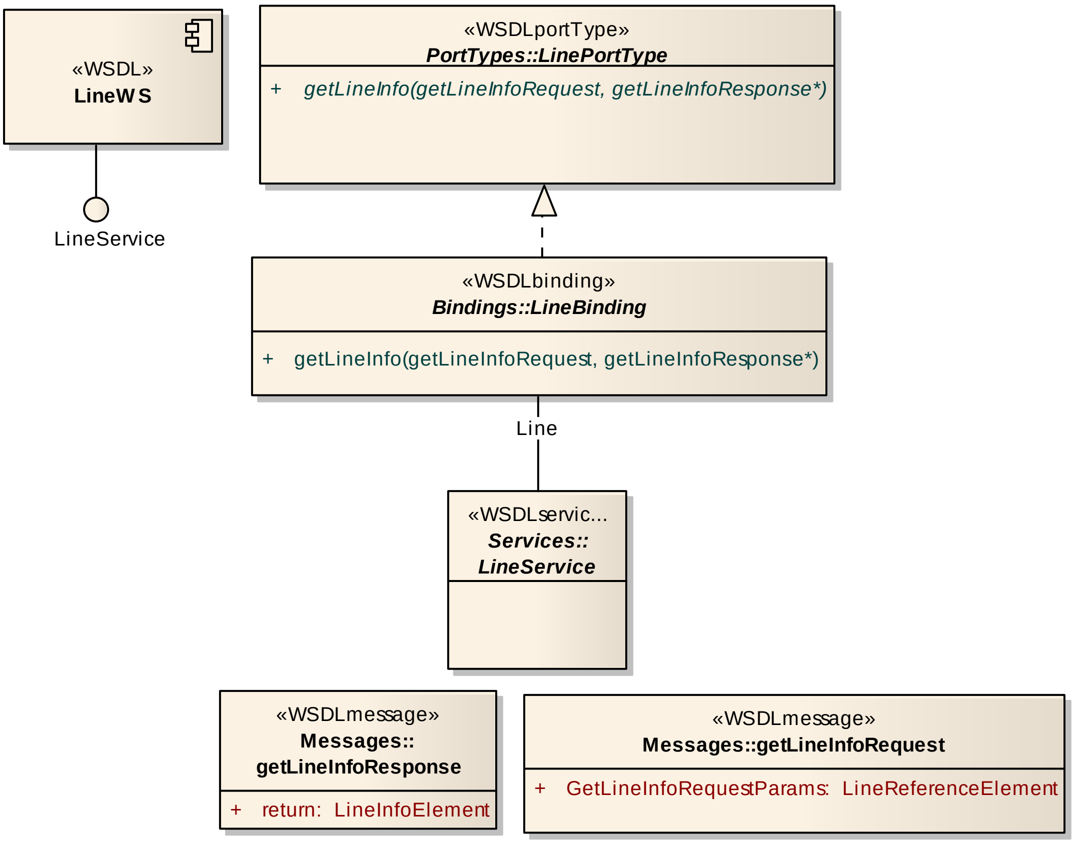


Figure 77 Web Service Model

13.1.1 Web-service definitions for travel information services

The Web-service definitions are available from the ARKTRANS Web-site: www.arktrans.no.

13.2 XML Schema

An XML schema is a structured document that contains the vocabulary used to communicate XML messages. We developed an XML schema based on the conceptual information models which includes a mixture of enumerations and classes. The classes are transformed into complex XML elements whereas the enumerations are transformed into simple XML elements as depicted in Figure 78. The following XSD schemas were developed in the project:

- CostFramework
- Incident
- Journey
- Misc
- Preferences
- ServiceAndDeviation
- TripPattern
- TripTimeTable
- Terminal
- TravelDataTypes
- RestrictionTypes
- ServiceTypes
- DeviationTypes
- AccessiblityTypes

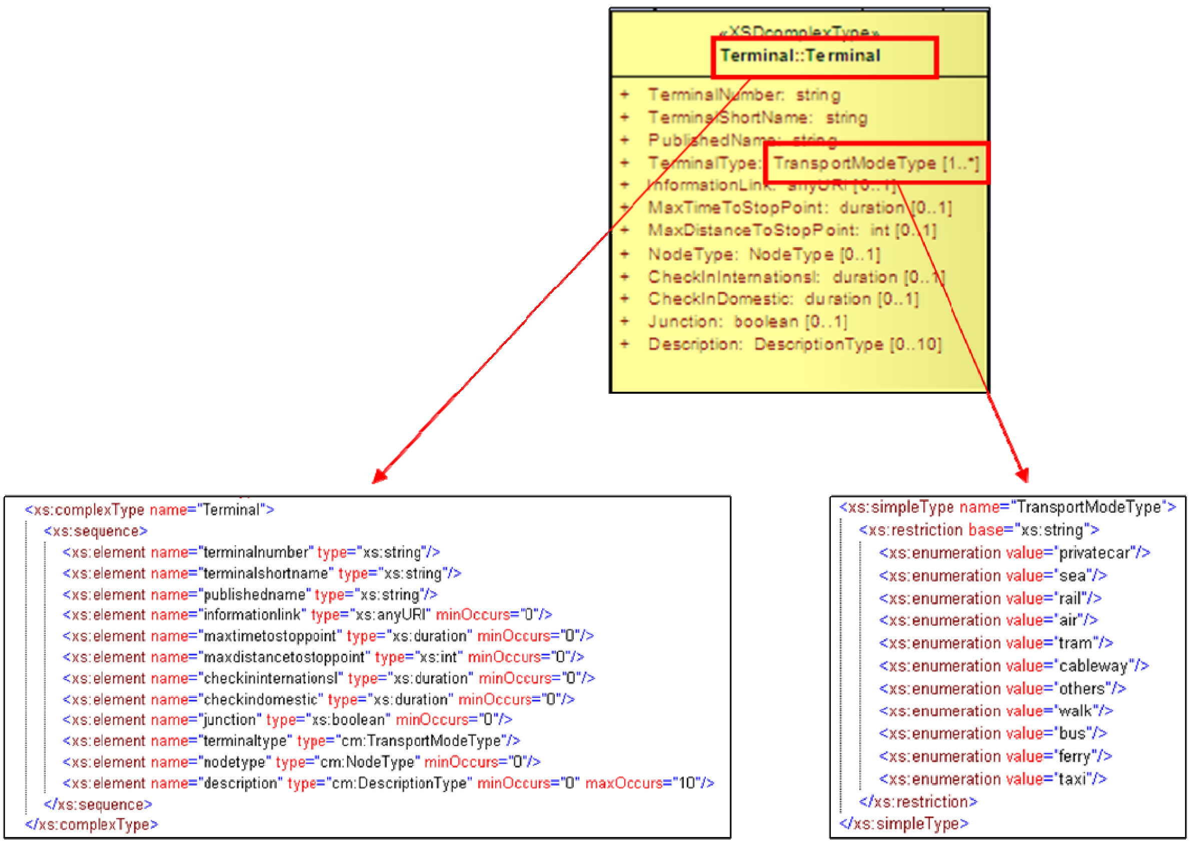


Figure 78 Transformation from model to XSD schema

13.2.1 XML Schema for travel information services

The schemas are available from the ARKTRANS Web-site: www.arktrans.no.

14 Terminology

This chapter defines some terms that are important to the overall understanding of ARKTRANS, among others the named interactions in the process diagrams in Chapter 11. However, the terminology list is not complete. The whole ARKTRANS report defines terminology with respect to roles, decomposition of the transport sector, functionality, interactions, information elements, etc. For some terms the Norwegian term is also provided in parentheses.

14.1 Access

Information about access rights to Transportation Network Sections assigned to a Transport Means. May include access restrictions or access assignment with or without timeslots.

14.2 Accessibility

The ability to access and benefit from the functionality provided by a service or a facility. Information about such accessibility is very important for some user groups. A lift may for example be available, but the physical conditions in the lift may influence on the usability.

Accessibility is often associated with disabilities. According to the concept of universal design, accessibility is however a matter that permanently or temporarily is relevant to all of us, e.g. people with heavy luggage, people with broken legs, people with small children, elderly people, etc.

14.3 Area Traffic Information

Information about the Transport Means in an area with respect to position, speed, direction, and in some cases also the destination they are heading for. Used by the Traffic Manager and by Transport Means (especially in air and sea transport) when they plan their operations.

14.4 ARKTRANS Services

ICT services that are specified in the information and communication views of ARKTRANS.

14.5 Arrival Information

Overall information about estimated or actual time of arrival directed to named recipient (e.g. a Traffic Manager, a Transfer Node or a Transport User).

May contain:

- Transport Means or trip identification or trip identification
- Timestamp
- Point of departure
- Destination
- ETA
- ATA

14.6 Classification

A classification of a Transport Means done according to a traffic management strategy, e.g. depending on risk calculation, priority strategies, service level strategies, etc. This classification will influence on the traffic management measures taken towards the Transport Means.

14.7 Clearance

Permissions assigned to Transport Means by one or more Transport Regulators to access, arrive, depart, etc. May also be negative. Based on the *Transport and Trip Report*.

14.8 Contract Information

A contract describes business conditions. May contain

- ContractID
- Contract type (Standard, long term, short term, load unit type)
- Contract time frame
- Customer
- Service provider
- Service type
- Quantity
    - Type
    - Total quantity (min, max)
    - Trip quantity (min, max)
    - Committed quantity
    - Timeframe
- Quality
    - Priority (express, high speed, normal speed, post service)
    - Cost level
    - Security
    - Conditions (clean, temperature, etc.)
    - Religious requirements
- Transport Item information – see *Item Information*
- Terms
    - Price
    - Payment
    - Penalty (Demurrage, Damage, ServiceDeviation)
    - Bonus (early delivery)
    - Commissions (broker – Percentage/min/max, Transfer Node)
    - Ability to change
    - Availability
    - Other conditions
- Start location
- Final destination

14.9 Dangerous Goods Information

Overall information or detailed information (depending on the situation) about dangerous cargo carried by a Transport Means. In case of no emergency, overall information informing about the presence of dangerous cargo is sufficient. In case of emergency, detailed information is required. May contain one or more of the following:

- Information about the presence of dangerous cargo.
- Information about dangerous cargo type
- Information about the amount and localisation of dangerous cargo on board
- Information about how to handle such dangerous cargo

14.10 Deviation

A deviation is an actual or foreseen deviation from a plan, for example:

- Time schedule deviations (delay, early arrival/departure).
- Transport execution deviations (disruption, cancellation, execution alterations with respect to transport modes, replacement of Transport Means, reduced capacity, and re-routing to new journey patterns)
- Service deviations (reduced service, increased service)
- Stop deviation (new stop added, stop omitted)

14.11 Departure Information

Overall information about estimated or actual time of departure directed to named recipient (e.g. a Traffic Manager, a Transfer Node or a Transport User).

May contain:

- Transport Means or trip identification
- Timestamp
- Point of departure
- Destination
- ETD
- ATD

14.12 Environmental Demand

Demands for specific traffic management issues due to emergencies. The Emergency Management domain may for example request re-routing of the traffic or other traffic management measures due to an oil spill.

14.13 Environmental Information

Meteorological information or other environmental conditions, e.g. information about pollution (dust, spill of harmful materials, etc.), noise, etc.

14.14 Environmental Notification

Notification sent to the Emergency Management domain about an emergency or possible emergency.

14.15 Exception Request

Request for specific permissions related to traffic issues. E.g. related to the transport of load that is higher or broader than usual.

14.16 Generic Route Information

Distributed by the Traffic Manager. Describes the recommended normal routes, alternative routes and route diversions (in case of obstructions). It is up to the Crew on board to decide how to adapt to the route information. May be a part of the Network and Traffic Status information.

14.17 Generic Information

Generic information provided by Information Service Providers, e.g. information about travel times, cost information, travel information in general and context dependent information.

14.18 Guidelines

Guidelines about how to do traffic management, i.e. traffic management strategies.

14.19 Handling Instruction

A Handling Instruction specifying conditions for the handling of a Load Item when *Transport Tasks* (loading, unloading, other terminal operations, etc.) are executed. May include requirements for special treatment and special terms of agreement, e.g. for handicapped travellers, unaccompanied children, diseases/allergy.

The handling instruction may be entirely or partly derived from the *Transport Item Instructions* (defined by the associated *Transport Execution Plans*) and from conditions defined by regulations and frameworks (e.g. related to type of Transport Means and type of cargo).

14.20 Incident

Abnormal and unplanned situation that may affect safety or the traffic flow in a negative way such as:

- Unwanted situations and situations that may lead to emergencies (e.g. minor accident, engine breakdown, error, dangerous behaviour, robberies, etc.)
- Near accidents
- Specific *Transportation Network Conditions* that may need attention
- Specific weather conditions
- Specific environmental conditions (e.g. pollution)
- Illegal behaviour

14.21 Incident and Accident Information

Information about incidents and accidents may include:

- Type of incident
- Position
- Number of people involved
- Number of fatalities
- Number and types of injuries
- Dangerous goods involved
- Surroundings

14.22 Irregularity Notification

Notification about irregularities on-board a Transport Means. May support local (on-board) incident and emergency management.

14.23 Item Information

Information about an item that in relation to transport may be a *Load Item* that is transported or a *Transport Item* that is to be transported. The information may be stored on electronic tags attached to the item.

This information may for example be:

- The ID of the item and (if relevant) if it contains other items also the IDs of these items
- For each ID:
    - Type of content (e.g. goods type) or empty indication
    - Amount/weight/volume

- Requirements with respect to handling (e.g. temperature) (*Handling Instruction* if *Load Item* and *Transport Item Instruction* if *Transport Item*)
- Alert requirements
- Requirements with respect to information publishing (e.g. broadcasting information abort dangerous goods)

14.24 Item Properties

Information about an item, e.g. a Transport Means, a Transport Item or a Load Item. Will consist of:

- Item Information
- Item status (e.g. loaded, in warehouse, etc.)
- Item *Tracking* information
- Item condition (e.g. temperature, humidity, etc.)

14.25 Itinerary

Specifies the route and the time schedule for a transport of a *Transport Item*. The content of an Itinerary may depend on the type of transport and on the phase (during the transport preparations and planning vs. after the firm booking).

The Itinerary is crucial in person transport, as the traveller must know about all Journey Segments. In freight transport however, the actual route of the freight transport may be of no interest to the Transport User. But even in freight transport Transport Users may request an Itinerary.

As illustrated in Figure 81, the Transport Service Provider will return an Itinerary that specifies how the transport will be executed (if an Itinerary is required by the Transport User). The Transport User may combine information form several Itineraries (received from different Transport Service Providers) into an Itinerary for the whole transport chain.

An Itinerary specifies how a *Journey* is to be carried out by means of one or more *Journey Segments* – see Figure 79

14.26 Journey

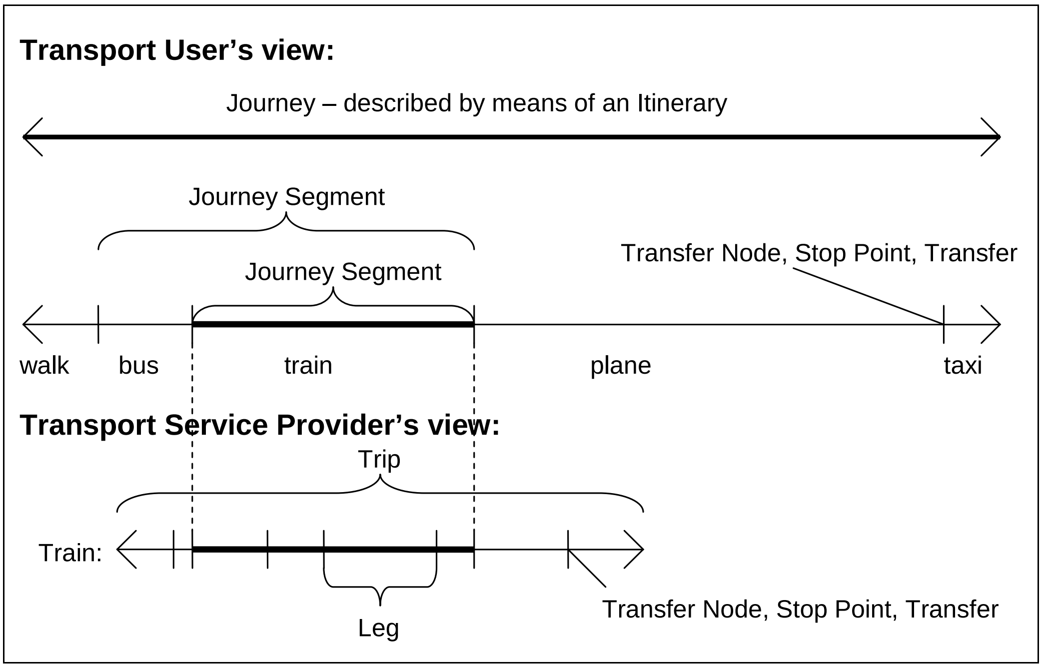


Figure 79 Different views upon transport

A Journey is the total distance a Transport Item is to travel. As illustrated in Figure 79, the Journey represents the Transport User's view upon the transport, and a Journey may be composed of one or more *Journey Segments*.

A Journey may be described by a *Travel Plan* or an *Itinerary*.

14.27 Journey Segment

A part of a *Journey*.

A Journey Segment may also consist of a set of consecutive Journey Segments executed by different Transport Means. The decomposition of Journey Segments into more Journey Segments is done dynamically as the transport execution is decided upon.

A Journey Segment may be carried out by means of one or more *Legs* of one or more *Trip* (which represents the Transport Service Provider's view upon a transport as illustrated in Figure 79).

14.28 Leg

A leg is the part of a *trip* that is between two consecutive stops at *Transfer Nodes*. See Figure 79

14.29 Line

The term line is commonly used about routes or *trips* that are known to the public by similar names or numbers.

NOTE: We are *not* using the route concepts in the formal definitions in ARKTRANS as it is unclear. A route may have many variations, it may be a repetition of strictly the same pattern every time, it may be composed of sub-routes, it may be circular, it may be a common reference to a public transport service in both directions between end points, or just in one direction, etc. In ARKTRANS we focus is on the *trip*s accomplished by a specific Transport Means as they are moving from a start point to an end point along a particular *trip pattern*.

14.30 Load Item

Transport Operations and *Transport Tasks* are dealing with Load Items. A Load Item may be a passenger, a load unit, a trade unit, a cargo item or a loading area in a Transport Means.

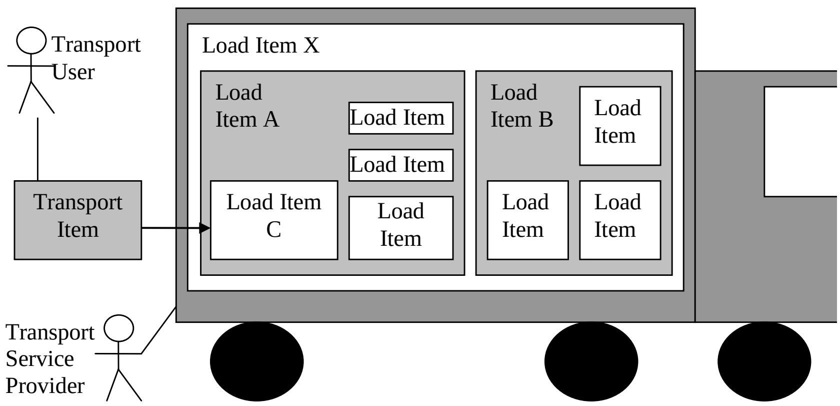


Figure 80 Transport Means with Load Items

Figure 80 illustrates that Load Items may be included in other Load Items, and that a loading area of a Transport Means also may be considered to be a Load Item.

A *Transport Items* will in those parts of the Transport Service Management domain that are dealing with the transport operations become one or more Load Items (more than one if the Transport Item has to be split – for example due to capacity problems). Handling requirements with respect to Load Items are described by means of *Handling Instructions* (which are mode specific and dependent on the *Transport Operation*), derived from the *Transport Item Instructions* (which are generic and mode independent) related to the associated *Transport Items.*

Load Item deviations may influence on the associated Transport Items. Temperature deviations related to Load Item A or Load Item X may for example affect Load Item C, and the Transport User of the Transport Items related to Load Item C should be notified.

14.31 Load Item Properties

The *Item Properties* applied on a Load Item.

14.32 Network and Traffic Status (NTS) (Trafikkforhold)

Information to Transport Network Users, Transport Service Providers and others reflecting a total assessment of the traffic and the Transportation Network that may affect safety and efficiency. May include several types of information such as:

- Traffic Information (including Incident and Accident Information and traffic flow information)
- Transportation Network Condition information
- *Generic Route Information* (to all Transport Network Users in the area, not individual routes)
- Area Traffic Information

14.33 Notification of illegal behaviour

Notifications about behaviour that violates laws or regulations related to transport.

14.34 Operation Status

The status reported from the Transport Operation Worker to the Transport Operation Manager. The content will depend on the transport operation to be executed (defined in the *Transport Operation Plan*), for example:

Must contain:

- Reference to the Transport Operation Plan
- Reference to the *Load Items* (for example list of passengers that have boarded the Transport Means and seat allocations, cabin allocations, etc.)
- Deviation information (if relevant), for example
  - o Deviations with respect to Load Item
    - Missing Load Item
    - Un-registered Load Item
    - Deviations with respect to *Handling Instructions*, quantity or condition (e.g. damage, injury and illness)
  - o Missing clearances for
    - Transport Means
    - Load Item
  - o Time schedule deviations – Delay or early arrival
  - o Transport execution deviations
    - Disruption
    - Cancellation

    - Reduced capacity
    - Re-routing to new journey patterns.
  - Stop deviation
    - New stop added
    - Stop omitted
  - Service deviations
    - Reduced service
    - Increased service
  - Damage affecting or caused by third party

14.35 Operational Route Plan

Detailed route plan for a *Transport Operation*. For internal use by the Transport Service Provider (Transport Operation Manager and the Transport Operation Worker). The route to be followed is also of relevance to the Transportation Network User responsible for the Transport Means operation.

Defines the detailed route and time schedule of a specific the transport operation, how to get between the locations, specific attention that is required due to *Network and Traffic Status*, etc.

May include:

- Route information (id, description, etc.)
- Valid for information
- General information
- List for one or more locations that should be visited
  - Location information (Transfer Node, address, etc.)
  - ETA
  - ETD
  - Tasks to be done
  - Guidelines (how to drive, etc.)
  - Remarks

14.36 Preference Check

The result from a check between the preferences of a Transport User and a *Travel Plan*. Will confirm or disprove that the travel plan is according to the preferences.

14.37 Product Validation

The confirmation of the use of a product, e.g. a travel with public transport. May initiate a payment transaction or confirm that payment is done.

14.38 Quality Status

Confirms that safety and quality assurance procedures are accomplished according to regulations and that the state of the Transport means and cargo is ok (e.g. weight and balance information).

May also provide information about the state of the Driver with respect to

- Driving and resting hours (influences on whether the transport can be done according to the plans.
- Tiredness
- Stress
- Level of disturbance/absence of mind
- Level of experience

- Level of knowledge about route and cargo and local Network and Traffic Status

14.39 Resource Booking / Booking Response

The booking of a Transportation Network Resource and the related response.

14.40 Resource Plan

Specifying the working plan for the resources involved in the transport operation (personnel, equipment and Transport Means). The work load for the crew has to be considered.

14.41 Route

Specification of the route assigned to a specific Transport Means.

14.42 Route Plan

A time table related to a transport services that includes time schedules for one or more locations on a route. The route plan is managed by the Transport Service Management domain, but may be of interest to Transport Users, Traffic Managers and others. The *Transport Service Description* is based on the Route Plan.

There are several types of route plans:

- Draft Route Plan - Preliminary version of the planned route plan established by the Transport Service Planner. Used for strategic and tactical planning.
- Planned Route Plan – The public version of the time table on which the transport operations are based. May be of interest to Transport Users, Transfer Nodes, Traffic Managers, Travel Information Providers, and others.
- Actual Route Plan – includes real time information about estimated or actual arrivals and departures. May be published to Transport Users by means of information services. (Arrival Information and Departure Information is however directed to named recipients, e.g. an Transport Regulator, a specific Transport Service Provider or a specific Transport User)
- Operational Route Plan

A Planned or Actual Route Plan may be published as a time table and may include one or more of the following messages:

- Trip information (id, description, etc.)
- Trip pattern information (Transfer Nodes that are to be visited)
- Planned time schedules for one or more checkpoints and/or Transfer Nodes
- Actual Route Plans will also include real-time information for arrivals and departures.

14.43 Safety Deviation

A deviation that may influence of the safety, e.g. a deviation with respect to the Transportation Network.

14.44 Safety Operation

Operation that will be handled and responded upon by Transport Means. May facilitate automated operation or automated support to the Driver in situations that may lead to accidents.

14.45 Safety and Security Instructions

Safety and security issues (environmental safety included) related to a *Transport Operation* and *Load Items*. A part of the Transport operation Plan (TOP) that is provided to the Crew ahead of a *Transport Operation* .

14.46 Safety Status

Information about safety issues related to a Transport Means. May include:

- The status of functions that are of importance related to safety (breaks, fuel level, engine condition, etc.)
- Type and Quantities of Dangerous Goods
- Fire extinguishers onboard
- First Aid Skills of Crew
- Emergency Preparedness Means
- Onboard Contingency
- Plans
- Company Contingency Plans,
- Contact/Key-personnel
- Condition of Transport Means

14.47 Statistics

Statistics related to transport issues.

14.48 Security Violation Report

14.49 Service

A service that is offered by Transport Service Providers (meals served, help provided, etc.) as well as facilities (more physical installations like toilets, lifts, waiting rooms, etc.) that is a part if the infrastructure). Such services and facilities are available on-board Transport Means during the transport, at arrivals to and at departures from a Transfer Node, and at Transfer Nodes.

14.50 Storage Plan

A plan for space allocation that must consider:

- Optimisation of space usage with respect to space allocation and throughput.
- Weight and balance control
- Segregation control (Load Items must be stored according to regulations, e.g. food cannot be stored together with chemicals).

A part of the *Transport Operation Plan*.

14.51 Stop Point

A location at a Transfer Node where Transport Means stops for boarding/alighting or loading/unloading. This may for example be a gate, a track, or a quay. A Transfer Node may contain one or more stop points, and each stop point must have a unique identification.

14.52 Tracking

Information about the localisation of a Transport Means, a *Load Item* or a *Transport Item* and in many cases also information like the speed, direction and heading of the Transport Means.

Tracking information is provided to the Transport Service Providers or to the Traffic Managers from on-board equipment or equipment attached to *Load Items*, or it may be provided by the Transport Execution Worker. The Transport User may get tracking information from equipment attached to the *Transport Items.* However, if the Transport User does not have tracking equipment attached to the Transport Items, tracking information may be received from the Transport Service Provider in a *Transport Execution Status* (TES).

14.53 Traffic Control Information

Specific traffic control information distributed from the Transportation Network Utilisation domain to Transport Service Providers or the On-board Support and Control domain. May be related to specific transport means or to safety issues. May specify details about traffic management measures related to individual Transport Means, e.g. the predicted time slot or time for a specific departure.

14.54 Traffic Image (Trafikkbilde)

See *Area Traffic Information*.

14.55 Traffic Information (Trafikkinformasjon)

Dynamic information. May be *Incident and Accident Information* and traffic flow information, I.e. information about traffic density, speed and delay. The traffic flow information may be historical information, current situation or prognosis for the future (forecast), etc.

14.56 Transfer Node

A location or an area where Transport Means may stop to allow passengers to enter or leave the Transport Means, or to allow the loading and unloading of cargo. Transfer Nodes may be small stations or bus stops, or large and complex terminals that arrange for the handling of many Transport Means at the same time, e.g. airports with many gates, railway stations with many tracks or cargo terminals.

Two or more Transfer Nodes may be co-located, and such a co-location of Transfer Nodes may be considered as a Transfer Node as well, e.g. the Oslo Airport Gardermoen terminal that includes several airport terminals (domestic, international, arrival, departure, freight terminals, etc.), a railway station, and a bus terminal. A Transfer Node must have a unique identification.

14.57 Transportation vs. Transport

The term transportation is used when talking about transport in general, as seen from the viewpoint of the society. Thus, a Transportation Network denotes the network that arrange for transport in general; and transportation planning is the overall planning of how transport is to be carried out.

The term transport (and not transportation) is however used about the specific transport done by transport companies and others providing transport services. The providers of transport services will do transport planning – the planning of how to execute actual transport operations.

14.58 Transportation Network

The Transportation Network is the infrastructure provided by roads, fairways, railways, air corridors and *Transfer Nodes*.

14.59 Transportation Network Condition (Ferdselsforhold)

Dynamic information about abnormal and unplanned conditions in the Transportation Network (slippery road, turbulence, high waves, obstructions, restricted view, air pollution, oil spill, etc.) due to situations that cannot be controlled (weather, incidents, accidents, etc.). May affect safety as well as the traffic flow.

May be historical information, current situation or prognosis for the future (forecast).

14.60 Transportation Network Information

Static as well as dynamic information about planned situations in the Transportation Network infrastructure and regulations valid in the Transportation Network (e.g. closed roads, platooning, speed limitations, restrictions, constraints, and diversions). The information may be used for route planning.

May include:

- Speed limitations and other information about regulations
- Quality information
- Constraint information:
    - Type of constraint
    - Localisation
    - Condition (normal, reduced)
    - Remarks

14.61 Transport Item Properties

The *Item Properties* applied on a Transport Item.

14.62 Transport and Trip Reporting

Information about the Transport Means movement, the passengers and the cargo may have to be reported to Transport Regulators, e.g. customs declarations for a Transport Means or clearance request before vessel enters a port. The report may include:

- Transport Means information
- Departure Information
- Arrival information
- *Load Item* information. This may be
    - Passengers that have actually boarded the Transport Means. May include the following information for each passenger:
        - Passenger ID
        - Passenger category (man, woman, child, baby)
        - Agreement (business class, tourist class, etc.)
        - Resource allocation (seat, cabin, compartment, etc.)
        - Handling instructions. May include requirements for special treatment and special terms of agreement, e.g. for handicapped travellers, unaccompanied children, diseases/allergy.
    - Cargo Load Items on-board the Transport Means. May contain the following information for each item:
        - ID (Load unit ID or Waybill id)
        - Consignor and consignee (with respect to this trip)
        - Size and weight
        - Information about certificates
        - Information about special load (*Dangerous Goods Information*, food, etc.)

  - Position on-board
- Crew information, for example
  - ID and nationality
  - The certificates of the Crew (documenting qualifications of a person, e.g. the qualification of driving Transport Means carrying a specific type of dangerous cargo, navigation qualifications for specific areas, etc.)

The report may be directed to a named Transport Regulator or via a single window provided by the Information Transfer Service Provider. The information may be reported by the Transport Service Management or the On-board Support and Control domain.

14.63 Transport Item

An item which the transport demand is about. Transport services are needed related to these Transport Items. A Transport Item may be a person (the traveller), a load unit, a trade unit or cargo. A Transport Item may contain Transport Items, and so on.

Generic requirements related to the handling of a Transport Item are defined in the *Transport Item Instruction*.

When the actual *Transport Operations* are planned and executed, the Transport Items are considered to be *Load Items* and they may be a part of other *Load Items.*

14.64 Transport Item Instruction

The Transport Item Instruction specifies specific treatment conditions for transport services related to Transport Items, e.g. fragile cargo, handicapped travellers, unaccompanied children, food, animals, etc. The instructions are provided by the Transport User, and the instructions will together with conditions defined by regulations and frameworks (e.g. related to type of Transport Means and type of cargo) influence on the establishment of *Handling Instructions* related to *Transport Operations*.

14.65 Transport Item Properties

The *Item Properties* applied on a Transport Item.

14.66 Transport Item Reporting

Information about one or more Transport Items reported to Transport Regulators.

14.67 Transport Item Status (TIS)

In case the *Transport Execution Status (TES)* reports about a deviation related to one or more *Transport Items*, Transport Item Statuses (TIS) for the affected Transport Items are provided to the Transport User.

The TIS will inform about the Transport Item condition (e.g. damage, lost, values representing temperature, etc.); deviation description and status location. It must contain:

- Reference to the transport execution plan
- Reference to the Transport Items
- Type of deviation. This may for example be
  - Missing Transport Item
  - Un-registered Transport Item
  - Deviations with respect to Transport Item Instructions, quantity, and damage
  - Missing clearances for Transport Item
  - Time schedule deviations – Delay or early arrival

14.68 Transport Execution Plan (TEP)

The Transport Execution Plan (TEP) is the basis for the Transport User's booking and follow up of a Transport Service provided by a Transport Service Provider (see B in Figure 81). One TEP may be related to several Transport Items, e.g. a number of goods items that are to be transported between two locations.

The Transport Service Provider may return an *Itinerary* which specifies details on how the transport is carried out (see C in Figure 81). The Transport User may include information from this Itinerary into an *Itinerary* that covers many TEPs – which defines the execution of the whole transport chain (see D in Figure 81). Thus, one TEP may cover the whole Transport Plan or just one or more of the *Journey Segments* in the Transport Plan.

Several TEPs may relate to the transport of the same physical object (the Transport Item in the TEPs) at the same time:

- The TEP negotiated between the original Transport User (the sender or the traveller) and a Transport Service Provider. This TEP may, depending on the needs of the Transport User, cover a door-to-door transport service or just a Journey Segment.
- If the Transport Service Provider has to sub-contract parts of the service that is provided to the Transport User, there will be a TEP or TEPs used for booking of services from sub-contractors (the Transport Service Provider will then be a Transport User and use the functionality described in the Transport Demand domain).
- More TEPs derived from the needs for further sub-contracting.

The Itinerary may refer to the relevant TEPs.

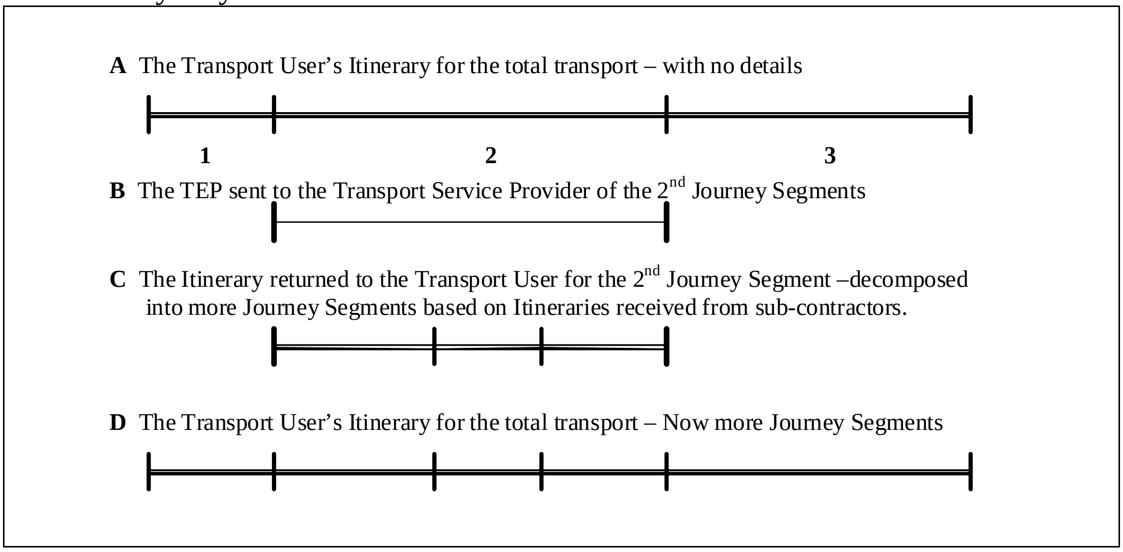


Figure 81 TEPs and Itineraries

As illustrated in the Figure, the Transport Service Provider may split the transport defined by a TEP into several Journey Segments. This may for example be the case if the Transport Service Provider is a forwarder. The Journey Segments will be described in an *Itinerary*. For each Journey Segment subset, the Transport Service Provider will become a Transport User and book the required transport service from other Transport Service Providers. (The original Transport User may however not have to be aware of this) by means of a TEP.

The TEP is in the Transport Service Management domain used as the basis for the transport service provision and transport operation management. This TEP must contain all details of relevance for the transport operation planning and follow up, e.g. information about all the Transport Items and the transport services to be delivered.

A TEP may contain the following information:

- Transport Service Providers identification
- Transport User identification (e.g. also associated customer numbers)
- *Contract Information* (in general or for a specific booking towards a Transport Service Provider)
    - References to existing contracts
    - Other requirements
    - Information about the ability to change the TEP (deadline for cancellation or changes, costs related to changes, etc.)
- The Transport Items to be transported (passenger(s), load units or goods)
- Transport item instructions, e.g.
    - Space allocation (e.g. seat)
    - Treatment
    - Special service requirements, e.g. for handicapped travellers, unaccompanied children, traveller with diseases/allergy, food, etc.
- Transport service requirements
    - Location (start, end, transits)
    - Time schedule (departure/pick-up and arrival time/delivery times
    - The services type and, if relevant, sub-services (the service type may for example be transport between locations, and the sub-services may be loading, unloading, customs declarations, etc. related to this transport)
- Information service Requirements, e.g. status reporting requirements

14.69 Transport Execution Status (TES)

The status of the transport service to be provided from the Transport service Management domain to the Transport Demand domain. The status may be one of two

- Confirmation of “according to plan”.
- Notification about transport execution deviations. If deviations in delivery time, an estimated time of delivery/estimated time of arrival is provided.

The transport execution deviations may for example be

- Time schedule deviations (delays or early arrival)
- Disruption execution
- Cancellation
- Execution alterations with respect to transport modes, replacement of Transport Means, reduced capacity, and re-routing to new journey patterns.
- Stop deviation
    - New stop added
    - Stop omitted
- Service deviations
    - Reduced service
    - Increased service

In case the TES reports about a deviation, *Transport Item Statuses (TIS)* for the affected Transport Items are provided to the Transport User.

14.70 Transport Means Status

Static as well as dynamic information about operative state, maintenance, economic transactions related to the Transport Means. May provide routine reports, e.g. reporting of mileage.

14.71 Transport Operation

A Transport Operation contributes to the delivery of Transport Services and to the fulfilment of one or more *Transport Execution Plans* (TEPs), either directly by executing operations on the items addressed or indirectly by means of preparations.

A Transport Operation may for example be to consolidate a container (load Load Items into a container); to load Load Items (containers, pallets, goods, etc.) into a Transport Means; to move a Transport Means from one location to another, to unload Load Items; transhipment of Load Items at a terminal; to split a container; document handling related to Load Items, etc.

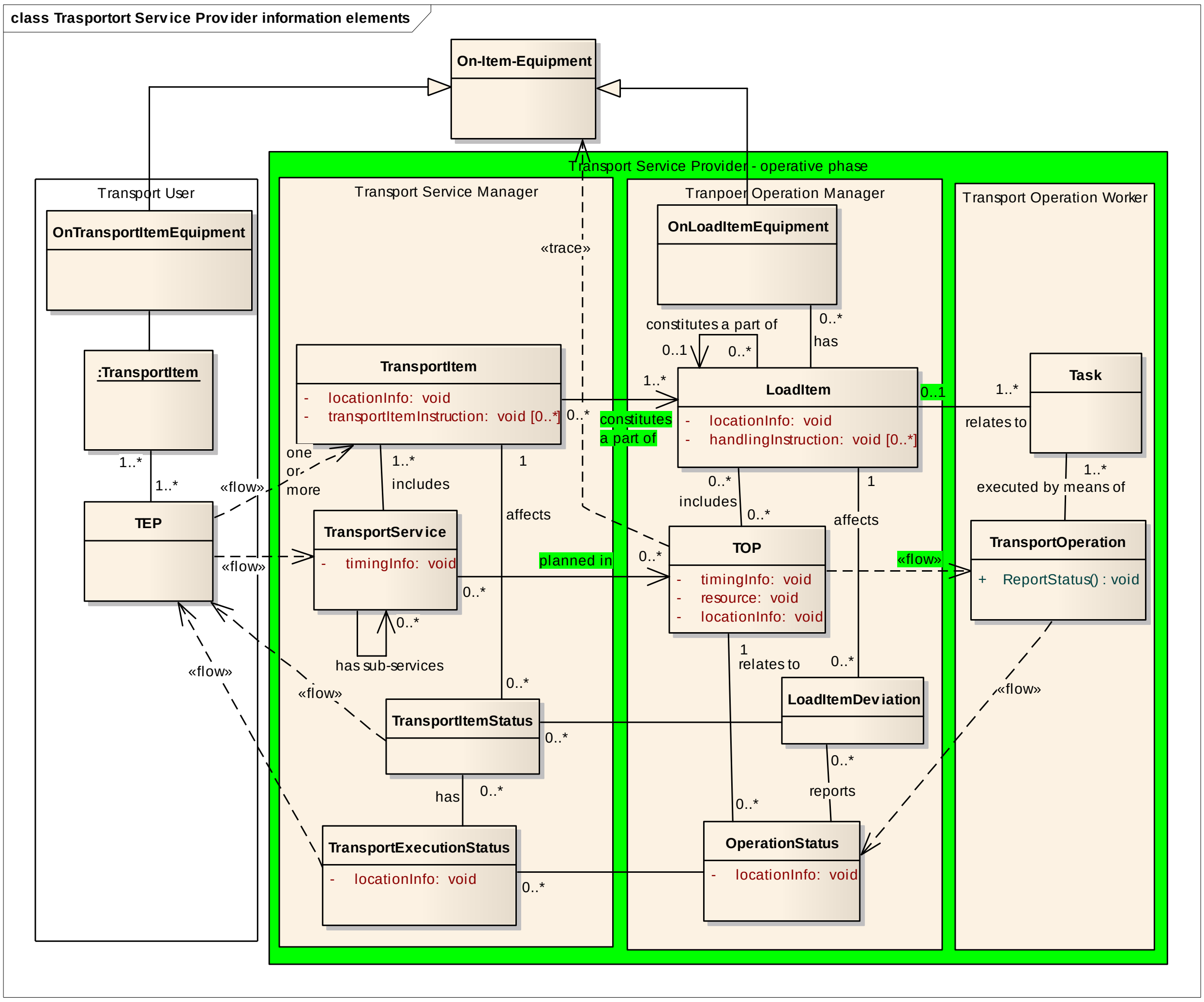


Figure 82 Information elements related to transport services and operations

A Transport Operation is planned and managed by the Transport Operation Manager and may include handling of *Load Items*. The best possible utilisation of resources is emphasized when the transport operation is planned. The transport operation planning may result in a Transport Operation Plan (TOP).

Figure 82 illustrates (in an informal way) the information elements, flows and dependencies in the Transport Service Management domain. The Transport Service Manager receives the TEPs from the Transport Users.

- The TEP defines the Transport Items to be handled and the transport services that are requested.
- During the execution of the transport operations, there may be status reports related to the TEPs and the Transport Items.

The relevant parts of the TEPs (the requested services, the Transport Items, etc.) are handed over to the Transport Operation Manager.

- A Transport Item identified in the TEP becomes one or more Load Items (more than one if they for example have to be split due to capacity problems – e.g. the total volume of oil in two tanks).
- *Transport Operation Plans* (TOPs) are established based on:
    - The needs for consolidation/splitting operations. The optimal organisation of Load Items may require such operations. Pallets may for example be put into containers, container may be loaded into Transport Means, containers may be unloaded, containers may be split, etc.
    - The service demands expressed in the TEPs (consolidation, splitting, transhipment, transport, document handling, etc and location and time schedule information associated to the service requests.)
    - Internal needs for transport operations. This may be needs for transport of empty load units; or needs due to plans for scheduled transport services. In the latter cases there may be no Load Items associated with the TOP (e.g. no bookings on a scheduled bus departure – the passengers will just arrive).
- During the execution of the transport operations, there may be operation statuses related to the TOPs and Load Item deviations related to the Load Items. Such status information may cause the need for:
    - Additional transport operations, e.g. the removal of goods (i.e. Load Items) from a container (i.e. Load Item). Such needs will be expressed by means of TOPs.
    - Provision of status information for the affected Transport Items to the Transport Service Manager

The TOPs are provided to the Transport Operation Workers.

- One transport operation may
    - Cover a number of Load Items, but each Load Item may have individual handling instructions
    - Include guidelines that are common to all the Load Items, e.g. a storage plan for a loading operation
- The transport operations are executed by means of several tasks related to the individual Load Items.
- Status is reported.

14.72 Transport Operation Information

Information provided to the Transportation Network User about a Transport Operation, e.g. the locations to be visited. Will contain selected part of the *Transport Operation Plan*.

14.73 Transport Operation Plan (TOP)

Specifies the *Transport Operation* to be executed. This includes information about:

- The type of operation to be carried out
- The related location(s) (e.g. pick-up and delivery locations) and time schedules. May contain
    - *Operational Route Plan* - detailed information of the route to be followed.
    - The locations to be visited - the detailed route plan has to be established by the Transportation Network User.
    - The location(s) at the Transfer Node where the operation will take place
- For each location there may be

  - From Load Item(s) – e.g. the Load Items to be loaded or the Load Item to be split. For each "From Load Item" there may be Handling Instructions
  - To Load Item(s) – e.g. the Load Item that the "From Load Items" are to be loaded into (a container, loading area of Transport Means, etc.) or the Load Items that are to be unloaded from the "From Load Item". For each "To Load Item" there may be Handling Instructions
- *Safety and Security Instructions*
- Guidelines describing how the operation is to be carried out. This may be (will vary depending on the nature of the operation)
  - The sequence in which the Load Items are to be handled
  - The Transport Means Support Services that are booked
  - A *Storage Plan* – e.g. the seat/space allocated to Load Items on-board the Transport means or the use of Terminal Areas
  - Handling instructions
  - Etc.
- The resources to be used (coordinated with the Resource Plans), e.g.
  - The Transport Operation Worker(s) to be involved
  - Transport Means to be used
  - Equipment to be used
  - The Transportation Network Resources that are booked/to be used
- The services and Transportation Network Resources that are booked

14.74 Transport Preferences

The preferences of the Transport User when searching for relevant *Travel Plans*.

14.75 Transport Properties

Information about the transport properties are provided to the Traffic Manager from the On-board Support and Control domain. This information is the basis for traffic management measures towards the Transport Means. This information may be

- Transport Means information:
  - The identity of the Transport Means
  - Overall information about the Transport Means, for example
    - ID
    - Nationality (e.g. flag state)
    - Weight and size
    - Construction (e.g. number of axles, hull, etc.)
    - Engine (e.g. Euro IV standard)
    - Fuel type
  - Overall information about the transport operation such as
    - Type of cargo on board (e.g. hazardous materials)
    - Loading factor (incentives may be provided to encourage full loads)
    - Cargo weight
  - Destination information
    - Route description
    - Arrival/departure locations (e.g. Transfer Node or specified loading bays)
    - Time schedule (e.g. assigned time slots)
- Transport Means tracking information
- Trip information
  - Arrival information
  - Departure information

  - Available certificates
- Overall information about the *Load Items*. This may be
  - Number of passengers and crew
  - Type of cargo on board
  - Dangerous Goods Information

14.76 Transport Service

A transport service is offered to the Transport User by a Transport Service Provider. A transport service is related to one or more *Transport Items*. Several types of transport services may be offered, e.g.:

- Transport
- Transport Item Handling
  - Loading
  - Unloading
  - Packing of Transport Items into Load Units
  - Splitting of Transport Items (e.g. Load Units) to Transport Items
- Document handling
  - Reporting to Authorities (e.g. costumes declarations)
- Transport Item storage
  - Warehousing
  - Depot storage
  - Transit storage
  - Quarantine
- Transhipment - movement of Transport Items
  - Between Transport Means
  - Between Transport Means and storage areas.
  - Between different storage areas
- Case handling – misc. cases related to Transport Item
- Etc.

14.77 Transport Service Description (TSD)

Information about an available Transport Service published to support Transport Users in finding relevant services.

14.78 Transport Task

A Transport Task is carried out by a Transport Operation Worker. The task is related to one Load Item and is defined by a *Transport Operation Plan* (TOP). A Transport Task may for example be

- Transport task - transport of Load Items from one location to another
- Inspection task – Check the condition of the Load Item
- Load Item handling task – handling of Load Item according to the Handling Instruction.
  - Pick up of Load Item
  - Delivery of Load Item
  - Packing of Load Items into another Load Item (e.g. Load Units)
  - Splitting of Load Item (e.g. Load Units) to Load Items
  - Loading of Load Item
  - Unloading of Load Item
  - Special treatment (dangerous cargo, food, disabled, children travelling alone, etc.)
- Document handling task – reporting about Load Items
  - Reporting to authorities (e.g. customs declaration)

  - Reporting to parties in the transport chain
  - Etc.
- Load Item storage task – storage of Load Item according to the Handling Instructions and the storage plan that was generated during the transport operation planning. The storage may be in a
  - Warehouse storage
  - Transit Area storage - while waiting for further transport or handling
  - Depot storage - while waiting for special treatment (e.g. customs clearance)
- Load Item transhipment task - movement of Load Item according to the Handling Instructions and the logistics plan for transhipment that was generated during the transport operation planning
  - Between Transport Means (if desired a cross docking)
  - Between different storage areas or between Transport Means and storage areas.
- Status reporting task – reporting to Transport Operation Manager
  - Transport operation status reporting
  - Load Item status reporting

14.79 Travel Information / Travel Information Services

Misc. information or information services that provide travel information about:

- Deviation information related to terminals, trips or stops
- Line information
- Terminal information (Transfer Nodes)
- Time table information
- Trip information
- Service information related to terminals, trips or stops
- Generic Information

For description of the services that are *ARKTRANS services* – see 12.4.

14.80 Travel Plan /Travel Plan Service

Specifies a travel alternative between two locations by means of one or more *Journey Segments*. A Travel Plan is returned from Travel Information Service provider. (An *Itinerary* is however a description of a *Journey* provided by Transport Service providers).

For description of the TravelPlan service (an *ARKTRANS service)* – see 12.4.

14.81 Trip

A trip is a tour or voyage accomplished by a Transport Means according to a planned route and time schedule or on a more ad hoc basis. A trip may consist of one or more legs, and includes stops at two or more Transfer Nodes. See Figure 79.

14.82 Trip Pattern

A Trip Pattern represents the topological route of a transport services (used instead of the route term since the route term may be confusing).

14.83 V2V communication

Electronic interactions between Transport Means (V2V is Vehicle-to-Vehicle).

14.84 V2I communication

Electronic interactions between Transport Means and the infrastructure (V2I is Vehicle-to-Infrastructure).

14.85 Warnings

Warnings sent to Transport Means in situations that may lead to accidents.

14.86 Yield Management Decision

Strategies about how to do yield management, e.g. how to adjust the price according to the transport demand.

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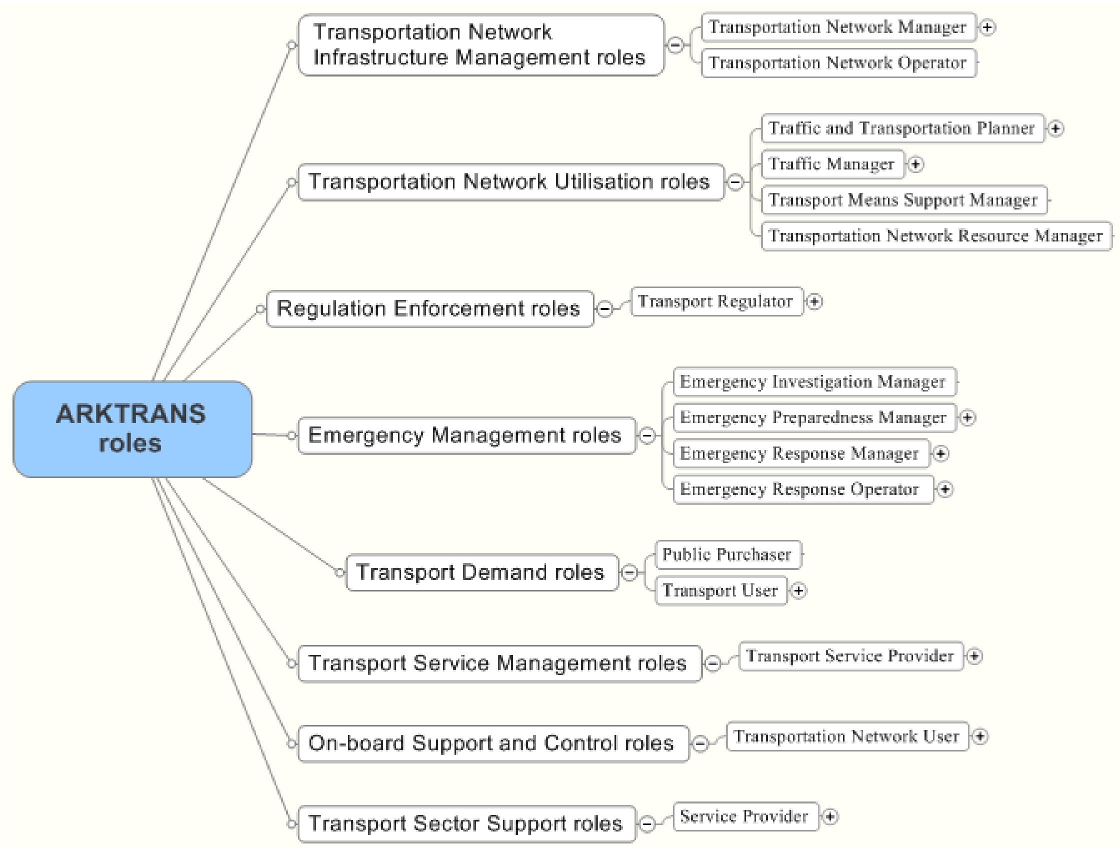
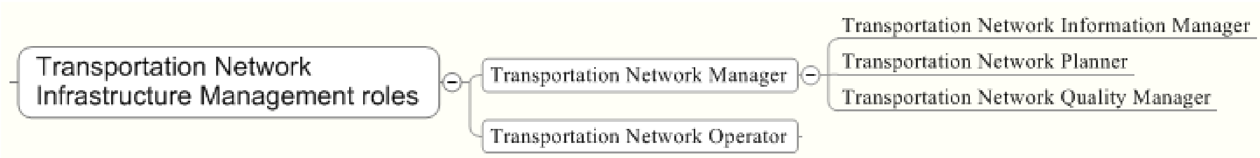
Annex A. Mind Maps showing Roles

The following mind map shows the structure of all the roles defined in ARKTRANS.

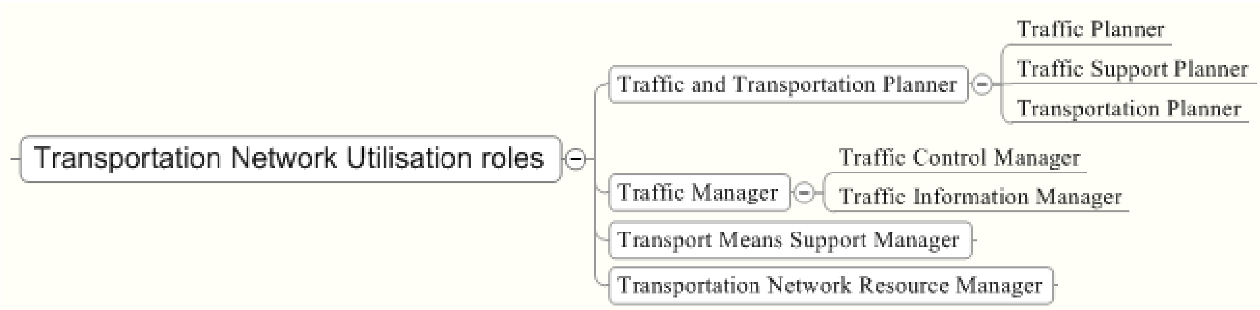
A.1 Overall roles



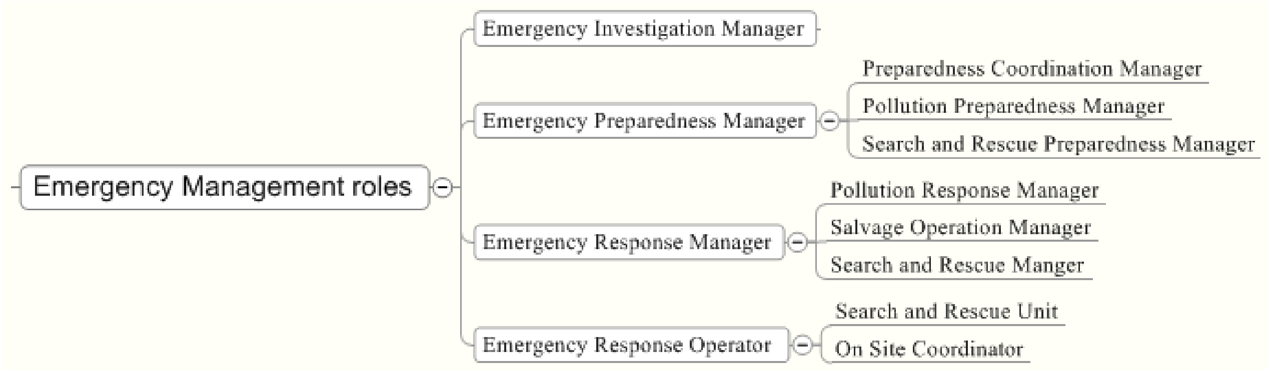
A.2 Transportation Network Infrastructure Management roles



A.3 Transportation Network Utilisation roles

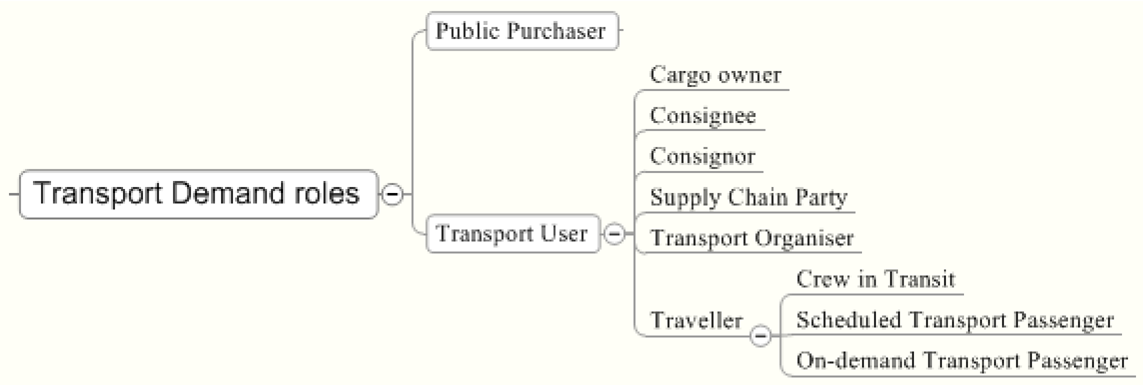


A.4 Emergency Management roles

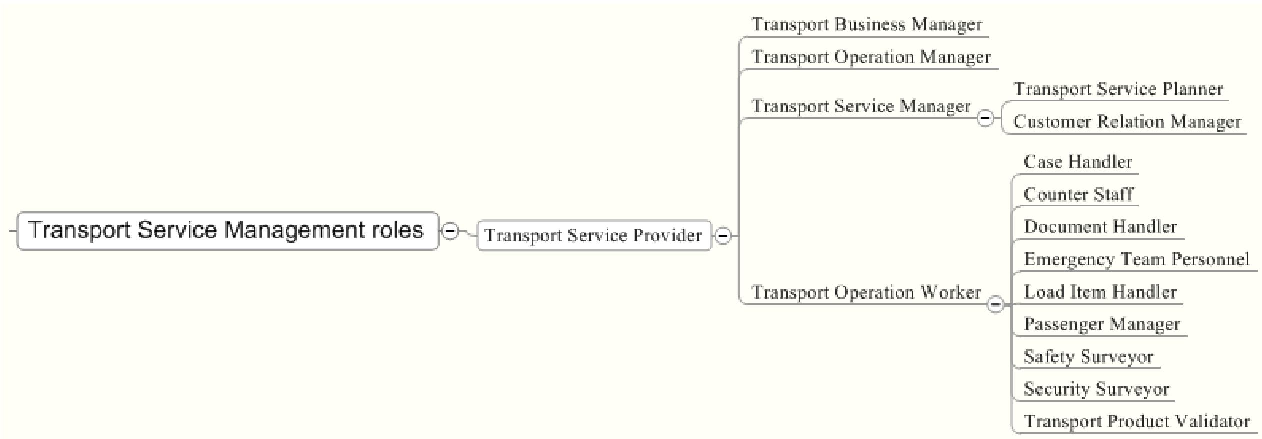


A.5 Regulation Enforcement roles

A.6 Transport Demand roles

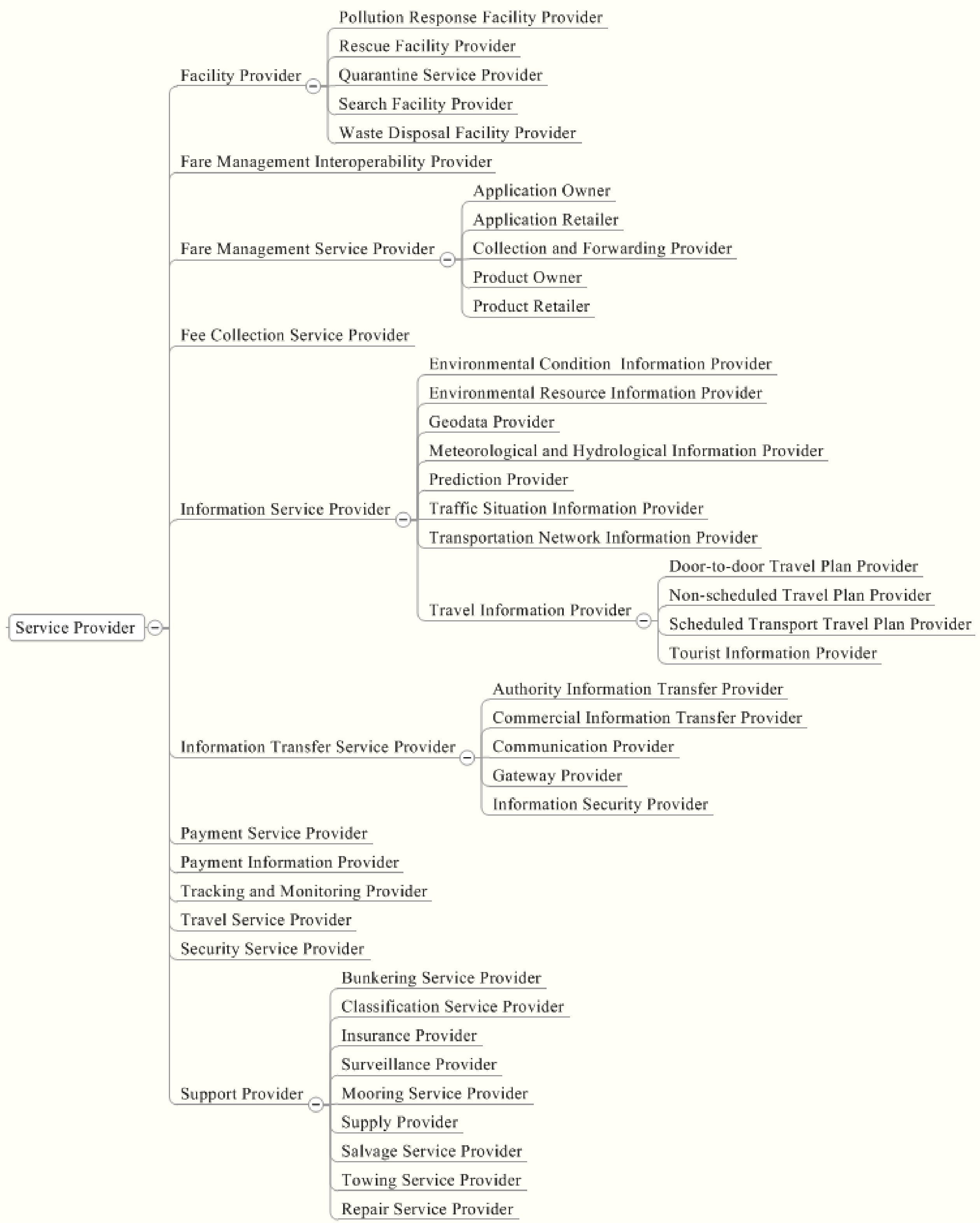


A.7 Transport Service Management roles



A.8 On-board Support and Control roles

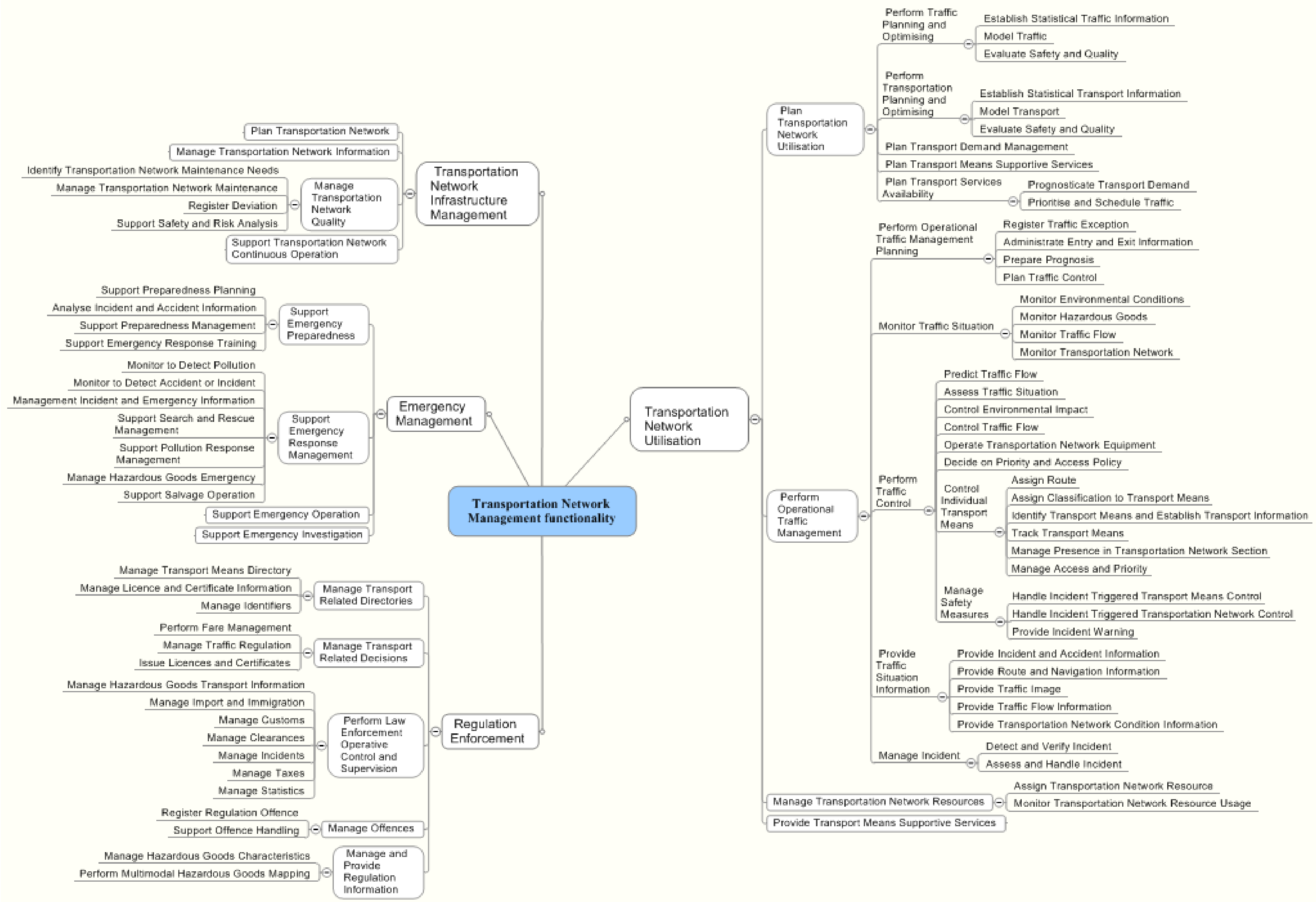
A.9 Transport Sector Support roles



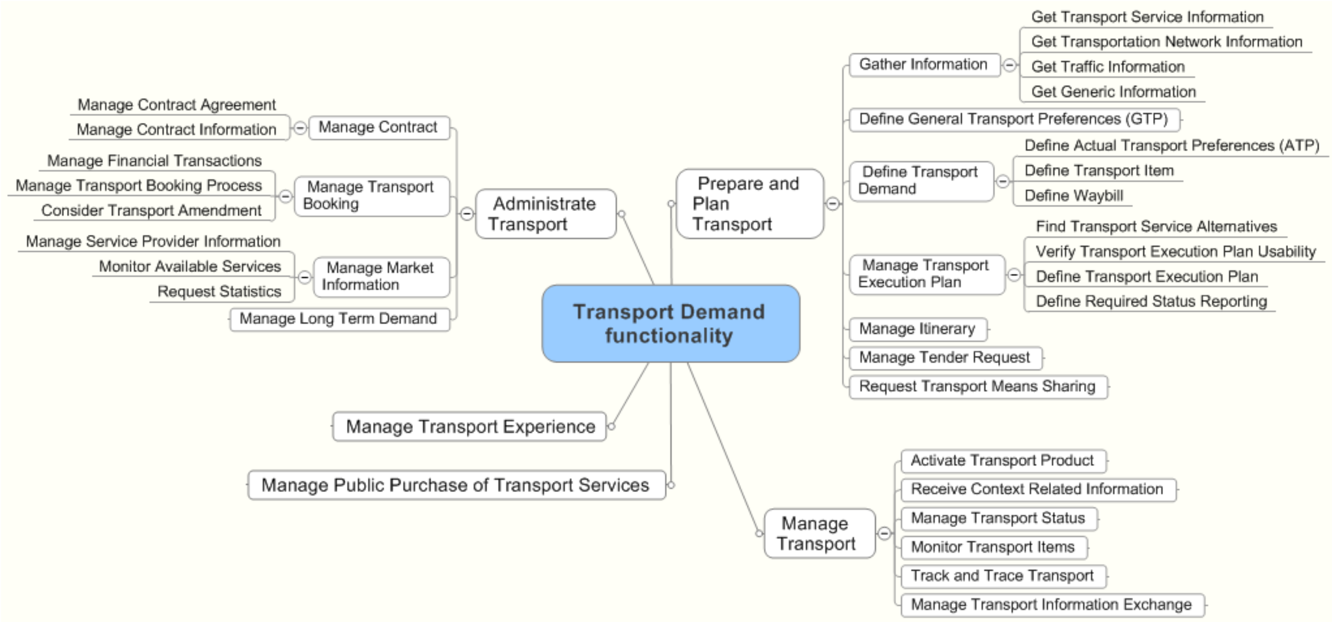
Annex B. Mind Maps showing the functional breakdown

The following mind maps show the functional breakdown within each of the sub domains in the Reference Model. The complete functional description can be found in chapter 6, 7, 8, 9 and 10.

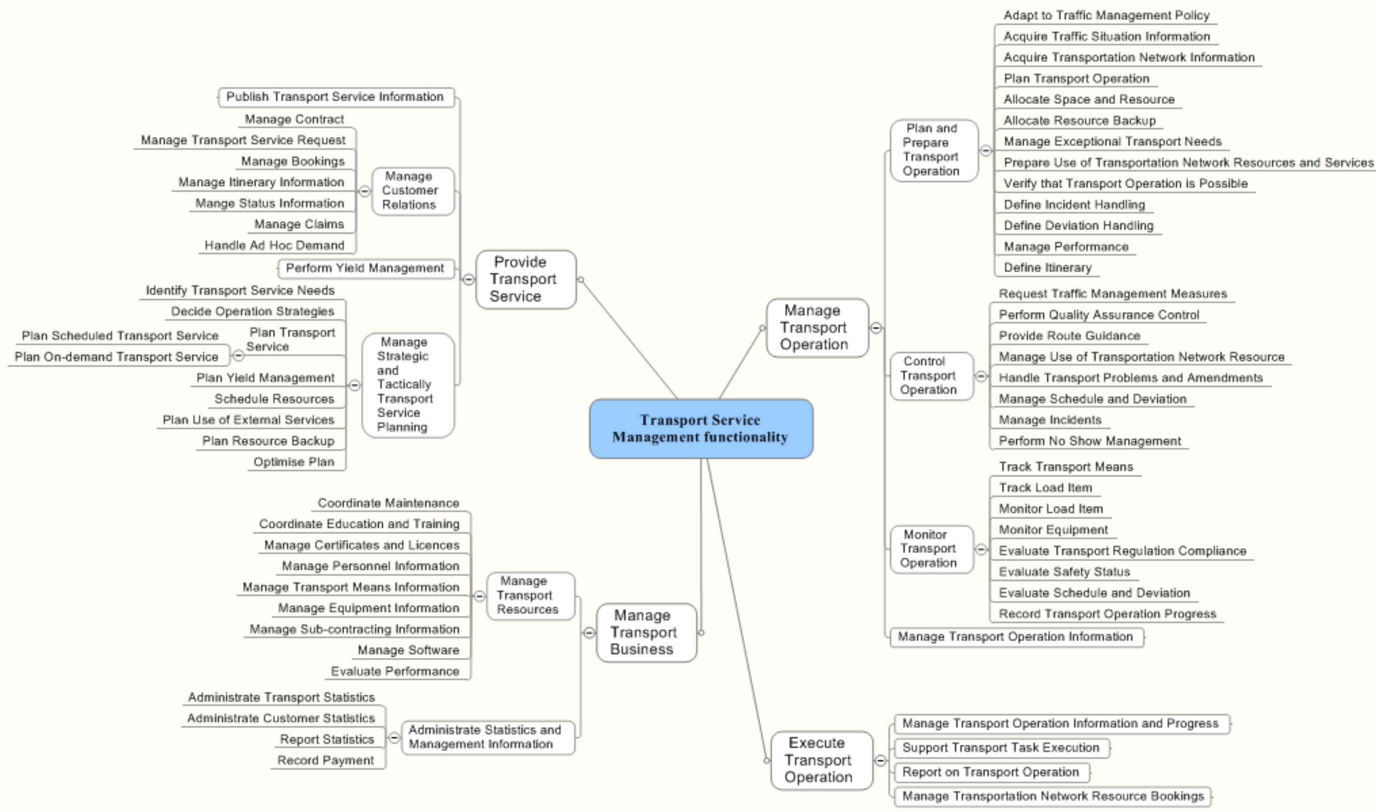
B1 - Transportation Network Management



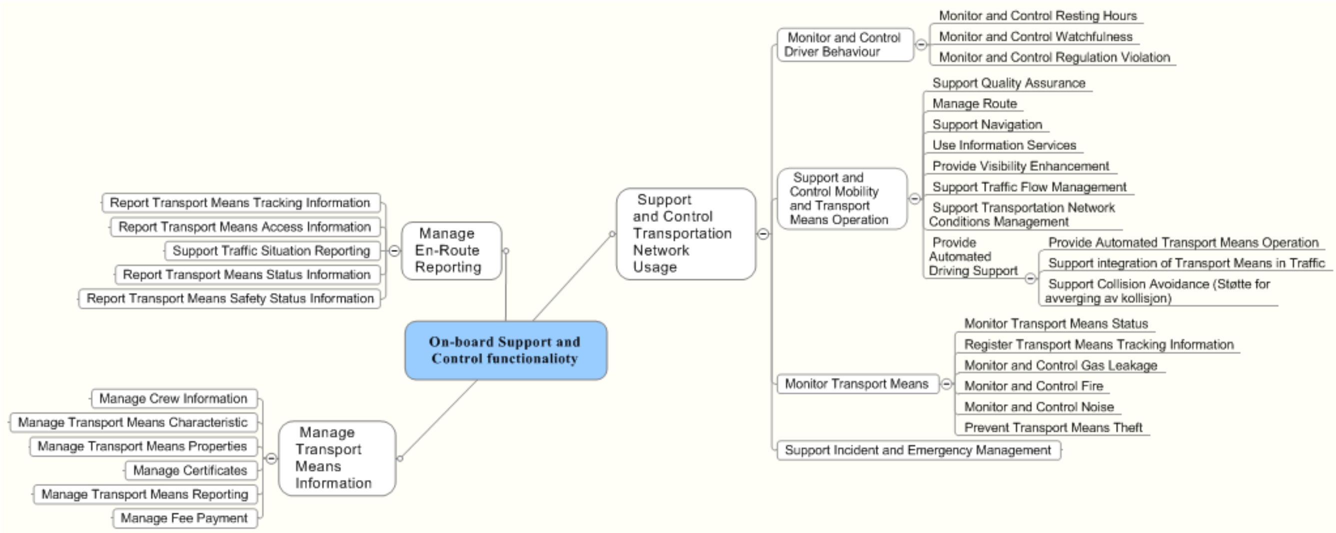
B2- Transport Demand



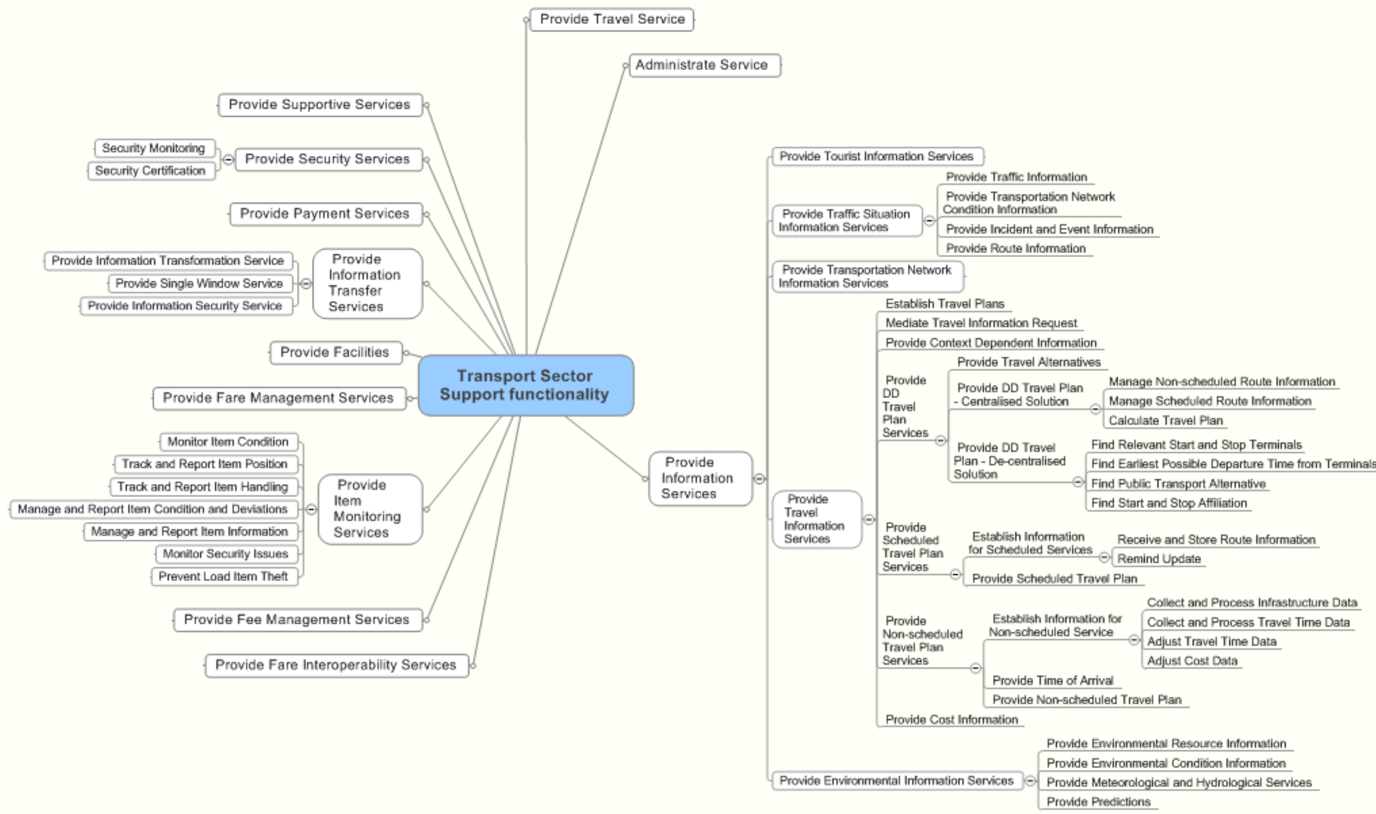
B3 - Transport Service Management



B4 – On-board Support and Control

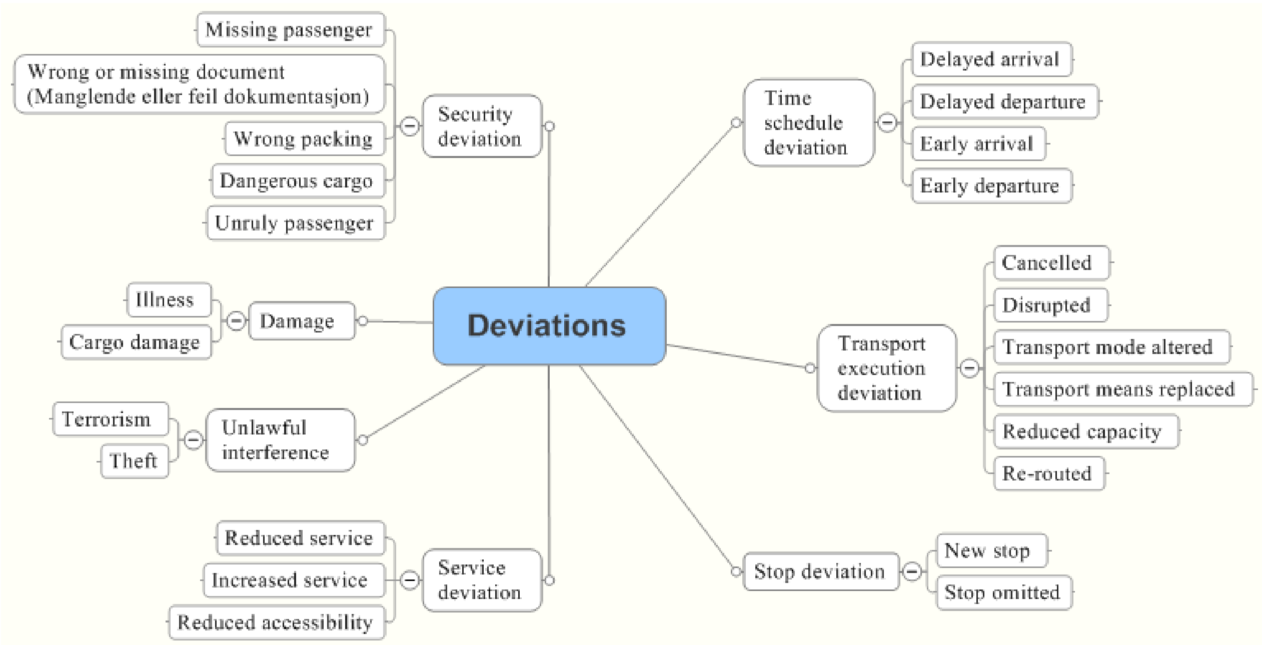


B5 - Transport Sector Support

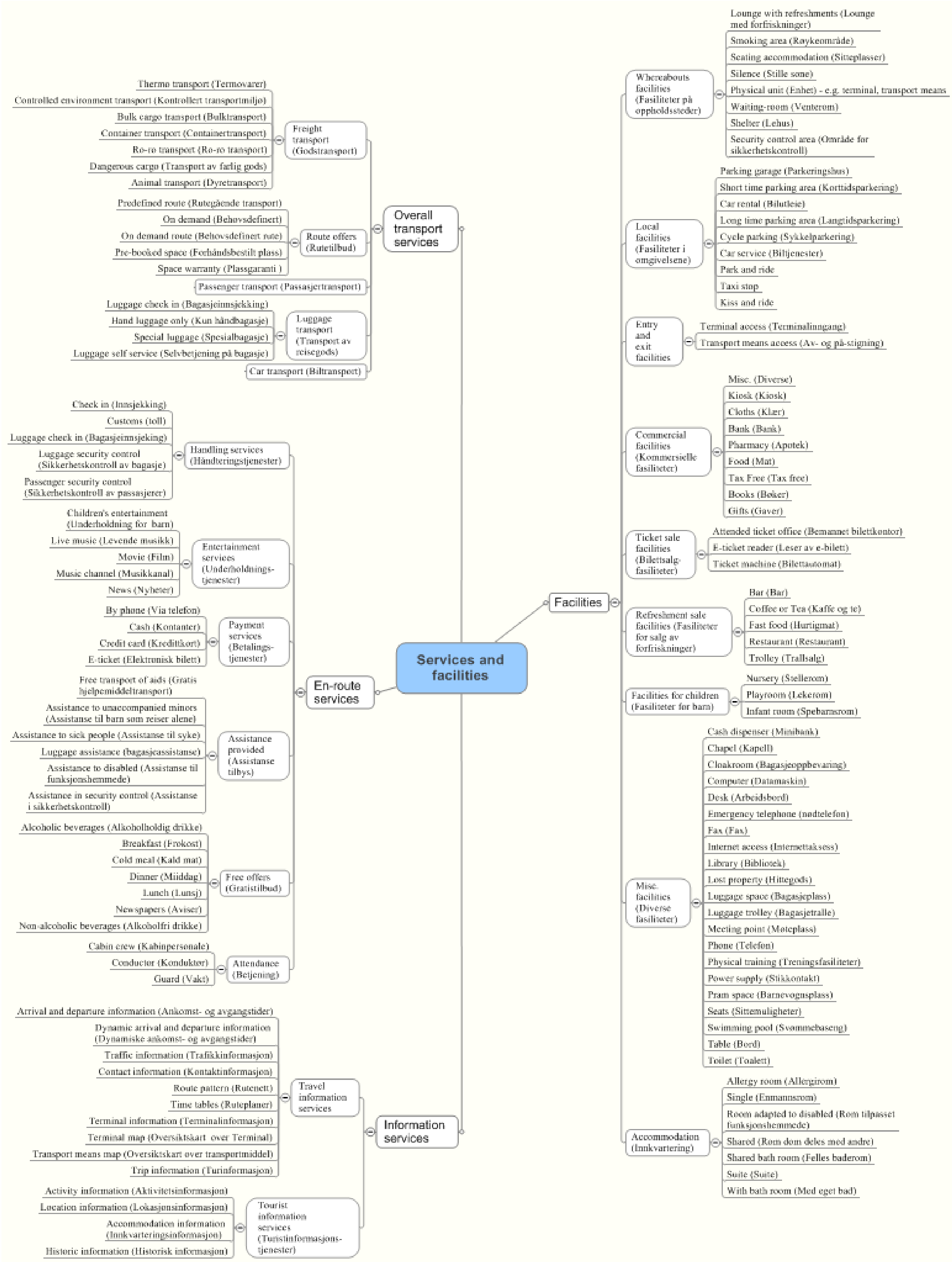


Annex C. Mind maps showing deviations, restrictions, services and facilities and accessibility

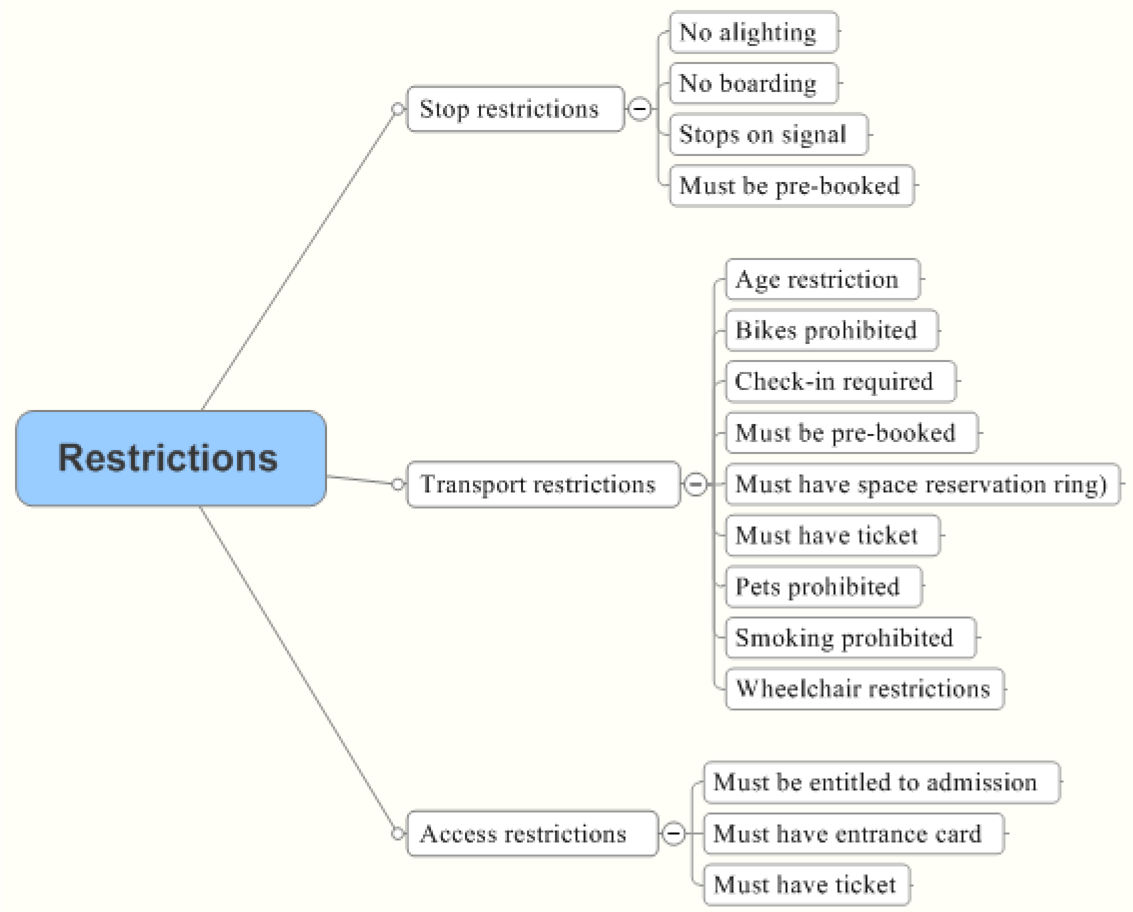
C1- Deviations



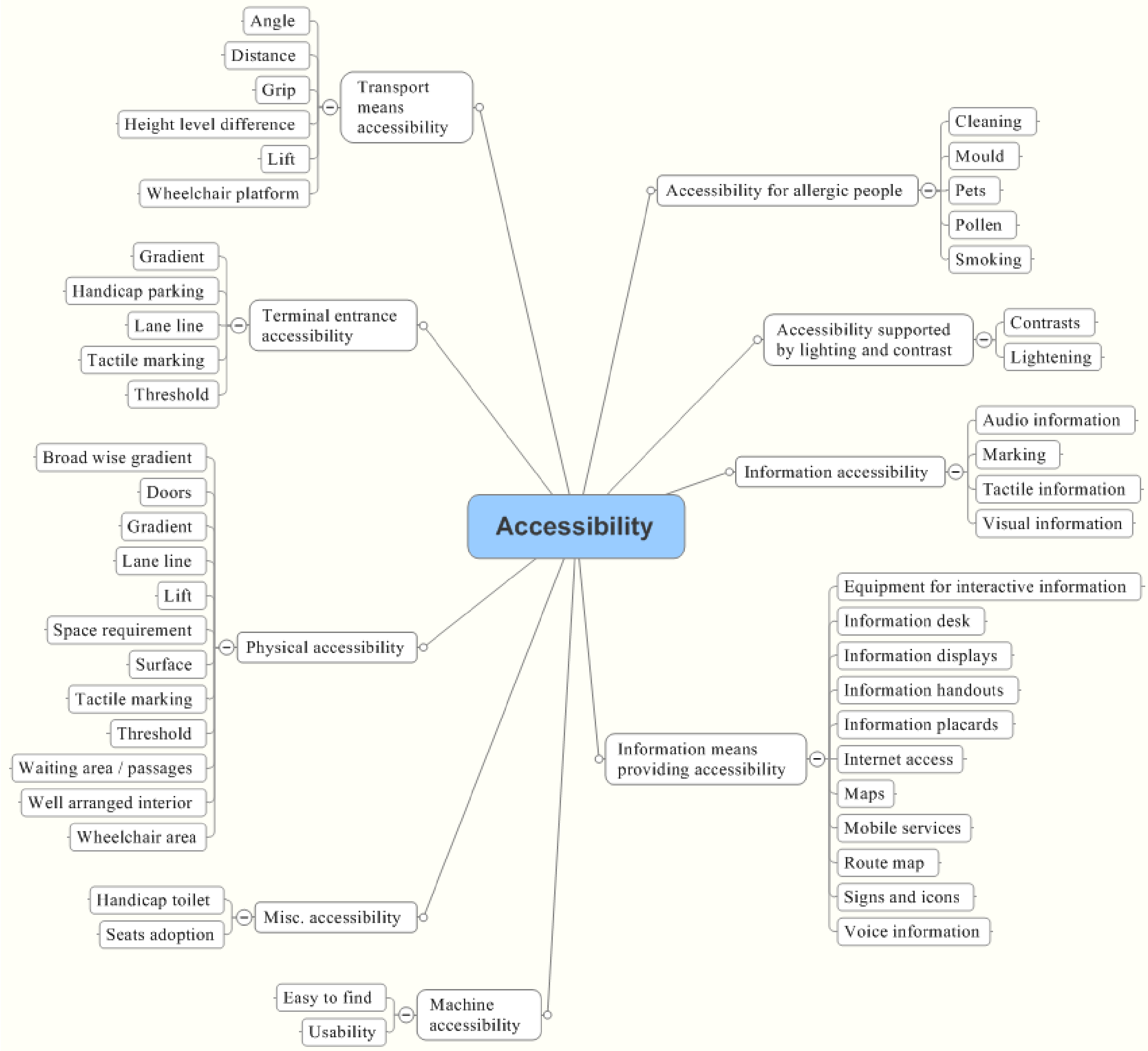
C2 – Services and facilities



C3 – Restrictions



C4 – Accessibility



Annex D. Technical Aspects

This Annex is the description of technical aspects as provided in version 5 of ARKTRANS (from 2006). It describes technologies and possible solutions that arrange for interoperability between ITS solutions. The specifications are included in this version of ARKTRANS without any updates. Hence, parts of the content may be "expired" or not complete, seen from the current state of the art. However, we also think it contains valuable information, and it is included as an Annex to provide information to those who may have a special interest in technical aspects.

Loose Integration

A loose integration of ITS solutions is preferred, mainly through synchronous/asynchronous messages realized by the now ubiquitous "web services" technology. The interactions have to be specified with respect to:

- Their information content. XML messaging should be used
- The description of the service, e.g., by means of WSDL or ebXML Collaboration Protocol Profile (CPP).
- Support for complex services supporting business processes/workflow, transactions, service descriptions, etc.
- The messaging solution. The best selection for interaction with loosely coupled systems is currently probably SOAP with XML encoded messages. ebXML Messaging Specification (ebMS) is also an alternative.
- The communication solutions. These should be allowed to vary depending on the situation

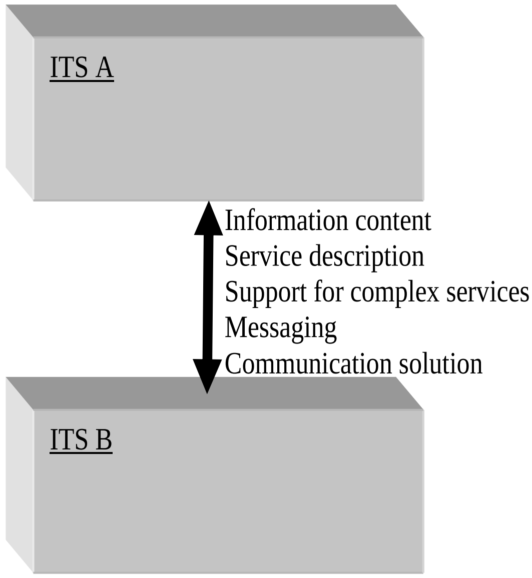


Figure 83 Loosely coupled systems

Characteristic	Measure
The offered business service is designed in such a manner that many consumers can use it, potentially in many different circumstances	Stability
Dependencies on other components or services are minimized. The offered service implementation is highly independent.	Horizon of change is minimized
Mandatory dependencies on other components and services by the consumer are minimized. For example a Flight Reservation service that forces you to also use a specific Car Reservation service, is not loosely coupled in the business sense. Though that dependency could be the result of poor service design, or purely a business decision, either way flexibility for the service consumer is constrained.	Flexibility
Conformance (with eco system, sector, industry, de facto or de jure standards)	Uses de facto or industry standard semantics and rules
Provider and consumer obligations are formally declared in a contract specification model	Understandability
Upgrade policy is an integral part of the component or service design and contract	Upgradeability

Figure 84 Loose Coupling design characteristics [23]

Start with the current basic standards,
but prepare for adoption to future complex web service standards when mature.

This is a conservative approach to Service Oriented Architecture (SOA). This technology area is rapidly developing. Web services standards and specifications are at the core of SOA. Gartner Group predicts a maturing and adoption timetable of web services standards and specifications [24]. SOAP, WSDL and UDDI is now regarded as established technologies (see Figure 85 and section. D.1 Simple Web Services).

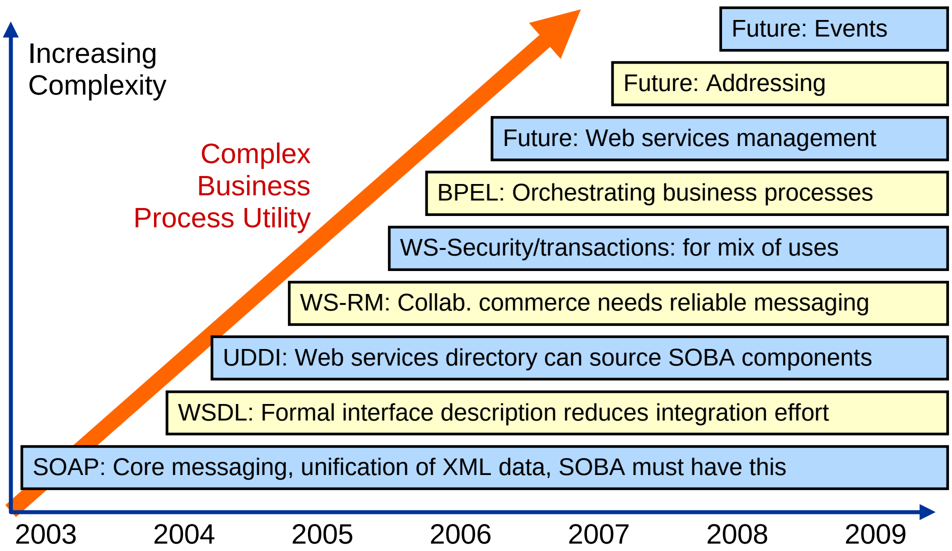


Figure 85 Use of web service standards and specifications in SOA [24]

The approach will enable solutions that can be implemented today, but will evolve in the future to more advanced standards and specifications as these become mature and supported by vendors (see Figure 85. and section D.2 Complex Web Services)

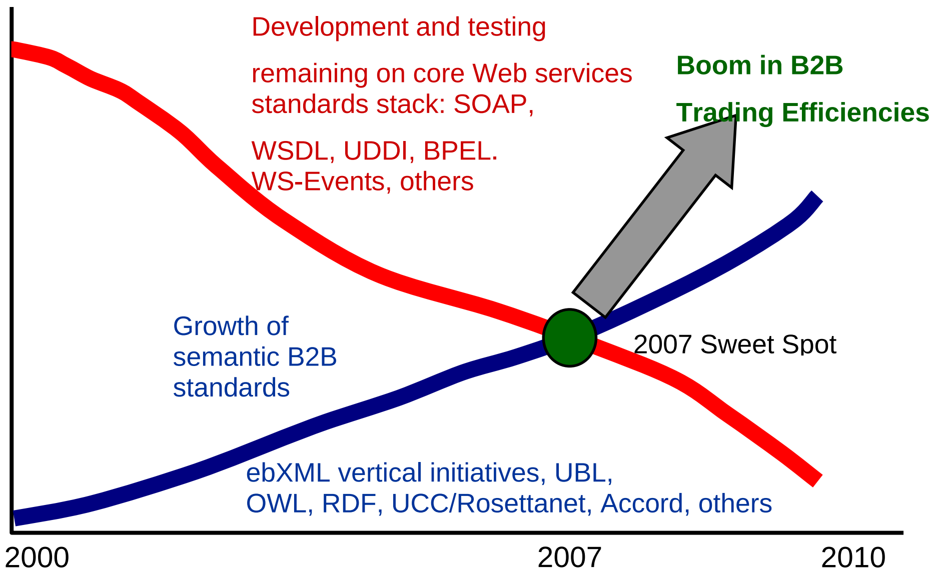


Figure 86 Adoption of advanced standards and specifications [24]

The Gartner report concludes with set of general recommendations that seems valid also for ARKTRANS:

- Understand the limitations of Web services standards and specifications and the high-value scenarios that are possible.
- If you use standards and specifications
  to increase the capabilities and efficiencies of your SOAs,
  be prepared to re-factor and re-architect to gain performance, reliability and security.

- When writing a new SOA application that requires advanced Web services, design in layers of abstraction that can map to possible standards.
- Do not consider basic Web services support as a significant differentiator among vendors. Consider vendors that participate in the standards process and help shape new standards as being significantly more credible.
- Participate in standards development activities at OASIS and W3C where you have a vested interest in the outcome. You don’t have to be a formal member to track discussions, read minutes and listen in on conference calls.
- Do not expect Web services standards to transform your business; use Web services standards to transform your architectures, processes and applications.

Note that web standards are not a stack; they are a web of dependencies. And they are many addressing specific aspects needed for a complete solution.

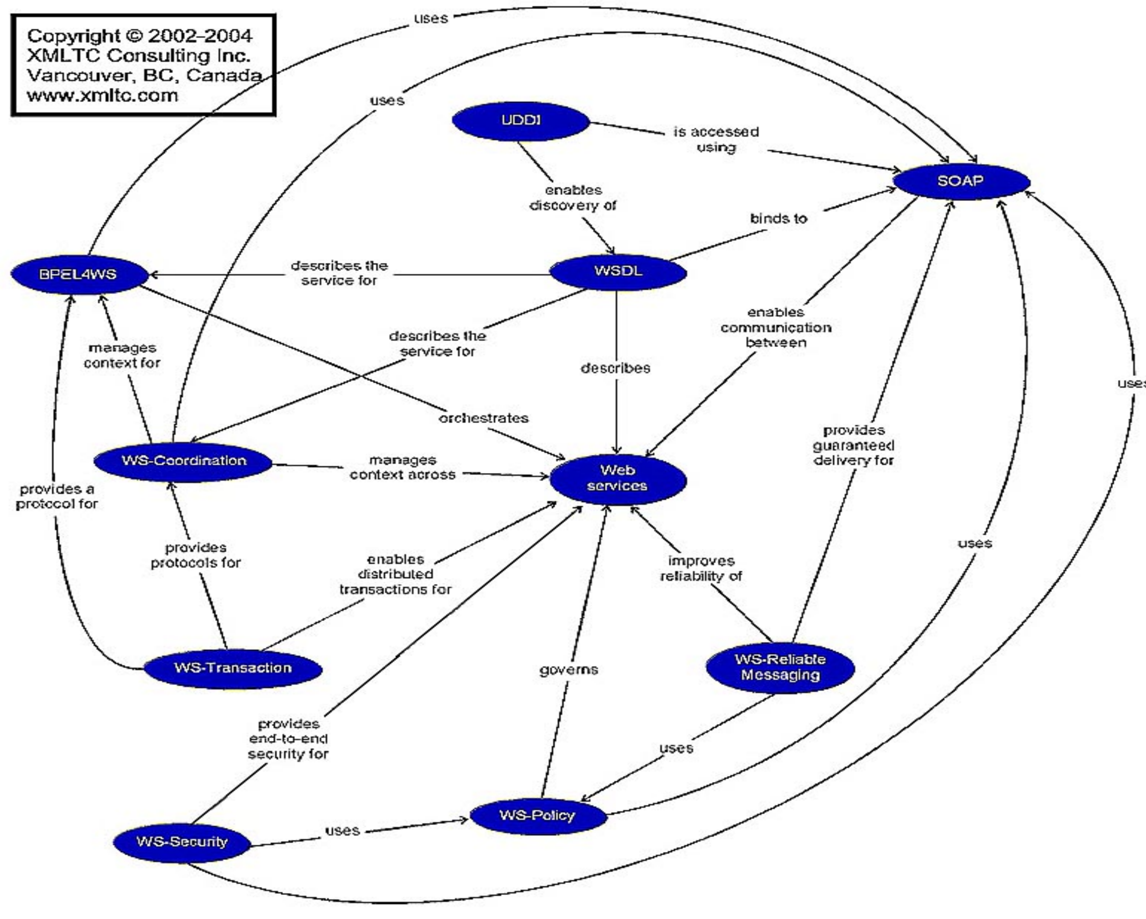


Figure 87 Mind map of XML standards [25]

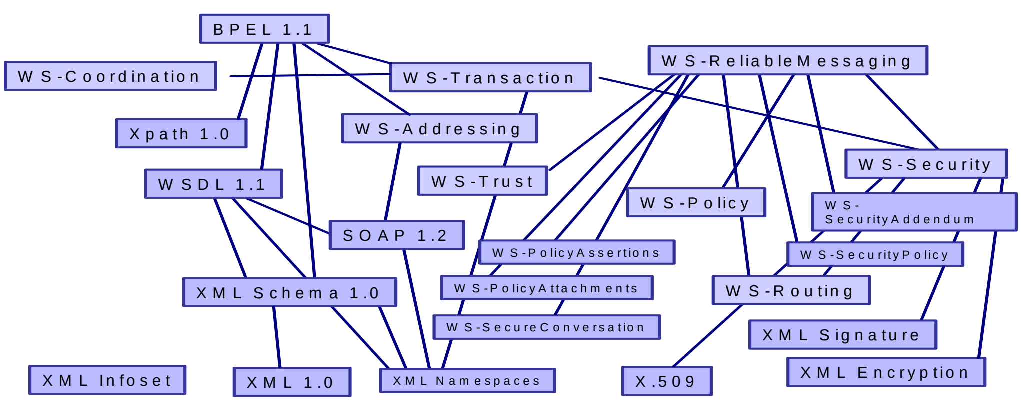


Figure 88 A partial view of current WWW XML standards [26]

D.1 Simple Web Services -- State of the Art

XML is the key technology for achieving *platform and language independence* – it is an extensible, human readable, mark-up language for any kind of structured information, and can enclose or encapsulate information in order to pass it between different computing systems which would otherwise be unable to communicate.

The Web service-related protocols described below are XML-based, and they are adequate for simple Web-services requiring a remote procedure-call style of communication.

D.1.1 Simple Object Access Protocol (SOAP)

SOAP is simple, has broad industry acceptance, and comes with extensive tool support. SOAP also provides a message format for communicating with and invoking Web services.

Other remote procedure call technologies may also be relevant: Remote Method Invocation (RMI), IIOP (Internet InterOperability Protocol) and XML-RPC (Remote Procedure Call using XML), but SOAP is currently preferred because:

- SOAP is more open than RMI/IIOP and can support a wider spectre of clients
- Exposing a web services interface may be more beneficial than exposing an RMI/IIOP interface.
- Web services transport protocols run over HTTP and are more firewall-friendly and human readable than RMI.
- XML-RPC is more limited to RPC functionality than SOAP – more low level.

D.1.2 Web-service Definition Language (WSDL)

Web-service Definition Language (WSDL) is an XML format that describes how to access Web services. The network services are described as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information. The operations and messages are described abstractly, and then bound to a concrete network protocol and message format to define an endpoint. Related concrete endpoints are combined into abstract endpoints (services). WSDL is extensible to allow description of endpoints and their messages regardless of what message formats or network protocols are used to communicate.

D.1.3 Universal Description, Discovery and Integration (UDDI)

Universal Description, Discovery and Integration (UDDI) provide a registry that clients can use to discover available services.

D.2 Complex Web Services – Ongoing Work

There is a great deal of interest for more complex Web services, and there are many initiatives providing possible solutions. So far, no solution has proven to be the best, and even though many of the main principles are the same, they fluctuate with respect to the use of terminology.

No final decisions about the ARKTRANS realisation of complex Web services are taken.

D.2.2 Web Service Based Initiatives

As shown in Figure 89, the relevant frameworks and initiatives can be put into a proposed stack that use or extend WSDL, have roots in the semantic Web's resource description framework and the DARPA Agent Mark up Language for Services (DAML-S), and include ebXML specifications [27].

- Network is transport protocols
- XML-based messaging layer decouples messaging from the from the transport protocols. The XML message and procedure calls are encapsulated by a header. SOAP or the

ebXML Messaging Solution may be used. The latter builds on SOAP by using its header specification extensibility.

- Service description provides the functional description of the Web service in terms of its interface and implementation by means of description languages like XML Schema. WSDL is commonly used, but ebXML CPP is better on error handling specifications.
- Non-functional description may describe quality of service, cost, geographic location, number of retries, and legal factors. Web service Endpoint Language (WSEL) is the only protocol designed for this purpose; however, it remains in progress.
- Conversations describe the correct data types and message sequences for a Web service.
- Choreography coordinates several Web services into a pattern, e.g. the order in which the operations of each Web service must be involved.
- Transaction facilitates the monitoring of transactions between Web services. The possible transactions between the states are described.
- Business process and workflow describes how to compose higher level services from other services.
- Contracts outline the format of machine-readable contracts that enables automated electronic business relations. Negotiations are supported.
- Discovery publishes details about Web services.

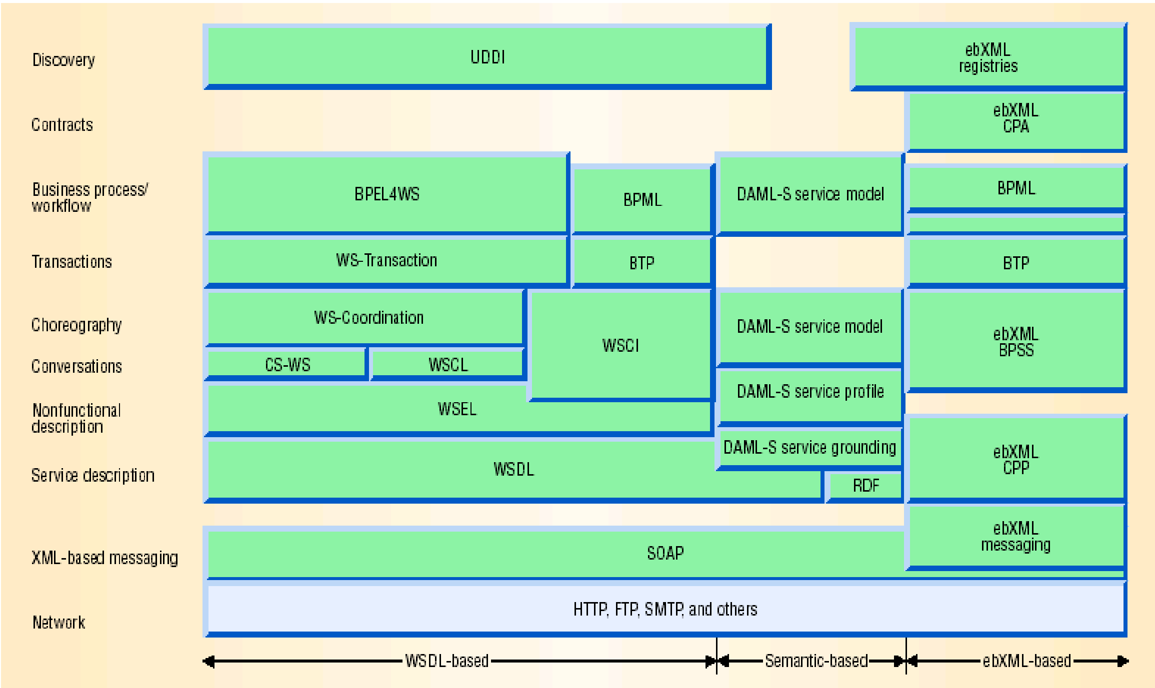


Figure 89 Proposed Web-service stack [27]

The most interesting initiatives are outlined in the following subsections: (not all standards are described; for a comprehensive list see [28]

D.2.2.1 Set of related XML standards by W3C - Choreography

World-Wide-Web Consortium (W3C) [29]has established several standards for the Internet. The Web Service Choreography Working Group addresses the describing linkage and usage patterns between Web-services by means of a common interface and composition language. WSCL (Web Service Conversation Language) and especially WSCI (Web Service Choreography Interface) are relevant submissions in addition to the Web Service Architecture. Also important and related are transaction handling which are covered by two related standards: WS-AtomicTransaction – short duration, ACID transactions, and WS-BusinessActivity – longer running, business transactions standardize service transactions. The first working draft of the Web Service Choreography specification on Web Service Choreography Requirements was published in August 2003, review period ends January 2005.

D.2.2.2 Security standards for web services

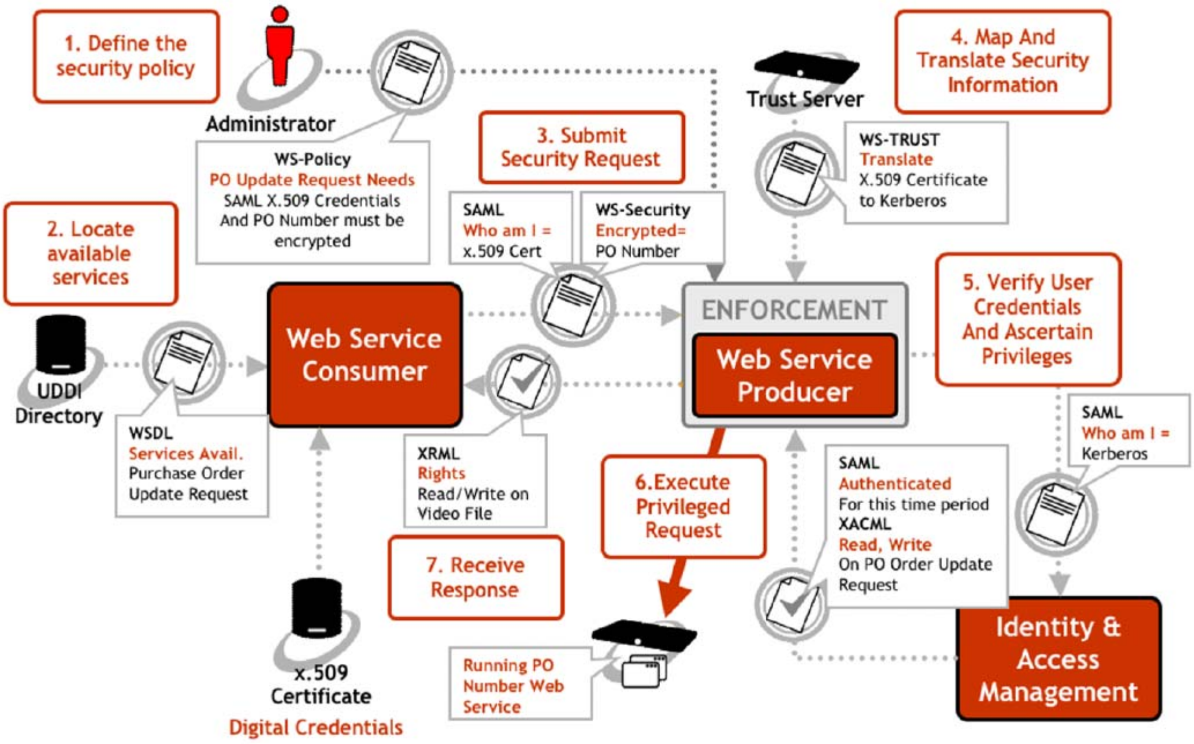


Figure 90 Security standards overview [30]

Security is treated as a separated aspect / protocol layer. It does not come for free. A treat analysis is needed to determine the level of security appropriate to the each service in ARKTRANS. The important standards are:

- SAML -- Security Assertion Markup
  Language is a standard for supporting single sign-on for affiliated sites. SAML assertions communicate security information such as authentication, attributes and authorization-decision statements.
- XACML - eXtensible AccessControl Markup Language
  makes it possible to express and enforce access control policies using a single XML based language.
- WS-SECURITY
  a proposed standard for enhancing SOAP messaging in order to authenticate parties and to protect the confidentiality and integrity of Web services messages. Security tokens can include a Kerberos ticket, Username/Password digest, X.509 certificate, XrML tokens, or a SAML assertion.

- WS-I BASIC PROFILES
  The WS-I Organization has set out to create guidelines that describe how specifications will work together. WS-I Basic Profile and WS-I Basic Security Profile are two examples of guidelines that enable interoperability at the wire/message layer and security protocol layer respectively.

D.2.2.3 Set of profiles for XML standards use by WS-I

Web Service Interoperability Organization (WS-I) is an open industry organization chartered to promote web services interoperability across platforms, operating systems and programming languages. WS-I profiles define sets of Web services specifications that work together to support specific types of solutions. The new profiles are designed to provide developers with mechanisms for building interoperable, attachment-enabled applications. To date, WS-I has finalized the Basic Profile, Attachments Profile and Simple SOAP Binding Profile. Work on a Basic Security Profile is currently underway.

D.2.2.4 BPML (the Business Process Modelling Language)

The Business Process Management Initiative [31] is a non-profit initiative working towards establishing standards for the management of business processes that span multiple applications, corporate departments and business partners. They have specified BPML (the Business Process Modelling Language).

D.2.2.5 ebXML

ebXML Joint Co-Ordination Committee [32] is a joint activity of UN/CEFACT (the United Nations body responsible for UN/EDIFACT) [33] and OASIS (Organization for the Advancement of Structured Information Standards). Their charter is to develop an XML-based infrastructure for electronic commerce. Of special interest are BPSS (the Business Process Specification Schema) that is a meta-model for business processes that is part of the ebXML framework, and the CPPA (the Collaboration-Protocol Profile and Agreement Specification).

	Web Services	+	ebXML
Type	Request/response		Collaboration
Communication	RPC-style synchronous communication between tightly coupled services, Document-style asynchronous communication between loosely coupled services		Synchronous, asynchronous communication
Business Service Interface description	WSDL		CPP, CPA (WSDL within CPP, with CPA also)
Protocol and Formats	SOAP, XML		ebXML Message Service (over SOAP), XML, BPSS (as "business" protocol)
Content Standards	None		Recommended Standards (e.g. OAGI BODs, EDIFACT, UBL)
How to find business partners	UDDI Registry		ebXML Registry (UDDI Registry may point to an ebXML Registry or Registry objects (e.g. CPA))

Figure 91 Comprehensive message delivery with ebXML [34]

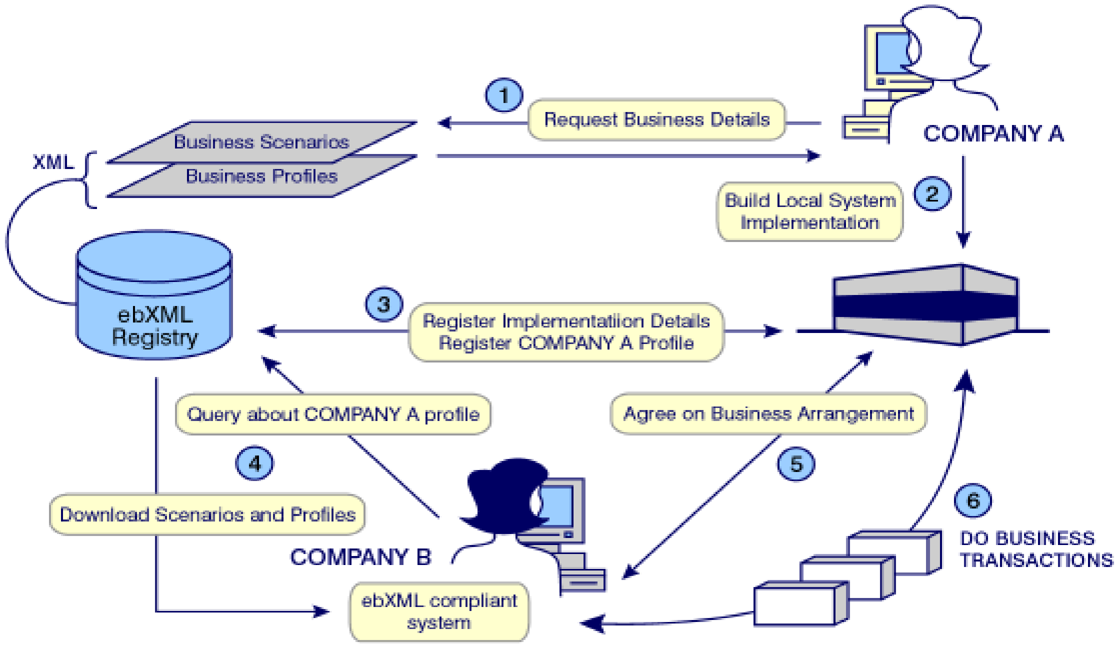


Figure 92 High-level overview of ebXML interaction between two companies [26]

The heart of ebXML's architecture is the idea of interoperable registries and repositories. A common e-business framework, like that offered by ebXML, has to be able to enable businesses to find each other and to create new business relationships. The ebXML Registry model is designed to offer a shared repository that stores business profiles for registered companies, and registries like these are best described as tools for storing company profiles and ebXML specifications for trading relationships (including business process models and message formats and structures). Once connected to an ebXML-compatible registry, your applications will be able to use it to access business process information, as well as the business information models used by your company's prospective partners. You can run your own registry, or use one of several central registries. These are set up to support different types of business, in order to speed up the process of finding an appropriate partner.

Outside the ebXML registry, there are some key components of the ebXML architecture. These are a data communication infrastructure, a 'semantic framework' and a set of tools that enable organizations to find each other.

The data communication infrastructure gives ebXML applications a standard message transport mechanism, so that applications can exchange messages without needing complex interfaces. This mechanism also details how a message is constructed, defining the structure of message headers and bodies. For ebXML to be successful its message transport mechanism must have a delivery model that allows applications to send messages without needing to handle acknowledgements, as well as offering applications an effective security models. It will also need to provide developers with a standard set of interfaces to handle incoming and outgoing messages. Using the ebXML Messaging Service specification, you are able to use any application-level messaging protocol you like, including SMTP and HTTP and the SOAP protocol used to offer web services. In order to ensure your ebXML messages are secure, you can use secure protocols like HTTPS or work with digital signatures to embed ebXML in a Public Key Infrastructure security system.

One of the reasons for the development of XML is the vision of a self-describing semantic web. EbXML takes this approach to heart in its Semantic Framework. In practice this is a common 'business grammar' that gives organizations a common language for defining and describing business processes, as well as the information used within an organization. The ebXML semantic framework also includes reusable business logic components that handle common business processes and their associated XML vocabularies, and can be used to define the messages used in your business processes. In a similar manner, ebXML's Business Process Models describe how business processes operate and interact, both inside and outside a company. You can think of ebXML's business process models as 'verbs', with its information models 'nouns' and 'adjectives'. Together these can produce a description of a business that can be understood by anyone using ebXML.

D.2.2.6 Business Process Execution Language for Web Services (BPEL4WS)

A joint activity of BEA Systems, IBM, and Microsoft have established the Business Process Execution Language for Web Services (BPEL4WS) and the companion specifications WS-Coordination and WS-Transaction, etc.

Business Process Execution Language (BPEL) defines a notation for specifying business process behaviour based on Web Services. Business processes can be described in two ways:

- Executable business processes model actual behaviour of a participant in a business interaction.
- Business protocols, in contrast, use process descriptions that specify the mutually visible message exchange behaviour of each of the parties involved in the protocol, without revealing their internal behaviour. The process descriptions for business protocols are called abstract processes.

BPEL is used to model the behaviour of both executable and abstract processes. The scope includes:

- Sequencing of process activities, especially Web Service interactions
- Correlation of messages and process instances
- Recovery behaviour in case of failures and exceptional conditions
- Bilateral Web Service based relationships between process roles

BPEL is a vendor-neutral mechanism for describing the behaviour of business processes. The latest version of this technology is currently being standardized by a larger group working through OASIS. The value of BPEL is based on two fundamental attributes of the technology. First, because BPEL makes no assumptions about the environment in which a business process will execute the technology is completely platform-neutral. The second fundamental attribute that makes BPEL valuable is the language's complete focus on process-oriented abstractions. BPEL's primary value lies more in the interactions it defines than in its execution capabilities. Implementations of business processes depend on capabilities that are specific to a particular execution environment. Because of this, implementing complete business processes in a truly portable way is not one of BPEL's goals.

- Version 1.0 released by IBM, Microsoft and BEA in August 2002
- Accompanied by WS-Coordination, WS-Transaction which remain uncommitted to standards bodies
- Version 1.1 submitted to OASIS April 2003
- XML language for describing business processes based on Web services
- Convergence of XLANG (Microsoft) and WSFL (IBM)
- Unprecedented industry consensus
- IBM, Microsoft, Oracle, Sun, BEA, SAP, Siebel …

Organization for the Advancement of Structured Information Standards (OASIS) is a not-for-profit, global organisation that drives the development, convergence and adoption of e-business standards, among others BTP (the Business Transaction Protocol) and ebXML.

Among the vendors with products supporting BPEL based solutions are: Oracle, IBM, BEA, and also Microsoft (indirectly by import export of BPEL specifications, but internally using the proprietary XLANG).

D.2.2.7 OAGIS - Open Applications Group Integration Specification

The Open Applications Group (OAGi) is a non-profit consortium focusing on best practices and process based XML content for eBusiness and Application Integration [35] [36].

Central in OAGIS is building a content based virtual business object model that enables an enterprise business application to build a virtual object wrapper around itself through the use of OAGI compliant API's. This interoperability is achieved with object oriented advantages without the requirement to implement a software application in a specific object oriented technology.

To communicate with a business software component in this model, events are communicated through the integration backbone in the form of an OAGI compliant Business Object Document (BOD) to a virtual object interface. The integration servers provide services such as publish and subscribe, request and reply, transport mechanisms, data mapping tools, integration routing and logging capabilities [37].

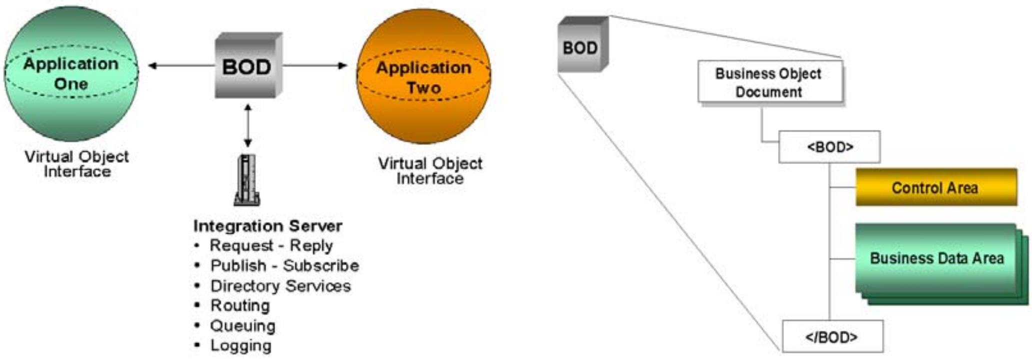


Figure 93 OAGIS Business Object Document (BOD) and the content based virtual business object model [37]

OAGIS fits with ebXML, but is in nature framework independent and can be used with different frameworks. The metaphor for how they work together is that OAGIS is the payload and ebXML the envelope [38]:

- Communication Layer (T&R)
  - ebXML Transport
- Partner Agreements (CPP, CPA)
  - Format - ebXML
- Process Definitions (BPSS)
  - Format – ebXML
  - Content - OAGIS
- Syntax
  - OAGIS Tags
- Meaning of Information
  - OAGIS Dictionary

The Open Applications Group Integration Specification (OAGIS) is an effort to provide a canonical business language for information integration. It uses XML as the common alphabet for defining business messages, and for identifying business processes (scenarios) that allow businesses and business applications to communicate. Not only is OAGIS the most complete set of XML business messages currently available, but it also accommodates the additional requirements of specific industries by partnering with various vertical industry groups.

The Open Applications Group (OAGi) -- the organization that oversees the OAGIS -- was formed in November 1994 in an effort to dramatically ease everywhere-to-everywhere integration (inside and outside of the enterprise, as well as across the supply chain). OAGi has done this by crafting standards where necessary and by recommending standards where they already exist.

The first release of OAGIS was developed in 1995 to address the need for a common business language that would enable business applications to communicate. OAGIS provides the definition of business messages in the form of Business Object Documents (BODs) and example business scenarios that provide example usages of the BODs. The business scenarios identify the business applications and components being integrated and the BODs that are used. The current release, OAGIS 8.0, includes 200 business messages and 61 business scenarios that can be used to integrate business applications.

OAGi also partners with other standards bodies to provide a true canonical business language. OAGi recognizes that no one organization can be all things to all people, however by partnering with industry vertical groups OAGIS provides the means to plug in the additional requirements and constraints that meet the specific needs of each vertical industry.

Because of this long history of delivering quality usable integration standards, OAGIS has support from application vendors and implementation providers, and has been implemented by various customers in over 40 countries worldwide.

OAGIS 8.x is expressed in XML Schema and provides the transactional and operational information needed to support the needs of business and application integration. You can access OAGIS along with all of the resources that OAGi makes freely available from the OAGi Web site.

OAGi have also developed a repeatable process for quickly developing high quality business content and XML representations of that content [39].

D.2.2.8 BizDex – Australian National B2B Registry

The National Office for the Information Economy (NOIE), an Australian federal government agency, has partnered with Standards Australia to develop a national framework to promote and support B2B interoperability throughout Australia. The framework is known as BizDex.

The BizDex position on standards is an example to follow by ARKTRANS
BezDex has assembled a coherent set of mature standards, and also how new standards shall be incorporated as they evolve [40].

The world of e-business standards is complex and fragmented. BizDex is designed to promote re-use of standards work. Where a suitable standard exists, BizDex will re-use rather than re-invent the standard. However it should be recognised that industry or geography constraints often require international standards to be extended. BizDex provides a methodology and governance framework to develop such extensions. BizDex is committed to the use of de-jure and open standards.

- *ebXML vs. Web Services*
  The ebXML framework was developed by OASIS and UN/CEFACT as the “next generation EDI”. It is specifically targeted at B2B interoperability and comprises an overall architecture and an associated set of protocols and specifications. Web Services are largely vendor driven and have a much broader focus than ebXML. The basic Web Service standards (SOAP, WSDL, UDDI) alone are inadequate for B2B purposes because they lack fundamental business attributes like security & reliability and do not address the process & information parts of the alignment domain. However an emerging set of “extended” Web Services standards (e.g. WSReliable Messaging, WS-Atomic Transaction, WS-Security, WSPolicy, etc) will address the limitations of the basic WS stack and will most likely be much more widely supported in the marketplace than some ebXML protocols. Although the extended WS specification domain is currently confused by a variety of competing vendor specifications, some leading candidates for open standards are emerging. There is also evidence that some ebXML working groups are moving towards harmonization with equivalent WS working groups. For these reasons, the position taken by BizDex is to support the ebXML reference architecture, but to apply

Web Services protocols and standards wherever possible. This rationale is behind the selection of UDDI rather than ebXML as the registry standard.

- *EDIFACT and other legacy standards*
  BizDex must be a practical and usable framework. Accordingly it is important to recognise that the vast majority of B2B transactions today are EDIFACT messages and that BizDex must add value to the existing infrastructure. At this point it is useful to remember that BizDex is focused on automation (and hence cost reduction) of the setup phase of a B2B collaboration. On the other hand, EDIFACT is a library of business messages. Accordingly there is nothing to stop a community from continuing the use of existing EDIFACT MIGs (Message Implementation Guidelines) but using BizDex to reduce the cost of setup for new community members. The table below lists some specific standards supported or preferred by the BizDex framework. The list is non-exhaustive because BizDex is a really an architecture that is designed to support new standards as they evolve.

Layer	**Relevant Standards**
Alignment domain layers	
Process	Modelling: UN/CEFACT UMM (UML profile) Syntax: ebXML BPSS (BCSS in future) Libraries: RosettaNet PIPs
Information	Modelling: UN/CEFACT CCTS (UML profile) Syntax: XML (UBL /UN naming & design rules) EDIFACT Libraries: UN/CEFACT Core Components UBL, OAGIS (horizontal) EANcom, xbrl, HL7, etc.. (industry)
Security	Trust: ABN-DSC (future – federated domains) Protocol: WS-Security (message), SSL (transport)
Message	Protocol: ebXML MS, EDIINT AS1/AS2, SOAP Extended WS stack (WS-RM/Trans/etc)
Other relevant standards	
Registry	BizDex is built upon and is fully compliant with the UDDI v3.0 standard. BizDex adds some additional interfaces and classifications to support B2B automation.
Profile	Partner profiles in the registry are represented as WSDL and/or ebXML CPP schema
Agreement	Bilateral agreements in the registry are represented as WS-Policy and/or ebXML CPA schema
Identifiers	Public processes will be built upon public identifiers such as ABN (business), EAN GTIN (item), etc.
Private process recommendations	
Orchestration	WS-BPEL (OASIS)
Transform	XSLT (W3C)
User Forms	X-Forms (W3C)

Figure 94 Standards adopted by BizDex [40]

D.2.2.9 UN/CEFACT modelling (UMM) and business collaboration framework (BCF)

United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) is engaged in the definition and standardization of the UN/CEFACT Modelling Methodology (UMM):

- Formal description technique for describing Open-edi scenarios
- Concentrates on business semantics
- Provides a procedure similar to a software development process
- Uses UML and is based on a UML Meta Model (UML Profile)

UMM is based on UN/CEFACT Business Collaboration Framework (BCF) for B2B and serves as a meta model for modelling B2B.

(Introductionary references are [41], [42]).

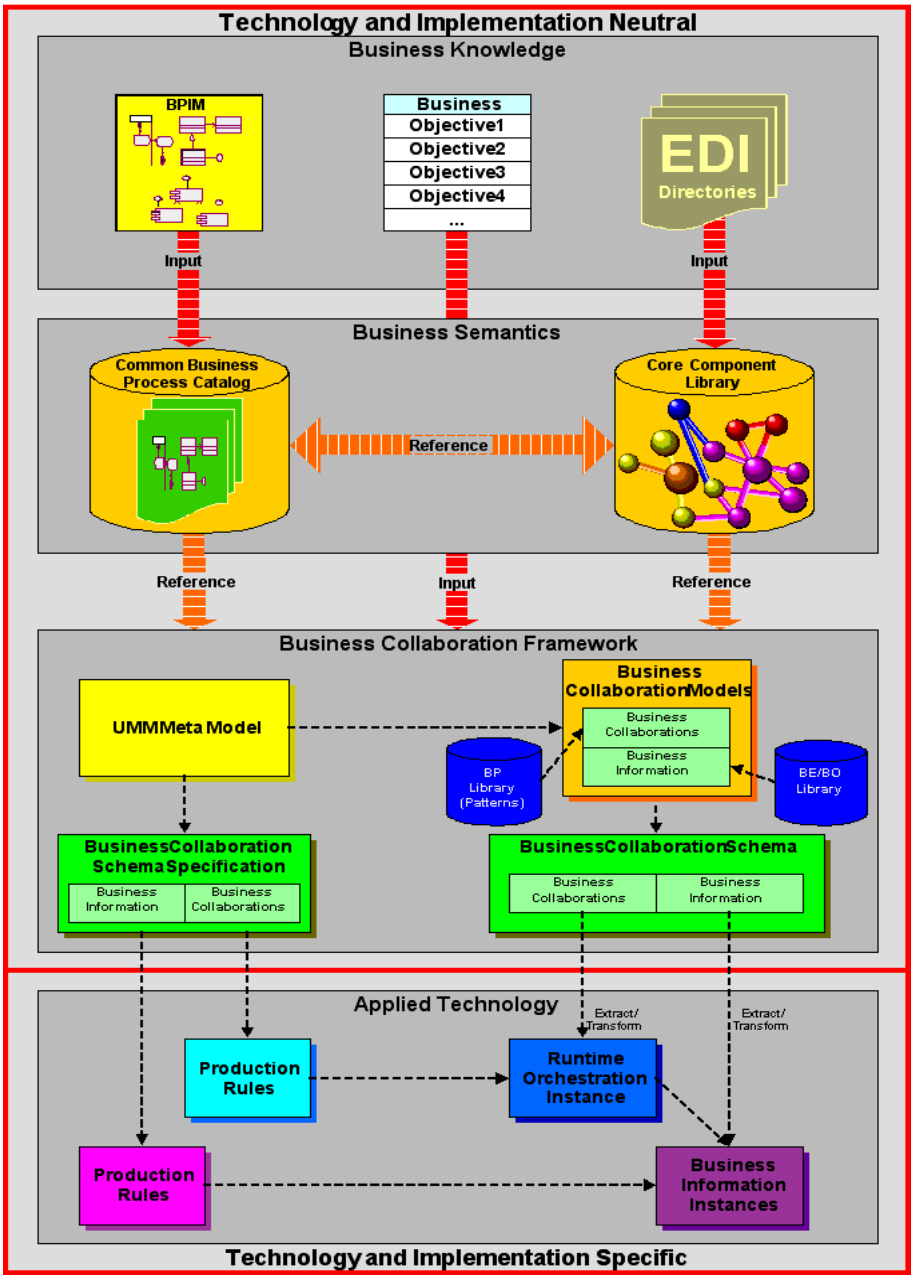


Figure 95 UN/CEFACT eBusiness vision [41]

D.3 Messaging Realization

ARKTRANS specification model viewpoints artefacts can be transformed to realization artefacts by a combination of manual and automatic processes.

ARKTRANS provides a high level transport sector specification of the following distributed system model view points:

- Functional view
  functional decomposition into sub domains, sub areas of sub domains and functions
- Process view
  as UML Use Cases described with semi formal business process diagrams (UML Activity diagrams), including information flow between actor roles
- Information view
  as high level (analysis) information models / ontologies represented as UML class models and/or Extended Entity Relationship (ER) models

The ARKTRANS specifications are similar to specifications created by UN/CEFACT Modeling and Methodology (UMM). See Figure 96.

Orchestration specifications may be generated / derived from the behaviour model. Message XML Schemas may be specified and generated based on information model entities and behaviour view information flow specifications.

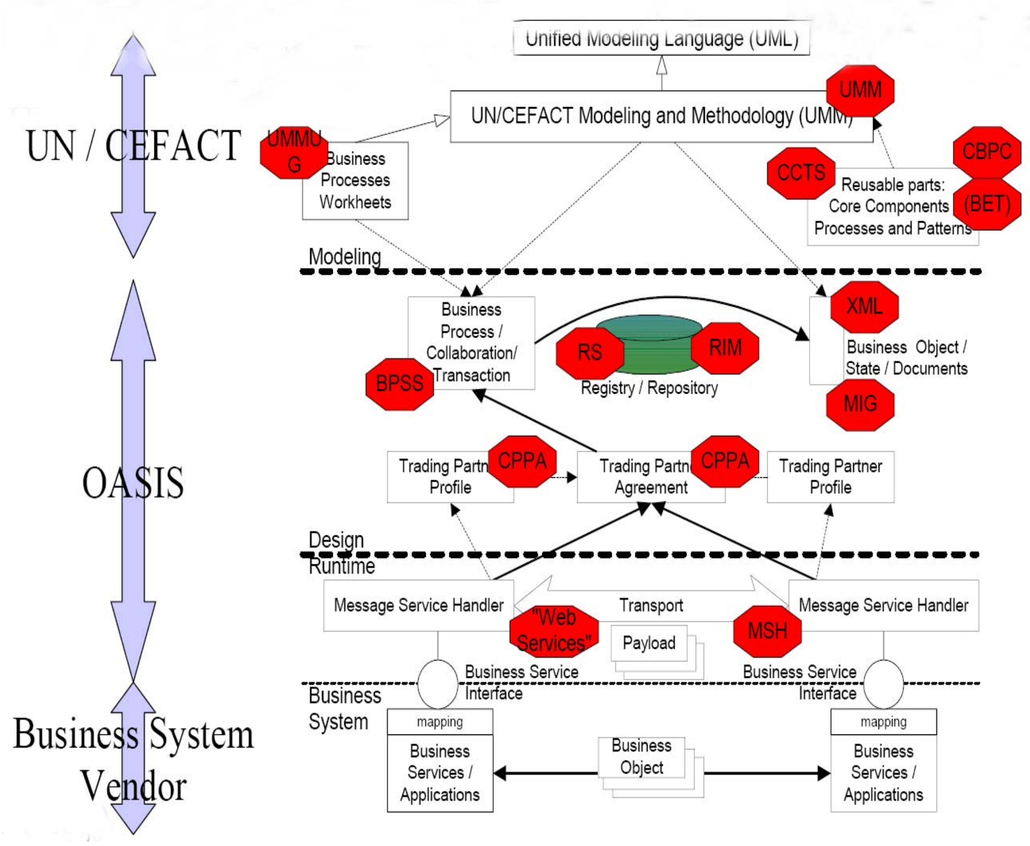


Figure 96 Modelling, design and runtime – UN/CEFACT and OASIS roles [42]

Both WS-BPEL and ebXML are candidate standards for ARKTRANS implementation, at the moment a cautious and staged approach is recommended selecting elements from each standard and preparing for a possible convergence (both approaches are part of the OASIS initiative).

Currently, there are two main approaches proposed for the specification of B2B protocols, the WSDL-based approach (including WS-BPEL) supporting Web Service languages, and the ebXML-based approach supporting languages defined along the ebXML project.

Unfortunately, these approaches are not quite compatible, thus an organization wanting to engage in B2B collaboration needs to decide whether to embark on any of these new approaches, and which ones to use [43]. Or one could carefully select parts of each approach.

ebXML extends the basic web services standards / functionality, but are not a content standard which ARKTRANS aspires to. However, to implement ARKTRANS much of the ebXML functionality may be needed, especially for more advanced scenarios.

The BizDex architecture is an advanced example to be considered by ARKTRANS

BezDex has assembled a coherent set of mature standards, and has a strategy how new standards shall be incorporated as they evolve [40]. (See section 0). It is advisable that ARKTRANS takes a staged approach, and starts with a basic simple architecture.

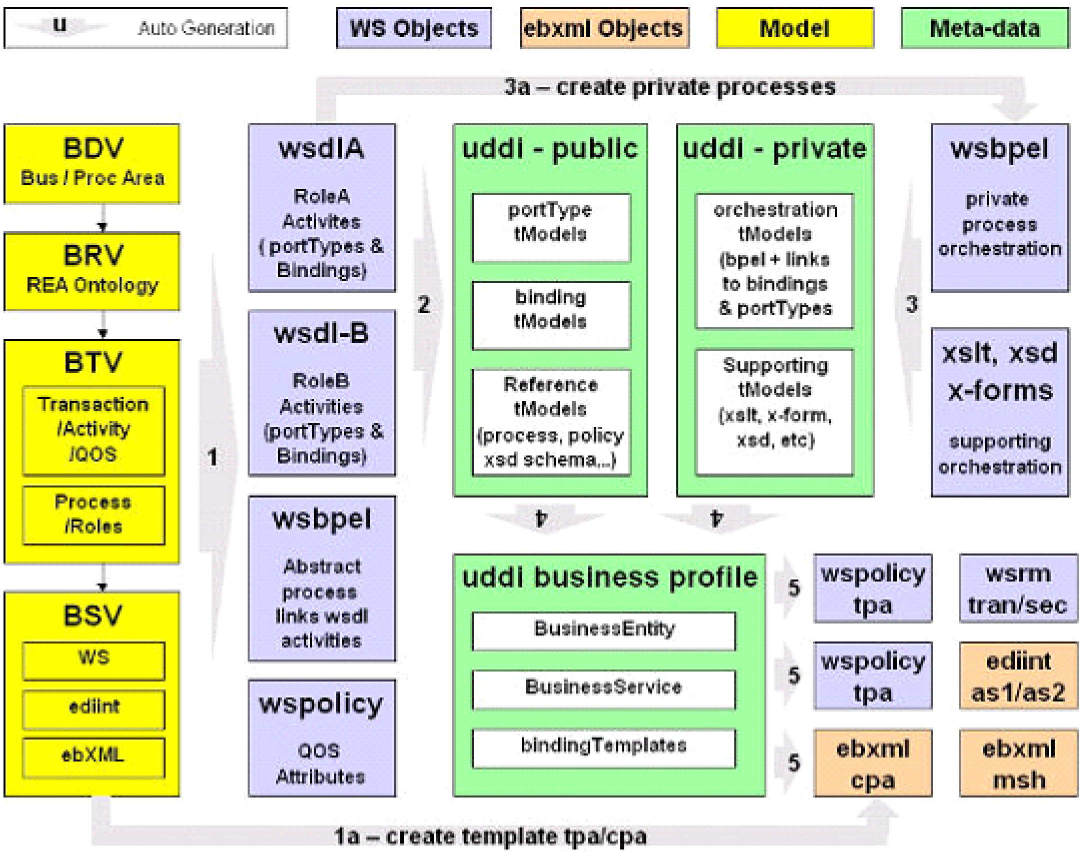


Figure 97 BizDex architecture [44]

D.3.1 Messaging

Consider using messaging following the current ebXML Messaging standard v 2.0. [45]

This standard complies with the SOAP specifications:

- Simple Object Access Protocol (SOAP) 1.1 [SOAP]
- SOAP Messages with Attachments [SOAPAttach]

And it provides additional functionality like reliable messaging.

An ebXML Message is a communications protocol independent MIME/Multipart message envelope, structured in compliance with the SOAP Messages with Attachments [SOAPAttach] specification, referred to as a Message Package.

There are two logical MIME parts within the Message Package:

- The first MIME part, referred to as the Header Container, containing one SOAP 1.1 compliant message. This XML document is referred to as a SOAP Message for the remainder of this specification,
- zero or more additional MIME parts, referred to as Payload Containers, containing application level payloads.

The general structure and composition of an ebXML Message is described in the following Figure 98.

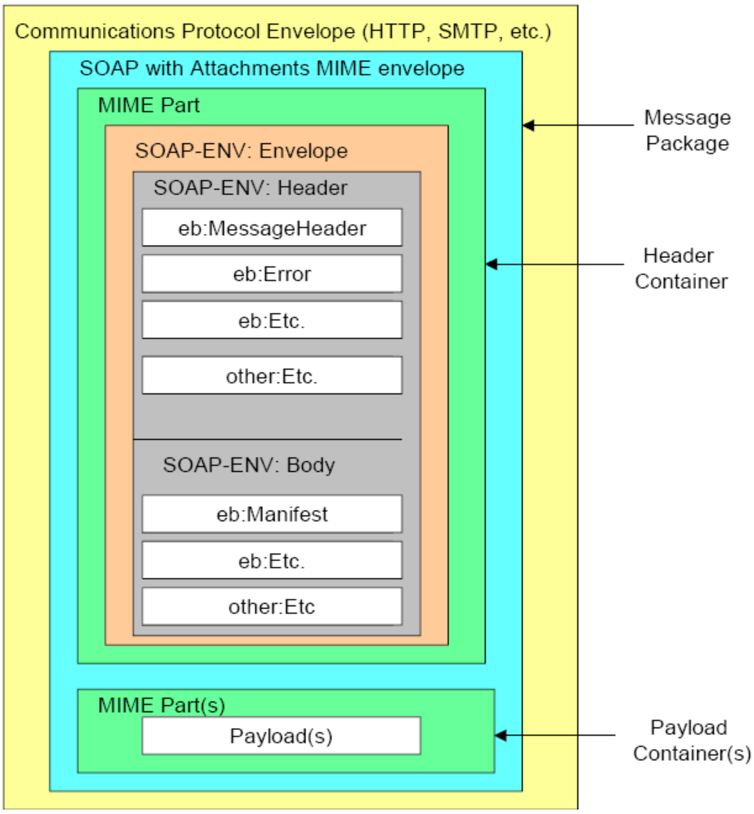


Figure 98 ebXML message structure [45]

ebXML Messaging (also called TRP - Transport Routing & Packaging) specifically focuses on the means to transmit a document (payload) from one party to another, possibly via intermediaries. This protocol is an attempt to standardize the way B2B transactions are transmitted in a manner which includes all sizes of companies from the Large Enterprise (LE) to the Small & Medium Enterprise (SME). ebXML-MS does not define the business processes or the content of the messages being sent. ebXML-MS only concerns itself with the secure and reliable transmission of the payload. ebXML-MS Message Service Handler (MSH) sits between the network protocol (SMTP, FTP, HTTP, etc.) and the Business Process at each end. In this way, the MSH is independent of both the transport protocol and the higher level Business Processes. ebXML-MS can be used to transmit any payload over any network connection.

ARKTRANS is advised to initially use ebXML-MS
as the protocol stack alternative ebXML Minimal in Figure 99.

This is in harmony with the conservative minimal position taken related Business Process Transaction Implementation – see section 0 below. Note that the message payload standard is the very basic XML standard – see section 0 D.3.3 Information Content for ARKTRANS position on the implementation of this.

It is advisable to prepare for a evolution of ARKTRANS to more advanced protocol stacks. The Light alternative adds both a specific message content standard (EML EDIFACT) for the message payload plus a Business Process Specification Schema (BPSS) layer on top. The BCF + ebXML alternative shows a complete protocol stack based on ebXML plus UN/EDIFACT Business Collaboration Framework (BCF).

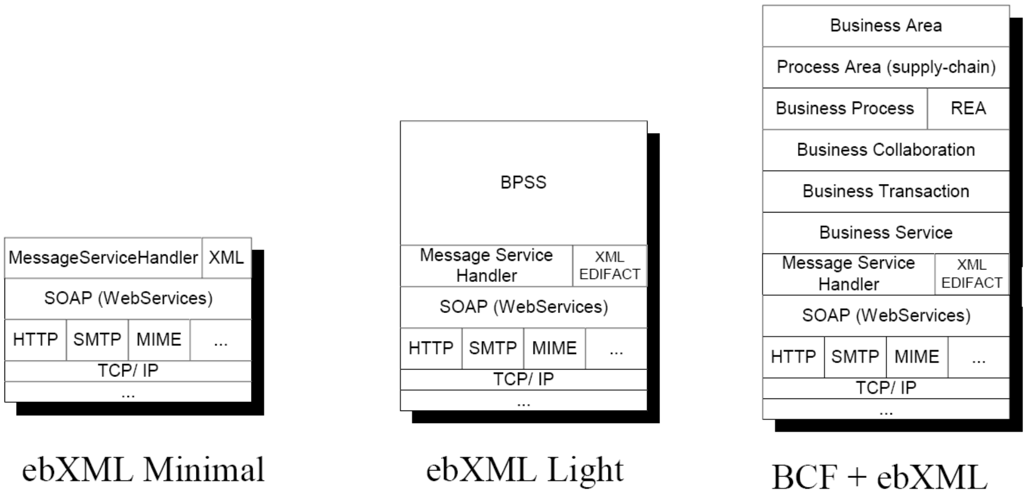


Figure 99 ebXML protocol stack levels extended with UN/CEFACT BCF [42]

D.3.2 Business Transaction Implementation

Business transactions should be according to collaboration agreements expressed by a business transaction framework. The business transaction framework may provide:

1. Mechanisms for business transaction choreography:

- Specification of the possible states, the associated transitions, and the associated messages/information exchange.
- Specification of logical rules for the transitions as well as for transaction completion including logical rules for exception handling and recovery.

2. Specifications of generic business transactions for handling of business relations.

3. Message templates

ARKTRANS will not need mechanisms that support dynamic establishment of the choreography. The exact rules for generic business transactions related to transport will be defined by ARKTRANS (second alternative above). Exception handling is an important part issue. The business transaction framework must define a set of exception types, e.g. message format error, transmission error, message not sent, and delivery failure.

Business transactions ranges from simple request / response conversations between two parties to complex and long (minutes to days) conversations between multiple parties involving commitment or rollback of entity state changes in multiple sites according to protocol actions or failure conditions.

The implementation of traditional transactions is based on two-phase commitment and two-phase locking, and may for example be realised by means of DBMS services (SQL, RPC). Business transactions may be implemented based on Internet technology like XML, HTTP, SMTP, SOAP, etc. on Web Servers.

Extensions that support business transaction needs have to be added. Some alternatives are described above in section 0. The Web Services Transactions specifications define mechanisms for transactional interoperability between Web services domains and provide a means to compose transactional qualities of service into Web services applications.

The Web Services Transactions specifications describe an extensible coordination framework (WS-Coordination) and specific coordination types for:

- Short duration, ACID transactions (WS-AtomicTransaction)
- Longer running business transactions (WS-BusinessActivity)

D.3.3 Information Content

Basic ARKTRANS implementation requirement:
ARKTRANS messages shall be defined by means of XML Schemas (XML XSD).

The second edition recommendation is described in 3 separate documents providing:
0) an overview and tutorial [46], **1)** the structure definition ,[47]and **2)** the data type definition [48].

ARKTRANS message schemas
shall be based on the ARKTRANS domain information model

This is essential to ensure semantic capability and ensure reuse.

Rules and standards how to do this has to be determined – the OASIS OAGI Business Object Document (BOD) approach should be considered [35].

OAGIS BOD messages make use of today's best practices of object-oriented design by defining a common consistent Noun or object that has Verbs or methods that indicate the action to be performed upon the Noun. By using this construct, it is possible for OAGIS messages -- and the code that reads and produces OAGIS messages -- to leverage this reuse. Once the initial OAGIS BOD can be read or produced, much of the code can then be used to read or produce the next message.

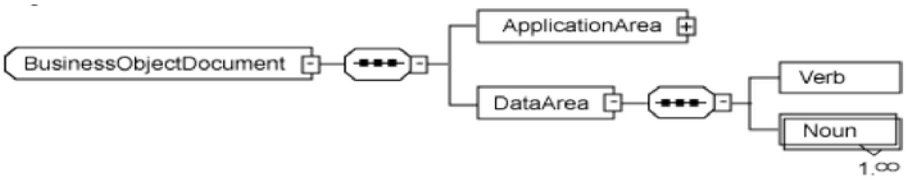


Figure 100 General structure of all BODs [35]

All of the OAGIS BODs use the same general structure:

- The name of the BOD is the VerbNoun combination being applied
  (notice that the Verb and Noun are used as separate elements in the DataArea)
- An Application Area
- A DataArea that contains the Verb and one or more of the Nouns indicated

Annex E. ARKTRANS Roles and Objects: Examples

E.1 ARKTRANS Roles

The tables below shows additional information related to tthe roles specified in 5.1 by the means of the following columns:

- *Superior and Detailed roles* as defined in 5.1 - English and Norwegian terms.
- *Terms used in road transport* – Specifies road transport terms for the superior or detailed roles. Commonly known road transport roles or stakeholders may also be referred.
- *Terms used in maritime transport* – Specifies maritime terms for the superior or detailed roles. Commonly known maritime roles or stakeholders may also be referred.
- *Terms used in rail transport* – Specifies rail transport terms for the superior or detailed roles. Commonly known rail transport roles or stakeholders may also be referred.
- *Terms used in air transport* – Specifies air transport terms for the superior or detailed roles. Commonly known air transport roles or stakeholders may also be referred.

Only the superior roles and detailed roles are used in the framework architecture descriprion. The mode related terms are just examples that show the linkage to the different transport modes and the modal terms should not be considered as a part of the architecture. The intention is to help stakeholders to understand the meaning of the superior and detailed roles. (The mapping to the modal terms is done by Norwegian stakeholder and reflects the Norwegian situation. Some Norwegian terms may be used, and Norwegian stakeholders that possess the roles may be mentioned.)

E.1.1 Roles related to Transportation Network Management

The Transportation Network Management domain relates to a wide spectre of roles andis further decomposed into four domains (see Chapter 6):

- Transportation Network Infrastructure Management
- Transportation Network Utilisation
- Emergency Management
- Regulation Enforcement

E.1.1.1 Roles related to Transportation Network Infrastructure Management

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	In road transport	In maritime transport	In rail transport	In air transport
Transportation Network Manager Transportinfrastrukturforvalter		Road administration County authorities Municipals Private road owner	Coastal Administration Port terminals Harbour master	Railway administration Terminal owner Railways station owner	Aviation authority Airport owner

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	In road transport	In maritime transport	In rail transport	In air transport
		Terminal owner			
	Transportation Network Planner Transportinfrastrukturplanlegger	Road administration County authorities Municipals Private road owner Terminal owner	Coastal Administration Ports Port terminals Harbour master	Railway administration Terminal owner Railways station owner	Aviation authority Airport owner
	Transportation Network Information Manager Transportinfrastruktur informasjonsansvarlig	See above	See above	See above	See above
	Transportation Network Quality Manager Transportinfrastrukturkvalitetsansvarlig	See above	See above	See above	See above
	Transportation Network Quality Manager Transportinfrastruktur kvalitetsansvarlig	See above	See above	See above	See above
Transportation Network Operator Transportinfrastruktur operatør		Engeneering company Companies handling equipment operation (e.g. software, electronics, …) Equipment vendors Professionals	Engeneering company Companies handling equipment operation (e.g. software, electronics, …) Equipment vendors Professionals	Engeneering company Companies handling equipment operation (e.g. software, electronics, …) Equipment vendors Professionals	Engeneering company Companies handling equipment operation (e.g. software, electronics, …) Equipment vendors Professionals

E.1.1.2 Roles related to Transportation Network Utilisation

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Traffic and Transportation Planner Trafikk- og transport-planlegger		County municipality 1 Ministry of Transport and Communications2 Road Administration) Terminals	County municipality (ferries related to county roads) Ministry of Transport and Communications (ferries related to national roads) Ports Port terminals	Raailway administration Ministry of Transport and Communications Railway inspectorate Reailway terminals Railway stations	Aviation authority Ministry of Transport and Communications Aviation inspectorate Airports
	Traffic Planner Trafikkplanlegger	See above	See above	See above	See above
	Transportation Planner Transportplanlegger	See above	See above	See above	See above
	Traffic Support Planner Trafikksupport-planlegger (ansvarlig for nødvendige ressurser og tjenester)	Leading car planning (in case of convoing across mountain areas) (Kolonnekjøring)	Nautical support planner (e.g. tug boats, capacity of locks and bridges, capasity of pilots)	Shunting locomotive planner etc.	Airport operation planner
Traffic Manager Trafikk-styringsansvarlig		Traffic Management Centre (TCM)	Vessel Traffic Management centre (e.g.VTS)		Air traffic control centre
	Traffic Information Manager Trafikk-informasjonsansvarlig	Traffic Information Centre (TIC)3) Reginal traffic information centre	VTS (Vessel traffic services) Maritimt informasjonssenter (melding til sjøfarende) Kartverket (etterretning til sjøfarende)	Driftsoperativt senter (DROPS) Toganvisere Transportledere	LETIS (Luftfartsverkets elektroniske trafikkinformasjons-sentral)
	Traffic Control Manager Trafikkontrollansvarlig (ansvar for informasjon og kontroll relatert til trafikken på	Traffic Control Centre (TCC) Vegtrafikksentral (VTS) (Regionale Vegtrafikksentraler4)	VTS-centre Pilot	(Sentralisert Trafikkontroll (CTC)) Togledersentral Lokale stillverk	Air traffic control centre Approach control at airport

[1] The regional authority assigns transport permissions for freight and passenger transport within a region.

[2] The Department of Transport assigns transport permissions for freight and passenger transport across regions.

[3] Vegtrafikksentral Oslo (TIC-N) - Responsible for dissemination of traffic information towards national and international public media.

[4]Control of tunnels and bridges.

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	transportinfrastrukturen)	Vaktsentraler5		Togledelse (JBV) TXP (manuell trafikkontroll)	
Transport Means Support Manager Trafikksupportansvarlig		Provider of car leading convoiys	Port receiving waste Provider of tug boats Pilots Those providing access to infrastructure segments – e.g. Bridge and Lock operators	Provider of shunting locomotives Hvordan styres sporvekslere – må togselskapene bestille dette?	Provider of ”follow-me” car
Transportation Network Resource Manager Transport-infrastruktur ressursforvalter		Parkerings department City administration Road administration Terminal	Port Terminal	Terminal Station	Airport

E.1.1.3 Roles related to Regulation Enforcement

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Transport Regulator Transportregulerende Myndighet	Agricultural Authority Landbruksmyndighet	Agricultural Authority	Agricultural Authority	Agricultural Authority	Agricultural Authority
	Armed Forces Authority Militærmyndighet	Armed forces	Coast Guard Armed forces	Armed forces	Armed forces
	Cargo and Transport Inspection Authority	Statens Vegvesen			
	Civil Law Authority Politimyndighet	UP (kontrollerende) Trafikkpolitiet (ulykker) Statens Vegvesen (begrenset)	Coast Guard Police	Police	Police
	Clearance Authority Ankomstmyndighet		Forsvaret Kystverket		
	Customs Authority Tollmyndighet	Tollvesenet	Tollvesenet	Tollvesenet	Customs
	Emergency Authority	Statens Vegvesen	SFT	Jernbaneverket	Aviation authority (plans)

[5] May be permanent or seasonal. May have subordinate centrals.

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Beredskapsmyndighet	Forsvaret Sivilforsvaret DNMI TBO – Transportbedriftenes Beredskapsorganisasjoner Police	Forsvaret Coastal Administration Interkommunale beredskapsutvalg DNMI TBO – Transportbedriftenes Beredskapsorganisasjon Coast Guard Police		Forsvaret (early warning in case of war/mobilisation)
	Environmental Authority Miljømyndighet	SFT	Kystverket SFT	SFT	SFT
	Fare Authority Takstmyndighet	Kommuner (parkering) Fylkeskommunen (kollektivtakster) Ministry of Transport and Communications (kollektiv-takster - på tvers av fylker)	Fylkeskommunen (kollektivtakster) Ministry of Transport and Communications (kollektiv-takster - på tvers av fylker)	Ministry of Transport and Communications Stor-Oslo Lokaltrafikk Oslo Kommune	Fri takstfastsettelse av selskapene selv, unntatt kortbanenettet hvor Ministry of Transport and Communications er inne i anbudsrundene
	Fee Collection Authority Innkrevingsmyndighet	Toll og avgiftsdirektoratet[6]	Coastal Administration Toll og avgiftsdirektoratet[7]	Jernbaneverket	Aviation authority Euro control
	HAZMAT Authority Myndighet for farlig gods	Direktoratet for brann og eksplosjonsvern (ADR-forskrift) Statens Vegvesen SFT	NCA (National Competence Authority) - Kystverket SFT	Sikkerhetstjeneste	Luftfartstilsynet
	Health Authority Helsemyndighet				
	Immigration Authority Immigrasjonsmyndighet				
	Information Centre Authority Myndighet for informasjon-kontaktpunkt		National Single Window SafeSeaNet		

[6] E.g. fee collection

[7] E.g. fee collection

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Legislative Authority Lovgivende myndighet	National Authorities EU International Authorities	National Authorities EU International Authorities	National Authorities EU International Authorities	National Authorities EU International Authorities
	Licence Authority Løyvemyndighet (løyver tildeles avhenging av kvalifikasjon)	Fylkeskommunen 8 Ministry of Transport and Communications9 Statens Vegvesen (førerkort) Stortinget og SD (bomstasj.)	Fylkeskommunen (ferger i et fylke) Ministry of Transport and Communications (riksvegferger)	Jernbaneverket Ministry of Transport and Communications Jernbanetilsynet	Aviation authority Ministry of Transport and Communications Luftfartstilsynet
	Privacy Regulatory Authority Tilsynsmyndighet for personvern	Datatilsynet	Datatilsynet	Datatilsynet	Datatilsynet
	Procecution Authority Myndighet for straffeforfølgelse	Domstoler	Domstoler	Domstoler	Domstoler
	Registrar Authority Registermyndighet	National coordinator of IDs National coordinator of fare management IDs	National coordinator of IDs National coordinator of fare management IDs	National coordinator of IDs National coordinator of fare management IDs	National coordinator of IDs National coordinator of fare management IDs
	Safety Regulatory Authority Tilsynsmyndighet for sikkerhet	Statens Vegvesen	Sjøfartsdirektoratet	Statens Jernbanetilsyn	Aviation authority
	Statistics Authority Myndighet for statistikk	Ministry of Transport and Communications Vegdirektoratet Statistisk sentralbyrå Fylkeskommunen	Statistisk sentralbyrå	Jernbaneverket Statistisk sentralbyrå Jernbanetilsynet	Statistisk sentralbyrå Transportøkonomisk Institutt Aviation authority
	Security Authority Sikkerhetsmyndighet	Nasjonal sikkerhetsmyndighet (NSM) Datatilsynet Police Armed forces Misc. authorities	Nasjonal sikkerhetsmyndighet (NSM) Datatilsynet Police Armed forces Misc. authorities	Nasjonal sikkerhetsmyndighet (NSM) Datatilsynet Police Armed forces Misc. authorities	Nasjonal sikkerhetsmyndighet (NSM) Datatilsynet Police Armed forces Misc. authorities
	Traffic Authority Trafikkmyndighet	Public Road Administration Police	Coastal administration Coast guard	Jernbaneverket	Avinor Eurocontrol
	Transportation Network Authority Infrastrukturmyndighet	Public Road Administration Police	Coastal administration Coast guard	Jernbaneverket	Avinor Eurocontrol

[8] The regional authority assigns transport permissions for freight and passenger transport within a region.

[9] The Department of Transport assigns transport permissions for freight and passenger transport across regions.

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Transport Means Inspection Authority Transport	Statens Vegvesen v/Trafikkavdelingene (kjøretøyet)	Sjøfartsdirektoratet Flag state inspection Port state inspection	Operatør NSB/Jernbaneverket Statens Jernbanetilsyn (sporveier???)	Aviation authority
	Transport Means Regulatory Authority Tilsynsmyndighet for transportmidler	Statens Vegvesen v/Trafikkavdelingene (kjøretøy og fører)	Sjøfartsdirektoratet	Statens Jernbanetilsyn	Aviation authority
	Veterinary Authority Veterinærmyndighet				

E.1.1.4 Roles related to Emergency Management

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Emergency Preparedness Manager Beredskapsansvarlig	Preparedness Coordination Manager Beredskapskoordinator	Beredskapsutvalg SFT Statens Vegvesen Forsvaret Sivilforsvaret DNMI TBO – Transportbedriftenes Beredskapsorganisasjon	Beredskapsutvalg SFT Forsvaret Coastal Administration DNMI	Beredskapsutvalg SFT Jernbaneverket	Beredskapsutvalg Aviation authority (plans) Forsvaret (early warning in case of war/mobilisation)
	Search and Rescue Preparedness Manager Beredskapsansvarlig for redningstjeneste	Police Rescue Coordination Centre Rescue Sub-centre	Police Rescue Coordination Centre	Police	Police Rescue Coordination Centre
	Pollution Preparedness Manager Beredskapsansvarlig for forurensning	Statens Forurensningstilsyn Helsetilsynet	Statens Forurensningstilsyn Kystverket	Statens Forurensningstilsyn	Statens Forurensningstilsyn
Emergency Response Manager Ansvarlig for håndtering av ulykker	Pollution Response Manager Leder for operasjon som begrenser forurensning	Statens Forurensningstilsyn	Statens Forurensningstilsyn	Statens Forurensningstilsyn	Statens Forurensningstilsy
	Salvage Operation Manager Bergingsleder	Police Statens Vegvesen	Vessel Operator Bergingsselskaper	Operator	

Superior roles Overordnede rollebegrep	Detailed roles Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
			Maritime Assistance Services		
	Search and Rescue Manger Leder for redningsaksjon	Vegtrafikksentral 10 Police	SAR Police Rescue Coordination Centre	Driftsoperativt senter (DROPS) Police Rescue Coordination Centre	Police Rescue Coordination Centre
Emergency Response Operator Redningsoperatør	On-site Coordinator Skadestedsleder	Police Fire department	Coast Guard	Police	Police Fire department
	Search and Rescue Unit Redningsenhet	Bergingstjeneste (NAF, Viking) Police Fire department Medical aid	Coast Guard Medical aid Air plane Vessel	Bergingstjeneste Police Fire department Medical aid	Coast Guard Fire departmen Medical aid Air plane Vessel
Emergency Investigation Manager Leder av ulykkesetterforskning		Police	Ulykkeskommisjon Police	Ulykkeskommisjon Police	Ulykkeskommisjon Police

E.1.2 Roles related to Transport Demand

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
Public Purchaser Offentlig innkjøper		Fylkeskommunen 11 Ministry of Transport and Communications12 The parlament og Ministry of Transport and Com. (bomstasjoner)	Fylkeskommunen (ferger i et fylke) Ministry of Transport and Communications (riksveiferger)	Fylkeskommunen Ministry of Transport and Communications	Fylkeskommunen Ministry of Transport and Communications

[10] Tunnels and bridges

[11] The regional authority assigns transport permissions for freight and passenger transport within a region.

[12] The Department of Transport assigns transport permissions for freight and passenger transport across regions.

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
Transport User Transportbruker	Cargo owner Vareeier	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)
	Supply Chain Party Ledd i logistikkjede	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde)
	Consignee Varemottaker	Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) Importer	Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) Importer	Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) Importer	Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) Importer
	Consignor Avsender	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) Exporter	Shipper Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) Exporter	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) Exporter	Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) Exporter
	Traveller *Reisende*				
	Transport Organisator Transportorganisator	Forwarder (ordering transport) Travel agency Tour operator Logistics provider Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) WEB-services	Forwarder (ordering transport) Travel agency Tour operator Logistics provider Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) WEB-services	Forwarder (ordering transport) Travel agency Tour operator Logistics provider Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) WEB-services	Forwarder (ordering transport) Travel agency Tour operator Logistics provider Manufacturer (produsent) Wholesaler (Videreselger) Retailer (Forhandler) End Customer (Sluttkunde) WEB-services
Traveller Reisende		Passenger Traveller	Passenger Traveller	Passenger Traveller	Passenger Traveller
	Crew in transit Besetning I transit				
	Scheduled Transport Passenger Passasjer på rutegående transport	Passenger Public transport traveller	Passenger	Passenger	Passenger

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
	On-demand Transport Passenger Passasjer på ikke-rutegående transport	Taxi passenger			

E.1.3 Roles related to Transport Service Management

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
Transport Service Provider Leverandør av transporttjenester	*Transport Service Manager* *Transporttjenesteansvarlig*				
	Transport Operation Manager Transportoperasjonsansvarlig	Terminal operator Warehouse operator Document handling organisation Back office/fleet manager for o Taxi central o PT operator (bus, tram, etc.) o Truck operator o Emergency fleet o NAF/Viking/Falken o Goods distribution	Terminal operator Warehouse operator Document handling organisation Shipping agent Fleet operator o Shipping company o Trampline operator (non-scheduled) o Freight line operator (scheduled) o Ferry operator o PT operator	Terminal operator Warehouse operator Document handling organisation Train operator o NSBs materiellenhet o Driftsoperative senter (DROPS) o Cargonet o Flytoget	Terminal operator Warehouse operator Document handling organisation Airline operator
	Transport Business Manger Leder av transportvirksomhet	Drosjeeier Lastebileier Container eier	Ship owner Container owner		
	Transport Operation Worker *Transportarbeider*				

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
Transport Service Manager Transporttjeneste-ansvarlig		Forwarder Terminal service provider Carrier providing transport services o Passengers o Cargo Provider of document handling services Warehous service provider Depot service provider	Forwarder Terminal service provider Carrier providing transport services o Passengers o Cargo Provider of document handling services Warehous service provider Depot service provider	Forwarder Terminal service provider Carrier providing transport services o Passengers o Cargo Provider of document handling services Warehous service provider Depot service provider	Forwarder Terminal service provider Carrier providing transport services o Passengers o Cargo Provider of document handling services Warehous service provider Depot service provider
	Customer Relation Manager Kundekontakt	See above	See above	See above	See above
	Transport Service Planner Transporttjenesteplanlegger	See above	See above	See above	See above
Transport Operation Worker Utfører av transportoperasjoner	Load Item Handler Ansvarlig for gods-/passasjerhåndtering	Terminal worker Warehouse worker Passenger handler Cargo handler Baggage handøler Handler	Terminal worker/Stevedore Warehouse worker Passenger handler Baggage handøler Handler	Terminal worker Warehouse worker Passenger handler Baggage handøler Handler	Terminal worker Warehouse worker Passenger handler Baggage handøler Handler
	Document Handler Dokumentbehandler	Driver Document handler	Document handler		
	Case Handler Saksbehandler	Driver Saksbehandler			
	Transport Product Validator Kontrollør	Conductor Validator	Ticket controller	Conductor Validator Ticket controller	Handler
	Counter staff Skrankepersonale				
	Passenger Manager Passasjeransvarlig		Hotellsjef Cateringpersonale	Togsjef Cateringpersonale Sovevognskonduktør	Purser
	Safety Surveyor Sikkerhetsinspektør (safety)	Driver	Master		Pilot

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
	Security Surveyor Sikkerhetsinspektør (security)	Driver	Master (on-board) Gate control personnel Security Personnel Watchman Surveyor	Traffiksikkerhets-ansvarlig	Pilot (on-board) Gate control personnel Security Personnel Watchman
	Emergency Team Personnel Redningsteam		Fire team Rescue team	Fire team Rescue team	Fire team Rescue team

E.1.4 Roles related to On-board Support and Control

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
Transportation Network User Trafikant		Road user	Seafarer		
	Crew				
	Pedestrian Fotgjenger				
	Cyclist Syklist				
Crew Besetning	Master Kaptein	Driver	Captain/Master	Engine driver13 Traffic Control Central Operator (takes decisions about conveying)	Captain

[13] May not have any influence on the conveying – managed by the control center and the signaling system)

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Terms used in road transport	Terms used in maritime transport	Terms used in rail transport	Terms used in air transport
	Driver Fører	Professional driver Private driver Motor cycle driverl Driver of private car, lorry, truck, minibus, bus, tractor, snow scooter, etc. Taxi driver PT driver	Helmsman	Driver Tram driver Train driver Locomotive engineer (US) Engin driver (UK)	Pilot
	Chief Maskinist	Driver	Chief engineer		
	First Officer Nestkommanderende	Driver	Mater	Ombordansvarlig/Togsjef/Conductor	First officer
	Navigator Navigatør	Driver	Navigator		Navigator
	People on duty Mannskap	Hjelpemann Reservesjåfør	Styrmann Navigatør Maskinist Andre offiserer Konduktør Kundekontakter Øvrig besetning	Konduktør (also ticket conductor) Billettør Ombordpersonell Servicepersonell	Cabinpersonale Navigatør Maskinist

E.1.5 Roles related to Transport Sector Support

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Service provider Tjenesteyter	Fare Management Interoperability Provider Leverandør av samordnede billetteringstjenester		Indivitual operators (Transport Service Providers) Consortia of operators Public authorities Private companies	See road	See road

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Fee Collection Service Provider Leverandør av avgiftshåndtering	Fee collection company[14] Farry operator using Autopass	Farry operator using Autopass Collector of annual fee and coastal fee	Agents Travel agencies Samarbeidende operatører (Fylkeskommunale)	Euro control (underveisavgift) Airports Aviation authority Finansdep.
	Security Service Provider Leverandør av sikkerhetstjenester	Company providing security personnel	Company providing security personnel	Company providing security personnel	Company providing security personnel
	Payment Service Provider Betalingsformidler	Fee collection company[15] Ferjeselskap	Ferjeselskap Collector of annual fee and coastal fee	Agents Travel agencies Samarbeidende operatører (Fylkeskommunale)	Euro control (underveisavgift) Airports Aviation authority Finansdep.
	Payment Information Service Provider Leverandør av betalingsinformasjon				
	Tracking and Monitoring Provider Leverandør av sporings- og overvåkingstjenester	Collection of PT providers PT provider Local government Freight monitoring provider	AIS infrastructure LRIT infrastructure Freight monitoring provider	Freight monitoring provider	Freight monitoring provider
	Travel Service Provider Leverandør av reiselivstjenester	Travel agencies Hotel Restaurant Travel agencies Kundesentre	Travel agencies Hotel Restaurant Travel agencies Kundesentre	Travel agencies Hotel Restaurant Travel agencies Kundesentre	Travel agencies Hotel Restaurant Travel agencies Kundesentre
	Support Provider				
	Facility Provider				
	Fare Management Service Provider				
	Information Service Provider				
	Information Transfer Service Provider				
Support Provider	Bunkring Service Provider Leverandør av bunkringstjenester				
	Classification Service Provider Leverandør av klassifiseringstjenester				

[14] May operate on behalf of county or municipal authority. Operates toll roads, administrates fee collection, pays off loans, management of information, etc.

[15] May operate on behalf of county or municipal authority. Operates toll roads, administrates fee collection, pays off loans, management of information, etc.

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Insurance Provider Forsikringsselskap	Forsikringsselskaper	Insurance company	Insurance company	Insurance company Egenassurandør
	Surveillance Provider Leverandør av overvåkingstjenester	EU-kontroll	Veritas		
	Mooring Service Provider Leverandør av fortøyningstjenester		Lensemen at terminals		
	Supply Provider Leverandør av forsyninger	Cateringselskap Oljeselskap Warehouse provider	Terminaler Oljeselskap Skipshandlere Tug boat operator??? Warehouse provider	Cateringselskap Oljeselskap Technical service provider Equipment provider Skiftelokk??? Warehouse provider	Cateringselskap Oljeselskap
	Salvage Service Provider Leverandør av bergingstjenester	VIKING Falcken	Tug boat companies		
	Towing Service Provider Leverandør av tauetjenester				
	Repair Service Provider Leverandør av verkstedstjenester				
Facility Provider	Pollution Response Facility Provider Leverandør av fasiliteter for bekjempelse av forurensning		Leverandør av oljelenser		
	Rescue Faclility Provider Leverandør av utstyr til redningsoperasjoner	Police Fire department Medical authorities Defence forces Civil Defence Voluntary organisations	Police Fire department Medical authorities Defence forces Civil Defence Voluntary organisations	Police Fire department Medical authorities Defence forces Civil Defence Voluntary organisation	Police Fire department Medical authorities Defence forces Civil Defence Voluntary organisation
	Search Facility Provider Leverandør av redningsutstyr	Police Fire department Medical authorities Defence forces Telecom Companies Civil Defence Voluntary organisations	Police Fire department Medical authorities Defence forces Telecom Companies Civil Defence Voluntary organisations	Police Fire department Medical authorities Defence forces Telecom Companies Civil Defence Voluntary organisation	Police Fire department Medical authorities Defence forces Telecom Companies Civil Defence Voluntary organisation
	Quarantine Service Provider Leverandør av karantenetjenester				

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Waste Disposal Facility Provider Leverandør av fasiliteter for avfallsmottak		Ports		
Fare Management Service Provider Leverandør av billetteringstjeneste	Application Owner Applikasjonseier	Collection of PT providers PT provider Local government	See road	See road	See road
	Application Retailer Applikasjonsforhandler	Retailer of tickets eBusiness (Web, SMS, WAP, ..)	See road	See road	See road
	Collection and Forwarding Provider Leverandør av mellomlagre	Provider of ICT services	See road	See road	See road
	Product Owner Produkteier	Collection of PT providers PT provider/Transport Service Provider Local goverment	See road	See road	Airlines Collection of airlines Government
	Product Retailer Produktforhandler	Ticket Issuing Equipment Conductor Retailer of tickets eBusiness (Web, SMS, WAP, ..)	See road	See road	See road
Information Service Provider Leverandør av informasjonstjenester	Environmental Condition Information Provider Leverandør av informasjon om miljøforhold				
	Environmental Resource Information Provider Leverandør av informasjon om miljøressurser	AREALIS-prosjektet Statens Vegvesen	Det Norske Veritas Hydrographic Service SFT	Det Norske Veritas	Aviation authority
	Geodata Provider Leverandør av geografisk informasjon	Statens kartverk County authorities Kommunenes sentralforbund Landbruksdep. Energiforsyningens fellesorg. Telecom companies	Hydrographic Service C-Map	Jernbaneverket Statens kartverk	Aviation authority
	Meteorological and Hydrological Information Provider				

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Leverandør av meteorologisk og hydrologisk informasjon				
	Prediction Provider Leverandør av prognoser		Driftsprognoser Oljespredningsprognoser		
	Traffic Situation Information Provider Leverandør av informasjon om trafikkforhold	Transport management centre Traffic Control Central Traffic Information Central Radio channels Internet service providers Text TV Weather offices Transportation Network Authority Navigation system providers (e.g. Tom-Tom)	Traffic Information Central Weather offices Radio and TV channels Route planners Transportation Network Authority Navigation system providers	Traffic Information Central Web Weather offices Transportation Network Authority	Traffic Information Central Weather offices Flyværtjenesten Transportation Network Authority
	Transportation Network Information Provider Leverandør av infrastrukturinformasjon	Providers of navigation systems Transfer node owners Transfer node regisries	ENC providers Providers of sea charts Transfer node owners Transfer node regisries	Transfer node owners Transfer node regisries	Transfer node owners Transfer node regisries
	Travel Information Provider				
Information Transfer Service Provider Leverandør av informasjons-overføringstjenester	Authority Information Transfer Provider Leverandør av informasjons-overføringstjenester mot myndigheter		Port Single window National Singel window SafeSeaNet (European level)		
	Commercial Information Transfer Provider Leverandør av informasjons-overføringstjenester mot kommersielle aktører		Port community system		
	Communication Provider Leverandør av kommunikasjonstjenester	Telecom company	Telecom company	Telecom company	Telecom company
	Gateway Provider Leverandør av gatewaytjenester	Provider of ICT services	Provider of ICT services	Provider of ICT services	Provider of ICT services
	Information Security Provider Leverandør av tjenester for informasjonssikkerhet				

Superior roles / Overordnede rollebegrep	Detailed roles / Detaljerte rollebegrep	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Travel Information Provider Leverandør av reiseinformasjons-tjenester	Door-to-door Travel Planner Leverandør av dør-til-dør reiseplanlegger	Trafikanten			
	Non-scheduled Travel Planner Transport Leverandør av reiseinformasjonstjenester for ikke-rutegående transport	VisVeg NAF Gule sider			
	Tourist Information Provider Leverandør av turist-informasjon.	Travel agencies Reiseinformasjon for Sogn og Fjordane(?)	Travel agencies	Travel agencies Kundesentre	Airline company Travel agencies
	Scheduled Transport Travel Plan Provider Leverandør av reiseinformasjonstjenester for rutegående transport	Norsk Reiseinformasjon Trafikanten Bus operators	Norsk Reiseinformasjon Vessel operators	Norsk Reiseinformasjon NSB	Norsk Reiseinformasjon Air lines

E.2 ARKTRANS Objects

The tables below shows additional information related to the objects specified in 5.2 by the means of the following columns:

- Superior object names / Overordnet objektnavn –overall generic terms valid across all the transport modes and in some cases also for both freight and personnel transport – in English / Norwegian.
- Detailed object names / Detaljert objektnavn – refinements of the superior object names. These are also valid across all the transport modes and in some cases also for both freight and personnel transport – in English / Norwegian. A detailed role may be a superior role specified elsewhere in the table. In such cased the term is printed in italic.
- Terms used in road transport – Road transport terms for the superior or detailed object names or commonly known road transport objects.
- Terms used in maritime transport – Specifies maritime terms for the superior or detailed object names or commonly known maritime objects.
- Terms used in rail transport – Specifies rail transport terms for the superior or detailed object names or commonly known rail transport objects.
- Terms used in air transport – Specifies air transport terms for the superior or detailed object names or commonly known air transport objects.

The modal terms may be English and/or Norwegian.

E.2.1 Object names related to Transportation Network Management

The Transportation Network Management domain relates to a wide spectre of roles and is further decomposed into four domains (see Chapter 5.3):

- Transportation Network Infrastructure Management
- Transportation Network Utilisation
- Emergency Management
- Regulation Enforcement

E.2.1.1 Object names related to Transportation Network Infrastructure Management

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Transportation Network Transport-infrastruktur	Checkpoint Sjekkpunkt	Road-side equipment			
	Transfer Node				
	Transport Link Transportlenke	Road/street (vei, gate) Gang og sykkelvei Tunnel (Tunnel) Bridge (bro)	Fairway Inland waterways River	Railroad	Corridor
	Transportation Network Section Seksjon av transportnettet	Ferjeleie Tunnel Bro Område i by Veikryss Terminal			Airport
	Transportation Network Equipment				
	Transportation Network Resource				
Transfer Node Transfer Node		Freight terminal PT terminal Bus stop Taxi stop	Port Freight terminal Passenger terminal Ferry terminal	Freight terminal Station	Airport Airport terminal
	Access Point Aksesspunkt	Bus terminal entrance	Port terminal entrance	Station entrance	Aitport entrance Airport terminal entrance
	Junction Transfer Node Knutepunkt-Transfer Node	Bussterminal Kollektivknutepunkt	Ferjeleie	Sentralstasjon	Lufthavn Passasjerterminal
	Passenger Transfer Node Passasjer-Transfer Node	Passasjerterminal Skysstasjon Holdeplass	Passasjerterminal Ferjeleie	Stasjon Holdeplass	Flyplass
	Freight Handling Transfer Node Gods-Transfer Node	Godsterminal Containerterminal Skysstasjon Omlastingsterminal?	Havn Kai Omlastingshavn Containerhavn Ro-ro terminal	Godsterminal Containerterminal Sidespor Depot	Flyfraktterminal
	Ro-ro Transfer Node Ro-ro-Transfer Node		Fergeterminal Ro-ro terminal	Motor rail terminal	
Transportation Network	Loading and unloading area	Loading bay	Quay	Platform	gate

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Resource Ressurs i transportinfrastrukturen	Laste- og lossesone				
	Parking Area Parkeringsplass				
	Stop Point Stoppunkt	Platform	Quay	Track Platform	Gate
	Terminal Area				
	Waiting Area Venteområde	Waiting area		Sidetrack	
Terminal Area Terminalområde	Maneuvering Area Manøvreringsområde		Indre havneområde	Track Reception area	Runway
	Ramp Area Rampe				
	Service Area Serviceområde	Stasjoneringssted Bensinstasjon Butikk Parkerings-/rasteplass Hvileplass	Dokkingterminaler	Skiftestasjon Lokomotivstall Trikkestall Vedlikeholdsbase	Flytekniske områder
	Transhipment Area Omlastingsområde				
	Transit Area Transitområde		Transit area	Transit area	
Transportation Network Equipment Urstyr rilknyttet transportinfrastrukturen	Access Control Equipment Utstyr for tilgangskontroll	Kortleser Bomstasjon Gate control equipment	Gate control equipment		Adgangskontroll
	Communication Facilitating Equipment Infrastrukturutstyr for kommunikasjon	Road-side equipment for communication (e.g. CALM stations)	AIS infrastructure		
	Information Equipment Informasjons-fomidlingsutstyr	Variable message sign Variable information board Punktradio Communication equipment	Communication equipment AtoN (Aids to navigation)	Elektroniske skilt Communication equip Togradio Skifteradio Konduktørradio Mobiltelefon	Electronical signs Communication equipment Monitors ATIS (Automatisk provider of met.info)
	Resources Management Equipment Utstyr som styrer disponering av ressurser		Havnesystem	Stillverk (lokal styring av spor til-gang på stasjon) Sporadmin.	Bakkekontroll

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Security Equipment Overvåkningsutstyr	Video			
	Signaling Equipment Signalanlegg				
	Transport Means Handling Equipment Utstyr for hådntering av transportmidler	Equipment for truck weighing		Turntable	
	Traffic Control Equipment Trafikkkontrollutstyr	Equipment for ATC (Automated Traffic Control) Utstyr for manuell trafikkontroll Signalanlegg Sentralstyringsanlegg Trafikksignalsentral	AIS base stations VTS system	Togradio/GSM-R CTC (Centralised Traffic Control) Stillverk ATC (Automated Train Control) Mobile phone Styringsanlegg Sikringsanlegg Penser Blokktelefon	VOR (Very High Frequency Omni range) ILS (Instrument Landing System) NDB (Non Directional Beacon) Radar UHF/VHF/HF Air Control Navigasjonssystem på bakken
	Trffic Monitoring Equipment Trafikkovervåkingsutstyr	Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler Video Field station for measurement of traffic information16 (like speed, video, numbers)	Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler Video Radar Speed meters Video monitors AIS base station	Visuelt Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler Video Speed meters Video monitors ATC-balisier Mobile phones	ITV (inter-tv) Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler Video Issensor Bremseeffektmåler Video monitors
	Traffic Regulation Equipment Trafikkregulerings-utstyr	Signal management (detectors, radar) Variable signs			
	Transportation Network Condition Monitoring Equipment	Field station for measurement Met. data (temp., wind,	Met. sensors (temp., wind, humidity, air pressure, view)	Met. sensors (temp., wind, humidity, air pressure, view)	Met. sensors (temp., wind, humidity, air pressure, view,

[16] Ulike nivåer. Nivå 1 måler kontinuerlig. Nivå 2 Måler periodisk 2-4 ganger per år. Nivå 3 måler en periode hvert år.

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Utstyr som overvåker ferdelsforhold	humidity, air pressure, view) Environmental data (pollution, remaining salt)	Sailing conditions sensors (current, waves, water level) Radar		ice)

E.2.1.2 Object names related to Transportation Network Utilisation

Not defined

E.2.1.3 Object names related to Emergency Management

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Emergency Equipment Nødutstyr		Fire alarm in tunnel Brannslukningsutstyr Nødtelefon	Oljelenser Livbåter Flåter		

E.2.1.4 Object names related to Regulation Enforcement

Not defined

E.2.2 Object names related to Transport Demand

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Transport Item Transportenhet	*Goods Item*				
	Load Unit				
	Luggage				
	Passenger				
	Trade Unit				
Goods Item Godsenhet	Termo Load Termovare				

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Environmental Affected Load Miljøpåvirkelig last				
	Non-floating bulk Ikke.flytende bulk				
	Floating bulk Flytende bulk				
	Special Cargo *Spesialgods*				
	General cargo Stykkgods				
	Project cargo Prosjektgods				
Load Unit Lastbærer	Pallet Palle				
	Container Container				
Luggage Bagasje	Animals Dyr				
	Normal Luggage Normalbagasje				
	Unhandy luggage Uhåndterlig bagasje				
Special Cargo Spesialgods	Food Matvarer				
	Animals Levende dyr				
	Human Remains Levninger				
	Valuables Verditransport				
	Dangerous Cargo Farlig gods				
Trade Unit Handelsenhet	Carton				
	Can				
On-Transport Item Equipment Utstyr på transportenheten	Equipment for Transport Support Utstyr for transportstøtte	Tags for intellgent goods Sensors	Tags for intellgent goods Sensors	Tags for intellgent goods Sensors	Tags for intellgent goods Sensors

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Equipment for Transport Item Identification Utstyr for identifisering av transportenhet	Electronic tags Bar codes RFID technology	Electronic tags Bar codes RFID technology	Electronic tags Bar codes RFID technology	Electronic tags Bar codes RFID technology
	Equipment for Demand Information Provision	Tags holding transport demand information	Tags holding transport demand information	Tags holding transport demand information	Tags holding transport demand information

E.2.3 Object names related to Transport Service Management

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Transport Worker Support Equipment Utstyr som støtter transportarbeideren		PDA, laptop, etc. with applications On-board unit	PDA, laptop, etc. with applications On-board unit	PDA, laptop, etc. with applications On-board unit	PDA, laptop, etc. with applications On-board unit
Load Item Lastenhet		Load unit Cargo Passenger	Load unit Cargo Passenger	Load unit Cargo Passenger	Load unit Cargo Passenger
On-Load Item Equipment Utstyr på lastenhet	Identification Equipment Utstyr for identifisering				
	Monitoring Equipment Utstyr for overvåking				
	Tracking Equipment Utstyr for sporing				
	Security Equipment sikringsutstyr				
	Positioning Equipment Utstyr for posisjonering				
Load Item Scanning Equipment Scanningsutstyr		RFID-reader Bar code reader	RFID-reader Bar code reader	RFID-reader Bar code reader	RFID-reader Bar code reader
Terminal Equipment Terminalutstyr	Loading and Unloading Equipment Laste- og losseutstyr	Kran Truck Vekt Forklift ???	Kran Truck Forklift Container truck	Kraner Trucker Forklift Vekt	Bagasjehandlings-system Highloader Tralle Vekt Forklift

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Passenger Handling Equipment Utstyr som betjener passasjerer	Insjekkingsautomater Info.systemer Rullestol		Insjekkingsautomater Info.systemer	Betalingsautomater Insjekkingsautomater Info.systemer Bagasjestyring Rullestol

E.2.4 Object names related to On-board Support and Control

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Transport Means Transportmiddel		Vechicle	Fartøy (vessel) Ferjer	Tog Motorvogn Sporvogn T-bane Container	Fly Helikopter
	Private Transport Means Privat transportmiddel	Sykkel Privatbil Motorsykkel Moped	Fritidsbåter	Privat vogn Privat container	Privatfly Mikrofly Hangglider
	Emergency Transport Means Utrykningskjøretøy	Utrykningskjøretøy Ambulanse Politibil Brannbil Bergingsbil Politimotorsykkel	Redningsskøyte Ambulansebåt Kystvaktskip	Beredskapstog (det står blant annet et på Oslo S)	Politihelikopter Redningshelikopter Utrykningsbåt Utrykningskjøretøy

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Transport Means for Passengers Transportmiddel for passasjerer	Yrkesmessig kjøretøy som frakter passasjerer Taxi Buss Sporvogn Matebuss Skolebuss Turbuss Ekspressbuss Flybuss	Hurtigbåter Ferjer Cruiseskip Rutebåt Svevebåt(Hovercraft) Kombinerte passasjer- og lasteskip Hurtigruta	Passasjertog Motorvogn Sporvogn T-bane Lokaltog Kombinerte passasjer- og godstog	Passasjerfly Rutefly Charterfly Helikopter
	Freight Transport Means Transportmiddel for gods	Yrkesmessig kjøretøy som frakter gods Lastebil Lastebil som frakter farlig gods Budbil Kjøretøy som driver egentransport17 av gods Kun: Godsbiler og tilhengere?	Lasteskip Bulkskip – olje, gjødsel, malm (ikke containere) Containerskip perm. containerceller Delvis containerskip Lekter (Barge carrier) Bilbåt (auto carrier) Gen. lasteskip (kveg, paller,...) Ro-ro skip Kombinerte passasjer- og lasteskip Ferjer Hurtigruta	Godstog Kombinerte passasjer- og godstog	Fraktfly Rutefly Helikopter Charterfly
	Service Providing Transport Means Transportmidler som tilbyr tjenester	Redningsbil Følgebil Bil med gulblink	Mateskip (Feeder) Taubåt Losbåt	Skiftelok Hjelpelok	
	Green Transport Means Grønt transportmidel				
On-Board Equipment Utstyr ombord i transportmiddel	ATC Equipment Utstyr for automatisk trafikkontroll	Automatic sped adaption Automatic lane keeping		ATC (Automatic Train Control)	ILS (Instrument Landing System)

[17] Egentransport er transport av gods for egen virksomhet, f.eks. tankbilen til meieriet (dårlig eksempel siden meieriene ikke eier bilene selv...)

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Equipment for Driver Support Utstyr som støtter føreren	Automatic Speed Adaption Electronic charts Navigation sypport systems Info. systems PDAs	Auto pilot ECDIS Info.system	Info.systemer Togtelegram (TTS) ATC (Automated Train Control) ATS (Automated Train Stop) Signalsystem	Autopilot Electronic charts Info.system
	Equipment for Driver Control Utstyr som overvåker og evt. responderer på førerens atferd og tilstand			Dead man’s control ATC (Automated Train Control)	Alarms
	Equipment for Transport Means Monitoring and Control Utstyr som overvåker og evt. responderer på transportmiddelets tilstand	Automated distress call eCall	Automated distress call Emergency beacon	Automated distress call	Automated distress call
	Equipment for Environmental Issues Miljørelatert utstyr				
	Navigation Suppor Equipment t Utstyr for navigasjonsstøtte	Navigasjonssystem	Navigasjonssystem ECDIS		ILS (Instrument Landing System) DME (Distance Measuring Equipm)
	Speed recorder Fartsskriver	Fartsskriver			
	Trip recorder Ferdsskriver		Ferdsskriver/Blackbox		

E.2.5 Object names related to Transport Sector Support

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
Communication Equipment Kommunikasjonsutstyr		Mobiltelefon/SMS Radiokom. FM RDS-TA[18] RDS-TMC[19] DAB T/PEG[20] VHF El.brikker (AUTOPASS)	Mobiltelefon Satellittkommunikasjon VHF (radio) Transponder (bl.a. AIS)	Togradio GSM-R ATC	Radio
Item Scanning Equipment		Scanning equipment at terminals or in vehicles.	Scanning equipment at terminals or in vehicles.	Scanning equipment at terminals or in vehicles.	Scanning equipment at terminals or in vehicles.
On-item Equipment	Identification Equipment Utstyr som støtter identifisering	AUTOPASS-tags Transponders on vehicles RFID tags on goods	AIS RFID tags on goods	RFID tags on goods	RFID tags on goods
	Monitoring Equipment Utstyr som overvåker lastens tilstand	Video On-Cargo Equipment Tag RFID Misc sensors (temparature, humidity, gas detector, etc.)	Video On-Cargo Equipment Tag RFID Misc sensors (temparature, humidity, gas detector, etc.)	Video On-Cargo Equipment Tag RFID Misc sensors (temparature, humidity, gas detector, etc.)	ITV (inter-tv) Video On-Cargo Equipment Tag RFID Misc sensors (temparature, humidity, gas detector, etc.)
	Tracking Equipment Sporingsutstyr	Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler AIS On-Cargo Equipment Tags (active/not active)	Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler On-Cargo Equipment Tags (active/not active)	Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler On-Cargo Equipment Tags (active/not active)	Utstyr som sporer gods Utstyr som sporer terminalressurser Utstyr som sporer transportmidler Transponders On-Cargo Equipment Tags (active/not active)
	Security Equipment Tyveri- og ranssikringsutstyr	Tyveridetektor		Tyveridetektor?	

[18] RDS-TA – Radio Data System Traffic Announcement

[19] RDS-TMC - Radio Data System Traffic message Channel – datapakker som dekodes og kan benyttes av informasjonssystemer

[20] DAB T/PEG – Digital Audio Broadcast

Superior object names Overordnet objektnavn	Detailed object names Detaljert objektnavn	Examples or terms used in road transport	Examples or terms used in maritime transport	Examples or terms used in rail transport	Examples or terms used in air transport
	Positioning Equipment Posisjoneringsutstyr	GPS/DGPS GSM	GPS/DGPS AIS with GPS	Satellittløsninger GPS/DGPS Blokkadr. (togradio) CTC (Centralised Train Control)	Satellittløsninger GPS/DGPS MADS (Auto. Detection Service, posisjon for helikopter)
Payment Equipment	Fee Equipment for Registered Payments	Elektronisk betalingsutstyr Toll bar Payment machine			
	Payment Equipment for Anonymous Payment	Elektronisk betalingsutstyr Toll bar Payment machine			
Ticket Equipment Biletteringsutstyr	Ticket Machine	Bilettautomat Charging equipment	Bilettautomat Charging equipment	Bilettautomat Charging equipment	
	Validation Machine	Valideringsautomat Validation machine	Valideringsautomat Validation machine	Valideringsautomat Validation machine	
	Medium Access Device				
	Customer medium	Card for electronic ticket	Card for electronic ticket		

Annex F. Disabilities and universal design

It is difficult to find an agreed upon definition of the term ‘disability’. The United Nations High Commissioner for Human Rights has an ongoing ad-hoc committee [49] that is still discussing the term disability, with different suggestions from countries [50, 51]. Several governmental and non-governmental organisations have developed their own definitions, and The Disability Discrimination Act 1995, DDA (c.50) in the United Kingdom defines a disabled person as one having “a physical or mental impairment which has a substantial and long-term adverse effect on his ability to carry out normal day-to-day activities” [52]. The carrying out of such ’normal day-to-day activities’ is thus strongly related to the environment of the person. If he/she is in an environment where he/she is able to perform activities in a normal way, the person would in this particular situation not be considered disabled. “International Classification of Functioning” (ICF) is WHO’s framework for health and disabilities. In ICF, disability and functioning are viewed as outcomes of interactions between health conditions (diseases, disorders and injuries) and contextual factors [53]. The focus has shifted from separating disabled from the rest (“cause”), and instead focussing on measuring ability to function in the society (“impact”) regardless of the reasons for one’s impairment. In ARKTRANS we focus on the transport sector and peoples’ use of this (either as travellers or workers), thus regarding a particular context. We have in this article chosen to define our use of the term disabled as DDA did, keeping the WHO definition of the disability being related to this context, in mind. The DDA definition in no way states that contextual factors are not important, contextual factors contribute to the abilities to carry out “normal day-to-day activities” such as using public transport. The focus is held on accessibility as in the ability to partake in a normal environment.

The population in many countries is getting increasingly older. Japan expects 33% of its citizens to be senior citizens by 2050, Europe and North America isn’t trailing far behind with figures around 25% [54]. Older people in general tend to obtain a lot of disabilities, for instance problems with seeing, hearing and moving around. While medical and technical research provides us with tools and surgery that eases or even removes a person’s disability (for instance eye surgery and hearing aids), there is still a set of problems relating to disabled or elderly people which still cannot be helped in such ways. An example could be a person with a strong need to sit down and relax every hundred metres. In order for her to be able to navigate the environment by herself, the environment must support this. Creating an environment that will let most people be self-manageable heightens their comfort level; people want to be self-reliant.

F.1 Universal design

Public services have gradually changed from humans assisting you in different tasks to letting users themselves perform the task, be it withdrawing money from an ATM or using self-service machines at the airport to check in and mark your luggage with a baggage tag. It might very well be an efficient way of dealing with such services, but they also require the users to understand and be able to properly use such systems. Many people have tried to coin a definite term for what constitutes “universal design”. While “Design for all” is more often used in Europe, we will in this article use the term universal design (UD). Trost interprets UD as being “comprehensive philosophy” while design for all relates more to “practical applications” [55]. Beecher and Paquet describe universal design as “a process intended to promote the development of products or environments that can be used effectively by all without adaptation or stigmatization” [56]. This means that a person otherwise defined as disabled would be able to use a product or environment without having to resort to special support as manual assistance.

NCSU defines seven principles of universal design: equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance of errors, low physical effort and size and space for approach and use [57]. There are efforts going on to produce equipment and tools with such principles in mind. In Japan companies are improving the accessibility of ATMs, [58] and the

Copenhagen Metro in Denmark is being designed with the concept "Stations for all" [59]. The goal is to let people navigate systems and environments regardless of their otherwise hindering disabilities or impairments.

There's a lot of research on advanced systems that will help disabled people in their daily activities. A prototype of an "American Sign Language recognition apparatus" [60, 61] which will translate sign language into spoken language. A guidance system for handicapped people suggests adding RFID tags in the environment, connected to information about the environment taking your special disability into consideration, is a way to helps travellers move around [62]. While identifying the different needs depending on impairment or disability, Matsubara et al. also emphasize the semantic similarity of this information.

According to investigations, at least ten percent of the population have problems using the public transport system [63]. The group with more severe disabilities related to transport is a small subset of these. Among the ten percent is a large group of people, often elderly, that do not use the transport because of small problems. This gives an indication that many people that would normally not use public transport today would be able to do so if it was accessible to them. Their otherwise hindering disabilities would, given a more accessible context, be rendered unimportant.

When linking universal design and availability to the transport sector, there are two main points to focus on: Design of the environment and information about the environment. In order to create a travel planner these two will be tightly linked. An environment with a small degree of accessibility would possibly be easier to navigate in if the traveller already knows about the limitations, and can plan for this. In such a case, experienced accessibility would be enhanced via the use of good information in advance.

One important aspect of creating an environment with focus on universal design is the impact it has, not only for disabled persons. People not normally physically or mentally impaired might in some situations have great use of a more accessible environment. Examples are using prams, carrying heavy bags after a shopping spree, or having to use crutches after performing knee surgery.

F.2 Disabled and design of the environment

There's currently a growing emphasis on creating environments that are available to all persons, regardless of any disabilities. In Norway there's a discussion proposition about altering the Norwegian laws in order to forbid discriminating persons with disabilities in a broad scale: "The Committee shall draft a new bill and/or proposals to amend existing legislation in order to strengthen the protection accorded by the law against the discrimination of persons with disabilities. The object is to promote full participation in society and equality between persons with disabilities and other citizens" [64]. Focus in Norway and abroad has shifted from supporting for disabled as a welfare approach to a human rights approach, that "everyone is able to take part in society on an equal footing" (ibid.).

When designing an environment where all kinds of people can partake, one needs information on how to best design these. Support organisations in Norway have for a long time created guidelines for what constitutes a proper environment for their users [63, 65]. Deltasenteret (The Delta Center) is the Norwegian competence centre for "participation and accessibility for all". It is financed through the Directorate for Health and Social Affairs. Many of the organisations and the Delta Centre have cooperated in defining a proper public transport environment. Among them is the template for accessibility for public transport [66]. This pamphlet covers the areas of infrastructure (accessibility on the terminal), means of transportation (the buses etc.), information needs and management / routines.

F.3 Disabled and information about the environment

So far, we have only covered regulations and hopes for increasing the accessibility of the environment. But the environment isn’t always designed like that. Users can have a wide range of disabilities, permanent or temporary. It doesn’t help a blind user if the transport terminal has been developed only with wheelchair users in mind. In a travelling mode, it can be valuable to know the qualities of the terminals before deciding how to travel. Such information enables the travellers to find the most accessible terminals and Transport Means. The question is what kind of information one needs to know before deciding if and how to travel. Is there any subset of information that is more important to know before-hand, or does all kinds of information have to be treated in the same manner? Registering all kinds of information would risk ending up with a hard-to-maintain system, while registering too little information would give little value to the specific users. They key point is finding the appropriate level of information registration.

Annex G. Work related to travel information services

Existing route and travel information formats have been consulted to get input about the concerns of existing solutions.

G.1 Exchange formats in operation

Route information exchange formats used today are mainly related to one transport mode, and applications to more transport modes required adjustments. Route information for trains may for example be specified by means of an air transport format, but the train departures have to be registered as flights. The available formats also have shortcomings with respect to provision of information about the availability of services and facilities, and dynamic information. Formats that so far are consulted during the ARKTRANS work are:

- REGTOPP formats [14]are mainly used for buses, but may also be used for trams, metro and ferries. The format is widely used by Trafikanten, who participates in ARKTRANS.
- Swedish format for route information used by Samtrafiken [15]
- The internal format used by Norsk Reiseinformasjon, who participates in ARKTRANS.
- SSIM [16] commonly used for air transport and used by Braathens and Avinor, who both participate in ARKTRANS
- UIC formats [17] for trains
- EDS International File Format [18] used by The Norwegian State Railways, who participates in ARKTRANS

G.2 TRIDENT

The TRIDENT (Transport Intermodal Data sharing and Exchange NeTworks) [19] project (EU project IST-1999-10076) has specified comprehensive information model packages that are relevant to ARKTRANS. TRIDENT is also considered by ERTICO.

The following TRIDENT information model packages are of interest to ARKTRANS:

- The global package
  The general objects define the super object, TridentObject, which all objects inherit from. Thus, all objects will have an id, a version, a creation time, expiry time, a creator id, a validity domain, and a validity period.
- The data type package
  The PT enumerated data types include many data type definitions that are required by the other packages.
- The location package
  Specifies information models for locations and topology. Some of the specifications in the PT package (see below) may be of more relevance with respect to the provision of route information to Transport Users, but the location package also provides many of the definitions that the PT package depends on.
- The public transport (PT) package
  Includes information models for timetables and the status of Transport Means.
- The trip package
  Includes information models for trip times for public transport rides, road journeys, and various connecting lines between transport modes and from the origin of journeys to the destination. An itinerary information model is also provided.

G.3 TRANSMODEL

TRANSMODEL [20] specifies a data model that supports public transport operation and management as well as passenger information. Multimodality is supported to some extent (bus, trolley bus, light rail), but does not fulfil the ARKTRANS view upon multimodality.

As far as we can see, TRANSMODEL is mainly related to fleet management (tactical as well as operational). Passenger information is limited to information about departures and arrivals. A terminology for public transport is defined, but so far ARKTRANS has chosen to use the terms preferred by the participants in the multimodal work group.