Multimodality for people and goods in urban areas

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WP4 – D4.7 Traffic management enablers specifications - iteration 1

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Instant Mobility WP4
D4.7 Traffic management enablers specifications -iteration 1

WP4	D4.7Traffic management enablers specifications -iteration 1
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0.2	06.12.2011	Marco Bottero,SamsonTsegay (MIZAR)	First draft content
0.3	16.12.2011	Marco Bottero, SamsonTsegay (MIZAR)	Use case, public interfaces and components diagrams added
0.4	20.12.2011	Marco Bottero, SamsonTsegay (MIZAR)	Component descriptions added
0.5	21.12.2011	David Ferrer Figueroa (TID)	Actors definitions added

Abstract

This document contains a draft description of the traffic management enablers, which is addressing Scenario 3. This document is divided into four sections. The first section is the introduction, setting the context of the deliverable. The second section describes the use cases functional decomposition (based on the work of WP3). Section 3 describes the public interface and the interaction with external services. It defines the environment in which the platform will be deployed and the requirements of these external actors to interact and take advantage of the platform. It is the outside view of the platform. Section 4 provides the enablers description. It is the inside view of the platform. It presents a description of the application in terms of systems and components.

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1. Introduction

The "Instant Mobility" project is developing and exploring a concept for transforming the mobility of persons and goods in the future through application of advanced Internet technologies. The project has created a concept for a virtual "Transport and Mobility Internet", a platform for information and services able to support radically new types of connected applications for scenarios centred on the stakeholder groups:multimodal travellers, drivers, passengers, transport operators, goods vehicle operators, road operators and traffic managers.

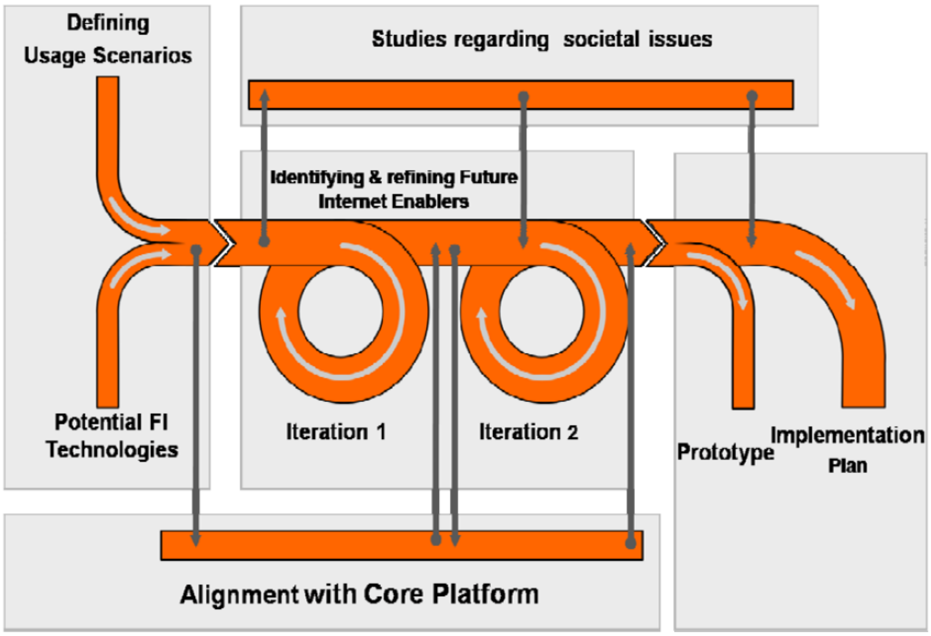

Figure 1: Project overall process & main results

The project defines requirements for Future Internet technology tools and enablers, so that all these services will be available to any Internet-connected user, whether using a portable, vehicle-based or fixed terminal. These requirements underpin a set of technical specifications for both domain-specific and FI enablers that will in turn be created as software conceptual prototypes for a virtual demonstration.

1.1 WP4 objectives in Instant Mobility

The purpose of the "Future Internet Specific Enablers" work package is to derive from the Use case Scenarios analysis and the Future Internet technologies roadmap produced by WP3, the detailed technical specifications of the components necessary to implement these scenarios. These components can be the proposed Future Internet enablers (either Generic or domain-specific) or services build on top of these enablers.

1.2 Objectives of deliverable D4.7

The objective of this Deliverable "Traffic management enablers specification – iteration 1" is to define the online traffic and urban management generic and domain specific enablers, required to implement the Development Scenario "Transport Infrastructure as a Service", which has been described in Deliverables D3.1 (as the Lead Scenario "Online traffic & infrastructure management") and D3.3.

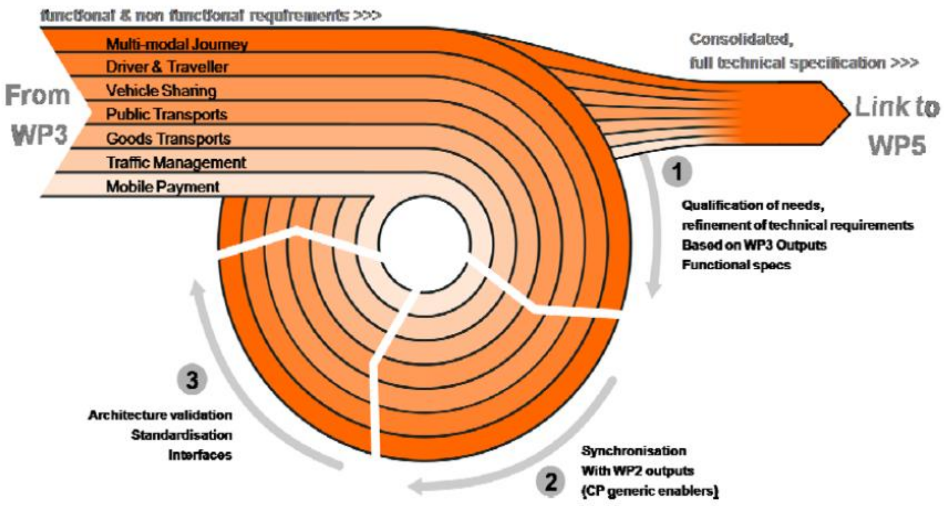

Figure 2: Iterative specifications of enablers in WP4

Deliverable D4.14 “Traffic management enablers specification – iteration 2”will review and update the set of requirements described in this document. The description of generic and domain specific enablers performed in this document is aimed at the implementation of a conceptual prototype (in WP5 “realisation and prototyping”) and at the provision to the FI-WARE project of the inputs required by WP2 “Program collaboration”.

1.3 Context and background

1.3.1 Summary of the reference Scenario

The reference scenario for the specification of Traffic Management enablers is Development Scenario 3, which is named “Transport Infrastructure as a Service”. The main objective of this Scenario is to carry out a study of the conditions needed for dynamic traffic & integrated urban space management, on how to use Future Internet technologies such as cloud data storage, Cloud computing virtualization or services-in-the-cloud. By exploiting the enablers provided by the FI-PPP programme, this scenario will allow the rapid deployment of a new generation of traffic management services. These will result in an improvement in the levels of mobility on the roads by acting as B2B services, for instance by providing accurate RTTI for mobility services such as routing information, personalized route guidance, eco-driving support.

1.3.2 Problems to be solved

The common problems that the proposed new services need to face are listed below.

- From the point of view of a Traffic Control Manager/Local Authorities/Transport Agencies:
  - o Efficient maintenance of traffic control hardware is difficult and costly;
  - o It is frequently hard for a Traffic Control Centre to have full detailed knowledge of a wide area;

  - Local authorities/Transport agencies find it difficult to reduce congestion in cities and to improve the distribution of traffic on the road network;
  - Transport agencies often are not able to undertake effective planning, due to the lack of relevant data;
  - The cost of obtaining precise matching information from different sources (such as: sensors, external systems, etc) is costly.
- From the point of view of the travellers:
  - Travellers often are not able to take good decisions during trips due to insufficiently detailed or not fully reliable information (e.g. duration of congestion, consistent real time driver information and useful advice).
  - Difficulty in planning trips, and in particular getting a reliable estimate of their time of arrival, due to the lack of customized tools with integrated real time information (e.g. which take into account possible congestion due to large events, road works, etc).

1.3.1 Rationale: how future internet solutions could address the above problems

The Future Internet solution will address the above problems by providing a machine-to-machine interaction between travellers and the control centre. Sharing information from travellers about their planned and ongoing trips can enable the control centre to process current and expected traffic to provide individual travel guidance as well as system wide optimization for travel time, costs or pollution. The provision of information sharing could be based on an OBU using mobile technology to interact with traffic control in the cloud. This should be based on FI-Ware WP5 Internet of things.

By means of the Generic Enablers provided by the FI-PP, it will be possible to collect and analyse massive amounts of data from diverse sources, as well as to classify it. The Traffic Control Centre will be able to manage and consume FI services for improving traffic management and the high level actuation of traffic strategies.

Having high quality data measurements of traffic will allow algorithms to make high quality traffic forecasts. Such traffic forecasts will be available by means of open interfaces that will use the Service Delivery Framework which is planned to be developed in the FI-WARE project. This means that any application or service interested in the outcomes of this Scenario will be able to consume them, e.g. trip planners could use the traffic forecasting of this Scenario or route guidance for travellers will incorporate updated information of traffic. Moreover, traffic lights could be controlled by high technology techniques, using adaptive mechanisms which can fix timing phases according to the real demand of vehicles in the road.

Travellers will be able to take important decisions by having access to relevant data, such as: receiving recommended speed in order to create a green wave, comparing travels times with different transport modes, knowing in advance the availability of parking spaces, etc.

1.4 Abbreviations

BPMN	Business Process Modelling and Notation
CP	Core Platform
FI	Future Internet
GE	Generic Enabler
IaaS	Infrastructure as a Service
IOS	Internet of Services
IOT	Internet of Things
OBU	On-Board Unit
OMA	Open Mobile Alliance
OSM	OpenStreetMap
PaaS	Platform as a Service
PT	Public Transport
RSU	Road Side Unit
TLC	Traffic Light Controller
TMC	Traffic Management Centre
VM	Virtual Machine

2. Use case decomposition

WP3 Scenario 3 "Transport Infrastructure as a Service", which represents the main income for this document, defined five main applications: "Real time traffic & route info", "Floating passenger data collection", "Virtualised intersection intelligence", "Cooperative traffic signal control", "Area-wide optimisation strategies". This section contains the use case decomposition of these four applications.

The following actor definitions apply:

Name	Definition
Traveller	Travellers including public transport users and motorists
Driver	Only means professional drivers, e.g. lorry drivers, delivery van drivers
Service provider	Provides, manages and updates the running service, on the server side (e.g. booking services provider, trip planner, ridesharing provider); includes service integrator
Data provider	Provides traffic data, map contents, location based contents etc; includes map provider and content provider
Transport operators	Operates public transport, air transport, ferry, trucks, trains including bus companies, airlines and rental bicycle operators
Terminal operators	Operates transport hubs e.g. airports, ports
Traffic operator	Manages road traffic and infrastructure (e.g. urban traffic control systems, area supervision platforms), including urban road operator and motorway operator

This Scenario puts traffic management and control online, offering a greater flexibility and performance of the current functions of today's traffic management, enables direct vehicle-to-traffic system interaction, and allows new possibilities for local, sector and wide area optimisation.In this scenario many of the functions of today's traffic management are performed with greater flexibility and performance thanks to future Internet enablers. Using Internet-based services allows a fully distributed but strongly connected architecture, and provides access to traffic system-sourced data for road user services. The high computing power allows wide area optimisation, making use of road user sourced data giving a more complete network monitoring than using a limited number of detector loops, cameras, etc.

The mentioned applications could be divided into two categories: information collection & exchange (“Real time traffic & route info” and “Floating passenger data collection”) and service provision (“Virtualised intersection intelligence”, “Cooperative traffic signal control” and “Area-wide optimisation strategies”). This section contains the use case decomposition of the applications.

The description of the Scenario is performed through an use-case modelling technique. Use case models are a mean to capture functional requirements and support constructs to expressre-use. In addition, they can be considered as the first step of system design. The basic idea is toalign the use case model to the defined process decomposition framework. A close alignment ofboth concepts allows a better translation of use cases into technical artefacts, improves communication between stakeholders and implementers, and increases the potential for re-uselater in the lifecycle.

The most complex uses cases are further decomposed by a BPMN (Business Process Modelling and Notation) flow. A business process is “a collection of related andstructured activities that produce a specific service or product for a particular customer”, and BPMN“is a graphical representation for specifying business processes in a business process model.The objective of BPMN is to support business process management, for both technical users and business users, by providing a notation that is intuitive to business users, yet able to represent complex process semantics.”

2.1 Real time traffic & route info

Within this application, the vehicle acts as a probe for traffic estimation sending data to a traffic service on the Internet; these data are mashed-up with other sensor data coming from the road infrastructure to give real-time traffic conditions over the full road network. The drivers can receive this information using their personal device through an on-line and updated map including traffic data (continuous map download and updates).

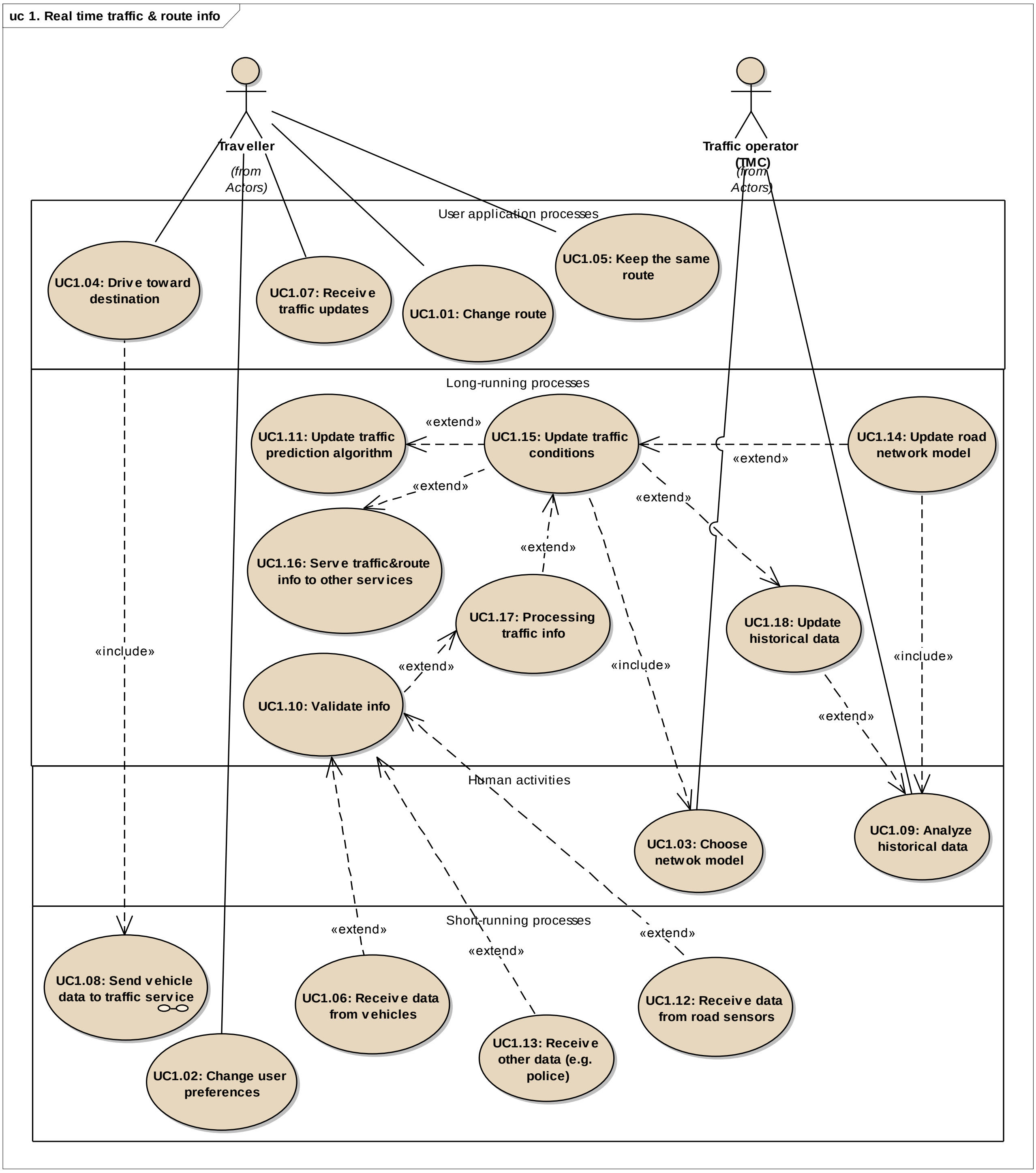

Figure 3: Use case decomposition diagram of Real time traffic & route info

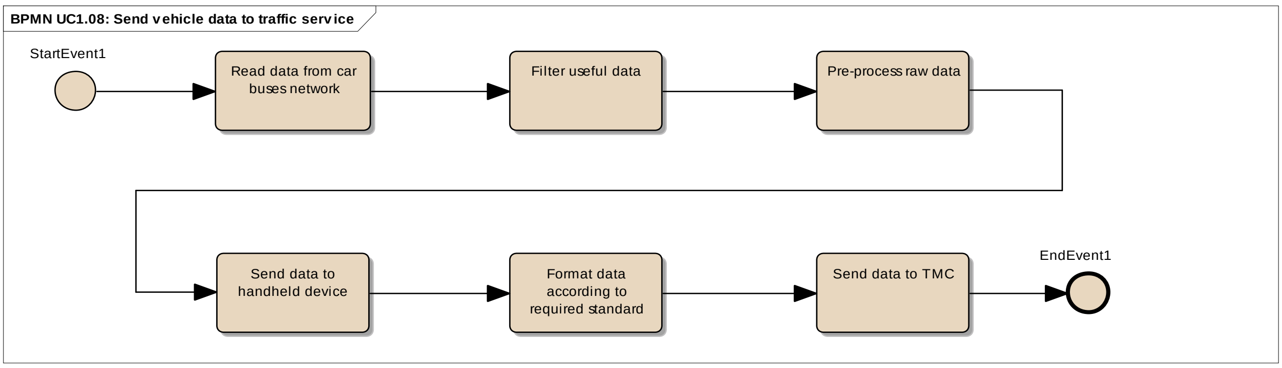

Figure 4: BPMN flow for "UC1.08: Send vehicle data to traffic service" use case

2.2 Floating passenger data collection

This service will provide passenger density and position measurements over the transport network, and will be able to perform accurate predictions on passenger density, based on a wide range of input data. These measurements are then used by the Transport Operators and the Organizing Authorities to optimize and regulate instantaneous quality of service.

This service has two aspects:

- Gather all the available information, from various sources to make an accurate estimate of passengers' density, within the transport network;
- Distribute the relevant information to Transport Operators and Organizing Authorities.

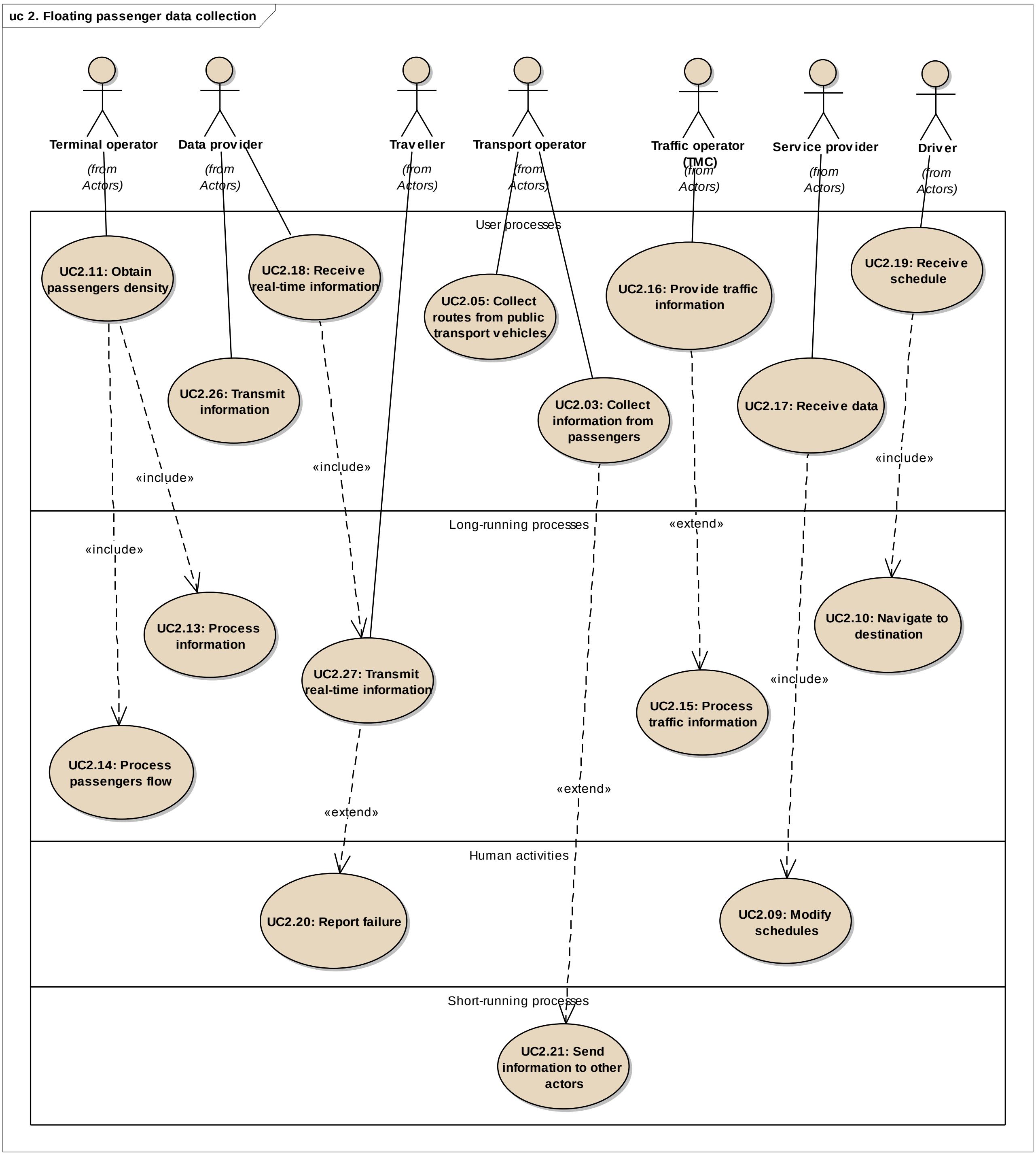

Figure 5: Use case decomposition diagram of Floating passenger data collection

2.3 Virtualised intersection intelligence

This Service consists of having the traffic control operations hosted in the cloud, and at the same time use the adaptive and distributed technique by means of secure virtual local traffic light controllers connected with the traffic centre, leaving local virtual systems the task of providing safety controls and communications.

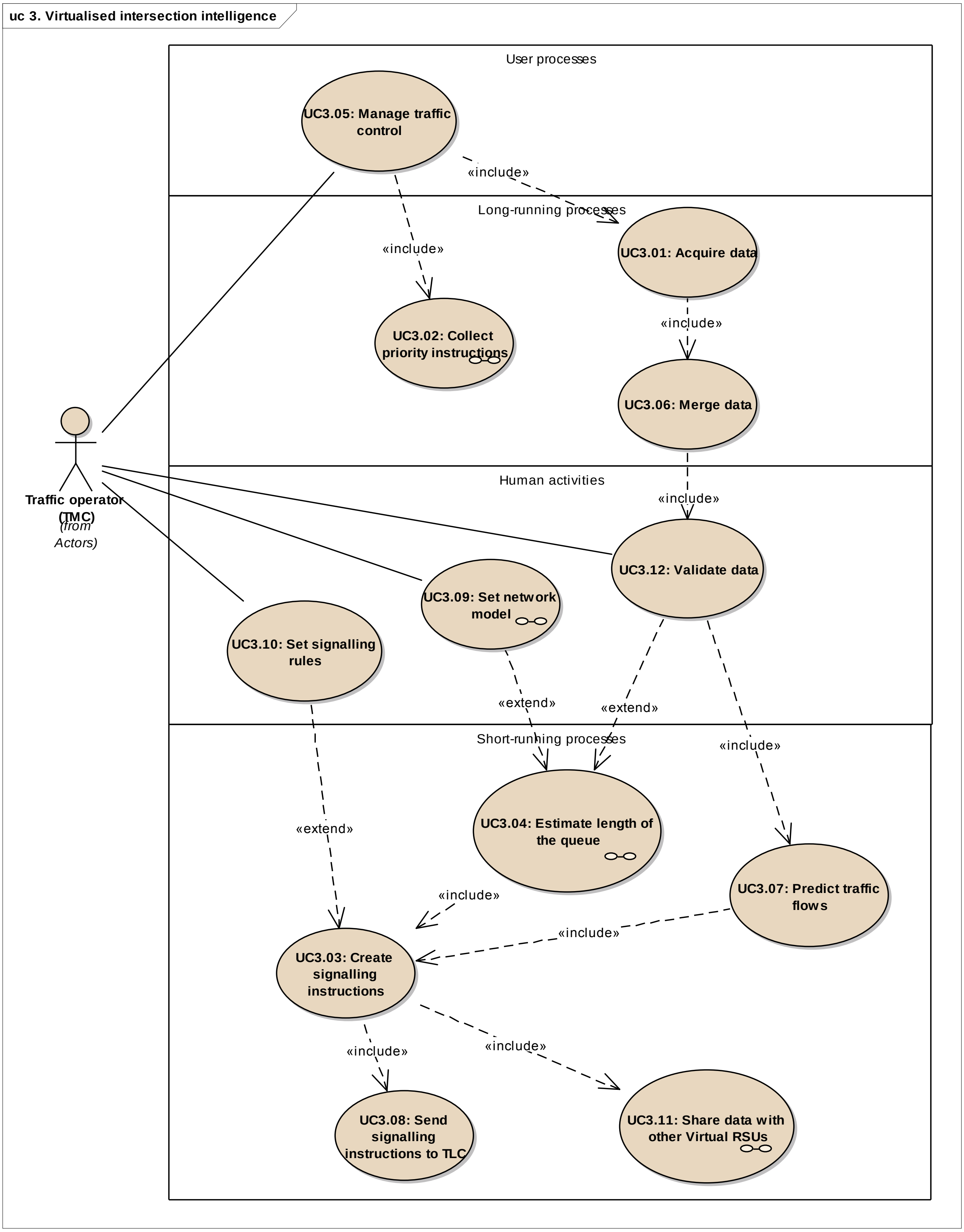

Figure 6: Use case decomposition diagram of Virtualised intersection intelligence

The "Virtualised intersection intelligence" Service concentrates in the adaptive and distributed traffic control technique, giving the fact that is one of the most complex ones and it has demonstrated to be one of the best solutions in the case of heavy and unpredictable traffic conditions. The objective of this Service is to improve traffic control by using the facilities provided by FI-PPP for having a high quality traffic forecasts as well as for reducing the amount of hardware required for each intersection. BMPN flows regarding the most important uses cases are represented in the following pictures.

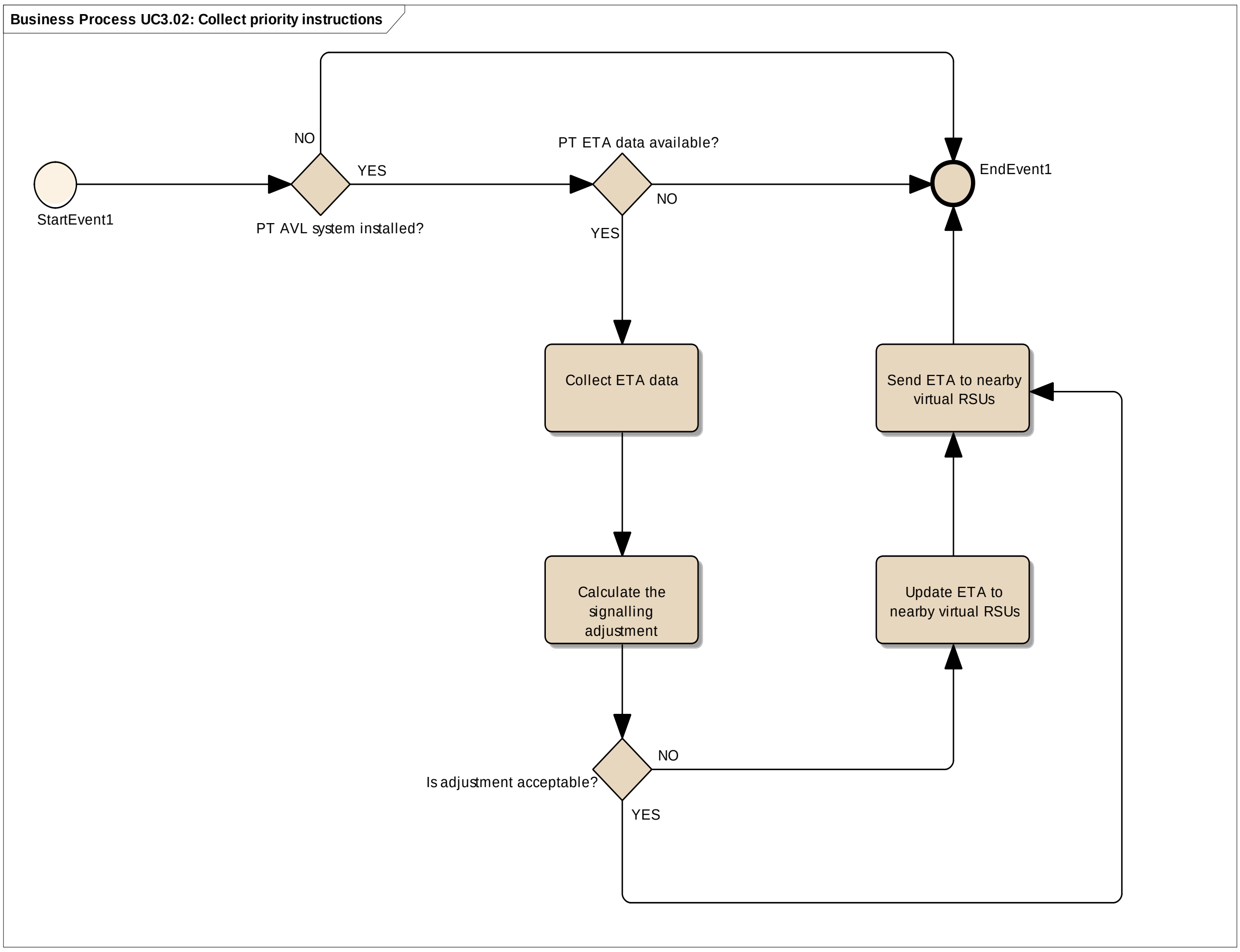

Figure 7: BPMN flow for "UC3.02: Collect priority instructions" use case

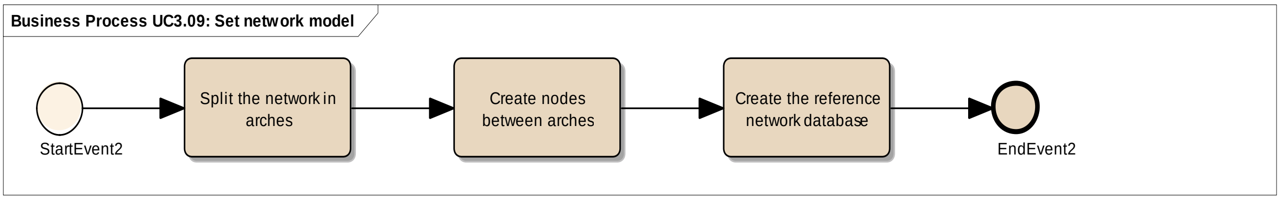

Figure 8: BPMN flow for "UC3.09: Set network model" use case

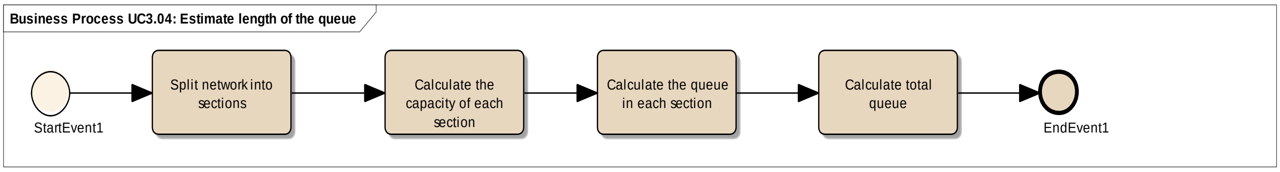

Figure 9: BPMN flow for "UC3.04: Estimate length of the queue" use case

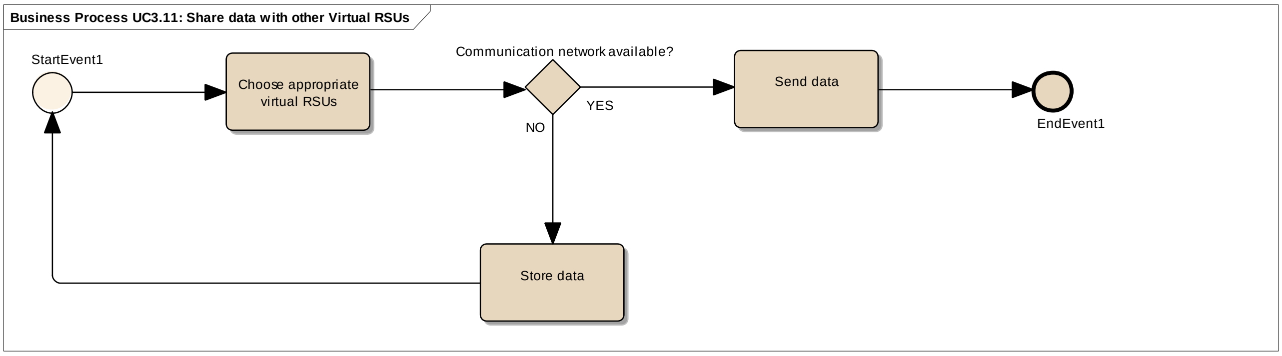

Figure 10: BPMN flow for "UC3.11: Share data with other Virtual RSUs" use case

2.4 Cooperative traffic signal control

Cooperative traffic signal control is ad-hoc networks created in the cloud between clusters of vehicles and the traffic management infrastructure, offering drivers a recommended speed to avoid stopping, and the adapting the traffic signals to the real demand in real time. The service will use information from both vehicles and infrastructure to formulate strategies to achieve the optimization of the network operation. The service makes use of traffic signal control systems available in the network. In addition to that, the systems will generate information (e.g. route or speed advice) that is sent to vehicles and back offices to inform drivers and operators of the best ways of driving to minimise delays and maximise efficiency of the network.

The service will use two main general enablers provided by the Core Platform. On one hand, cloud computing solutions are used to be able to access a pool of configurable computing resources (e.g. networks, servers, storage, applications and services). Cloud Infrastructure as a Service (IaaS) and Cloud Platform as a Service (PaaS) are the service models that will be used in this scenario.

On the other hand and in order to retrieve and filter the sensor information coming from vehicles and traffic management infrastructure, Internet of Things (IoT) infrastructures will be used. The general idea behind is that a Publish/Subscribe mechanism will be deployed so that sensors can publish their measurements while the data aggregation and filtering services, which could be running in the cloud are subscribed to those data publications receiving a copy of the raw data which they have to transform in actions to be sent to the traffic signal control.

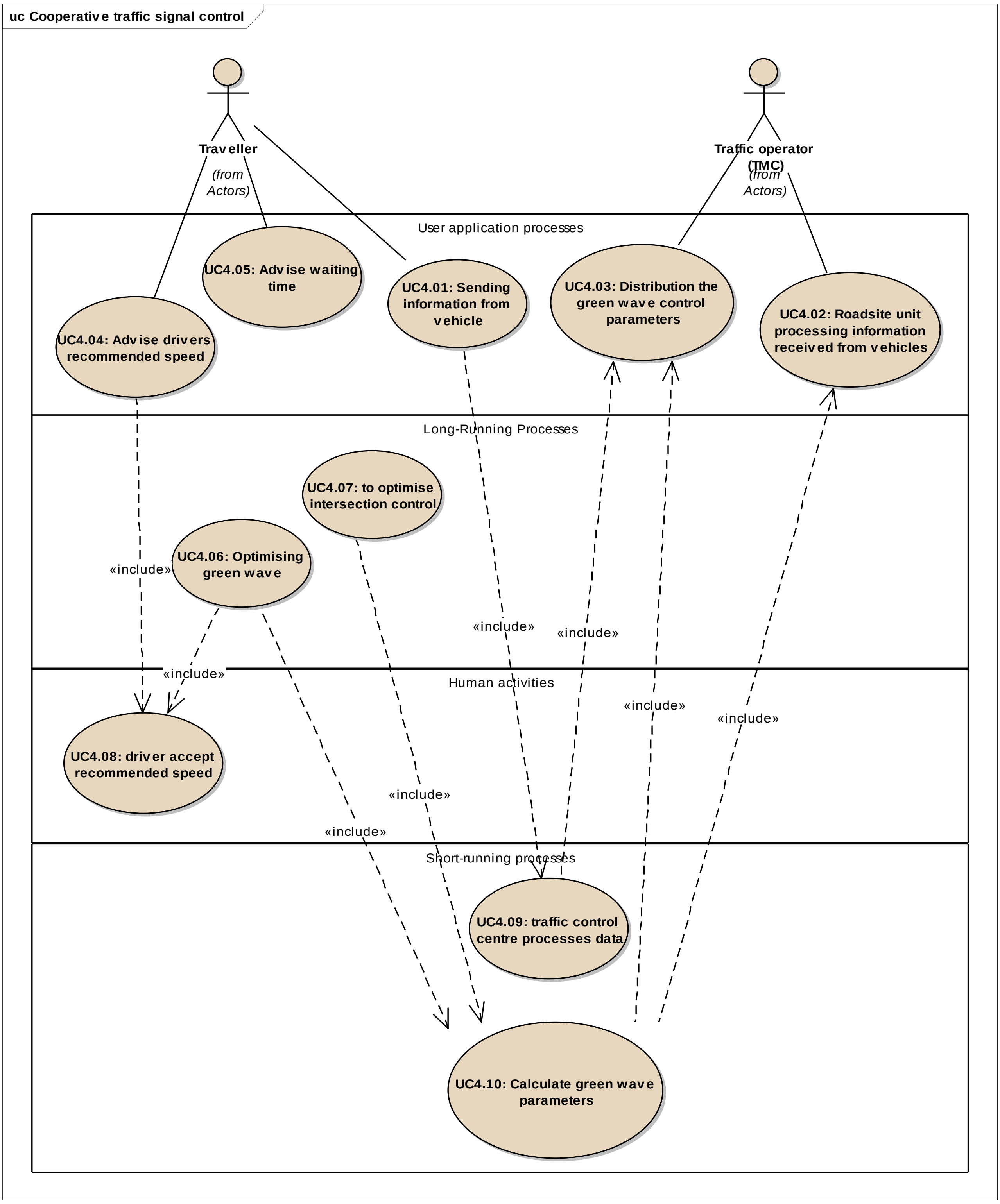

Figure 11: Use case decomposition diagram of Cooperative traffic signal control

2.5 Area-wide optimisation strategies

This scenario will focus in the provision of a modular solution that can collect data from different sources and mash-up it by applying different strategies of aggregation. Furthermore, this service will concentrate into provide as an outcome analysed data from different perspectives and summarizing it into useful information that can feed algorithms and strategies of traffic management. Strategies of self–learning will be applied and algorithms for traffic network flow prediction.

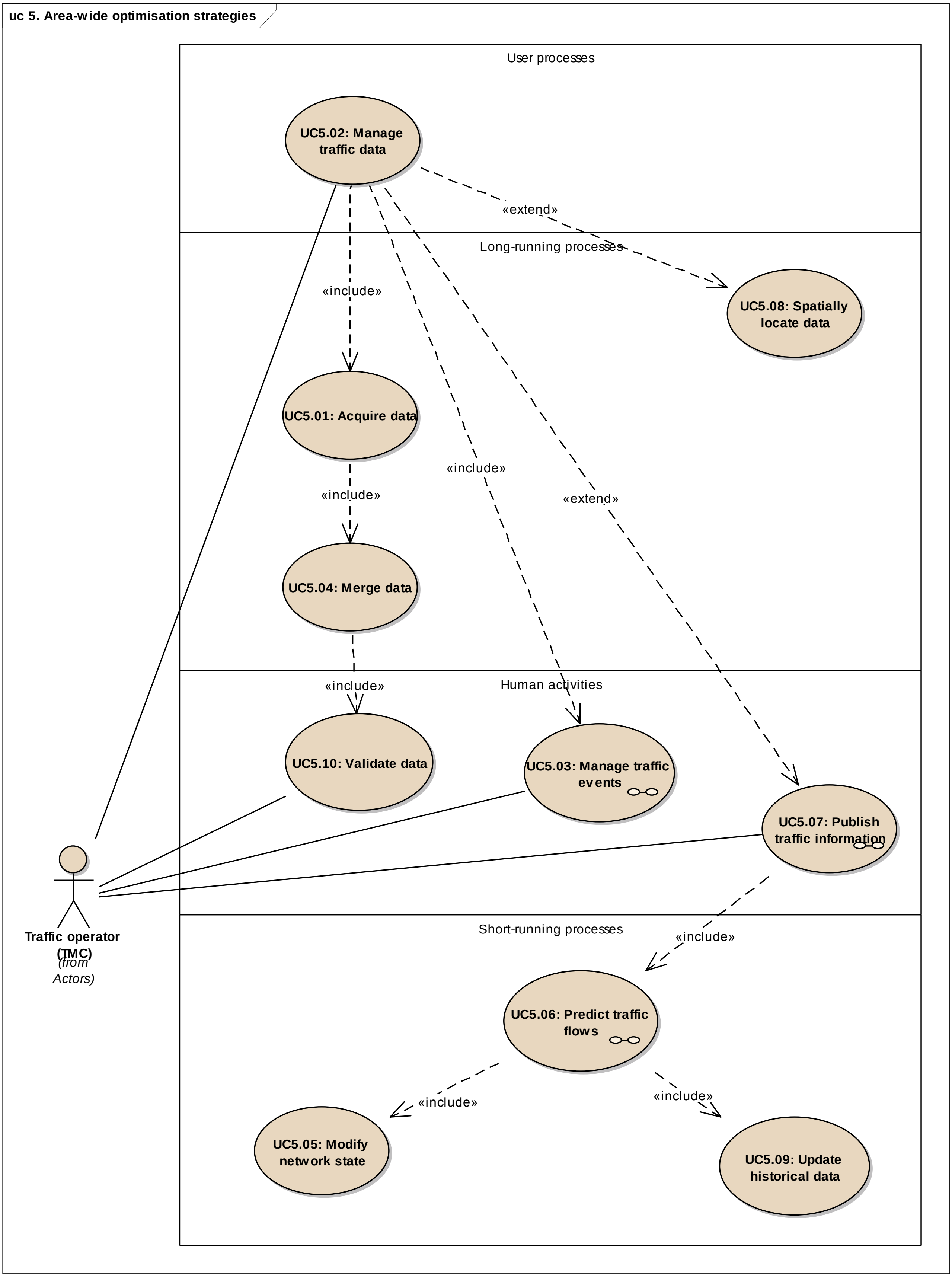

Figure 12: Use case decomposition diagram of Area-wide optimisation strategies

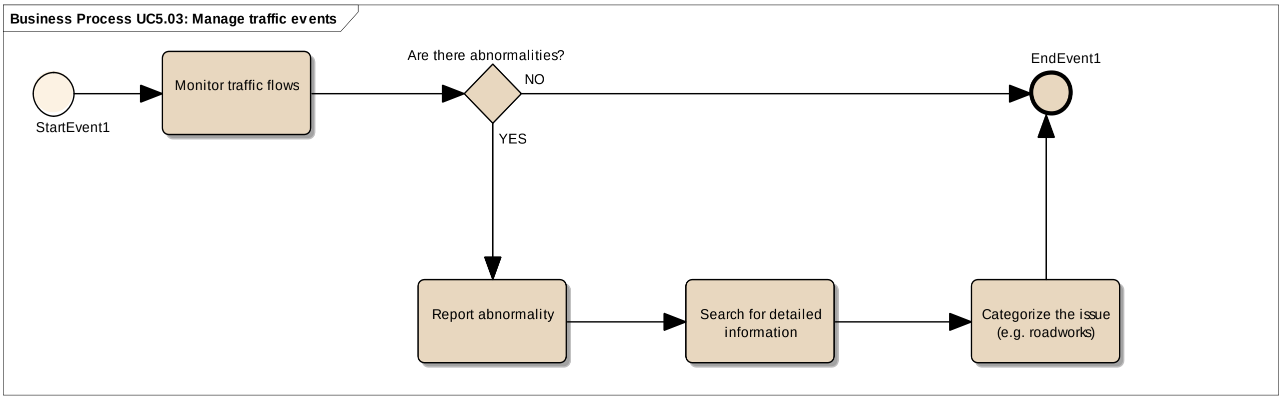

Figure 13: BPMN flow for "UC5.03: Manage traffic events" use case

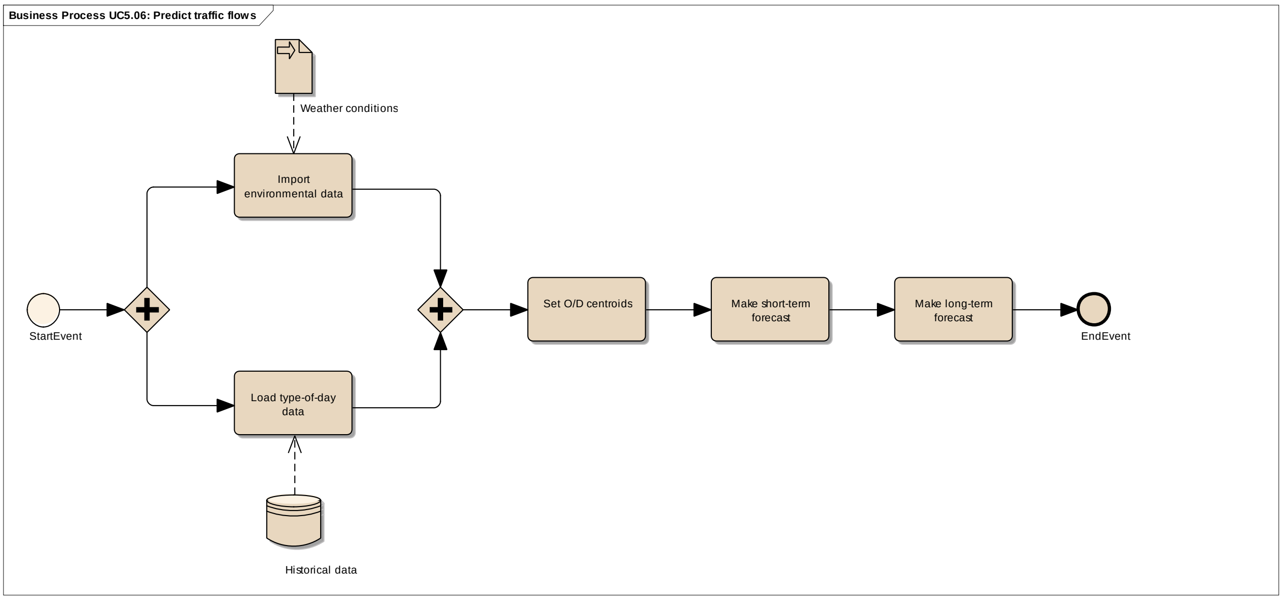

Figure 14: BPMN flow for "UC5.06: Predict traffic flows" use case

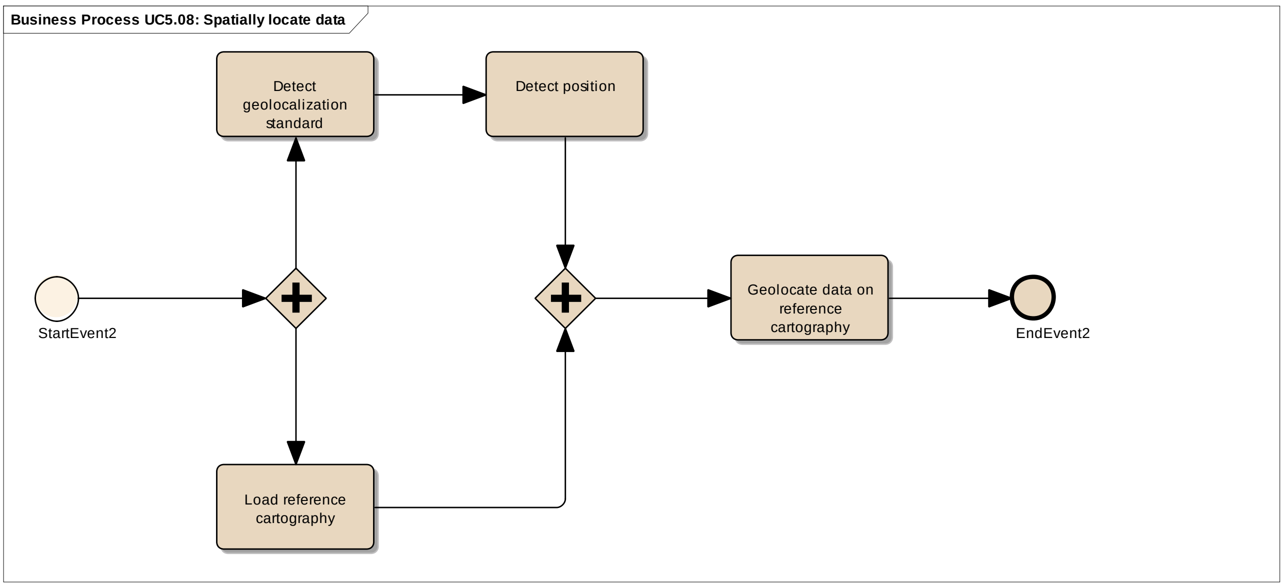

Figure 15: BPMN flow for "UC5.08: Spatially locate data" use case

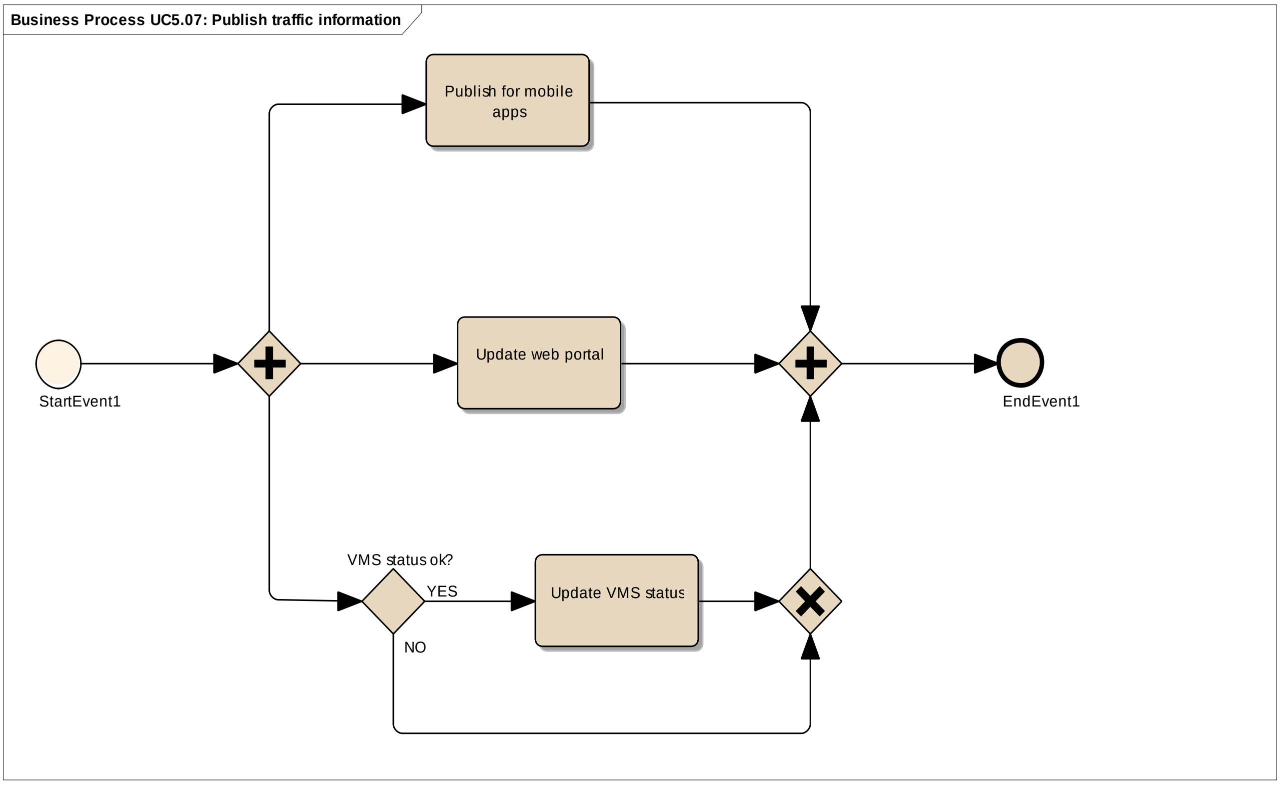

Figure 16: BPMN flow for "UC5.07: Publish traffic information" use case

Accurate real-time and accurate traffic flow information is valuable for traffic network managers. There are on the market many algorithms for traffic network flow forecasting, that have a common obstacle for their successful which is "the precision and correctness of the data input". Thanks to the development of traffic monitoring technologies, various methods of collecting data are available nowadays, like automatic number plate recognition (ANPR) technology, which allows recognizing individual vehicles. Today in Europe such approaches are common. However, such approaches deduce final traffic information, coming from smaller area of the traffic network of the city basically from the area where the infrastructure is available. As a result the Traffic management centre provides estimated information in areas with no dedicated infrastructures

That is why this serviceis focused in the provision of a modular solution that can collect data from different sources and mash-up it by applying different strategies of aggregation. Furthermore, this service will concentrate into provide as an outcome analyzed data from different perspectives and summarising it into useful information that can feed algorithms and strategies of traffic management.

3. Public interface and interaction with external services

The deployment diagram below gives an overview of the system that realize the five applications defined in the "Transport infrastructure as a service" Scenario as well as which system interacts with each actor. The actors involved in this Scenario are 7: Providers (Data, Service), Operators (Traffic, Terminal, Transport) and end-users (Traveller, Driver).

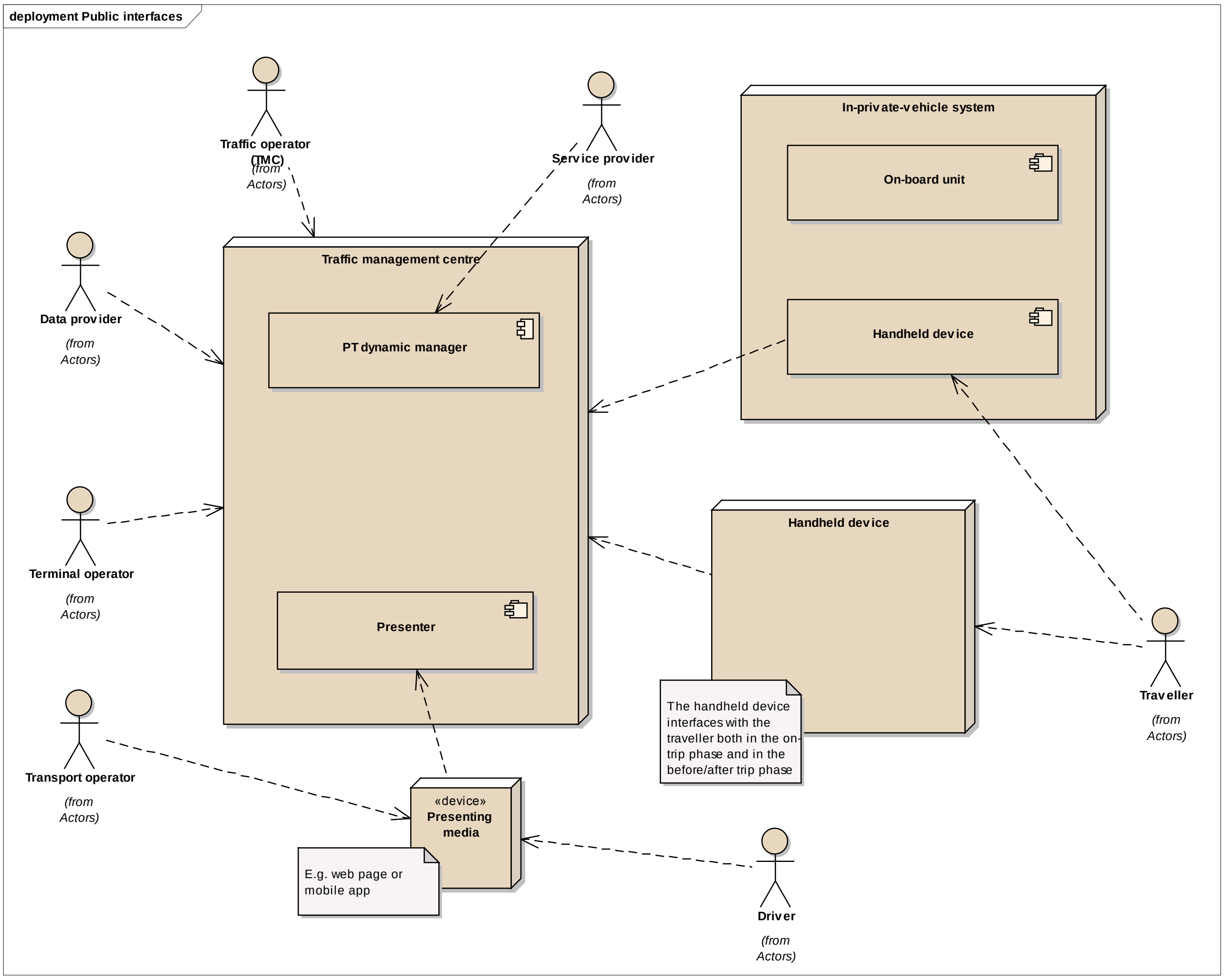

Figure 17: Systems and actors

3.1 Traffic operator

The traffic operator provides with real-time traffic information to other actors in order to let them organize and optimize their routes. This real-time traffic information is firstly collected from other actors, such as mobile phones of the travellers, floating car data, incidences reported, etc. Later on, it is restructured and sent to other actors.

The real-time traffic is also compared to historical data in order to provide with the best possible service and predict future traffic flows.

Another of its main responsibilities is to manage the traffic control. It controls the signalling rules and creates signalling instructions to make the traffic more fluid. It uses the Green Wave control system, where a series of traffic lights are coordinated to allow continuous traffic flow over several intersections in one main direction.

It also provides transport priority and ITS.

3.2 Data provider

The Data provider collects historical and real-time traffic information. Later on, it forwards all this information to other actors.

3.3 Service provider

The Service provider is in charge of providing adapted schedules to the drivers, and providing static and dynamic information of its fleet to other actors.

It allows the public transport system to be more efficient

3.4 Terminal operator

The Terminal operator is in charge of obtaining the passengers density at the terminals, process this information and then inform to the service provider. It allows to provide a more efficient public transport system by adapting the number of vehicles to the demand of the users and to reroute passengers if some public transport means are overloaded.

3.5 Transport operator

The transport operator is in charge of collecting the routes from the public transport vehicles as well as information from the passengers related to their position, itinerary followed, means of transportation, preferences, etc.

This information is sent to other actors in order to improve their functionalities.

3.6 Traveller

The traveller interacts with the platform using standard communication protocols from the Open Mobile Alliance (OMA). Each traveller provides his profile to the system, which include detailed information regarding his properties and preferences.

This profile has to be developed in collaboration with WP3 partners in order to collect all the necessary information from the passenger.

It also receives traffic updates from other actors, which lets it to modify or not its route depending on this received information.

3.7 Driver

The driver receives new and updated transport itineraries in the in-vehicle transport management system. By using the integrated navigation system, the driver will receive route guidance to the pick-up and drop-off places, as well as estimated arrival times taking into account the traffic situation.

4. Enabler overall description

The component diagram belowdescribes the main components needed to realize the traffic management enablers.Following the approach of“Transport infrastructure as a service” Scenario, two main Packaging Components have been defined:

- Traffic management centre;
- In-private-vehicle system.

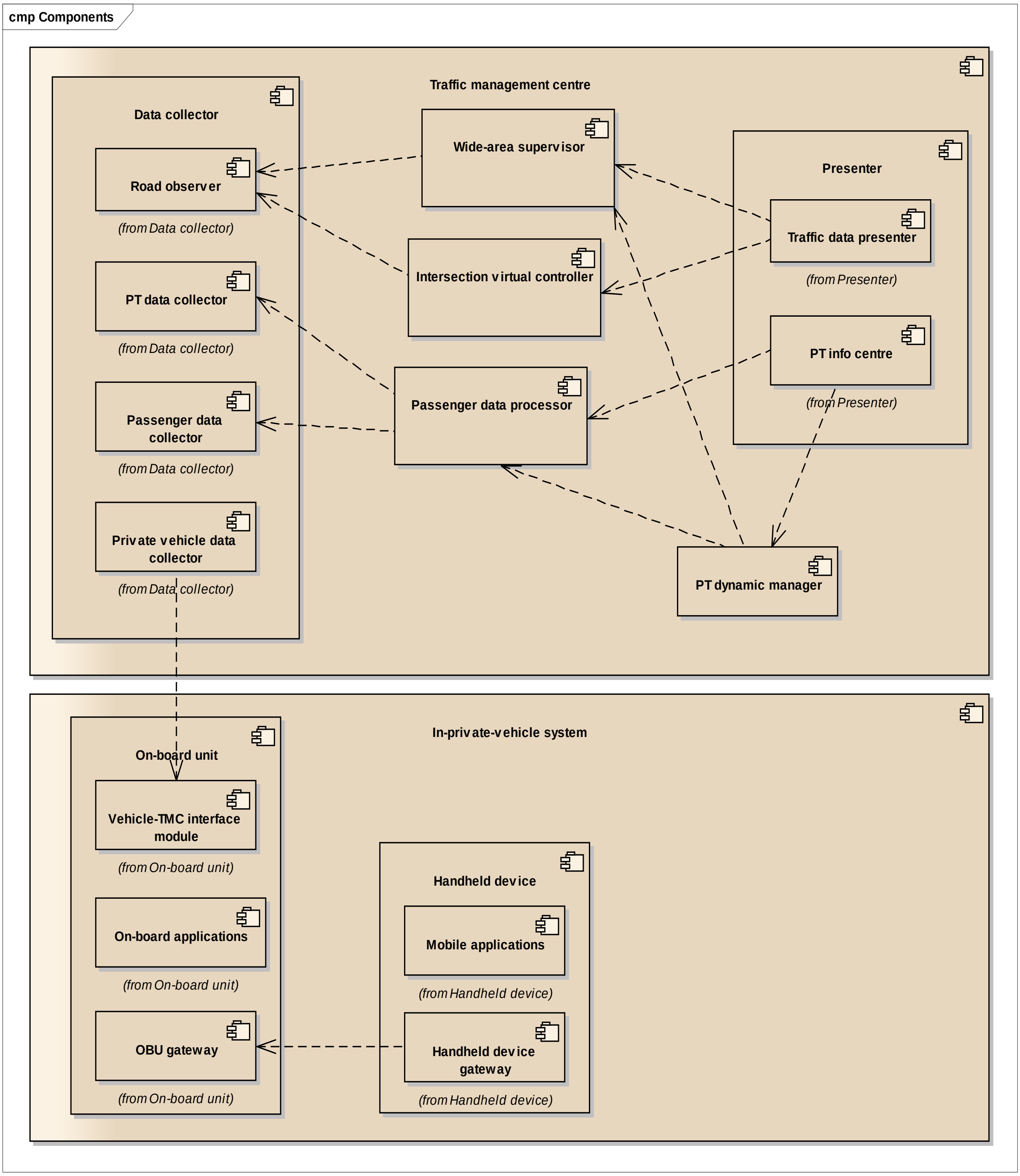

Figure 18: Main components

The Traffic management centre hosts the data collection and processing processes and consists of six main components, aimed at data collection from different sources (Data collector), data processing (Wide-area supervisor, Intersection virtual controller, Passenger data processor and PT dynamic manager) and information diffusion (Presenter). Some of these components are further composed by sever sub-components. Detailed descriptions of all of these entities will be given in the next sections.

The in-private-vehicle system consists of two main sub-components (On-board unit and Handheld device) and has a multi-skill role. In particular, it is aimed at:

- Vehicle data collection and sending to the traffic management centre;
- Information reporting, especially as regards real-time navigation services, traffic events information and cooperative signalling information.

The handheld device can be detached from the vehicle, in order to follow the traveller also when using other means of transportation, until the end of his journey. Further information about this component can be found in Deliverable D4.4 ”Vehicles and handheld devices enablers set”.

4.1 Data collector

The data collector is a packaging software component, aimed at the collection of data from different and innovative sources. Into other words, this component works as a frontend between the data processing components and the external data sources.

The Data collector consists of four sub-components, and each of these has the function to collect data from a specific source. Therefore, data are saved in a cloud server, in order to make them accessible to all other modules of the system and to external applications. As regards the relationships within the whole Scenario, the system, which will be deployed in a could server, will use functionalities of the “On-board unit” component for gathering data from private vehicles.

4.1.1 Private vehicle data collector

Input: tracking and data from equipped private vehicles
Output:aggregated and extended floating car data (XFCD)
The Private vehicle data collector gives information about the position, the speed, the status of the equipped vehicles. It will be possible to collect data regarding, for example, the status of the windscreen wiper, the external temperature, the activation of safety systems (airbags, ABS, ESP, EBA, ...) for incident detection. Data gathered from the different buses of the vehicles will be aggregated into an effective way, in order to prepare them to be used for data validation, environmental/traffic forecasts and alarms generation.

4.1.2 Road observer

Input: data from road sensors
Output:aggregated traffic data
The road observer has the role to interface with traffic monitoring systems to collect data and archive them into a global database. The main characteristic of this component is the capability to work as a frontend between existing systems with proprietary communication standards (mainly working by IP technology) and with common reference standards. Some of them could be:

- Datex II. The DATEX standard was developed for information exchange between traffic management centres, traffic information centres and service providers and constitutes the reference for applications that have been developed in the last 10 years. The second generation DATEX II specification also enable consistent communication and data exchange for all actors in the traffic and travel information sector.
- Siemens OCIT-C (Open Communication Interface for Road Traffic Control Systems – Centre to Centre). The interface is designed for general use and is aligned to practical requirements. Thanks to its low implementation costs, it is also suitable for solutions with users who do not have large budgets. The interface definition describes the structure of the data to be exchanged as well as the common protocol and the functionality. A characteristic feature of this interface is the coverage of all requirements from the field of traffic control systems, from traffic control to higher level traffic management.

4.1.3 PT data collector

Input:data from PT vehicles: tracking, position, schedules, routes

Output:complete PT information

The PT data collector has the role to interface with PT, in order to import data from vehicles and from PT operators database. This component will enable the creation of a real-time update database, which can be divided into two sections:

- Static database, where are collected information about schedules, routes, plate numbers, chassis numbers and all the identification data of PT vehicles;
- Dynamic database, where are collected real-time updated information: tracking, doors opening status, odometer, speed, delay of the vehicle, ...

4.1.4 Passenger data collector

Input:data (various kinds) from travellers

Output:representation of the density of passengers over the network

This module is aimed at the collection of data from different sources for the representation of the position of the passengers over the network. The component will enable the system to read and import data from different sources, like:

- Bluetooth devices, for example as regards the travel time estimation. Bluetooth scanner can read the worldwide unique MAC address of active Bluetooth devices within a range of 100 to 400 metres. They also catch the signal strength of in-car navigation systems and hands-free kits. The anonymous nature of the MAC address identification systems guarantees the saving of the privacy for the owners of tracked devices.
- Crowd sourcing. This data collection service is invoked to generate data, aggregate and/or fuse data, to process data or information, or more directly to develop transportation applications or planning and design of transportation solutions. A key enabling factor for the emergence of crowd-sourcing strategies within transportation is the recent main-streaming of communal communications platforms, most notably Web 2.0 technologies, which have provided a platform and intelligence engine for engaging the ‘crowd’ and enabling active participation and multi-path communications between the masses and transportation agencies.

- Mobile apps. The recent market saturation of key mobile technologies such as GPS-enabled Smart-phones and other mobile devices have provided additional key components in establishing a fertile, functional framework for crowd-sourcing in the transportation community.

4.2 Wide-area supervisor

Input:aggregated data from data collector

Output:complete analysis of the traffic status over the whole network

This module has the role to perform a complete supervision of the area where data are collected from. In particular, this component will enable to:

- Validate data, comparing information from different sources, which have been collected by the previous modules;
- Geolocate data on the reference cartography. The cartography will be based on the OpenStreetMap platform. OpenStreetMap (OSM) is a collaborative project to create a free editable map of the world. Two major driving forces behind the establishment and growth of OSM have been restrictions on use or availability of map information across much of the world and the advent of inexpensive portable GPS devices. The maps are created using data from portable GPS devices, aerial photography, other free sources or simply from local knowledge. Both rendered images and the vector dataset are available for download under a Creative Commons Attribution-ShareAlike 2.0 licence.
- Estimate the current traffic flow over the network, either using dynamic routes calculation engine;
- Make high-precision traffic forecasts, thanks to high quantity of reliable data coming from the data collector;
- Automatically generate and manage traffic events, and to send alerts to traffic operators and platform managers;
- Manage traditional (like Variable message signs) and innovative on-street and off-street information devices.

4.3 Intersection virtual controller

Input:aggregated data from data collector

Output:adaptive traffic signalling policies

This component will enable the system to implement virtual road side units (RSUs), hosted in the cloud, in comfortable server farms. This module can apply different control strategies to control different systems and/or different sub-areas of the same system. Different control strategies can be applied according to local needs, availability of traffic measures and design options. Mainly, the system is fully adaptive on traffic and applies dynamic optimisation concepts.

The control strategies applied to the network are the result of an optimisation problem aiming to minimise the overall time spent in the network by private traffic and public transport. The optimisation is based on the continuous monitoring of the controlled network.Traffic flows are measured every second and the intersection status is updated every three seconds. Real time optimisation and monitoring ensure for an immediate reaction on traffic demand and events (incidents, priority requests).

The overall network optimisation is decomposed into co-ordinated junction problems solved by the virtual intersection units.The units are hosted in-the-cloud, so they can easily and efficiently interact continuously to evaluate the effects of the planned control actions on the downstream intersections. Each unit looks-ahead in the optimisation horizon in order to compute its own control strategy in accordance with the upstream intersections.

4.4 Passenger data processor

Input:aggregated data from data collector

Output:estimation of the distribution of the passengers over the whole network

This module is aimed at the processing of collected passengers data, in order to have a complete representation of the density and of the distribution of the passengers over the network. This component will also enable the system to perform O/D analysis of the transport demand and to macro-estimate the real paths followed by the travellers.

4.5 PT dynamic manager

This module has the role to dynamically change routes and schedules of PT vehicles, basing on data coming from other two modules: “Passenger data processor” and “area-wide supervisor”. This enabler belongs to the set of “Public transport operators’” enablers, which is described in deliverable D4.5.

4.6 Presenter

The presenter is a packaging software component, aimed at the presentation and at the communication of data processed by the system. Into other words, this component works as the interface between the system and the end-user (the traffic operator or the traveller, depending on the different applications).

The Data collector consists of two sub-components, and each of these has the function to collect data from a specific source and to present them into an effective way. The first, is aimed at the representation of traffic data, while the second is aimed at the provision of information to PT operators and users. Therefore, data are saved in a cloud server, in order to make them accessible to all other modules of the system and to external applications.

4.6.1 Traffic data presenter

Input:processed information regarding traffic monitoring

Output:complete graphical and textual representation of the traffic conditions

Traffic data presenter is a road information in-the-cloud component for easy access via Internet to road information available in the traffic management centre.Road closures and restrictions, road conditions, weather condition, construction, traffic flow and speed, traffic cameras, variable message sign status is provided and updated regularly.Systems use a database to store content, metadata, and/or artefacts that might be needed by the system. A presentation layer displays the content to regular users and is based on a set of templates. Administration is done through browser-based interfaces.

Other components and other systems can take required real-time updated information from this module.

4.6.2 PT info centre

Input:processed information regarding PT fleets

Output:share PT information with actors

This module has the role to give a complete representation of the status of the PT lines, updating it in real-time. Available information are classified and shared with PT operators and travellers, enabling them to have a continuously updated picture of the PT resources available. In case of road works or other unpredictable events, this component forwards instructions to PT vehicles, in order to adapt the service to the unforeseen situation.

4.7 On-board unit

This packaging hardware module represents the on-board device installed in private vehicles. This enabler belongs to the set of "Vehicle & handheld devices" which is described in deliverable D4.4.

4.7.1 Vehicle-TMC interface module

This module represents the communication component (resident on the on-board unit) between the traffic management centre and the On-board unit, used for transmitting to the traveller informationrelated to traffic events, hostile environmental conditions and speed advice (or waiting time at the next traffic light) information.

This enabler belongs to the set of "Vehicle & handheld devices" which is described in deliverable D4.4.

4.7.2 On-board applications

This module generically represents all the applications installed on the on-board unit and aimed at supporting the traveller during his journey (e.g. real-time navigation applications, emergency management applications, entertainment...).

This enabler belongs to the set of "Vehicle & handheld devices" which is described in deliverable D4.4.

4.7.3 OBU gateway

This module represents the communication component (resident on the on-board unit) between the On-board unit of the vehicle and the handheld device. This enabler belongs to the set of "Vehicle & handheld devices" which is described in deliverable D4.4.

4.8 Handheld device

This packaging hardware module represents the mobile device used by the traveller. This enabler belongs to the set of "Vehicle & handheld devices" which is described in deliverable D4.4.

4.8.1 Handheld device gateway

This module represents the communication component (resident on the handheld device) between the On-board unit of the vehicle and the handheld device itself. This enabler belongs to the set of "Vehicle & handheld devices" which is described in deliverable D4.4.

4.8.2 Mobile applications

This module generically represents all the applications installed on the handheld device and aimed at supporting the traveller during the three phases of his journey (pre-trip, on-trip, after-trip). This enabler belongs to the set of "Vehicle & handheld devices" which is described in deliverable D4.4.

5. Conclusions

This document has provided a high level description of the enablers identified from the scenarios belonging to the traffic management enabler set. The next step after this deliverable will be harmonization between the enabler sets described in deliverables from D4.2 to D4.8 to ensure consistency and completeness, followed by development of detailed descriptions of all enablers. The second iteration of the enabler determination process will be described in deliverable D4.14.