TRANSFORMING TRANSPORT

DELIVERABLE

D9.1 - Integrated Urban Mobility Pilot Design

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Abstract:	This deliverable provides the plan for the Integrated Urban Mobility pilots. The initial pilot takes place in Tampere, Finland, with as use cases contextual awareness and urban mobility. The main use case in Valladolid, Spain, is urban mobility. The deliverable provides the background for the pilots, the main use cases, the big data tools which will be used and the time line of the pilots.

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Definitions, Acronyms and Abbreviations

Acronym	Title
API	Application Program Interface
AWS	Amazon Web Services
DATEX II	DATa EXchange, standard for information exchange between traffic management centres (www.DATEX II.eu)
ETA	Estimated Time of Arrival
FCD	Floating Car Data
FTA	Finnish Transport Agency
GPS	Global Positioning System
GTFS	General Transit Feed Specification
JMS	Java Messaging Service
JSON	JavaScript Object Notation
KPI	Key Performance Indicators
LAM	Automatic Measuring Device (Liikenteen Automaattinen Mittaus)
NoSQL	Not Only SQL database
OD	Origin-Destination
ORA	Parking regulatory ordinance
PHP	Hypertext Preprocessor
PT	Public Transport
REST	Representational state transfer
SDK	Software Development Kit
SW	Software
TMC	Traffic Management Centre
TT	Transforming Transport
UC	Use Case
UML	Unified Modeling Language
VMS	Variable Message Sign
XML	eXtensible Markup Language
CentOS	Community Enterprise Operating System

Executive Summary

This deliverable reports on the **design of the Integrated Urban Mobility pilots** in the Transforming Transport project. The deliverable gives an overview of the requirements, objectives and use cases, and describes the data assets, big data technology and infrastructure, as well as the roadmap for implementation of the pilot.

The initial pilot is located in Tampere (Finland); the replication pilot is located in Valladolid (Spain).

Big data has the potential to assist urban traffic managers to identify traffic disruptions and to try to mitigate the effect of roadworks and exceptional situations. Big data also allows to keep drivers more up to date on current traffic situation and to provide them with services for route and parking optimisation.

1 Overall Motivation and Ambitions for Pilot Domain

1.1 Motivation

Urban traffic management centres (TMCs) are in charge of keeping traffic flowing on the city's road network. However, as they do not have visual contact to all roads in the network, they are not always aware on the status of the traffic in the network and the cause of disruptions. Hence, traffic management is in need of accurate information regarding the traffic status and problems occurring in the transport network.

Roadworks are challenging both for drivers and traffic management, as they can easily create bottlenecks and disturb traffic flow. Tools are needed for traffic management to alleviate the problems caused by roadworks.

Also, drivers of both personal cars and freight vehicles, as well as users of public transport, are in need of accurate real-time traffic status to be able to optimize their trips and to efficiently use working time. Traffic policy is changing to a more pedestrian and cycling friendly cities, and in major streets in the city centres are expected to be turned into car-free streets only accessible for public transport, cyclists and pedestrians. This will in some cases put goods delivery and loading/unloading of the delivery trucks and vans as well as maintenance vehicles without sufficient and adequate access to desired locations in the city centre and space for their commercial operations. Hence, freight transport is in need of tools for optimizing routes and finding suitable free parking places.

Use of Big Data methods allows to better identify the source of the traffic disruptions, assist in taking the most optimal traffic management decisions, and assist in informing users with short delays. There is a wide range of potential traffic data sources, e.g. traffic light data, traffic cameras, vehicle floating car data (public transport, freight and maintenance). Big data analytics can provide a wide range of benefits, e.g.

- improvement of the situational awareness of traffic circulation in the city;
- ensure viability of urban logistics;

- more efficient traffic management due to more rapid detection of disturbances, and potential guidance of mitigation measures;
- reduction of traffic congestion in the city centre through offering traffic planners with more accurate tools;
- increased fluency and timeliness of public transport in the city centre;
- decreased pollution through optimized routing and parking optimization of freight vehicles;
- optimization of routes and delivery times taking into account existing deliveries and maximizing response times;
- optimization of workload depending on vehicle capacity, avoiding empty vehicles;
- improvement of road maintenance, especially in winter.

1.2 Integrated Urban Mobility Pilots

The document describes the plans for the two big data pilots in the Integrated Urban Mobility domain of the Transforming Transport project.

The initial pilot is located in the city of Tampere in Finland. Tampere is the largest inland city in the Nordic countries. The pilot aims to improve the situational awareness regarding traffic context through the use of big data methods, and by providing tools to the traffic management centre. The second objective of the pilot is to provide solutions for urban logistics, taking into account the new parking policy which will reduce the amount of parking places in the city centre considerably. The following partners are involved in the Tampere pilot: VTT, Infotripla, Mattersoft, Taipale Telematics and the City of Tampere.

The replication pilot is located in the city of Valladolid in Spain, the capital of the Castile and León region. The main objective of the pilot is to generate a traffic model for specific areas in the city where freight transport has more impact, to analyse different freight delivery scenarios, and to create a planning tool for delivery fleets. The following partners are involved in the Valladolid pilot: CARTIF, PTV, TomTom, LINCE and the City of Valladolid.

1.3 Structure of the document

The methodology followed in this document and the document structure is based on the Transforming Transport deliverable D2.1 "Pilot Coordination Methodology Handbook"[1].

Chapter 2 of this document provides the plan for the Tampere pilot

Chapter 3 provides the plan for the Valladolid pilot

Chapter 4 indicates general aspects on the pilots, and explains how the initial pilot will be replicated.

1 Transforming Transport D2.1 - Pilot Coordination Methodology Handbook, Deliverable of the Transforming Transport project, 22.2.2017

2 Design of Initial Pilot: Tampere

The initial pilot is located in the city of Tampere in Finland. Tampere has 228,173 inhabitants (31.12.2016) inhabitants (region about 350,000), and is the largest inland city in the Nordic countries. The city centre is located on the isthmus between two large lakes, Pyhäjärvi and Näsijärvi. During wintertime, the average temperature between November and March is below zero degrees, causing challenging road weather conditions.

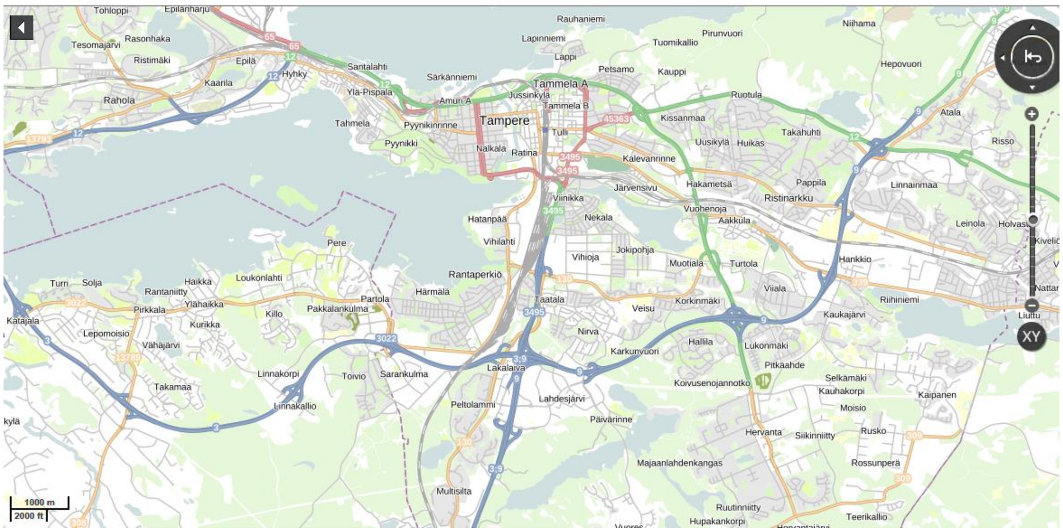


Figure 1. Map of the Tampere street network

The City of Tampere has decided on major infrastructure works during the next years. The Rantatunneli is the largest road tunnel in Finland (2.3 km) and bypasses the city centre. The tunnel opened in November 2016, but work on the connection between the city road network and the tunnel continue in 2017. The City of Tampere has decided to install a tram network, replacing major bus lines, and works started at the end of 2016. Road works will continue until the opening of the tram network, which is planned for 2021.

In the City centre, a new multi-purpose Arena and the Central Deck, including office blocks and residential towers, will be built on top of the current railway tracks. The construction will start in 2017.

The City of Tampere has issued a new parking policy, which will significantly reduce the amount of parking places in the city centre in the near future. Provision of goods and services in the city centre is hence becoming more challenging. This will cause especially challenges for goods distribution and for the delivery of services in the city centre.

In specific areas of the city centre, on-street parking is restricted to specific time slots to allow freight delivery.

Related to the parking policy, the city also supports car sharing initiatives as a means of sustainable transport to complete public transport. Car sharing also would decrease the need for parking spaces. In the future, through car sharing the required number of parking places for housing cooperatives, which is the common form in Finland of real estate ownership, could be decreased[2]. Special parking permits could be provided for car sharing for city owned parking places.

The main target of the Tampere pilot is hence twofold:

- improvement of situational awareness regarding the traffic context and providing traffic management with improved tools to be able to diagnose traffic disruptions and take mitigating actions;
- improvement of urban logistics, especially for goods delivery. For this purpose, a parking reservation system for freight and services is planned. Big data can assist in the planning of the initial parking locations, and in adapting the amount and location of the parking places in the future based on demand, as well as in guiding drivers to the locations.

The Tampere pilot also collaborates with the H2020 AUTOPILOT project[3] (Automated Driving Progressed by the Internet of Things), which started in January 2017. The AUTOPILOT has a pilot in Tampere, in which VTT is involved, and which has as use cases automation for urban driving (intersection support) and automated valet parking. The TT project will collaborate with the

[2] Autojen yhteiskäyttöä pilotoidaan kolmessa rakennushankkeessa, 24.1.2017, http://www.tampere.fi/tampereen-kaupunki/ajankohtaista/tiedotteet/2017/01/24012017_8.html
[3] http://autopilot-project.eu/

AUTOPILOT project, by exploiting synergies between TT and AUTOPILOT. The combined TT-AUTOPILOT scenario is presented in Section 2.3.4

2.1 Requirements

Currently, the urban TMC is not always aware of the state of the traffic in the city, e.g. traffic jams are noticed but the source of the traffic jam is unknown and hence the possibilities to take mitigating actions are limited. In order to come to a high quality real time situational awareness on the traffic, the urban TMC will utilize all possible information available. The quality and coverage of the information has to be increased by new and improved data sources.

In addition to the urban TMC, also travelers are in need of accurate real-time information. Up to date information of traffic increases comfort of traveling and also allows to make timely decisions, e.g. delay a trip or taking an alternative route to avoid traffic jams.

Urban freight delivery need solutions for efficient delivery of goods, while avoiding traffic jams and unproductive time caused by looking for a suitable parking space. The problem will get more critical in the coming years, as the amount of street parking will decrease substantially.

Hence, the major requirements are:

- R1 improvement of the performance of the urban traffic management to better manage the traffic in the city,
- R2 improvement of the quality of the information regarding traffic status provided to end-users,
- R3 improvement of last-mile logistics by providing possibility to reserve parking areas for goods and service delivery, in collaboration with major stakeholders

2.2 Objectives

The major objectives are:

- O1 Provision of tools for urban traffic management for diagnosis of traffic status and for selection of alternative solutions for mitigating the impact of roadworks and other events. Addition of new data sources for improved situational awareness, such as social media and traffic cameras. This objective corresponds to requirement R1.

O2 Provision of tools for drivers and travelers regarding traffic status. This objective corresponds to requirement R2.

O3 Provision of tools to improve the access of goods delivery vehicles to parking places. This objective corresponds to requirement R3.

2.3 Use Cases / Scenarios

Starting from the major requirements and the objectives, a set of use cases are defined. There are 3 major use cases:

1. Improved situational awareness through access to additional data sources and tools for urban TMC personnel
2. Tools for provision of traffic information to drivers and public transport users
3. Tools for urban logistics

Each of the use cases is dividing in sub use-cases, describing distinct interactions between different actors. UML use case diagrams are used to present the different actors and the different sub use-cases. For each of the sub use-cases a textual description following a fixed structure is provided. The following aspects are described for each of the sub-use cases: Actors, Repetition, User Interface, Resources and tools, Initial situation, Impulse, Description, Exception, End situation (user's view and system's view).

2.3.1 Use Case 1: Improved Situational awareness through additional data sources

In this use cases, which realises Objective O1, different new data sources will be made available to the personnel of the urban TMC. The TMC operator assesses whether the information provided may have an effect on the traffic situation, and enters the data into the traffic management system.

The urban TMC has currently already several sources of information available for assessing the traffic status, e.g. through phone calls and traffic cameras. The following data sources will be used:

1. **future events**: information on future events, which affect traffic conditions, is entered by the urban TMC operator in the system.
2. **planned roadworks**: information from planned construction works is provided to the urban TMC, who can enter them into the system.
3. **unplanned events:** information provided through phone calls, sensor detection and traffic cameras. The city of Tampere is increasing the amount of traffic cameras to be installed at intersections. The information from the traffic cameras will be analysed automatically in the TT project.
4. **social media:** information will be extracted from social media and presented to the urban TMC, which enters them into the system.

Each of these data sources contributes to getting a more detailed view of the traffic situation, either of the real-time situation, or allow to make predictions on future events, and allow the urban TMC to take corrective actions, and to provide improved real-time information to the users.

Figure 2 shows the use case diagram. For each of these data sources a sub use case (UC 1.01 - UC 1.04) has been determined, which is explained in more detail in the following sections. In addition, a sub use case (UC-1.05) has been defined for making the data, which have been entered by the urban TMC into the system, are made available as open data in real-time for other developments.

Figure 2. Overview of the situational awareness use cases

2.3.1.1 UC-1.01 – Create information about planned events

Repetition	Several times per week
Actors	TMC operating personnel (user)
User interfaces	Information creating service on the desktop web browser
Resources and tools	PC with a modern web browser installed.
Initial situation	The documentation about future events, that will affect traffic conditions, is available for TMC personnel

Impulse	TMC personnel has decided to add information about a new planned event into the system. Only events with expected negative consequences to the transport system are to be added.
Description	The user reads the planning documentation and adds information of each new event to the system. The event is specified by at least the following features: start time, end time (if known), event type by predefined code, location reference, transport mode to be affected and severity.
Exceptions	False interpretations and typing errors are to be minimized by unambiguous menu based interface. The user can see existing events in the system when starting to add new events. The obsolete information should be controlled and removed by the user (e.g. events with no ending time defined).
End situation from the user's point of view	The user gets a confirmation that a new event has been added to the system. The event is visible on the user interface and can be found by correct search parameters.
End situation from the system's point of view	The new event has been added to the system database. The event data is accessible for other functions of the system.

2.3.1.2 UC-1.02 – Automatically create information about roadworks

Repetition	When a new construction plan is finished
Actors	Transport planners (user)
User interfaces	User interface of a planning SW.
Resources and tools	Planning SW with data output functions
Initial situation	The plans about future roadwork, that will affect traffic conditions, are finished.
Impulse	User decides to create a data set containing the road work plan.
Description	The user performs a data creating function on a planning SW. The details are to be designed outside TT project.
Exceptions	The details are to be designed outside TT project.
End situation from the user's point of view	The user gets a confirmation that a new data set has been created by the system.

End situation from the system's point of view	The new data set has been added to the system data repository. The data can be delivered to the utilizers if needed. Delivery as open data may be considered. The details are to be designed outside TT project.

2.3.1.3 UC-1.03 – Create information about unplanned events

Repetition	Several times per day
Actors	TMC operating personnel (user)
User interfaces	Information creating service on the desktop web browser
Resources and tools	PC with a modern web browser installed.
Initial situation	An event affecting transport system has just occurred and some information about the event is available for the user
Impulse	Based on the information available for TMC from various sources (e.g. traffic cameras, phone calls, sensor detections), the user evaluates the situation and decides to add a new unplanned event into the system. Only events with instant negative consequences to the transport system are to be added.
Description	The user collects enough information of an event and adds new event to the system - without unnecessary delay. The event is specified by at least the following features: start time, end time (if known), event type by predefined code, location reference, transport mode to be affected and severity.
Exceptions	False interpretations and typing errors are to be minimized by unambiguous menu based interface. The user can see existing events in the system when starting to add new events. Obsolete information should be controlled and removed by the user (e.g. events with no ending time defined).
End situation from the user's point of view	The user gets a confirmation that a new event has been added to the system. The event is visible on the user interface and can be found by correct search parameters.
End situation from the system's point of view	A new event has been added to the system database. Event data is accessible for other functions of the system.

2.3.1.4 UC-1.04 – Mobility data from social media

Repetition	Several times per day
Actors	• social media user on the move • information service provider in cooperation with TMC
User interfaces	• user: social media (e.g. Twitter, Facebook) applications, web browser
Resources and tools	• user: web browser or social media applications installed on a mobile device or on a desktop computer • service provider: data receiving interface, data management tools
Initial situation	The user has registered to the media and defined his/hers interests. User -like numerous other users- is willing to send and receive information about transport conditions on a certain area. User's applications are active while on the move.
Impulse	Mobility data is collected by the application according the app's features – continuously or at times.
Description	Mobility data is collected by the application according the app's features – continuously or at times. Service provider gets the data from social media provider's data delivery interface.
Exceptions	If no data is available from the social media provider's data delivery interface, an error message is expected.
End situation from the user's point of view	Service provider has got the data, which will be used to refine traffic situation awareness information to e.g. TMC.
End situation from the system's point of view	Data is received continuously.

2.3.1.5 UC-1.05 – Events delivery as open data

Repetition	Several times per day
Actors	• Helpdesk providing support and management service for data delivery • Developer utilizing the open data to implement and manage applications
User interfaces	Helpdesk: desktop UI, web browser Developer: SW requesting or receiving data from the machine-readable delivery interface

Resources and tools	Helpdesk: system management tools on desktop Developer: SW developing tools on desktop, web browser
Initial situation	The event data is created by TMC and stored in system's database. The developer has got access codes to get the data (the need to recognize and authenticate utilizers will be decided before opening the data). The instructions and terms to utilize the data have been published on a publicly accessible data catalogue.
Impulse	Triggered by timer, the snapshot data set is updated regularly (e.g. once per minute) on the delivery interface
Description	The application on the developer's server is regularly requesting the data from the delivery interface. The access is given and data returned if the utilizer is authenticated and the request is appropriate.
Exceptions	If the utilizer or the request does not follow the terms and instructions, an informative error message is returned from the interface.
End situation from the user's point of view	The utilizer's application receives the data set and is able to process the data as expected.
End situation from the system's point of view	The data set is returned from the interface and the transaction is written on the log file (timestamp, utilizer's id, requested data set id, final status id).

2.3.2 Use Case 2: Traffic information related use cases

In this use case, which realises Objective O2, the information regarding the traffic status is distributed to the users. The information presented can either be personalised or of general nature, e.g. presented at VMS or published at web or social media. Several users and communication channels are addressed, both for vehicle drivers and public transport users:

1. **vehicle drivers (both personal cars and freight).** Information to the drivers can be either:
    - **general,** e.g. through Variable Message Signs (UC 2.08), or through social media (UC-2.10);

- **personal device**. The information presented is personalized, and can be pushed to the user based on a predefined profile (sub use case UC-2.06), or presented upon request (sub use case UC-2.07). The application can be integrated in e.g. a navigator application from a 3rd party (sub use case UC-2.09).

2. **public transport users**
    - **general,** e.g. through social media (UC-2.13);
    - **personal device**. The information presented is personalized, and can be pushed to the user based on a predefined profile (sub use case UC-2.11), or presented upon request (sub use case UC-2.12).

Figure 3 shows the use case for private (and freight) transport, Figure 4 shows the use case for public transport.

Figure 3. Overview of the traffic information use cases

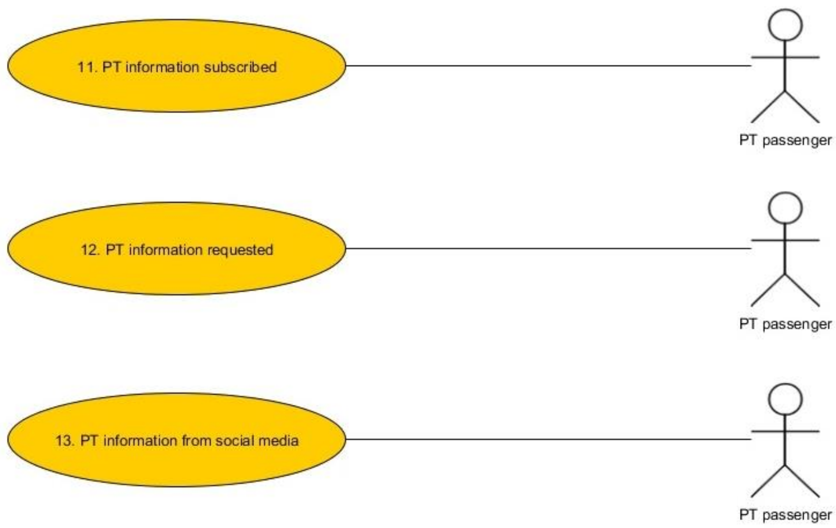


Figure 4. Overview on the use cases related to public transport information.

2.3.2.1 UC-2.06 –Traffic information subscribed

Repetition	Several times per day
Actors	Vehicle driver
User interfaces	Web browser or application
Resources and tools	Desktop PC and/or mobile phone with appropriate applications installed
Initial situation	The user has created a personal profile to the system either manually or assisted by the system (e.g. by automatically learning about routine routes and schedules). The profile includes e.g. which event types, routes and time periods the user is interested in. The traffic data is in system's database.
Impulse	The system detects that there is an event matching to user's profile.
Description	The system publishes a message containing information about the event. The application in user's terminal device gives an alarm when there is an event matching to user's profile. A short information about the event is shown on the terminal's display. The user can get more information (written or spoken) by clicking the event symbol or text.

Exceptions	If the event does not match user's profile, no alarm is given. However, all events are shown in the application, and the user can get more information by clicking the event symbol or text.
End situation from the user's point of view	User is constantly aware of the traffic situation on his/hers usual route and time.
End situation from the system's point of view	The information is put available for all users enabling the use of information according the users' needs.

2.3.2.2 UC-2.07 – Traffic information requested

Repetition	Several times per day
Actors	Vehicle driver
User interfaces	Web browser or an application
Resources and tools	Desktop PC and/or mobile phone with appropriate applications installed
Initial situation	The user needs to drive to a familiar destination. The traffic conditions are unknown for the user on the route. The data is in system's database.
Impulse	The user requests to see the map display on a certain area.
Description	The user starts the application, chooses the map display area and selects the information (e.g. traffic fluency, incidents, camera images, parking availability) he/she wants to see.
Exceptions	If real time information is not available for some information type, the map symbol is shown differently (e.g. opaque).
End situation from the user's point of view	User is aware of the traffic situation on that area and time.
End situation from the system's point of view	The basic traffic information is available for all users.

2.3.2.3 UC-2.08 – Traffic information on VMS

Repetition	Once per day
Actors	• Vehicle driver • TMC personnel

User interfaces	Variable message sign (VMS), a large roadside display operated by TMC
Resources and tools	User does not need tools or resources
Initial situation	The data is in system's database.
Impulse	The TMC staff decides to publish a message on VMS displays.
Description	TMC staff sends a message to the displays. The message is shown on some or all displays according to the pre-defined plan. Drivers passing by the display can see the message. The message contains at least location reference and the description of the event.
Exceptions	In case of a data transmission or other technical problem, the display stays blank.
End situation from the user's point of view	User is aware of the event and can reroute the trip, if needed.
End situation from the system's point of view	The message is on the display until it will be removed. Traffic is routed as rationally as possible.

2.3.2.4 UC-2.09 – Traffic information on navigator

Repetition	Several times per day
Actors	Vehicle driver
User interfaces	Navigator application's display
Resources and tools	Navigator application installed fixed on vehicle's cockpit or on a mobile device
Initial situation	The user needs to drive to an unfamiliar destination. The traffic conditions are unknown for the user on the route. The navigation system has got the event data from data delivery interface.
Impulse	The user starts the navigation process on application.
Description	The user starts the navigation process by typing / pointing the destination address – and origin if needed. The application shows the route and estimated travel time taking into consideration the events on the route. Possible new events will update the navigator's route choice.
Exceptions	If the user changes the route during the trip, the new route is calculated with updated travel time taking into consideration the events on the new route

End situation from the user's point of view	User gets as realistic travel time estimation as possible.
End situation from the system's point of view	The traffic information is available for navigator users and the traffic is routed as rationally as possible.

2.3.2.5 UC-2.10 – Traffic information on social media

Repetition	Several times per day
Actors	Vehicle driver
User interfaces	Social media (e.g. Twitter, Facebook) applications, web browser
Resources and tools	Web browser or social media applications installed on a mobile device or on a desktop computer
Initial situation	The user has registered to the media and defined his/hers interests. User -like numerous other users- is willing to send and receive information about traffic conditions on a certain area.
Impulse	• a new event is created on the system database with a feature to share it also on social media OR • one of the users publishes a message
Description	The message containing information about an unplanned traffic event is published on social media. The users will receive the message and they can discuss and elaborate it.
Exceptions	If false or obsolete information is published on social media, the users will correct and update it.
End situation from the user's point of view	User gets traffic information not only from TMC, but also from other users.
End situation from the system's point of view	The traffic information is available for social media users, and the information gets value added from the users.

2.3.2.6 UC-2.11 –PT information subscribed

Repetition	Several times per day
Actors	PT (public transport) passenger
User interfaces	Web browser or application
Resources and tools	Desktop PC and/or mobile phone with appropriate applications installed
Initial situation	The user has created a personal profile to the system either manually or assisted by the system (e.g. by automatically learning about routine stops, stops, lines and schedules). The profile includes e.g. which event types, lines and time periods the user is interested in. The PT data is in system's database.
Impulse	The system detects that there is an event matching to user's profile.
Description	The system publishes a message containing information about the event. The application in user's terminal device gives an alarm when there is an event matching to user's profile. A short information about the event is shown on the device display. The user can get more information (written or spoken) by clicking the event symbol or text.
Exceptions	If the event does not match user's profile, no alarm is given. However, all events are shown in the application, and the user can get more information by clicking the event symbol or text.
End situation from the user's point of view	User is constantly aware of the transit situation on his/hers usual route and time.
End situation from the system's point of view	The information is put available for all users enabling the use of information according the users' needs.

2.3.2.7 UC-2.12 – PT information requested

Repetition	Several times per day
Actors	PT (public transport) passenger
User interfaces	Web browser or an application
Resources and tools	Desktop PC and/or mobile phone with appropriate applications installed
Initial situation	The user needs to travel to a familiar destination. The transport conditions are unknown for the user on the route. The data is in system's database.

Impulse	The user requests to see the map display on a certain area.
Description	The user starts the application, chooses the map display area and selects the information (e.g. traffic fluency, incidents, PT delays, camera images, PT vehicles real time locations) he/she wants to see.
Exceptions	If real time information is not available for some information type, the map symbol is shown differently (e.g. opaque).
End situation from the user's point of view	User is aware of the transport situation on that area and time.
End situation from the system's point of view	The basic traffic information is available for all users.

2.3.2.8 UC-2.13 – PT information on social media

Repetition	Several times per day
Actors	PT (public transport) passenger
User interfaces	Social media (e.g. Twitter, Facebook) applications, web browser
Resources and tools	Web browser or social media applications installed on a mobile device or on a desktop computer
Initial situation	The user has registered to the media and defined his/hers interests. User -like numerous other users- is willing to send and receive information about transport conditions on a certain area.
Impulse	• a new event is created on the system database with a feature to share it also on social media, OR • one of the users publishes a message
Description	The message containing information about an PT event is published on social media. The users will receive the message and they can discuss and elaborate it.
Exceptions	If false or obsolete information is published on social media, the users will correct and update it.

End situation from the user's point of view	User gets PT information not only from TMC and PT operator, but also from other users.
End situation from the system's point of view	The PT information is available for social media users, and the information gets value added from the users.

2.3.3 Use Case 3: Urban logistics

This use case responds to 03 (provision of tools to improve the access of goods delivery vehicles to parking). As the amount of on-street parking will decrease in the near future, it will become more difficult for goods vehicles to find a parking place, which may result in additional traffic in the city centre and hence more congestion. The solution planned by the Transforming Transport project for urban freight (and service) delivery is a system for parking reservation.

Several parking areas will be assigned by the city traffic planner for goods delivery. These parking areas can then be reserved by logistic providers or by the drivers themselves. The test will be performed in the area of the city centre shown in Figure 5. Parking enforcement (i.e. wardens) also need access to reservation data, to verify that the vehicle occupying the parking place has the right to park.

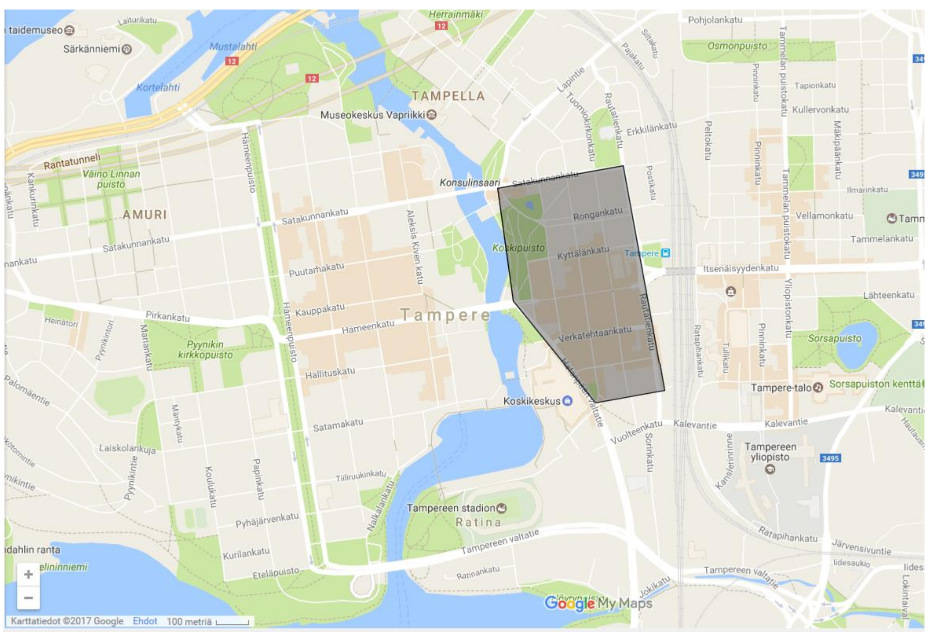


Figure 5. Test area for urban logistics in Tampere city

Figure 6 shows the UML diagram for this use case. The use case has been split in several sub use-cases:

- **Maintenance of the available parking spaces (UC-3.01).** Traffic planners assign the parking places, which can be reserved by the parking reservation system.
- The scheduling planner of the transportation company plans the routes for freight delivery and makes **advance booking of the parking space (UC-3.02)**
- The driver starts its shift and drives to the next destination, using the best route based on a real-time traffic information. The Vehicle **transmits continuously data** during the trip **(UC-3.11)**
- Due to delays in the delivery or due to the traffic condition, changes may need to be made in the reservation. The driver can then **update the booking reservation (UC-3.02b).**
- At **arrival at the parking space (UC-3.3)**, the driver registers the space. When the vehicle departs, the space is released.

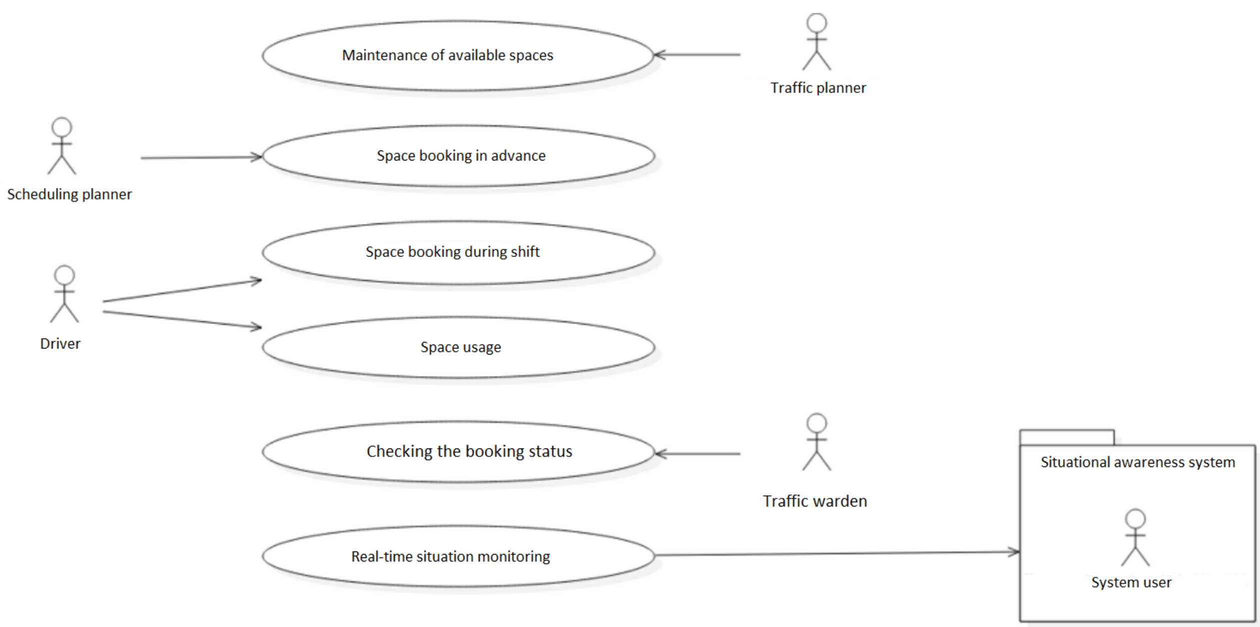


Figure 6 Overview of the use cases related to urban logistics

In addition to the sub-use cases for the users, two sub use cases are included for the traffic warden: **checking the status of the parking booking (UC-3.4),** and **checking the parking permission (UC-3.5).**

2.3.3.1 UC-3.01 – Maintenance of available spaces

Repetition	Once per month
Actors	Traffic planners responsible for stowage and parking spaces
User interfaces	Management interface for the space booking system
Resources and tools	Computer and a browser
Initial situation	Booking system contains information of available spaces used for stowage and parking
Impulse	A new space needs to be added or details of an existing one modified (remove/re-add).
Description	Traffic planner logs in the system in order to update stowage and parking space details. When adding a new space, the planner adds location information, name and description for each space, and defines the timeframes when the space can be used for parking or stowage. The planner can modify all information about existing spaces.
Exceptions	If traffic planner modifies the parking spaces where bookings have been made, the system generates a warning. A possibility to send a message to all users who have made a booking is provided.
End situation from the user's point of view	Traffic planner has updated the information to correspond with current offering and updated information is available to other users.
End situation from the system's point of view	Booking system contains up-to-date information about available stowage and booking spaces.

2.3.3.2 UC-3.02 – Space booking in advance

Repetition	Daily
Actors	Scheduling planner of the transportation company
User interfaces	Booking systems' booking interface
Resources and tools	Computer and a browser
Initial situation	Scheduling planner has planned the delivery route
Impulse	Parts of the destinations of the delivery route are located within the area covered by the booking system. The planner needs to make a booking for all required parking and stowage spaces.
Description	Scheduling planner logs in the system in order to make bookings for the stowage and parking spaces needed. The planner chooses preferred spaces, defines a preferred timeframe and the register number of the vehicle that will use the booked space.
End situation from the user's point of view	Scheduling planner has made all bookings that are needed for stowage and parking.
End situation from the system's point of view	The booking system contains up-to-date information about bookings.

2.3.3.3 UC-3.02b – Space booking during duty

Repetition	Daily
Actors	Driver
User interfaces	Mobile application of the booking system
Resources and tools	Smartphone
Initial situation	Driver is performing his duty
Impulse	Driver knows he is arriving at the booked space during a timeframe that is outside the initial booking, or a valid booking has not been made.
Description	Driver browses upcoming or prevailing bookings and can modify them within a pre-defined timeframe. He can also make new reservations.

End situation from the user's point of view	Driver has booked all required spaces and can be assured that the needed space is available for him upon arrival.
End situation from the system's point of view	The booking system contains up-to-date information about bookings.

2.3.3.4 UC-33 – Space usage

Repetition	Several times a day
Actors	Driver
User interfaces	Mobile application of the booking system
Resources and tools	Smartphone
Initial situation	Driver is performing his duty
Impulse	Driver arrives at destination located within an area covered by the booking system.
Description	The mobile application of the booking system recognizes the vehicle to be approaching nearby stowage and parking places based on the GPS-signal. Upon arrival, the driver selects the exact space from the application and reports his arrival. Once the driver has left the space, he reports the space to be available again.
End situation from the user's point of view	The driver has successfully delivered the goods and during delivery the used space has been marked as reserved.
End situation from the system's point of view	Stowage or parking space has been marked as reserved throughout the parking/stowage. Once the vehicle departs, the space is released and available for other bookers.

2.3.3.5 UC-3.4 – Checking the booking status

Repetition	Several times a day
Actors	Traffic warden
User interfaces	TODO
Resources and tools	TODO
Initial situation	Traffic warden performing a duty

Impulse	Traffic warden arrives at destination, located within an area covered by the booking system. There are parked vehicles within the booking area's parking places, so the warden checks the vehicles right for parking.
Description	TODO
Exceptions	
End situation from the user's point of view	The warden has performed his duty and made sure the vehicles have the right to use the spaces.
End situation from the system's point of view	Checking the booking does not alter information in the booking system.

2.3.3.6 UC-3.5 – Checking the parking permission

Repetition	Multiple times per day
Actors	Traffic warden
User interfaces	Reservation system mobile app for traffic wardens
Resources and tools	Smart phone or tablet
Initial situation	Traffic warden is performing regular duties
Impulse	Traffic warden enters area where reservation system is used for parking places. There are one or more vehicles using the parking places.
Description	Traffic warden checks from the mobile app which vehicles are entitled to use parking places. If vehicle is not permitted to use the parking place, the traffic warden may fine that vehicle or have it towed away. The parking ticketing and towing are not part of the reservation system.
End situation from the user's point of view	Traffic warden has fulfilled duties.
End situation from the system's point of view	This use case does not alter the system state.

2.3.3.7 UC-3.11 - Data transmission from vehicles

Repetition	Daily on each trip
Actors	Driver
User interfaces	Fleet management and parking place reservation system
Resources and tools	www (mobile/laptop)
Initial situation	Driver logs into the vehicle and starts the trip
Impulse	Driver needs to navigate to the destination parking place
Description	Driver logs into the vehicle, starts the trip and navigates to the reserved parking place using the best route based on a real-time traffic information avoiding incidents and traffic jams. Vehicle sends anonymous traffic smoothness, incident and diagnostics data automatically during the trip.
Exceptions	Traffic jams, Vehicle diagnostics warnings of engine failures
End situation from the user's point of view	Driver arrives at the destination and parks a vehicle.
End situation from the system's point of view	Reserved parking place is marked as “busy”, driver’s trip is marked as “finished”.

2.3.4 Use Case 4: Automated Driving: common scenario with AUTOPILOT project

The H2020 project Autopilot (www.autopilot-project.eu) will develop new services on top of IoT to involve autonomous driving vehicles, like autonomous car sharing, automated parking, or enhanced digital dynamic maps to allow fully autonomous driving. The AUTOPILOT project has a test site in Tampere, maintained by VTT. The main use cases for AUTOPILOT in Tampere are Automated Valet Parking and Intersection Support for urban driving.

A combined Transforming Transport-AUTOPILOT scenario has been developed:

1. The user enters the automated vehicle and enters the destination address (on a smartphone app, connected to the vehicle). The app calculates the vehicle route based on the current (or predicted) traffic status, and determines drop-off point and final parking place. The app calculates the route and the estimated arrival time (ETA). The app reserves the parking place from the ETA onwards.

2. The vehicle approaches a signalized intersection. The vehicle receives information on the real-time status of the traffic light from the back-end system, and optimizes the speed based on the information received. On the intersection, the traffic camera provides real-time information on other road users (vehicles, pedestrians, cyclists) on a conflicting course to the automated vehicle.
3. The traffic cameras installed on the intersection provide information to the Traffic Management Centre regarding the flow of traffic.
4. The vehicle receives continuously traffic information. If an event occurs on the route, the route and the ETA areis recalculated. In case of delay, the parking reservation is modified.
5. The vehicle drives automatically to the drop-off point. The vehicle drives automatically to the parking place and parks itself. The vehicle registers itself that it has taken the reserved place.

The scenario will be implemented near the VTT facilities in the Hervanta city district. Figure 7 shows the location of the test site and the planned test route.

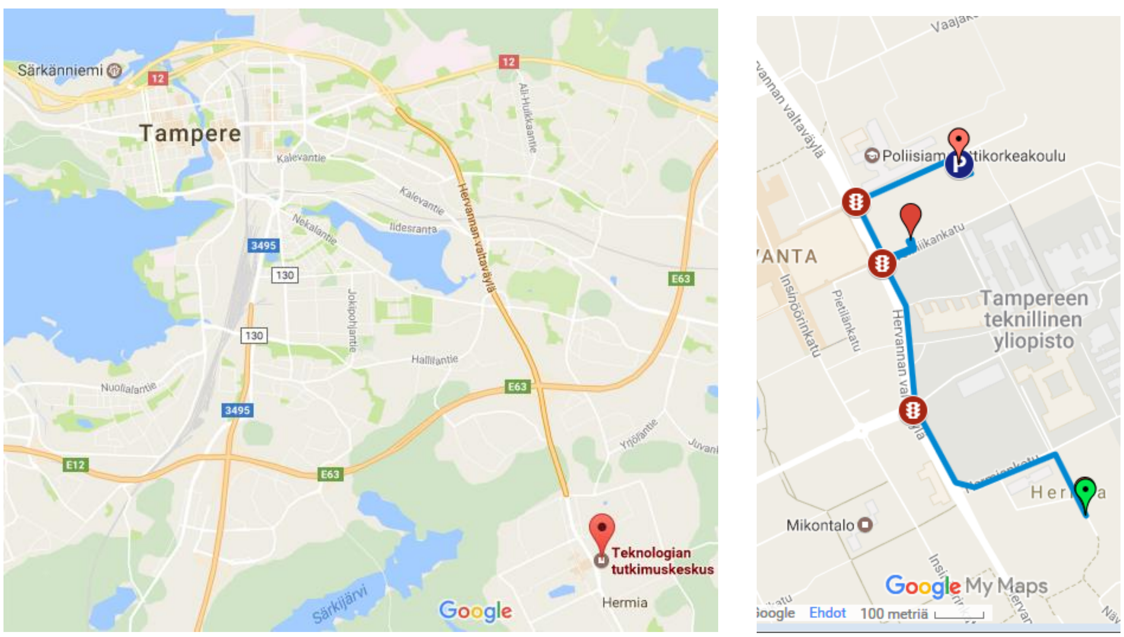


Figure 7 Location of the AUTOPILOT test site in the Hervanta district in Tampere and planned test route

The following figure shows the different use cases in this scenario, as well as their relation to the TT and AUTOPILOT projects.

Figure 8. Overview of the common AUTOPILOT-TT use cases

2.3.4.1 UC-4.01. Determining destination

Repetition	Daily on each trip
Actors	Autonomous vehicle user
User interfaces	Destination selection
Resources and tools	Smartphone, vehicle connected to internet
Initial situation	User gets into the vehicle and logs into the vehicle
Impulse	User activates the UI.

Description	The user enters the automated vehicle and enters the destination address (on a smartphone app, connected to the vehicle). The app calculates the vehicle route based on the current (or predicted) traffic status, and determines drop-off point and final parking place. The app calculates the route and the estimated arrival time (ETA). The app reserves the parking place from the ETA onwards.
Exceptions	Connection failures, Failure to find the drop-off point or a route to the drop-off point. Failure to find a (free) parking place near the drop-off point, in which the vehicle can drive in unmanned mode.
End situation from the user's point of view	Destination (drop-off point and parking place) determined.
End situation from the system's point of view	Reserved parking place is marked as "busy", route is completely determined.

2.3.4.2 UC-4.02. Intersection Traffic camera analysis

Repetition	Continuously (e.g. every 10 seconds)
Actors	TMC user
User interfaces	-
Resources and tools	Traffic Cameras connected to the Tampere city network
Initial situation	Traffic camera connected and ready
Impulse	continuous
Description	The traffic cameras at the intersection take continuously images of the intersection. The software analyses the traffic for a specific link (e.g. number of cars in different lanes, car speed, exceptional situations) and calculates key figures. Based on settings, the information is provided to the TMC.
Exceptions	Connection failures, technical failures
End situation from the user's point of view	TMC user gets status information from intersection and data on traffic exceptions.

End situation from the system's point of view	Data is forwarded.

2.3.4.3 UC-4.03. Automated driving route support

Repetition	Daily on each trip
Actors	Autonomous vehicle and its user
User interfaces	Vehicle UI
Resources and tools	Smartphone, vehicle connected to internet
Initial situation	Automated trip ongoing
Impulse	TMC informs on a traffic exception along the programmed route
Description	The automated vehicle has subscribed to traffic information, and receives information on an event from the TMC, e.g. road blocked, along the programmed route. The vehicle calculates a new route, and calculates the new ETA for the drop-off and parking place. The user is informed on the route change. The reservation for the parking place is updated.
Exceptions	Connection failures, Failure to find the drop-off point or a route to the drop-off point. Failure to find a (free) parking place near the drop-off point, in which the vehicle can drive in unmanned mode.
End situation from the user's point of view	Route (drop-off point and parking place) updated.
End situation from the system's point of view	Reserved parking place is marked as "busy", route is completely determined.

2.3.4.4 UC-4.04. Registration of parking place

Repetition	Daily on each trip
Actors	Autonomous vehicle and its user
User interfaces	Vehicle UI
Resources and tools	Smartphone, vehicle connected to internet

Initial situation	User drop-off
Impulse	Vehicle initiates the parking maneuver
Description	The vehicle parks autonomously in the parking place, and registers that the parking place is occupied.
Exceptions	The parking place is completely or partly occupied, and the autonomous vehicle cannot park itself.
End situation from the user's point of view	Parking completed.
End situation from the system's point of view	Reserved parking place is marked as "busy", route is completely determined.

2.4 Data Assets

The Tampere pilot site will use a variety of Open Data sources regarding traffic and weather. The data assets are summarized below. Details on the data assets can be found in the Data inventories:

Table 1. Data assets in the Tampere pilot

Name of Data Asset	Short Description	Initial Availability Date	Data Type	Link to Data ID Card (in basecamp)
Tampere Public Transport SIRI Interface (Realtime)	Real-time data from the public transport information system.	6/2013	public transport real time data	https://3.basecamp.com/3320520/buckets/1429164/uploads/446350552
Tampere Public Transport Journeys API	Public transport interface, which combines static and real-time interface.	beta version available	public transport static and real time data	https://3.basecamp.com/3320520/buckets/1429164/uploads/446350709
Tampere incidents and roadworks	Incidents and roadworks in Tampere.	available	incidents, roadworks	https://3.basecamp.com/3320520/buckets/1429164/uploads/446365620

Name of Data Asset	Short Description	Initial Availability Date	Data Type	Link to Data ID Card (in basecamp)
Tampere parking facilities	DATEX II-interface for the status of the parking halls	available	status of parking facility	https://3.basecamp.com/3320520/buckets/1429164/uploads/446365455
Sensior FCD (Taipale)	Real-time FCD (Floating Car Data) data from moving vehicles.	available	location, heading, speed, time-stamp and trip start-end information	https://3.basecamp.com/3320520/buckets/1429164/uploads/447221202
Traffic lights	Data from sensors on intersections equipped with traffic lights. Induction loops.	available	Traffic volume, congestion level, queue length, waiting time	https://3.basecamp.com/3320520/buckets/1429164/uploads/447178879
Tampere traffic cameras	Data from traffic cameras installed at major intersections.	tbd	images.To be developed: traffic fluency	https://3.basecamp.com/3320520/buckets/1429164/uploads/447174926
Social media	Social media Tampere traffic related information	available	tweets	https://3.basecamp.com/3320520/buckets/1429164/uploads/447173750
Prolonged driving times (Mattersoft)	Prolonged driving times recognition, can be used for early congestion detection and forecast	Partially available and to be further developed	Format for encoding a variety of geographic data structures (GeoJSON)	https://3.basecamp.com/3320520/buckets/1429164/uploads/447171935
Digitraffic	Service of Finnish Transport Agency: real time information and data about traffic, weather and condition information on the Finnish main roads.	Available	fluency data, LAM sensor data, traffic disorders, road weather, road weather cameras	https://3.basecamp.com/3320520/buckets/1429164/uploads/446406102

In addition to the data assets, which have been defined in the previous tables, other local[4] and national[5] open data sources could be used, and if so, will be added to the Data Assets table.

2.5 Big Data Technology, Techniques and Algorithms

2.5.1 Data Collection

For improving situational awareness, the different providers will increase the amount of real-time data sources, fuse and analyze these data to get a better view of the situational awareness.

The pilot builds on existing infrastructure for data collection. In the City of Tampere a wide set of data is already collected. The data assets, which will be used in the project, are listed in Table 1.

The datasets, which are used in the pilot, are mainly stored at servers of actors responsible for data collection. The data are accessed through the interfaces, made available by these actors. The data whichare generated by the project will be made available using international standards, e.g. DATEX II, in these cases when standards exist.

Existing tools: CentOS 7, Linux shell scripts, Java (Apache Maven), Apache Subversion, Apache Ant, Apache Tomcat, Jersey, REST API, MongoDB, Elasticsearch, PostgreSQL (PostGIS), JSON , XML, XPath, XMLBeans, RabbitMQ, AMQP 1.0 (Qpid), dom4j/SAXReader

2.5.2 Preparation and curation of data

New infrastructure, such as traffic **cameras** will be taken into use during the project. **New sources of information, e.g. social media** will be taken into use.

For traffic cameras, algorithms are planned to be developed for extracting data, e.g. on traffic fluency and events, and these data will be made available for situational awareness.

Related use cases: UC-1.02 (new data related to future roadworks), UC-1.04 (data extraction from social media), UC-4.04 (traffic cameras)

[4] http://www.tampere.fi/tampereen-kaupunki/tietoa-tampereesta/avoin-data.htm: ta catalogue of the City of Tampere.

[5] Opendata.fi (avoindata.fi) is a service for Finnish open data and interoperability standards and guidelines, and is managed by the Population Register Centre.

Existing tools: CentOS 7, Linux shell scripts, Java (Apache Maven), Apache Subversion, Apache Tomcat, Jersey, REST API, PostgreSQL (PostGIS), JSON , XML
The following tools will be used for the development: PostgreSQL (PostGIS), social media API SDKs.

Tools will be selected case by case depending on the timely needs.

2.5.3 Access to data

The pilot builds on existing methods for **data access**. Data access will be granted to project partners for developing the tools needed during the project. Data will be made available as open data.

Related use cases: UC-1.05

Existing tools: CentOS 7, Linux shell scripts, Java (Apache Maven), Apache Subversion, Apache Ant, Apache Tomcat, Jersey, PHP, REST API, MongoDB, Elasticsearch, PostgreSQL (PostGIS), JSON , XML, XMLBeans, DATEX II, SIRI, GTFS, web services/Apache Axis2, REST API,

2.5.4 Batch processing of data

The pilot will be using existing data processing architectures. Data are transmitted in batches at regular time intervals.

Existing tools: CentOS 7, Linux shell scripts, Java (Apache Maven), Apache Subversion, Apache Ant, MongoDB (NoSQL) and PostgreSQL (PostGIS, psql) databases, Elasticsearch for search and analytics, JSON , XML, XPath, XMLBeans, OpenTripPlanner, OpenStreetMap.
All software is running and a scalable and flexible virtual server environment.

2.5.5 Streaming/real-time processing of data

The pilot will use **streaming/real time data processing** architectures for analysing e.g. traffic camera input.

Existing tools: CentOS 7, Linux shell scripts, Java (Apache Maven), Apache Subversion, Apache Tomcat, Jersey, apache (load balancer), REST API, MongoDB, Elasticsearch, PostgreSQL (PostGIS), JSON , XML, XMLBeans, RabbitMQ,
The following tools will be used for further development: open source tools, MongoDB, Elasticsearch, PostgreSQL (PostGIS), RabbitMQ, AMQP 1.0 (QPid JMS)

Tools will be selected case by case depending on the timely needs.

2.5.6 Descriptive Data analytics

The pilot will build **diagnostic solutions** for contextual awareness. By fusion of data of different sources, unplanned events, such as traffic jams or accidents, are more rapidly identified.

Related use cases: UC-1.03

Existing tools: Linux shell scripts, Java (Apache Maven), Apache Subversion, Apache Maven, MongoDB, Elasticsearch, PostgreSQL (PostGIS, psql), QGIS, R, Apache JMeter, Chart.js, Sensu, Python (watchdogs), org.apache.poi (MS Excel reports)

Tools for further development: open source tools, MongoDB, Elasticsearch, PostgreSQL (PostGIS, psql), QGIS, Apache JMeter, Sensu, GIS tools for Hadoop

Tools will be selected case by case depending on the timely needs.

2.5.7 Predictive Data analytics

The pilot will develop tools for **predicting future traffic situation** (short time traffic fluency prediction).

Existing tools:_Java (Apache Maven), Apache Subversion, PostgreSQL (PostGIS, psql),

Tools used for development: open source tools, PostgreSQL (PostGIS, psql),

Tools will be selected case by case depending on the timely needs.

2.5.8 Prescriptive Data Analytics

The pilot will develop tools for **assisting traffic management** (TMC) in taking mitigating actions in case of roadworks.

Related use cases for mitigating actions: UC-1.01

Existing tools: PHP, JavaScript, HTML5, CSS, jQuery, jQuery UI, Bootstrap, Google Maps JavaScript API, PostgreSQL (PostGIS, psql), OpenLayers

Tools for further development: open source tools, PostgreSQL (PostGIS, psql), Tools will be selected case by case depending on the timely needs.

2.5.9 2D-visualisation

The pilot will develop tools for **informing users**, and an application for reservation of an optimal parking place.

Related use cases: UC-2.08 (VMS), UC-2.09 (info on navigator), UC-2.10 (social media), UC-2.12 (PT information), UC-2.13 (PT information on social media)

Existing tools: angular, JavaScript, HTML5, CSS, jQuery, Bootstrap, PostgreSQL (PostGIS, psql),

Tools for further development: open source tools, ReactJS, Node.js

2.6 Positioning of Pilot Solutions in BDVA Reference Model

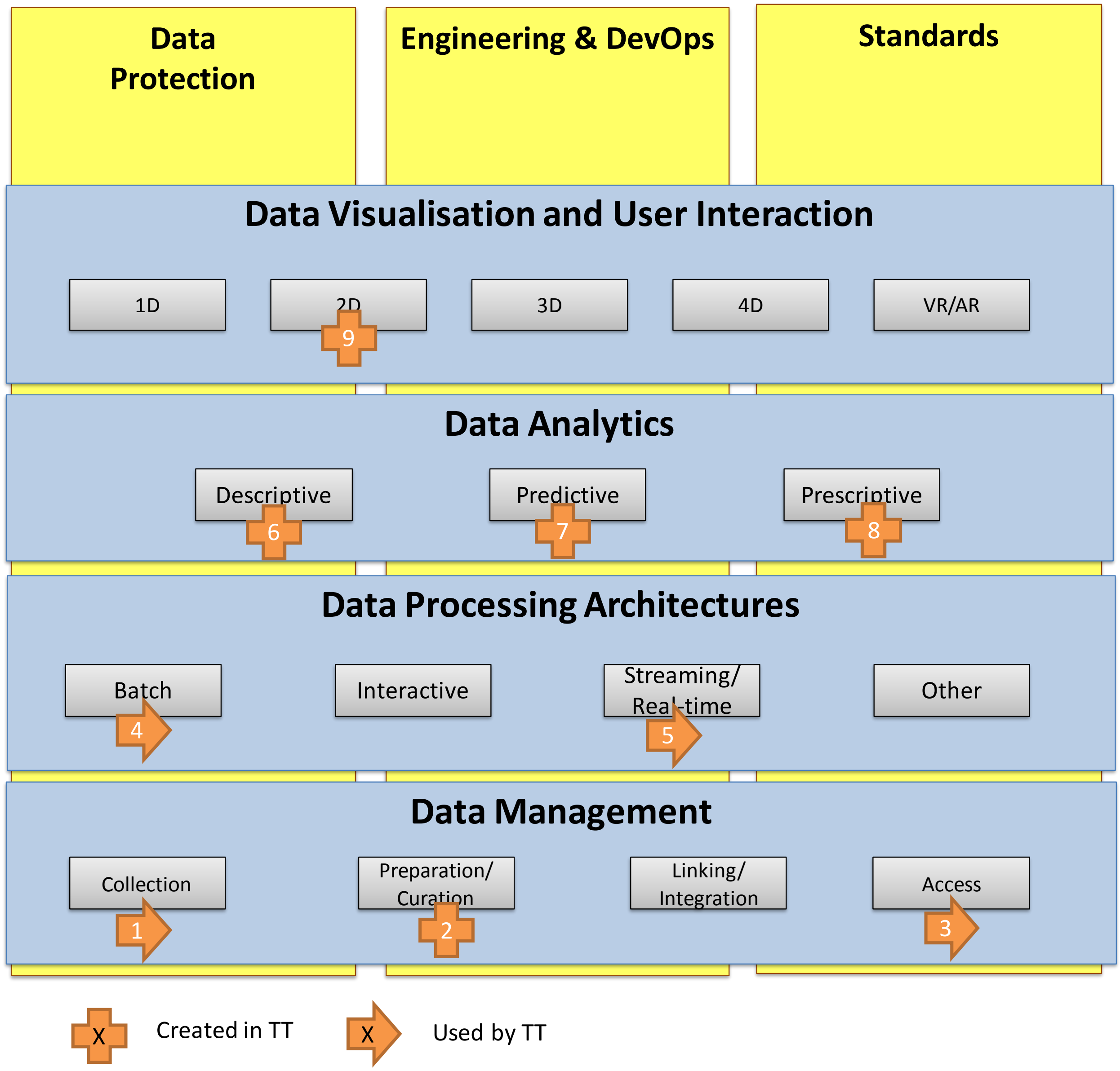


Figure 9. Positioning of the Pilot Solutions, used in the Tampere pilot, in the BDVA reference model. The numbers in the arrows and crosses refer to subsections 2.5.x

2.7 Big Data Infrastructure

The infrastructure in the Tampere pilot is distributed over the different partners. There are several sub-systems collecting and managing data from various sources. These sub-systems and the data will be fused in order to create the information for the use cases.

- Infotripla will provide their data management platform complying with relevant big data architecture and interfaces. The platform is used to collect and manage the data to be used in various information services.
- Mattersoft will provide real-time and static public transport locations, as well as further derived punctuality information, prolonged driving time information and exception information, and later to be defined means to collect freight delivery related location and capacity information.
- Taipale will provide their own servers for storing and analyzing big data information from thousands of moving, mainly heavy vehicles in bus and transport traffic.
- VTT has servers and software for storing and processing floating car, traffic and weather data.

Figure 10 shows the initial architecture of the Tampere pilot site:

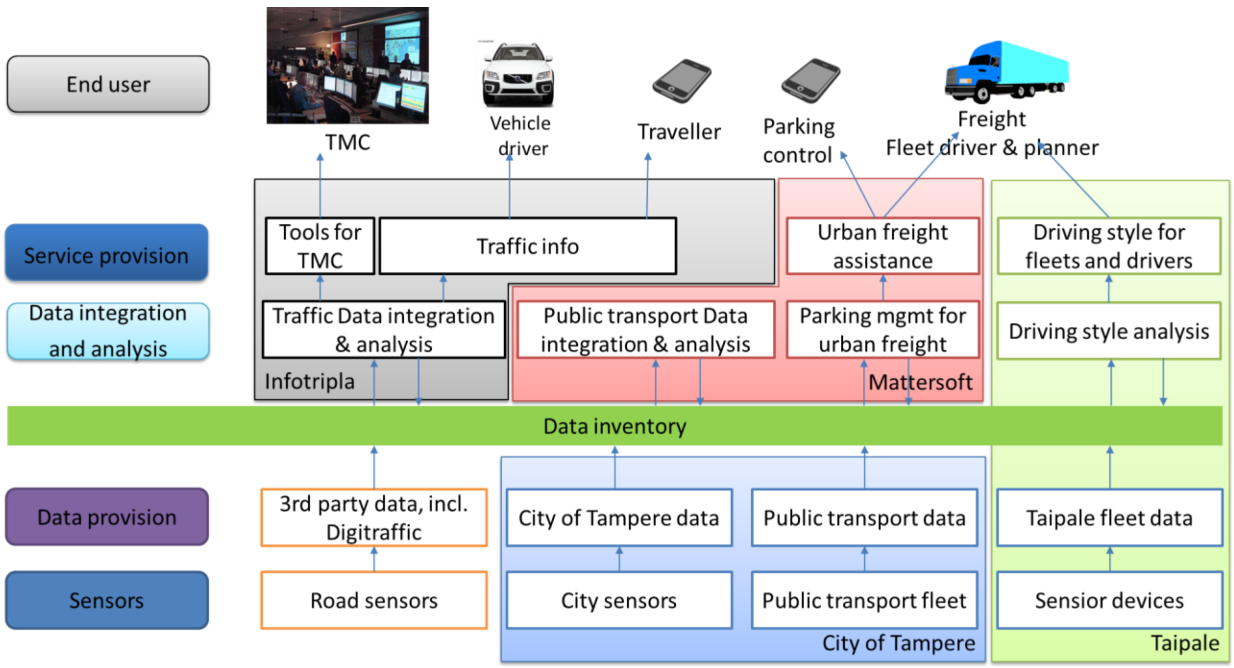


Figure 10. Initial architecture of the Tampere pilot

2.8 Roadmap

Table 2. Roadmap of the Tampere pilot

Stage	Delivery Date (Project Month)	Features / Objectives Addressed	Embedding in Productive Environment	Big Data Infrastructure Used	Scale of Data
S1: Technology Validation	M6	O1. Setting up architecture and data collection. O2. Setting up architecture O3. Setting up architectures, fleets and parking management solution	Embedded in test environment of the partners	Current infrastructure of the partners will be used	Volume: several hundred GB per month; Velocity: about 10 GB/day

Stage	Delivery Date (Project Month)	Features / Objectives Addressed	Embedding in Productive Environment	Big Data Infrastructure Used	Scale of Data
S2: Large-scale experimentation and demonstration	M12	O1. Verify algorithms in order to improve urban TMC strategies. O2. Development and testing of tools for information provision O3. First pilot of loading bay app with limited number of users.	Embedded in test environment of the partners	current infrastructure for analysis: new data sources	Volume: several hundred GB per month; Velocity: about 10 GB/day
S3: In-situ trials	M24	O1. Collection of data and real-time analysis of data for urban TMC. Use of developed tools by urban TMC O2. Operational use of the information tools O3. Full-scale pilot of loading bay app with limited number of operators.	Integration in production environment of the partners	Current infrastructure of the partners will be used	Volume: several hundred GB per month; Velocity: about 10 GB/day

3 Replication Pilot: Valladolid Integrated Urban Mobility and Freight Pilot

Valladolid is located in the North-Central Spain, with a population of 307,052 inhabitants (2015) and an area of 197.7 square kilometres. It is the administrative capital city of Castile and León region (Figure 11), it is strategically located and well connected through a wide network of highways, the high-speed train and the conventional railway. Additionally, it is considered a major logistics node, within the Atlantic Corridor.

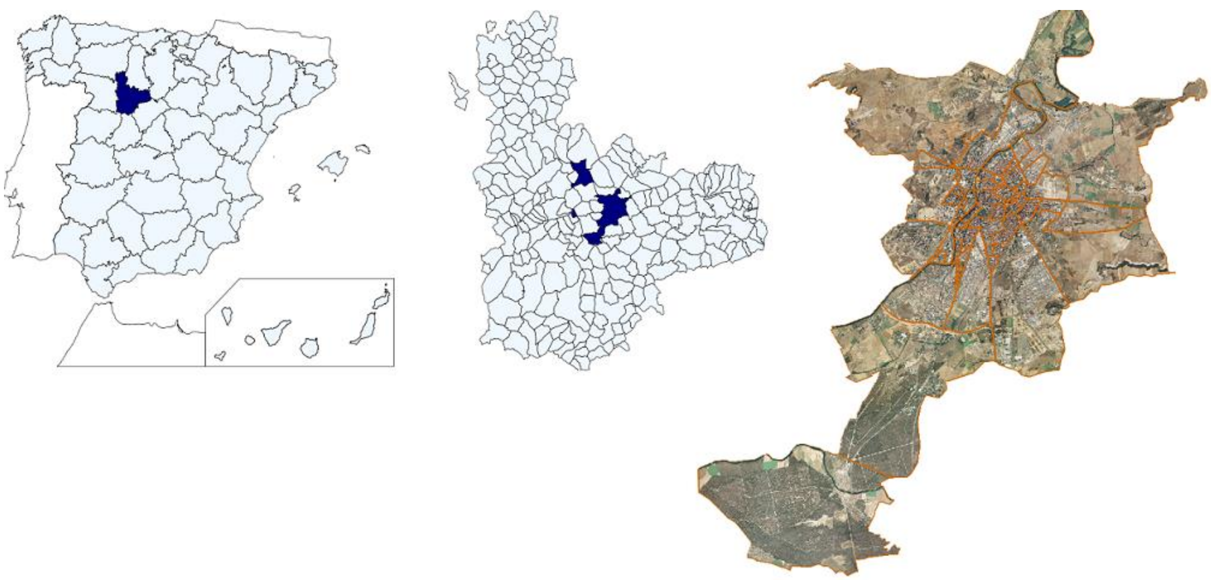


Figure 11 Valladolid city (Spain)

The interurban network that provides access to the city is in good shape and has enough capacity to ensure a reasonable traffic flow most of the time. Traffic flow within the city reaches the rush hour at 8:00AM, when almost 11,500 vehicles are entering the city. Most of them are light vehicles (private cars and freight delivery small and medium sized vans). Second rush hour takes place between 2:00PM and 3:00PM and the third one between 6:00PM and 7:00PM.[6]

Freight delivery within the city has a great impact on traffic flow and is responsible for traffic congestion to a high extent. To manage freight delivery daily operations, the local administration has a specific regulation that limits load and unload operations to 30 minutes.

Central areas of the city face a number of situations every day:

- Misuse of parking areas by private vehicles, so that they are not free for freight delivery vehicles as they should.
- Not enough load and unload areas to cover current needs.
- Not enough control and surveillance to ensure an adequate use of load and unload areas.

Moreover, though Valladolid is not among the most polluted cities in Spain, the city council foresees an action plan in case emissions reach a dangerous level for the citizens. Among the envisaged actions, and in extreme cases, they would be forbidding circulation along the central area.[7]

This situation calls for new regulations that ensure an efficient operation of last mile delivery, that doesn't hinder the city traffic flow. In order to come up with adequate recommendations that can lead to such regulations, a thorough analysis of current urban freight delivery activities will be performed within the Transforming Transport project.

Next, a description of current urban freight activity in Valladolid is described.

Urban freight activity in the city centre is regulated by the City Council. [8] Figure 12 shows the related area where 116 different stop locations are available for these activities. Currently, about

[6] PIMUSSVA: http://www.pimussva.es/wp-content/uploads/2016/05/PIMUSSVA_Caracterizacion_del_trafico_externo.pdf
[7] http://www.lavanguardia.com/politica/20170201/413906513596/valladolid-delimita-la-zona-que-cerrara-al-trafico-si-hay-contaminacion-grave.html
[8] https://www.valladolid.gob.es/es/perfil-contratante/expedientes-contratacion/contrato-gestion-servicio-publico-modalidad-concesion-estac.ficheros/311204-12.-Plano_Desplegable%20Disco%20Control.pdf

2,280 linear meters are available to park in the city centre in addition to specific pedestrian zones. The rules of use of these load and unload areas are:

1. Pedestrian zones (grey shadow): maximum authorized mass 3,500kg. Monday to Saturday from 7:30AM to 11:00AM.
2. Centre zones (red flag in red shadow): maximum authorized mass 8,000kg. Monday to Saturday from 7:30AM to 12:00PM and Monday to Friday from 4:00PM to 6:00PM.
3. Specific zones (black flag in red shadow): maximum authorized mass 8,000kg, Monday to Friday from 8:00AM to 8:00PM and Saturday from 8:00AM to 2:00PM.
4. Others (blue shadow): maximum authorized mass 12,000kg, Monday to Saturday from 8:00 to 2:00PM and Monday to Friday from 4:00PM to 8:00PM.

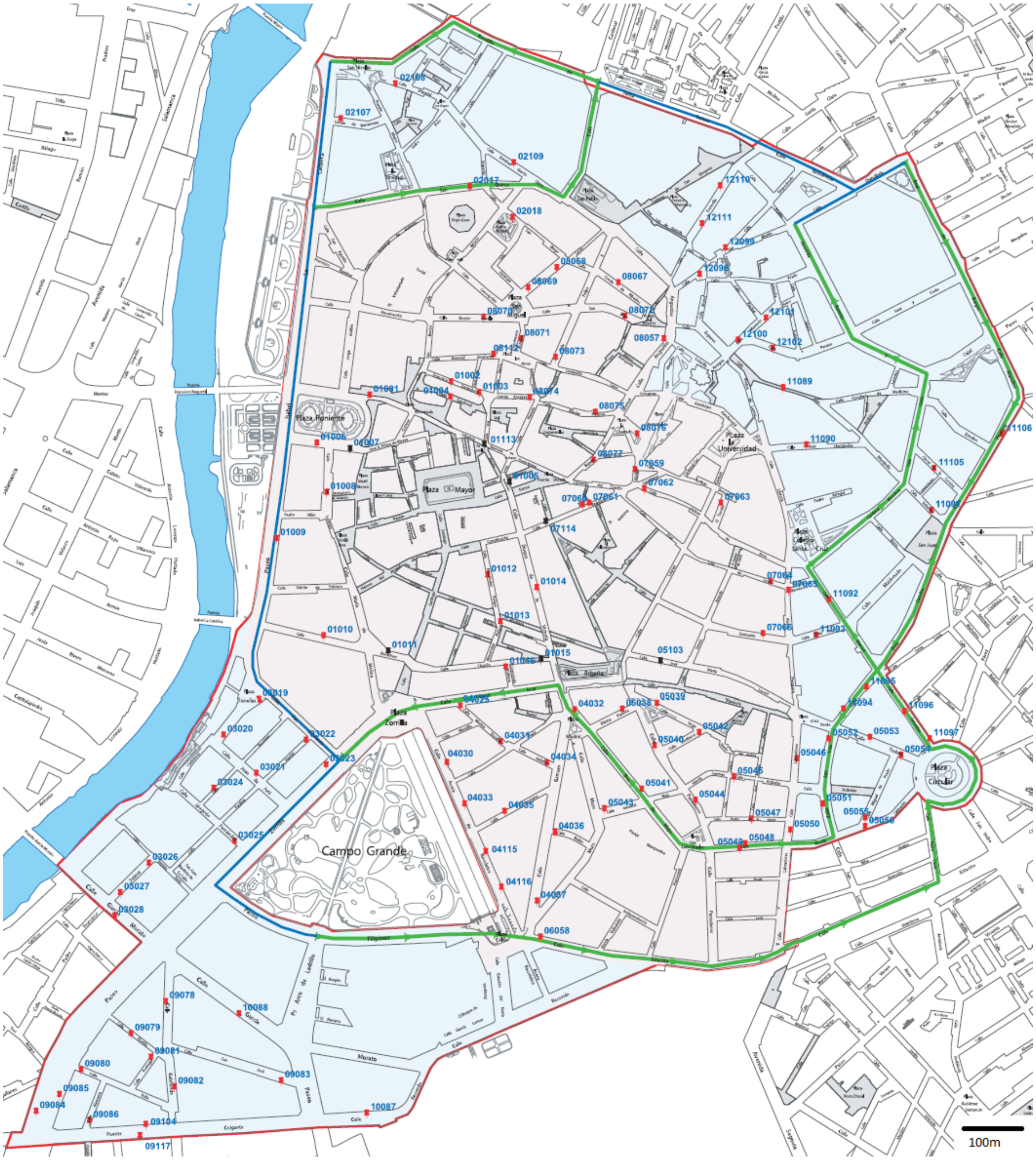


Figure 12 Load and unload zones in Valladolid city centre

3.1 Requirements

Valladolid integrated urban mobility and freight pilot has been designed following advices and specifications from two points of view: the City Council (as mobility manager) and the freight delivery companies (as user).

In regard to the City Council, the main interest they have is to ensure the sustainability of urban mobility, so the analysis of different scenarios that include freight transport is a priority for them. The main requirements in this case are:

- **Improvement of the situational awareness of traffic flow** in the City.
- **Reduction of traffic congestion** in the city centre.
- Ensuring **viability of urban logistics**.

On the other hand, in order to efficiently perform their daily activity, freight and service companies are interested, amongst other, in reach destination in time and avoid dedicated freight places congestion. Their main requirements is:

- **Optimization of routes and delivery times** taking into account ongoing deliveries and minimising response times.

3.2 Objectives

Main objective within this pilot is to generate traffic models in Valladolid with specific relation to commercial/logistic fleets. These models can be used later on by City Council for traffic planning and traffic management tasks. So, next two objectives related with requirement R1, R2 and R3 are been defined:

O1. **Generating a traffic model** for particular areas in the city where freight transport has more impact. Two strategies will be implemented:
  a. To develop a traffic model based on discrete events.
  b. To develop and calibrate a traffic model for the use in PTV traffic management systems.

O2. Option to **analyse different freight delivery scenarios** and make best decision according to the results.

Also to achieve freight delivery companies requirement R4 an additional objective is defined:

O3. Creation of a **planning tool for delivery fleets** and to inform drivers about the route plan they must follow to ensure fulfilment of (not limited to):
   a. Minimise the time freight vehicles are inside city centre boundaries, which is related to traffic alleviation.
   b. Minimise the distance travelled by freight vehicles inside city centre boundaries, which is related to pollution reduction

3.3 Use Cases and Scenarios

The scenarios to be analyzed in Valladolid pilot are connected to regulated parking area for load and unload activities in the city center. As commented previously in this area 116 different stop locations (2,280 linear meters approx.) are available for these activities in addition to specific pedestrian zones (Figure 12).

The locations available to be used for loading and unloading activities are identified with the traffic signal shown in **Error! Reference source not found.** (left image). When an authorized car s tops in these locations a control disk (right image in **Error! Reference source not found.**) will be used. This disk allows to stop 30 minutes at most.

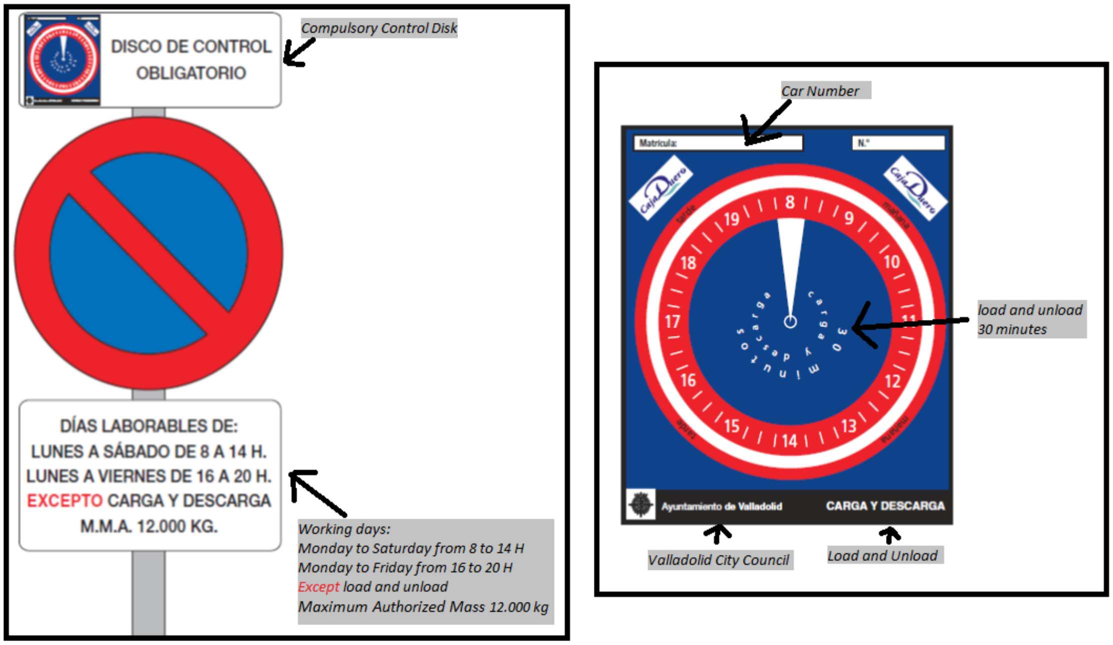


Figure 13 Traffic Signal (left) and Control Disk (right) use in load and unload authorized zones

In order to well understand the framework, and how the needs of freight urban mobility domain are, an incremental development will be used. In first stages a reduced area going to be modelled, which will be expanded in later stages. Next, section 3.3.1 describe the selected areas and in section 3.3.2 the scenarios to be simulated are presented.

3.3.1 Urban freight areas to be modelled.

- Area A: To analyse different traffic situations in the city centre, including freight delivery within the current City Council traffic model, a specific area of the city centre has been selected to be modelled in first stages. The specific area is shown in Figure 14 and includes Regalado Street, Duque de la Victoria Street, Constitución Street, Menendez Pelayo Street, Ochavo Square, Fuente Dorada Street and López Gómez Street. There are 7 freight stop zones (parking room for 17 cars) and several pedestrian streets for load and unload services (see Table 3 for details).

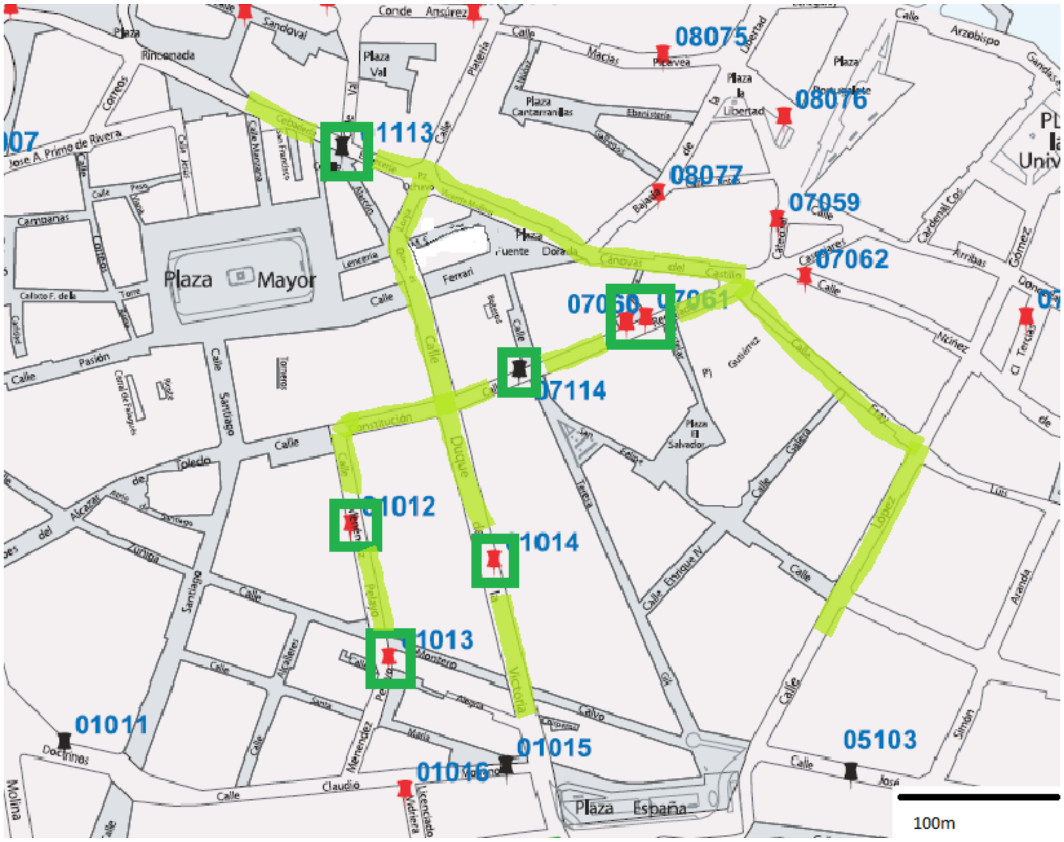


Figure 14 Valladolid Urban Mobility and Freight Pilot. Area A.

Table 3 Stop Zone include in the model. Area A.

Number	Situation	Longitude (meter)	Parking type	Time slot	Comments
01012	Menendez y Pelayo, 1	12.40	Parallel	Mo to Sa 7:30AM-12:00PM, Mo to Fr 4:00PM-6:PM	Centre zone
01013	Menendez y Pelayo, F6	10.20	Parallel	Mo to Sa 7:30AM-12:00PM, Mo to	Centre zone

				Fr 4:00PM-6:00PM	
01014	Duque de la Victoria, 15	14.50	Parallel	Mo to Sa 7:30AM-12:00PM, Mo to Fr 4:00PM-6:00PM	Centre zone
01113	Corrillo	14.50	Parallel	Mo to Fr 8:00AM-8:00PM, Sa 8:00AM-2:00PM	Specific zones
07060	Regalado, 13	5.90	Parallel	Mo to Sa 7:30AM-12:00PM, Mo to Fr 4:00PM-6:00PM	Centre zone
07061	Regalado, 13	9.50	Parallel	Mo to Sa 7:30AM-12:00PM, Mo to Fr 4:00PM-6:00PM	Centre zone
07114	Regalado corner with Teresa Gil	15.00	Parallel	Mo to Fr 8:00AM-8:00PM, Sa 8:00AM-2:00PM	Specific zones
N.A.	Pedestrian zones	500.00 (approx.)	N.A.	Mo to Sa 7:30AM-11:00AM	Pedestrian zones

- Area B: This area is an extension of the streets considered in first stages. The extended area is shown in Figure 15 and it includes the load and unload zones managed by the City Council where vehicles below 8,000 kg are allowed. This Area B includes 56 more stop zones for load and unload than previous area.

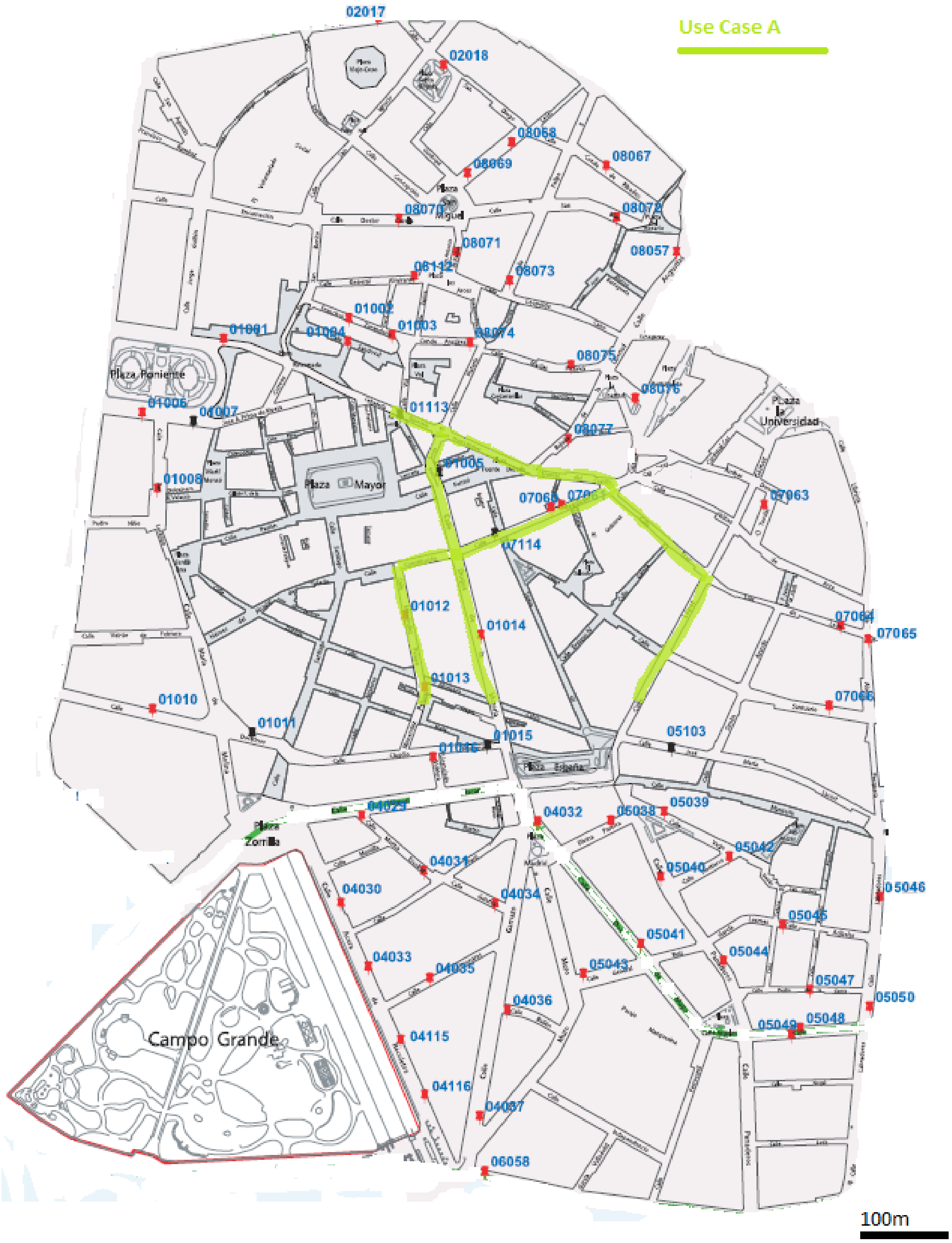


Figure 15 Valladolid Urban Mobility and Freight Pilot. Area B.

3.3.2 Use Case 1: Support for City Council Decision-Making

The following scenarios will be simulated (traffic model) in the zones enclosed by the previous areas in order to establish the optimum space that will be dedicated to freight services:

- Scenario I: Increase/decrease the capacity of load and unload freight zones and analyse how it affects freight traffic.
- Scenario II: Change time slots (timetable and stopping time) and analyse how it affects freight traffic.
- Scenario III: Simulate street works and analyse how traffic is distributed.
- Scenario IV: Analyse how restricted use of pedestrian zones affects load and unload activities.

The analysis of the previous scenarios will allow knowing what will happen to freight transport in the city centre. The City Council will be able to implement new policies and regulations that promote freight traffic reduction, delivery park places congestion abatement and use optimisation, contributing additionally to pollution reduction and to traffic alleviation.

Next, traceability between requirements, objectives and scenarios in use case 1 are shown:

Requieremts

- **R1** Improvement of the situational awareness of traffic flow
- **R2** Reduction of traffic congestion
- **R3** Viability of urban logistics

Objectives

- **O1** Generate traffic models
- **O2** Analyse different freight delivery scenarios

Scenarios

- **SI** Modify capacity of load and unload freight zones
- **SII** Change time slots (timetable and stopping time)
- **SIII** Simulate street works
- **SIV** Analyse how restricted use of pedestrian zones affects load and unload activities

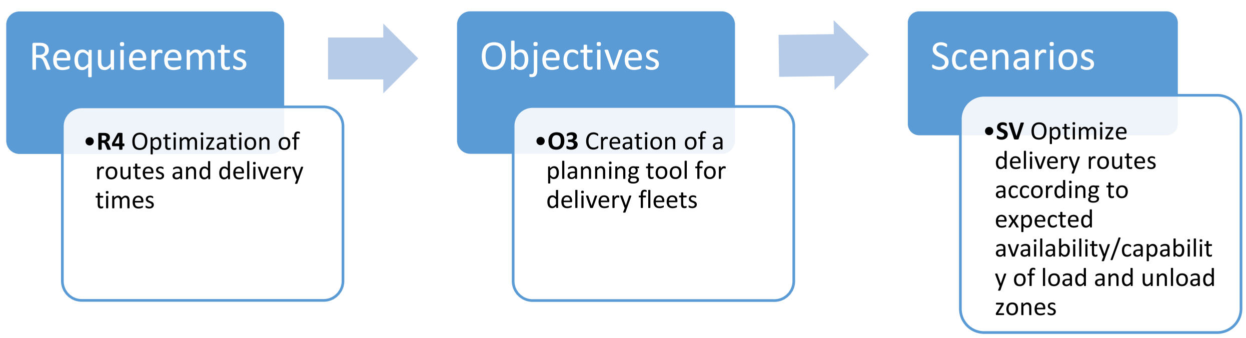
3.3.3 Use Case 2: Improve Delivery Services.

Finally, based on delivery services requirements an additional scenario will be evaluated:

- Scenario V: Optimize delivery routes according to expected availability/capability of load and unload zones.

In that scenario Delivery companies will dispatch vehicles knowing they will follow routes that minimise travel time and increasing driver satisfaction, since they will be guided across the city proposing them the best next stop.

Next traceability in this use case 2 are shown:



3.4 Data Assets

Currently next data asset are available in Valladolid Pilot. None of them contains confidential or personal data.

Table 4. Data assets used in the Valladolid pilot

Name of Data Asset	Short Description	Initial Availability Date	Data Type	Link to Data ID Card (in basecamp)
T9.3-Valladolid_Magnetic loops	Number of vehicles every 15 minutes	November 2016	XLS	https://3.basecamp.com/3320520/buckets/1429164/uploads/437620247

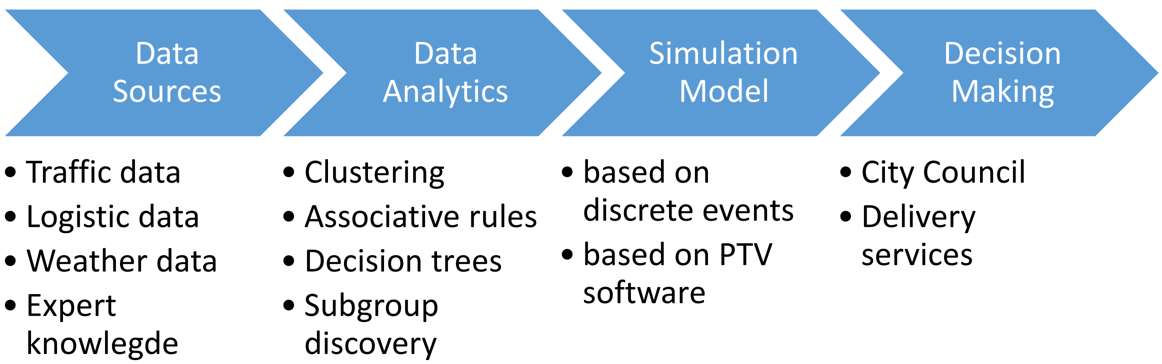
Name of Data Asset	Short Description	Initial Availability Date	Data Type	Link to Data ID Card (in basecamp)
T9.3-Valladolid_GPS traces	Day, Time and GPS position related to freight and services supply	March 2017	GPX	https://3.basecamp.com/3320520/buckets/1429164/uploads/437619850
T9.3-Valladolid_Wheather data	Temperature, Rainfall and Visibility in Valladolid city	January 2016	XLS	https://3.basecamp.com/3320520/buckets/1429164/uploads/437620501
T9.3-Valladolid_Pneumatic Loops	Speed and vehicles' category that go through specific roads	June 2017		https://3.basecamp.com/3320520/buckets/1429164/uploads/452608839
T9.3-Valladolid_TrafficIncidences	A list of roadworks or other incidences/events that have an impact on the traffic inside the city	April 2017		https://3.basecamp.com/3320520/buckets/1429164/uploads/452608981
T9.3-Valladolid_TrafficLights	Information about synchronization between traffic lights	April 2017		https://3.basecamp.com/3320520/buckets/1429164/uploads/452609139
T9.3-Valladolid_ORAdata	Information collected by limited parking regulatory ordinance (ORA) related with loading and unloading places	June 2017		https://3.basecamp.com/3320520/buckets/1429164/uploads/452607974

Name of Data Asset	Short Description	Initial Availability Date	Data Type	Link to Data ID Card (in basecamp)
T9.3-Valladolid_FCDtomtom	Timestamp and GPS points of trips	N.A.	Proprietary format	https://3.basecamp.com/3320520/buckets/1429164/uploads/454283339

3.5 Big Data Technology, Techniques and Algorithms

Next scheme shows how data analytics will be used to improve a traffic simulation model to be used in this pilot. Basically, once all available data sources, different scenarios will be modelled and, finally, next expected results will be obtained:

(1) Reports to the City Council. Based on the analysis of the scenarios some decisions will be made in order to improve the freight traffic within the city centre.
(2) Capability to predict occupation of loading and unloading places. Based on this prediction a travel plan will be designed for every vehicle that minimises travel time and distances and optimises delivery park places occupation. This plan will be sent to the drivers in advance.



In next sections main steps are explained.

3.5.1 Data Sources

In Valladolid pilot design different raw data (traffic, logistic and weather related data) will be stored in their original form. Data will be transmitted in batches at regular time intervals. This Data Collection will be stored in a database management systems as MySQL or PostgreSQL. Moreover, since different data sources will be handled, these should also be Linked/Integrated in advance.

Then all available data are going to be preprocessed, so different Preparation/Curation techniques will be used including data cleaning, data transformation and/or data reduction. E.g., floating car data (FCD) is generally recorder and sent by GPS-devices for driving vehicles, but, usually, this records doesn't contain marks related to the start and the stop of each route or tour of these vehicles. Therefore, the first issue is to implement a stop detection, which does detect each stop of the vehicle and is able to determine the category of the stop (red traffic light, traffic jam, real stop at a depot or customer on a logistical delivery tour). Also trajectory map matching is not a trivial operation.

R software will be used as main tool to do these tasks. If needed other platforms are available as MatLab, Orange, Weka or SciPy. Within this tasks 1D and 2D graph visualisation will be used to interact with domain experts.

3.5.2 Data Analytics

In this pilot data analytics algorithms will be used to extract knowledge from the traffic data. In that sense, data will be analysed in order to find traffic flow patterns along the day. Based on these patterns, the different scenarios proposed previously will be simulated and evaluated in next step.

Different algorithms, mainly Descriptive methods as clustering algorithms, associative rules or decision trees will be applied to discover patterns in traffic behaviour. These patterns will allow us to analyse the traffic flow model along the day according to patterns, weather and seasonal data.

In order to apply these techniques also R software are going to be used, with Matlab or/and Rapid Miner. As well 2D and 3D graph visualization are going to be used to validate the result with domain experts.

3.5.3 Simulation Model

Once the most representative patterns have been discovered, this knowledge will be used in the next step to generate traffic models for the city and simulate different scenarios. In this step two proprietary software tools will be used as Predictive methods: one based on discrete events models (microsimulation) and another based on an ad-hoc traffic model.

- Discrete events software: Since in this pilot data collected from magnetics loops are available, a simulation software based on discrete events has been selected as first option to model traffic and make predictions. In this case the selected software to simulate the scenarios is WITNESS. All knowledge extracted from previous step will be used now to configure the model, both the simulation initial conditions and events (traffic lights, cross, parking zones, etc.) behaviour.
  Figure 16 shows a prototype of the front-end model in zone A proposed in section 3.3.1. Since this WITNESS interface allows manage the time, 4D visualisation will be used to show the predictions, in addition to 1D and 2D.

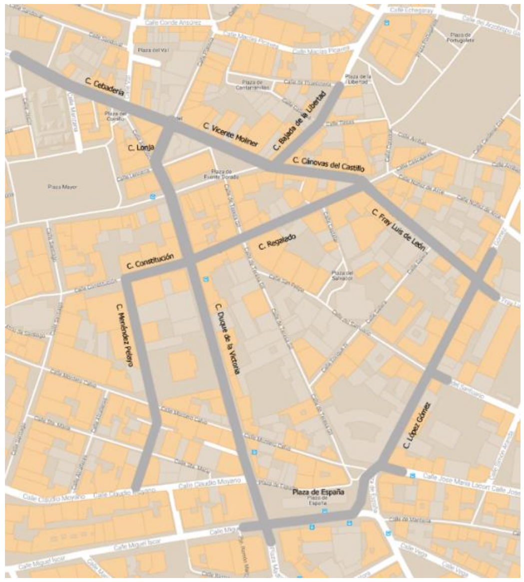


Figure 16 Valladolid model. Area A.

- Ad-hoc traffic model: PTV traffic management systems are also going to be used in this case. For these agent-based models the origin-destination (OD) matrices are an important part, since they represent all traffic streams between traffic cells (e.g. city districts or industrial areas). With specific assignment procedures the traffic can be allocated to a road network and, in an iterative analysis, the model will be refined to reach fine-granular district that are sufficiently populated to allow for deducing traffic estimates.
  Currently traffic models are built up in a semi-automatic way including a lot of manual work but, within this pilot, the plan is to obtain a higher grade of automation. So, based on historical FCD, different OD matrices will be provided for different times (week days, hours in the day, bank holidays, etc.) in order to calibrate the traffic model.

3.5.4 Decision Making

Finally, Prescriptive algorithms will be applied within the pilot since different simulations (scenarios described in Section 3.3) are going to be analysed in order to make decisions. Thus, the prediction about occupation of loading and unloading places will be obtained and then will be used by delivery services to plan the routes in advance. Also City Council will be able to modify regulations related to loading and unloading activities in the city center.

3.6 Positioning of Pilot Solutions in BDVA Reference Model

In Valladolid pilot design different raw data (traffic, logistic and weather related data) will be stored in their original form (Collection Data Management), will be preprocessed-(Preparation/Curation Data Management) and will be combined (Linking/Integration Data Management) in order to apply both Descriptive and Predictive Data Analytics algorithms. All this using Batch Data Processing Architectures.

Besides, Prescriptive Data Analytics algorithms will be developed within the pilot since different simulations are going to be analysed in order to make decisions.

More details about all these positioning has been explained in previous Section 3.5.

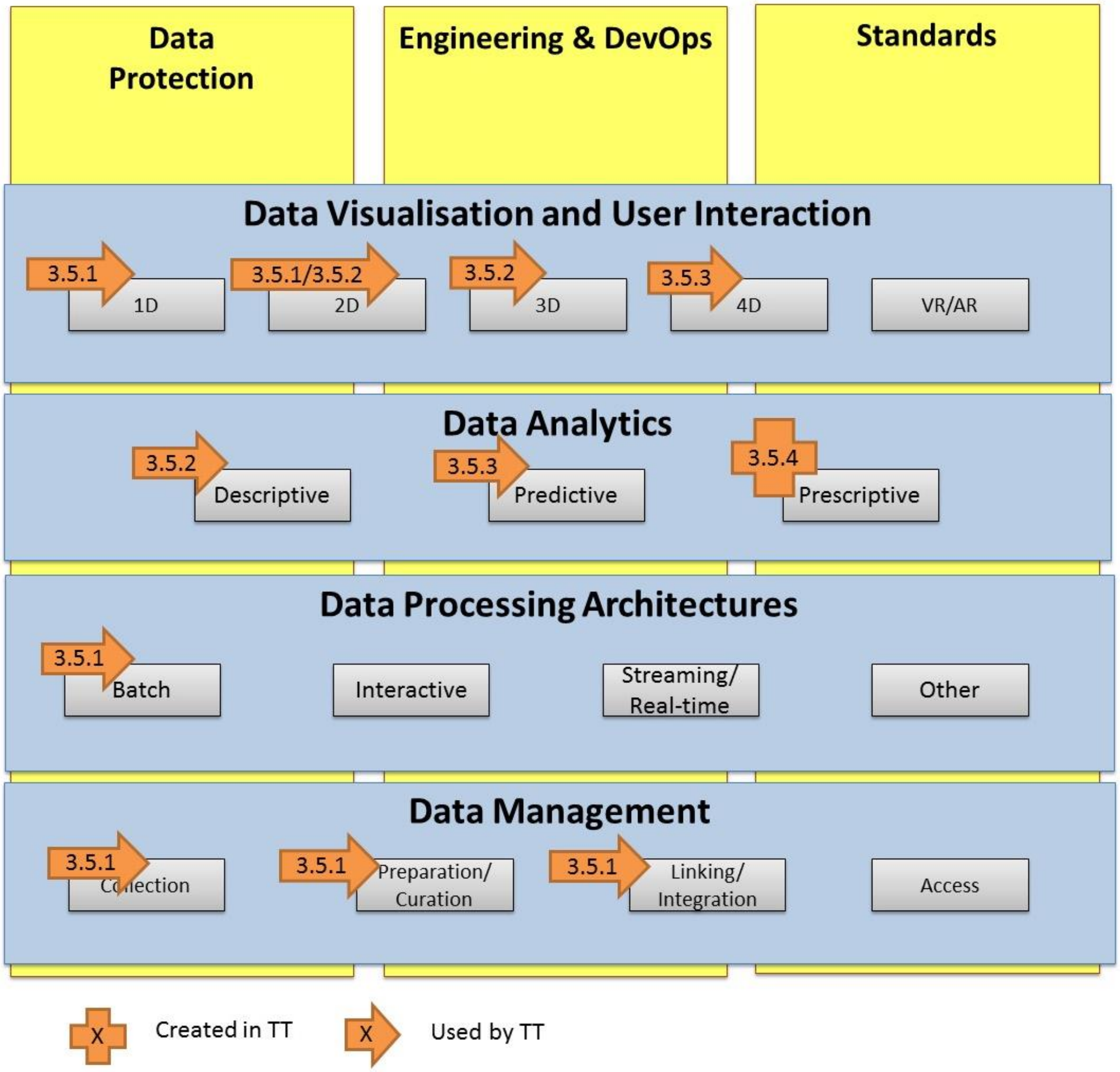


Figure 17. Positioning of the solutions in the Valladolid pilot in the BDVA reference model

3.7 Big Data Infrastructure

Figure 18 shows an overview of data infrastructure that will be used in Valladolid pilot.

In the first stages CARTIF's platform will be used. Currently a small computer cluster is available to develop parallel, distributed algorithms for data analytics and based mainly on open source software.

- The data will be stored in different SQL or NoSQL databases, depending on the type of data sources considered. Currently only structured data are going to be analysed, so MySQL or PostgreSQL will be used.
- Different data analytic tools can be applied: R, Rapid Miner, Weka, etc. Also some commercial tools are available, as Matlab.
- To generate the traffic models two commercial tools will be used.

In the last stages, if needed, prototypes built in CARTIF's platform will be deployed in AWS or similar. Also existing data processing structure already available in PTV and TomTom companies will be used, extending where necessary the capabilities for pilot demands.

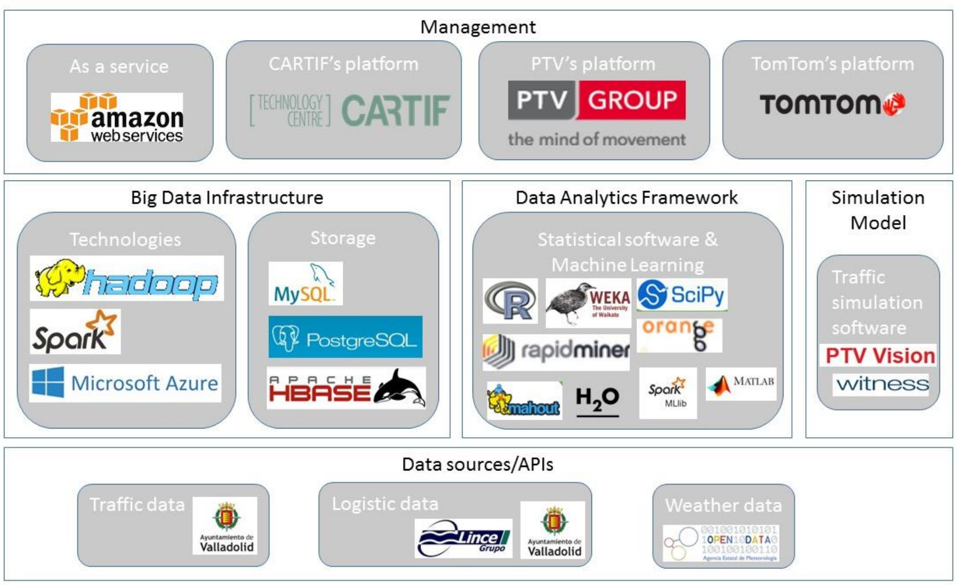


Figure 18 Valladolid Urban Mobility and Freight Pilot. Data Infrastructure.

3.8 Roadmap

Table 5 Roadmap for the Valladolid pilot

Stage	Delivery Date (Project Month)	Features / Objectives Addressed	Embedding in Productive Environment	Big Data Infrastructure Used	Scale of Data
S1: Technology Validation	Month 9	O1 – Area A	Validate data analytics algorithms to extract knowledge	Cartif's infrastructure + PTV infrastructure	Historical real data from 2016 + Area A
S2: Large-scale experimentation and demonstration	Month 15	O1 – Area B O2 – Area A	Validate simulation model to predict occupation in load and unload places	Cartif's infrastructure + PTV infrastructure	Historical real data from 2016 and 2017 + Area A Historical real data from 2016 + Area B
S3: In-situ trials	Month 27	O2 – Area B O3 – Area A		Cartif's infrastructure + PTV infrastructure + AWS if needed	Historical real data from 2017 + Area B

4 Commonalities and Replication

4.1 Common Requirements and Aspects

The two pilots on Integrated Urban Mobility are located in cities with a similar size (200, 000– - 300, 000 inhabitants) which are the major local centres.

Both cities are looking for solutions for urban logistics, mainly for optimising the parking of freight vehicles in the city centre. In Valladolid there is a freight delivery parking system in place, using specific traffic signs and disks, which are used by the drivers. In Tampere, there is no such regulated system, but due to the new parking policy the number of on-road parking will decrease, and the city is looking for new solutions together with major stakeholders. An electronic system for parking space reservation for goods delivery is proposed.

Common requirements in both pilot sites are:

- Improvement of the situational awareness of traffic flow in the City. In Tampere, the main focus is on improving the knowledge of the TMC on the traffic status, which will allow to inform more efficiently on traffic status. In Valladolid, the focus is on providing fleet management (and drivers) with better information to support planning.
- Reduction of traffic congestion. In Tampere, this is planned through development of tools for Traffic Management Centre allowing to take measures to mitigate traffic jams. In Valladolid traffic congestion will be reduced as a consequence of improved freight delivery flow, mainly at specific time slots, e.g. when activity at loading and unloading areas is maximum.
- Ensuring the viability of urban logistics. In Tampere, a solution will be developed together with major stakeholders to find a solution for freight delivery, especially taking into account future parking scarcity. In Valladolid, logistic operator will know prediction of how freight parking occupation is, allowing to plan trips avoiding waste time looking for parking.
- Optimization of parking of freight delivery in the city centre, reduce time for freight delivery spent in the city centre.

4.2 Replication

Both cities have similar probems, and needs to improve situational awareness and urban logistics. The concepts which will be piloted in Tampere, like the tools for the TMC and the reservation system for freight delivery, are of relevance for Valladolid. Partners will exchange experiences on the implemented measures during the project, both for situational awareness and urban logistics, and check for the feasibility of implementation of the concepts in their city. The focus in Valladolid on parking place availability is more on simulation, in Tampere on reservation of parking slots.

5 Conclusions

This document describes the plans for the integrated urban mobility pilots in the Transforming Transport project. The initial pilot takes place in the city of Tampere, Finland, and the replication pilot in Valladolid, Spain. This document will serve as a reference for the work performed in these two pilots.