simpli·city

The Road User Information System Of The Future

WP7 – Use Case I: Meeting the Increased Mobility Demand

D7.1.1: Preliminary Use Case Specification (Use Case I)

Deliverable Lead: SRM

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This deliverable describes real-world scenarios that will form the base for the real-world validation process within SIMPLI-CITY. The scenarios will be based on two different use case topics, one located in Dublin and one in Bologna and related services. Data sources and use case requirements are highlighted. This deliverable is a preliminary use case specification that will be followed by an extended final one.

SEVENTH FRAMEWORK PROGRAMME

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Executive Summary

The SIMPLI-CITY project foresees two Use Case scenarios, which will be the way to test the theoretical structure and software prototypes in a real-world environment. Indeed the work package WP7, along with WP8, is aimed to demonstrate the effectiveness of SIMPLI-CITY to provide reliable mobility-related services and apps to be delivered to road users by means of the Personal Mobility Assistant.

In the framework of the work package WP7, this deliverable D7.1.1 presents preliminary specifications for the Use Case I: “Meeting the Increased Mobility Demand”.

The Use Case I is further divided into two topics: “Routing to a Big Event” (Use Case topic I.1, located in Dublin) and “Personalised Traffic Restrictions” (Use Case topic I.2, located in Bologna). Those two Use Case topics are strictly connected to each other: Indeed the Use Case I.2 in Bologna is partly based on the Use Case I.1 in Dublin, because data elaboration procedures from tests in Dublin are part of personalised traffic restrictions elaboration in Bologna.

The Use Case topic I.1 in Dublin is further divided into two subtopics: “Road Traffic Diagnosis” (Dublin1) and “Road Traffic Prediction” (Dublin2).

For assessing the Use Case topics (and subtopics), a common layout is used in order to allow comparison among them, and analysis of aspects like goals, actors, exploited data set(s), or pre- and post-conditions. All available data sets from Bologna and Dublin are listed in this deliverable and assessed, as well as actors and pre- and post-conditions.

This deliverable provides only an initial description of Use Cases implementation. Thus, within deliverable D7.1.2, a final Use Cases specification will be presented.

Table of Contents

1 Introduction

SIMPLI-CITY – The Road User Information System of the Future – is a project funded by the Seventh Framework Programme of the European Commission under Grant Agreement No. 318201. It provides the technological foundation for bringing the "App Revolution" to road users by facilitating data integration, service development, and end user interaction.

Within this document, a preliminary definition of Use Cases related to the realization of SIMPLI-CITY as well as a list of potential data sources needed for the implementation of these Use Cases, are provided.

In the framework of work package WP7, this deliverable D7.1.1 presents preliminary specifications for the Use Case I: "Meeting the Increased Mobility Demand". The Use Case I is further divided into two topics: "Routing to a Big Event" (Use Case topic I.1, located in Dublin) and "Personalised Traffic Restrictions" (Use Case topic I.2, located in Bologna). Those two Use Case topics are strictly connected to each other. The Use Case topic I.1 in Dublin is further divided into two subtopics: "Road Traffic Diagnosis" (Dublin1) and "Road Traffic Prediction" (Dublin2).

1.1 SIMPLI-CITY Project Overview

Analogously to the "App Revolution", SIMPLI-CITY adds a "software layer" to the hardware-driven "product" mobility. SIMPLI-CITY will take advantage of the great success of mobile apps that are currently being provided for systems such as Android, iOS, or Windows Phone. These apps have created new opportunities and even business models by making it possible for developers to produce new applications on top of the mobile device infrastructure. Many of the most advanced and innovative apps have been developed by players formerly not involved in the mobile software market. Hence, SIMPLI-CITY will support third party developers to efficiently realise and sell their mobility-related service and app ideas by a range of methods and tools, including the Mobility Services and Application Marketplaces.

In order to foster the wide usage of those services, a holistic framework is needed which structures and bundles potential services that could deliver data from various sources to road user information systems. SIMPLI-CITY will provide such a framework by facilitating the following main project results:

- Mobility Service Framework: A next-generation European Wide Service Platform (EWSP) allowing the creation of mobility-related services as well as the creation of corresponding apps. This will enable third party providers to produce a wide range of interoperable, value-added services, and apps for drivers and other road users.
- Mobility-related Data as a Service: The integration of various, heterogeneous data sources like sensors, cooperative systems, telematics, open data repositories, people-centric sensing, and media data streams, which can be modelled, accessed, and integrated in a unified way.
- Personal Mobility Assistant: An end user assistant that allows road users to make use of the information provided by apps and to interact with them in a non-distracting way – based on a speech recognition approach. New apps can be integrated into the Personal Mobility Assistant in order to extend its functionalities for individual needs.

To achieve its goals, SIMPLI-CITY conducts original research and applies technologies from the fields of Ubiquitous Computing, Big Data, Media and Data Streaming, the Semantic Web, the Internet of Things, the Internet of Services, and Human-Computer Interaction. For more information, please refer to the project Website at http://www.simpli-city.eu.

1.2 Document Purpose, Scope and Context

The overall objective of work package WP7 is to demonstrate (together with WP8) the feasibility of SIMPLI-CITY's approach to build services and innovative mobility-related end user apps by integrating different data sources and to present them to the end user by means of the Personal Mobility Assistant. In the context of work package WP7, the purpose of this document is to explain how the solutions provided by SIMPLI-CITY are applicable in a real-world setting and to provide valuable insights from real-world tests to the Research, Technology, and Development (RTD) work packages.

Therefore, this deliverable D7.1.1 is focused on the initial Use Case definition including a first preliminary description of the scenario (containing the according data sources and their descriptions). A more in-depth analysis of the Use Cases will be performed in the following deliverable D7.1.2 "Final Use Case Specification (Use Case I)", including an estimation of the required equipment for the test bed(s), and the metrics needed for the later evaluation of the Use Case implementation and taking into account the work undertaken in the project's RTD work packages (namely the work packages WP4-6).

1.3 Document Status and Target Audience

This document is listed in the Description of Work (DoW) as "public" since it provides preliminary specifications for the SIMPLI-CITY Use Case I: "Meeting the Increased Mobility Demand" and can therefore be used by external parties in order to get according insight into the project activities.

While the document primarily aims at the project partners, this public deliverable can also be useful for the wider scientific and industrial community. This includes other publicly funded projects, which may be interested in collaboration activities. Furthermore, potential operators of the SIMPLI-CITY framework like, e.g., municipalities, will get a preliminary insight into the benefits from SIMPLI-CITY.

1.4 Abbreviations and Glossary

A definition of common terms and roles related to the realization of SIMPLI-CITY as well as a list of abbreviations is available in the supplementary document "Supplement: Abbreviations and Glossary", which is provided in addition to this deliverable.

Further information can be found at http://www.simpli-city.eu.

1.5 Document Structure

This document is broken down into the following sections:

- Section 1 provides an introduction for this deliverable, including a general overview of the project, and outlines the purpose, scope, context, status, and target audience of this deliverable.

- Section 2 provides a short description of the frame of this deliverable.
- Section 3 describes the subtopic Dublin1: “Road Traffic Diagnosis” – that is the first subtopic of the Use Case topic I.1 “Routing to a Big Event” – and its planned implementation in Dublin.
- Section 4 describes the subtopic Dublin2: “Road Traffic Prediction” – that is the second subtopic of the Use Case topic I.1 “Routing to a Big Event” – and its planned implementation in Dublin.
- Section 5 provides a description of the Use Case topic I.2 “Personalised Traffic Restrictions” and its planned implementation in Bologna.
- Section 6 provides a short description of the activity that will be performed for latter evaluation of the Use Case implementation.
- Section 7 shortly draws the conclusions of the deliverable.

2 Use Case I: Meeting the Increased Mobility Demand

Besides the theoretical definition of the structure of the SIMPLI-CITY architecture (see deliverable D3.1: Global Architecture Definition), a further step to do is to test and validate the prototypes delivered by work packages WP4-6 in real-world scenarios. For this purpose, two Use Case scenarios are foreseen by the SIMPLI-CITY project:

- Use Case I: Meeting the Increased Mobility Demand.
  - Use Case Topic I.1 “Routing to a Big Event”.
  - Use Case Topic I.2 “Personalised Traffic Restrictions”.
- Use Case II: Enhancing the Driving Experience.
  - Use Case Topic II.1 “Environmental Awareness Rising”.
  - Use Case Topic II.2 “Rising the Driver’s Comfort”.

This deliverable D7.1.1 provides detailed information about Use Case I and more specifically Use Case topic I.1 “Routing to a Big Event” in Dublin (Sections 3 and Section 4) and Use Case topic I.2 “Personalised Traffic Restrictions” in Bologna (Section 5). The Dublin Use Case topic has been divided into two subtopics concerning respectively road traffic diagnosis (subtopic Dublin1) and road traffic prediction (subtopic Dublin2).

The two Use Case topics in Dublin and Bologna are strictly connected to each other, in particular the Use Case I.2 is partly based on the Use Case I.1, because data elaboration procedures from Dublin Use Cases are part of the personalised traffic restrictions elaboration that will be conducted in Bologna.

Concerning data, in particular, all available data sets from Bologna and Dublin are listed and analysed in this deliverable, as well as for actors, pre- and post-conditions. Assessing the Use Cases, a common layout is used in order to allow comparison among them.

The three scenarios are described in the following Sections and for each of them the conditions that must be true for their implementation are individuated. Such conditions are strictly related to several SIMPLI-CITY tasks that are being accomplished throughout the development of the project. And these tasks are related to components of the SIMPLI-CITY Architecture, as described in the deliverable D3.1: Global Architecture Definition.

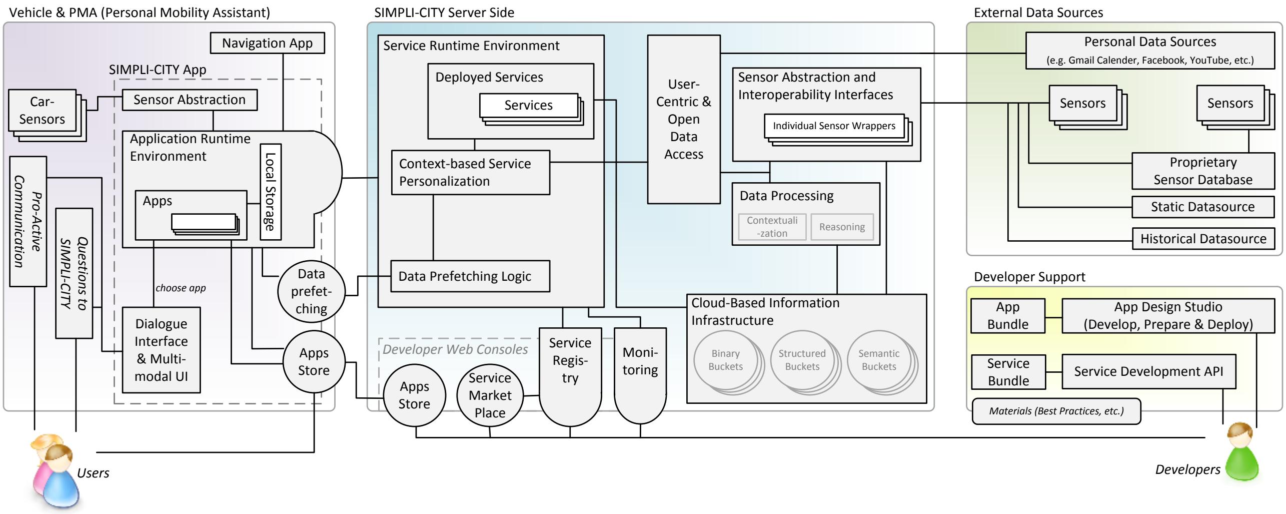

Figure 1: SIMPLI-CITY Architecture

Open data model and access are delivered by Task 4.1 (Privacy-Aware Data Modelling and Access Framework). Indeed this task develops the means to support the description, annotation, and handling of mobility-related data.

Data storage is handled by Task 4.2 (Cloud-based Information Infrastructure), facilitating the access, storage, and retrieval of mobility-related data.

Stream data model and access are delivered by Task 4.3 (Sensor Abstraction and Interoperability Interfaces). It provides the means to integrate real-data coming from different sources i.e., sensors and sensor networks in general, small objects, telematics, and cooperative systems.

User data management is provided by Task 4.4 (User-Centric Data and Open Data Management). It facilitates integration between user-centric data and open data repositories.

Stream data model and access are delivered by Task 4.5 (Media Data Streams and Data Prefetching), providing interfaces to let services and end user applications make use of data streams and developing data prefetching mechanisms.

Service deployment is accomplished by Task 5.1 (Service Development API). It offers service developers the means to access the technical components that may need them and support them with the functionalities needed to design and develop new mobility-related services.

Service personalisation is handled by Task 5.2 (Context-based Service Personalisation) to define information necessary to describe the status of end user, locations or objects relevant to the interaction between the end user itself and an application.

Runtime environment and registry is accomplished by Task 5.3 (Service Registry and Service Runtime Environment). This task offers the backend functionalities to register, discover, and invoke services.

Applications/Services marketplaces are delivered by Task 5.4 (Mobility Service and Application Marketplaces), providing an environment from which end user applications can be downloaded and used by mobile devices, other applications or service developers.

Dialogue and voice-based multimodal user interface is delivered by Tasks 6.1-6.2 (Voice-based Multimodal User Interface). These tasks are aimed to develop a multimodal User Interface able to interact with the end user in a non-distracting way.

Environment for applications runtime is provided by Task 6.3 (Mobile Application Runtime Environment). This task is aimed to deliver the user frontend functionalities, i.e., to execute applications and integrate them into the Personal Mobility Assistant.

Environment for design of applications is provided by Task 6.4 (Application Design Studio) and a graphical user interface will be accomplished to support application developers during the whole development process.

3 Use Case Topic I.1: Routing to a Big Event – Subtopic Dublin1: "Road Traffic Diagnosis"

3.1 Introduction and Motivation

The domain targeted by this scenario is transportation and advanced traffic analytics for realizing the road user information system of the future.

Every year, road traffic congestion wastes billions of hours of time and uselessly produces tons of carbon in the atmosphere. More important, it is getting worse, year-by-year. It also stresses and frustrates motorists, encouraging road rage and reducing health of motorists themselves, and increases traffic inefficiency in the cities (e.g., a situation of traffic congestion may dramatically interfere with the passage of emergency vehicles travelling to their destinations where they are urgently needed). All of them, among others, are examples of negative effects of congestion in cities.

Quick and reliable information on occurrence of traffic congestion in specific streets or a specific area may be very precious for road users in order to let them choose to avoid those streets. And such information could even be valuable for appropriate tools and services to design and propose road users some alternative routes for their trips.

Traffic congestion can be easily detected, visualized and analysed through stream traffic data (e.g., GPS location of vehicles, loop detector) or by interpreting various standards such as SIRI (Service Interface for Real Time Information) and SCATS (Sydney Coordinated Adaptive Traffic System). Optimization mechanisms using existing data mining and machine learning approaches are examples of techniques used by modern traffic systems.

However, the matter of explaining traffic congestion causes is a more complex challenge. About half of traffic congestion is recurring, and it could be attributed to rush hours; on the other hand, most of the rest could be attributed to no recurring events, such as road accidents, roadwork, major events or critical weather conditions. Obtaining explanations in real-time when a congestion suddenly occurs in the road network is yet an unexplored issue in transportation research. Contrary to the well-known Traffic Message Channel (TMC), which mainly delivers any types of traffic and travel information to motor vehicle drivers, SIMPLI-CITY will provide new information that can be exploited by end users. Indeed, explanations of bad traffic conditions will be provided. The latter requires integration and interpretation of a large amount of data, not simply capturing and delivering it to the end user as it is currently done in state-of-the-art solutions. Furthermore, thanks to SIMPLI-CITY, this information could also be exploited by app/service developers in order to provide value-added apps or services.

3.2 Goals and Objectives

This scenario addresses the road traffic congestion diagnosis issue, i.e., how to identify the nature and causes of traffic congestions by answering related questions, e.g.:

- How does a specific event impact the traffic condition of this area?
- Shall delays be expected?
- Is re-routing appropriate?

Such questions have remained open because relevant data sets (e.g., about road works, city events), their correlation (e.g., road works and city events connected to the same city area), and historical traffic conditions (e.g., road works and congestion in Dublin's Canal street on July 24th, 2010) are not fully open and jointly exploited.

Pure Artificial Intelligence (AI) diagnosis approaches focus on the latter point for inferring the cause-effect relationships while Semantic Web technologies tackle the first two points for integrating heterogeneous and large data. However, pure AI diagnosis approaches fail to timely compute diagnosis results for large-scale applications such as the traffic ones, system diagnosis (vehicles motors), and fault systems. In SIMPLI-CITY, current approaches will be extended to compute accurate diagnoses for situations where cause-effect relationships have not been established before. The list of potential heterogeneous sources of effects (road traffic congestion) and their causes (e.g., road weather conditions, events) that we consider in this scenario will be provided by city partners of the consortium (see Dublin and Bologna related data sets in Tables 1-7 of this deliverable).

The following is an example of end user and Personal Mobility Assistant (PMA) interaction:

- Jane: "I'd like to know the traffic condition on M50 now".
- PMA: "There is a traffic jam right now".
- Jane: "Why?".
- PMA: "A car accident happened 30 minutes ago in the M50 – M10 junction in Dublin West".

3.3 Actors

The actors of the Dublin1 scenario are as following:

- SIMPLI-CITY end users that will interact with the traffic diagnosis system through a SIMPLI-CITY app (always running in the PMA) in order to have real-time explanation of traffic situations in desired zone. They are responsible for stating the context, i.e., time of the day, location and anomaly to be diagnosed (e.g., congested roads, delayed ambulance, delayed buses). In an according app, this context could also be automatically derived and provided to the app, i.e., minimizing the necessary end user interaction.
- SIMPLI-CITY software developers can take advantage of the traffic diagnosis system through its public APIs. The latter will allow easy composition and integration with other apps and services. Their role consists in ingesting and manipulating results from the traffic diagnosis APIs following a specific pre-determined interface.

3.4 Description

In the context of SIMPLI-CITY, various sources of data from the transportation department of large cities (firstly experimented with Dublin) will be used to decrypt the reason of traffic congestions in these cities. The automated diagnosis method, core-reasoning service of SIMPLI-CITY, will be used for helping the car driver to have an understanding of real-time traffic situation in cities. This aspect of the SIMPLI-CITY framework can be used by car, bus or truck drivers, and pedestrians but also city managers.

Using SIMPLI-CITY, it will be possible to automatically detect in real-time traffic congestion or delayed buses as traffic anomalies and retrieve their diagnosis as the set of possible

events that could be the causes. In a traffic context, queries such as “Why is there a traffic congestion in Dawson road now?” are answered by SIMPLI-CITY approach: “This is caused by a music concert in Canal road that starts in 30 minutes, with a probability of 0.4”. In addition investigation on when traffic congestion may be expected to stop will also be part of this scenario, and queries such as “When is the traffic congestion expected to be over?” are answered by SIMPLI-CITY approach: “This is expected to be over within 120 minutes, with a probability of 0.5”.

In addition to the traffic congestion detection in real time and relative diagnosis, search facilities are envisioned to easily retrieve explanations (filtered by time: date, period of the year; space: location, street, junction; impact). In conclusion, appropriate visualization features will be provided for easily interpreting congestions and their diagnosis over time and space.

The DoW has originally listed various service examples for both the subtopics Dublin1 and Dublin2, within the Use Case Topic I.1 “Routing to a Big Event”. During the first investigation about the Use Case, the consortium has identified the following ones as being high-priority services that should be implemented first:

- Context-based control of navigation
- Initial alternative routes and transport modes planning
- Individual traffic updates during the journey
- Recommendations of other transport modes during travel

Such services (and according end user apps) will provide a set of functionalities aimed at a end user, willing to attend a big event and needing real-time information to reach the destination in the quickest and most profitable way, e.g., regarding the actual traffic condition, available transport modes, etc.

Afterwards, additional services (e.g., parking space-related services) could be added one-by-one and they will be definitely individuated and described within next deliverable D7.1.2, where final Use Cases specification will be presented, depending on results of next user interviews, actual availability of related data and the remaining efforts.

3.5 Data Set

This scenario will require the data sets described in Table 1. Data is described along its source, description, format type, frequency update, available historic data (from when it has been collected), size of data available collected per day and name of the data provider. It contains:

- The Dublin Bus Stream, which is encoded according to the SIRI standard (http://www.siri.org.uk). The real-time stream is persisted into a Comma-Separated Values file (CSV). Each file represents one day of SIRI data, i.e., information of 1,000 buses is updated every 20 seconds. Congested buses, delayed buses and congested roads can be captured in real-time by processing this stream of information.
- The Dublin traffic flow measurement, which is encoded according to the SCATS standard. It captures the density of traffic on some roads of Dublin City. Therefore this data set will be used for complementing and confirming the congestion status captured by SIRI.

- The journey times across some roads in Dublin City, represented in TRIPS (Travel-time Reporting and Integrated Performance System) format. This real-time stream is persisted into CSV and is required for capturing congested roads, mainly by complementing information captured by SIRI.
- Social media feeds, which are related to traffic-related information in Dublin City. Accidents, delays are frequently updated in real-time using reputable sources of information.
- Weather information, which is used for contextualising road traffic conditions.
- Road weather condition, which capture the status of roads in Dublin City, e.g., amount of precipitation, temperature of roads.
- Road works and maintenance, which captures all types of road works together with their contractor, duration, impact on traffic.
- City Events, which are captured through Eventful (http://eventful.com) and EventBrite (http://www.eventbrite.com). An average of 187 main events a day are reported in Dublin City.
- DBPedia together with a core Static Ontology, which are used for representing SIRI, SCATS, TRIPS, social media feeds, weather information, road conditions, road works and city events.
- In addition to the above data sets, the Dublin City road network is used for interpreting road traffic congestion propagation in Dublin City.

The following Table 1 shows an overview of Dublin City Data Sets available for the Dublin1 Scenario development. For each “Data source” a very short “Description” is provided with also the information on the relative “Format type”. The “Temporal frequency” (in seconds) indicates the regularity of such data updating and the “Historic” indicates the year when such data has been made available. The “Size estimation per day” (in Gigabytes) indicates the expected dimension of data to be received by the “Data provider” per day, in order to keep the relative Data source continuously updated.

Table 1: Overview of Dublin City Data Sets for Dublin1 Scenario (Traffic Diagnosis)

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
Dublin Bus Stream	Vehicle activity (GPS location, line number, delay, stop flag)	SIRI XML-based	20	2010	4-6	(Private) Dublin City Council
Dublin Traffic Flow Measurement along 24 Traffic Intersection IDs	Traffic Light Strategy	XML	30	2011	0.055	
	Strategic Intersection Sensing	XML	900	2011	0.022	
Journey times across Dublin City (47 routes)	Dublin Traffic Department’s TRIPS system	CSV	60	2012	0.028	(Public) Dublinked – (http://dublinked.ie/datastore/datasets/dataset-215.php)

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
Social-Media Related Feeds	Reputable sources of traffic information in Dublin Ireland	tweets	user-generated	2011	0.001	(Public) LiveDrive (https://twitter.com/LiveDrive), Aaroadwatch (https://twitter.com/aaroadwatch), GardaTraffic (https://twitter.com/GardaTraffic)
Wunderground for Dublin	Real-time weather information	CSV	[5, 600] (depending on stations)	1996	[0.050, 1.5] (depending on stations)	(Public) Wunderground (http://www.wunderground.com/weather/api)
Road Weather Condition	Temperature of road surface (54 stations)	CSV	600	2012	0.1	(Public) NRA (NRA - National Roads Authority http://www.nratraffic.ie/weather)
Road Works and Maintenance	Information on road works and maintenance	PDF	3,600	2012	0.01	(Public) Dublinked (http://dublinked.ie)
Events in Dublin (small)	Events with small attendance	XML	Not considered	2011	0.001	(Public) Eventbrite (https://www.eventbrite.com/api), UpComing (http://api.eventful.com)
Events in Dublin (large)	Events with large attendance	XML	Not considered	2011	0.05	(Public) Eventful (http://upcoming.yahoo.com/services/api)
DBPedia	Structured facts extracted from wikipedia	RDF	No	No	3.5 × 106 concepts	(Public) DBPedia (http://dbpedia.org)
Dublin City Roads	Listing of type, junctions, GPS coordinate	RDF	No	No	0.1	(Public) Linkedgeodata (http://linkedgeodata.org)

3.6 Pre-Conditions and Post-Conditions

Making reference to the Global Architecture, components, and relative tasks as described in Section 2, the conditions that must be true for the Dublin1 scenario to start are:

- Access to a web connection for accessing all data and services related infrastructures. That will be accomplished by means of SIMPLI-CITY tasks T4.1-T4.5 and T5.1-T5.5.
- Installing/Access to the application that achieve the Dublin1 scenario through task T5.4.
- Access to sensor data in The following Table 1 shows an overview of Dublin City Data Sets available for the Dublin1 Scenario development. For each "Data source"

a very short "Description" is provided with also the information on the relative "Format type". The "Temporal frequency" (in seconds) indicates the regularity of such data updating and the "Historic" indicates the year when such data has been made available. The "Size estimation per day" (in Gigabytes) indicates the expected dimension of data to be received by the "Data provider" per day, in order to keep the relative Data source continuously updated.
- Table **1** through tasks T4.1and T4.3.
- Access to the end user request through the application in tasks T6.3 and T6.4.
- Access to end user profile for personalisation through tasks T4.1 and T5.2.
- Access to unified data model for easy integration capturing road traffic congestions and various heterogeneous type of data through tasks T4.1, T4.3, and T4.4.
- Access to a reasoning module for capturing road traffic congestions through correlation, fusion, filtering techniques, and retrieving diagnoses of congested roads, congested buses and delayed buses. This is achieved through tasks T4.1 and T4.4.
- Access to a cloud infrastructure for retrieving historical information and storing results, all through task T4.2.
- Access to a voice-based multimodal end user interface through tasks T6.1 and T6.2 for communicating end user requests and systems results.
- Access to available anomalies (congested buses, delayed buses, congested roads) to be diagnosed through tasks T4.1 and T4.4.

The condition that must be true for Dublin1 scenario to terminate successfully is:

- Sufficient mobile battery to communicate and display the results.
- Sufficient network connection.

3.7 Trigger

The SIMPLI-CITY end user initiates the Dublin1 scenario by requesting explanation of congested roads or buses in Dublin City. Once the Dublin1 scenario application is selected, two possibilities are offered to the SIMPLI-CITY end user:

- Getting real-time road traffic diagnosis and their results given a spatial boundary box and a set of pre-selected parameters (e.g., type of road traffic anomalies such as congested buses, roads) over Dublin City.
- Searching historical road traffic diagnosis given a spatial boundary box over Dublin City and a time window.

The latter possibilities can be easily interpreted by the SIMPLI-CITY app and service developer through various visualisation techniques i.e., map-based, graph-based, diagram-based representation of diagnosis results, all interpreted by the multimodal framework of SIMPLI-CITY. The different multimodal options that will be made available by the Multimodal Dialog Interface component to generate User Interface (UI) will be further regarded within next deliverable D7.1.2, where final Use Case specification will be presented.

3.8 Main Flow

In the context of road traffic diagnosis, the SIMPLI-CITY end user (i.e., the road user) and system interact reciprocally. In this deliverable, only a general overview of the information

and data flow is presented. Further details will be provided in the next deliverable D7.1.2 Final Use Case Specification (Use Case I), taking into account the work undertaken in the project's RTD work packages (namely the work packages WP4-6).

First of all, the SIMPLI-CITY end user specifies the type of traffic anomaly she/he is interested in, e.g., delayed buses, congested buses, congested roads, and a boundary box where the system should track for anomalies and diagnosis results. The SIMPLI-CITY system updates in real-time the status of anomalies and their diagnosis. Finally, the SIMPLI-CITY end user may explore and select anomalies to have a more detailed description of their diagnosis. This information could also be used by app/service developers in order to provide value-added apps or services.

In the context of the search of historical road traffic diagnosis, the SIMPLI-CITY end user and system interact as following. First of all, the SIMPLI-CITY end user optionally specifies the following parameters:

- The type of traffic anomaly the end user is interested in, e.g., delayed buses, congested buses, or congested roads.
- A boundary box or specific location where the system should track for anomalies and diagnosis results.
- A time window.
- Some keywords for refining the search.

Then the SIMPLI-CITY system displays information and statistics related to the query results.

This analysis can then be used in an app to deliver according information to the end user. Furthermore, it could also be exploited by app/service developers in order to provide value-added apps or services.

3.9 Relationship With Other Use Cases

Implementation and findings of the subtopic Dublin1 can be the basis both of the subtopic Dublin2 and of the Use Case Topic I.2 in Bologna.

In particular, the Dublin1 scenario can be integrated into the Bologna scenario. Once integrated, SIMPLI-CITY end users could get explanation on why re-routing is suggested. For instance re-routing could be proposed because of an accident on a specific street or because of a concert on another road.

Furthermore, the functionalities of this Use Case scenario can be integrated also with the Use Case II "Enhancing the Driving Experience" scenarios, which provide functionalities related to environmental awareness and driver's comfort rising.

3.10 Use Case Requirements

In relation with the main flow (Section 3.8), and according to deliverable D2.3 (Requirements Analysis), the PMA will have to take into account the following main requirements:

- SIMPLI-CITY end users should have the possibility to have real-time explanation of abnormal traffic conditions. In other words, reasoning mechanisms should be supported by SIMPLI-CITY for identifying the nature and causes of abnormal traffic conditions such as traffic congestion.

- Offer functionalities for querying historic diagnosis results through the following parameters: The type of traffic anomaly the end user is interested in, e.g., delayed buses, congested buses, congested roads, a boundary box or specific location where the system should track for anomalies and diagnosis results, a time window, some keywords for refining the search.

3.11 Priority

The Dublin1 scenario is of high priority (1) in the SIMPLI-CITY system on a scale of [1,5].

4 Use Case Topic I.1: Routing to a Big Event – Subtopic Dublin2: "Road Traffic Prediction"

4.1 Introduction and Motivation

The domain targeted by this scenario is transportation and advanced traffic analytics for supporting the road user information system of the future.

Good road navigation systems should be able to anticipate critical situations in road traffic, e.g., congestions, major delays, or strong perturbations, so relevant and accurate solutions are available in real-time. In such a way, car drivers would have the possibility to anticipate critical road traffic situations and reach any part of a city without unexpected conditions. SIMPLI-CITY, through this scenario and its exposed services, aims to provide such a navigation system. By predicting road traffic condition, SIMPLI-CITY ensures complete satisfaction of end users.

SIMPLI-CITY will make use of the spatial-temporal correlation of heterogeneous data (e.g., mobility-related data such as SIRI bus data, loop detector following the SCATS format, weather information, road conditions) for anticipating a critical situation in road traffic and then provide flexible services and apps to car drivers. In particular, SIMPLI-CITY will make strong use of the auto-correlation of heterogeneous stream data from various Dublin City sensors (e.g., real time weather information, bus information, travel time estimates) to understand how data is linked over time and sensors. This information can then be used both in backend services and end user apps.

Contrary to *diagnosis* (as presented in Section 33), which correlates causes to its effects, road traffic *prediction* aims at deriving its effects. Similarly to the diagnosis scenario, SIMPLI-CITY will integrate relevant information from various sensors in Dublin City.

4.2 Goals and Objectives

This scenario addresses the road traffic prediction problem, i.e., how to predict when buses will be delayed? When buses will be congested? When roads will be congested? When travelling time on some roads will not be acceptable? All this requires access to different sources of information (e.g., historical information about buses, the Dublin road network) for understanding how both delays and congestion are propagated. Other sources of information e.g., weather information, road condition, road travel time, are also important as they can help in correlating facts e.g., bad road conditions could impact travelling time, which combined together also impact the road congestion status.

The objective of this scenario is to show how SIMPLI-CITY can easily handle flexible traffic-related prediction using heterogeneous mobility and traffic related data, where information is evolving on a time basis, and where external and heterogeneous information from open data and sensors need to be integrated and correlated. Discovery, personalization, and composition of mobility-related services and their data are of important interest in this scenario.

Contrary to state-of-the-art approaches, which do make use of the context, the SIMPLI-CITY approach will provide flexible predictive reasoning mechanisms to support any traffic-

related event to be predicted. Congested roads and buses are examples of events that will be predicted in this scenario.

The following is an example of end user and PMA interaction:

- Jane: "I'd like to know the traffic condition in 55 minutes on M50"
- PMA: "The traffic condition is slow and expected to be normal on 30 minutes".

4.3 Actors

The actors of the Dublin2 scenario are as following:

- SIMPLI-CITY end users that will interact with the traffic prediction system through a SIMPLI-CITY app in order to have real-time prediction of traffic situations. Similarly to the Dublin1 scenario, they are responsible for stating the context. Therefore they give information about the type of prediction (i.e., congested roads, congested or delayed buses), a boundary box where they want the prediction, and a time window for the prediction to be elaborated. In an according app, this context could also be automatically derived and provided to the app, i.e., minimizing the necessary end user interaction.
- SIMPLI-CITY developers can take benefits of the traffic prediction system through its public APIs. The latter will allow easy composition and integration with other apps, and even customization with other data sets that could be relevant for a better contextualisation of the prediction. The role of the SIMPLI-CITY developers consists in ingesting and manipulating results from the traffic prediction APIs following some specific pre-determined interfaces.

4.4 Description

Similarly to the Dublin1 scenario, the traffic prediction scenario from Dublin will demonstrate how various sources of data from the transportation department of large cities (firstly experimented with Dublin) can be integrated, lifted, combined, fused and relevantly used to predict road traffic conditions, hence providing SIMPLI-CITY end users with insight on traffic dynamics in the city. The automated prediction method, core-reasoning service of SIMPLI-CITY, will be used for helping the road users to make efficient plans. This aspect of the SIMPLI-CITY framework can be used by car, bus or truck drivers, and pedestrians/cyclists but also city managers. The service could also be used and integrated with re-routing techniques for re-shaping routes on the fly based on predictive results.

Once the information to be predicted is known by the SIMPLI-CITY system, real-time prediction is provided and its results are refreshed on a time basis. Locations and boundary boxes could be as large as the complete size of Dublin.

The interface will be specified and optimally designed for mobile apps, so the SIMPLI-CITY system can benefit from all the functionalities.

Similarly to the subtopic Dublin1, also throughout the subtopic Dublin2 several services (and according end user apps) will be developed and implemented.

The DoW has originally listed various service examples for both the subtopics Dublin1 and Dublin2, within the Use Case Topic I.1 "Routing to a Big Event". During the first investigation about the Use Case, the consortium has identified the following ones as being high-priority services that should be implemented first:

- Context-based control of navigation
- Initial alternative routes and transport modes planning
- Individual traffic updates during the journey
- Recommendations of other transport modes during travel

Such services (and according end user apps) will provide a set of functionalities aimed at a user, willing to attend a big event and needing real-time information to reach the destination in the quickest and most profitable way, e.g., regarding the actual traffic condition, available transport modes, etc.

Afterwards, additional services (e.g., parking space-related services) could be added one-by-one and they will be definitely individuated and described within next deliverable D7.1.2, where final Use Cases specification will be presented, depending on results of next user interviews, actual availability of related data and the remaining efforts.

4.5 Data Set

This scenario will require a subset of data sets described already in The following Table 1 shows an overview of Dublin City Data Sets available for the Dublin1 Scenario development. For each "Data source" a very short "Description" is provided with also the information on the relative "Format type". The "Temporal frequency" (in seconds) indicates the regularity of such data updating and the "Historic" indicates the year when such data has been made available. The "Size estimation per day" (in Gigabytes) indicates the expected dimension of data to be received by the "Data provider" per day, in order to keep the relative Data source continuously updated.

Table **1** (with details in Section 3.53.5). In particular, it will require:

- The Dublin Bus Stream to capture delayed buses and inferred congested buses and roads. This will be considered as one main stream for achieving prediction. Mainly it will be used to achieve cross-correlation i.e., identifying similar patterns over the historical information.
- The Dublin traffic flow measurement, to complement and confirm the congestion status captured by the Dublin Bus Stream information. It will also be used as a main stream, where historical correlation will be performed. In addition, it will be used as context for the Dublin Bus Stream information.
- The journey times across some roads in Dublin City, again to complement and confirm the congestion status captured by the Dublin Bus Stream information. Self-correlation will also be performed to derive frequent patterns, and it will also be used as context for the prediction scenario.
- Weather information, which is used for contextualising road traffic conditions.
- Road weather condition, which captures the status of roads in Dublin City, will also be used for contextualising the prediction result.
- City Events, which are captured through Eventful and EventBrite, all used for contextualising traffic prediction results.
- DBPedia together with a core Static Ontology, which are used for encoding the description of various information from the latter data sets.
- The Dublin City road network, which is used for refining the prediction results in Dublin City.

4.6 Pre-Conditions and Post-Conditions

Making reference to the Global Architecture, components, and relative tasks as described in Section 2, the conditions that must be true for the Dublin2 scenario to start are:

- Access to a web connection for accessing all data and services related infrastructures in tasks T4.1-T4.5 and tasks T5.1-T5.5.
- Installing/Access to the application that achieves the Dublin2 scenario through task T5.4.
- Access to sensor data reported in Section 4.5 through tasks T4.1 and T4.3;
- Access to unified data model for easy integration capturing road traffic-related data through tasks T4.1, T4.3, and T4.4.
- Access to a reasoning module for fusing stream data, contextualizing and correlating its information, detecting relevant patterns, identifying relevant rules that can be used for prediction, and applying rules in an appropriate context for accurate prediction. This is achieved through tasks T4.1 and T4.4.
- Access to a cloud infrastructure for retrieving historical information and storing results, all through task T4.2.
- Access to a voice-based multimodal end user interface through tasks T6.1 and T6.2 for communicating end user requests and systems results.

The condition that must be true for Dublin2 scenario to terminate successfully is:

- Sufficient mobile battery to communicate and display the results.

4.7 Trigger

The SIMPLI-CITY end user initiates the Dublin2 scenario by requesting prediction of congested roads or buses in Dublin City. Once the Dublin2 scenario application is selected, prediction results are computed based on the end user request i.e., type of prediction, location and time window.

All results will be displayed on the Dublin City map, so prediction can be easily interpreted by SIMPLI-CITY end users. Furthermore, this information could also be exploited by app/service developers in order to provide value-added apps or services.

4.8 Main Flow

In the context of road traffic prediction, the SIMPLI-CITY end user and system interact reciprocally. In this deliverable, only a general overview of the information and data flow is presented. Further details will be provided in the next deliverable D7.1.2 Final Use Case Specification (Use Case I), taking into account the work undertaken in RTD project's work packages (namely work packages WP4-6).

First of all, the SIMPLI-CITY end user specifies the parameters, which are required to achieve road traffic prediction:

- The type of traffic prediction the SIMPLI-CITY end user is interested in e.g., delayed or congested buses, congested roads, their number, their duration, their probability.
- A specific location or boundary box where the prediction should be computed e.g., a street or a delimited space location.
- Some intervals of time that are required for capturing when the prediction should occur.

The SIMPLI-CITY system updates in real-time the status of prediction, and gives back to the end users the results of the elaboration. This information can then be exploited by app/service developers in order to provide value-added apps or services.

4.9 Relationship With Other Use Cases

Implementation of the subtopic Dublin2 and findings that will be achieved can be integrated into the Bologna scenario and therefore improve the Use Case Topic I.2. If integrated, the system underlying the Bologna scenario can make use of the prediction to improve the quality of the re-routing, e.g., by anticipating and avoiding any area with a large number of congested roads.

Similarly, the predictive approach can also be used to improve the Dublin1 diagnosis scenario. In this context, a diagnosis of future traffic anomalies (e.g., delayed buses, congested buses, congested roads) could be computed, supporting the SIMPLI-CITY end user in better preparing and anticipating her/his journey by car in Dublin City.

The Dublin1 scenario could be itself valuable for the subtopic Dublin2 implementation, providing the baseline to be compared with possible re-routing suggested to SIMPLI-CITY end users.

Furthermore, the functionalities of this Use Case scenario can be integrated also with the Use Case II "Enhancing the Driving Experience" scenarios, which provide functionalities related to environmental awareness and driver's comfort rising.

4.10 Use Case Requirements

In relation with the Main Flow (Section 4.8), and according to deliverable D2.3 (Requirements Analysis), the Personal Mobility Assistant will have to take into account the following main requirements:

- Anticipate critical situations in road traffic, e.g., congestions, major delays, or strong perturbations, so relevant and accurate solutions are available in real-time. In such a way, car drivers would have the possibility to anticipate critical road traffic situations and reach any part of the city without unexpected conditions.
- Provide support for end users to obtain information about their impact factor and their severity (e.g., to show the estimated amount of additional time caused by a traffic jam delay).

4.11 Priority

The Dublin2 scenario is of medium priority (3) in the SIMPLI-CITY system on a scale of [1,5].

5 Use Case Topic I.2: "Personalised Traffic Restrictions", Bologna

5.1 Introduction and Motivation

The domain targeted by this scenario is transportation and advanced traffic analytics for realizing the road user information system of the future.

Mobility needs in a city cannot be considered as a static issue. They change frequently, depending on many different factors. Most of them are related to road users' needs but one important factor is strictly related to traffic restrictions that could be introduced by the city administration to limit access to certain roads or areas of the city. Some of the above mentioned restrictions are time-related, thus they change according to the time or the day of the week (weekdays vs. bank holidays, etc.). Furthermore, restrictions could be affected by policy makers' decisions and the area or the timing are often modified, sometimes even involving public transport routes and timetables.

As a consequence, road users (even more if not living in the city, e.g., tourists) could be uncertain regarding right of access to a given area at a given time by a given mean of transport, and such uncertainty is one of the negative aspects of road restrictions.

Besides traffic restrictions, congestion and/or road works could affect traffic situation in a city. All these factors play a key role for the initial modal choice made by road users. They may prefer to use a different mode of transport, instead of the usual one, for their trips, if duly and timely informed.

5.2 Goals and Objectives

The Bologna scenario will test how to provide road users (car drivers, bus users, cyclists, pedestrians) with information about accessibility of roads and further aspects through the PMA. Thanks to the PMA, road users will be able to plan their own routes taking into account both information about traffic situation and about permissions to enter limited traffic areas in the city.

5.3 Actors

The actors of the Bologna scenario are the following:

- SIMPLI-CITY end users that will interact with the PMA in order to receive real-time information about the accessibility to a specific area of the city. The PMA will be able to take part of the data from the end user profile and from external sources, while some other data will be stated by end users in real time (e.g., context, timing, special needs, permissions, etc.).
- SRM: As Public Transport Authority, SRM manages bus-related data as bus stop locations, bus routes, and bus schedules in Bologna.
- Municipality of Bologna: As local government, the Municipality of Bologna is in charge of traffic planning, traffic regulation and it is responsible for environmental issues. The Municipality of Bologna manages traffic-related data (e.g., length of

queues at traffic lights, real-time traffic on roads, information about parking opportunities, etc.).

- TPB Scarl: TPB Scarl is a consortium between bus operators and manages the public transport service by bus in the city and in the province of Bologna. Bus service is defined by the service agreement between SRM and TPB. TPB manages also bus-related data such as real-time GPS bus positioning and time prediction at bus stops.
- SIMPLI-CITY developers can take benefits of the personalised traffic restrictions system through its public APIs. The latter will allow easy composition and integration with other apps and services, and even customization with other data sets that could be relevant for a better contextualisation of the traffic analysis and prediction and correct elaboration of re-routing.

5.4 Description

Similarly to the scenarios implemented in Dublin within the Use Case Topic I.1, the personalised traffic restrictions scenario from Bologna will demonstrate how various sources of data from the transportation department of large cities (firstly experimented in Bologna) can be integrated and relevantly used to examine actual road traffic conditions and elaborate possible re-routing, hence providing SIMPLI-CITY end users with insight on traffic dynamics in the city. The automated prediction method, core-reasoning service of SIMPLI-CITY, will be used for helping road users to make efficient plans in real time. This aspect of the SIMPLI-CITY framework can be used by car, bus or truck drivers, and pedestrians/cyclists but also city managers.

The Municipality of Bologna collects traffic-related data (e.g., traffic condition, bus locations, car parking lots availability, etc.) through sensors. Data are then processed by specific applications and outputs are used to regulate traffic lights, give useful information to bus users, and inform car drivers on the availability of parking lots.

Furthermore the city is divided into some areas having different traffic restrictions, depending on vehicles and drivers. Restrictions vary also depending on the day and the hour (weekdays and Sunday, day and night, special days, etc.). Some restrictions, for example the city centre pedestrianization during weekends, affect also bus routes.

It is not easy for road users, especially for incoming car drivers, to know exactly which area of the city they can access.

SIMPLI-CITY will act as a specific “assistant” able to know at any time where and how it is possible to access the city. It could help road users to reach their destination easily and using the most appropriate transport mode, thus reducing driving time, congestion and CO_2 emissions.

According to the DoW, Use Case Topic I.2 “Personalised Traffic Restrictions” is only made up from one service:

- Personalised city access.

Anyway this service is by far the largest one in terms of necessary development efforts. At the same time, this service provides the highly innovative functionality of personalised traffic restrictions for the city centre, different neighbourhoods or even single streets, adapted to the current day and time and based on real-time traffic information.
Even if many aspects related to mobility (e.g., traffic condition, bus locations, parking, etc.) are already considered within the service originally foreseen to be implemented in this Use

Case by the DoW, nevertheless additional services (e.g., parking space-related services) could be added one-by-one and they will be definitely individuated and described within next deliverable D7.1.2, where final Use Cases specification will be presented, depending on results of next user interviews, availability of related data and the remaining efforts.

A practical example on how the scenario is expected to work in Bologna Use Case is described in deliverable D2.1, Section 5.1. Deliverable D7.1.2 – Final Use Case Specification (Use Case I) will accurately describe the scenario that will be implemented.

5.5 Data Set

Personalised traffic restrictions scenario will require some different sets of data, related both to the user's vehicle and to the road and traffic conditions. Such data sets will be better illustrated in the next deliverable D7.1.2 – Final Use Case Specification (Use Case I), due in month 18. Anyway, in this section they are introduced and described in short.

User's vehicle information can be listed as follows:

- Number of the car plate.
- Number or code of permission (alphanumeric IDs).
- Emission level values (euro0, euro1, euro2, etc.).
- Power source (gasoline, diesel, CNG, EV, etc.).

Data related to road and traffic conditions and available for the Bologna scenario development are described below in Tables 2-7. Similarly to the Table 1 (showing an overview of Data Sets available for the Dublin scenario development), in the following tables for each "Data source" a very short "Description" is provided with also the information on the relative "Format type". The "Temporal frequency" (in seconds) indicates the regularity of such data updating and the "Historic" indicates the year when such data has been made available. The "Size estimation per day" (in Gigabytes) indicates the expected dimension of data to be received by the "Data provider" per day, in order to keep the relative Data source continuously updated.

They contain:

- The Bologna road network data that are made of 8 different sets, which are all encoded according to the ESRI SDE standard; information is updated every day. These data are necessary to define and describe the road network as framework for the implementation of the scenario in Bologna. Even if updated every day, some of the data could be considered substantially static data, because very few changes could happen (e.g., links, allowed directions of travel, reserved lanes, etc.). While others are more frequently modified (e.g., roadwork, interim traffic measures, etc.).

Table 2: Road Network Data Set

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
Bologna Geographic Information System (BGIS) – Links	Digital mapping of links on roads	ESRI SDE	86,400	2005	0.01	Municipality of Bologna

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
(BGIS) - Allowed direction of travel on links	Digital mapping of allowed travel directions	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
(BGIS) - Reserved lanes	Digital mapping of dedicated bus and taxi lanes	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
(BGIS) - Traffic Lights	Digital mapping of traffic lights' locations	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
(BGIS) - Traffic detectors	Digital mapping of loops' locations	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
(BGIS) – Roadwork	Digital mapping of roadwork and impact on road links	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
(BGIS) - Interim traffic measures	Digital mapping of interim traffic measures and impact on road links	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
(BGIS) - Variable message signs	Digital mapping of variable message signs' locations	ESRI SDE	86,400	2005	0.01	Municipality of Bologna

- Traffic information data are made of 3 different sets, which are encoded according to the Web Service SOAP or Binary standard. Information is updated every 5 minutes. These data will provide the actual status and the density of traffic in some roads and intersections and they will be used to process routing. Dynamic data on traffic flow and status of traffic are provided by the Traffic control centre of the Municipality of Bologna.

Table 3: Real-time and Dynamic Traffic Information Data Set

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
CISIUM - Central Integration and Supervision for Information on Urban Mobility - Traffic control centre - Traffic flow	Dynamic data on traffic flow	Web Service SOAP	300	2011	0.05	Municipality of Bologna
CISIUM - Index of traffic congestion	Traffic status on road links	Web Service SOAP	300	2011	0.05	Municipality of Bologna
Utopia - Urban Traffic Optimisation by Integrated Automation - queues at the traffic light intersections	Length of queues at the traffic light intersections	Binary	300	1999	0.1	Municipality of Bologna

- Public Transport data are made of 7 different sets, which are encoded according to 3 different standards (ESRI SDE, GTFS and Web Service SOAP), dynamic information is updated every 5 minutes and static information every day. These data will provide the actual status of Public Transport service in the city of Bologna.

Table 4: Public Transport Data Set

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
Bus Routes	Digital mapping	ESRI and GTFS	n.a.	2008	n.a.	SRM
(BGIS) - Bus Routes	Digital mapping	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
Bus stops	Digital mapping	ESRI and GTFS	n.a.	2008	n.a.	SRM
(BGIS) - Bus stops	Digital mapping	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
Bus timetable	Digital mapping	ESRI and GTFS	n.a.	2008	n.a.	SRM
(BGIS) - Bus timetable	Digital mapping	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
Waiting time at bus stop	Open-Data	Web Service SOAP	Real time (where available) otherwise scheduled	n.a.	0.05	TPER https://solweb.tper.it/tperit/webservices/hellobus.asmx

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
Nearest ticket office	Open-Data	Web Service SOAP	n.a.	n.a.	0.05	TPER https://solweb.tper.it/tperit/webservices/hellobus.asmx

- The Bologna Cycle Lanes Network data are made of 2 different sets. The content should be the same but they are stored on two different servers, because one data set is an open data, while the other set is reserved to the Municipality. They are both encoded according to the ESRI SDE standard, information is updated every day.

Table 5: Cycle Lanes Data Set

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
(BGIS) - Cycle lanes	Digital mapping of urban cycling lanes	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
Cycle lanes	Open-Data	ESRI SDE	n.a.	2012	0.001	Municipality of Bologna

- Parking data are made of 3 different sets, which are encoded according to ESRI SDE and to Web Service SOAP standards. Dynamic information is updated every 5 minutes while static information is updated every day. These data are useful to locate some of the existing parking structures and to know parking lots availability, as a framework for the implementation of the scenario in Bologna. Data on street park-o-meters' location are available as well.

Table 6: Parking Location and Availability Data Set

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
(BGIS) - Parking structures	Digital mapping of parking structures locations	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
CISIUM - parking status	Parking lots availability in parking structures	Web Service SOAP	300	2011	0.05	Municipality of Bologna
Park-o-meter	Open Data	ESRI SDE	n.a.	2012	0.001	TPER/Municipality of Bologna

- Traffic restriction data are made of 2 different sets, both statics and both encoded according to ESRI SDE standard. Information is updated every day. These data are necessary to define and describe the traffic restrictions introduced by the Municipality of Bologna to manage and regulate traffic in the city. They will be used to process routing, matching with the access permissions in charge of vehicles and drivers.

Table 7: Traffic Restriction Data Set

Data source	Description	Format type	Temporal frequency (in s)	Historic (yyyy)	Size estimation per day (Gbytes)	Data provider
(BGIS) - Limited traffic zone	Digital mapping of restricted traffic areas	ESRI SDE	86,400	2005	0.01	Municipality of Bologna
(BGIS) - Urban pedestrian zone	Digital mapping of pedestrian areas	ESRI SDE	86,400	2005	0.01	Municipality of Bologna

5.6 Pre-Conditions and Post-Conditions

The conditions that must be true for the Bologna scenario to start are:

- Access to information about end user's permissions made by an alphanumeric code, allowing access to one or more restricted areas. This is achieved through tasks T4.1, T5.1 and T5.2.
- Access to information about traffic restrictions in force in the city at the expected travel time. This is achieved through tasks T4.1 and T4.3.
- Access to information about origin (the starting point of the trip or end user's current position) and destination (the ending point of the trip – an address or a Point of Interest (POI)). This is achieved through tasks T4.1, T4.2, T4.4, T6.1, and T6.2.
- Access to data about traffic, congestion, roadwork and road closures (real-time data or historical data).This is achieved through tasks T4.1-T4.4.
- Access to data about bus service: bus availability, bus routes, bus schedules, bus stops, bus GPS position and expected time at bus stops. This is achieved through tasks T4.1-T4.4.
- Access to cycle lanes network through tasks T4.1, T4.2, and T4.4.
- Access to information about parking availability (real-time or historical data). This is achieved through tasks T4.1-T4.4.

The condition that must be true for Bologna scenario to terminate successfully is:

- Data are accessed and processed and the PMA is able to interact with the end users without any problem (battery, stoppage, etc.).

5.7 Trigger

The SIMPLI-CITY end user initiates the Bologna scenario by requesting how to get to a specific destination in Bologna. Once the Bologna scenario application is selected, it will provide to the SIMPLI-CITY end user the following information on her/his route:

- Which traffic restrictions are expected during the trip to the final destination, also depending on road user's traffic permissions.
- Which are the possible routes and modes of transport that fit better with the planned trip, depending on real-time or historical data on traffic, parking, roadwork, road closures, etc.

All the results will be displayed on the Bologna City map, so they can be easily read by SIMPLI-CITY end users. In the meanwhile, a voice command will drive the end user turn-by-turn to the destination, also informing him/her in case a re-routing is needed (unexpected congestions, unavailable parking lots, etc.).

As already mentioned in Section 5.4, even if many aspects related to mobility are already considered within the service originally foreseen to be implemented in this Use Case by the DoW (i.e., personalised city access), additional services could be added one-by-one depending on the remaining efforts and actual availability of related data (e.g., parking space-related services). The next deliverable D7.1.2 will definitely present the final Use Case specification and all the services that will be implemented.

5.8 Main Flow

In the context of personalised traffic restrictions, the SIMPLI-CITY end user and system interact reciprocally. In this deliverable, only a general overview of the information and data flow is presented. Further details will be provided in the next deliverable D7.1.2 Final Use Case Specification (Use Case I), taking into account the work undertaken in RTD project's work packages (namely work packages WP4-6).

First of all, the SIMPLI-CITY end user specifies the origin and the destination of the trip, choosing also the starting time between "now" and "on a specific date". The SIMPLI-CITY system matches the information about end user's traffic permissions, possible routes by car, traffic congestion and possible routes by other mode of transport.

If the starting time of the trip is on a future specific date, the SIMPLI-CITY system will also elaborate historical information about road conditions (traffic, parking lots availability, etc.).

The PMA will provide to the SIMPLI-CITY end user all possible routes, both by car (taking into account traffic restrictions) and by other means of transportation (bus, bicycle, etc.), and will ask the end user to choose one of these routes.

Especially for real-time navigation some events affecting the trip could happen: A sudden increase of congestion, a delay in bus arrival time, a sudden reduction of available parking lots, etc. Any variation that occurs along the route during the trip will be processed by SIMPLI-CITY and further information will be delivered in real-time to the end user through the PMA.

5.9 Relationship With Other Use Cases

The Bologna scenario can be integrated both with the Dublin1 and the Dublin2 scenarios. Once integrated the personal traffic restriction scenario will be able to manage real-time traffic information or predict possible traffic-related problems along the road.

More specifically, the Dublin1 scenario could be valuable for the implementation of the scenario in Bologna, providing a clear and updated description of the traffic situation in the city and a diagnosis useful to properly understand possible usual traffic alterations, e.g., congested road, delayed bus, etc.

Implementation of the subtopic Dublin2 and findings that will be achieved in the scenario of Dublin can be integrated in the Bologna scenario and therefore improve the Use Case topic I.2. If integrated, the system underlying the Bologna scenario can make use of the prediction to improve the quality of the re-routing, e.g., by anticipating and avoiding any area with a large number of congested roads.

Furthermore, the functionalities of this Use Case scenario can be integrated also with the Use Case II "Enhancing the Driving Experience" scenarios, which provide functionalities related to environmental awareness and driver's comfort rising.

5.10 Use Case Requirements

In relation with the Main Flow (Section 5.8), and according to deliverable D2.3 (Requirements Analysis), the Personal Mobility Assistant will have to take into account the following main requirements:

- Optimize the route in order to reduce costs for the end users as much as possible, taking into account parking fees per hours, tolls to access specific areas of the city, traffic congestion affecting travelling time and consequently fuel consumption, etc.
- Calculate the optimized route depending on real-time conditions and mode of transport used. In particular, on one side it should take into account all access restrictions in force in the city (as they change depending on the day and on the time) when calculating the route in order to avoid forbidden areas. On the other side it should be able to re-calculate the route when conditions change (traffic congestion, no more parking lots available, etc.) and communicate to the end user the new route.
- It could be used by end users on different devices, such as smartphones, tablet or on-board car-computers in order to ensure the widest coverage and portability.

5.11 Priority

The Bologna scenario is of high priority (1) in the SIMPLI-CITY system on a scale of [1,5].

6 Evaluation

In this section of the deliverable, a general overview of the evaluation activity is presented. More detailed information on this topic will be provided in the next deliverable D7.1.2 Final Use Case Specification (Use Case I).

A technical evaluation will be accomplished throughout the Use Cases implementation in order to verify the performance of SIMPLI-CITY in real world cases and validate the prototype used in the tests. No involvement of end users is required at this stage. Evaluation will be done by partners FGM, SRM (in collaboration with the Municipality of Bologna) and TEMP. Use case involved partners (TIE, IBM, TALK and CRF) will be asked to actively participate in order to get reliable results from evaluation activities.

A usability evaluation will be accomplished throughout the Use Case implementations in order to verify the performance of the prototype and its level of user-friendliness.

The methodology to test and evaluate the PMA will be discussed and agreed together with all the involved partners. FGM will define an evaluation strategy and provide the evaluation metrics and tools to the consortium.

Findings will be shared with the RTD work packages (i.e., the work packages WP4-6) in order to give feedback to researchers and developers, so that the SIMPLI-CITY processes and outcomes could be improved accordingly.

Overall results of the evaluation activity will be reported in D7.3 Evaluation Report due in project month 36.

7 Conclusions

The aim of this deliverable D7.1.1 was to present an initial specification of the Use Case I: Meeting the Increased Mobility Demand, in which the SIMPLI-CITY platform and solutions will be tested and the reliability of the first Personal Mobility Assistant prototype will be verified in the real world.

Two scenarios will be tested in the city of Dublin dealing with road traffic diagnosis and predictions. The first scenario addresses the road traffic congestion diagnosis issue, i.e., how to identify the nature and causes of traffic congestions. The second scenario addresses the road traffic prediction problem, i.e., how to predict traffic congestions in advance.

The implementation in Bologna will consider the trip (re-)routing in a city with some traffic restrictions directly linked to vehicles and drivers.

Both tests will be useful to evaluate if and at what level the SIMPLI-CITY's PMA could be suitable to road users in planning and conducting their displacements in cities, potentially becoming the "Road User Information System of the Future".

For each case, a first initial description of the scenario has been provided, with its motivation and main objectives; subjects involved have been individuated and their roles have been described; data sets required and main flows to the PMA correct functioning have been illustrated; finally, requirements and conditions for the Use Cases' tests have been presented.

It is then important to stress again the fact that this deliverable D7.1.1 has presented some preliminary specifications. The Use Case's specification is an iterative process, and thus as the work package WP7 and the RTD activities are on-going, it is possible that some SIMPLI-CITY issues could either be enhanced or modified. And thereby services and functionalities to be tested could be different. In particular, additional services (e.g., parking space-related services) could be added one-by-one depending on results of next user interviews, actual availability of related data and remaining efforts. Thus within the forthcoming deliverable D7.1.2, a final and improved Use Case specification will be prepared, which will be based on results from the RTD work packages WP4-6, for which this deliverable provides additional inputs.

References

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