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STREETLIFE

Steering towards Green and Perceptive Mobility of the Future

WP2 – STREETLIFE Architecture and Integration

D2.1 – Report on gap analysis and incentive models

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Author(s): Lena Farid, Florian Thiemer, Silke Cuno, Benjamin Dittwald, Dominic Gorny (Fraunhofer), Giuseppe Valetto, Annapaola Marconi (FBK), Michael Bahr, Birgit Obst, Veronika Brandstetter (SIEMENS), Davide Frigeri, Francesco Avesani (CAIRE), Stefan Schaffer (DFKI), Mika Vuorio (Logica)

Partner(s): Fraunhofer, FBK, SIEMENS, CAIRE, DFKI, Logica

Editor: Michael Bahr (SIEMENS)
Lead Beneficiary of Deliverable: SIEMENS

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Internal Reviewers: Peter Deussen (Fraunhofer), Sandro Castronovo (DFKI)

EXECUTIVE SUMMARY

Work Package 2 "STREETLIFE Architecture and Integration" is responsible for the design of the STREETLIFE blueprint architecture. The scope of this document is to gather and aggregate information about existing gaps in mobility policies aiming at sustainable mobility and technological gaps that might have an architectural impact in the three city pilots of Rovereto, Berlin and Tampere. The results lay out gaps and commonalities between the three city pilots that can be exploited for the blueprint architecture. Each STREETLIFE pilot city shows great interest in ICT solutions for mobility services and incentive models supporting sustainable mobility. Interviews and research approve, that there is a need for different, variable ICT solutions in these cities. We also evaluated existing experiences of mobility services and incentive models, which are applicable for the STREETLIFE system and will be used for discussions in the future of the project. Using a scenario-based approach we mapped the already defined use cases for each city pilot to its available data sources and components, and we indicated the gaps and marked them as to be implemented as part of the STREETLIFE project. We have used that analysis to identify functional areas that are necessary and are under-specified and under-developed. Therefore, they represent gaps, in the sense that they are areas of attention; at the same time, they also represent opportunities of synergetic development for the project.

The different applicability of components of the blueprint architecture to the STREETLIFE city pilots is an important aspect of the gap analysis: Some gaps identified in the general work on the STREETLIFE mobility system are not a gap in some city pilots. Furthermore in this document we show established methodologies for security requirements for software development processes, modelling of threats and risks for software systems and a comprehensive collection of standard security approaches to avoid security threads and risks. We show a first snapshot of requirements that derive from the gap analysis of the city pilots, which will be used as input for the blueprint architecture. With this deliverable we provide a context diagram of the STREETLIFE system, showing how STREETLIFE acts with itself and the outer environment.

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D2.1 – Report on gap analysis and incentive models

ABBREVIATIONS

API	Application Programming Interface
BAIM	Barrier-free Information on Public Transportation for Mobility-Impaired People
BER	STREETLIFE Berlin-Pilot
CIP	City Intelligence Platform
CO_2	carbon dioxide
D	Deliverable
DoW	Description of Work
FP7	Seventh Framework Programme
ICT	Information and Communication Technologies
KPI	Key Performance Indicator
MS	Milestone
NGO	Non-governmental organisation
P+R	Park and Ride
PaaS	Platform as a Service
PT	Public Transit
PUM	Plan for Urban Mobility
ROV	STREETLIFE Rovereto-Pilot
SW	Software
TRE	STREETLIFE Tampere-Pilot
WP	Work Package

PARTNER NAME CORRESPONDING TO ABBREVIATION IN STREETLIFE DOW

Fraunhofer	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.
FBK	Fondazione Bruno Kessler
SIEMENS	Siemens AG
DFKI	Deutsches Forschungszentrum für Künstliche Intelligenz GmbH
AALTO	Aalto University
DLR	Deutsches Zentrum für Luft- und Raumfahrt
CAIRE	Cooperativa Architetti e Ingegneri – Urbanistica
Rovereto	Comune di Rovereto
TSB	Berlin Partner for Business and Technology
Tampere	City of Tampere
Logica	CGI Suomi Oy

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1 INTRODUCTION

The goal of Work Package 2 "STREETLIFE Architecture and Integration" is to define a software and service architecture for the STREETLIFE project. The high-level architecture should be generic enough to be used as blue-print for different cities. It is supposed to guide the development of the solutions in the different research work packages and the deployment plan in the different pilots. The architecture shall consider all features provided by the work packages.

The document at hand titled "D2.1 - Report on gap analysis and incentive models" is the first STREETLIFE deliverable inside the Architecture Work Package 2. It is scheduled for Month 6 of the project and will be followed by three STREETLIFE deliverables on architecture with specific focus on the STREETLIFE blueprint architecture, the STREETLIFE security architecture, and specific architectures of the STREETLIFE pilots starting from Month 12.

The delivery of D2.1 at Month 6 is situated after the end of the initial inception phase of the project (M1-M4), in which the research work packages WP3-WP6[1] collected their requirements, and before the development of the STREETLIFE blueprint architecture.

The Deliverable 2.1 is supposed according to the DoW to gather requirements of the running WP2 tasks of the architecture work package at this point of time. These are the Tasks 2.1-2.4 on "Requirements and site survey" (T2.1), "Gap analysis and incentive models" (T2.2), "Architecture components specification" (T2.3), and "Security architecture" (T2.4). Additionally the deliverable is considering the requirements of the research work packages developed so far, especially the use cases of Deliverable 6.1 on "Specification of city pilots for the first STREETLIFE operation and evaluation" in Chapter 3 of this Deliverable D2.1.

The general idea of the deliverable at hand on "Gap analysis and incentive models" is a) to give in terms of gaps an analysis of incentive models and mobility policies (Chapter 2), and (b) to give a snapshot on continuous work on gap analysis (Chapters 3–4) in compiling best practices, resolving in a gap analysis including security gaps. Deliverable D2.1 leads to a number of requirements in its Chapter 5 (Requirements). Furthermore, since the Deliverable D2.1 has the goal to support the reference architecture and the conceptual models that will drive the forthcoming phases, especially the STREETLIFE blue-print architecture, the deliverable closes with a short prospect on the STREETLIFE architecture with the STREETLIFE context view. (Chapter 6)

This structure was chosen because the starting situation of STREETLIFE and its conceptual formulation suggests strongly to combine both a) a top-down approach to work-out the blue-print architecture of a STREETLIFE mobility system which is needed as reference architecture in STREETLIFE to guide the development of the solutions in the different research work packages and the deployment plan in the different pilots; and b) a bottom-up approach to ensure the requested integration of the different already existing mobility systems of three different pilot cities. This approach is iterative with two research and development circles. The approach with the measure of an overarching common blueprint architecture is promising, because it

[1] Those Work Packages are the WP3 on Mobility Data Integration, WP 4 on Mobility Management & Emission Control, WP5 on End-user Applications and WP 6 on the city pilots.

mitigates the risk of fragmentation and clusterization of the three city pilots, each with different needs, ambitions and goals, all with different infrastructures and legacy systems.

The Deliverable D2.1 describes work in progress. Its outcome must be regarded as a current, intermediate snapshot of the continuous gap analysis and closure leading to the first iteration of the pilots and it includes first consolidated initial results on architecture and related stuff in M12 (MS2), continuous gap analysis and closure leading to this.

The "incentives gap analysis" for sustainable mobility requires to analyse on the one side the existing gaps in "mobility governance" of the pilots, but also in viewing existing "technological gaps". Besides that, many other aspects that involve urban sustainable mobility were discovered: they range from land planning and infrastructure instruments to incentives on greener types of fuel, to incentives aimed at increasing the usage of public transport and bicycles.

Deliverable D2.1 basically acts on the assumption that different types of strategies for mobility management exist: the first are policies and laws, like national promotion programmes, and in some countries laws regarding climate or air quality. Some nations require a mobility management plan by employers, others require transport planning by companies and schools. Another kind of strategy regards fiscal measures: many countries recognise fiscal measures for sustainable mobility, such as reimbursement for public transport or bicycles, businesses supplying bicycles for their employees, or measures for reducing car use, such as the CO_2 tax for rental cars in Belgium. The third group of strategies is about awareness raising and promotion, is more about marketing, with many campaigns for promoting bicycling, walking, and public transport. Finally, the STREETLIFE project is seen as a great chance to analyse the mobility management – a point of view that many times has gone un-noticed: The mobility manager of a city has a real chance of having a full vision and understanding of the mobility situation as a whole, and its goal is to induce in citizens an environmental-friendly culture towards more sustainable means of transportation. For all points discussed below commonalities and differences could be worked out.

In **Chapter 2 "Sustainable Mobility Policies and Incentives Models"** concludes that the three pilot sites have great interest in ICT solutions for mobility and in policies for sustainable mobility. Rovereto's focus is on the congestion of the centre and the problems related to it, and there is a definite demand from the population for a greener way of moving and of living. In Tampere the prominent topic is on public transportation. In Berlin the research led to clear topics, like bike safety, enhanced ICT solutions for mobility management, and the need for more updated multi-modal info on traffic. Regarding the incentives part, several concepts were studied from a STREETLIFE point of view.

Chapter 3 "Snapshot and gap analyses" highlight gaps, which may have an architectural impact. Gaps in this general context are regarded as elements that need to be developed by means of the work carried out within the various STREETLIFE Work Packages, and situated within the STREETLIFE architecture. For that the input to the architecture of the STREETLIFE mobility information system provided by the pilot specifications [16] was analysed especially because it is necessary at this point to identify the functional and data elements that are necessary in the project, and to position those needs within an architectural framework for the STREETLIFE platform in the identification of "gaps" (cf. Deliverable D6.1 [17]). So the chapter also contains a data gap analysis, that in parallel with the analysis of the functional elements analysed comes into play in each of the various scenarios. The gap analysis furthermore provides an overview of commonalities and specifities with respect to functionality between the three pilots and refines the STREETLIFE Scenarios and Use Cases looking from the perspective of the STREETLIFE scenarios and use cases onto closing the gaps on the path towards the first iteration of the three city pilots.

Moving forward several STREETLIFE functionalities must consider aspects of data protection and privacy issues. This requires technical and organizational security measures. The aim of **Chapter 4 "STREETLIFE Security"** summarizes commonalities and differences across the pilots and their security goals. The detailed results of the security analysis will be used as an input for the blueprint architecture. The chapter also gives a short overview over the applied methodologies needed and continuously performed in STREETLIFE to identify the concrete security goals as well as risks and threats and finally for the derivation of the security requirements. As a result, it seems so far clear among the three pilots that data security as well as user privacy are the most important aspects that must be sustained. Furthermore, all three pilots consider to implement an identity and access management system and anonymisation and pseudonymisation mechanisms for user data if possible. Besides common security goals each pilot has several individual ones.

The results listed above lead to **Chapter 5 "STREETLIFE Requirements"**. In this chapter, a brief introduction into key aspects of the requirements analysis as well as its methodology for STREETLIFE is given. The key aspects revolve around defining requirements for a unified system architecture that would consequently form the STREETLIFE blue-print architecture, whilst taking into consideration the challenges of seamlessly integrating different already existing components and the different scenarios posed by the three city pilots. The methodology described in this section prescribes three phases known as the elicitation phase, the consolidation phase and the review phase. These were elaborated on and put in context with other relevant activities in the project, such as the integration of mobility data, the creation of a mobility management and emission control panel and the creation of end-user applications. The outcome of the first iteration for the elicitation phase has been presented in the form of a table (see Section 5.2). The table depicts a snapshot of the requirements for the blue-print architecture. The table is in no manner complete and shall be extended and enhanced during the course of the project.

Finally, **Chapter 6** on the **"STREETLIFE Context View"** provides a good structure for the definition of the details of the different architectural views of the STREETLIFE architecture and a prospective on the blueprint architecture. It identifies and discusses three major architectural areas for any STREETLIFE urban mobility system: These are a) the **Logical centralized mobility management**, b) the **Users** and c) the **Data Sources.** The architectural specification of the items of the STREETLIFE context view is done for the important functional view and the information view first and is based on the findings of the context view. Very soon, the architectural work has to distinguish between the blue-print architecture and the pilot-specific architectures.

2 Sustainable Mobility Policies and Incentives Models

In this part of the deliverable we are going to perform an analysis of current approaches to increase the use of carbon-emission friendly transportation modes, with a focus on weaknesses and limitations.

2.1 Introduction

The topic of the incentive gap analysis applied to the STREETLIFE project can be seen in two ways: the existing gaps in mobility policies aimed at improving sustainable mobility in the three cities, but also the existing technological gaps in mobility management. We deal with both the subjects in this document, not only because both of them are strongly involved into the STREETLIFE project, but also in order to have a better understanding of the current situation of mobility in the three pilot sites.

During the process of carrying out an incentive gap analysis there is the need to consider many aspects that involve urban sustainable mobility: from land planning instruments to incentives on greener types of fuel, to incentives aimed at increasing the usage of public transport and bicycles.

There are different types of strategies for mobility management: the first is policies and laws. There are laws, national promotion programmes, and in some countries there are laws regarding climate or air quality. Some nations require a mobility management plan by employers, others require transport planning by companies and schools.

Another kind of strategy regards fiscal measures: many countries recognise fiscal measures for sustainable mobility, such as reimbursement for public transport or bicycles, businesses supplying bicycles for their employees, or measures for reducing car use, such as the CO_2 tax for rental cars in Belgium.

The third group of strategies is about awareness raising and promotion, is more about marketing, with many campaigns for promoting bicycling, walking, and public transport.

The STREETLIFE project is a great chance to analyse also another point of view interested in mobility that many times has gone un-noticed: the mobility management. The mobility manager of a city has a real chance of having a full vision and understanding of the mobility situation as a whole, and one of her goals is to induce in citizens an environmental-friendly culture towards more sustainable means of transportation.

2.2 Methodology

The best solution for getting a deeper knowledge about mobility policies is asking the people who know the three pilot cities about the implemented solutions, the level of success these solutions had, and also some details on the recent history of applied mobility solutions.

In order to reach this goal we have decided to follow two different paths that aim at the same goals but on different routes. The first solution is a comprehensive interview run using Skype (the ones we have already taken lasted for 45–60 minutes) with 2–3mobility experts selected by the pilots. Before the interviews we have submitted a questionnaire to the mobility experts with options for some of the questions. In the questionnaires we came up with a list of objectives for mobility policies and the actions to be taken to achieve this goal, in order to get a view of the pilot sites as complete as possible. As is shown in Annexes B and C, the interview is pretty long because the answers about the type of policies implemented are open, and once we have gone into details with the people, usually the answers were long, detailed, and complex.

The complexity of the questions (and of the answers), coupled together with the fact that we needed more than 2–3 answers on some topics and some other practical reasons (time needed to establish contacts with people to plan the interviews), made us take the choice to use a second path also, that involves the Advisory Board members. We organized a very short survey for Advisory Board members and we submitted it to them by e-mail, so that they could answer it when they like and the time for answering should not take more than 10 minutes. We have just finished redacting the short interview model, so we have not spread it around to the pilots yet, but the idea is that because of the existing differences incurring between the three pilot sites, the pilots will be allowed and encouraged to implement the surveys with other questions more suited to their place. Obviously if they think the surveys are already fine, they will not have to add anything.

The status update on the interview phase goes as follows: In Tampere we have already had the long interview with one person, and we are planning the second one. The same goes for Rovereto. In Berlin we have not had any interviews at the moment, but in these days we are planning dates for those with two people. We have just finished redacting the short surveys, and in the next weeks we are planning to distribute them. Because of their nature (shorter time required to fill in) and the means of contacting people (they will be submitted by e-mail) our priority were the longer ones, so we started work on the 2nd type of survey later. The Deliverable D2.1 will be updated with the forthcoming answers and results coming from the further interviews and from the advisory board members by Milestone MS2 (first version of STREETLIFE architecture, techniques, tools, impact assessment plan).

As a result of the progress of the works, in the document that follows the sections about Rovereto and Tampere show results and findings from the interviews, while the Berlin section is at the moment the result of an analysis of some written documentation of relevant work. The plan is to implement it as soon as we will take the interviews as planned.

2.3 Rovereto

The following text is a summary of the interview held with Mr. Andrea Larcher, currently working in the Rovereto Municipality in the traffic and transportation sector.

The administration of Rovereto has made sustainable mobility one of its priorities. The municipality established sustainable mobility as one of its 10 strategic objectives. In the land-planning instrument of the city, which was updated in 2009, objectives for sustainable mobility were integrated in land planning choices. In the group of strategies mentioned that are aimed at reaching sustainable mobility there is the goal of creating more synergies within the Vallagarina territory, a group of municipalities that has Rovereto as the destination and the starting point of most of the trips made for work.

One of the sectors concerning sustainable mobility on which the administration put many resources and invested time in the last few years was cycling: the bicycle network has been updated and enhanced in the last few years, and a service of bike sharing called "C'Entro in Bici" has been installed. Another experiment that took place in Rovereto was one with "anarchic bikes", following the example of Amsterdam where they are called white bikes. The municipality has provided 20 bikes at the full disposal of the citizens, and citizens could take the bikes in the place where they were and leave them when they did not need the bikes no more, with no connection whatsoever with the stations. The experience has had positive and negative aspects: bikes disappeared less than expected, but the possibility to leave bikes anywhere without any constraints has generated distortions, due to the fact that some bikes were left in rarely visited places of the city and some days passed before someone went to retrieve them. Another problem to keep in mind in this specific experience deals with the required resources that the administration needs to invest to keep this service going, because there is the need to send operators around the town to recover the bikes, and to employ the operators for the maintenance and repair of the bikes.

In the month of April 2014, a bike-sharing service run by a third party will start that will provide 60 electric bikes, spread over eleven stations throughout the city. Data from these bikes will be available for the STREETLIFE project.

One of the most successful experiences was PEDIBUS. In the PEDIBUS service children walk to school accompanied by parents and/or traffic officers, following a signalled and predefined route. In Rovereto the PEDIBUS routes were planned together from the technical office of the municipality, traffic officers, and parents of the children involved.

In the slow mobility department, Rovereto took many steps forward in the recent years, with the development of some roads with a 30 km/h limit in many residential areas, operations of traffic calming, and some infrastructural investments on crossings and architectural barriers.

One of the most recent experiences was Car Pooling destined to municipal employees, but unfortunately it did not give satisfactory results. The problem of this experience was the high rigidity of the system, which offered only two commuting routes from the nearby municipalities, with no possibility of arranging different destinations. Also an experimentation of car sharing took place in Rovereto, with two stations in the centre of the city, but at the moment both experiments are not so widespread and successful, so one of the topics where the city needs to improve is the diffusion of car sharing and carpooling services.

Another sector of sustainable mobility where some tweaks and changes took place in the last years was Public Transportation: on the planning side, the Area Plan for Local Public Transport regarding not only Rovereto, but also the municipalities in the neighbourhood was approved in 2012. An example of good practice regarding fares of public means of transportation is the introduction of the MIT card that enables citizens to use different means of transportation with only one card, making the use of alternative ways of moving easier.

On the parking side, the city is currently working on a reorganization of the parking system to reduce the pressure that is currently on the parking lots nearest to the city centre. The ideas in order to achieve this goal are to set up a group of parking lots in the outer parts of the city and to change the payments' structure in order to distinguish between short period parking and long period parking.

In the implementation process of many of those practices there was a high level of citizens' involvement: the PEDIBUS experience was planned through consultation with parents of the children involved, but the process of citizens' involvement was not used only for single experiences, but also on a higher level. The City of Rovereto recently produced the Plan for Urban Mobility (PUM), and in the activities leading to the formation of the plan there were many moments destined to participation and involvement of citizens, that had a big role in the process.

It is not an easy exercise to find a straight relationship between strategies for sustainable mobility and an improvement in the environmental condition, but there are good reasons to believe that all these practices produced some good results: there was a reduction in the number of days in which the city exceeded the established threshold for the emissions of PM10 (atmospheric particulate matter with a diameter of 10 µm or less), there were more and more cyclists on the roads (it has to be said that this is more an impression, there are not specific data in support of this statement), and the number of users of public transport has been growing, especially since the extension of services from Rovereto to the neighbouring municipalities.

Rovereto really believes in the potential of ICT technologies for sustainable mobility, and is investing in innovation, green technologies, and in becoming a European city.

2.4 Berlin

In the city of Berlin the process towards sustainable mobility begun some time ago, and it can be seen from the change that took place in the city's modal split from 1998 to 2008, where the percentage of private cars decreased from 38% to 32% [1]. The modal split is a quantification of the percentage of people based on the different means of transportation they use for their trips.

The modal split has changed significantly in 10 years (see Figure 1), but the goal of the city is to reduce the share of private car use to 25% in 2025, so there is still a lot of work to be done to reach that goal. The modal split is trending towards more sustainable mobility means of transportation especially in the younger parts of the population, because younger people prefer walking, cycling, or public transportation, and cars lost significance as a status symbol in the last years.

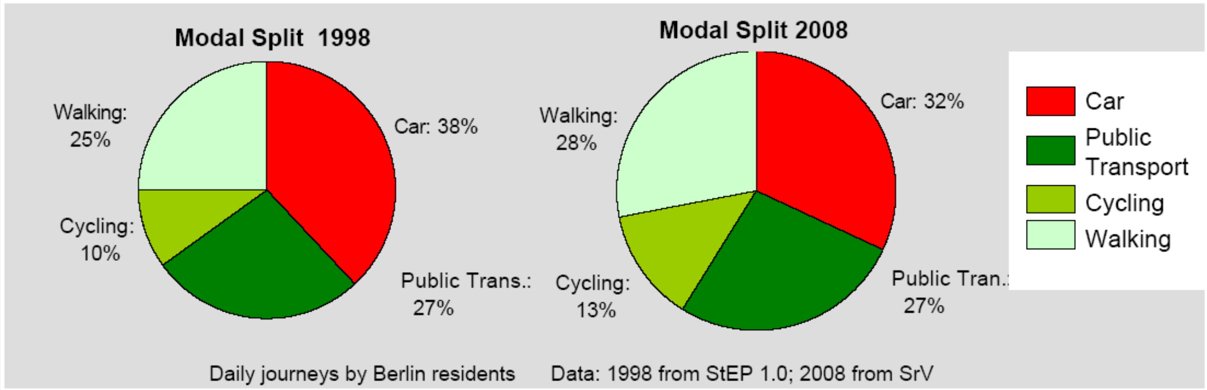

Figure 1 Modal Split of Berlin, 1998 and 2008

The intermodality is the path chosen to reduce car percentage in the modal split, and the city is trying to encourage this by exploiting the potential of the technologies available, increasing the capacity of the service and exploring new synergies.

Land planning plays a big role in the implementation and spreading of sustainable mobility, and the city of Berlin has the privilege of having very favourable conditions for spreading sustainable mobility: the planning of the city has as one of its main features urban diversity and a mix of functions, a polycentric city with many district centres that enable citizens to have very short trips for fulfilling their daily needs and no car dependency, with an easy use of public transport, cycling, and walking [2].

The policies the city followed to reach the actual status are the following:

- Strengthening the backbone of Urban Transport, with extension of the network and its qualification

- Intermodality, with the combination of different ways of moving, like cycling and public transport, improvement of bike and ride facilities

- Cycling: extension of the cycling network, and increase in bicycle parking facilities in public and private spaces. But every coin has two sides: if it is true that in times of crisis and urban fashions support the use of alternative means to the car, it is equally true that there are some problems connected with the proliferation of bicycles, pedestrian, representing still a success for the policies: there are security issues, and the division of space and time between different modes of transport.

- Walking: looking to pedestrians, there is definitely a need for new strategies in this regard, because the process of aging of the population requires an ever-increasing quality of urban spaces with the gradual disappearance of architectural barriers, and is increasing the amount of conflict with cyclists also.

- Opening of the environmental zone: A so-called environmental zone (“Umweltzone”) has been established in Berlin since 2010, in which cars can enter only under certain conditions, one of which is low emission levels. Compared to the emissions levels that were recorded before the introduction of the area, there have been significant reductions in emissions, accounting for 58% of the particles of diesel exhausted and 50% of articulated carbon-induced traffic. The positive effect of this restriction is then certified, but the levels of certain substances in the air are still too high, so further efforts are needed to achieve the air quality standards.

- Car sharing is a service that is growing in the city, but given its young nature the effects of its diffusion on the habits of mobility are not yet well defined: what is certain is that this service generates additional demand for space, especially in parking lots. At 2012, the numbers of vehicles available for car sharing in Berlin is 2,475, and there are six companies for car sharing services

- Bike sharing: We kept it separated from the cycling section, because there are two services that need to be mentioned not only because they operate in Berlin, but because are also cases of very good practices. The first is NextBike [3], a company who runs bike sharing services across many cities in Europe. In the NextBike system people have to register, after that they can reserve a bike with the app, or using a phone line and then ride the bike, and after the usage the bikes need to be brought back to NextBike stations. The website of NextBike has also a functionality where people can check out in which stations there are bikes available.

The other service is Call a Bike [4]: is a bike-sharing service given by Deutsche Bahn that is currently running in many German cities that works similar to NextBike, giving the user after his/her registration the possibility to book and use a bike. In some cities, the users, once they have reached a major road intersection, only have to lock the bike and send information that their time of utilization of the bike is over and the address of the place where the bike is, without the need to bring the bike back to one of the Call a Bike stations.

2.5 Tampere

The following text is a summary of the interview held with Mr. Erno Holmberg, currently working in the mobility management office in the City of Tampere.

Sustainable mobility is a very important topic in the political agenda of the city of Tampere. In Tampere the available experiences are not about individual episodes of policies, but an effort that the administration is doing with the ECO_2 project [5], a project to create an eco-city efficiently and with reduced emissions of carbon, which wants to implement the strategic policies of the city on several levels, and among them also includes policies for sustainable mobility. In 2010 transportation produced 18% of the total emissions of greenhouse gases produced by the city of Tampere.

Inside the ECO_2 project the municipality of Tampere has tried to increase the spread of bicycle mobility by improving the conditions of the cycle network infrastructure, creating new tracks, and trying to eliminate the points of discontinuity with a tunnel under the railway line and a pedestrian bridge over Tammerkoski falls. The volume of cyclists in the summer months has increased from 100.000 in 2000 to 139 thousand in 2012, and these investments have worked. On a STREETLIFE project point of view is necessary to point out that such investments also require significant investment of financial character, and so administrations may need to opt for other types of incentives in a time of economic recession.

There are other actions to encourage the mobility path that ECO_2 expect from 2012, of which, however, we are not yet able to assess the effects, such as increased bicycle parking, the organization of events such as cycling days, the growing number of the places where you can rent bikes.

The city has also put a lot of work into increasing the range of available alternative mobility options, and the information side has been strengthened very much in the last few years, with real-time monitors for bus time-tables and parking systems [6]. All data gathered from the systems are open data, so anyone can make any applications as they like regarding bus timetables and bus monitoring.

Another goal the city is working to achieve is facilitate traveling with public means of transportation: last two years have been very active in bus traffic for the Tampere region. In July 2014 Tampere will be responsible of all the bus lines that are operating in the Tampere metropolitan region. At the moment there are many bus companies and they are responsible for line organizing by them self. After July 2014 all bus lines are organized from Tampere Public transport office which means better synchronization for lines, lower fair, better and faster service for customers. Lempäälä, Pirkkala, Ylöjärvi and Nokia are neighbouring cities who will join to the public transportation-system.

Another type of policy that will be put on the field in future is establishing some zones of Tampere as motor free areas, especially Tampere's main street in the centre, Hamenkaatu, where most of the traffic passes by, and in future the traffic for half of that street will be closed to make it a pedestrian and bicycle street, still open to public transportation. This will change dramatically traffic in Tampere City Centre. Pilot stage will take place by the end of 2014.

The most important thing in Tampere about parking is the real time parking space monitoring: if you drive into the city, there are monitors by the roads that tell you how many parking spaces there are available and where. It is a real time system and it is pretty new. The parking situation in Tampere is pretty good, with lots of underground parking spaces, and because of this, park and ride is not so common.

The city of Tampere has also conducted a feasibility study on the application of carpooling for jobs, finding out that in Finland the car sharing is still not a widespread practice, and to be economically viable should be established only in contexts with a large number of employees that create critical mass, such as the municipality of Tampere.

Another area in which the municipality has invested a great amount of resources, and that relates very closely to STREETLIFE, is Infomobility to increase general knowledge about alternative mobility options. Infomobility is the widespread use of technology to enhance knowledge of citizens about the current mobility situation. Especially the subject of real-time information, with real-time monitoring of buses that allows citizens to have all the details necessary to move with public transport, appears to have had positive results, given that the share of the modal split for public means of transportation has grown from 16% in 2005 to 19% in 2012.

Also with regard to public transport in Tampere there is the experience of work-benefit tickets: tickets for public transport in which the enterprise decides to pay a fee for its employer. The experience has been implemented recently, so there are still no precise results. One thing that has already emerged is a conflict with the Finnish tax system, for which subscriptions also for commuting between home and work become taxable above a certain amount of money, creating a bias in favour of the use of private vehicles.

Even in the parking sector, innovations are coming from the side of info-mobility: there are panels that show real time indications of open spaces and parking spaces in which they are located, and this is a recent innovation also.

2.6 Best practices in ICT services for mobility

The following paragraph is a review of some of the most interesting experiences that have been brought up in the mobility sector: some of these have a strong connection with the ICT topic, others are interesting experiences on a policies' point of view, even if their technological content is not that advanced. We picked some experiences that represent good examples of some possible areas that could be involved into a project like STREETLIFE, and in the process of editing this section we selected one meaningful experience for each of the most common types of measures taken to boost sustainable mobility (e.g. Ride Sharing, Mobility Marketing). Obviously STREETLIFE will not include all these features, but at least these arguments should be included in the discussion of the possible applications and/or future expansions of the STREETLIFE system.

2.6.1 SFPark

SFPark [7] is a technology that is being tested at the moment in the city of San Francisco (U.S.A.), and is very interesting on a STREETLIFE project point of view because it is an innovative approach both on the policies side and on the ICT mobility instruments' side.

On the technological side it contains an app, the possibility of payments with the smartphone, open data, but the real innovation (and the reason why this system is being tested) it is on the policies' side.

SFPark is a system of demand-responsive pricing: to achieve the right level of parking availability, SFPark periodically adjusts meters and garages pricing up or down to match demand.

Demand-responsive pricing encourages drivers to park in underused areas and garages, reducing demand in overused areas. More parking availability brings to streets less congested and safer.

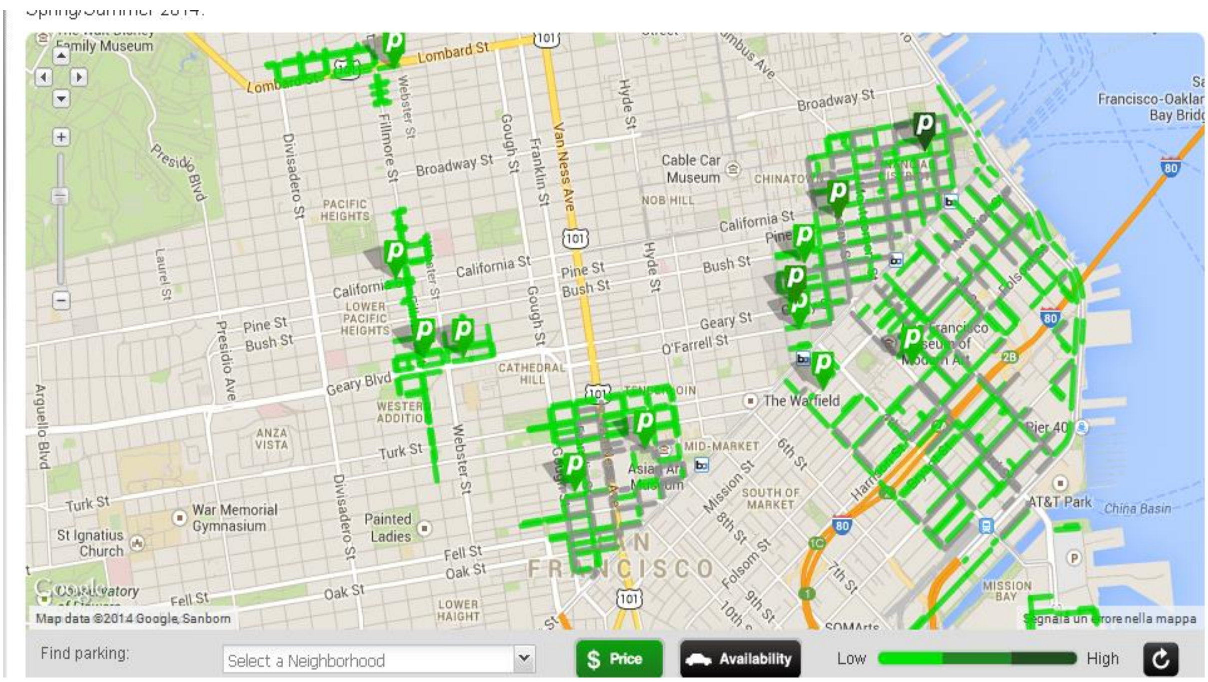

Figure 2: Visual representation of different fares [7]

In every parking or garage included in the pilot area there are parking sensors that collect data about occupancy rate at different times of the day and the week. The fixed goal of occupancy for parking slots is the 80%, and basing on this principle the rates are adjusted as follows:

- when the occupancy rate is between 80% and 100% per cent, the hourly rate will be raised by $0.25;
- when occupancy is between 60% and 80%, the rate stays the same as fixed;
- when occupancy is between 30% and 60%, the rate will be lowered by $0.25;
- when occupancy is less than 30%, the rate will be lowered by $0.50

Another interesting feature of SFPark is the Special Event Parking Management: in the pilot area there is the BallPark of San Francisco Giants, and in the days of the games the rates are lowered or raised depending on the availability of parking slots.

SFPark is a pilot project, and the first report about the results is scheduled to come out in the spring of 2014, so we still do not know how this project has affected parking management in the city.

The tools regarding visualization of available parking slots and general parking situation are very interesting for STREETLIFE. The idea of Demand Responsive Pricing is very interesting for mobility management, but the are some dependencies and requirements for the pilot sites to be solved in order to put this feature into STREETLIFE. Demand Responsive Pricing needs the availability of real time data on occupancy rates for all the parking slots of the zone where it is applied, not just part of them, and also needs a municipality willing to invest money to boost a smarter utilization of the existing parking lots.

2.6.2 BlaBlaCar – A Ride-sharing Service

BlaBlaCar [8] is one of the most famous ride-sharing websites in Europe. Ride-sharing means that on BlaBlaCar there is a matching between people searching for a ride, and people that drive their cars and are willing to share the costs of it with passengers.

In this section we quote BlaBlaCar because it is one of the most famous websites about ridesharing, and it is an example of a platform for ridesharing that works well. As we are experimenting during the course of the project, there are some legal issues that need to be addressed about the possibility of giving or taking a ride if there is an amount of money as a form of payment agreed upon behind the ride.

On the policies' side of the ridesharing, there is a distinction that needs to be made: in the comparison between car-sharing and ride-sharing, has been concluded that the former is best suited for big cities, while the latter is better suited for long distances, where the incentive in sharing the costs of riding a private car is much bigger, and the driver is more interested in finding someone to share the ride with.

Another reason why we have decided to quote BlaBlaCar is that the website of this platform on the social side is on a very high level, and on many things it could be a very good benchmark for the social side of STREETLIFE: there are features about the comfort of the ride, the reputation of people involved, the possibility of a personalization of the user profile, preferences on the car share, and a system of customer retention based on the historical data of the user (BlaBlaCar Experience Levels) that are very suitable for gamification.

2.6.3 BAIM project

The BAIM project [9] took place in Berlin and Frankfurt, and the goal of this project was to give accessible information of the provision of barrier-free travelling chains. Obviously, the provision of barrier-free public transportation is a necessary requirement for such a project, but it is a type of requirement that asks for a great amount of investments from the municipalities.

The BAIM project offers a journey planner, on the website or on the smartphone, that provides the user with detailed information on the accessibility of public transportation facilities, including vehicles, buildings, and special assistive features. The system offers different types of information based on the type of disability; the first phase of the BAIM project was successful, and from the results of it came also the BAIM plus project, that took as a starting point the results of the first project, and developed a routing system for another target: people over 55 and people over 65.

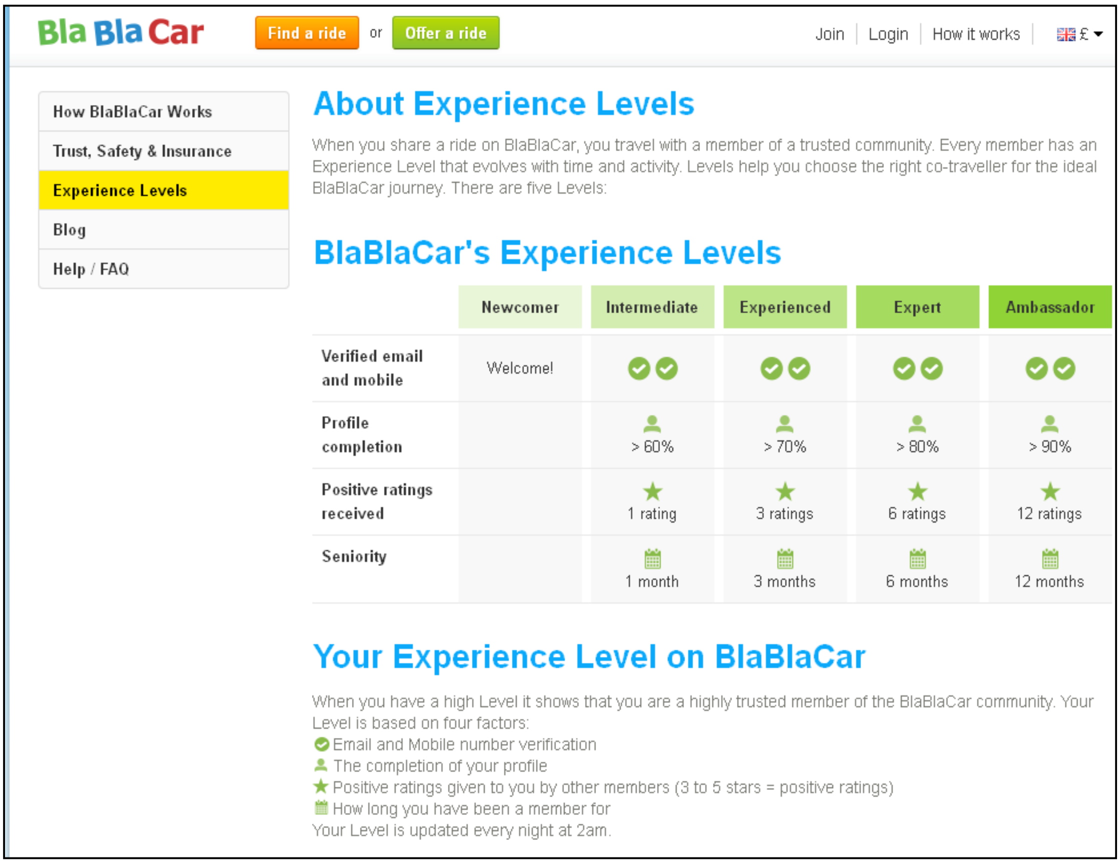

Figure 3: The customer retention system in BlaBlaCar [8]

Although elderly people are not in the main target of the STREETLIFE project, one of the STREETLIFE features is the journey planner, and in an ageing society like the one where we live, in future there will be more and more demand for some particular kind of routing, designed and thought for specific parts and segments of the population. Having in mind experiences like the BAIM project can help to vision future developments of the STREETLIFE system, that can count on customization and personalization based on the particular needs of selected types of users as a means for reaching widespread popularity.

2.6.4 CALL-A-BUS services

Another example of successful practice that is currently taking place in Germany is the one about CALL-A-BUS services[10]. In this scheme citizen are allowed to call and book a bus within half an hour from its arrival. It is a type of service suitable for rural areas with low concentrations of inhabitants, in fact the area where CALL-A-BUS is being experimented in Germany is a very rural one with 30 thousand inhabitants where the towns are very much distant one from the others.

There are some studies about this type of services, confirming that if the requirements are fulfilled, CALL-A-BUS can be more convenient than traditional bus services. The potential economic benefits measured in the German area where it is being tested are high: there are estimations that the cost of Multibus (as it is called) is 400,000 € per year, with a reduction of costs of about 40,000 € compared with traditional line buses. There is not only the economical side though: the satisfaction level of customers is very high, and at the same time the demand for this type of transport is growing.

This type of mobility scheme is not optimal for the City of Berlin, but Rovereto and Tampere could present some of the requirements needed for this service. This is especially true for the mobility sector that has to connect Tampere and Rovereto with the other municipalities, in areas with low density and low demand in definite times of the day fulfilling two major requirements for the success of such a mobility scheme.

2.6.5 The PEAK AVOIDANCE experiment in the region of The Hague (NL)

The Peak Avoidance experiment is a practice about road pricing. Road pricing is considered one of the most powerful options to take away congestion and pollution from the streets. If the use of the road system is charged higher at congested periods and congested locations, road users will be more encouraged to use alternative modes, routes, or times.

The test took place in September-November 2006 on the A12 motorway from Zoetermeeer to The Hague in The Netherlands [11]. This road is heavily congested due to the large number of commuters travelling to The Hague during the peak hours, so 340 of the 6.000 daily commuters were recruited to take part in the test.

People received an incentive if they travelled by car not in the peak hours (7.30 – 9.30), by public transport, bicycle or carpool, or if they did not travel at all. In test period the system of incentives changed, to check which one was the better: for 3 weeks people who did not travelled in peak hours were given 3 Euros, for 4 weeks they were given 7 Euros, and in a third version they were given 7 Euros if they avoided travelling between 7.30 and 9.30, and 3 Euros if they travelled in the shoulders of the peak period (7.30-8.00; 9.00-9.30). Participants also had an alternative, in choosing to get a smartphone that provided real time traffic information instead of money. 232 participants chose the money reward, 108 chose the smartphones.

In the periods without rewards, 47%-50% of the participants travelled by car during the rush hour, so a big part of the population sample already travelled outside the rush hour before the test. With the reward, the percentage of travellers in the peak went to 26% with a 3 € reward, and to 19%-20% with a 7 € reward. Most of the results were realized by travelling before the peak hour (car trip before 7.30 went from 20% to 33%-39%), but there was also a decrease in total use of car from 80% to 75%, and an improvement in the utilization of public transport use (from 4% to 10%-12%).

After the end of the reward phase, car use during the rush-hour returned to the pre-measurement levels, so the incentive system worked, but citizen's behaviour returned the same as before once the pilot phase was over. Another interesting result from this test was that the users whom chose the smartphone, and had access to travel information, travelled less in the peak hours also after the end of the project. There is no doubt that the smartphones given were a very powerful kind of incentives, but once people had access to the information needed to improve their transport choices, they made a good use of them.

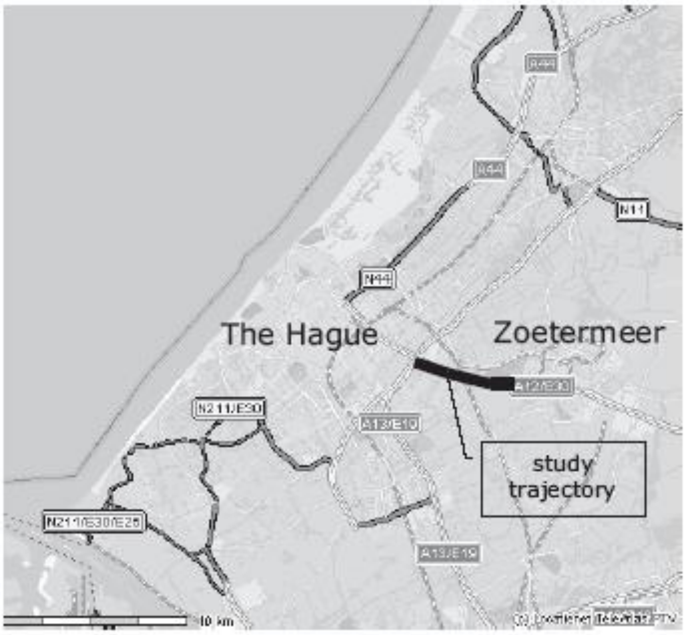

Figure 4: The region of the pilot test between Zoetermeer and The Hague

2.6.6 Mobility Marketing in Darlington, Peterborough and Worcester

These three English cities have worked successfully on mobility management. Between 2004 and 2009 they invested in measures to encourage more sustainable mobility behaviour, and they resulted in a 9% decrease in car traffic [12]. Residents were the principal target group: measures included promotion of walking and bicycling, marketing of public transportation, travel information, mobility campaigns and personal approaches to residents.

The use of buses increased from 12% to 22%, bicycle riding increased from 10% to 30%, the number of trips by foot increased from 3% to 13%. These changes provided many benefits: fewer traffic jams, more sustainable traffic, lower emissions, better air quality and less traffic overload. The programme led to an annual savings of 17,500 tons of CO_2, fewer people injured in accidents and better air quality. The Department for Transport concluded that this approach has proven cost-effective and financed the measures with a total of 12 million Euros.

2.6.7 Versement Transport in France

The Versement Transport ("transport tax") is an urban transport tax. In urban areas with more than 10,000 inhabitants, companies with more than nine employees must pay the tax: 0.55% to 2.6% of the total salary costs [13]. The percentage depends on the size of the area and the quality of the public transport. With this income stream, the local transport authorities finance public transport, along with other local authority levels, central government and the European Union. France has a number of cities that reintroduced trams with part of the money from the Versement Transport. The tram is often an icon for new quality in inner cities and thus a form of city marketing. Various cities have replaced unsightly traffic routes with high quality public spaces, allowing better modal connections between various transport modes. This tax is a good example of incentive that comes from national laws.

2.6.8 My short trips campaign (Belgium)

In Flanders 40% of trips taken by car are shorter than 5 km, and 7% are shorter than 1 km. The aim of the short trips campaign is to encourage as many people as possible to make these short trips on foot or by bike. The campaign uses a social network approach, having people participate in groups. Each group member signs a contract where they commit themselves to reduce their short car trips by 20% and replace them by walking or cycling for one month [14].

Participants input on a website their kilometres, and immediately see their results in terms of saved emissions, saved costs and calories burned. At the end of the month contestants can win individual and group prizes via a free prize draw.

Materials and support are free (offered by the NGO that organizes the campaign), so the municipalities are given an incentive to take part and involve groups of citizens, and every municipality is encouraged to carry out a satisfaction survey among participants.

In 2011 participants made 18,182 short walking and cycling trips during the campaign month, totalling 143,394 km. They saved 23.5 tons of CO_2 and burned 7 million extra kilo-calories that in the website are measured in pieces of cream pie also.

2.6.9 Stimulating intermodality and e-bike commuting in employment areas in Greater Lyon

In the city of Lyon industrial estates were developed at the outskirts of the city with very good road access but often little or no public transport access. A mobility survey of two areas indicated that car use represents more than 85% of home to work trips. In the pilot project employees were offered the possibility of subscribing for a free 3-week period which could be followed by a 3-month rental period. The main goal was to introduce commuters who normally drive alone to work by car to test an e-bike or a conventional bike as an alternative mode of their daily travel. A fleet of 40 different high quality models of bikes were delivered to volunteer test-commuters. A cycle & ride facility was also provided near public transportation stops to cover the last mile to the workplace [15].

The main finding was a long-term change in the car use in the first demonstration site: 10% modal shift from car to cycling, and 20% of test-commuters purchased a bike. The impact of the test period was quantified as follows: 40.000 km car mileage reduction, 12 tons of CO_2 emissions avoided.

2.6.10 Development of the e-ticketing system in Brescia, *Italy*

Before the development of the measure, intermodality in the urban area of Brescia was only for suburban travel involving the train station and the main stations of the suburban bus stops. Fare integration between the various companies was possible only for students of the suburban area in possession of integrated passes.

The main goal of this project was the introduction of a new contactless card integrating various transport systems in terms of technology and fares [16]. This was intended to encourage the use of collective systems such as local public transportation, bike sharing, car sharing and the future Metro, and thus enhance the park and ride.

The card allows citizens to use the same contactless card for the following services:

- Parking Pass
- PT Pass (in the urban area)
- BiciMia Pass (bike sharing)
- Prepaid Pass

2.7 Conclusions

From the first interview that we had in Rovereto and Tampere we can extract some tendencies. In all the pilot sites there is great interest in ICT solutions for mobility and in policies for sustainable mobility (the two subjects are connected most of the times, but not always). The bigger question in Rovereto is about the congestion of the centre of the city and all the problems connected to it (parking slots are full, people need time to find a place and the emission level grows), and there is a definite demand from the population for a greener way of moving and of living.

In Tampere the biggest topic is Public Transportation (especially buses), because one of the most critical aspect of mobility in Tampere regards the connections between Tampere and the other big cities that are around. Another main topic is about the future: the Tampere area is expected to have a big demographic growth in the next 15-20 years, and this growth will put more pressure on the mobility system.

In Berlin we are waiting to have the interviews, but from our research came out some pretty clear topics, like bike safety, enhanced ICT solution for mobility management, and the need for more updated multi-modal info on traffic.

Regarding the incentives part, all the experiences presented in this section show a good level of success, with the only exception of SFPark that is still in a pilot phase. On a STREETLIFE-project point of view the cases that require money are not suitable examples to follow, because the idea is to stimulate a better usage of the existing transportation alternatives without asking any additional money from the administrations involved.

Seeing the level of success that ridesharing sites have reached, that could be a useful functionality for the STREETLIFE system. Another functionality that is very interesting for the STREETLIFE project is the Call-A-Bus case, because it is an efficient solution that needs a good level of participation from the users, and also because in two of the three pilot sites there are good conditions to make it work.

Another case that is very interesting from a STREETLIFE point of view is the “My Short Trips” campaign, where gamification was used in terms of better health as a consequence of the usage of some means of transportation. The gamification in STREETLIFE will aim to a similar effect, with the difference that the target of gamification will not be the impact on people’s health, but the impact on the environment.

3 Snapshot and Gap Analysis

This section analyses the input to the architecture of the STREETLIFE mobility information system provided by the pilot specifications (which can be found in Deliverable D6.1 [17]), in order to provide a "snapshot" of the situation on the ground at the inception of the project, to identify the functional and data elements that are necessary in the project, and to position those needs within an architectural framework for the STREETLIFE platform. The principal goal of this analysis is the identification of "gaps", that is, functional and data elements that, although necessary, are not covered by current data and software assets available within the consortium (these are also listed in Deliverable D6.1). The gaps represent elements that need to be developed by means of the work carried out within the various STREETLIFE Work Packages, and situated within the architecture.

The sections of this chapter look from different perspectives on the identification of the gaps. Section 3.1 looks at the functionalities necessary to realize the STREETLIFE scenarios and use cases. The data sources are considered in Section 3.2. An exemplary view into the continuous refinement of the STREETLIFE scenarios and use cases is given Section 3.4. The refinement, which is actually done in the pilot activities, will identify gaps on the way to the realization of STREETLIFE use cases in the first iteration of the pilots. Section 3.5 has a component-oriented perspective and maps pilot-specific scopes onto the initial STREETLIFE architecture, and Section 3.6 looks from the perspective of a STREETLIFE mobility management.

3.1 Commonality and specificity with respect to functionality

The information for this analysis has been gleaned from the scenario descriptions of the three pilots in Berlin, Germany (BER), Rovereto, Italy (ROV), and Tampere, Finland (TRE) as given in D6.1 [17] and in Annex D.

The pilots have a number of commonalities. First of all, the scenarios that they want to pursue all maintain a strong focus on the goal of promoting greener and more sustainable modes of transportation in urban mobility, through use of advanced ICT solutions; the solutions themselves, however, pursue that goal in a wide variety of ways, which depend largely on the differences in their urban environments and the requirements upon mobility dictated by those environments. For instance, in the BER and ROV pilot there are ICT-supported solutions that promote bike transportation in various ways, whereas that is not a focus in the TRE pilot due to longer periods of snow covering the streets; in TRE, park and ride is instead a priority, which is embraced by an ad hoc scenario; park and ride is also a priority for ROV, but the way the scenario in ROV is constructed is somewhat different from park and ride in TRE, since it considers – beyond support for the citizen/driver – also ways to support the mobility management staff in the ROV municipality, who may want to proactively influence drivers in their mobility decisions to push park and ride options in the city, either according to policy, or dynamically, in response to particular circumstance; etc.

Another common trait of the three pilots is that they all present in their scenarios a mix of end user- (i.e. citizen-) oriented and mobility management-oriented functionality. However among the three pilots there is a difference in *how* they present the functionality above and that difference is architecturally relevant:

- In the BER pilot, scenarios are strongly separated among three end user-oriented (BER-PTP, BER-CPI and BER-BUI) and two management-oriented scenarios (BER-MGMT and BER-BES). Consequently, functionality to address these scenarios and the derived use cases also seems strictly disjoint, that is, no functionality and software components for mobility management has a role in the 15 use cases of the three user-oriented scenarios and no end user functionality appears in the seven use cases of the two management-oriented scenarios.

- In the ROV pilot, only three scenarios have been defined; however, each scenario presents some aspects (and corresponding use cases) addressing end user functionality, and some others addressing the mobility management facets of the same scenario. In the ROV pilot, in other words, the separation between end user- and management-oriented features is at the level of granularity of the use cases.

- The TRE pilot has taken an approach to scenario definition similar to BER. However, it introduces scenarios and use cases that address an additional set of potential STREETLIFE stakeholders, that is, (3rd party) developers of mobility related applications on top of STREETLIFE-provided features. Among the five scenarios in the TRE pilots, TRE-02, TRE-04, and TRE-05 are end user-oriented, TRE-03 is management-oriented, and TRE-01 is developer-oriented. It must be noticed that TRE-02 and TRE-04 also contain some developer-oriented aspects.

Concerning the input to architectural specifications, those differences in the make-up of the pilot scenarios are relevant, in terms of the ability of recognizing and tackling integration about different types of functionality, and the corresponding architectural elements that are supposed to deliver that functionality. These important integration requirements and challenges are likely to be clearly visible from scenarios that integrate closely the perspectives of multiple system stakeholders and the related functionality (for instance, incorporate some end user-oriented together with some mobility management-oriented use cases).

We have carried out a further, more fine-grained analysis of the commonalities and peculiarities of the scenarios, considering exactly what kind of functionality is required in each of them, and how that functionality may be mapped onto distinguishable architectural elements. The results of that analysis are recapped in Table 1. Notice that the assignment of functionality to the pilot scenarios in Table 1 is conservative, that is, it is possible that some functionality can be useful in some other scenarios besides those listed in Table 1, but that functionality is only explicitly mentioned or described in the scenarios that are listed below.

Table 1: Architectural functional units and their mapping to scenarios

ARCHITECTURE FUNCTIONAL UNIT	BER SCENARIOS		ROV SCENARIOS		TRE SCENARIOS	
Multimodal trip planner	**BER-PTP**	e.u.	**ROV-PR**	e.u.	**TRE-02**	e.u.
					TRE-04	e.u.
User tracking	**BER-PTP**	e.u.	**ROV-CP**	e.u.	**TRE-02**	e.u.
	BER-CP	e.u.	**ROV-BS**	e.u.	**TRE-04**	e.u.
	BER-BUI	e.u.	**ROV-PR**	e.u.		
User notification system	**BER-PTP**	e.u.	**ROV-PR**	e.u. & m.m		
	BER-CP	e.u.				
	BER-BUI	e.u.				
	BER-MGMT	m.m.				
Trip matching system			**ROV-CP**	e.u.		
Carbon calculator	**BER-PTP**	e.u.			**TRE-05**	e.u.
Reservation system	**BER-BUI**	e.u.	**ROV-BS**	e.u.		
Planner adaptation (policy-based)	**BER-MGMT**	m.m.			**TRE-03**	m.m.
Incentives system	**BER-BUI**	e.u.	**ROV-CP**	m.m.		
Gamification system	**BER-CPI**	e.u.	**ROV-CP**	e.u. & m.m		
	BER-BUI	e.u.				
Crowdsourcing system	**BER-PTP**	e.u.	**ROV-PR**	m.m.		
Social network	**BER-CPI**	e.u.	**ROV-CP**	e.u.		
Personalization system	**BER-PTP**	e.u.			**TRE-02**	e.u.
Mobility simulator	**BER-BES**	m.m.	**ROV-PR**	m.m.		
Traffic monitoring	**BER-MGMT**	m.m.				
KPI monitoring	**BER-MGMT**	m.m.				
Analytics support	**BER-BES**	m.m.	**ROV-CP**	m.m.		
			ROV-BS	m.m.		
			ROV-PR	m.m		
Planning support			**ROV-BS**	m.m.		
Third-party integration framework					**TRE-01**	s.d.

Legend:
e.u. = end user oriented
m.m. = mobility management oriented
s.d. = software developer oriented
(Identifiers of the scenario BER, ROV, and TRE refer to the identifiers introduced in the scenario specifications within Deliverable D6.1)

The architectural functional units listed in Table 1 are all candidates to become software components in the STREETLIFE architectural blueprints.

Table 1 highlights how there is one central component that all of the three pilots require, which represents the principal means to deliver functionality to end users/citizens that is the *multi-modal trip planner*. As shown in the survey of available software assets the consortium has carried out, each pilot can already rely on its own instance of the multi-modal trip planner. The trip planner functional element – in all three pilots – is in fact represented by the combination of two well-identified software components: a server-side route calculation engine, on top of which the STREETLIFE project can implement enhanced multi-modality, personalization, and other advanced routing and planning features, and a mobile app, upon which the STREETLIFE project can build to deliver that additional functionality to users. Other mobile apps are also planned in the various scenarios of the three pilots, as they represent the natural vehicle for delivering mobility functionality and support to end users.

A number of other elements listed in the table are required by – and common to – two pilots out of three. Some of them are also common to a multiplicity of the scenarios in those pilots: notable examples are the *user tracking* and *user notification* elements (towards the end user) and *analytics support* (towards mobility management), which makes them prominent candidates for incorporation in the blueprint architecture. Conversely, there are several recognizable functional units that are specific to a single pilot, or even a single scenario within a pilot. It is noticeable that they pertain mostly to either the mobility management area or the software developer support area of the functionality described in the pilot scenarios. For these, it needs to be discussed whether they should be also incorporated in the blueprint architecture, or could be designed and implemented only within the architecture of the individual pilots.

To highlight gaps, which may have an architectural impact, in terms of the fine-grained functional elements identified above in Table 1 we have attempted to match the functional units of Table 1 (as extracted from scenario specifications) to the software assets that are already available to the clusters of partners operating in the BER, ROV, and TRE pilots, as reported by the survey that has been done for Deliverable D6.1 [17]. However, that exercise has demonstrated unsuitable for gap identification, since the software assets that are described in Deliverable D6.1 are different in two important ways: first, for the most part they are listed at a significantly coarser level of granularity than the functional assets derived from the analysis of the scenarios; second, and perhaps most importantly, the majority of the surveyed software assets represent infrastructure and platform software, rather than application-level software. They can act as enablers of the functional elements listed above, but not directly implement that functionality. The major exception, which matches well one-to-one with a specific functional element, is the *multimodal trip planner*, which – as mentioned above – already exists within all pilot clusters.

Given this observation, the identification of specific architectural gaps requires first the definition of an infrastructure-level view of the STREETLIFE architecture, that is, the architectural specification of a runtime platform that can host all the functional elements identified here. That view can elucidate how some of those functional units can be covered, directly or indirectly, by some of the platform elements that are already considered assets to STREETLIFE; some likely examples are the *user notification system* element, and the *third-party integration framework* element.

Some of the other functional elements are likely to be covered by developments planned in various STREETLIFE Work Packages; for example, *incentives system* and *personalization system* are likely subjects of the activities researching end user applications in WP5; similarly, *KPI monitoring*, *analytics support* and *planning support* are likely subjects of activities researching tools for mobility management support in WP4.

Although the analysis of the commonality and specificity of pilots with respect to functionality cannot by itself lead to the identification of specific gaps in the functional view of the STREETLIFE architecture, we have used that analysis to identify functional areas that are necessary and are under-specified and under-developed. Therefore, they represent gaps, in the sense that they are areas of attention; at the same time, they also represent as opportunities of synergetic development for the project. Those considerations are reported in Section 3.3 of this chapter; to focus on those areas of attention, we have considered the functional perspective presented here in combination with the data-centred perspective and gaps, which are discussed in the following Section 3.2 of this chapter.

3.2 Data gaps analysis

In parallel with the analysis of the functional elements necessary to the three pilots, as candidates to become components within the STREETLIFE architecture, we have also analysed the data sources that come into play in each of the various scenarios, by providing the necessary information for their implementation; we have then compared them with the list of data sources that have been surveyed for each pilot.

This activity has been carried out at the beginning of the project in the context of STREETLIFE Work Packages dealing with pilots planning as well as data modelling and integration, and its results are recorded in Deliverable D3.1 [18], including the current availability status of each identified data source at the date on which Deliverable D3.1 was published. The availability status of a data source for a given pilot can be any of the following:

- **In use:** The data source is already integrated and being used by the current mobility services that are offered in the pilot location, and is available to the cluster of partners working in the corresponding STREETLIFE pilot.

- **Available:** The data source is available to the cluster of partners working in the corresponding STREETLIFE pilot.

- **Availability TBD**: The data source exists in the pilot location, but the availability to the STREETLIFE partners cluster for that pilot still needs to be investigated and determined.

- **Not available:** The data source is not yet available to the STREETLIFE partners cluster for that pilot; that does not mean that the data itself does not exist, but rather that work is necessary to design and implement a procedure – and the corresponding software – to obtain the data and represent it and deliver it in a suitable digital format, so that it can be acquired by, and used within, the STREETLIFE mobility information system.

In Table 2, we have used the above information to highlight data-related gaps that need to be covered in order to enable the various pilot scenarios. We have considered those data sources for which the availability in a given pilot is either “Availability TBD” or “Not Available”. Table 2 identifies the following nine data gaps.

Table 2: Gaps related to STREETLIFE data sources – matched to relevant scenarios.

ID[2]	NAME	DEFINITION	PILOTS	SCENARIOS
DS20	Bike sharing state	Current position of available bicycle	**ROV**	**ROV-BS**
DS23	Bike flows	Past and real time information about traffic on bike lanes	**ROV**	**ROV-BS**
DS24	Bike floating data	Data captured by bike fleet	**ROV**	**ROV-BS**
DS28	Weather	Weather condition and forecast	**BER**	**BER-PTP, BER-BUI**
DS29	Crowd sourcing	Users input information about bus delays, accidents, etc.	**BER**	**BER-PTP, BER-BUI, BER-MGMT**
DS30	User profile	Static personal information	**BER, ROV**	**BER-PTP, BER-CPI, BER-BUI, ROV-BS, ROV-CP, ROV-PR**
DS31	User preferences	Captured using the interaction with the system	**ROV**	**ROV-BS, ROV-CP, ROV-PR**
DS32	Social networks		**BER, ROV**	**BER-CPI, ROV-CP**
DS34	CO_2 emission	Formula to determine carbon footprint	**BER, ROV**	**BER-PTP, BER-CPI, BER-BUI, ROV-BS, ROV-CP, ROV-PR**

Table 2 shows that the identified data gaps impact the BER and ROV pilots, whereas the TRE pilot seems to have all the necessary data sources already available. Moreover, the table shows how the data gaps are going to impact in particular the end user-oriented scenarios within the BER and ROV pilots. Another observation is that most data gaps affect a multiplicity of scenarios, which means those missing data sources are likely critical for the STREETLIFE system as a whole. Prominent examples are *User profile* and *CO_2 emission* data sources.

We can also see that the majority of the information in the data gaps has to do either with user representation (e.g., *user profile*, *user preferences* and *social networks*), or floating and crowdsourced information that can enable real-time updates and interactions with the user within certain scenarios (e.g. *bike sharing state*, *bike flows*, and *bike floating data*).

3.3 Architectural gaps and opportunities for synergy

As a conclusion, we offer our observations – based on the snapshot discussed above – about the areas that we have found under-developed, in terms of either functionality or data, or – often – a combination of both.

The areas we discuss below seem to be important for the goals of the STREETLIFE mobility information system in general, as well as the goals of one or more of its pilots. We therefore consider them as gaps, but they also represent opportunities for synergy among the pilots, and to develop common and general solutions that can be re-used across pilots, can represent

[2] Reference ID for the DATA OVERVIEW TABLE in Appendix A of D3.1

software components for the STREETLIFE blueprint architecture, and, as such, can become general assets in advanced mobility support solutions based on STREETLIFE beyond the three project pilots and for other deployments in future sustainable mobility urban contexts.

Crowdsourcing support: although some amount of crowdsourcing support exist in some pilots, there is at the current stage no clear and unified technical solution to the acquisition of crowdsourced data, its processing, and its injection into the various functional elements that could potentially take advantage of it. A component (or possibly a set of components) of the STREETLIFE blueprint architecture should take care of such a solution, and offer for integration within the pilot systems, based on a clear set of guidelines and interfaces.

Floating data support: with “floating data” we intend data generated by vehicles and users as they circulate in the city, and captured within the STREETLIFE mobility information system automatically; we differentiate it from crowd sourcing data, which is instead information that is voluntarily input by the system users and stakeholders. The support of floating data is very similar to that of the crowdsourcing support discussed above. A component (or possibly a set of components) of the STREETLIFE blueprint architecture should take care of an end-to-end technical solution for the integration of floating data and its use, offering that component to the pilot systems, based on a clear set of guidelines and interfaces.

KPI environment: Key Performance Indicators related to sustainable mobility are going to be an important element of the STREETLIFE mobility information system in at least two ways: 1) as part of the mobility management dashboards of the individual pilots, and 2) at a more general level to collect and process information that leads to establishing the impact of the various ICT-based mobility solutions promoted by STREETLIFE. Support for measurement, analysis and reporting of mobility-related information at the level of abstraction of KPIs is not addressed in any pilot by functionality and data capabilities that are available at the current stage. We envision an environment for the management of KPIs, and which allows to define KPIs, link them to metrics, visualize and analyse them in customizable ways, and report them. This can be a generic component in the STREETLIFE blueprint architecture. Carbon emission calculation support can be for example seen as a specific instantiation of the KPI support functionality of that component.

Social networking support: some of the scenarios in the pilots make a case about the importance of providing a social aspect to the pursuit of more sustainable mobility options in an urban context. Current capabilities in the pilots may enable limited social networking features, but we envision a more comprehensive component of the STREETLIFE blueprint architecture that enables the design, construction and management of social networks of STREETLIFE users, which may span across scenarios and related applications, and that can be instantiated in each of the pilots according to its own social networking requirements.

Incentives system: Some of the scenarios in the pilot make a case about the importance of injecting incentives in the provided mobility applications. A system of incentives and functionality for its support is lacking among the assets currently available. We envision a component in the STREETLIFE blueprint architecture that enables the definition, maintenance and enactment of incentive campaigns and initiatives that are tightly linked to the usage of the sustainable mobility solutions promoted by the STREETLIFE information system. A viable path to build such a component, and one upon which partners and pilots can converge, is to organize such an incentive system around the gamification of the STREETLIFE end user applications.

Data collection component: user data will be generated by the usage of ICT-based mobility solutions. The data is send to the STREETLIFE system for storing and further processing. The KPI environment will for example perform processing of this data. A component strictly considering the privacy of users, while still providing all necessary information for KPI assessment is so far not available. We envision a component in the STREETLIFE blueprint architecture that takes account of the willingness of the user to share data. A manifold user management can for example implement anonymisation, pseudonymisation and authentication mechanisms. This will also require corresponding functionality on the part of the mobility applications. Depending on the users data sharing requirements the data collection component can save statistical, behavioural and aggregated user data while respecting privacy concerns of the user. Thus we are able to realize a solution that keeps the balance between privacy needs of the user and statistical data analysis by the STREETLIFE system.

3.4 Refinement of STREETLIFE Scenarios and Use Cases

This section looks at the continuous refinement of STREETLIFE scenarios and use cases towards their realization in the corresponding STREETLIFE city pilot.

The initial scenarios and use cases for the three pilot cities of the STREETLIFE project are listed and described in Deliverable "D6.1 Specification of city pilots for the first STREETLIFE operation and evaluation" [17]. They are on different levels of maturity depending on the pilot site and the prioritization of the scenarios within the pilot sites. This is a consequence of the different sizes of the pilot cities – directly for the choice and prioritization of the scenarios and use cases, indirectly for the set of already existing data sources and software components. (The already existing data sources and software components are also listed in Deliverable D6.1 [17] and in Annex D).

The scenarios and use cases are under continuous refinement towards the first iteration of the STREETLIFE pilots. This work is currently undertaken with respect to the deployment and evaluation of the pilots and with respect to research tasks on mobility data integration, mobility management and emission control panel, and end-user applications. Scenarios and use cases are selected that have a high priority for the STREETLIFE mobility system, that provide a major hub in the development of the STREETLIFE pilots, and that provide the basic methods for the first iteration of the pilot deployment. The refinement of the selected scenarios and use cases helps in identifying the gaps in the STREETLIFE data model, the missing data sources, and the gaps in the collections of the specific software components.

The current work of the pilot activities and the research tasks on mobility data, mobility management, and end user applications together with the support of architecture development is a continuous gap analysis with a finer and finer granularity. The focus is on the first iteration of the STREETLIFE pilots. Identified gaps are closed with this goal in mind.

Here in Deliverable D2.1, only two refined scenarios and use cases are shown as an example, in Section 3.4.1 for the Berlin pilot and in Section 3.4.2 for the Rovereto pilot. Both examples are more detailed than its initial version in Deliverable D6.1 [17]. Moreover, both will be further detailed, and adapted if necessary, in the future during the preparation and implementation of the corresponding STREETLIFE pilots.

3.4.1 Berlin Use Case "Guidance Bike/Car Sharing" (BER-MGMT-4)

The Use Case "GuidanceBikeCarSharing" (GBCS) is a specific development and refinement of the original STREETLIFE Use Case BER-MGMT-4.

The STREETLIFE system will collect several information about upcoming events from available public event portals via an API. To derive the impact to traffic they have to be classified. The current availability of bikes from bike sharing services, of cars from car sharing services, of parking slots and the actual traffic situation like roadwork or congestion for a specific area has to be known as input for modal split calculation. To calculate the transportation mode coverage for a guidance regarding a specific event and type of audience, especially the modal availability and demand have to be known. Also the modal history regarding an area for a period of time can help to validate the calculation. The STREETLIFE system then will create guidance regarding specific events for the system operator. For a registered event they shall be automatically calculated and presented including the event notification to the system operator. The STREETLIFE system will support a recommendation system to inform service operators about critical areas where their transportation modes are required.

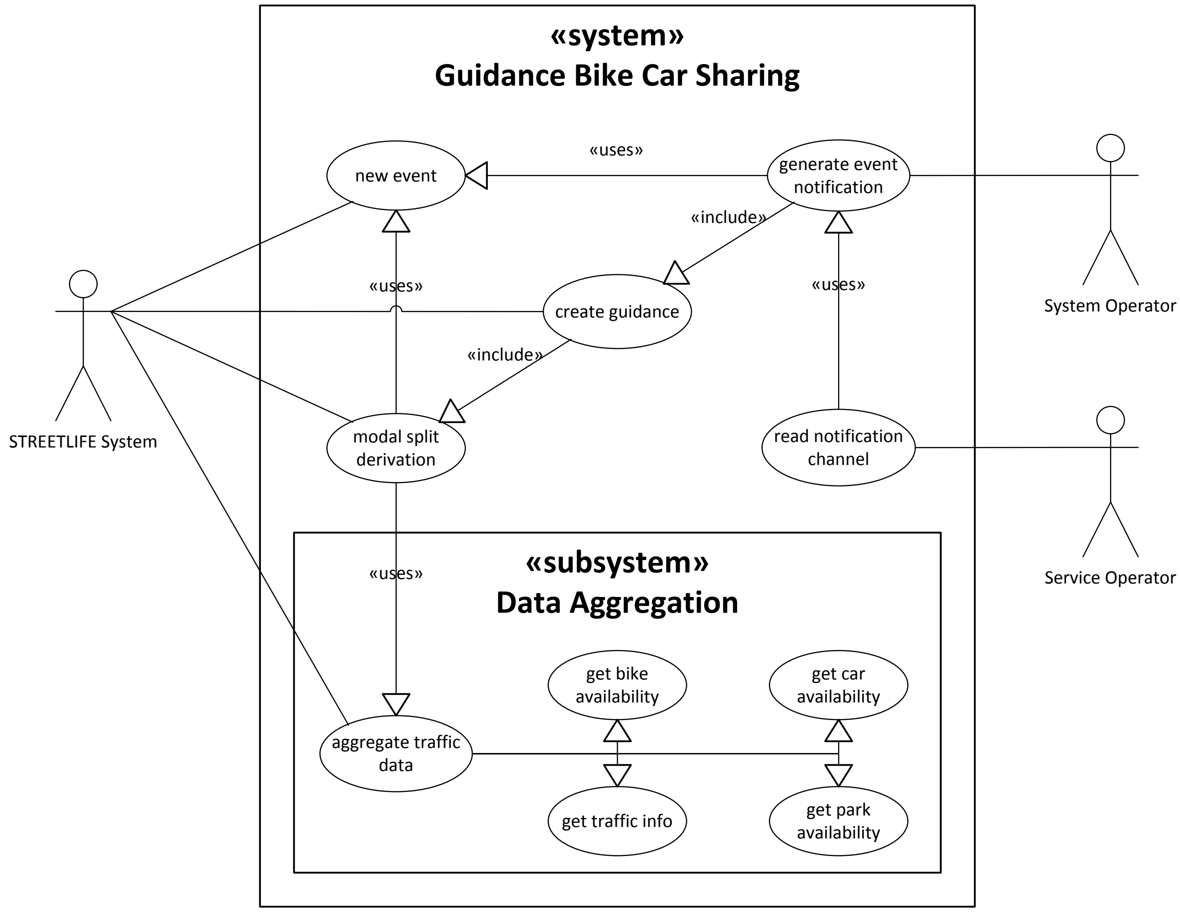

Figure 5: UML Use Case Diagram for Guidance Bike Car Sharing

Table 3: Overview of UML-Use Cases and Description

USE CASES	SUB USE CASES	DESCRIPTION
New Event	**Event registration**	Event has to be detected and analysed
	Event classification	Audience has to be characterized regarding modal split
Data aggregation	**Bike availability**	Aggregated from bike sharing operation
	Car availability	Aggregated from car sharing operation
	Park availability	Aggregated from parking management
	Traffic circumstances	Aggregated from traffic info, incidents and public transport
Modal split derivation	**Modal demand**	Calculate and defines demand on transportation modes
	Modal availability	Defines availability of transportation modes
	Modal history	History data and changes in availability regarding start and end date time of event
Guidance	**Transportation Mode Coverage**	Calculation of necessary transportation mode
	Generate guidance	Guidance regarding specific event
Notification	**Create Notification**	Report system operator about event and guidance & system operator publishes notification
	Notification channel	Channel system for notifications which service operator can subscribe

3.4.2 Rovereto Use Cases "Park&Ride (P+R)" (ROV-PR)

The Scenario ROV-PR "Park&Ride (P+R)" has been selected as the scenario to be implemented in the STREETLIFE Rovereto pilot with the highest priority. The focus – in the first iteration – is on the following four use cases out of the five use cases of the park and ride scenario ROV-PR described originally in D6.1 [17]:

- ROV-PR/1 "Planned P+R"
- ROV-PR/2 "On-the-fly P+R"
- ROV-PR/3 "On-the-ground P+R support"
- ROV-PR/4 "P+R alert"

The following data sources and software components are needed for the intended four use cases of the ROV-PR scenario ("Park&Ride (P+R)"). Items between parentheses denote optional data sources. Identifiers ROV-DSx of the data sources are with respect to the data overview table in Annex A of Deliverable D3.1 [18].

Data sources:

- ROV-DS1 City road network – already integrated
- ROV-DS2 Street names and numbers – already integrated
- ROV-DS5 Bus routes and schedules – already integrated
- ROV-DS10 Parking garages – available, to be integrated
- ROV-DS13 Residual capacity of parking garages – to be done (This data source will be produced internally by the app that is the output of use case ROV-PR/3 and can be consumed directly by the other ROV-PR use cases.)
- (ROV-DS21) Crowdsourced information about incidents and accidents – to be done (This data source will be produced internally by the app that is the output of use case ROV-PR/3 and can be consumed directly by the other ROV-PR use cases.)
- ROV-DS22 User profile – available, to be integrated
- (ROV-DS23) User preferences – available, to be integrated

Software components:

- Multi-modal route planner – available, to be modified (for ROV-PR/1 and ROV-PR/2)
- ViaggiaRovereto mobile app – available, to be modified (for ROV-PR/1 and ROV-PR/2)
- Mobile app for parking/traffic aides – to be done (for ROV-PR/3)
- P+R management console – to be done (for ROV-PR/2)

Table 4 lists the amount of additional work needed for the above software components and data sources that are required for the four use cases of the STREETLIFE Rovereto Scenario ROV-PR (Park&Ride). They might need to be customized, extended, implemented altogether, or deployed in the field. Already integrated data sources are not listed in Table 4.

Table 4: Details of required Development Work for the identified Data Sources or Software Components

DATA SOURCE OR SOFTWARE COMPONENT		DETAILS OF DEVELOPMENT WORK
Data Sources	**ROV-DS10**	Data is available: must be formatted, so that locations can be represented as POI in the OSM maps, and meta-data needs to be stored in data model
	ROV-DS13	Data will be acquired through flow of notifications from the parking/traffic aides' mobile app – data representation and acquisition is part of the development of that mobile app
	ROV-DS21	Data will be acquired through flow of notifications from the parking/traffic aides' mobile app – data representation and acquisition is part of the development of that mobile app
	ROV-DS22	Current user model needs to be augmented in accordance with the STREETLIFE user model
	ROV-DS23	Current user preferences model needs to be augmented in accord with the STREETLIFE user model
Software Components	**SW: route planner**	Modification to explicitly recommend and highlight P+R travel options
	SW: ViaggiaRovereto	Modifications: 1) properly represent P+R travel options in GUI; 2) receive and display alerts on P+R and require P+R alternative to route planner
	SW: aides' mobile app	New app: must provide an easy and user-friendly way to notify the system about incidents, accidents and parking availability
	SW: P+R management console	New app or web-based system, which must: 1) display notifications from aides' app; 2) allow to compose and issue alerts on P+R

3.5 Mappings of Pilot-Specific Scopes

This section maps pilot-specific scopes of components onto the initial STREETLIFE architecture for identifying missing components specific to the STREETLIFE city pilots.

The different size of the three pilot cities has an influence on the focus of the anticipated scenarios and use case in each of the three STREETLIFE pilot cities. While the STREETLIFE blueprint architecture provides a general description of the STREETLIFE mobility system applicable to cities of any size, the actual pilot cities will only use those components of the blueprint architecture that support their goals of the pilots and that are necessary for their size and for the scenarios applicable to their size. Furthermore, some components are more important in one pilot city and less important in another pilot city.

The different applicability of components of the blueprint architecture to the STREETLIFE city pilots is an important aspect of the gap analysis: Some gaps identified in the general work on the STREETLIFE mobility system are not a gap in some city pilots. The “gaps” (or more precisely, the areas of the missing data source or software component) are simply not applicable to the specific STREETLIFE city pilot.

A gap analysis has been performed as initial starting point for the specialization of the pilot-specific architectures in comparison to the blue-print architecture. The scenarios and use cases provide the basis for the scope of each city pilot. This scope has been mapped on the very first initial version of the blue-print STREETLIFE architecture which is component-oriented (Figure 2 of [19]) in order to identify the relevant areas for each pilot. Each STREETLIFE city pilot focusses on those respective areas, data sources and components. Mapping the existing SW components and data sources onto the above scope of the specific STREETLIFE city pilot yields the gaps, that is the missing components. Note, that many of the already existing components need to be extended in order to realize the STREETLIFE scenarios and use cases of the specific STREETLIFE city pilots.

The findings of this Section 3.5 are similar to the findings of Sections 3.1–3.3. However, both use a different angle for approaching the task of identifying gaps. Especially Section 3.1 is looking at the functionalities of a STREETLIFE system. The line of thought is going from the STREETLIFE scenarios and use cases towards the functional architectural elements. On the other hand, this Section 3.5 is looking at the pilot components, starting from a high-level component-based general architecture over the pilot-scopes towards the pilot-specific components.

The mappings of the pilot-specific scopes are given in Section 3.5.1 for the Berlin (BER) pilot, in Section 3.5.2 for the Tampere (TRE) pilot, and in Section 3.5.3 for the Rovereto (ROV) pilot.

3.5.1 Berlin BER Pilot – Software Component Mapping

The Berlin pilot (BER pilot) will consider both, end user scenarios and management scenarios. Figure 6 shows the areas covered by the Berlin pilot. This coverage of the parts of the initial STREETLIFE architecture as given in the Description of Work [19] is derived from the collected scenarios and use cases reported in Deliverable D6.1 [17].

The surveys on available data sources and available software components [17] showed that there are no serious gaps. Nevertheless, several data sources and software components are not readily available or usable. These detailed gaps will be identified during the course of the project and closed as part of the work done towards the implementation, deployment and evaluation of the Berlin pilot. The following paragraphs give an overview where such detailed gaps are located.

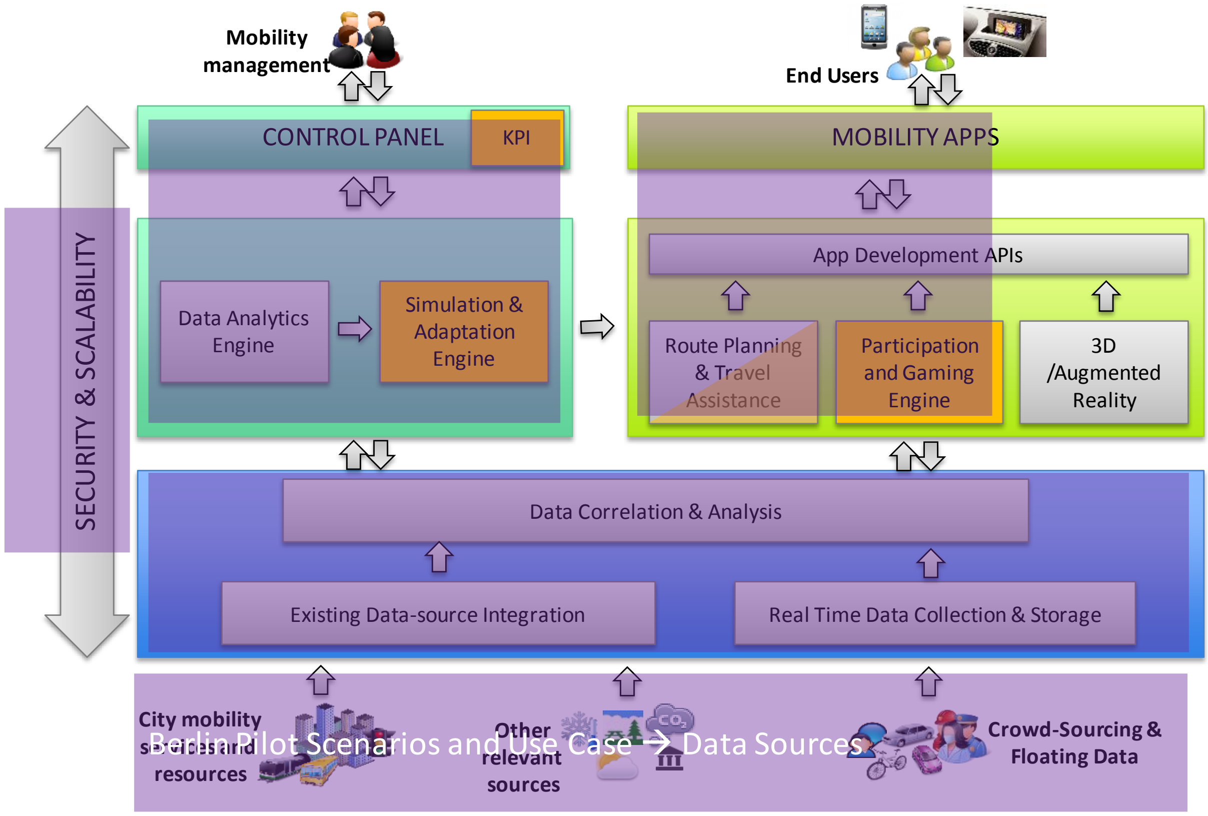

Figure 6: Mapping of Pilot Scope for Berlin Pilot

Management part (green in Figure 6): Some of the functionality and software components for mobility management are already available and in use at VMZ. Missing functionalities are:

- The determination of the specific STREETLIFE KPIs and their visualization (Scenario BER-MGMT).
- The specification, modelling, and simulation of what-if scenarios as part of the back-end services (Scenario BER-BES).
- The integration of the relevant parts and functionalities of the Siemens City Intelligence Platform (CIP) into the mobility management.

Mobility Apps part (yellow in Figure 6): Not all mobility apps anticipated in the STREETLIFE project will be part of the Berlin pilot. Here, only apps for route planning and travel assistance as well as for the participation and gaming engine will be considered.

- The specific gaps are smallest for the route planning: existing route planers will be extended with specific features in multi-modal route planning tailored to STREETLIFE goals and especially to Berlin. The most prominent example is the support of cyclist safety in the multi-modal route planner. (Scenario BER-PTP).

- Travel assistance is a rather new concept. Technological development and integration into the multi-modal route planner is required here. (Scenario BER-PTP).
- Providing incentives through the participation and gaming engine is a functionality that is necessary but is only available as a set of ideas and use cases in the Berlin pilot. The Berlin pilot will join forces with the other STREETLIFE pilots in order to close this gap and to develop a common STREETLIFE solution for the incentivation of environmentally travel in the cities. The starting points are the use cases that include incentives, usually termed “Green Leaves” as working terminology. (Scenario BER-PTP).

Data part (blue in Figure 6): Due to the large size of Berlin, the data part of STREETLIFE plays an important part in the Berlin pilot. There is already experience in retrieving, storing, and presenting of mobility data available in the Berlin pilot at VMZ. Furthermore, VMZ provides access to a large set of relevant data sources for the STREETLIFE mobility system. See STREETLIFE Deliverable D6.1 for details please see [17]. The gaps are mainly additions with few new data sources and extensions with specific STREETLIFE functionality. Both are derived from the scenarios and use cases of the Berlin pilot.

Furthermore, the Siemens City Intelligence Platform (CIP) will provide the necessary data storage, interfaces, and data extraction, data transformation, and data loading based on the STREETLIFE data model and the common STREETLIFE web interfaces. The STREETLIFE data model and the common STREETLIFE web interfaces are specified and developed and finally implemented in the CIP in the course of the STREETLIFE project. The STREETLIFE web interfaces provide a common specification for accessing STREETLIFE data, sending requests to the STREETLIFE system and getting back responses as well as for integrating additional services and apps into the STREETLIFE system.

3.5.2 Tampere TRE Pilot – Software Component Mapping

STREETLIFE will integrate the Tampere region passenger information system and journey planner with real-time feeds. The Tampere pilot (TRE pilot) offers to the citizen’s safe, personalized, and real-time routing solutions covering all modes of transport to achieve the best experience. Multi-modal integration of park and ride will also check availability of parking slots as part of the trip suggestion and will calculate the CO_2 footprint. State-of-the-art 3D and augmented reality apps are tested as part of the pilot’s field trials.

The Tampere pilot architecture follows the STREETLIFE blueprint architecture and builds on the investment the City of Tampere already has made in their Intelligent Transport Systems. STREETLIFE offers to the traffic management centre and city administration tools for flow management of travellers through the configuration possibilities of the journey planner. One of the key aspects in the TRE pilot are open APIs for third party access further promoting an active developer community in Tampere.

Tampere has a very good selection of static and real time data sources in European formats like DatexII and SIRI. The surveys on available data sources and available software components [17] showed that there are no serious gaps. Three major software components were identified that are already available for the STREETLIFE Tampere pilot.

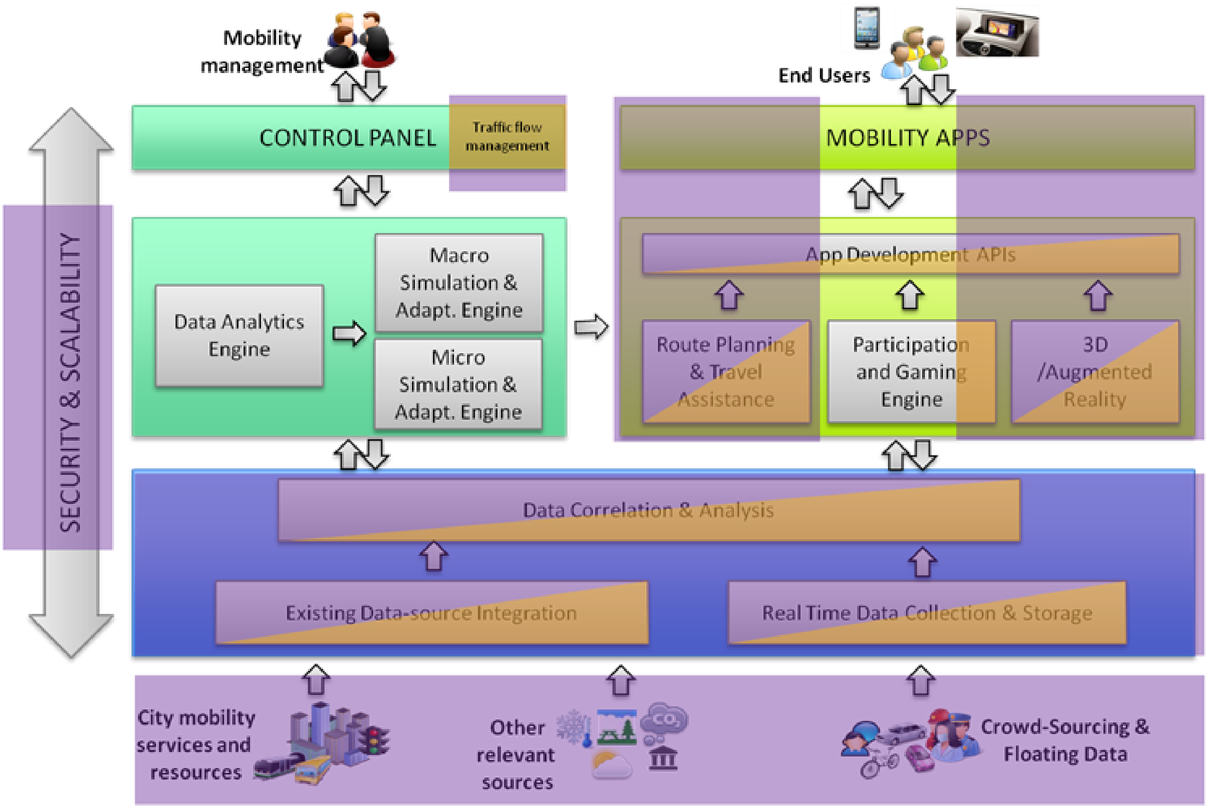

Figure 7: Mapping of Pilot Scope for Tampere Pilot

The main work is integration of these systems in Tampere and in certain parts their enhancement. Besides using the integrated real time data in STREETLIFE pilot, it is provided to open APIs. The key research goal is fluent integration of all real time data sources so that end used experience is smooth. The STREETLIFE will enable that user's mobile app, the physical stop displays and the actual vehicle arrival as all in sync. In addition to the real time integration the most new development work is done on the 3D and augmented reality app which works also as crowd sourcing data source.

The following list contains the available major software components and the planned integrations and enhancements. Naturally there are other software components like mapping and address look up available in Tampere.

- A multi-modal route planner currently in use for the Tampere region. It runs on a cloud environment. The missing integrations are:
  - Multi-modal transport routes with personalization. It will be integrated with real-time feeds for example park facility availability and real time bus departure times.
  - CO_2 calculation and comparison to private vehicle for the trip suggestion is added. This carbon footprint is shown in the existing journey planner's user interface promoting public transport over private car.

- People flow management with journey planner configuration possibilities are tested. Meaning public transport traffic can be spread to wider network and therefore reduce congestion. This enables one tool in the control panel for the traffic management centre and city administration.
- Open data API integration. The real time data integrated into journey planner data is connected to open

- Real time passenger information and traffic lights priority system. This acts as a key data source and provides one of the main real-time feed for the multi-modal journey planner. The existing solution tracks all vehicles once per second. The real time API from the real time passenger information is enhanced and extended. The parking availability data is similarly from a separate system.
- 3D and augmented reality software with 3D model of Tampere. Solution is extended on multiple levels. The research done and field trials on virtual mobility, 3D virtual environments and gamification is elaborated in [20]

3.5.3 Rovereto ROV Pilot – Software Component Mapping

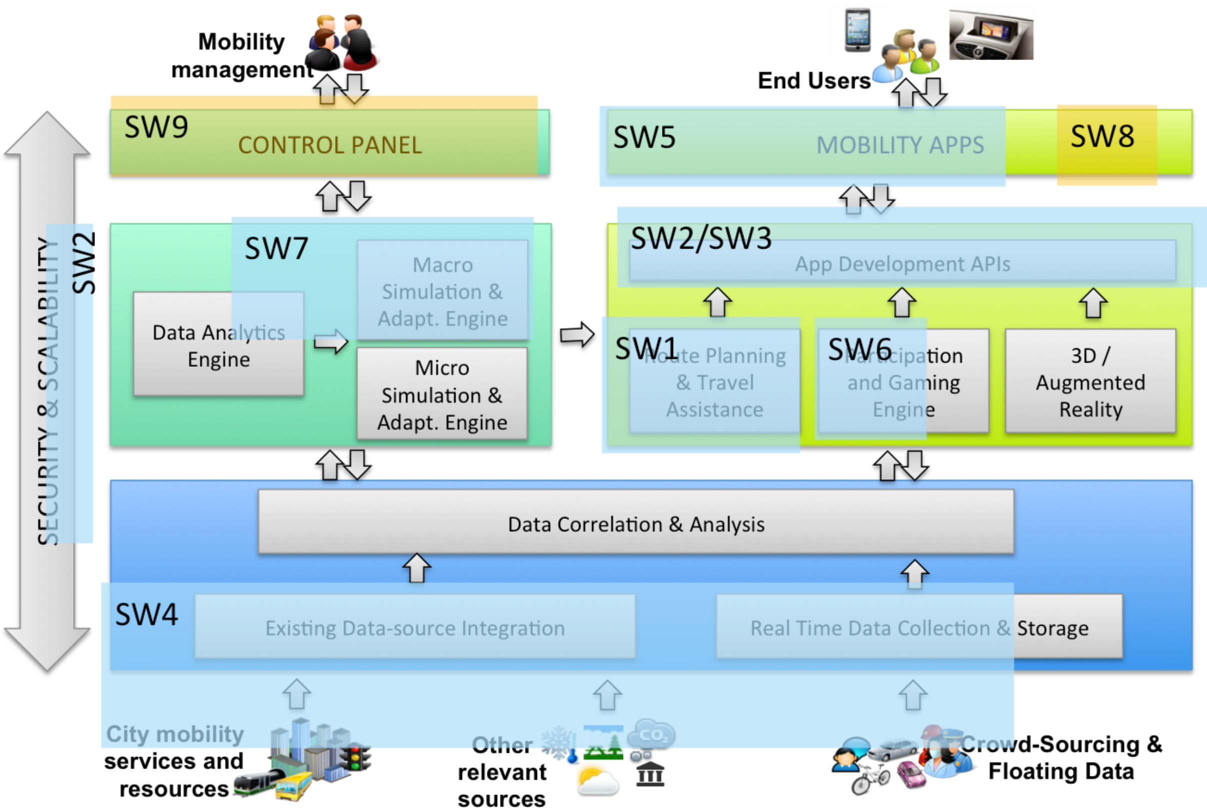

Figure 8: Mapping of Pilot Scope for Rovereto Pilot

We identified seven major software components that are already available for the STREETLIFE Rovereto pilot. Most of them need to be extended for the STREETLIFE mobility system in the Rovereto pilot. The following list contains the available software components and the planned extensions. References SWx are with respect to the overlaid light blue boxes visible in Figure 8.

- A multi-modal route planner (SW1) currently in use for the cities of Rovereto and Trento. The planner already supports real-time data and multi-modal transport routes and will be extended to deal with dynamic mobility policies and more sophisticated personalization of user preferences (e.g. health/green), to become a full-fledged instance of the architectural functional unit named *Multimodal trip planner* in Table 1.

- The SmartCampus hosting environment offering Platform-as-a-Service (PaaS) facilities (SW2) that support the server-side development, deployment, and execution of mobile apps.

- The SmartCampus Client framework (SW3) supporting the client-side development and execution of apps. SW2 and SW3 together do not correspond to any architectural functional unit identified in Table 1, but provide generic infrastructural support to the development and hosting of many of the instances of those functional units that will be deployed in the ROV pilot.

- The SmartCampus Open Services framework (SW4) supporting the integration of heterogeneous and distributed data sources and services. This is again a facility that provides infrastructural support; in particular, it will be its responsibility to integrate those data sources, among those listed in Table 2, which are relevant to the ROV pilot The framework will also need to be extended to support floating data and the integration of the data streams produced through the functional unit identified as the STREETLIFE *crowdsourcing system* in Table 1.

- Viaggia Rovereto mobile app (SW5), currently in use in Rovereto and available on the Google PlayStore. The app allows to plan and monitor multi-modal trips (by foot, car, or public transport) and to consult up-to-date information on public transport timetables, urban viability, and parking availability. The app will be extended to include also alternative/green transport means (e.g. bike/car sharing, car pooling), to better exploit the participation of citizens and to promote green behaviours. That way, it will represent an instance of the *End-user mobile apps* architectural functional unit of Table 1.

- A gamification engine (SW6) supporting the development and execution of games on top of existing mobile apps. The engine will be extended to allow the definition of games also from non-IT experts, and it will represent an instance of the architectural functional unit *Gamification System* mentioned in Table 1.

- Cube mobility simulator (SW7), a software for macro-simulation of the mobility system actually used in Rovereto. The current model is only suited for the simulation of traffic regarding cars, and the simulation model will be extended to include other means of transportation towards the goal of having a multi-modal traffic simulation model. The Cube mobility simulator represents an important element within the architectural functional units *Mobility Simulator* and *Analytics Support* in Table 1.

The following software components have not been available yet to the Rovereto pilot. They will be made available and integrated during the STREETLIFE project. References are with respect to the light orange overlaid boxes in Figure 8.

- Mobile app for parking/traffic aides (SW8), which is a different instance of the *End-user mobile apps* architectural functional unit with respect to WP5.
- Management console, which will represent a front-end component to the vast majority of the architectural functional components that are geared towards the management of mobility scenarios (marked in Table 1 as *m.m.*), including *Planning Support*, *Analytics Support* and *User Notification System.*

3.6 Mobility Management View

Each of the pilots has different scenarios and use cases, some very specific to mobility management within that single pilot. Some of these components are already finished and available for some pilots, others are not. But almost all of the pre-existing components do not explicitly lie in the thematic priority of project activities devoted to mobility management support in STREETLIFE. They mostly refer to a more specific level in the pilot sites whereas a mobility management and emission control panel in the focus of the project addresses a higher management related level.

Hence, mobility management activity is quite unrestricted to define architecture for a mobility management and emission control panel. Therefore, the goal of this definition process should be a common platform for this management and control panel placed over STREETLIFE pilot sites, instead of developing single or hybrid modules for each single pilot. Furthermore, the mobility management architecture has to be aligned in this process with the general STREETLIFE architectural blue-print.

In the mobility management and emission control panel, different relevant topics have to be addressed. For emission control, CO_2 calculations are necessary. Management policies have to be projected and park and ride as well as car and bike sharing have to be supported also regarding to modal split. Additionally, KPIs from the different pilot sites have to be derived, aggregated and monitored in the control panel. These KPIs might be partly pilot specific but it is not excluded that they cannot be calculated for other pilots.

The interface from the STREETLIFE mobility management support to the pilots can be a generic interface. This interface has to connect traffic management systems and trip planning in the different pilots with the mobility management and emission control panel. In order to influence trips e.g. by policies the trip planning has to be addressable before and after the planning process in the trip planner.

If it is possible existing pilot APIs are used. Otherwise an API as an interface for the mobility management control panel has to be developed. This is one open question that has to be clarified during the architecture process in the next steps. It applies also to the different formats, interfaces, licences and ownerships for existing data and components. For usage in the mobility management the possible field of application has to be cleared. E.g. for the existing components in the Tampere pilot the legacy system needs to be taken into account in the architecture. For the Rovereto pilot most software components have free accessibility for STREETLIFE partners. The same applies to the available software components in the Berlin pilot.

Another open point concerning the data storage has to be clarified. Does the mobility management and emission control panel need an additional data model and data storage e.g. for KPI calculation and the management of calculation results? This has to be decided during the ongoing architecture process. Furthermore, a potentially critical point might be the communication to external service providers that should be addressed but are not in the STREETLIFE project.

These open questions and maybe further questions that occur in the next development steps have to be answered in the architecture process.

3.7 Conclusion

The starting point of our considerations in the snapshot and gap analysis of this chapter have been the STREETLIFE scenarios and use cases from Deliverable D6.1 [17] (see also STREETLIFE Use Cases). Important and necessary input is the surveys on available data sources and available software components, also provided in Deliverable D6.1. But also the experiences in the ongoing work of the preparation of the pilots is valuable input to be considered.

Functionality-centred perspective: We looked at what kind of functionality is required for a STREETLIFE mobility system and how this functionality might be mapped on distinguishable architectural elements. Most of the identified functionalities are applicable to multiple pilots. The multi-modal trip planning is necessary in all three pilots. Also the monitoring of a user related to the selected multi-modal route has a high relevance across all pilots. The others are in relevant in two pilots. The multi-pilot functionalities have to be considered in the STREETLIFE blueprint architecture. The few single-pilot functionalities might be also relevant for the STREETLIFE blueprint architecture, at least for the pilot-specific architectures.

Data-centred perspective: We identified nine major data gaps. They are in the areas of bike information such as bike sharing information, crowd sourcing, user profile, social networks and CO_2 emission. The data gaps impact in particular end-user scenarios. Many of them are concerned with user representation and with user input such as floating data and crowdsourcing information that can be used for real-time updates. Some data gaps are more critical for the STREETLIFE mobility information system since they affect multiple scenarios (user profile, CO_2 emission).

Mobility Management perspective: Existing solutions are pilot-specific. The evaluation and presentation of the STREETLIFE KPIs as well as the STREETLIFE emission control panel are new functionalities and components common to all pilots in general, but some specific aspects and instantiations with respect to metrics, STREETLIFE KPIs and their evaluation and presentation will be different in the pilots.

Component-oriented perspective: The pilot activities play an important role in identifying and closing gaps. This is done through the continuous refinement of the STREETLIFE scenarios and use cases and in defining and realizing the functional scope of the pilot-specific STREET-LIFE systems in the necessary components of the pilot. The existing systems of in the three pilot systems cover already many of the required components for a STREETLIFE system. However, often they need extensions and further development in order to provide the full functionality necessary for a STREETLIFE system.

Some areas that are important for the goals of a STREETLIFE mobility information system need further development. The identified gaps provide opportunities for synergies within the activities of the STREETLIFE project and between the three STREETLIFE pilots. The following major areas have been identified: floating data support, crowdsourcing support, social networking support, user management, incentives system, KPI environment to derive and present STREETLIFE KPIs, data collection component.

The future work of the STREETLIFE project towards closing the gaps is anchored in the pilot activities and thrives on the architectural guidance and specification and on the corresponding research activities on data modelling, mobility management, and end user applications. The necessary continuous refinement of the STREETLIFE scenarios and use cases, data sources, components and STREETLIFE functionalities will lead to a larger level of detail in the identified gaps providing valuable input to the blueprint and pilot-specific architectures and to the preparation of the pilots and their specification finally leading to an agile closing of the gaps. The iterative approach of the STREETLIFE pilots supports this well.

4 STREETLIFE SECURITY

The STREETLIFE project develops collaborative multi-modal and low-carbon ICT mobility services, and tests these services under real-world conditions involving citizens of the three pilot sites. Thus data protection and privacy issues must be considered. Some of these aspects are, for example:

- collecting personal data
- analysing user behaviour
- monitoring user behaviour
- tracking of user location
- central processing and storage of date
- cloud computing technologies

The above named functionalities by STREETLIFE require technical and organizational security measures. These security measures can be derived by the security and privacy needs of the users, national legal positions, best-practices in IT security, and so on.

The goal of the security analysis is to find a well-balanced trade-off between functionality and security needs.

The methodologies and conclusions presented in this chapter give an insight into the work that has to be done from a technical point of view in order to maintain data protection and privacy. Since the security analysis is in a permanent flow the completed results will be released together with the blueprint architecture.

In the following sections the three methodologies performed in STREETLIFE to collect the security needs, to model the risk and threats, and to elicit the security requirements are presented.

SQUARE functions as a meta-methodology where all the three steps named previously are placed in a chronologically structured sequence. DREAD helps to quantify and prioritise the risks and threats. The *IT-Grundschutz* provides a well-documented pattern catalogue for vulnerabilities, threats, and counter measures. In the risk and threat analysis we evaluate and select those vulnerabilities and threats that are relevant for STREETLIFE. The resulting security measures will be extracted from *IT-Grundschutz* and transformed into STREETLIFE security requirements.

4.1 Methodology

4.1.1 SQUARE

SQUARE is a methodology to elicit security requirements in the software development process. It provides the following advantages:

- Security requirements are addressed early in the development process.
- Separation of concerns: A business view specifies "what should be secured"; a designer view represents the "how to secure".
- Allows reusing goals and security requirements.
- Delivers argumentation and justification for security requirements. The linkage between goals, threats, risks and finally the security requirements is documented throughout the whole analysis process.

Security requirements have an impact on system design and functionality. A late change of security requirements in the development lifecycle often results in unnecessary rework, poor design and security vulnerabilities. For example, security vulnerabilities alone cost the economy about $60 billion per year. On the other side, an early focus on security analysis can provide up to 21% return on investment (see [21]). Furthermore SQUARE has the flexibility to choose between multiple analysis and elicitation techniques for each step. For these reasons we decided to use a subset of SQUARE to elicit and document the security requirements in STREETLIFE.

A detailed explanation of SQUARE can be found in [22].

4.1.2 DREAD

DREAD (Damage potential, Reproducibility, Exploitability, Affected users, Discoverability) is a methodology for modelling threats and risks of a software system [23]. The risks are represented through categorized lists of threats addressing various parts of the STREETLIFE system. Each threat has a short description, a target that the threat addresses, a risk value, a list of potential attack techniques and references to the countermeasures. The risk value is based on the five risk dimensions from the DREAD methodology to determine the importance of a specific threat. Each risk dimension of the DREAD analysis is composed through a risk value numerated from 1 to 3 and a rational to describe why a specific risk value is selected. The overall risk rating is computed through the addition of the risk values of each risk dimension. Thus multiple risks can be compared and prioritized for future work.

4.1.3 BSI IT-Grundschutz

The combination of "*IT-Grundschutz procedure 100-2*" [24] and the corresponding *IT-Grundschutz catalogues* [25] provide a comprehensive collection of security threats and security measures and a methodology to select and modify appropriate security measures. The catalogues and the procedure are an instantiation of ISO/IEC 27001.

We use the *IT-Grundschutz catalogues* in order to identify similar and unique threats for each pilot and to derive appropriate security measures. References to the entries of the *IT-Grundschutz catalogues* will be placed in the risk assessment and in the threat analysis.

4.2 Conclusion

The aim of the security analysis in terms of a gap analysis is to identify commonalities and differences across the pilots and their security goals.

Furthermore, a risk assessment and threat analysis is performed by taking standard approaches from the *BSI IT-Grundschutz catalogues* – an instantiation of ISO/IEC 27001 – into account.

A survey among the three pilots asking about the security goals resulted in two common goals.

The data security and the user's privacy are the most important aspects that must be sustained. All three pilots consider implementing an identity and access management system and anonymisation and pseudonymisation mechanisms for user data if possible.

Besides the common security goals each pilot has several individual security goals. For Rovereto a trust mechanism for participants of the park and ride system needs to be established. In Tampere it is important that the performance and availability of the existing system is not reduced when integrating the STREETLIFE extensions. In Berlin additional access policies need to be defined in order to retain KPIs of participating companies.

The identified threats and risks share a lot of similarities. This may be a result of the similar architecture across the pilots with its related security risks and standard approaches for distributed web applications. For example every pilot needs protection mechanisms against unauthorized access to the system and unauthorized disclosure of private user data.

The results of the security analysis will be used as an input for the blue-print architecture.

5 STREETLIFE REQUIREMENTS

Requirements analysis is the first step in software development. It focuses on the problem space that defines what is desired in a system in terms of functionality and quality properties.

Ideally, to move onto the architectural phase a consistent, prioritized list of key goals and requirements for the system are handed over to the system/software architect to be used as an initial context for the architecture definition [26]. Thus, the strong interconnection between requirements analysis, architecture definition and software construction must be taken into account.

For the three pilot cities, a general, unified system architecture should be designed, the so-called blue-print architecture. However, the three pilot cities in turn demand different usage scenarios from the STREETLIFE system. Moreover, the requirements need to reflect the seamless integration of existing components for a successful deployment and operation of the city pilots. These aspects pose a major challenge for the architecture and thus for the requirements analysis.

In this deliverable we present a first snapshot of the requirements for the STREETLIFE system. A set of blue-print and site specific requirements has been gathered but is in no manner complete. The next sections elaborate on the methodology used for the requirements analysis (Section 5.1) and list a selection of the blue-print requirements gathered so far in the project. The requirements selection contains mainly requirements for the blue-print architecture (Section 5.2).

5.1 Requirements Methodology

At this stage of the project it was unfortunately not possible to conduct extensive interviews and workshops with the STREETLIFE system stakeholders to identify their real concerns about the system. This is due for the next deliverable (D2.2) where the requirements will be further refined using stakeholder feedback from the city pilots Advisory Boards.

For the mean time the consortium's extensive knowledge and prior work in the field of green mobility was used to elicit the STREETLIFE system requirements presented in Section 5.2.

The methodology consists of three phases: elicitation phase, consolidation phase and review phase. The following sections elaborate on the three phases for the requirements analysis.

5.1.1 Elicitation Phase

The elicitation phase is tightly coupled with the current output of the city pilot planning. There, a number of scenarios broken down into detailed use cases were compiled to describe the city pilots along with a list of initial system requirement ideas. The latter was taken into consideration here as a starting point for the first stage of the elicitation and have been in some cases amended, improved and/or refined. The second stage comprised of deriving additional requirements directly from the use case specification, while taking into consideration the technical aspects and interactions that would take place in a use case.

The STREETLIFE activities regarding the integration of mobility data, the creation of a mobility management and emission control panel and the creation of end-user applications are also tightly coupled with the requirements elicitation as they will refine the use cases for the pilots and define and implement specific parts of the blue-print architecture. In this regard, the fine-tuning between the aforementioned activities and the STREETLIFE architecture will be an on-going process throughout the project leading to new requirements and possibly eliminating unnecessary or inadequate requirements. This will be the third stage of the requirements elicitation phase.

It is important to note that we can only present a snapshot of the requirements at this time. Furthermore, the elicitation phase, until completion of the project, will follow an iterative and incremental approach combining the three stages discussed above. Meaning, at every iteration new requirements may be added and existing requirements will be enhanced, amended and possibly refined.

While drafting the requirements we carefully put ourselves in the role of the stakeholders, who have specific interests and concerns for the STREETLIFE system. By identifying the concerns we were able to elicit the requirements in a systematic manner.

Additionally, the differentiation between site specific architecture and blue-print architecture were taken into consideration. This task has required and still requires additional consideration and discussion. The important question is, whether a requirement is truly specific to a pilot site or there is a reasonable generalisation that still covers the relevant details of the requirement as collected from the pilots. So it is very likely, that several differentiations between blue-print and pilot-specific architecture will be revised during the further development of the STREETLIFE architecture, both blue-print and pilot-specific.

As a means for systematically gathering the requirements a table along with a description of the fields has been created by Siemens and circulated to the partners. This table, used for gathering the STREETLIFE requirements presented in Section 5.2, is an extended version of the Volere methodology [27][28]. The structure of the requirements table is also based on Siemens' extensive experience collected through the participation in the EU-funded project "Internet of Things-Architecture" [29]. The following is a description of the fields in the table (all fields are mandatory, with the exception of the stakeholder field):

ID (Identifier)

Since several work packages collect requirements in parallel, a flexible, unique and robust numbering scheme is needed for the requirements.

The scheme used for the STREETLIFE requirements is defined as such: *m.n*, where *m* = WP #, and *n* = running index. For (external) stakeholders *m* > 10 is chosen. The running index is three digits wide with leading zeros for indices < 100. This allows sorting by ID in the Excel-based requirements table.

Initially, concerns are collected. Frequently, a collected concern results in more than one requirement. In that case, one could either assign new index numbers to the new requirements and document their heritage in the dependency field, or one could indicate this fact in the index number itself. We opted to introduce sub-indexes. For instance, if collected concern 9.017 results in two requirements, they are indexed as 9.017.1 and 9.017.2. For the sake of robustness, it is also recommended to indicate this split in the dependency field.

Category

During the requirement process, especially when engaging stakeholders, not only architecture-related concerns will be voiced, but also concerns about how to conduct the trials, implementation constraints, blue-print-architecture-related aspirations, etc.

The value vector for this field includes: project management, stakeholder interaction, pilots, implementation, specific architecture (for one city), and blue-print architecture (common for all)

The value of this field has to hold at least one of the above values. If more are chosen by the submitter then subsequent requirement splitting has to take place.

Title

This field represents a short title for the requirement for easy verbal reference by humans. It summarizes the description of the requirement.

Description

The description is the intent of the requirement. It is a statement about what the system has to fulfil according to the rationale (see below). The value of this is field is in prose.

Rationale

The rationale is the reason behind the requirement's existence. It explains why the requirement is important and how it contributes to the system's purpose. The content of the rationale will provide input for the STREETLIFE (business) goals.

Target

The target field implies the city demonstrator to which the requirement applies. Alternatively, this field may apply to the blue-print system aspects. The value vector for this field comprises: Berlin, Rovereto, Tampere, blue-print, or not applicable.

Stakeholder

This is the stakeholder to whom this requirement concerns. The type of stakeholder is required, not his or her personal name.

The stakeholder can be a person, a group of persons, stating in the line of "I require this requirement to be fulfilled since I have a concern that will be satisfied by this requirement." With the same intent, [26] defines a stakeholder with the following sentence: "A stakeholder in the architecture of a system is an individual, team, organization, or classes thereof, having an interest ("concern") in the realization of the system."

Fit Criterion

A quantification or measurement scale to assess after the implementation to which extent the original requirement is supported by the to-be implemented system. The scale should be at least binary ("… = fulfilled" and "… = not fulfilled").

The following fields are included in the table for book keeping purposes. The version of the table circulated internally between the project partners includes them but they will not be part included in this deliverable for brevity. The fields are:

Collection Date

This field holds the date the requirement was written down by the submitter. The standard to be used for the date is that of ISO 8601 (yyyy-mm-dd), e.g. 2014-03-31.

Submitter

The submitter is the person who wrote down the requirement in the first instance, i.e. the "scribe". The person who writes down the requirement must have the knowledge and authority required for the type of requirement. The content of this field has the following scheme: Last name, first name, organisation, STREETLIFE WP# (where applicable).

Originator

This field denotes the name of the originator for this requirement. This field provides work package 2 with a referral point if questions about the requirement arise, or if the requirement is rejected. Thus, one can ensure that the true source of the rationale is traceable, especially if the source of a rationale lies outside the project (scientific literature; standard; European norm; advisory board members, etc.).

5.1.2 Consolidation Phase

In the consolidation phase the requirements resulting from the elicitation phase are scrutinized. Here an investigation of the type of dependencies with other requirements takes place. The type of dependencies can be any of: "conflict", "contingent upon" or "supports". Furthermore, a mapping to the STREETLIFE domain model will take place, which includes a definition of the main abstract concepts, their responsibilities, and their relationships [30]. Furthermore, a prioritization of requirements is conducted.

Following the approach we are taking by [26] for the blue-print architecture, the consolidation phase also encompasses specifying which architectural view and which architectural perspective a requirement belongs to.

The technical requirements are to be mapped onto an architectural view. An architectural view as defined per [26] is "a representation of one or more structural aspects of an architecture that illustrates how the architecture addresses one or more concerns held by one or more of its stakeholders." Architectural views are: context view, functional view, information view, communication view, concurrency view, deployment view, operational view.

The requirements that are meant to be qualitative are to be mapped onto an architectural perspective. As defined by [26]: "An architectural perspective is a collection of activities, checklists, tactics and guidelines to guide the process of ensuring that a system exhibits a particular set of closely related quality properties that require consideration across a number of the system's architectural views." An architectural perspective could be any of, but not limited to: availability and resilience, evolution, usability, internationalisation, security, privacy, or trust.

In the consolidation phase one last mapping is done for each requirement to the Work Items that have been internally defined to address a problem or unit of functionality in the project, see deliverable D6.1 [17]. With this type of assignment we can infer to which extend the corresponding work item has been addressed so far in the project and consequently add additional new work items that have been missing.

The consolidation phase is particularly important as it is key to communication between requirements collectors and the architecture group of STREETLIFE regarding open questions, misunderstandings and prioritization of requirements.

The fields of the table used for the consolidation phase will be provided with the next deliverable

5.1.3 Review Phase

After every implementation iteration, the requirements have to be evaluated with respect to the fit criterion. It is still to be decided upon how we will deal with requirements that do not fulfil their defined fit criterion. In any case, they will be re-evaluated together with the corresponding parts of the blue-print and pilot-specific architecture and the pilot-development. This will be closely evaluated with the relevant activities in the project and reported on in the up-coming deliverable D2.2 "STREETLIFE Blueprint Architecture, Security Architecture, and Site-specific Architectures".

5.2 Blue-print Requirements Specification List

The following table is the result of the first iteration of the elicitation phase and holds the requirements derived from the output of WP6 – "City Pilot Planning and Evaluation" [17]. The table below shows an excerpt of the original requirements table. The fields depicted below are the most notable ones at this time. Internal fields for book keeping purposes have been omitted here for brevity.

The results depicted in the table below will be subjected to the consolidation phase as well as further development in parallel with the city pilot planning.

Table 5: STREETLIFE blue-print Architecture Requirements

ID #	TITLE	DESCRIPTION	RATIONALE	TARGET	FIT CRITERION
2.022	**performant validation of web forms**	Validation of all web forms including the registration form has to be performant.	Suggestion: Validation of all forms including the registration form should be performed locally on the client side (for performance reasons). Server sided validation would not be efficient. For privacy reasons, data would have to be transferred over a secured connection. Especially for the registration process, there is a privacy issue with server-sided validation (user is not registered with system but his data is already processed there)	Blue-print, pilot-specific	Not fulfilled = validation of the registration is slow: > 5s. Fulfilled = Validation of the registration is fast : < 5s. (with busy indication)
3.001	**access to transportation services and data**	The STREETLIFE system MUST have access to services and data from different local transportation services and providers to enable the computation of multi-modal results	Different multimodal routes should be offered to the user. Combinations of car/bike sharing, public transportation, private bike/car usage, park and ride possibilities, walking should be considered.	Blue-print	Fulfilled = the system has access to required services and offers a user the possibility to plan multimodal connections; Not fulfilled = the system does not have access to required services
4.001	**Visualisation of KPIs for end user**	The public STREETLIFE website MUST be able to visualize public KPI information for end user.	(web presentation layer as part of the architecture)	Blue-print	A public KPI is visible for end user = fulfilled A private KPI is visible or a public KPI is not visible for end user = not fulfilled
4.002	**End user feedback**	The STREETLIFE system MUST have a user survey for general feedback or social functionality like guest books or discussion forum. (BER-RI-39)	(social functionality supports gamification aspect)	Blue-print	
4.003	**Live view of KPIs for end user**	The public KPIs SHOULD be updated continuously if presented to the user. (BER-RI-40)	(specific period for updates not required here,)	Blue-print	Fulfilled= user must not be required to press a button for updates
4.004	**Service operator feedback**	A transport service operator MUST be able to subscribe to a specific set of system event notification of the STREETLIFE system. He can be notified via appropriate mechanisms. (BER-RI-41)	(system events: are identified and suggested by the system based on actual life events)	Blue-print	
4.005	**Prediction of mobility situation**	The STREETLIFE System MUST predict the mobility situation for an event depending on historical data	For CO_2-Reduction a simulation must exist to predict future CO_2-Reduction by considering the mobility situation	Berlin Pilot	fulfil=existing history data, existing event

4.006	**high availability of STREETLIFE mobility platform**	The STREETLIFE mobility platform must be highly available for user registration	The STREETLIFE mobility platform has to be highly available and has to have a short response time. This is also true for the process of user registration: The prospective STREETLIFE user wants to have a fluent registration experience. During the registration process, the response of the STREETLIFE system has to be fast, and there must be no "crash" of the registration web pages. Such a web page crash during the registration process would leave the user afraid. He would not know whether he has be registered or not and what happened to his personal data, which might include some sensitive data.	BER, ROV, TRE	Fulfilled = SL mobility system is available 99.9% AND immediate response for pages AND response to transmission registration form < 5s. Not fulfilled = one of the Fulfilled-conditions is not fulfilled.
4.007	**Map- or chart-based visualization**	The STREETLIFE system must visualise data map-based and in charts	Better acceptance and understanding by graphic representation	Blue-print	Not fulfilled= No visualisation on a map or via charts. Fulfilled=Data can be visualized in a map or chart
4.008	**Visualization of global traffic and carbon emission situation**	The STREETLIFE system must visualise the global traffic and carbon emission situation as well as events in (near) real time	Essential information for user	Blue-print	Not fulfilled= Global traffic and carbon emission situation and events cannot be visualized in (near) real-time. Not fulfilled= no map (near) real time data is available. Fulfilled=Global traffic and carbon emission situation and events are visualized in (near) real-time.
4.009	**Visualization of historic data**	The STREETLIFE system should visualise historic data	Comparison with previous conditions/states	Blue-print	Not fulfilled= No visualisation of historic data. Fulfilled=Historic data can be visualized
4.010	**API for data import**	The STREETLIFE system must provide an API to import data, also streaming data		Blue-print	
4.011	**Creation and editing of model policies**	The STREETLIFE system MUST be capable to create and edit model policies		BER, ROV	
4.012	**Common technology for modules with well-defined interfaces**	Modules of STREETLIFE system must be implemented in a common technology with well-defined interfaces for mutual communication		Blue-print	
4.013	**Real-time reaction on changes**	The STREETLIFE system must react on changes in real-time		Blue-print	
4.014	**Validation of crowd notifications**	The STREETLIFE system MUST allow the mobility manager to decide how	Crowd-sourced info must be validated by mobility management	Blue-print	crowd-sourced info can be validated and evaluated by the management = fulfilled

		compelling the alert notification is on a numeric scale			
4.015	**Multi-modal journey planning**	The STREETLIFE system MUST support multi-modal route planning	Multi-modal routing is a key aspect to exploit all mobility resources and reduce CO_2 emissions	Blue-print	multi-modal route planning supported = fulfilled
4.016	**Policy-driven journey planning**	The STREETLIFE system SHOULD give the possibility to inject policies affecting the planning of journeys	e.g. big events, streets/areas to avoid on a certain date, park and ride facilities to prefer, new facilities to promote	Blue-print	possible to inject policies affecting the planning of journeys = fulfilled
4.017	**Analysis of transport usage**	The STREETLIFE system MUST present aggregated statistics on usage and routes of transport modes	e.g. bikes usage and routes, parking usages, carpooling routes and usage	Blue-print	mobility manager is able to get historical data about usage = fulfilled;
4.018	**Transport data query**	The STREETLIFE system SHOULD give the possibility to query the system to extract specific statistics	e.g. modal split divided for type of users to times of week and day; average time/CO_2 emissions reduction on the most common routes	Blue-print	mobility manager can search and see visualised data about modal split or other type of indicators = fulfilled;
4.019	**Simulation**	The STREETLIFE system SHOULD support the mobility manager in carrying out “what if“ scenarios and simulate policy alternatives	When planning for new policies to be injected in the system, it is very important for the mobility management to have the possibility to simulate the effects of these policies	Blue-print	simulation of policy injections and what if scenarios allowed = fulfilled
4.020	**Simulation input**	The STREETLIFE system should allow to update the input data in the city simulator	once the data sets for simulation are defined, the system should be able to update these data sets with new and more recent data when they are available	Blue-print	datasets for simulation are updated from STREETLIFE = fulfilled
5.001	**Green Leaves**	The user of the STREETLIFE system SHALL gain "Green Leaves", a measure for saved tons of greenhouse gases.	(green leaves are the incentives for gamification for saving co and also for other things as crowd sourcing information)	Blue-print	fulfilled= user must be able to see the green leaves and from which trip user gained them from
5.002	**Green Leaf Benchmark**	The STREETLIFE website SHOULD provide a "Green Leaf" Benchmark, set by highest gain of today´s STREETLIFE App users.	(gamification)	Blue-print	
5.003	**Account for Green Leaves / CO_2-Reduction points**	The STREETLIFE system MUST provide a user personalised account, where the green leaves / CO2-reduction points will be saved.	Every user has different and specific Green Leaves / CO2 Reduction points (WP5: this can be a sub green leaf category) that might be used for monetary purposes similar to air miles	Pilots	
5.004	**Rules for Calculating and collecting CO_2-reduction points**	The STREETLIFE system MUST collect CO_2-reduction points depending on consistent and faire rules .	The CO_2-Reduction Points have to be calculated	Berlin Pilot	fulfil=Gaming regulations and rules defined, Gaming engine available and applicable

5.005	**Comparison of "green leaves"**	The STREETLIFE system MUST provide a comparison of "green leave" points the user collects himself/herself with the collected "green leave" points of other users.	The should exists a top list, so the green leaves of every user must be comparable	Berlin Pilot	
5.006	**"green leave" top list**	The STREETLIFE system SHOULD provide a top list naming the users which collected the highest amount of "green leave" points.	For gamification there have to exists a top list for incentive	Berlin Pilot	
5.007	**user identity available**	The STREETLIFE system user identity SHALL be available when needed by the STREETLIFE system and if compliant to the user's privacy settings	The system must be able to identify the user accessing it and map activities to that user identity	Blue-print	Not fulfilled= delivery of user identity takes place.
5.009	**anonymous access to the system**	The STREETLIFE system MUST allow registrationless user identity	User registration is needed for profiling and access control. (A cookie shall be placed on the user's device)	Blue-print	users can be registered = fulfilled
5.010	**Only store anonymised user data**	The STREETLIFE system SHALL only store anonymized user trip related data	An activity, a cluster of taken trips, or an inferred profile should not be traced back to a specific person.	Blue-print	Not fulfilled= data stored in the system can be traced back to a specific user. Fulfilled: no system data references any user's identity.
5.011	**Comparison of user statistics**	The STREETLIFE system SHOULD give users the opportunity to compare and share their trip statistics with other users (anonymously)	for deliberation and optimising travel behaviour (part of web presentation layer, community creation is required -> WP5)	Blue-print	Not fulfilled = no user statistical data available. Fulfilled= other users have tracked their trips and have shared their statistical data.
5.012	**support of multi-modal route planning**	The STREETLIFE-App MUST be able to support multi-modal route planning	multi-modal split is known to have major reduction effect on CO_2-emissions	Blue-print	Not fulfilled = system is not available, or multimodal routes are not supported. Fulfilled = user requested a connection and is provided with a list of routes (with at least one multimodal connection)
5.013	**compute carbon footprint**	The STREETLIFE system MUST be able to compute the carbon footprint for every planned trip	This measure is needed for gamification, and to present to the user an idea of the greenness of the different alternatives. Deliberation can be assisted by providing carbon footprint resulting from the trip.	Blue-print	Not fulfilled = no carbon footprint calculating in place; Fulfilled = carbon footprint calculation available and shown in the trip view of the app
5.014	**user data input**	The STREETLIFE-App MUST allow user input (coordinates of origin and destination, preference selection)	Entering position data on their own account, if automatic tracking is turned off, or preference not set.	Blue-print	Fulfilled = each customizable attribute of the user profile is adjustable via the app interface; Not fulfilled = one or more attributes cannot be adjusted by the user

5.015	**save planned trips**	The STREETLIFE system SHALL save user selected planned trips	a user may want to plan a trip a days, hours or minutes before the actual trip	Blue-print	Not fulfilled = planned trips cannot be saved; Fulfilled = future connection requested, a trip is selected and saved by the user;
5.016	**computation of carbon footprint**	The STREETLIFE system must be able to compute the carbon footprint individually for the selected modes of transportation.	Individual modes of transport result in different carbon footprint. This information can help with deliberation	Blue-print	Not fulfilled = STREETLIFE system is not able to compute the carbon footprint individually for the selected modes; fulfilled = carbon footprint is communicated to the user for each selected mode of transportation
5.017	**Authenticating users 2**	A user SHALL authenticate himself by entering his credentials (e.g. username/password, token on mobile device, Single Sign-on, or any other adequate authentication credentials)		Blue-print	not fulfilled = no authentication mechanism available for the user; fulfilled = user can authenticate
5.018	**Authenticating users 3**	The STREETLIFE system SHOULD support authentication via username/password or email/password		Blue-print	not fulfilled = system does not support the described authentication; fulfilled = user can authenticate as described and system can identify and provide tailored services to the user
5.019	**other authentication methods**	The STREETLIFE system MAY support other authentication methods	This can make the system easier to use, if the user does e.g. not have to create login credentials. One could login via Facebook account or fingerprint or ...	Blue-print	not fulfilled = no other authentication methods available; fulfilled = other methods available;
5.020	**system wide unique user ID**	The user shall have a STREETLIFE system wide identity that is unique for all the users activities	The unique UID is needed to enable routing in combination with a user profile/preferences. By logging into the system profiles, stored by the user, can be used for the calculation of routes.	Blue-print	Not fulfilled = multiple uids necessary for different activities; fulfilled = after the authentication no further authentication required.
5.021	**User Profile & feedback**	The user MUST be able to create a profile with a number of preferences incl. Allow questionnaires for feedback	Routes are calculated with respect to the profile. The feedback option via questionnaires should be activatable by the user, if desired.	Berlin Pilot (potentially Blue-print)	Not fulfilled = profile creation not possible; preferences not adjustable. Fulfilled = Profile creation with all requested preferences possible.
5.022	**multiple profiles**	The user MAY create several profiles, name and store them	By making use of several profiles the user can quickly select frequently used settings.	Berlin Pilot (potentially Blue-print)	Not fulfilled = no or only one profile possible. Fulfilled = several profiles possible with one login.

5.023	**user profile storage**	The system shall store the user profile data (locally or remotely? (Consider data privacy)	The data has to be stored, so that it can be reused for future user requests. A user should not have to enter the same data again and again.	Blue-print	Not fulfilled = the system does not store user data. Fulfilled = the system stores user data for later usage.
5.024	**registration of users**	The system MUST provide a means for registering users	Some data should be secured for privacy reasons. Therefore users have to register to use the system. Registration is further required to create login data for authentication.	Blue-print	Not fulfilled = no registration available; Fulfilled = registration (for account creation) is possible
5.025	**centralised UID management system**	The STREETLIFE mobility system SHOULD have a centralised Identity Management System for users	A centralized UID management has several advantages: - central management of user identities - easy and fast relation of data and activity to users (if allowed by user) - easy and fast security management of user data - higher performance and lower complexity compared to distributed UID management - single sign on	Blue-print	Not fulfilled = no centralised User ID management available; Data exchange over the Internet required for UID management Fulfilled = User ID management is local to the Mobility Management; no data exchange over the Internet required for UID management (except where interaction with the user is required).
5.027	**encrypted registration data**	Registration data MUST be stored in an encrypted manner on the end user device.	As described in req ID 2.022, registration on the client side might be used for performance reasons. To secure registration data on the end user device, it has to be encrypted.	Blue-print	Not fulfilled = unencrypted storage of registration data on end user device. Fulfilled = encrypted storage of registration data on end user device.
5.028	**App and website share UID**	A corresponding App and a STREETLIFE connected website MUST share the same Identity Management System.	The system is more usable if users need only one ID regardless of whether they connect via a mobile app or a website.	Blue-print	Not fulfilled = user created an account via the app and cannot login with his credentials via the website or vice versa. Fulfilled = user created an account via the app and can also login via the website or vice versa.
5.029	**encrypted registration data**	Registration data on the STREETLIFE mobility system (server side) MUST be stored in an encrypted manner (system option)	As required in req ID 2.022, registration must be performant. If the validation of the registration data is fast enough on the server side (SL mobility system), registration data on the SL mobility system (server side) has to be encrypted in order to secure it. Idea: user data on system is encrypted with public key of user (only user can decipher it). Further Work: need to decide which user data is stored where and under what circumstances	Blue-print	Not fulfilled = unencrypted storage of registration data / user data on SL mobility system. Fulfilled = encrypted storage of registration data / user data on SL mobility system.
5.030	**Single Sign-On**	The STREETLIFE mobility system MUST provide a single sign on capability for log in to the STREETLIFE mobility system and its offered services. Use of single sign-on capability is configurable by user.	The user can use all offered services of the SL mobility system with just his SL account and a single sign on. The user does not need multiple IDs for using the provided SL services. Especially, the user would not need to login to its accounts of other traffic operators such as car sharing providers. The SL mobility system deals with this log	Blue-print	Not fulfilled = after STREETLIFE login the user needs further login for e.g. carpooling.

			in. The single sign-on to other services might be switched off by the user.		Fulfilled = the user can configure further login credentials (e.g. for carpooling) in the preferences.
5.031	**Authenticating users**	A user MUST be authenticated by the STREETLIFE system, before accessing personalized services of the STREETLIFE system.	With user accounts the system uniquely identifies a user and can provide tailored services and information to the user.	Blue-print	Not fulfilled = no authentication mechanism is in place. OR user has always to authenticate (even for open services) Fulfilled= an underlying authentication mechanism is in place for personalized services only, user can register with the system and obtain credentials.
5.032	**Localization only with permission**	The permission to locate the user must be asked.	Privacy laws must be obeyed.	Blue-print	Fulfilled: Journey planner asks a permission to locate the user. Not fulfilled: user is located without permission.
5.033	**Configurability of route search**	User must be able to set route search attributes, such as preferred methods of transportation, and the amount of walking and waiting.	User can plan a route which suits him/her best.	Blue-print	Fulfilled: user can change search attributes. Not fulfilled: user cannot change search attributes.
5.034	**User – authentication and access control**	The STREETLIFE system MUST support both authenticated and anonymous access and provide profile-specific access control to its functionalities	Anonymous access may be sufficient for some (limited) app functionalities e.g. planning a trip	Blue-print	access control supported and anonymous access allowed = fulfilled
5.035	**User – profile and preferences**	The STREETLIFE system MUST support an extensible model for user profile and preferences	The system should give the possibility to define scenario-specific user info and preferences	Blue-print	user profile and preferences can be extended = fulfilled
5.036	**Gamification – Show rules and instructions**	The STREETLIFE system SHOULD present to the end-user the rules of the game	The rules of the game should be always clear and available	Blue-print	possible to show rules of game = fulfilled
5.037	**Gamification – Show earned "green leaves"**	The STREETLIFE system SHOULD allow end-users to inspect the earned "green leaves" (points) and how many (green leaves) she needs to reach the reward	Viewing own progresses and the gap for reaching awards is a key aspect in gamification	Blue-print	possible to inspect earned points and points toward next reward = fulfilled

5.038	**Gamification – Send game updates**	The STREETLIFE system MUST inform the end-user about changes in game rules (e.g. new rewards)	The rules of the game should be always clear and available	Blue-print	users receive notifications about game changes = fulfilled
5.039	**Gamification – game definition and management**	The STREETLIFE system MUST support the definition and management of games	The system should give the possibility to define, manage, and operate games	Blue-print	possible to define and manage new games = fulfilled
5.040	**Crowd-sourcing**	The STREETLIFE system MUST support notification of traffic and transport information from end-users and traffic/parking aids	Mandatory functionality for crowd-sourcing	Blue-print	crowd-sourcing of mobility-related issues supported = fulfilled
5.041	**Crowd-sourcing notification details**	On-the ground notifications MUST include information identifying the specific parking/traffic aid and the transport/parking facility of interest	Crowdsourcing information, to be useful, should be associated to specific mobility resources	Blue-print	each notification can be associated to a specific mobility resource/facility = fulfilled
5.042	**Monitor chosen journey**	The STREETLIFE system SHOULD allow end-users to monitor the chosen journey plan	monitoring the journey allow the end-user to promptly react to changes in the journey, but also to signal problems when they occur	Blue-print	users can monitor planned journey = fulfilled
5.043	**Journey notification**	The STREETLIFE system SHOULD allow to send notifications to end-user about incidents and alternative plans	Receiving notifications and alternative plans allow to enhance the travel experience and reduce costs/CO_2 emissions	Blue-print	users are notified about travel issues and receive alternative plans = fulfilled
6.004	**Social networks**	The STREETLIFE system SHOULD support the definition and management of social networks (either native or exploiting existing systems)	Social networks are needed to define trusted networks of people in car pooling	Blue-print	is possible to define and manage a SN = fulfilled
6.015	**Real-time data in journey planning**	The STREETLIFE system SHOULD consider real-time data during route planning	Considering real-time data allows to enhance the travel experience and reduce costs/CO_2 emissions	Blue-print	journey planning considers real-time data = fulfilled

5.3 Conclusion

In this section a brief introduction into key aspects of the requirements analysis as well as its methodology for STREETLIFE has been given. The key aspects revolve around defining requirements for a unified system architecture that would consequently form the STREETLIFE blue-print architecture, whilst taking into consideration the challenges of seamlessly integrating different already existing components and the different scenarios posed by the three city pilots.

The methodology described in this section prescribes three phases known as the elicitation phase, the consolidation phase and the review phase. These were elaborated on and put in context with other relevant activities in the project, such as the integration of mobility data, the creation of a mobility management and emission control panel and the creation of end-user applications.

The outcome of the first iteration for the elicitation phase has been presented in the form of a table (see Section 5.2). The table depicts a snapshot of the requirements for the blue-print architecture. The table is in no manner complete and shall be extended and enhanced during the course of the project.

6 STREETLIFE Context View

The *Context View* describes "the relationships" between the system and its environment. The relationships include the dependencies and interactions.

The main purpose of the STREETLIFE context view is to define the scope of the STREETLIFE system, especially in relation to the real world and the corresponding "environment" or "eco system", and to set the common context of the architectural work of the STREETLIFE project. This includes providing a common high-level understanding of the scope and the mechanisms of the STREETLIFE urban mobility system so that every stakeholder gets a first, positive impression that his or her concerns are addressed by the STREETLIFE system.

Naturally, the STREETLIFE context view has a strong connection to the STREETLIFE Usage Context (Figure 9) as developed in the STREETLIFE Description of Work [19].

Figure 9: STREETLIFE Usage View (after [19])

The context view is the first step of the actual development of the system architecture after the collection of scenarios, use cases, and requirements. It contains of two parts:

- The STREETLIFE Context Diagram – a graphical representation of the context view given in Figure 10 in Section 6.1.2.
- The relationships, dependencies, and interactions between the items of the context diagram – a textual description of this given in Section 6.2.

Further information on the context view can be found in [26] and [30]/[29]. These references have been also the basis for the STREETLIFE context view.

The STREETLIFE context view has been reviewed and revised by the members of the architecture work package of STREETLIFE, by the STREETLIFE partners in general, and by the participants of the Berlin Advisory Board Meeting.

6.1 STREETLIFE Context View – Graphical Representation

6.1.1 Introduction to the Context Diagram

A graphical representation is an appropriate means for presenting such a high-level description of the scope, the main interactions, and the environment of the STREETLIFE system. The graphical representation of the STREETLIFE Context View is given in Figure 10. The term *STREETLIFE Context Diagram* refers to this Figure 10 – in particular in this document D2.1 and in general in the architectural work of the STREETLIFE project.

The big challenge of a context diagram but also of the context view in general is the level of detail: It has to contain enough detail so that every stakeholder involved in the project can find himself and his concerns in the context diagram / context view. On the other hand, the context diagram must not have too much detail in order not to confuse the stakeholders looking at it. Each stakeholder might have a different point of view of the depicted system, so an item in the context diagram that is clear for one stakeholder may confuse another stakeholder and raise questions and in the worst disapproval. This kind of misunderstandings has to be minimized.

In the end, the context diagram has to be intuitive, but definitions and explanations are usually very helpful. Since the stakeholders are quite diverse, it is beneficial to have both the context diagram as a graphical representation as well as a textual description of the context view. A picture says a thousand words.

6.1.2 STREETLIFE Context Diagram

We have found an acceptable level of detail for the STREETLIFE Context Diagram in Figure 10, so that the context diagram as a whole but also each item by itself or group of items is easily understood, at least with a little bit of explanation. (These explanations are given in Section 6.2)

How the different items in the STREETLIFE context diagram (Figure 10) are drawn has some specific meaning. A general description of this is given in the following list:

- blocks (solid line): classes of specific “things” relevant for STREETLIFE such as components, components with certain functionalities, a set of functionalities, information sources, actors such as users, tools, etc.
- blocks (dashed line): categories that combine blocks of the same category, the blocks with the solid line inside the dashed line. The category might imply also some common (logical) location.
- arrows: interaction between blocks, usually including information exchange, in the direction of the arrow (data, events, requests, …)
- attachment of arrows to blocks: If the arrow connects to a block containing sub-blocks (such as a category, block with dashed lines), this means the interaction can be with any sub-block in the surrounding block, or at least with multiple ones. For example in Figure 10, the arrow with the interaction “KPI visualization” attaches to the category “Users” containing “Mobile” users and “Home” users. Both are actually interested in KPI visualization, so the arrow “KPI visualization” goes to the category “User” covering all kinds of interested users. In contrast to this, the interaction “Monitoring / Recommendations” is only relevant to mobile users, so the corresponding arrow attaches directly to the block “Mobile” user.
- position: some blocks encode a specific information in their position. This is described in Section 6.1.3.

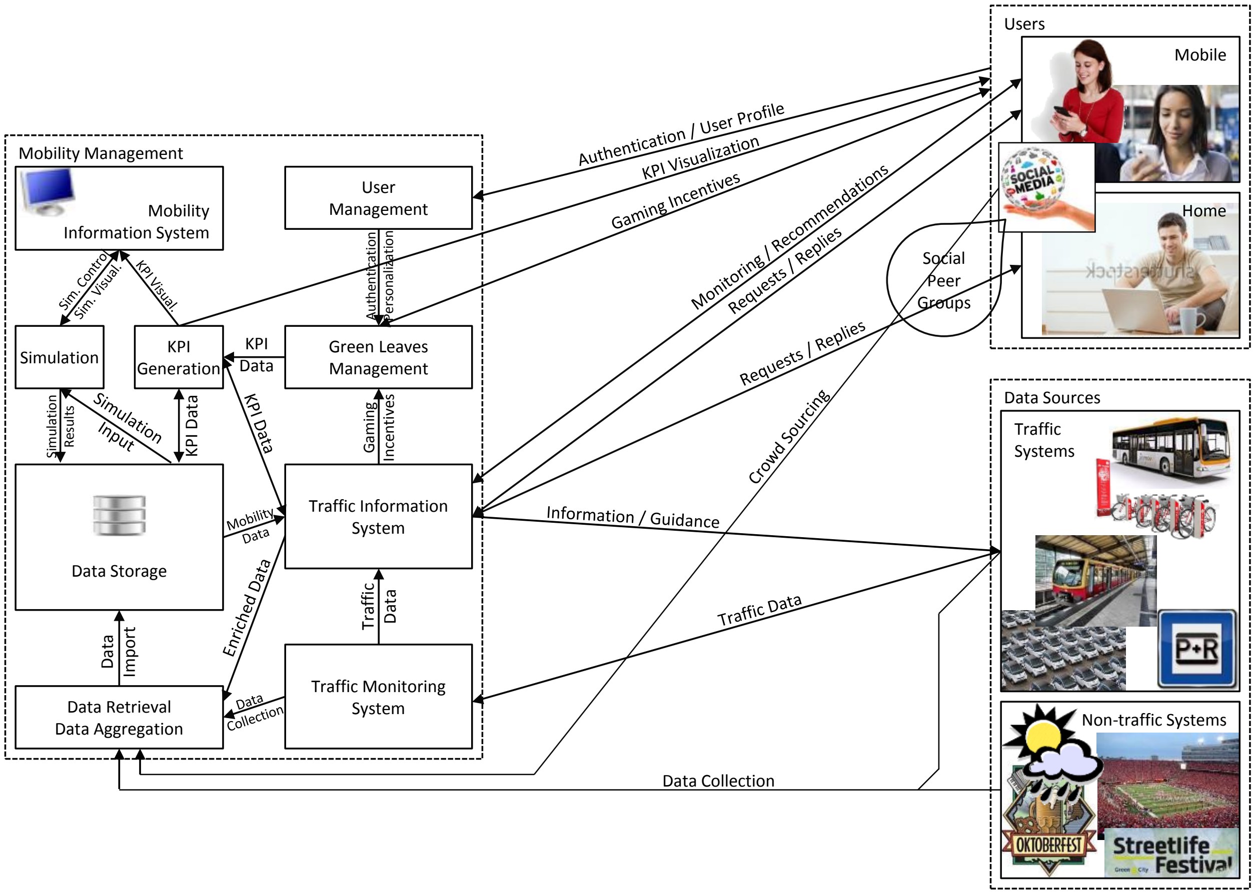

Figure 10: STREETLIFE Context Diagram

6.1.3 *Meaning of Positions in Context Diagram*

The meaning of the position of the items in the context diagram is shown in Figure 11.

The area on the left hand side of Figure 11 is the mobility management. It is called "logically centralized" since its functionality is sort of centralized, but its deployment might be distributed. The position of a component in the mobility management indicates whether it belongs to

- new STREETLIFE functionality for the mobility management (top part),
- STREETLIFE data components (bottom left part), or
- existing components for traffic monitoring and traffic information, extended with STREETLIFE functionality (bottom right part).

The area on the right hand side of Figure 11 contains items that are distributed over the city (or represent data points distributed over the city) – the users and the many data sources on traffic, mobility, and events.

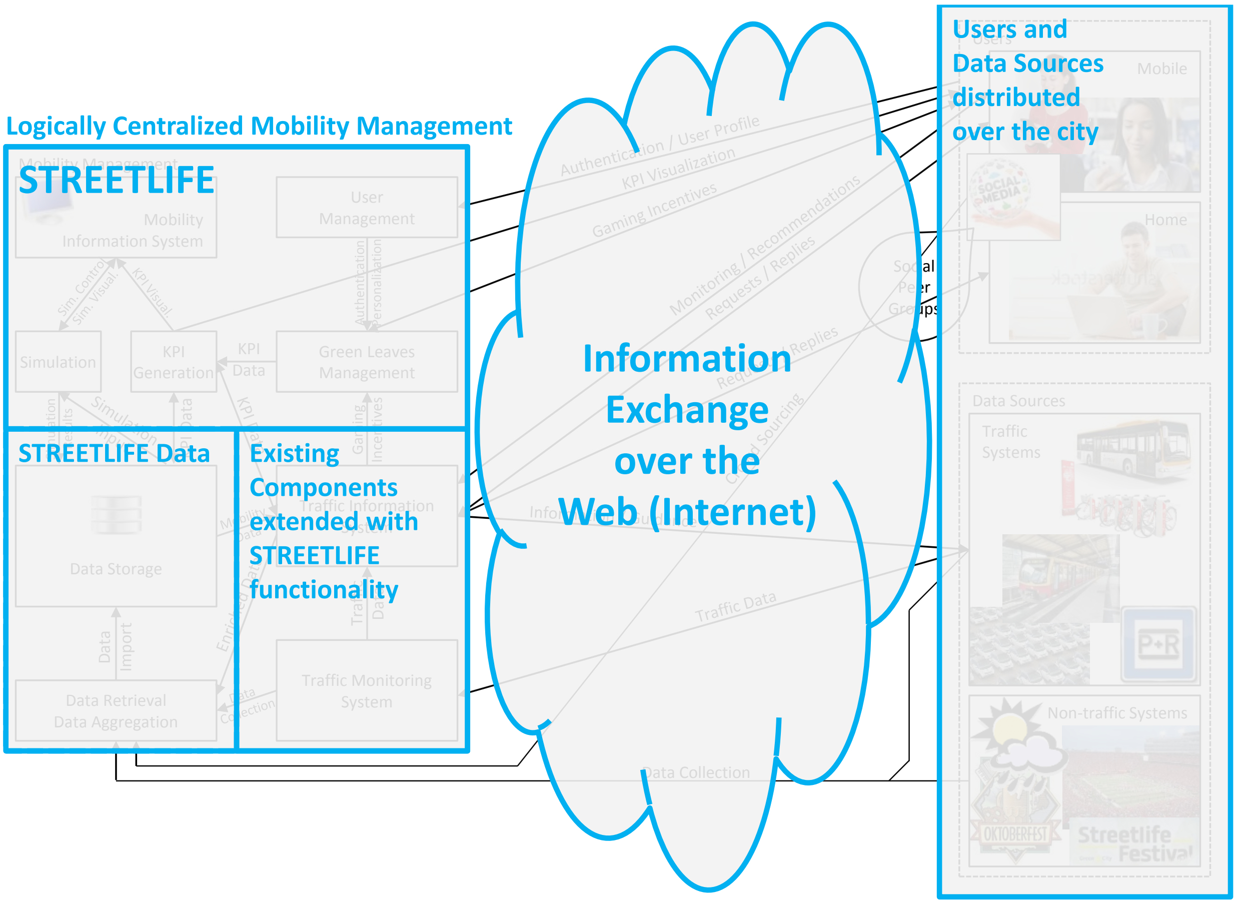

Figure 11: Meaning of Position in STREETLIFE Context Diagram

All communication between the mobility management on the left hand side and the users and data sources on the right hand side of Figure 11 passes through the area in the middle of Figure 11. This area stands for communication and information exchange over the World Wide Web or informally called “the web” or “the Internet”.

6.2 STREETLIFE Context View – Textual Representation

The following list provides some further information and explanation on all the items contained in the STREETLIFE Context Diagram (Figure 10). It is a textual representation of the STREETLIFE context view.

The sequence of the items in the following textual representation of the STREETLIFE context view is roughly from the bottom-left corner and clockwise to the bottom-right corner of the STREETLIFE context diagram (Figure 10). The clockwise sequence is only the general direction. Some neighbouring blocks might follow a conceptual order and deviate a little bit from the strict clockwise sequence. A category (block with dashed line) is explained first before the components (blocks with solid line) inside such a category are explained. Arrows are only explained after the blocks at both ends are described.

Mobility Management: The category Mobility Management contains all items related to a sort of centralized mobility management of a city. This can be the city administration themselves or an institution or company doing the mobility management on request of a city. The category Mobility Management corresponds to the blue part on the top in the STREETLIFE usage view (Figure 9) with the players Mobility Management and City Administration.

Data Storage: Data Storage is one of the central items in mobility management. Data Storage can be just a single data base, multiple data bases, or multiple databases distributed within the mobility management. There might be different data bases for different types of data such as real-time data / non-real-time data or simulation data.

Data Retrieval, Data Aggregation: This item provides the necessary interfaces, services, and functionalities for transferring the data from the data sources "in the wild" into the STREETLIFE data storage. Insertion of mobility data including field data, real world data, and enriched mobility data into the STREETLIFE data storage has to be done through the interfaces, services, and functionalities of the Data Retrieval, Data Aggregation.

Data Import (Data Retrieval, Data Aggregation → Data Storage): This arrow stands for the data flow of (external) data getting into the Data Storage through the interfaces, services, and functionalities of the Data Retrieval, Data Aggregation. This includes necessary conversions into the STREETLIFE data model.

Traffic Monitoring System: This item represents everything related to monitoring the traffic in the city, for instance, monitoring data from sensors in the streets and on gantries. It also represents traffic monitoring infrastructure already existing at the pilots.

Data Collection (Traffic Monitoring System → Data Retrieval, Data Aggregation): This arrow stands for the data flow of data from the (already existing) traffic monitoring system into the STREETLIFE Data Storage through the interfaces, services, and functionalities of the Data Retrieval, Data Aggregation. This includes necessary conversions into the STREETLIFE data model.

Traffic Information System: This item relates to everything that provides information on the traffic in the city beyond the simple monitoring. The already existing (software) components of the pilots for traffic information are located here, but also new information made available through the STREETLIFE system.

Traffic Data (Traffic Monitoring System → Traffic Information System): This arrow stands for the data flow between the traffic monitoring and the traffic information. It contains the traffic data that is used as input to the algorithms, functions, and procedures of the Traffic Information System in order to provide the traffic information. This arrow represents mainly the information flow of the existing software and hardware components of the pilot cities. The STREETLIFE information flow is meant to pass through Data Retrieval, Data Aggregation into Data Storage, where the Traffic Information System gets its data from.

Mobility Data (Data Storage → Traffic Information System): The data that is used as input to the algorithms, functions, and procedures of the Traffic Information System in order to provide the traffic information.

Enriched Data (Traffic Information System → Data Retrieval, Data Aggregation): New data of a higher quality that has been computed from the data available from the Data Storage by the Traffic Information System. This enriched data is fed back into the STREETLIFE Data Storage through the interfaces, services, and functionalities of the Data Retrieval, Data Aggregation. A direct storage of the enriched data in the STREETLIFE Data Storage might be also possible, but only for enriched data produced within the new STREETLIFE data model. Since the Traffic Information System includes existing components as the major part, the enriched data has to go through Data Retrieval, Data Aggregation in order to convert the information into the STREETLIFE data model.

KPI Generation: The item KPI Generation determines the STREETLIFE key performance indicators and their actual values based on the data collected in the STREETLIFE Data Storage. This item is one of the central components of WP4 Mobility Management and Emission Control Panel.

KPI Data (Data Storage ←→ KPI Generation): This bi-directional arrow represents in the one direction the flow of the input data for the KPI generation, which is taken from the STREETLIFE Data Storage. The other direction represents the storage of the KPI values in the Data Storage.

KPI Data (Traffic Information System ←→ KPI Generation): This bi-directional arrow represents in the one direction the flow of the input data for the KPI generation, which is taken from the Traffic Information System. The other direction represents the feedback of the KPI values into the Traffic Information System.

Simulation: Simulation tools and simulative analyses (what-if scenarios) of mobility situations based on data collected in the STREETLIFE Data Storage. This item is one of the central components of WP4 Mobility Management and Emission Control Panel.

Simulation Input (Data Storage → Simulation): This uni-directional arrow represents the data flow from the STREETLIFE Data Storage and the Simulation item for the simulations. The simulations use data from the STREETLIFE Data Storage as input.

Simulation Output (Simulation → Data Storage): This uni-directional arrow represents the storage of simulation results in the STREETLIFE Data Storage. The storage of the simulation results in the Data Storage is done directly without going through the Data Retrieval, Data Aggregation component. The Simulation component is developed by STREETLIFE and conformance of the simulation results to the STREETLIFE data model can be assumed. Nevertheless, it is also possible to insert the simulation results through Data Retrieval, Data Aggregation into Data Storage. The future architectural work will find an answer to this.

Simulation Input / Simulation Output ←→ Data Storage: The interactions Simulation Input and Simulation Output between Simulation and Data Storage have two different attachment points at the Data Storage. This indicates that the input data of the simulations and the results of the simulations may be located in separated databases, but still being part of the Data Storage.

Mobility Information System: Provision and visualization of mobility information of the STREETLIFE system. This can be any mobility information of interest to the mobility management including mobility information from the already existing traffic information components. However, the focus here is on the mobility information developed in the STREETLIFE project, especially KPI visualization and simulation control and visualization and interpretation support of simulations.

Simulation Control / Simulation Visualization (Mobility Information System ←→ Simulation): This bi-directional arrow represents the interaction of the mobility management with the simulation through the mobility information system. This interaction contains the configuration and control of the simulations and the visualization of the simulation runs and simulation results.

KPI Visualization (KPI Generation → Mobility Information System): This uni-directional arrow represents the values of the STREETLIFE KPIs that are given to the mobility information system for visualization.

Green Leaves Management: This item contains all management functionality for secure handling of the "Green Leaves", the "currency" of the STREETLIFE incentives. The Green Leaves can be thought of similar to miles in airline bonus programs or similar to points in hotel bonus programs. This requires a secure and formal management including accounting since real values are associated to it.

The data associated with Green Leaves incentives is a little bit special compared to the ordinary traffic data and mobility data. The Green Leaves data might be associated with real monetary values, depending on the extent of the incentive system. This needs special processes for accounting. It is assumed that the data related to Green Leaves incentives is stored in the Green Leaves Management. It is probably the natural solution to this issue. The final decision will be done during the discussion, specification, and development of the Green Leaves incentive mechanisms.

Gaming Incentives (Traffic Information System → Green Leaves Management): This uni-directional arrow represents the received gaming incentives ("Green Leaves") that are computed based on the actions of the user performed in the traffic information system and that are managed in the Green Leaves Management.

KPI Data (Green Leaves Management → KPI Generation): This uni-directional arrow represents statistics on non-personalized acquisition and on use of Green Leaves. This is an important STREETLIFE KPI.

User Management: The STREETLIFE mobility system is being developed for making environmental-conscious travel more comfortable for the citizens of the city. Or in other words, the STREETLIFE mobility system is for users (and the mobility management). This item represents all functionality and information for the management of user profiles, personalisation as well as authentication of users. There are privacy related questions connected with this item:

- The extend of the user management
- Where are the user management functionalities located?
- How much user data is stored?
- Where is the user data stored?

These questions on the privacy of user data have become much more important after the events in 2013 concerning the unrestricted data collection by NSA and GCHQ. The privacy of user data needs thorough consideration. The further architectural refinement of the user management might also lead to changes in the STREETLIFE context view with respect to the user management.

Authentication Personalization (User Management → Green Leaves Management): This uni-directional arrow represents the necessary authentication and personalization of the STREETLIFE incentives, the so-called "Green Leaves".

Users: The category Users contains all items related to users using the STREETLIFE system. It includes mobile users being on the move in the city or users "at home", that is currently not travelling.

Mobile: The item Mobile represents mobile users on the move in the city. They are currently travelling and using the STREETLIFE mobility system.

Requests / Replies (Traffic Information System ←→ Mobile): This bi-directional arrow represents requests by the mobile user to the traffic information system and the corresponding response. Such a request can be a route request for an immediate journey to a destination in the city from the current position.

Monitoring / Recommendations (Traffic Information System ←→ Mobile): This bi-directional arrow represents in one direction the monitoring of the travelling of the mobile user on the route selected from the set of routes proposed by the STREETLIFE system. The other direction represents recommendations for on the move changes in the travel itinerary due to events in the city or on the selected route.

Home: The item Home represents users currently not travelling. They are "at home" where "at home" means anything sort of stationary. It is assumed that the home user has access to bigger screens such as on laptops (although he might use his smartphone at home, too). Furthermore, requests are often for planning future trips with the STREETLIFE mobility system.

Requests / Replies (Traffic Information System ←→ Home): This bi-directional arrow represents requests by the home user to the traffic information system and the corresponding response. Such a request can be a route request for a future journey to a destination in the city from a given, arbitrary position.

Authentication / User Profile (User Management ←→ Users): This uni-directional arrow represents the information flow between the users – both mobile and home – and the STREETLIFE mobility management for user authentication. User authentication is necessary for personalized services that require an identification of a specific user. The arrow includes also the management of the user profile.

KPI Visualization (KPI Generation → Users): This uni-directional arrow represents the visualization of STREETLIFE KPIs that are interesting to the user of the STREETLIFE mobility system on the devices of the users. The STREETLIFE KPIs are interesting to users on the move (Mobile) and users at home (Home). Therefore, the arrow attaches to the category User. The actual design of the visualization will be different based on the available user device (smart phone vs. laptop).

Gaming Incentives (Green Leaves Management ←→ Users): This bi-directional arrow represents the interaction of the users, both mobile and home, with the management of the STREETLIFE incentives, the green leaves. For mobile users, this is the acquisition green leaves as well as the visualization (monitoring) of green leaves statistics and the green leaves management including the immediate redemption of green leaves. For home users, it is only the visualization of green leaves statistics and the green leaves management including the redemption of green leaves for future trips.

Social Media: This item represents all activities by the users that are directly (STREETLIFE groups) or indirectly (general mobility and events) related to STREETLIFE. Both mobile and home user have access to the social media, therefore the social media item is overlapping both Mobile and Home in Figure 11.

Social Peer Groups (Social Media → Social Media): This circle represents STREETLIFE related activity between STREETLIFE users within STREETLIFE groups in the social media.

Crowd Sourcing (Social Media → Data Retrieval, Data Aggregation): This uni-directional arrow represents traffic-related data retrieved by crowd-sourcing in social media. The crowd-sourced data can be from STREETLIFE groups within the social media or from mobility-related and traffic-related information in the social media.

Data Sources: The category Data Sources contains all items related to data sources for traffic data, mobility data and non-traffic and non-mobility data having an influence on traffic and mobility.

Traffic Systems: This item represents all data sources for traffic data and mobility data. The data sources, or more precisely, the data points, are usually distributed over the city. Examples for such traffic and mobility data are data related to public transportation (busses, commuter trains, underground, tram), bike sharing, car sharing, park and ride.

Traffic Data (Traffic Systems → Traffic Monitoring System): This uni-directional arrow stands for the data flow of data from already previously available traffic and mobility data sources into the already existing Traffic Monitoring System. This ensures integration of already existing components into the STREETLIFE mobility system.

Data Collection (Traffic Systems → Data Retrieval, Data Aggregation): This uni-directional arrow stands for the data flow of data from the traffic and mobility data sources (e.g. public transportation, car/bike sharing, park and ride) into the STREETLIFE Data Storage through the interfaces, services, and functionalities of the Data Retrieval, Data Aggregation. This includes necessary conversions into the STREETLIFE data model.

Information / Guidance (Traffic Information System → Traffic Systems): This uni-directional arrow represents guidance for certain (non-critical) decisions at the traffic systems. An example for such guidance is a recommendation for providing a certain number of rental bikes at certain bike sharing locations. Non-critical means, that the guidance is not influencing the actual traffic management (e.g. bus schedules) in the city.

Non-traffic Systems: This item represents all data sources for non-traffic data and non-mobility data that are relevant for the traffic management and for mobility. The data sources, or more precisely, the data points, are usually distributed over the city. The data is usually provided by external (non-mobility) services. Examples for such non-traffic and non-mobility data are weather data and event data (e.g. Oktoberfest, STREETLIFE Festival, football games).

Data Collection (Non-traffic Systems → Data Retrieval, Data Aggregation): This uni-directional arrow stands for the data flow of data from the non-traffic and non-mobility data sources (e.g. weather and events) into the STREETLIFE Data Storage through the interfaces, services, and functionalities of the Data Retrieval, Data Aggregation. This includes necessary conversions into the STREETLIFE data model.

6.3 Outside the Scope of STREETLIFE

Components not shown in the STREETLIFE Context view (see Figure 10 in Section 6.1.2 for the STREETLIFE Context Diagram) are considered to be out of scope of the STREETLIFE urban mobility system.

Usually, such items are not listed in a context view. However, the discussions with the project partners and the stakeholders showed that sometimes an explicit statement on things that are not part of the STREETLIFE mobility system is helpful. Therefore, this section explicitly lists some items that are out of scope of the STREETLIFE urban mobility system. Discussions indicated only one such item:

Traffic Control: The term Traffic Control is used in a broad variety of meanings, but here it has a very specific meaning: Traffic control influences the actual traffic and mobility in the city by directly controlling the traffic flow, i.e. by controlling traffic lights or by setting speed limits at variable message sign systems. This is done, for instance, at the Traffic Control Centre in Berlin [31].

There are two main reasons why such traffic control is out of scope of the STREETLIFE urban mobility system:

The traffic of a city is a very dynamic system, and small changes might lead to huge unforeseen changes not always to the better. A negative disturbance of the traffic of a city, no matter whether small as Rovereto or large as Berlin, is a big no-go. Providing safe solutions requires a huge effort in research and testing which cannot be covered by STREETLIFE. Therefore, STREETLIFE does not consider this kind of Traffic Control and leaves this functionality to specialized traffic control systems and to the experience of the mobility managers.

Traffic control as defined here is often a responsibility of public administration (e.g. the police) or a sovereign task. So, only especially authorised personal in a specific official status is allowed to do this traffic control. This means, that the STREETLIFE project would simply not allowed to do such traffic control and all research on this would be only theoretical and untested.

If there is the need to combine the STREETLIFE mobility system with Traffic Control functionality in the future, this can be easily done: The interfaces between the STREETLIFE mobility system and the traffic control are very similar to the interfaces used within the STREETLIFE mobility system, so that only a small effort for adaptations and extensions of the interfaces has to be considered.

6.4 Conclusion

Some version of the STREETLIFE context diagram will become the STREETLIFE "logo architecture" – an intuitive graphic for all stakeholders showing the high-level architecture of STREETLIFE providing its context and its scope.

The resulting STREETLIFE context view described in this document identifies three major architectural areas for any STREETLIFE urban mobility system:

- **Logically centralized mobility management:** instantiates the STREETLIFE data model in its data storage and contains large portions of the results of the mobility data integration.

STREETLIFE provides additions to the Mobility Information System such as simulation and STREETLIFE KPI generation and their visualization. These are developed by the activities on the mobility management and the emission control panel. Moreover, the STREETLIFE user management including the incentive (“Green Leaves”) management is coordinated here. This requires a close coordination with the activities on the end-user applications.

- **Users:** interaction of the users with the mobility management through mobility apps used from anywhere anytime. The “STREETLIFE face to the user” is located here in the end-user applications such as STREETLIFE mobility apps and webpages, e.g. the multi-modal route planner and the gamification (incentives).

- **Data Sources:** Many data sources are provided as is – by parties external to the STREETLIFE project, in a proprietary “non-STREETLIFE” data format. STREETLIFE has only little influence on the architecture of such data sources, its task is more of an architectural description of the data sources and their integration into the STREETLIFE urban mobility system (mobility data integration).

The context view provides a good structure for the definition of the details of the different architectural views of the STREETLIFE architecture. The architectural specification of the items of the STREETLIFE context view is done for the important functional view and the information view first and is based on the findings of the context view. Very soon, the architectural work has to distinguish between the blue-print architecture and the pilot-specific architectures. The STREETLIFE context view still covers both in a single graphic do to its high level description.

Note, traffic control – actively controlling the traffic flow by controlling traffic lights and speed limits based on the current traffic situation – is not considered in the STREETLIFE urban mobility system due to two reasons:

- The traffic situation of a city is a very dynamic system, and small control actions may have huge effects with tremendous negative impact.

- In some states, the STREETLIFE project would simply not allowed to do such traffic control since it is the responsibility of public administration (e.g. the police) / sovereign task.

7 CONCLUSION

Deliverable D2.1 provides a good identification of and overview on the technical areas of STREETLIFE that need to be in the focus for the development of the first iteration of the pilots but also in the focus of the architectural specification. The activities on the STREETLIFE blue-print architecture as well as on the pilot-specific architectures have to specify the areas of the identified gaps more precisely with high priority. This includes several functionalities common to multiple STREETLIFE pilots, that provide opportunities for synergies between the STREETLIFE pilots and are therefore handled in the blue-print architecture. The focus of the pilot-specific architectures is more on the identified gaps in the software components and data sources. For the latter, also the activities on data modelling play an important role in providing a STREETLIFE solution.

Chapter 2 on sustainable mobility policies and incentive models shows that the cities have an interest in ICT solutions for mobility and in policies for sustainable mobility according to the interviews taken. The specific focus, however, depends on the current and anticipated future situation in the city. Rovereto is looking at the congestion in the city centre and greener ways of mobility. Tampere focuses on public transportation and the demographic growth. In Berlin, support of bicyclists including bike safety, ICT for mobility management, and the integration and use of multi-modal mobility information is of interest.

Several concepts that used incentives for changing the mobility behaviour showed a good level of success. However, the STREETLIFE project will focus on incentivation concepts that do not require additional money from the administration. There have been experiments with gamification on the health of the user. STREETLIFE will use a similar concept but with gamification on the environmental effects of mobility. Two additional concepts have been identified that might be of interest to STREETLIFE: ICT support for ride-sharing and call-a-bus for areas with low density and low mobility demand in the surroundings of Rovereto and Tampere.

Chapter 3 approached the snapshot and gap analysis from different angles leading to a consistent picture on the identified gaps. The result is a snapshot on the continuous work of the STREETLIFE activities towards the first iteration of the STREETLIFE pilots. Deliverable D2.1 provides an overview of the identified gaps and guidance on where to focus the architecture activities and the pilot activities for the first iteration of the pilots.

Most of the identified functionalities are applicable to multiple pilots and need to be considered in the STREETLIFE blue-print architecture. The multi-modal trip planning with related functionalities such as the monitoring of the user with respect to a selected multi-modal route has a high relevance across all STREETLIFE pilots. Nine major data gaps in the areas of bike-related information, crowd sourcing, user profile, social networks, and CO_2 emissions have been identified. They impact in particular end-user scenarios. The refinement of the STREETLIFE scenarios and use cases which is currently done in the pilot activities in the three STREETLIFE city pilots will identify more but also more specific data gaps and will close them. The activities on the STREETLIFE data model provide the common modelling of the existing and missing data. The STREETLIFE project extends the currently pilot-specific mobility management with evaluation and presentation of STREETLIFE KPIs and the STREETLIFE emission control panel. These new functionalities and components are common to all pilots in general but some aspects such as KPI metrics are pilot-specific. The existing (software) components in the three STREETLIFE pilot cities cover already many of the required components for a STREETLIFE mobility information system, but they often need extensions and further development in order to provide the full functionality necessary. Only a few components need to be developed anew. The continuous refinement of the STREETLIFE scenarios and use cases as well as the preparation activities towards the first iteration of the city pilots will provide the necessary detailed input on this.

Chapter 4 on Security identifies commonalities and differences of the security goals and security risks across the pilots. Data security and user privacy are the two common goals that have to be sustained. All three pilots consider implementing an identity and access management system and anonymisation and pseudonymisation mechanisms for user data. However, there is a trade-off between the available functionality and the provided user information. The specific mechanisms to achieve data security and user privacy will be defined in the STREETLIFE security architecture. The identified security threats and security risks share a lot of similarities. For example, every STREETLIFE pilot needs protection mechanisms against unauthorized access to the system and unauthorized disclosure of private data of the user.

Furthermore, each pilot has several individual security goals. For Rovereto, a trust mechanism for participants of the park and ride system needs to be established. In Tampere, a tradeoff between the performance and availability of the existing real-time mobility system and the STREETLIFE security and privacy extensions has to be found. In Berlin, additional access policies need to be defined in order to secure data of participating companies.

Chapter 5 on Requirements for a STREETLIFE mobility information system concentrates on a snapshot of the requirements for the STREETLIFE blue-print architecture, since many of the STREETLIFE functionalities are common to multiple city pilots and therefore should be architecturally defined in the blue-print architecture in order to support the synergies between the three STREETLIFE city pilots. During the upcoming consolidation phase, the blue-print requirements will generate pilot-specific requirements on some details. The requirements process is an ongoing process incorporating new and updated requirements that are coming up during the further refinements of the STREETLIFE scenarios and use cases, the closure of the identified gaps, the preparation of the city pilots towards the first iteration, and the consolidation phase.

Chapter 6 contains the STREETLIFE context view as the starting point of the architectural activities towards the STREETLIFE blue-print architecture. The compilation of the STREETLIFE context view incorporates the results of the other chapters of Deliverable D2.1. The STREETLIFE context diagram provides an intuitive graphic for all stakeholders showing the high-level architecture of STREETLIFE providing its context and its scope.

Three major architectural areas for any STREETLIFE urban mobility system have been identified: a logically centralized mobility management, end-users interacting with the mobility management, and data sources.

The STREETLIFE context view provides a good structure for the definition of the details of the different architectural views of the STREETLIFE architecture. Those blocks of the STREETLIFE context view are further specified, first that have a high priorities according to the results of Deliverable D2.1, especially from the snapshot and gap analysis.

The future work of the STREETLIFE project towards closing the gaps is anchored in the pilot activities and thrives on the architectural guidance and specification and on the corresponding research activities on data modelling, mobility management, and end user applications. The necessary continuous refinement of the STREETLIFE scenarios and use cases, data sources, components and STREETLIFE functionalities will lead to a larger level of detail in the identified gaps providing valuable input to the blueprint and pilot-specific architectures and to the preparation of the pilots and their specification finally leading to an agile closing of the gaps. The iterative approach of the STREETLIFE pilots supports this well.

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B STREETLIFE INTERVIEW

1. Does the sustainable mobility issue occupy a prominent place in the politic agenda of the municipality? Did the subject found a place in any of the public statements released by the highest offices of the municipality itself? Did they found space in some of the strategic plans of the city?

2. What themes and objectives the municipality identifies as a priority to address the topics of sustainable mobility?

3. What are the "best practices" fielded by the municipality in terms of policies for sustainable mobility? Could you give us a brief description?

4. What results have been achieved in the implementation of these best practices? Did the municipality carry out a proper assessment about these? Has it been quantified the impact of these practices on CO_2 emissions? What critical considerations were eventually made by the municipality assessing the impact of the policies put on the field and which indications have emerged for their re-orientation?

5. What was the level of involvement and participation of citizens in the development and implementation of policies for sustainable mobility and what methods and tools were used by the municipality to encourage participation?

6. Basing on past experiences, how much profound does the municipality think can be the contribution of IT in achieving the best results for the policies of sustainable mobility?

C STREETLIFE SHORT INTERVIEW

To the advisory board members

SHORT SURVEY FOR STREETLIFE PROJECT– GAP INCENTIVE ANALYSIS

NAME

SURNAME

COMPANY

CITY

The double column for the answers is put into the survey for advisory board members working on cities that are not involved in the STREETLIFE project pilots.

1. How would you rate the policies and measures for sustainable mobility implemented to date in your city?

Please give a rating from 1 (very negative) to 5 (very good).

Give 0 in case of policies not implemented yet in that sector

Pilot	Place where you work	
		Mobility and traffic planning
		Implementation of the cycling paths network
		Realization of parking lots for bicycles and services for cycling
		Development of local public transport
		Development of on-call demand responsive services in public transport
		Technological solutions and information for intermodality (e.g. integration of different fares)
		Park and ride
		Better flow of vehicular traffic on the main roads network
		Traffic Calming
		Pedestrianization and restrictions to vehicular traffic
		Renewal of the vehicle fleet (e.g. incentives for vehicles with low emissions)
		Car Sharing
		Car Pooling
		Bike Sharing
		City logistics for the distribution of goods
		Info-mobility (end-users informations)
		Promotion and marketing of sustainable mobility
		Mobility Management
		Road safety and accidents' reduction

2. What is the level of priority that he believes should be assigned to the policies and measures for sustainable mobility in the future in the pilot city?

Please give a rating from 1 (very low) to 5 (very high).

Give 0 in case of policies not considered relevant at all

Pilot	Place where you work	
		Mobility and traffic planning
		Implementation of the cycling paths network
		Realization of parking lots for bicycles and services for cycling
		Development of local public transport
		Development of on-call demand responsive services in public transport
		Technological solutions and information for intermodality (e.g. integration of different fares)
		Park and ride
		Better flow of vehicular traffic on the main roads network
		Traffic Calming
		Pedestrianization and restrictions to vehicular traffic
		Renewal of the vehicle fleet (e.g. incentives for vehicles with low emissions)
		Car Sharing
		Car Pooling
		Bike Sharing
		City logistics for the distribution of goods
		Info-mobility (end-users informations)
		Promotion and marketing of sustainable mobility
		Mobility Management
		Road safety and accidents' reduction

3. In your opinion how important is the involvement and participation of citizens in policy decision making and increasing the effectiveness in their implementation?

Pilot	Place where you work	
		Indispensable
		Relevant
		Interesting
		Not relevant
		Low
		Of no importance

4. In your opinion what is the contribution of information technology in achieving the best results for the sustainable mobility policies?

Check the box corresponding to the opinion expressed.

Pilot	**Place where you work**	
		Indispensable
		Relevant
		Interesting
		Not relevant
		Low
		Of no importance

5. Indicate areas of intervention where the use of information technology would bring greater benefits to the mobility management and / or to guide citizens toward virtuous behavior and why?

Example: traffic data collection, real-time information, road control, public transport management

1	
2	
3	
4	
5	

D STREETLIFE USE CASES

D.1 STREETLIFE USE CASES FOR THE BERLIN PILOT

The following is the list of use cases developed for Berlin (BER) pilot.

Use Case Id	**Use Case Name**
Berlin Pre-trip planning (PTP) and on-trip itinerary surveillance	
BER-PTP-1	Trip Planning: supports end user trip planning and evaluation based on defined criteria (e.g. costs, carbon emissions, duration, length, etc.)
BER-PTP-2	Carbon footprint (CFP) advisory: Allows the estimated calculation for the carbon footprint for available modes of a planned trip.
BER-PTP-3	Itinerary tracking and adjustment: trip tracking and suggestions for alternative routes
BER-PTP-4	Crowd sourcing transport service quality & reliability assessment
BER-PTP-5	Create user profile with transport preferences
BER-PTP-6	End user registration
Berlin Car Pooling and Incentives	
BER-CPI-1	Car/Bike sharing booking
BER-CPI-2	Gaming/Incentives
BER-CPI-3	Trip communication and Sharing via Social Networks (Car Pooling Setup)
BER-CPI-4	Trip/Route feedback and tracking
Berlin Bike Usage and Incentives	
BER-BUI-1	Event Info Provision
BER-BUI-2	Events changing mode choice
BER-BUI-3	Safe Bike Routing
BER-BUI-4	Feasibility study/use case: Collision avoidance/warning – C2X-, STREETLIFE2X-Communications
BER-BUI-5	Incentive Management
Berlin Operator and Management Scenarios	
BER-MGMT-1	Derivation, Aggregation and Monitoring of main KPI
BER-MGMT-2	Generation of warnings and service quality feedback

BER-MGMT-3	KPI monitoring at STREETLIFE website
BER-MGMT-4	Event based service adjustment and feedback
Back-end Services	
BER-BES-2	Scenario simulation
BER-BES-3	Results presentation, feedback and delivery

D.2 STREETLIFE USE CASES FOR THE ROVERETO PILOT

The following is the list of use cases developed for Rovereto (ROV) pilot.

Use Case Id	Use Case Name and short description
Sharing Bikes	
ROV-BS/1	Find Bikes
ROV-BS/2	Retrieve Bikes
ROV-BS/3	Improve Bike usage
Car Pooling to Work	
ROV-CP/1	Find a carpool ride
ROV-CP/2	Offer a carpool ride
ROV-CP/3	Get a carpool ride
ROV-CP/4	Give a carpool ride
ROV-CP/5	Commuter Profile
ROV-CP/6	Incentives of Car Pooling to Work
Park & Ride (P+R)	
ROV-PR/1	Planned P+R
ROV-PR/2	On-the-fly P+R
ROV-PR/3	On-the-ground P+R support
ROV-PR/4	P+R alert
ROV-PR/5	Evaluate and plan park and ride

D.3 STREETLIFE USE CASES FOR THE TAMPERE PILOT

The following is the list of use cases developed for Tampere (TRE) pilot.

Use Case Id	**Use Case Name and short description**
Existing IT systems	
TRE-1/1	Reuse IT systems
Multimodal real-time Journey Planner	
TRE-2/1	Find multi-modal real-time affected journey
Transportation flow management	
TRE-3/1	Mitigate congestions in main bus stations
Park & Ride	
TRE-4/1	Make park & ride journey
CO_2	
TRE-5/1	View journey plans CO_2 emissions