SUNSET

Sustainable Social Network Services for Transport

www.sunset-project.eu

Grant agreement n°:270228

Start date: Feb 1, 2011

Duration: 36 months

Area: Smart Cities & Sustainability (CONNECT.H.5)

Project Officer: Mr.StefanosGouvras

Deliverable D 1.2

"Revised Scenarios and User and System Requirements"

Version: 1.0

Due date of deliverable : Nov 30, 2013

Actual submission date: Nov 30, 2013

Dissemination level: PU

Responsible partner: QMUL

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 270228. The project's website is at www.sunset-project.eu.

Summary

The main aim of this deliverable is to provide an update of the SUNSET system use cases and user requirements use in the operational system that was previously reported in the SUNSET project deliverable [D1.1]. In this report, D1.2, the use of the originally proposed user requirements in the current operational SUNSET system is analysed. A service-oriented view of the SUNSET system that also focusses on pragmatic deployment issues and on usability issues based upon feedback from a small set of internal project users that could otherwise hinder the uptake of the system, is considered and presented.

Document Information

Authors

Name	Partner	Email
Stefan Poslad, Haibo Mei, Zhenchen Wang	QMUL	Stefan@eecs.qmul.ac.uk
Gregor Broll	DOCOMO	broll@docomolab-euro.com
Johan Koolwaaij	NOVAY	Johan.koolwaaij@novay.nl
Benjamin Groenewolt	ENSCHEDE	b.groenewolt@enschede.nl

Editor

Name	Stefan Poslad
Partner	QMUL
Address	School of Electronic Engineering & Computer Science (EE), Queen Mary, University of London, UK
Phone	+44 2078823754
Fax	
Email	Stefan@eecs.qmul.ac.uk

History

Version	Date	Changes
V0.1	10-09-2012	Initial table of contents and structure proposed
V0.2	15-09-2012	Structure is further developed
V0.3	20-10-2012	Status of User & System requirements that are used in the operational system
V0.4	14-11-2012	Added comments on WP4,5, removed sections 2 on LL updated, section 4 UI, section 5 stake-holder update and appendices that related to these sections
V0.4.1	18-11-2012	WP2 and WP4 review and comments added
V0.4.2	20-11-2012	Minor update of use-case comments.
V0.4.3	20-11-2012	WP6 comments and edits to whole of comments
V0.5	21-11-2012	Edits to whole of document to address outstanding WP2 & WP6 comments. Major section added that reflects the service-oriented rather than user-requirement view of the system. Version submitted for internal review
V5.1	23-11-12	Minor edits to the document presentation took place in parallel with the internal review.
V5.2	26-11-12	Major edits made after the SUNSET internal reviews of this document
V5.3	28-11-12	Improved sections 3.1, 3.4 further
V5.4	29-11-12	Final review as WP leader
V1.0	30-11-12	Final version completed and sent to reviewers

Distribution

Date	Recipients	Email
30-11-2012	SUNSET partners	sunset@lists.novay.nl
30-11-2012	Project Officer	Stefanos.GOUVRAS@ec.europa.eu
30-11-2012	Project Archive	CNECT-ICT-270228@ec.europa.eu

Table of Contents

1 Introduction

This deliverable is the second SUNSET project Work Package 1 or WP1 (Scenarios and Requirements) deliverable. This deliverable, D1.2, reports an update of WP1's two main tasks: task T1.1 (scenario requirements analysis) and Task T1.2 (system requirements analysis).

This deliverable supplements the original WP1 deliverable [D1.1]. [D1.1] reported the user requirements analysis at the onset of the technical development of services to support the user requirements in the project at month 10 (M10) of the project. In contrast to [D1.1], D1.2 is finalised in M22 of the project and reports an analysis of the user and system requirements after substantial development and formative evaluation of the system has occurred. 7 major iterations or releases of the SUNSET Platform, called tripzoom, have occurred. During each of these 7 phases, the original design of tripzoom has been enhanced. In addition, a more detailed Service-oriented (S-O) view has become the focus of the system. This report focusses on the concrete services that can be accessed by the user rather than on the user requirements.

1.1 Goals

The goals of this deliverable, D1.2 (taken from the DOW[1]), are to report the status of the proposed user and system requirements in the operational system (Sections 2 and 3)

1.2 Main Results and Innovations

The main results of this document are an updated report of the analysis of user requirements and an analysis of user-centred services that are supported in the operational system. Table 1 explains how the results of this deliverable contribute to the project's main innovations. In this table, N/A" in the right column indicates that this deliverable does not contribute to a particular project innovation.

SUNSET innovations	Contribution of this deliverable
Social mobility services that motivate people to travel more sustainably in urban areas	The status of the motivating scenario driven requirements to change mobility behaviour that includes social interaction in the operational system is reported (up to and including M22 of this M36 long project)
Intelligent distribution of	The status of the incentive market-place

[11] The Description of the Work that is the detailed project proposal

incentives to balance system and personal goals	service is reported
Algorithms for calculating personal mobility patterns using info from mobile and infrastructure sensors	N/A
Evaluation methodologies and impact analysis based on living lab evaluations	N/A

Table 1: Contributions of this deliverable to SUNSET's innovations

1.3 Approach

This D1.2 update of D1.1 does not seek to repeat the bulk of the material in the previous version, D1.1 but rather to report the updates to D1.1. There are no updates to the generic user scenario or to the use cases themselves from D1.1. We have translated our description of the user requirements in relation to the use cases into a Service-Oriented (S-O) approach, where we can describe user requirements in relation to end-user services provided by the system.

Note the work in D1.2 is related to the work in several parallel SUNSET workpackage activities concerning the evaluation methodology (WP6) and the Living Lab (LL) Operation and Experimental Evaluation (WP7). Whereas WP6, Evaluation Methodology, specifies how to evaluate and measure aspects of the operational system via user interaction, WP1 D1.1 and D1.2 focus on the scenarios and requirements for use of the system. Whereas WP6 deliverable [D6.1] focusses on the evaluation approach, this deliverable D1.2 analyses the interplay between the system design, user and requirements. WP7, Living Lab (LL) Operation and Experimental Evaluation, deals more holistically with a summative evaluation of the completed system, rather than on requirements and user scenarios and on a formative evaluation of an iterative developing system. WP4 and WP3 deliverables D4.5 (Final Mobile Application Design) and D3.4 (Feasible and potentially successful incentives) report respectively, the user interfaces for the mobile device and the Living Lab controller portal used by the LL controllers in the deployed system.

The remainder of this approach is structured as follows. The bulk of this update report to [D1.1] is presented in the next two sections from two complementary perspectives: the Current System Status with respect to the Original [D1.1] User Requirements (Section 2); the Current System Status in Terms of User-centred Service-Oriented Support (Section 3). The report finishes with conclusions (Section 4).

2 Current System Status with respect to the Original [D1.1] User Requirements

This Section reports the status of the how the current Release, 7, (R7) of the system has been deployed and shows how it supports the user requirements.

2.1 Relation of Use-cases and User Requirements to System Requirements

The user requirements are based upon a structured analysis of the use-cases and then mapped to the system requirements, [D1.1, Section 8]. This confirms how the system supports the user requirements.

System requirements to support the use-cases are grouped into the following service blocks: mobility server sub-system (WP2), mobility client sub-system (WP4) and Infrastructure network & portal sub-system (WP5). In more detail, 95 system requirements for the mobility server were identified. This includes 11 for the Personal Mobility Store, 13 for the Mobility Pattern Detector, 9 for the Mobility Pattern Visualizer, 13 for the Incentive Market-Place, 10 for the Experience Sampling Store, 16 for the Relation and Identity Manager, 11 for the Privacy Manager, 5 for the Evaluation Support and 7 for the Infrastructure Network Manager. Most system requirements have a strong link with the scenarios, but the list includes still a few technical ones and a few derived from the DoW, without a direct link to the use cases.

2.2 Discussion of the Operational System with respect to the User Requirements

The user requirements are identified as use-case parts of the generic user traveller scenario [D1.1 Section 4] and the local transport authority stake-holder scenario. The latter type of stake-holder is also referred to as the city moderator and Living Lab controller or LLc. The user requirements were defined in [D1.1 Section 6] where the individual system requirements for each system component were related to the use-cases. Table 2 gives the mapping of the use-cases (and indirectly to user requirements) to the current system, reporting the status of how the user requirements are supported in the current system.

The main foci of the system releases with respect to the user requirements and services are as follows:

- Release R1; focussed on users' access to the tripzoom system services;
- Release R2: focussed on user-oriented (privacy) access control to services and to richer core travel information services ;

- Release R3: added the first support for incentives and for experience sampling;
- Release R4: improved the travel information services, use of incentives and the use of social network services;
- Release R5: focussed on: improving the use of incentives, user control of privacy preferences and on richer information views and on transport authorities or city moderators being able to first sample users to evaluate experiences.
- Release R6: focussed on better supporting city moderators to be able to issue experience sampling and to compare mobility patterns of user groups and can get overviews of their trips.
- Release R7: focussed on improvements in the service design of R1 to R6 and to offer more support for information management with respect to more finely-grained groups of travellers (see Section 3.4).

Scenario ID	User requirements	Support in the current version (R7[2]) of the system	Priority
US1	Mobility App registration &Download	Yes	High
US2	Social Network Reuse	Yes	High
US3	Mobility Pattern Analysis & View	Yes	High
US4	Improved Mobility Pattern Analysis	Yes	High
US5	Trip-based Pattern Analysis & Recommender	Partly supported, manual approach	High
US6	Trip Recommender Acceptance & Feedback	Partly supported, manual approach	Medium
US7	Real-Time Trip, Historical Trip, Transport choice, Info.	Yes, but moved from the Web portal to the mobile client	High
US8	Planned Real-time Trip Info and Recommender	N/A	High
US9	Real-time Trip Info. Confirmation using individual mobility monitoring and traffic sensors	N/A	Medium
US10	Trip Degradation Confirmation using Traffic cameras	N/A	Medium

[2] Release 7 of the system is available in M22 of the project (Nov. 2012)

US11	Trip change based upon Traffic cameras	N/A	Low
US12	Group-based aggregated Views of multiple individual Trips	Yes, for the buddy group and LL community	High
US13	Trip Change Incentives	Yes	High
US14	Ad hoc Location-specific Mobility Offers	Yes, manual via incentives	Medium
US15	Ad hoc group Travel Offers	Yes, manual via incentives	Medium
US16	Public transport recognition:	Yes	Medium
US17	Experience sampling	Yes	High
US18	Sharing Mobility Status Updates	Yes	Medium
US19	User-centred monitoring and visualisation of Mobility patterns.	Yes	High
US20	Reuse of SUNSET Widgets in External Applications	N/A	Medium
US21	Analysis of Mobility Patterns and Proposals for Mobility Improvement	Yes, manual via incentives or experience sampling	Medium
US22	Users can offer each other travel tips	Yes	Medium
SS1	Overview of transport movements in the city	Yes	Medium
SS2	Monitor sub-optimal situations	N/A	Medium
SS3	Creates incentives	Yes	High
SS4	Monitors effect of incentive use	Yes	High
SS5	Issue new experience sampling	Yes	High
SS6	View aggregated data related to policy objectives	Yes	High

Table 2: Mapping of user requirements to system status (N/A indicates not available)

In Table 2, the user requirements defined in D1.1 are reviewed with respect to the tripzoom status. More details of the experiences in supporting each use case can be found in Section, 2.3. At this time tripzoom can support the operational living labs. In each living lab, users can receive incentives, monitor their mobility patterns and get suggestions concerning how to travel greener and more energy efficiently, leading to more sustainable transportation use. From a living lab controllers' perspective, a living lab controller can monitor tripzoom functions by receiving feedback from the incentive market place

service and experience sampling questionnaires. Living lab controllers can thus learn about users' experiences and the effects of incentives and coordinate further incentive generation and user management to allocate users to LLs and to manage groups of users.

For incentive generation, living lab controllers can create incentives considering living lab, target group, incentive notification and valid time, descriptions sent to users, and reward given conditions. For user management, user grouping and living lab assigning are the most important functions. When grouping users, living lab controllers can create a specific group of users in a living lab, such as car users, and assign target users to this group. When assigning users to a living lab, its living lab controllers can allocates a tripzoom user to a living lab (Enschede, Leeds, and Gothenburg).

There are also some functions not realized because of strategy changes during development. Specifically, US8-11, are not supported as the focus shifted to be more heavily on personal mobility rather than on integration of real-time traffic data (see Section 2.3), and the focus shifted from a traveller user's access via a PC-based Web portal and mobile phone to a mobile phone only access to services (see Section 3.3).

2.3 Analysis of the Support for Use-cases in the Current System

The following comments assess the status of how the use-cases, given in Table 2, are supported in the system. The status of a user requirement is directly connected to the status of one or several WP specific sub-system requirements that are described in more detail in [D1.1]. [D4.5] reports the status of additional technical and system requirements on the mobile clients. Deliverables [D2.1, [D2.3], [D2.4] report the system status of additional requirements on the SUNSET service platform, and [D5.1] reports the requirements for the web portal and city dashboard. It is noted since the publication of [D5.1] that the use of the Web Portal has been reduced. It is now really only used for traveller registration and to get information about a LL. The main functionality of the mobility information services is realised as an application running on the mobile client (see comment about US20 below).

US1 – Mobility App Registration & Download

Users can download the mobile tripzoom app for iOS or Android from the App Store or Google Play. Download-links are available on the tripzoom web portal. The portal also allows users to register for tripzoom, optionally using their Facebook credentials. After users have downloaded and installed the mobile tripzoom app, they can also access tripzoom services from their mobile devices. Users who log in to the tripzoom app have to agree with different consents to allow the

application to handle their personal mobility data on their behalf. After that, users can start monitoring their personal mobility with the mobile tripzoom app. The respective system requirements T4.1-SR0 („Application Registration“) and T4.1-SR1 („Location Traces Measuring“) are fulfilled, while the activity detection described by T4.1-SR5 („Activity Detection “) is partially fulfilled.

US2 – Social Network Reuse

Tripzoom uses social networks and their features in different ways. The most basic one is the representation of tripzoom on social networks such as Facebook, Twitter, Foursquare and Google+, which have their own dedicated pages. Links to these pages are available on the tripzoom web portal which also integrates data feeds from Facebook and Twitter. Users can register for tripzoom and log in using existing Facebook accounts. They can also send invitations to friends on social networks (e.g. Facebook) to ask them to join tripzoom. Users can link their tripzoom account on Facebook and Twitter and post tripzoom-related information there. As of release R7, this feature is available in the backend system but this still needs to be integrated more deeply in the mobile clients. So far, only when a user joins tripzoom is this information posted on connected social networks. Otherwise, the respective system requirement T4.1-SR0 („Application Registration“) is fulfilled.

US3 – Mobility Pattern Analysis & View

The mobile tripzoom app automatically tracks the mobility activities of their users, including location traces and any initial segmentation into trips. This information is uploaded on the server-side for further analysis. From this analysis the system is able to derive long-term or smoothed mobility information such as visited places, frequent trips or transport modalities. This new information is connected with the user's trip list and provided back to the client. Users can look at and analyse their gathered mobility data using the "Me"-tab of the mobile tripzoom app. An additional community feature visualizes this abstract mobility data in a more user friendly way and shows users how well they perform regarding their saved CO_2 or costs compared to others in the tripzoom community. While the respective system requirements T4.1-SR1 („Location Traces Measuring“) and T4.1-SR6 („Experience Sampling“) have been fulfilled, the detection of transport modalities (T4.1-SR2) can still be improved by taking mobile client side activity information into account.

US4 – Improved Mobility Pattern Analysis

All trips are analysed at the server-side. Personal mobility patterns are generated using longer-term historical trip information. All analysis and pattern detection is done in such a way that even for a novice user with relatively little mobility data, quick results are generated with a

lesser accuracy to show the user something of the system's promise. As more mobility data becomes acquired, these results become more and more accurate. As example of this behaviour is place detection. This is initially capable of providing a rough estimate of the home and office location of a traveller, extending the set of personal places over time to include frequent transit locations or friend's homes to include more details of mobility patterns. The modality statistics are computed over different periods of time ranging from 2 weeks to 6 months, to observe changes in behaviour. And the modality detection re-uses historic manual corrections of the users to prevent making the same error over and over again. Improving place detection has its positive impact as well, since places can be assigned as the origin and destination of a trip.

US5 – Trip-based Pattern Analysis & Recommender

This user requirement is not fully supported in the current release R7. While the tripzoom system can basically send notifications to users (T4.1-SR4, "Notification Support"), the matching of different trip patterns that is a prerequisite for recommendations is supported in the current release R7. On the server-side, however, it is computed which users have a matching mobility pattern in the sense that they regularly travel from approximately the same origin to the same destination during the same weekdays and times. This could result in a recommendation to start carpooling with each other. However, communication of this information to other users is a privacy concern if someone is outside their social circle, and possibly non-interesting if someone is already in the social circle. Furthermore, these recommendations can also be crafted by the living lab controller as a proper incentive based on the long-term personal mobility profile, e.g. for all users who rarely use something else other than their car.

US 6 – Trip Recommender Acceptance & Feedback

If a user posts sufficient details about a trip to social network sites (US2/US18), other users can choose to use the liking and rating features of a social network. So part of this functionality can be viably supported over existing social networks, such as Facebook. Additionally, users are able to rate incentives. This way they provide feedback to the living lab coordinator as to which incentives they would like to see repeated in the future.

US7 – Real-Time Trip, Historical Trip, Transport choice Info

It was initially foreseen that a user receives mobility statistics about his or her public transport choices and consequences, via a SUNSET LL portal and is able to spot trends. During the course of the project it was decided not to have a full web portal anymore, but a landing page. The mobility statistics in the latest release of the system, R7, now shown in the mobile client, includes modality statistics, trip consequences in

terms of costs/lost time/emissions, and long-term trends by covering multiple periods of time, as described in US4.

US8 – Planned Real-time Trip Info and Recommender

This user requirement is not supported in release R7. While the tripzoom system can basically send notifications to users (T4.1-SR4, "Notification Support"), recommendations based on real time traffic information are not supported (see discussion of US9 Real-time Trip Info below).

US9 – Real-time Trip Info

This user requirement is not supported in release R7. While the tripzoom system can basically send notifications to users (T4.1-SR4, "Notification Support"), the creation of real-time trip info, its combination with roadside sensors, its personalization and its retrieval by other users, are not supported.

It was decided to drop this feature due to the complexity of crunching those big amounts of detector data with relatively low information gain compared to existing sources such as Google Traffic[3] and TomTom HD[4] Traffic. Unfortunately, those alternatives don't offer overlays to integrate such information for 3rd party mobile applications.

While the idea was to integrate a live traffic overlay in the city dashboard, such that the living lab controller could investigate the current traffic status, and to influence the traveller's behaviour by offering alternative routes. Those are easily integrated (example: https://maps.google.nl/?ll=52.219177,6.895123&spn=0.021428,0.066047 &t=m&z=15&layer=t). This functionality has never seen the light of day in the dashboard, nor has the geospatial / road network elements been used in incentive creation, i.e., users who drive over road X, as one of the specified incentive use cases.

A second, issue is the limited Live Traffic coverage. For example, as of Nov. 2012, M22, of this project, Google Traffic data is only available in major cities in selected countries and the road network covered is patchy. It exists at selected hot-spots for selected major 'A' roads and motorways, not for all major trunk-road entries and exits and within urban areas.

US10 – Trip Degradation Confirmation using Traffic Cameras

This user requirement is not available, see US9 – Real-time Trip Info.

US11 – Trip Change based upon Traffic Cameras

This user requirement is not available, see US9 – Real-time Trip Info.

---

[3] Goggle traffic is available as a clickable option via the Google Maps Website, http://maps.google.com/

[4] TomTom Live Traffic is available from http://www.tomtom.com/livetraffic/

US12 – Group-based Aggregated Views of Multiple Individual Trips

The Mobility Pattern Detector mainly computes personal mobility patterns and views. The only group pattern that is computed concerns the buddy group pattern as an average of the mobility performance of all buddies of a user. Other group profiles have to be computed using the personal data from the Mobility Pattern Detector (MPD) in combination with a target group selection based on the mobility data (e.g. all users with a home location in Enschede) or based upon explicit group definitions in the Relation Manager (apart from the buddy group).

US13 – Trip Change Incentives

The technical requirements for this user requirement - T4.3-SR0 ("Display Shelf"), T4.3-SR1 ("Point Scheme") and T4.3-SR2 ("On-the-go Bonus") are fulfilled.

US14 – Ad hoc Location-specific Mobility Offers

Incentives can be offered to users based on the location trace of their trip. So if a trip passes a certain (shop) location, an incentive can be provided to the user to visit the shop, e.g. a bike maintenance voucher for the frequent cyclist passing a bike shop. For more information on the implementation of incentives we refer to D2.4.

US15 – Ad hoc Group Travel Offers

This user requirement is not available in the current release R7. While the tripzoom system can basically send notifications to users (T4.1-SR4, "Notification Support"), group sharing features are not supported.

US16 – Public Transport Recognition

This feature will not become available in future releases, at least not in the level of detail as train number or bus line number. The PMS uses information from the Infrastructure Network Manager however to see if trips frequently pass along bus stops, tram or metro stops, or stations, and uses that information to improve modality detection. Another supported scenario is the automatic trip splitting in case of quick transit at logical transit points: if a user quickly changes from bus to train at a station, it is usually hard to split trips based on duration of stay. The fact that this happened at a station is an additional clue for the automatic trip splitting, and this location is also re-used as origin for (in this case) the train trip. We refer to D2.2 for more information on this.

US17 – Experience Sampling

The system offers the possibility for living lab controllers (and researchers) to add conditional questions to the system. These question definitions can be defined in the City Dashboard (CD), and are stored in the Experience Sampling Store (ESS) which also monitors the

conditions attached to the question, either on trip end or time-based. If a condition match is detected, the associated (multiple choice) question is fired towards the tripzoom client, where the user can either answer the question or decide not to answer. All answers are collected by the ESS. An answer overview is shown in the City Dashboard targeted at researchers. Refer to Deliverable [D2.1] for more information on experience sampling.

US18 – Sharing Mobility Status Updates

Users can see mobility information about their friends, e.g. last trip, distance, costs or emissions, in the "Friends"-tab of the mobile tripzoom application. The respective system requirement T4.2-SR3 ("Buddy Location") is fulfilled. Although the necessary functionalities are available in the backend system, the sharing of mobility status updates via social networks still needs to be integrated into the mobile clients. Trip planning is not supported.

US19 – User-centred Monitoring and Visualisation of Mobility patterns

The system supports various visualizations to display, browse through, and also to correct collected data or to provide additional information. The most important types of information in use are: Places (a location of some dimension that was automatically detected to be of importance by the user); Trips (a continuous movement from a starting point to a target point) and Trails (a recurring trip). A mobility overview maps the detected travel modalities to a user selectable set of parameters such as time or distance; for the user the mobility overview is presented as a list of modalities sorted according to chosen configurable parameters. The system solves the granularity problem of visualized data by letting users navigate starting from data overviews down to very detailed representations [D4.5].

US20 – Reuse of SUNSET Widgets in External Applications

The system does not offer user configurable widgets. The only widget provided gives an overview of the activity in the different living labs. It is shown at http://www.tripzoom.eu/portal/information.php but this can also be re-used in other places if required with some additional effort. The main reason for the current lack of wider widget support is because of limited time resources. The focus to date is on developing and maturing the components that can form the basis of the widgets rather than on researching and developing customizable widgets and on developing relationships with 3rd parties and market-places in order to gain agreements to embed these widgets on their Web sites.

US21 – Analysis of Mobility Patterns and Proposals for Mobility Improvements

The system does not offer fully automatic proposals to individual users. However, both experience sampling and incentives can be used to

provide the user with carefully crafted proposals in specific situations. E.g. experience sampling questions can be formulated suggestively, such as "Did you know that this home-office trip took you 20 minutes by car, just 5 minutes shorter than your average by bike?" or incentives can be targeted to users with a specific modal split, hence providing the implicit proposal to do it better or more optimal in the future.

US22 – Users can Offer Each Other Travel Tips

This user requirement is supported in the current release R7.

SS1 – Overviews /Aggregated Views of Transport Use

This stakeholder requirement is partially implemented in the city dashboard. In different living labs, the city dashboard provides stakeholder links to specific transportation websites. Those transportation websites were proposed in [D1.1]. They can aid stakeholder monitoring transport movement in a LL city. For example, the link http://www.leedstravel.info/cdmf-webserver/jsp/livecctv.jsp offers traveller information on road conditions from live traffic cameras in Leeds. However, there are limited numbers of transportation websites that can provide a satisfactory transportation overview in each living lab.

SS2 – Monitor Sub-optimal Situations

In the current release this is a manual process of the living lab controller using existing traffic information systems, such as Google Traffic or FileFlits[5].

SS3 – Create Incentives

This requirement is fully implemented in tripzoom release 7. Stakeholders can create incentives for travellers through the city dashboard. These incentives, later stored in the incentive market place, give targets and challenges to travellers to help them changing the travel route, modality and other behaviours. Those positive changes can lead to greener transportation. When creating an incentive, stakeholders need to specify incentive name, notification and reward descriptions, start date, end data, notification date, target user group and reward issue conditions. Travellers can receive new notifications from their mobile clients.

SS4 – (Transport Authority) Stake-holder Monitors the Release and Effect of Incentive Use

The CD and IMP together support this requirement. Through the CD, stakeholders can observe how many travellers been notified by an incentive and when a notification occurs in a living lab. Stakeholders can also observe how many travellers have been rewarded after finishing a target and challenge type of incentive. In addition,

[5] http://www.flitsservice.nl/ This is available in the Dutch language only.

stakeholders can also observe the rate of every incentive given to travellers.

SS5 –Issue New Experience Sampling

To get a user's opinion about any coming issue, such as a foreseen or unforeseen road closure, or the addition of a newly released tripzoom client etc, city authority stakeholders can create new experience sampling questions to users through the CD. When creating incentives, stakeholders need to state the question name, candidate questions, active conditions, repeat pattern and issuing conditions. The created experience sampling questions are stored in the experience sampling store that will issue the questions to travellers according to the issue conditions. After a period of time, stakeholders will receive traveller feedback and related statistics through the CD. From this information, stakeholders can better understand travellers' opinions.

SS6 – View Aggregated Data Related to Policy Objectives

The system offers an overview of all incentives in the CD. In this overview it can be seen how often an incentive is presented to a user, and in which cases the attached reward was given to a user. This can be linked to policies.

3 Current System Status in Terms of User-centred Service-Oriented Support

3.1 Iterative System-oriented Development

An iterative or incremental development approach was adopted to deliver the complexity of the Tripzoom system in a managed way. From M12, (Feb. 2012) of the project until the delivery date of this report, M22, (Nov. 2012), 7 major iterative releases of the Tripzoom system have been produced.

Earlier releases developed the simpler core system functionality and later releases extended this functionality, and on occasion, maintained existing functionality from a previous release. Thus the development and testing of each major release of the system took place on average every 6-7 weeks, including a 1-2 week user evaluation with a limited set of internal non-developer users. This plans for a formative evaluative of the user requirements and design rather than a summative evaluation to validate the finished design. This enables the evaluation of a preceding design to help form a better proceeding design. The details and processes for the iterative, formative, user evaluation of the system are reported in [D6.1].

During the iterative development and formative evaluation of the system, the view of the system shifted from a user-requirements driven system to a user-centred service-oriented (S-O) type system. This was driven by several needs:

- In [D1.1], it was highlighted that often users assume but do not explicitly state some core non-functional system functions (implemented as services) such as privacy, help and Language localisation to support international users' use of different languages and country contexts. An S-O system also captures and models these implied 'support' user services.
- Systems tend not to be composed of, designed and implemented in terms of high-level user requirement concept driven sub-systems but in terms of more technical, reusable, lower level (atomic and composite) service components. Hence, from M12 of the project, the development of the system focussed on the S-O view rather than on the user-requirements per se.
- During the iterative development, it became clearer which user requirements could feasibly be realised using system services in an operational system

During M11 of the project, some specific design and implementation choices at a project plenary of the main services were made that

resulted in an official accepted milestone 2 (internal Project) document that defined a service oriented (S-O) view of the system.

The S-O view analysis also identified the following user roles:

- Traveller: the user of the services;
- City moderator: the operator and controller of the tripzoom services in each LL city;
- Third party: Service providers who offer travel related services who may provide a means to exchange physical rewards for incentive points, e.g., offer a discount on buying a beverage near a public transport station based upon the use of public transport to that station;
- Researcher: can provide information to their user community on the LL goals, approach and privacy aspects.

Table 3 shows how the tripzoom services support the use-cases defined in [D1.1].

tripzoom Services	Corresponding D1.1 Use-case
Traveller support services	
TSS1: Travellers can get info on the LL	US1 Mobility App registration &Download
TSS2: Travellers can embark to the LL	US1 Mobility App registration &Download
TSS3: Travellers can get help from a helpdesk / user forum	Non-functional/System Requirement
TSS4: Travellers can give feedback on LL	US6 Trip Recommender Acceptance & Feedback
TSS5: Travellers can dis-embark from the LL	Implicit in US1
Traveller main services	
TMS1: Travellers can change their privacy preferences and profile	Non-functional/System Requirement
TMS2: Travellers can get overviews of their trips	US3 Mobility Pattern Analysis & View
TMS3: Travellers can zoom in on their trip details	US3 Mobility Pattern Analysis & View
TMS4: Travellers can see actual road conditions	US8 - US11 Real-time Trip Info.
TMS5: Travellers can see the	US21 Analysis of Mobility

consequences of their mobility pattern	Patterns and Proposals for Mobility Improvements
TMS6: Travellers can set personal goals	US19 User-centred monitoring and visualisation of Mobility patterns
TMS7: Travellers can compare their actual behaviour with their personal travel goal	US19 User-centred monitoring and visualisation of Mobility patterns
TMS8: Travellers can compare their actual behaviour with city level goals	US19 User-centred monitoring and visualisation of Mobility patterns
TMS9: Travellers can create or subscribe to groups and invite users	US2 Social Network Reuse
TMS10: Travellers can compare their mobility pattern with patterns from others	US2 Social Network Reuse
TMS11: Travellers can see where friends are and if they are travelling	US2 Social Network Reuse
TMS12: Travellers can receive tips & travel alternatives on how to reach personal goals	US2 Social Network Reuse
TMS13: Travellers can receive notifications	US5 Trip-based Pattern Analysis &Recommender
TMS14: Travellers can receive an incentive when they show compliance in actual travel behaviour with city level goals	US5 Trip-based Pattern Analysis &Recommender
TMS15: Travellers can receive an incentive when they are at a specific place or area at a specific time(period)	US5 Trip-based Pattern Analysis &Recommender
TMS16: Travellers can receive an incentive when they meet a SUNSET challenge.	SS4 Monitors effect of incentive use
TMS17: Travellers can see what challenges are ‘open’	SS4 Monitors effect of incentive use
TMS18: Travellers can publish some personal mobility facts on social media (share with friends)	US2 Social Network Reuse
TMS19: Travellers can rate incentives they liked	SS5 Issue new experience sampling
TMS20: Travellers can be recognized by	SS4 Monitors effect of

their achievement	incentive use
TMS21: Travellers can exchange points for a reward	N/A
City moderator main services	
CMMS1: City moderator can get overviews of mobility profiles	SS1 Overview of transport movements in the city
CMMS2: City moderator can see the consequences of mobility profiles	SS6 View aggregated data related to policy objectives
CMMS3: City moderator can compare total actual behaviour with city level goals	SS6 View aggregated data related to policy objectives
CMMS4: City moderator can see actual road conditions	SS6 View aggregated data related to policy objectives
CMMS5: City moderator can see where all SUNSET users are and if they are travelling	SS6 View aggregated data related to policy objectives
CMMS6: The city moderator can issue tips and travel alternatives on how to reach personal goals	SS3 Creates incentives
CMMS7: City moderator can issue incentives when travellers show compliance in actual travel behaviour with city level goals	SS3 Creates incentives
CMMS8: City moderator can issue incentives at a specific place or area at a specific time(period)	SS3 Creates incentives
CMMS9: City moderator can manage the lifecycle of a SUNSET user challenge	SS3 Creates incentives
CMMS10: City moderator can issue experience sampling questions	SS5 Issue new experience sampling
CMMS11: City moderator can analyse the response to the experience sampling questions	SS5 Issue new experience sampling

Table 3: tripzoom services and how they are related to D1.1 use-cases and user requirements

The Tripzoom service descriptions are not only related to the use cases but also provide user-level requirements to the system (service

component) development. The status of support for the user-level service descriptions in the Tripzoom system is summarized in the table below

Identifier: tripzoom service as specified in Leeds M11 Meeting	Status of being supported	Release where service is evaluated
TSS1: Travellers can get info on the LL	Yes	R6,R7
TSS2: Travellers can embark to the LL	Yes: LLc can assign travellers to specific LL through the CD	R1,R7
TSS3: Travellers can get help from a helpdesk / user forum	Yes	Pending
TSS4: Travellers can give feedback on LL	Yes	Pending
TSS5: Travellers can dis-embark from the LL	Yes: LLc can dis-assign travellers to specific LL through the CD	Pending
TMS1: Travellers can change their privacy preferences and profile	Yes	R2, R5,R7
TMS2: Travellers can get overviews of their trips	Yes	R2,R4,5,R6,R7
TMS3: Travellers can zoom in on their trip details	Yes	R2,R7
TMS4: Travellers can see actual road conditions	No	
TMS5: Travellers can see the consequences of their mobility pattern	Yes	R2,R6,R7
TMS6: Travellers can set personal goals	Yes, in IMP	Pending
TMS7: Travellers can compare their actual behaviour with their personal travel goal	Yes: Implemented by incentives issued by IMP	Pending
TMS8: Travellers can compare their actual behaviour with city level goals	Yes: Implemented by incentive issuing in IMP	Pending

TMS9: Travellers can create or subscribe to groups and invite users	Yes: Elgg[6] and facebook[7] provide such a function.	Pending
TMS10: Travellers can compare their mobility pattern with patterns from others	Yes	R6, ,R7
TMS11: Travellers can see where friends are and if they are travelling	No	
TMS12: Travellers can receive tips and travel alternatives on how to reach personal goals	Yes, is done by sending target & challenge incentives	Pending
TMS13: Travellers can receive notifications	Yes, done by IMP and CD	R4, ,R7
TMS14: Travellers can receive an incentive when they show compliance in actual travel behaviour with city level goals	Yes, but is realised manually by LLc.	Pending
TMS15: Travellers can receive an incentive when they are at a specific place or area at a specific time(period)	Yes	R3,R5,R6
TMS16: Travellers can receive an incentive when they meet a SUNSET challenge.	Yes	Pending
TMS17: Travellers can see what challenges are 'open'	Yes	Pending
TMS18: Travellers can publish some personal mobility facts on social media (share with friends)	Yes	R6, ,R7
TMS19: Travellers can rate incentives they liked	Yes	Pending
TMS20: Travellers can be recognized by their achievement	Yes	Pending
TMS21: Travellers can exchange points for a reward	Yes	Pending

[6] Elgg is open source social networking software that provides individuals and organizations with the components needed to create an online social environment, see http://elgg.org/

[7] Facebook is a social utility that connects people with friends and others who work, study and live around them, see en-gb.facebook.com/

CMMS1: The city moderator can get overviews of mobility profiles	Yes, city moderator (i.e. LLc) can monitor mobility profiles using feedback from IMP.	Pending
CMMS2: The city moderator can see the consequences of mobility profiles	Yes, city moderator (i.e. LLc) can see the consequences of mobility profiles in IMP.	R6,R7
CMMS3: The city moderator can compare total actual behaviour with city level goals	Yes, city moderator (i.e. LLc) can compare total actual behaviour with city level goals using feedback in IMP and ESS	Pending
CMMS4: The city moderator can see actual road conditions	No	
CMMS5: The city moderator can see where all SUNSET users are and if they are travelling	Yes, but the users may not be identifiable	Pending
CMMS6: The city moderator can issue tips and travel alternatives on how to reach personal goals	Yes, by city moderator issuing incentives to travellers.	R6, ,R7
CMMS7: City moderator can issue incentives when travellers show compliance in actual travel behaviour with city level goals	Yes	Pending
CMMS8: City moderator can issue incentives at a specific place or area at a specific time(period)	Yes	Pending
CMMS9: City moderator can manage the lifecycle of a SUNSET user challenge	Yes	R6,R7
CMMS10: City moderator can issue experience sampling questions	Yes	R6,R7
CMMS11: City moderator can analyse the response to the experience sampling questions	Yes	Pending

Table 4: tripzoom Services that are Supported and Evaluated. R1-R7 refer to the system release. IMP,CD refers to the Incentive Market Place service and City Dashboard to allow city moderators to manage mobility information on a city wide scale. Pending

means that this service has not yet been evaluated, but is expected to be evaluated later during the LL operation.

Nearly all of the user-level services are supported (Table 4). Not all of them have been evaluated to date but this is ongoing and will be expanded as soon as the main LL operation starts. The services not supported are:

- CMMS4: The city moderator can see actual road conditions
- TMS4: Travellers can see actual road conditions

They are not supported for the reasons given earlier (Section 2.3) related due to the lack of support for the real-traffic data feed use-cases, e.g., US8-11. The overall analysis that applies to these use-cases in Section 2.3 also applies to the equivalent services in this section.

3.2 Formative Evaluation of the S-O Design and User Requirements

[D5.2] has reported the system status and the user evaluation of the tripzoom releases from 1 to 4 but not reported any later systems releases 5-7. It has also not analysed how the system has been realised in relation to the user requirements and services.

The system development was planned to,

- be iterative,
- include a formative evaluation of user requirements and the corresponding S-O design for each iteration,
- feedback users' view of these to the developers after each release is evaluated.

The test user feedback tends to focus on the overall user experience of the tripzoom services, which can be difficult to map onto specific use-cases. Again this is a reason to analyse the user requirements not with respect to the use cases but with respect to the user-level Tripzoom service descriptions.

3.3 Generic User Requirements and Design Issues

Before we focus on the individual releases, there are some more comments about generic issues that concern UI consistency, ease of use, system availability, system accuracy and the user engagement / cold start problem. Each of these is discussed in turn below.

UI Consistency: there were two dimensions to construct a consistent user experience across the two main types of smart phones in use in the EU: Google Android based or Apple iPhone based and across mobile phone based Web access versus PC/laptop Web based access.

User feedback: Already in Release 2, inconsistencies were noted between the PC Web access and Mobile phone based access. Developers also noted that there are differences in the way sensors are accessed and used to determine the location, the inbuilt support and look and feel for location-based services such as map views that can lead to inconsistencies between via Android versus iPhone UI to access tripzoom services. It was also noted that as different members of a distributed software engineering team developed different platforms with different degrees of familiarity, there were inconsistencies in the use of terminology and the look and feel they used across platforms.

Informing an improved design: it became clear that users value in-app functionality more than Web-access via a PC or Laptop. Therefore we decided to use the Web portal as a landing-page and reduce functionality in it and focus on mobile phone service access. A decision was made to withdraw a system that provided PC-based Web portal access in order to avoid inconsistencies with the mobile phone based access and to be able to focus development resources just on the mobile phone access. However, it is still very challenging and project resource hungry to develop and maintain two different mobile phone access versions to tripzoom, viz, Android and iPhone.

Ease of use: mobility information services are content rich in the sense that there are many physical environment and personal contexts that affect them and that can be customised by service providers. For the designer, this leads to different options to set and configure mobility services, e.g., for travel authorities to support the setting and monitoring of flexible incentivised travel options attuned to users and their physical, e.g., spatial-temporal, context.

User feedback: non-intuitive, low-level design features were offered by the system; terms are used in the display that is either too confusing or too technical to enable end users to remember and recognise the service interaction, e.g., travel incentive services.

Informing an improved design: a pool of well-defined templates for a service such as incentive-based travel or mobility support are produced so that the LLc can readily select and refine an incentive to their needs; and to allow trendy and innovative labelling/naming of incentives.

System Availability: tripzoom requires the mobile phone to continually sense location, and rate of change in location, i.e., via GP, and the cost to transmit this information very periodically to the server

User feedback: users remarked that the continual operation of the tripzoom depleted the phone battery each part of a day, requiring more frequent charging of the phone, i.e., it became clear that phone battery usage is an issue.

Informing an improved design: more emphasis was put on mobility sensing algorithms to more selectively sense location and hence, to update locations of the in-network location-based service less frequently.

System Accuracy: in order to profile users' mobility it is vital that the tripzoom system is able to map patterns of location changes into routes, anchor destinations such as home and work and to recognise transportation modalities such as by bike, bus or car.

User feedback: the accuracy of transportation modality meant than transport modes could be often misclassified.

Informing an improved design: use of a hybrid location sensor technique is investigated to more accurate detect and classify the transportation modality. Novel location to route plotting algorithms were developed and deployed to map time-series location to transportation mode routes.

User engagement / cold start problem: when users start to use the app, the cold start problem makes the tripzoom services less appealing to them, especially a proposed killer app feature - use of info-graphics to inform the users of their mobility pattern in relation to their tripzoom community via social networks and their progress with respect to their personal history.

User feedback: This problem needs to be tackled in order to reduce the amount of early drop-outs. Compounding the cold start problem, is the wear-off problem that is likely to occur when a user's curiosity wears off and the added value of using the app stops growing (significantly).

Informing an improved design: It is recommended that a well-designed user manual and/or a step-by-step video tour (for first time users) are provided. To mitigate this problem, challenges and a fully functional tripzoom social network can be utilised to keep the user motivated.

3.4 Analysis of the Releases with respect to User Requirements and S-O Design

The main foci of the system releases with respect to the user requirements and services are as follows:

Release R1: focussed on users' access to the tripzoom system. Five sub-services are developed to support the Service TSS1. The main system components involved are mainly the Personal Mobility Store (PMS) and the Mobile sensing. Feedback from users is desirable. However, it is pointed out by some users that the login page on mobile device should be more consistent between the app main view and the login page view.

Release R2: focussed on user-oriented, (privacy) access control to services, and to richer core travel information services such as user

control to zoom in to inspect their trip details, to zoom out to get overviews of their trips, detection and provision of transportation modality related information such as which travel was by bus, car or bicycle, and the provision of mobility patterns, i.e., derivation of home and work locations. Four services are supported TMS1-3 and TMS5. Most services behind all these tasks worked but modality detection service seemed to be inaccurate due to the performance of implemented algorithm. Some usability issues were uncovered: some users lacked the know-how to interact with these services as a more informative user manual was needed. It was also noted that inconsistent terminology use such as friend vs. buddy was used. Information on the portal and mobile app is not synchronized which confuses users. As a result the UI was improved, the use of the web portal b travellers was dropped and the user manual was improved.

Release R3: added the first support for the use of the core incentive service (TMS15). Incentives could be set and received but not accepted by the user or translated into rewards. This also added the first support for experience sampling service, RMS2. The usability issues disclosed in this release include user help documentation is not complete and UI is not usable enough. However, it was found that the poor battery consumption in earlier releases has been significantly improved.

Release R4: focussed on Travellers be able to zoom out and can get overviews of their trips (TMS2), receive notifications of incentives or events (TMS13) and connect to social network services (TMS18). This release fixed previous release's issues and improved the localisation, web portal and incentive marketplace. However, it is not satisfactory concerning the mobility overview, external social networks and experience sampling. Despite component internal bugs, another main reason for those functional failures is a complex integration between SUNSET system and the use of external system service APIs.

Release R5: focussed on supporting: travellers being able to receive an incentive when they are at a specific place or area at a specific time period (TMS15); travellers being able to change their privacy preferences and profile (TMS1); travellers getting overviews of their trips (TMS2). The experience sampling services failed to function due to communication bugs and usability issues. These were both addressed in the next release.

Release R6: focussed on supporting city moderators to be able to: issue experience sampling questions to travellers (CMMS10), sample traveller responses to evaluate experiences (CMMS11); issue notifications; to get overviews of mobility profiles and to see the impact of mobility profiles. Travellers can publish and share some of their personal mobility facts on social media to their friends and compare their mobility patterns with the patterns of friends (US2). To further improve the whole system, users

had suggested integrating incentive and experience sampling with the filtering of target user groups and incentive categories.

Release R7: focussed on improving the services offered in R1 to R6 and on supporting user management in each living lab are used in the extended user profiles. In each living lab, users are more managed through groups. Living lab controllers can create groups such as car users, cycle users, etc., and then filter and manage these users accordingly. Through grouping, users can receive more detailed incentives and experience sampling questions. To support better grouping, user profiles are extended to have “household”, ”Carowner”, “Bikeowner”, “public Transportation” and ”SignUpTime” entries.

3.5 Living Labs as a Mechanism to Collect Real-life User Feedback

During the seven releases of tripzoom (to date,) the integrated system has been developed step-by-step. During the first six releases, only project team members (both developers and members that were not part of the development team) took part in the user-evaluation and testing process. Improvement areas included battery consumption, inaccurate transportation mode recognition and incentive management. These acted as user experience barriers to introduce the system to the general public. In release seven, a first step was made to introduce the systems to several users outside the project consortium members.

The introduction of external users helps to mature the system to be used in a more comprehensive evaluation. Workpackage 6 defines the evaluation methodology and framework, defined in [D6.1] and [D6.2], which will be implemented in the three LL cities, in Enschede, Leeds and Gothenburg.

Enschede acts as the main LL, whereas Leeds and Gothenburg act as reference sites. In terms of users, this means that Enschede aim’s for the full implementation LL evaluation according to the evaluation methodology described in [D6.2]. In contrast, Leeds and Gothenburg will cover only specific parts of the evaluation in order to cross check the results of Enschede or focus on specific topics as addition to the general work in Enschede. In the end, the LL will be operated in a way to best answer the research questions as they have been defined in the DoW. For the reference sites, this will typically mean that the amount of users in the reference LL's is smaller and the operational work will be less intensive.

During these Living Lab tests, user feedback on the tripzoom service will be collected, as well as on the impact the service has on individuals and on system mobility. These results will feed into the (upcoming) LL Evaluation document [D7.4].

4 Conclusions

A smart social mobility information system called tripzoom has been researched and developed. It is operational and offers rich support for the user requirements as specified in [D1.1]. During the development stage, pragmatically, a system focus on a service-oriented view rather than on a user-requirement view is desirable. In order to develop a usable system, an incremental development methodology that incorporates multiple stages of early user feedback to inform the later stages of development leading to more usable and advanced features to improve the system, should be adopted. Pragmatic concerns that relate to non-functional system requirements such as: UI consistency, ease of use, system availability, and system accuracy and the User engagement / cold start problem should be addressed - else these can significantly hinder the uptake and continued use of the system by users.

5 References

1. [D1.1, 2012] SUNSET Project Public Deliverable D1.1 Revised Scenarios and User and System Requirements. Available from http://www.sunset-project.eu/, Spring 2012.
2. [D2.1, 2013] SUNSET Project Public Deliverable D2.1 Mobility sensing and experience sampling services. Available from http://www.sunset-project.eu/, Spring 2012.
3. [D2.2, 2013] SUNSET Project Public Deliverable D2.2 Mobility pattern detection and visualisation service. Available from http://www.sunset-project.eu/, Spring 2013.
4. [D2.3, 2013] SUNSET Project Public Deliverable D2.3 Relation and privacy management service. Available from http://www.sunset-project.eu/, Spring 2013.
5. [D2.4, 2013] SUNSET Project Public Deliverable D2.4 Evaluation support and incentive services. Available from http://www.sunset-project.eu/, Spring 2013.
6. [D3.4, 2013] SUNSET Project Public Deliverable D 3.4 Feasible and potentially successful incentives. Available from http://www.sunset-project.eu/, Spring 2013.
7. [D4.5, 2013] SUNSET Project Public Deliverable D4.5 Final Mobile Application Design. Available from http://www.sunset-project.eu/, Spring 2013.
8. [D5.1, 2013] SUNSET Project Public Deliverable D5.1 Framework architecture & design. Available from http://www.sunset-project.eu/, Spring 2012.
9. [D5.2, 2013] SUNSET Project Public Deliverable D5.2 System integration. Available from http://www.sunset-project.eu/, Spring 2013.
10. [D6.1, 2013] SUNSET Project Public Deliverable D6.1 Evaluation approach for operational success and effectiveness of incentives Final Mobile Application Design. Available from http://www.sunset-project.eu/, Spring 2013.
11. [D6.2, 2013] SUNSET Project Public Deliverable D6.2 Evaluation methodology and measurement approach. Available from http://www.sunset-project.eu/, Spring 2013.

12. [D7.1, 2012] SUNSET Project Public Deliverable D7.1 Living lab plan. Available from http://www.sunset-project.eu/, Spring 2012.
13. [D7.4, 2014] SUNSET Project Public Deliverable D7.4 Reference Living lab report. Available from http://www.sunset-project.eu/, Spring 2014.