Project title:

Development of sensor-based Citizens' Observatory Community for improving quality of life in cities

Acronym: **CITI-SENSE** Grant Agreement No: **308524**

EU FP7- ENV-2012

Collaborative project

Deliverable D 6.2

Interim report on the methodology to link elements

Work Package 6

Date: 27.11.2013

Version: 2.0

Leading Beneficiary:	NILU - Norwegian Institute for Air Research
Editor(s):	Fredriksen, M., Kobernus, M. (NILU)
Author(s) (alphabetically):	Bartonova, A., Fredriksen, M., Kobernus, M., Lahoz, W.(NILU), Tamilin, T. (U-Hopper)
Dissemination level:	PU

Versioning and contribution history

Version	Date issued	Description	Contributors
0.1	24.07.2013	Initial draft	W. Lahoz
0.2		Comments/changes to version 0.1	W. Lahoz, M. Fredriksen
0.3	06.09.2013	General descriptions of testing methodologies and User friendliness design methods.	M. Kobernus
0.4	21.09.2013	Updated content various sections	M. Fredriksen
0.5	28.09.2013	Reviewed and revised content.	M. Kobernus, M. Fredriksen
0.6	05.10.2013	Reviewed and revised content	W. Lahoz
0.7	17.10.2013	Further revisions	M. Kobernus
1.0	18.10.2013	Final tidy up	W. Lahoz
2.0	27.11.2013	Address reviewer comments	M. Fredriksen, W. Lahoz
2.1	10.12.2013	Inserted comments and content	A. Tamilin
2.2	11.12.2013	Address comments from internal review	M. Kobernus
2.3	16.11.2013	Modified exec summary	A. Bartonova

Peer review summary

Internal review 1			
Reviewer	Jasmin Pielorz (UBIMET)		
Received for review	18.10.2013	Date of review	01.11.2013

Internal review 2			
Reviewer	Itziar Aspuru (Tecnalia)		
Received for review	05.11.2013	Date of review	17.11.2013

Executive Summary

This interim report provides an initial description of the methodology to link the "products" and "users" elements of the chain "sensors-platform-products-users". The final aim is to develop supporting applications/products/services that will help realize the goal of empowering citizens and citizen groups. This deliverable concentrates on the common denominator or the requested products.

The methodology builds on the concept of "apps" (application software). The need for a strong visualization element is a key factor influencing the design of apps. The overall progress of our work in WP6 so far is detailed with supporting diagrams, descriptions and status for each particular focus area. The main efforts to date relate to the development of specifications, initial mock-ups and the development of the foundations needed to build the various applications requested for use in the project case studies.

These products comprise various aspects, from data gathering systems, data storage, reporting, querying and also visualization and information dissemination. However, they also include end user products such as mobile phone applications which can be used by citizens to contribute their own personal observations as well as providing sensor data directly (for example, the phone can provide data via built in sensors). A wide collaboration across work packages 2-7, each with their specific expertise and requirements.

Developing project products and services includes the following steps:

- The design of the applications (apps) will be reviewed by the location officers for the various EIs to ensure that the requirements and wishes for functionality have been understood and have been implemented accordingly. This process will follow the concept of an Agile Development process, using processes such as Scrum or XP, which focus on quick iterations and client feedback to allow for the inevitability of changing requirements. We aim to start with some key use case stories. These stories will be detailed in use case descriptions and diagrams using UML (Unified Modeling Language). When performing this work we will employ an iterative and incremental process, preparing for the Test Driven Development (see section 4.5)
- The prioritizing of use cases to be implemented needs to be driven by the location officers in collaboration with WP6, WP7 (for the common visualizations) and WP5 (for the end user's viewpoint). In addition, the same process must be applied for WPs 2-3. To achieve this, WP6 will start with visualizing sensor data collected in CITI-SENSE that is common amongst all the Empowerment Initiatives (EIs). These include:

  - Real time data from station sensors;
  - Real time data from personal sensors;
  - Fixed historical data from station sensors (last 24h/72h);
  - Fixed historical data from personal sensors (last 24h/72h).

- Implementation of a method in the smartphone applications to enable the inclusion of personal perceptions from end users through questionnaires, VGI (Volunteered Geographic Information).

Table of contents

1 Introduction

The main objective of CITI-SENSE is ***to develop "Citizens' Observatories" to empower citizens and citizens' groups***: (i) to contribute to and participate in environmental governance; (ii) to support and influence community and policy priorities and the associated decision making; and (iii) to contribute to European and global monitoring initiatives. By Citizens' Observatories we mean communities of diverse users that will share technological solutions, information products and services, and community participatory governance methods using appropriate communication solutions (e.g., social media), and who will by these activities complement established environmental data and information systems and improve local decision making about environmental issues. The main objective will be accomplished by developing and testing an environmental monitoring and information system based on innovative and novel Earth Observation capabilities and applications (e.g., data assimilation ideas; Lahoz et al., 2010) focused on the citizen's immediate environment.

The primary objective of CITI-SENSE work package 6 (WP6) is to provide environmental data products on air pollution, meteorological conditions and noise to the various stakeholders, namely a) citizens, b) citizen's groups, c) policy makers, and d) the Global Monitoring for Environment and Security Initiative (GMES). This will make use of the concept of Citizens' Observatories. These products comprise various aspects, from data gathering systems, data storage, reporting, querying and also display. However, they also include end user products such as mobile phone applications which can be used by citizens to contribute personal observations as well as providing sensor data directly (for example, the phone can provide data)

A key element of the Citizens' Observatories concept is the chain linking the sensors and users making observations and the users of the information from these observations, the "sensors-platform-products-users" chain. This interim report provides an initial description of the methodology to link the "products" and "users" elements of this chain. This methodology builds on the concept of "apps", short for "application software". This goes beyond simply phone apps, as the term, as we use it, can comprise, mobile applications, web applications, social networking applications, and so on. The need for a strong visualization element is a key factor influencing the design of the apps. Other aspects contributing to the design of the apps are described; these include: (i) the personal value of the service (provision of data products for users) – What is the offer and value of the service? And (ii) how easy is it to use the service, including clear instruction to users on how to use the products and participate in the service.

Building on the tasks for deliverable D6.1 (Preparation for data assimilation and data fusion activities; available from http://citi-sense.nilu.no), and having identified the metadata for a number of sources of environmental data, the next step in WP6 is to set up a methodology linking products and users. As discussed above, this methodology is based on the concept of apps. This document is an interim report discussing this methodology.

The development of the apps will address the following three key elements of the EU call:

1) Enhancement of observing capabilities – ***by providing timely in situ quantitative information from mobile phone platforms to stakeholders***; and by testing and developing data fusion/data assimilation concepts to add value to this information;

2) Development of effective and efficient communication solutions for ***transfer of environmental data products from mobile phone devices to stakeholders***, including development of middleware and establishment of sustainable services – by using empowerment initiatives to test, implement and demonstrate communication solutions for transfer of environmental data products;
3) Empowerment of stakeholders – by providing a tested methodology to ***enable stakeholders to access environmental data products and interact with providers of these products***.

It is an aim of CITI-SENSE that stakeholders identified in items 1)-3) above receive information (e.g., on the environment) via a mobile or web based platform. Even so, web applications for more descriptions and information about both sensor data and case studies are needed.

Section 2 describes the Empowerment Initiatives: similarities among the requirements (Section 2.1); similarities among the suggested solutions (Section 2.2). Section 3 describes the criteria for design of the apps: visualization (Section 3.1); personal value of the service (Section 3.2); and user friendliness of the service (Section 3.3). Section 4 describes the design of the apps: overview (Section 4.1); preparation (Section 4.2); and testing methodologies (Section 4.3). Section 5 describes further work, which will be discussed more fully in deliverable D6.4 (Final report on methodology), due in month 45. Section 6 provides a summary of the collaboration with other WPs taking place to develop the aims of WP6.

2 Empowerment Initiatives

The Empowerment Initiatives (EIs) in CITI-SENSE, the locations involved, and the methods used to realize the EIs are detailed in Fig. 1. The tasks involved in these activities are described in deliverables D2.1 and D3.1. Deliverable D2.1 provides details of the protocols for the pilot case studies regarding environmental and health information for indoor and outdoor urban spaces at eight different locations (Barcelona, Belgrade, Edinburgh, Haifa, Ljubljana, Oslo, Ostrava and Vienna). The Vitoria EI concerns comfort in public spaces and details of its protocol for the pilot case study are dealt with in WP3 and deliverable D3.1. The links between the work in the EIs and that in other WPs, including WP6, are outlined in deliverables D2.1 and D3.1. These links are also summarized at the end of this document (Section 6).

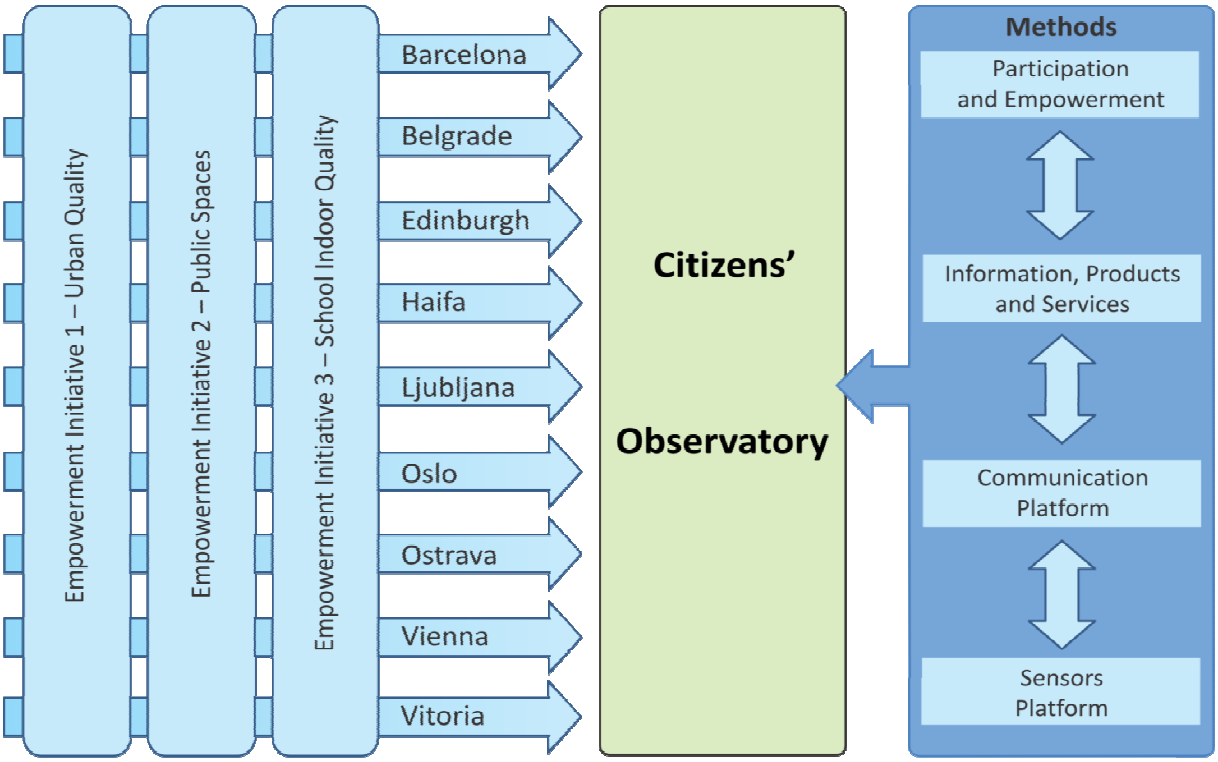

Figure 1. CITI-SENSE Implementation

2.1 Similarities among the requirements

The respective Pilot Case Study Protocols outlined in deliverables D2.1 and D3.1, provide a basis for the specification of the development of end user products. The protocols indicated that there are many similarities among the requirements. The main common requirement is the presentation of sensor data to the end user. This involves:

- Near real time values
- Historical values (last 24h/72h)
- Creation of different reports on the sensor data
- Getting information on user perception with questionnaires

All three of the Empowerment Initiatives highlight a need for web portals to present information about the case studies, provide measured values to the users, give a possibility to express subjective perception of experienced environmental condition through questionnaires, and administer sensor data and reporting mechanisms.

Two of the Empower Initiatives, Urban Quality and Public Spaces, want a smart phone application to present sensor data and incorporate user input.

2.2 Similarities among the suggested solutions

Since the visualization of sensor data will be presented both on a web portal and on a smart phone, the aim is to make use of techniques for developing plugins and widgets using technology that can be implemented on both the web and on a phone. The work done in Task 7.5 (Visualization widgets), supports this and suggest a number of technologies to achieve this aim.

To meet the requirements of providing report functions we see possible use of the Snowflake platform based on information in deliverable D7.1 (CITI-SENSE Architecture). This architecture opens up the possibility to query data across sensor platforms and to provide the data in a format that can be used in different reporting platforms, e.g., MS Excel.

To implement the need for capturing user perception we intend to integrate the CivicFlow product (http://www.civicflow.com) developed by U-Hopper with the pilot web portals and the phone application. The CivicFlow allows to create questionnaires and make them accessible through the different channels, such as a web widget embedded into 3rd party web page or as a mobile web app that can be visualized on the smartphones or embedded into 3rd party mobile apps. On top of the CivicFlow the CITI-SENSE will develop a number of widgets for simple use and embedding of perception acquisition questionnaires and visualization of simple statistics over collected data.

Web portals will be created using a content management system, CMS, to make it possible for each location to administer the web portals and add content.

3 Criteria for app design

The main criteria for the app design are a strong visualization element (see, e.g., discussion of ”infographics” by Spiegelhalter et al., 2011); and that the service (e.g., providing environmental information) has value to the citizen, and is user friendly. Specifically, User Experience is a crucial element of the CITI-SENSE applications having citizens as end-users. The success of the application depends on the citizens' acceptance of the app and the recognition of its value for their daily life and the community. Hence it is important to provide the intuitive interfaces for contributing data to the CITI-SENSE and easily accessible, through various visual means, information about the experienced environment conditions.

The applications will be designed to address the requirements of the Empowerment Initiatives (EIs) in the CITI-SENSE project, namely the provision of environmental information for schools (indoor air quality), and for selected cities across Europe (outdoor air quality; noise levels, etc). These cities span a variety of environmental and cultural conditions across Europe and as a consequence, special consideration needs to be made to ensure that our products meet the requirements, and also conform to varying cultural differences. The apps developed will be designed to take account of the requirements of the EIs, which are detailed in deliverables D2.1 and D3.1.

Feedback from the tests carried out in task 6.3 (Test the methodology linking the “products” and “users” elements of the chain) of WP6 will be used to update the apps developed in task 6.2 (Design and set up the methodology to link the “products” and “users” elements of the chain). Such feedback will address issues such as the value of the service; ease of use of the service; ease of participation in the service; and the response to user requests.

3.1 Visualization

It is increasingly recognized that visualization is key to imparting information to citizens. Examples are included in the Brussels Green week presentation by W.A. Lahoz, available from http://greenweek2013.eu. Visualization is a key element of the application design which, depending on the apps purpose, could include maps of pollutant concentrations, meteorological parameters (e.g., humidity, temperature, UV radiation) and environmental conditions (e.g., noise levels) in near-real-time. The maps provided by the app will be designed to cover a range of spatial scales (e.g., spot level; street level; neighbourhood level; city level) and temporal scales (e.g., current time; hours; days; weeks, as well as climatologies ranging from months to years).

A key to the visualization is ensuring that the complex data is presented in a simple and intuitive manner and is easily understood by the end user. This will be discussed in more detail, below.

Another important issue to be considered is the accessibility of the CITI-SENSE visualizations through the smartphones, since more and more people are getting the access to the internet through the mobile devices.

3.2 Value of service

It is important that when a service is offered to users, e.g., data products such as maps of temperature or particulate matter (PM) these users feel they are getting personal value. For

example, it is desirable that users feel they can make decisions to their benefit, based on the information provided by the service. This requires that the information provided to the user is user-friendly. Furthermore, there should be an indication of how much these data products can be trusted by the user; in other words, whenever possible, there should be information on the uncertainty associated with these data products. This makes particularly important to give to citizens means for expressing their voice, possibly in form of questionnaires or surveys, to express their evaluations of the received information and express in general subjective perceptions of the experienced conditions in comparison to the information provided by sensors. The apps to be designed in WP6 will strive to achieve these goals.

3.3 User friendliness

Very often applications are designed to showcase specific functionality or to achieve abstract goals, often at the detriment of the user's experience when trying to use a product or application. Within CITI-SENSE, we will set out to ensure that the user experience is positive, that our products are both simple and intuitive, and that we utilize industry standards and meet the user's expectations from our applications and products. "User Centered Design" (UCD) is a well-known method for designing a tool, such as a web portal or application interface, from the perspective of how it is used and understood by a human user. This is the approach that will be taken when designing all the various interfaces developed in the project. This approach relies heavily on the concept of "Human Interface Design" (HID). Applying this concept has resulted in designs, which through our internal review process, have been modified and, thus, upgraded. By being assessed by various stakeholders and user groups, and then modified based on the feedback received, the CITI-SENSE applications should quickly develop into relatively mature designs.

Figure 2. Example of the design process and the planned end result

4 App design

4.1 Overview

Within the CITI-SENSE project, there are a number of related applications that serve several of the case studies. The case studies are divided into three different Empowerment Initiatives: (i) Urban Quality; (ii) Public Spaces; and (iii) School Indoor Quality. The relationship between the different case studies can be a simple matter of sharing the same underlying code structure, same visualization widgets, or sharing the same application. In the case of the portals for the School Indoor Quality, these are set up on individual portals, but are cloned from a single portal. This will be discussed in more depth below.

4.2 App preparation

There are multiple development threads concurrently running within the project. This means that at any stage, new specifications, designs or code can be implemented. However, currently, there are three main development efforts within WP6. These correspond to the three different Empowerment Initiatives: (i) Urban Quality – Web Portals and Phone Application; (ii) Public Spaces - Web Portals and Phone Application; and (iii) School Indoor Quality – Web Portals.

Before any development can begin, it is necessary to carefully review the specifications. The specifications were made by the three Empowerment Initiatives creating protocols; details of these activities and links between them and WP6 can be found in deliverables D2.1 and D3.1 (see also Section 2 of deliverable D6.2). This leads to the development of Tasks (which are provided below in the section Specification of work, Tasks), description of responsibilities within the task, and the priority of the task. This information is vital to adequately plan the development of any products, software, etc., and is used by the development team, and work package leaders and project managers to ensure compliance with budget and timelines.

4.3 Specification of work, Tasks

The tables with the task descriptions below show the first draft of the tasks, and set up during this first phase of WP6. More details will be provided in deliverable D6.4 (Final report on methodology).

4.3.1 Naming conventions

Each test case is to be named in accordance with the following scheme:
TDCS-<_EmpowermentInitiative>-<Task description no>-V<version no.>

Empowerment Initiatives are named as follows
Urban Quality = UQ
Public Spaces = PS
School Indoor Quality = SI

Task description number
4 digits for each task description.

Version number
Two digits with a V prefix and ending with a dot.

An example of a test case following this naming convention would be:
TDCS-UQ-0001-V1.

4.3.2 Web application for Urban Quality

Task Name:	**Create web portals**
Task ID:	TDCS-UQ-0001-V1
Description:	Create web portal, for the Empowerment Initiative Urban Quality. Clone and create individual web portals for each location
Work to be done:	A lot of the work regarding structure, suggestion of model structures, and suggestions of templates and skins, will be covered in one process for all 3 case studies. 1. Suggest and provide support for templates, skins 2. Create main page for Urban Quality 3. Create individual web portals for each location (Barcelona, Belgrade, Edinburgh, Haifa, Ljubljana, Oslo, Ostrava, Vienna) 4. Access to each location from all location pages (dropdownlist/tabs/buttons) 5. Multilingual pages (local language/English)
Responsible:	WP6 WP2 WP4
Request from other WPs:	WP2: Content of text must be provided by each location
Priority:	MANDATORY

Task Name:	**Display available maps and graphs from WP7**
Task ID:	TDCS-UQ-0002-V1

Description:	Add visualization widget presenting maps and graphs
Work to be done:	Add modules to web pages to display maps and graphs delivered by WP7.
Responsible:	WP6 WP7
Request from other WPs:	WP7: available maps and graphs
Priority:	MANDATORY

Task Name:	**Display picture on map**
Task ID:	TDCS-UQ-0003-V1
Description:	Display map with pictures uploaded taken by a user's smart phone. The user can then click the map and look at the picture.
Work to be done:	Add visualization widget to show pictures taken both on web portal and on smart phone
Responsible:	WP7
Request from other WPs:	WP7: A map of a city that displays the location of where there has been uploaded a picture This map should be interactive, and allow the user to select an icon representing an image. The 'click' will return the image to be displayed to the user.
Priority:	

Task Name:	**Downloadable archive**
Task ID:	TDCS-UQ-0004-V1.
Description:	Downloadable archive of data including participant/station number/coordinates, pollution levels and meteorological data, and physical activity data It is possible to reuse the custom module suggested in task TDCS-SI-0024-V1., Specification of work, WP3b School Indoor Quality pilot

Work to be done:	Create function for querying data with different search parameters. The data response must be on a format that can be uploaded into an Excel sheet.
Responsible:	WP6 for display, search module WP7 for providing the data
Request from other WPs:	WP7: Query the data based on the parameters defined by WP2 WP2: Define the search/filter parameters
Priority:	

Task Name:	**Summary sheet of pollution levels for selected time periods**
Task ID:	TDCS-UQ-0005-V1
Description:	Summary sheet of pollution levels for selected time periods (monthly/quarterly/biannual/annual), Including highlighting of any breaches (pollutant, magnitude, location, frequency) above pollution guidelines. Reuse custom module TDCS-UQ-0004-V1.
Work to be done:	Create function for querying data with different search parameters. The data response must be visualized.
Responsible:	WP6 for display, search module WP7 for providing the data
Request from other WPs:	WP7: query the data WP2: How do you want to display the data?
Priority:	

4.3.3 Phone application for Urban Quality

Task Name:	**Basic structure**
Task ID:	TDCS-UQ-0006-V1
Description:	Create the basic structure
Work to be done:	My sensors My city Citi-Sense cities Air pollution, UV and weather forecast
Responsible:	WP6
Request from other WPs:	
Priority:	MANDATORY

Task Name:	**Display current measured values, text based**
Task ID:	TDCS-UQ-0007-V1
Description:	The first screen will show the current measured values from the sensors connected and handled by the phone. This will only be displayed as text and used to indicate that everything is working properly and that we get sensible values from the sensors.
Work to be done:	Find which sensors are connected to the smartphone. Display current measured values.
Responsible:	WP6
Request from other WPs:	WP7: Find which sensors are connected to the smartphone. Can the last measured values be stored in text file locally on the phone?
Priority:	

Task Name:	**Create settings**
Task ID:	TDCS-UQ-0008-V1
Description:	We need settings on the phone application so the user can relate his/her app to the sensors connected to the same smartphone. Need to set “My city” in case the user does not want to use the GPS function. The user can then still view maps for his/her city.
Work to be done:	Create settings page Create input for - Package id - My city When to be alerted. Add limit value for a parameter.
Responsible:	WP6
Request from other WPs:	
Priority:	

4.3.4 Web application for Public Spaces

Task Name:	**Create web portal**
Task ID:	TDCS-PS-0001-V1
Description:	Create web portal, for the case study, Public Spaces
Work to be done:	A lot of the work regarding structure, suggestion of model structures, and suggestions for templates and skins, will be covered in one process. 1. Suggest and provide support for templates, skins 2. Create main page for Public Spaces 3. Multilingual pages (local language/English)

Responsible:	WP6 WP3a WP4
Request from other WPs:	WP3a: Content of text must be provided by each location
Priority:	MANDATORY

Tasks of the web portal for Urban Quality will be done also for Public Spaces.

4.3.5 Phone application for Public Spaces

The requirements in the Public Spaces case will be included into the main CITI-SENSE phone application. The Task Description TDCS-UQ-0007-V1 will include the specific sensors used in this case to visualize the current measured values of UV, Acoustic comfort and Thermal comfort. Some specific development must still be done to address the requirements of this Empowerment Initiative.

Task Name:	**Sound alert function**
Task ID:	TDCS-PS-0002-V1
Description:	Develop a function that alerts the user of the smartphone when an acoustic index reaches a pre-determined value
Work to be done:	Find a technical solution for alerting the user. The sound measurements will be collected using a phone App called AudioTools. These measurements must then be sent to the CITI-SENSE server. Need to discuss with WP7 who will do the work. It will take some work to find out how to solve this function. How the data will be stored. What should the data be used for.
Responsible:	WP7 WP6
Request from other WPs:	WP3a: Content of text must be provided by each location
Priority:	MANDATORY

Task Name:	**Integration of Civic Flow questionnaires product from U-Hopper**
Task ID:	TDCS-PS-0003-V1
Description:	Integrate Civic Flow into the phone application
Work to be done:	Include Civic Flow application into the code for the phone application
Responsible:	WP7- UHOPPER WP6
Request from other WPs:	UHOPPER – Provided widget for including product into phone application
Priority:	MANDATORY

4.3.6 Web application for School Indoor Quality

General tasks

Task Name:	**Create web portal**
Task ID:	TDCS-SI-0001-V1
Description:	Create web portal
Work to be done:	1. Decide CMS system 2. Suggest and support for templates, skins 3. Create main page for CITI-SENSE school cases 4. Create individual web portals for each school (Oslo, Ljubljana, Belgrade, Edinburgh) 5. Access to each school involved in the experiment from all school pages (dropdownlist/tabs/buttons) 6. Multilingual pages (local language/English).
Responsible:	WP6 WP3
Request from other WPs:	WP3b: Suggest considering skins that could be used for free or bought at low cost. Will assist WP6 in this.
Priority:	MANDATORY

Task Name:	**Training CMS**
Task ID:	TDCS-SI-0002-V1
Description:	Session for training the location officers on how to edit/add/remove content
Work to be done:	Consider organizing a session using GoToMeeting. There will be continuous support during the project
Responsible:	WP6 WP3
Request from other WPs:	WP3b: Suggest considering skins that could be used for free or bought at low cost. Will assist WP6 in this.
Priority:	MANDATORY

Public pages

Task Name:	**Create map with location of schools**
Task ID:	TDCS-SI-0003-V1
Description:	Static picture with clickable point for each school Provide information about the school when the mouse is dragged over the picture of the school
Work to be done:	Insert a google map on web portal with clickable markers for each school describing the school and the link to the individual web page
Responsible:	WP6 for the picture and implementation WP3b for text
Request from other WPs:	WP3b, for each location: Provide information
Priority:	

Task Name:	**Facts page on CITI-SENSE Project**
Task ID:	TDCS-SI-0004-V1
Description:	Create fact page for the main page of CITI-SENSE schools
Work to be done:	Create page
Responsible:	WP3b
Request from other WPs:	WP3b: Provide/add text
Priority:	

Individual web pages for each school

Task Name:	**Search function**
Task ID:	TDCS-SI-0005-V1
Description:	The default CMS system search function will be added in each portal
Work to be done:	Add the search function
Responsible:	WP6
Request from other WPs:	
Priority:	

Task Name:	**Add picture of school**
Task ID:	TDCS-SI-0006-V1
Description:	Each school will have their own picture on the web portal
Work to be done:	Create pane for school picture

Responsible:	WP3b WP6
Request from other WPs:	WP3b: provide picture of school
Priority:	

Task Name:	**Create the school page**
Task ID:	TDCS-SI-0007-V1
Description:	Add page for description of the school
Work to be done:	Each location adds text to the page description of the location. This is done by WP3b.
Responsible:	WP6 WP3
Request from other WPs:	WP3b: Add content
Priority:	

Task Name:	**Display online data from sensors**
Task ID:	TDCS-SI-0008-V1
Description:	Display online data as graphs, statistics.
Work to be done:	Find out what can be provided by WP7. WP3b wants to be able to visualize each parameter of their real time data. Inform WP3b when we know what graphics can be provided by WP7 to see if this is acceptable. How can the plugins/widgets be added into to the portals? Possibly create a simple customized module to add query, so these modules easily can be switched to not

	show on public pages. These modules can easily be reused for web pages on the Urban Quality and Public Spaces web pages.
Responsible:	WP6 for adding on web WP7 for the visualization widgets/plugins
Request from other WPs:	WP7: What kind of visualization of real time data could you provide for these parameters: Temperature Relative humidity CO_2 NO_2 Dust Noise VOCs (Volatile Organic Compounds) Radon How do we "query" the widgets? What do you need to know? School? Sensor id? Location id?
Priority:	

Task Name:	**Facts page on each school portal**
Task ID:	TDCS-SI-0009-V1
Description:	Create facts page for each school
Work to be done:	Add page on web portal
Responsible:	WP3b location officers

Request from other WPs:	WP3b: Add content.
Priority:	

Task Name:	**Legislation page on each school portal**
Task ID:	TDCS-SI-0010-V1
Description:	Page with overview of relevant legislation , WHO Guidelines etc.
Work to be done:	Create page on web portal
Responsible:	WP3b location officers
Request from other WPs:	WP3b: Add content.
Priority:	

Task Name:	**General functionality**
Task ID:	TDCS-SI-0011-V1
Description:	Log in functionality to access administrative pages Multilanguage Offer administrative tools - Give user access - Edit content
Work to be done:	This is provided by the CMS system
Responsible:	WP6 for training WP3 for administration
Request from other WPs:	
Priority:	

Participant Pages

Task Name:	**View online data with high/normal/low indicators**
Task ID:	TDCS-SI-0012-V1
Description:	Create web portal
Work to be done:	
Responsible:	WP7
Request from other WPs:	WP3: Is it enough to use the same graphs as provided by dnet/airbase? They show colour indicators that display high/normal and low values of data. Is this the same visualization as in TDCS-SI-0008-V1? WP7: Could each school set their own high/normal/low limits?
Priority:	

Task Name:	**Function for not showing online data**
Task ID:	TDCS-SI-0013-V1
Description:	Each school would like to decide if the online data would be shown on the public pages.
Work to be done:	Figure out how this could be done. It should be possible to hide a sensor's real-time graphical representation by configuring the module to be invisible
Responsible:	Manually by WP3b
Request from other WPs:	WP3: Do you mean to hide one graphical object?
Priority:	

Task Name:	**Flagging sensor data**
Task ID:	TDCS-SI-0014-V1

Description:	- The data should have a flag indicating its quality, e.g.: 0: normal operation 1: test data 2: invalid data - It should be possible for the users to change the flag of the data.
Work to be done:	Discuss with sensor platform providers to find out if they have this option available in their system. This discussion needs to be done with WP8, WP6 and WP7. There might also be possibilities to do this in the CITI-SENSE platform architecture provided by WP7.
Responsible:	WP7/WP8
Request from other WPs:	WP7/WP8: Could each school set a flag on sensor/data? How can we display this flag? Could it be part of the graph as a text under?
Priority:	

Task Name:	**Plots**
Task ID:	TDCS-SI-0015-V1
Description:	Visualize the measured values during a time period (24h/72h).
Work to be done:	Add visualization widget for each sensor and parameter for the last 24h and 72h measured values
Responsible:	WP7
Request from other WPs:	WP7: Need plot plugin/widget of the last 24h and last 72h for each parameter on each sensor.
Priority:	

Task Name:	**Define operating hours for each school**
Task ID:	TDCS-SI-0016-V1
Description:	Need to define operating hours and days

Work to be done:	Decide where this is done. Either by WP7 or WP6. It is possible to have that setting stored in a custom module created by WP6. We define a settings module so the schools can register their operation time and do the query to the WP7 platform including the operation time.
Responsible:	NOT DECIDED
Request from other WPs:	WP7: Should the operation hours for each school be set on the customized module provided by WP6?
Priority:	

Task Name:	**View historical data**
Task ID:	TDCS-SI-0017-V1
Description:	Generate plots based on these parameters: Temperature Relative humidity CO_2 NO_2 Dust Noise VOCs Radon Time period
Work to be done:	Create customized module that shows the different parameters and fields for the chosen time period. Click generates requests to the CITI-SENSE platform (WP7) to return the plots requested. Display the plots.
Responsible:	WP6 for customized module WP7 for providing plots based on the chosen criteria
Request from other WPs:	WP7: - Plots of different parameters listed in description - Is it possible to give us a list of sensors/parameters that are registered in a school? WP3b: Is the time period days? Days and time?
Priority:	

Task Name:	**Define two limiting concentration levels for each parameter**
Task ID:	TDCS-SI-0018-V1
Description:	Set two limit concentration levels for each parameter 1. Recommended level 2. Extreme level
Work to be done:	This is a requirement that need further specifications and discussions with the different work packages in this project. And might not be included into the first version of the web portals,
Responsible:	NOT DECIDED
Request from other WPs:	WP7: Should these limit levels be set by WP6's customized module or is this a configuration from the sensor side?
Priority:	

Task Name:	**Computing averages**
Task ID:	TDCS-SI-0019-V1
Description:	Show average number of hours above recommended value for a specific parameter. Show average number of hours above extreme value for a specific parameter.
Work to be done:	Could be part of the customized module. Add possibility to restrict the time period to avoid gaps in the measurements. Need to be able to filter flagged data Calculate average and number of hours used to compute the average based on the sensor data This is a requirement that need further specifications and discussions with the different work packages in this project. And might not be included into the first version of the web portals,
Responsible:	NOT DECIDED
Request from other WPs:	WP3b: - Do you want to display this by doing a search or is this something that you would

	like always displayed on a page? - Do you mean that you would like to restrict the time period by defining the start/end date for the measurement OR the start/end date for when NOT to search for data? WP7: Query sensor data based on limit issue mentioned in TDCS-SI-0018-V1. Do you provide visualization for this or should this be done by WP6?
Priority:	

Task Name:	**Export data to excel**
Task ID:	TDCS-SI-0020-V1
Description:	It will be possible to choose the period that you want as well as one or several classrooms/sensor packages
Work to be done:	This could be part of the customized module. The module must have a setting that stores the school id. Display locations registered at the school. User can select locations and time period.
Responsible:	
Request from other WPs:	WP7: Query: - All locations on the selected school - All sensors on the selected location - Get Excel friendly data based on location of the selected school and the time period. WP3b: I think we need to filter the data with a start and end time stamp. Would this be ok?
Priority:	

Task Name:	**Reporting tool**
Task ID:	TDCS-SI-0021-V1
Description:	WAIT

	Should be discussed with the users. Only offered if they find this useful.
Work to be done:	This could be part of the customized module.
Responsible:	WP3b for decision
Request from other WPs:	
Priority:	ON HOLD

Task Name:	**Organize campaigns**
Task ID:	TDCS-SI-0022-V1
Description:	Include CivicFlow into the web pages
Work do be done:	Include the query and java scripts provided by UHopper to include the questionnaires and the results into the web page.
Responsible:	WP6 WP7 – UHOPPER
Request from other WPs:	WP7-UHOPPER: Provide widget/plugins
Priority:	

Customized module

Task Name:	**Creating a customized module that handles the Tasks TDCS-SI-16, 17, 18 , 19, 20, 21-V1**
Task ID:	TDCS-SI-0024-V1
Description:	We need to create a customized module for the school cases. This tool will give the user the opportunity to: Choose between different search criteria for querying the sensors data. We will need to create a settings module for the module so it can be plugged in and used for all the schools involved. That means setting up the school id, sensors ids, maybe limit values for each parameter, and the schools operation in hours and

	days.
Work to be done:	Specify search criteria and possible outputs. Both in graphs and excel friendly format.
Responsible:	WP6
Request from other WPs:	
Priority:	

4.4 Design Phase

Based on the work of creating tasks derived from the different requirements found in the initial specification documents for each Empowerment Initiative (EI) this work package aims to design various mockups as suggestions for possible solutions to the empowerment initiatives. These mockups are currently under development, but some examples are included below.

Several of the EIs in the project require a project portal to display results, live data and interact with their stakeholders. To begin the process of developing the web portals, we suggest they all have the same structure, look and feel, but are language specific for the host country. This enables us to create a template driven process where a single portal can be created, and then effectively "cloned" resulting in a ready to use template which can then be modified by each EI, as required.

4.4.1 Web Portals for School Indoor Quality

The various project partners involved in the schools studies have done the initial specification and design, and in some cases have produced mockups. However, since WP6 intends to provide a solution that meets all the stakeholders' needs, without variation from one partner to another, a degree of compromise is necessary.

WP6 has so far performed a specification review and design for the schools portal and suggested basic layouts that would meet the various needs of the stakeholders.

Specification Development
Specifications for the school portals were primarily performed by WP3, and have been published in the Pilot Protocol Study (Citi-Sense-D3.1_v13.08). This document details the various requirements for the various stakeholders in terms of objectives and general functionality, but did not focus on design of the end user application, in this case, a web portal.

Mockups & Design

To ensure that the end product meets the stakeholders' needs, a design workshop was held at NILU for WP3b members. During this workshop, basic wireframe designs were created to demonstrate the desired layout of the schools portal. Some of these wireframes are shown below.

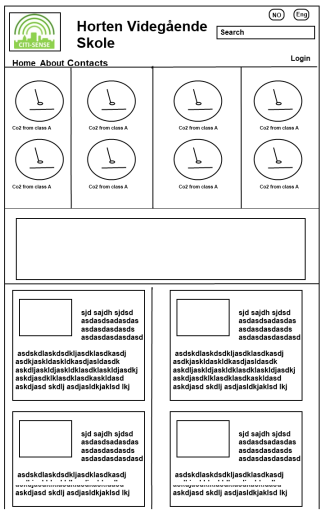

Figure 3. Main Portal Page mockup

This is the main page of the schools portal, in a wireframe design. Shown are the main components, the visualization widgets, as well as numerous textual areas, which are intended to draw the viewer in, so as to see other pages and content in the sub pages.

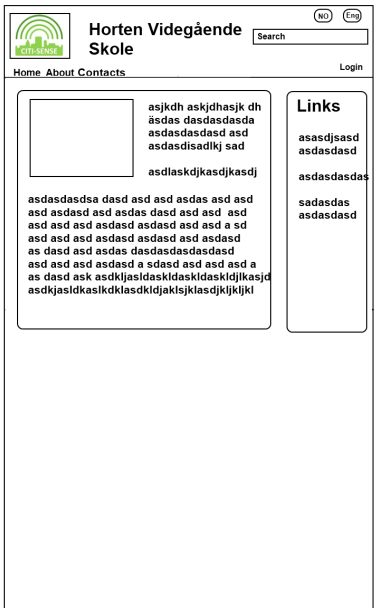

Figure 4. Sub page layouts for schools portal

The sub page design can be changed according to the need of the portal manager. Immediately above is displayed version 1, and immediately below, version 2.

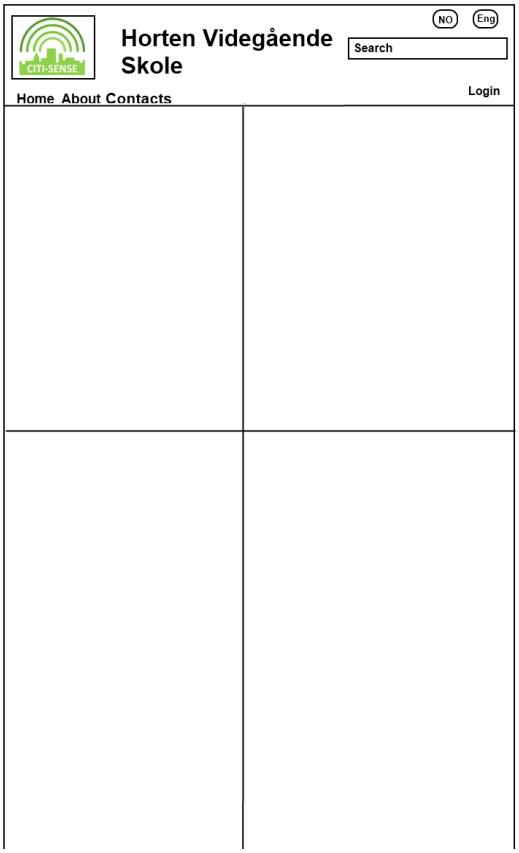

Figure 5. Alternative sub page layout structure

The above layout (version 2) differs from the previous one (version 1) in that the frames are divided equally allowing for the even distribution of content over the page. This is a 50-50 split, whereas in the previous layout there was a 65-35 split.

Once the basic layout is agreed, there is a need to demonstrate how the layout will look. More advanced designs have been created, going beyond the wireframe concept. These show a more realistic view of a portal, but are still mockups.

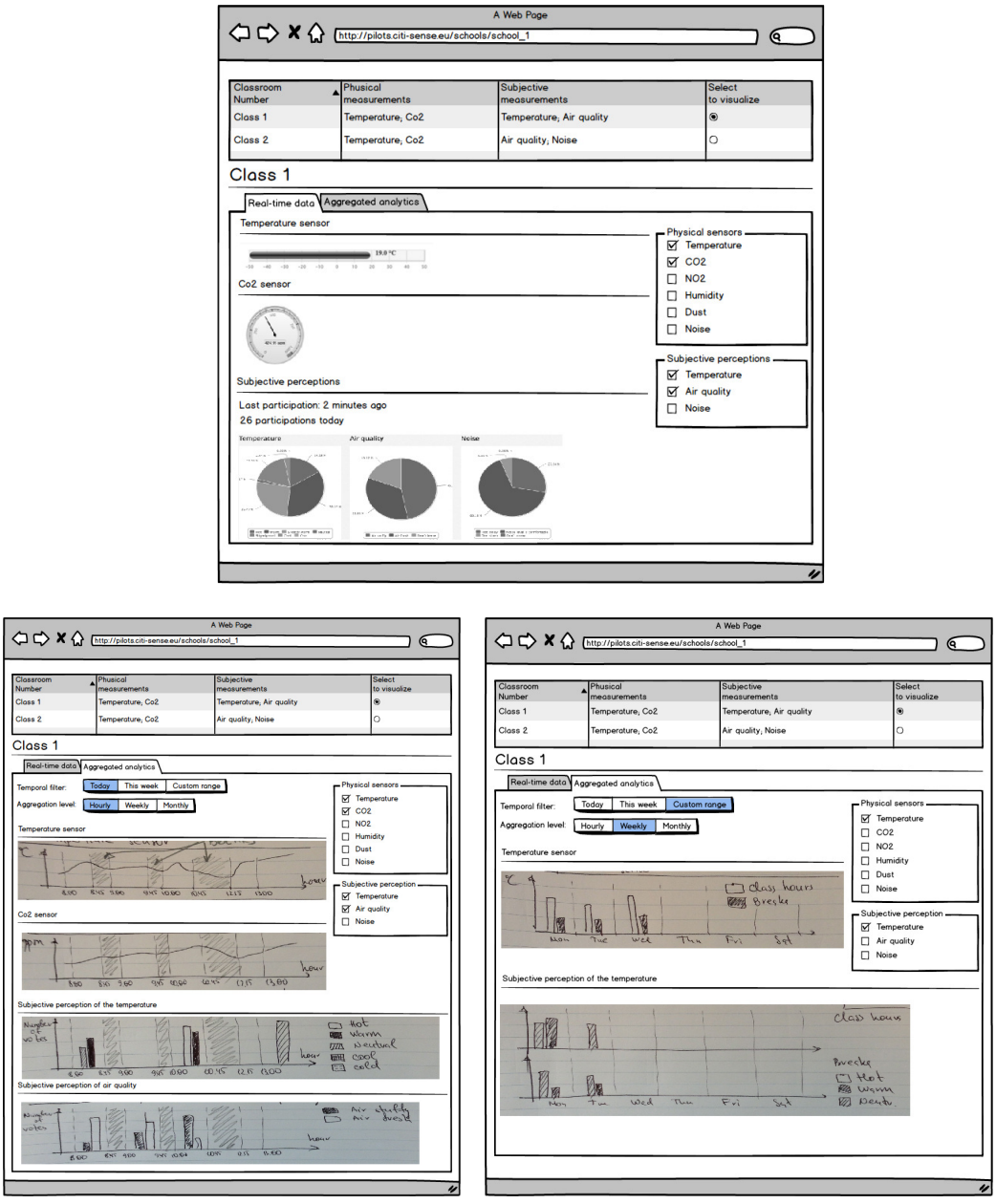

Figure 6. Examples of how an iterative process produces more advanced designs

Current Status

At the time of writing, the design as demonstrated in the two wireframes above has been implemented. The first of the school portals is under development and a basic demonstrator is online, displaying real-time data in the visualization widgets. These are for display purposes only as they show data from another location, and not the school. However, they demonstrate the look and feel of the design and enable the stakeholders to make comments, and request changes during the development process.

Figure 7. Screen shot of the first school portal

The basic principle for the schools portal is simple. Build one example; create all the necessary pages; insert all required modules; populate it with content; and then clone it as many times as required. In this way, we ensure homogeneity, reduce development time and provide content in English by default which can then be translated into the local language. This will ensure a consistent look and feel but at the same time allow the administrator of each portal to change anything at a local level, without affecting the other portals. In this way, they can be driven by local user requirements and be modified accordingly.

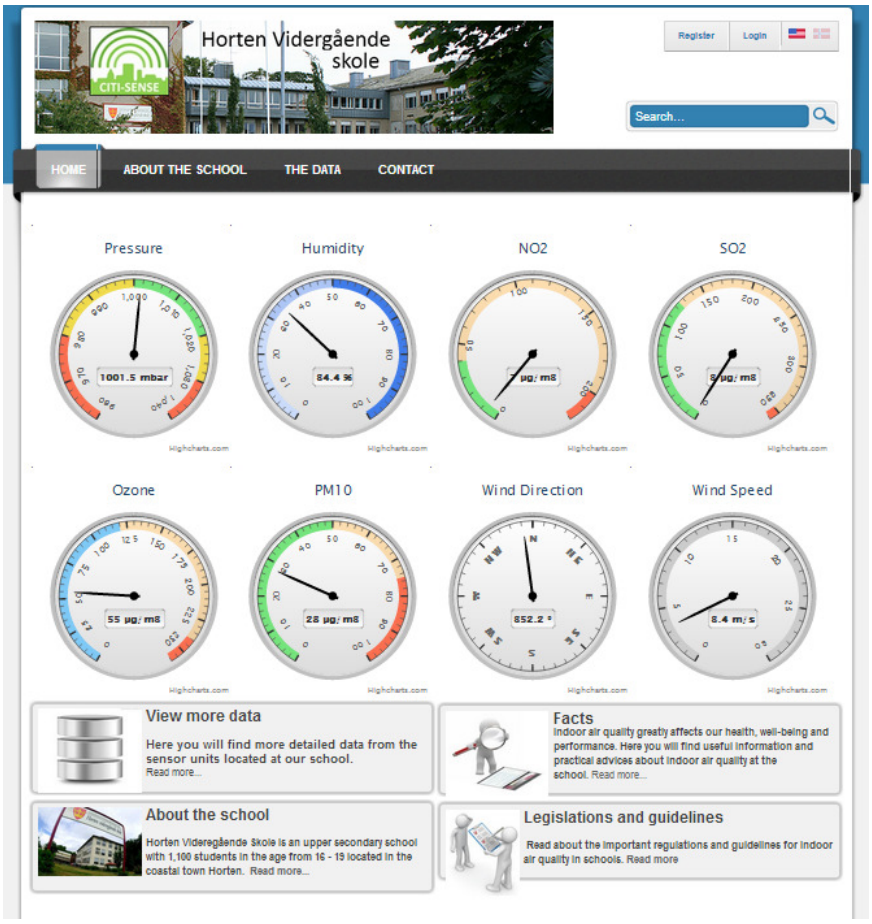

Figure 8. Current design for the main schools page

For acquisition and visualization of subjective perceptions the dedicated page powered by CivicFlow was set up, allowing children to express how they perceive the temperature, air quality and noise conditions in the school.

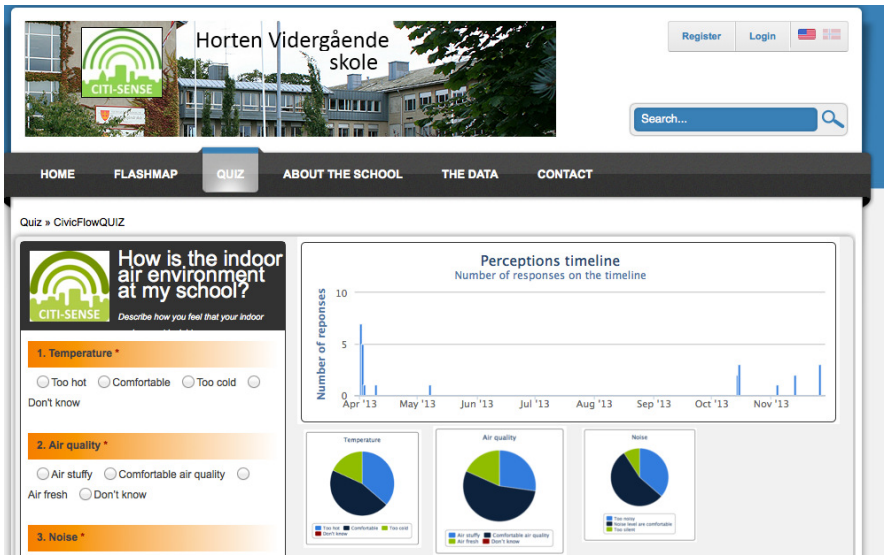

Figure 9. Acquisition and visualization of perceptions through questionnaires

There is an internal review process that will be used to ratify the above design, which is likely to lead to further refactoring (i.e., code optimization). The first of the schools portals (Oslo) was demonstrated in Belgrade at the Annual Meeting in October 2013 as a prelude to internal review and ratification.

4.4.2 Web portals Urban Quality

The EI for outdoor air quality (WP2) requires a phone application compatible with modern smartphones (android platform). This will be the main focus for the WP, but at the same time, a need has been identified for a web portal, as not all people have a smartphone. An initial design has been created; it is currently awaiting internal review.

Specification Development

Specifications have been developed following the same approach as described above. This involved creation of a wish-list, then expanding this into the deliverable D2.1, the WP2 (all locations) pilot case protocol compilation. However, this document focused on the needs for developing the smartphone application, and not the web portal. Consequently, an iterative review process is needed to ensure that the proposed web solution meets all the needs of the stakeholders.

Mockups & Design

Following the same basic look and feel as that developed in the WP3b portals for schools, we have provided a basic mockup for the WP2 stakeholders. This mockup will undergo review and revision prior to being considered ready for launch.

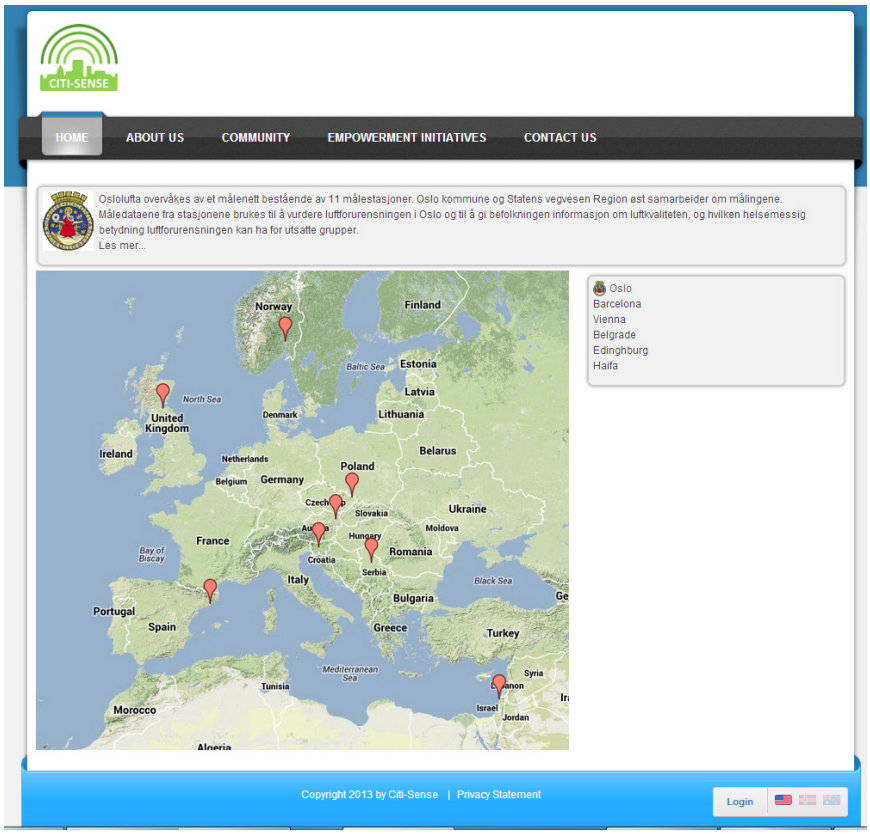

Figure 10. WP2 Outdoor Air Quality mockup

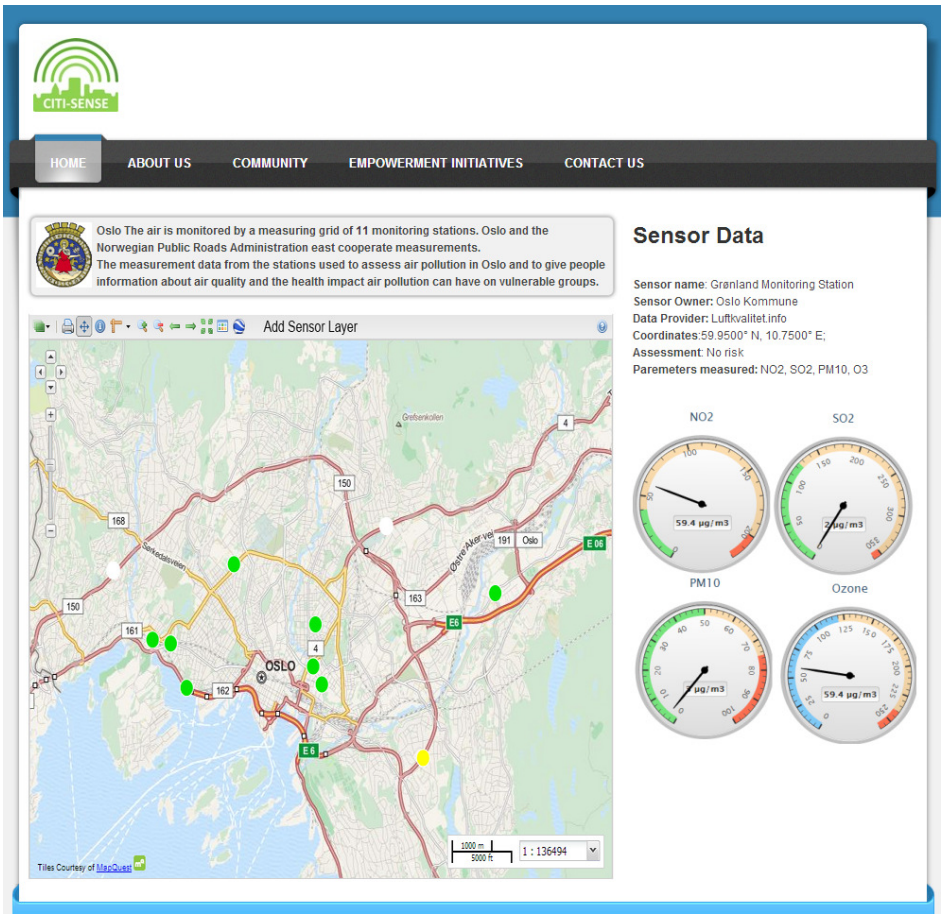

Figure 11. City view for WP2 mockup

Current Status

Although the above mentioned portals are for different WPs, they follow the same basic concept in design and implementation. That is, create one portal, review, refactor and approve it; then clone it for use by the various EIs. At the time of writing, we have begun the design, and review process for these portals. Implementation of the various portals is relatively simple and will proceed quickly, once stakeholder approval has been agreed. The project Annual Meeting (Belgrade 2013) was the first time these designs were seen by the wider project community; it is expected that there will be considerable feedback on the design and demonstrated functionality. During the period following the first Annual Meeting, it is intended to develop the proposed concept to a final stage, after which the portal implementation process will begin.

4.4.3 Phone application

The mobile device development for WPs 2 and 3a takes the form of a phone application. Initial design mockups have been developed to begin an iterative review process with the various stakeholders from the work packages. The design mockups are included below, with notes on their functionality. These designs are tentative, and thus may make it into the final version of the application.

Specification Development

The specification process has undergone the same approach for these WPs as for the other WPs. That is, it has generated a protocol and a wish list (deliverables D2.1 and D3.1). From these documents, we have derived common functional elements, which then are implemented in the design phase.

To have a methodical approach to the specifications, we have created an overview of the major functional requirements compatible with our development philosophy. As mentioned in section 4.3.4, we have found that the requirements from Public Spaces were similar (however, since the procedure of collecting data is quite different, a specific app to control this process is needed) to those for Urban Quality. The apps will be designed to take advantage of the common elements in the EIs.

During this process of reviewing the requirements, we considered the following users of a phone application:

1. The contributor. A user that is a contributor to the CITI-SENSE project and collects data;
2. The Regular user. A user with no connection to the project, but who wants to view the collected data.

To offer a useful application to both types of user we will:

1. Display the collected sensor data to the Regular user and the Contributor in a user-friendly way;
2. Display personal sensor data to the Contributor.

Mockups & Design

The Mockups and design of a phone application were created and shown to the location officers for feedback to see if the requirements and wishes of the user were understood. In this initial stage, the design was made without any consideration of budget or time costs. So the functionality associated with this design may not be implemented during this project

The following mockups have been created for the Contributor user, but will include elements that will be available for the Regular user.

Main Screen

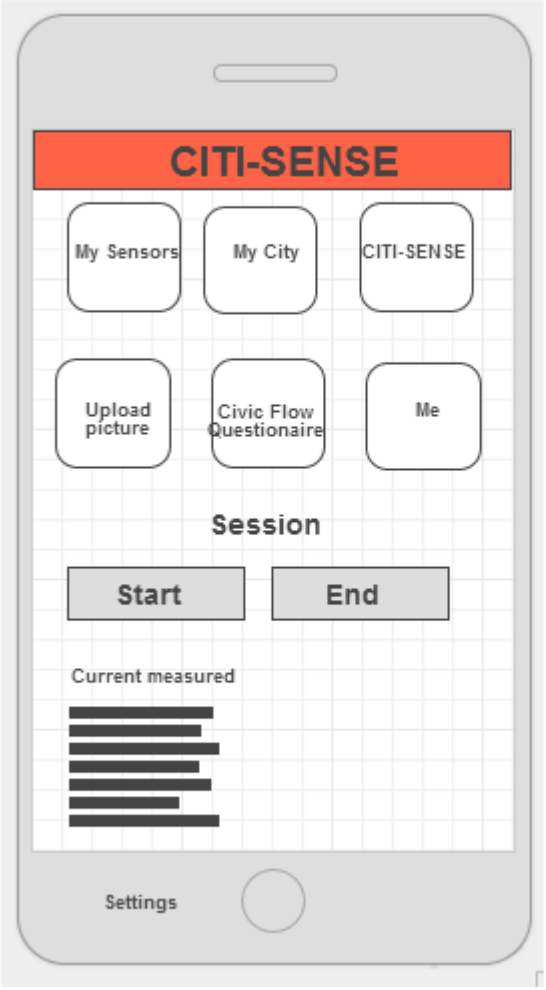

Figure 12. Main phone application screen

The main requirements are displayed as clickable buttons. To incorporate the Public Spaces initiative need for having limited periods of data collection, we suggest a functionality for starting and ending a measurement session.

My sensors

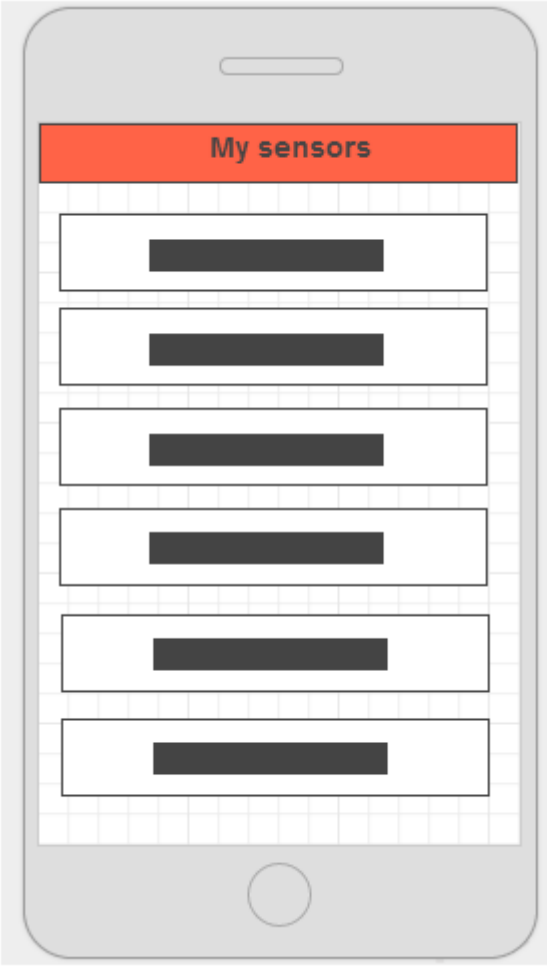

Figure 13. My Sensors screen

On this screen, each button represents a mobile and personal sensor related to this phone application. This can be a sensor directly connected to the phone by Bluetooth or a sensor that collects data independently but is associated to the user of the phone application.

Screen after clicking a sensor name – Real time

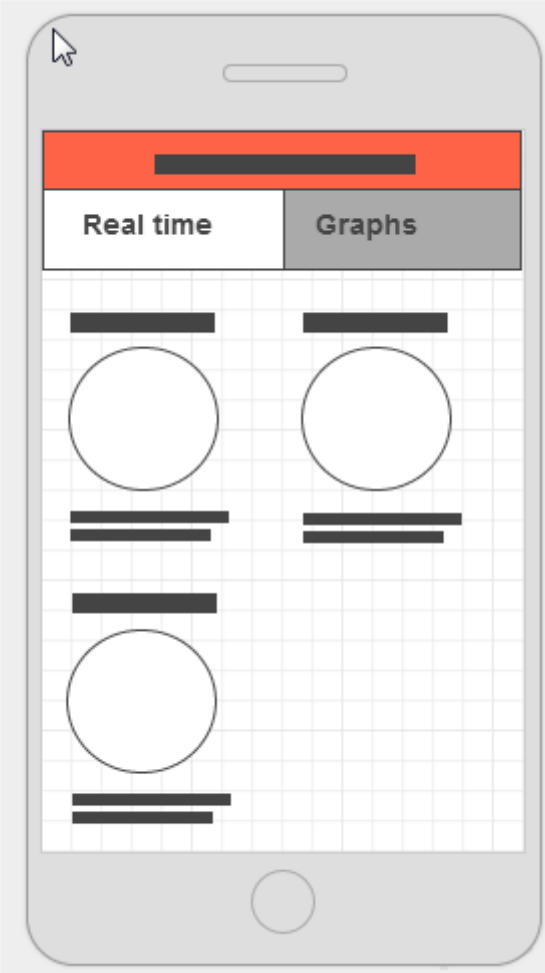

Figure 14. Real time values from sensor

Screen after clicking a sensor name – Graphs

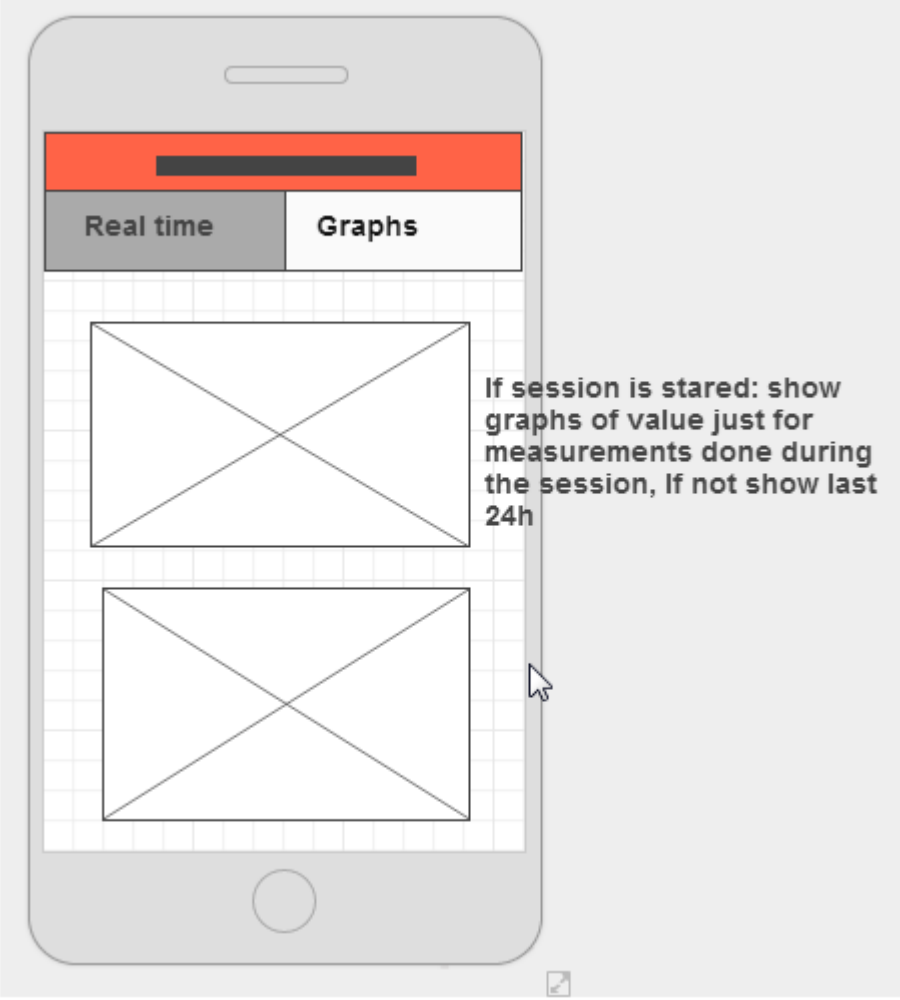

Figure 15. Historical values from sensor

When the user clicks a sensor, they can choose to look at real time values or historical values represented as graphs.

My City

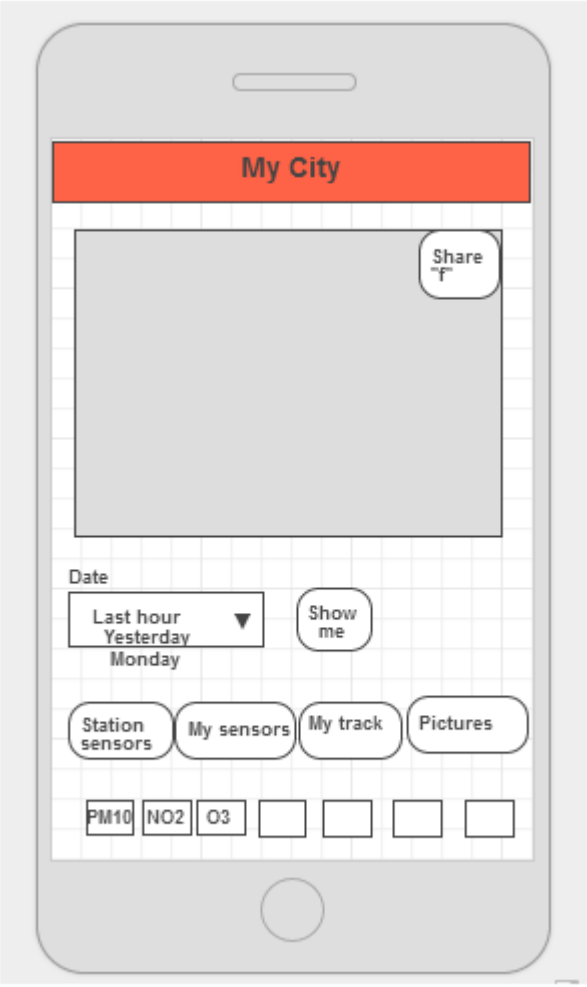

Figure 16. My City screen

The grey rectangle is a map of the city where the phone is currently positioned. The map has several layers which are described below.

Layer 1: Map of station sensors

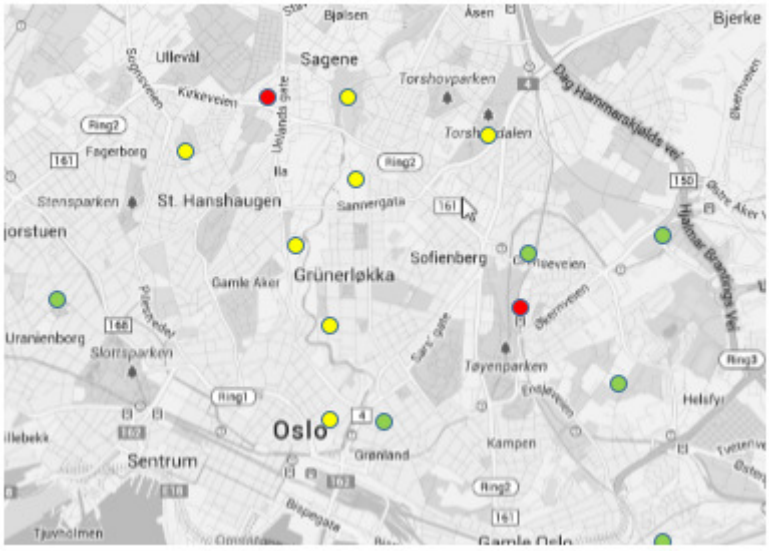

Figure 17. Map of station sensors

This layer displays the air quality index of the static sensors in the selected city. This can show output from static sensors deployed within the project, or can show already existing and open source data. The deliverable D6.1 contains information about services and data that can be used for each location.

Layer 2: Personal sensors connected to smartphone or application

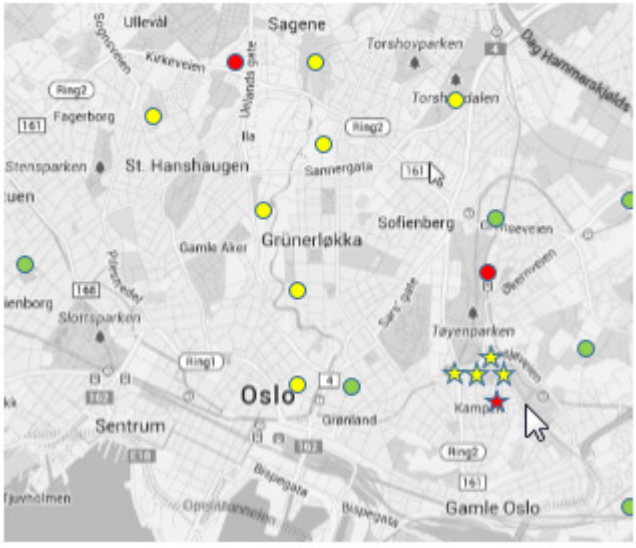

Figure 18. Map of personal sensors

This layer shows the Air Quality Index from the personal sensors. The mockup for this layer only displays personal sensors related to this specific map. There is a need to discuss how to display all personal mobile sensors in the selected city, not only those connected to the phone application.

Layer 3: Measured values from personal sensors during a time period, stored with the GPS position of the user.

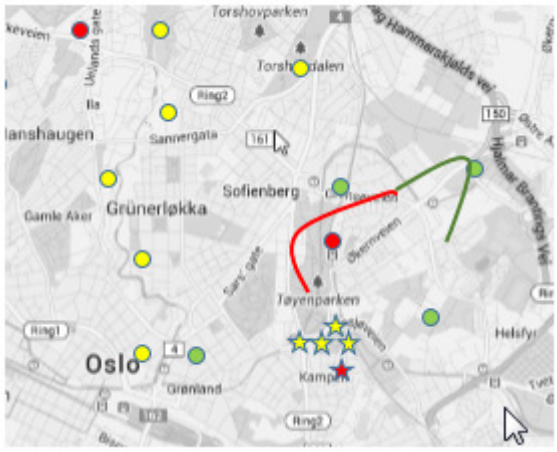

Figure 19. Map to display a track of the current user

Layer 4: These three maps can be further specified by choosing to show one parameter from PM10, NO2, O3, or others.

Layer 5: Pictures taken by user

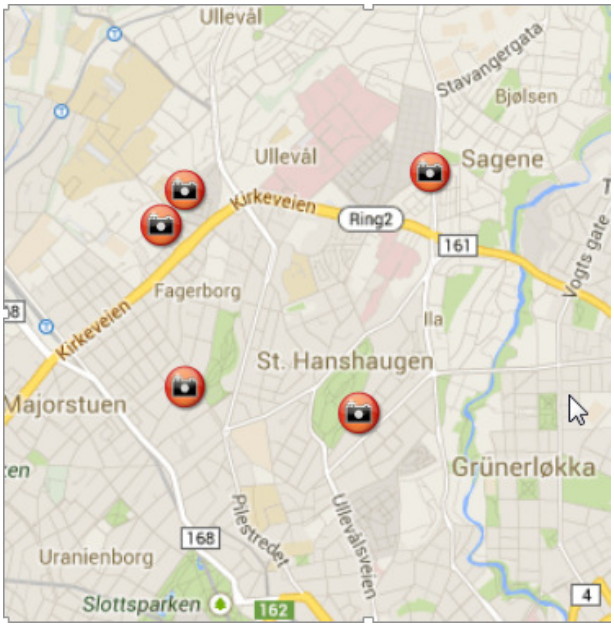

Figure 20. Map to display pictures taken

This layer contains a marker for each picture taken with a GPS position. When clicking on the marker the user can see a text provided by the user taking the photo. The screen design for taking a photo and uploading it into the CITI-SENSE platform is described later in this section.
We will add functionality to share the maps on social media such as Facebook and Twitter.

CITI-SENSE Cities

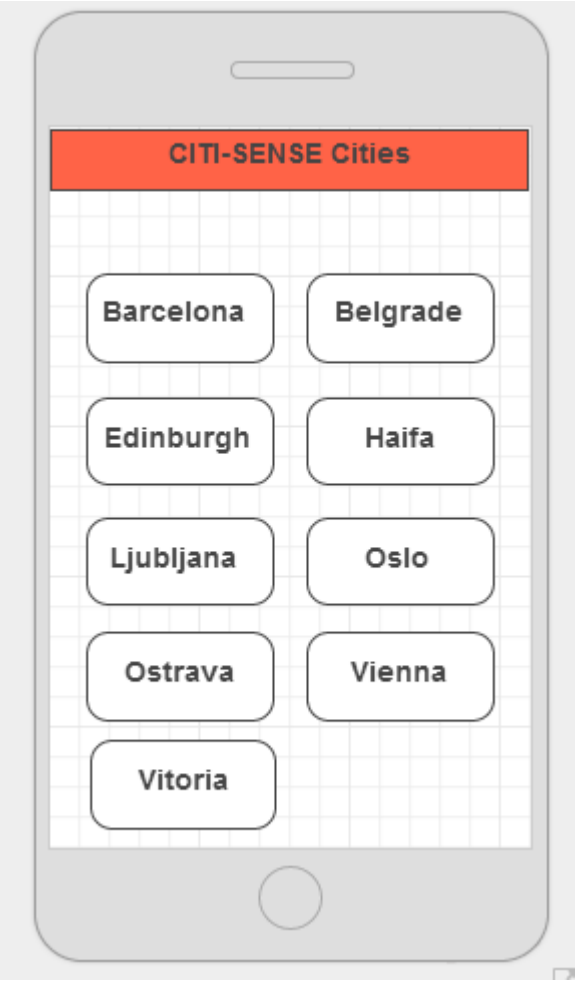

Figure 21. Screen showing participating cities

This screen will show the cities participating in the CITI-SENSE project. Note that for Vitoria the EI concerns comfort in indoor and outdoor public spaces, and not measurements of air quality parameters such as the air quality index.

Display Screen for each city

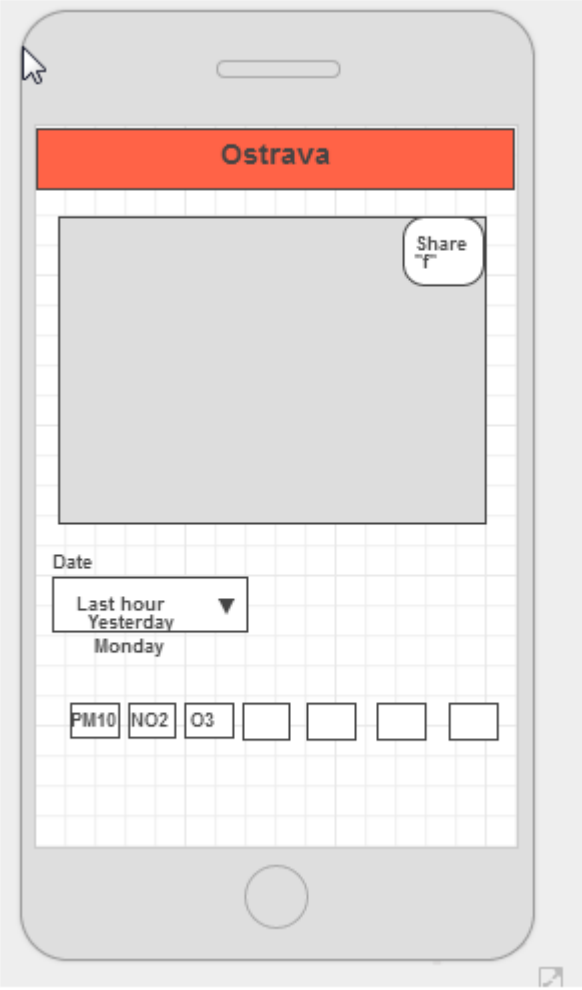

Figure 22. Screen for showing information available on a selected city

The presentation of each city is a map with sensor values, described in the “My City” option of the app.

Me

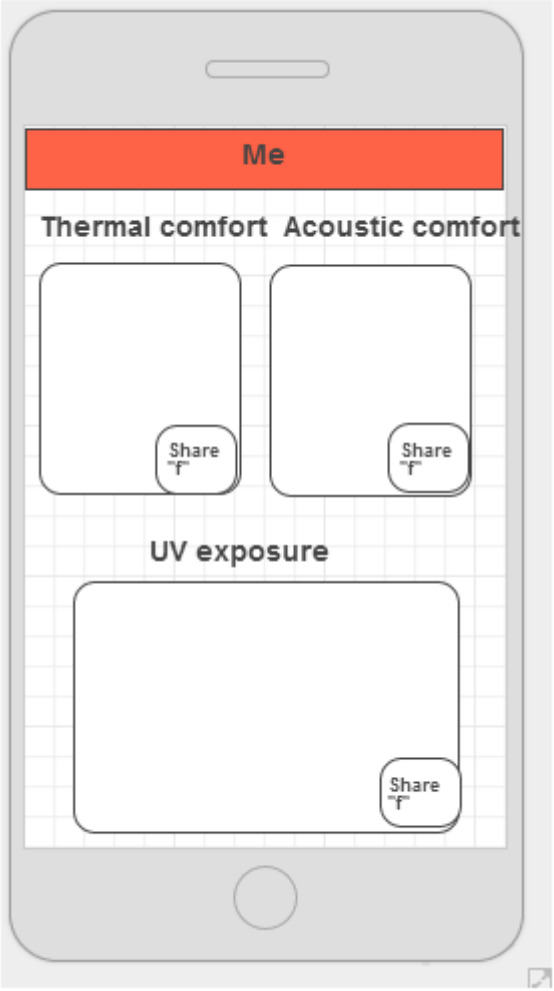

Figure 23. Personal information screen

This is the personal part of the phone application and gives the user an indication of his or her well-being and potential exposure.

Upload Picture

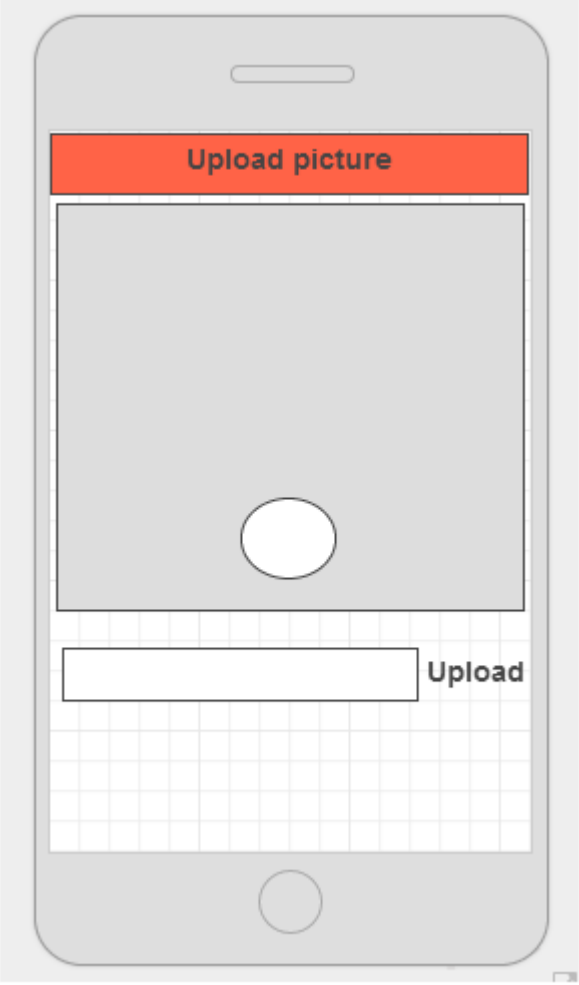

Figure 24. Screen for uploading a picture

Settings

Figure 25. Screen settings

We see a need for having a separate screen for different settings. That could include defining the participant ID and configuring the sensors that this application will support.

Current Status

At the time of writing, we have developed a phone application that calculates and displays the Air Quality Index with test data provided by DunavNET.

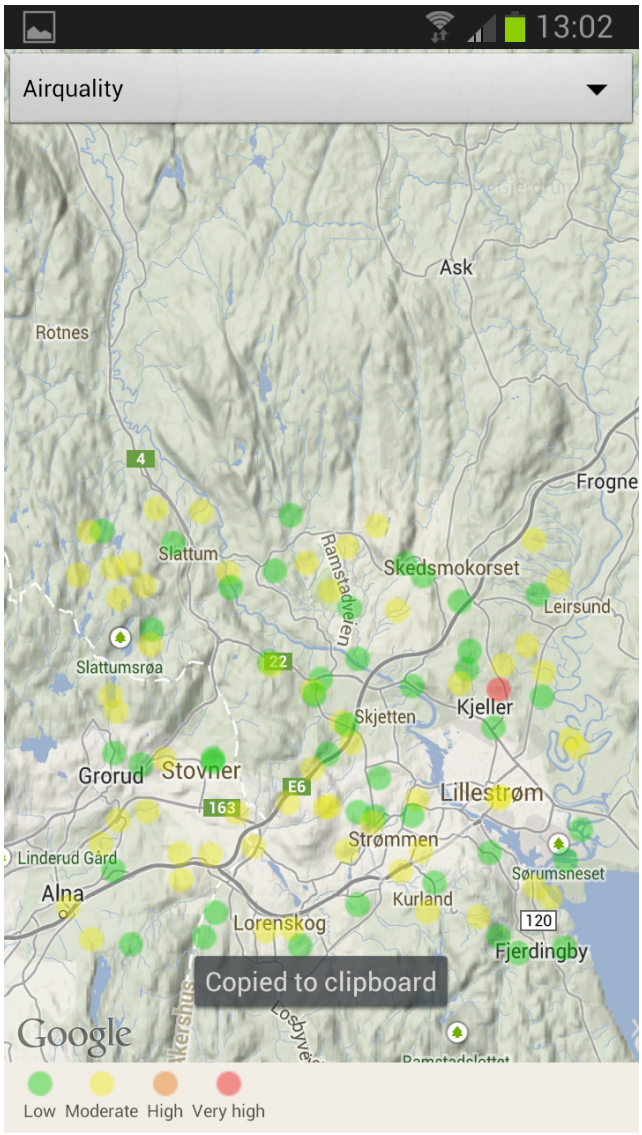

Figure 26. Map to show the Air Quality Index (AQI) as coloured dots

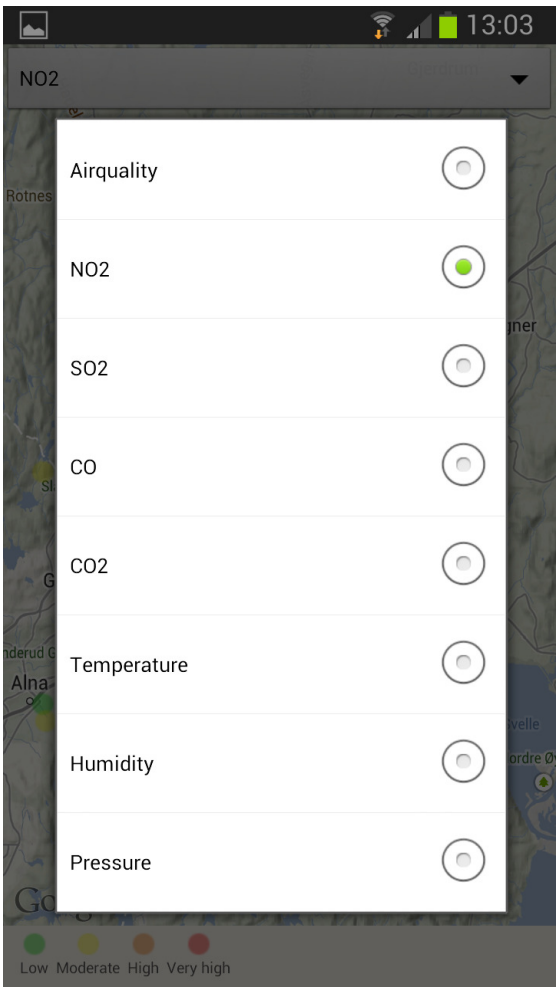

Figure 27. Screen to choose specific Air Quality (AQ) parameters

There is an option for showing a specific air quality parameter.

The data displayed are only test data, but they are provided by a sensor and a platform that will be used during the project.

4.5 Testing Methodology

Testing a product can be done in many ways. Typically, software applications will have a type of automated or scripted testing performed. This can be performed at a unit level, as well as for user interface systems. This is not the case for CITI-SENSE, as the time and effort required to develop automatic scripts to test and retest the user interfaces is beyond the scope of the project. However, unit testing will follow the "Test Driven Development" (TDD) approach; this is described later in this document. Graphical User interfaces (GUIs) will be tested manually by different users. This also is described later in this document.

All functional testing of the CITI-SENSE apps will be performed manually, by expert users of the system. Testing across the entire spectrum of the system and its underlying components will be performed by individuals with different technical expertise. From Software developers (performing unit testing) to project managers (performing functional testing) to potential end users (performing acceptance testing), the CITI-SENSE apps will be exercised in both a systematic and "ad hoc" fashion to discover issues arising from flaws in architecture, code bugs and inappropriate interface design. In addition, effort will be made to capture new requirements during this process and this in turn will lead to new developments and new testing cycles. This document will describe the procedures used to accomplish this.

Unit Testing is performed primarily by the lead developers responsible for the CITI-SENSE apps, as well as those working on the supporting services, such as the sensor data visualization, modelling systems and specific enablers.

Function Testing is performed by the individuals responsible for the original concept and design of the CITI-SENSE apps, which include members of the project management team, as well as software engineers and other stakeholders.

Acceptance Testing is performed by potential end users in actual or simulated real world conditions. Feedback from these users will likely be used to develop new functionality for the apps.

It should be noted that an individual tester can and often will, participate in testing at several levels.

Validation of the CITI-SENSE apps will take several forms including:

- test-driven development (TDD);
- functional testing;
- end user testing.

These methods are described in more detail below.

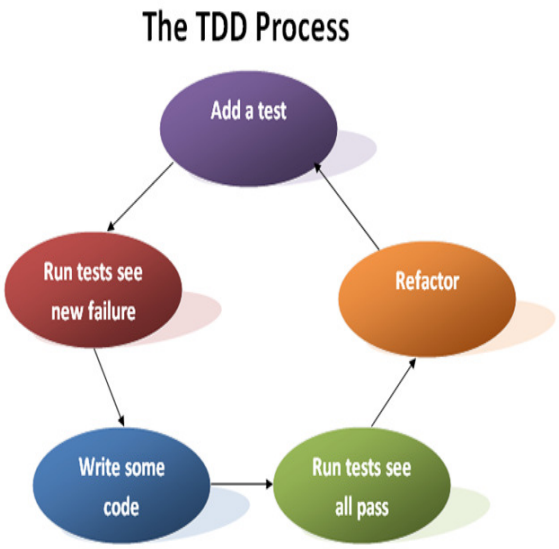

Figure 28. Test Development Process Flow

4.5.1 Test Driven Development

Test Driven Development, or TDD, is performed to ensure that functional units built during the development phase of the project conform to the specifications. This is low level Unit testing and is performed by the developers of the system.

In test-driven development, each new feature begins with writing a test. This test must inevitably fail because it is written before the feature has been implemented. (If it does not fail, then either the proposed “new” feature already exists or the test is defective.) To write a test, the developer must clearly understand the feature's specification and requirements. The developer can accomplish this through use cases and user stories that cover the requirements and exceptional conditions. This could also imply a modification of an existing test. This is a differentiating feature of test-driven development versus writing unit tests after the code is written: it makes the developer focus on the requirements before writing the code and is well suited to an agile development environment.

This type of testing is performed to varying degrees of complexity by the developers of the various systems that provide the data web services and the modelling services. Additional testing will be performed for the user interfaces, especially for the mobile phone applications. This will take the form of functional testing.

4.5.2 Functional Testing

Functional Testing is performed by project members and ensures that any delivered software meets the desired specifications. The specifications have been provided in detail in the Protocols described in D2.1 and D3.1 and developed during the project.

Human involvement in app development typically requires significant error trapping. Functional tests usually include supplying each field with a valid value, an empty value, an invalid value, and any edge

conditions including zero, negative, or a very large number or string, and special characters including apostrophes. Each navigation button must also be tested. The test cases will be designed to ensure that these boundary conditions are tested so as to prevent potential errors in data being transmitted and to ensure that the user experience is optimal.

4.5.3 End User Testing

Testing by users in real world conditions ensures that the software outcomes of the project will meet the high standards demanded by our target user groups. Any bugs, issues, or comments will be fed back into the project where they will form the basis of subsequent updates and redesigns.

Figure 29. Representation of End User Testing

4.6 Architecture Overview

To adequately test an application, several requirements must first be met. These include understanding the specified functionality as laid out in the requirements documentation, as well as understanding the overall architecture of the underlying systems and how they relate to each other. The following diagram demonstrates the major elements of the CITI-SENSE architecture.

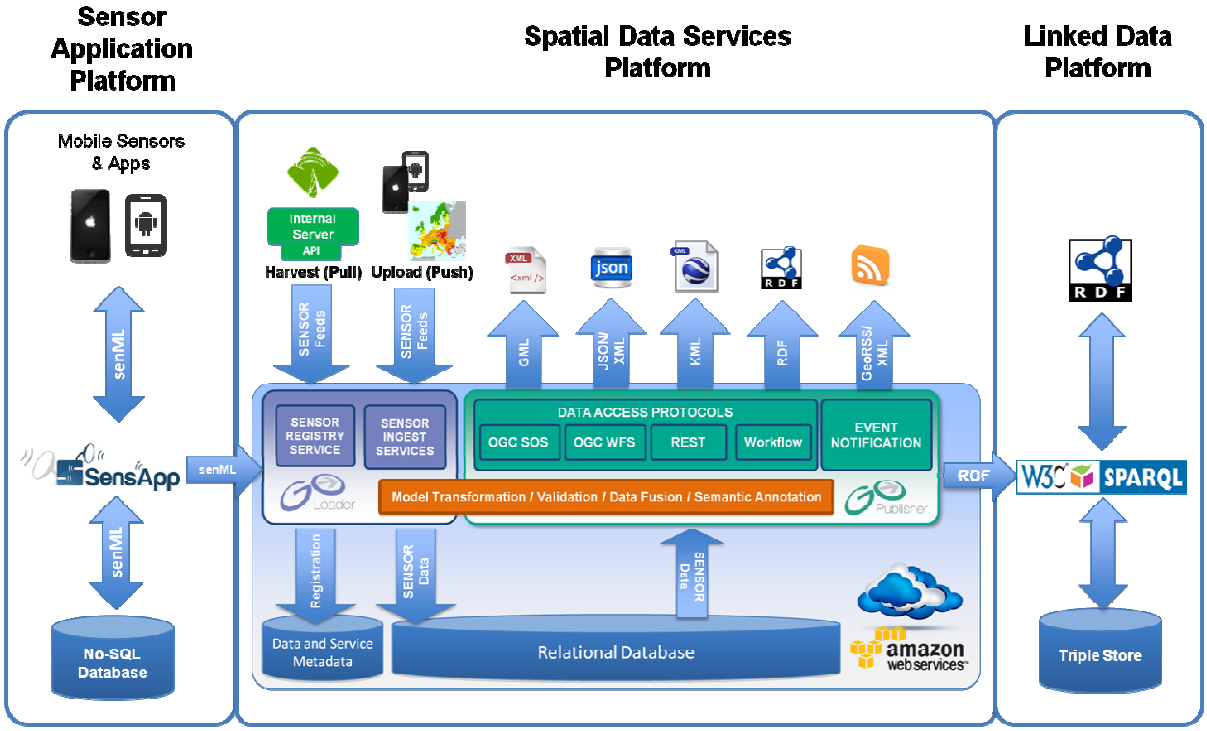

Figure 30. CITI-SENSE architecture

4.7 Release Process

Each time a set of changes are committed to the base code, a new release is created for the CITI-SENSE apps. These are given a new version number which is incremented according to the status of the release. For example, a major release, or a minor release would get a different number. A major release would increment the first number such as 2.0, which would be incremented to 3.0. A minor release would increment the second number, with 2.0 incremented to 2.1.

5 Further work

In the previous sections, we have detailed the current status of the various development threads currently under way in the CITI-SENSE project. In this section, we shall review the work that is planned for the next 6-9 months (roughly until mid 2014). Note: It is important to understand that this section pertains only to the work foreseen and is based on our understanding of the functional requirements at the current time. This could change in the future as the development of the various applications undergoes an iterative review process which is likely to lead to the discovery of new requirements and potential changes to the existing set up. For this reason we do not specify the complete scope of the development work required but only that of which we are currently certain.

Developing project products and services requires the following steps:

- The design of the applications (apps) will be reviewed by the location officers for the various EIs to ensure that the requirements and wishes for functionality have been understood and have been implemented accordingly. This process will follow the concept of an Agile Development process, using processes such as Scrum or XP, which focus on quick iterations and client feedback to allow for the inevitability of changing requirements. We aim to start with some key use case stories. These stories will be detailed in use case descriptions and diagrams using UML (Unified Modeling Language). When performing this work we will employ an iterative and incremental process, preparing for the Test Driven Development (see section 4.5)

- The prioritizing of use cases to be implemented needs to be driven by the location officers in collaboration with WP6, WP7 (for the common visualizations) and WP5 (for the end user's viewpoint). In addition, the same process must be applied for WPs 2-3. To achieve this, WP6 will start with visualizing sensor data collected in CITI-SENSE that is common amongst all the Empowerment Initiatives (EIs). These include:

  - Real time data from station sensors;
  - Real time data from personal sensors;
  - Fixed historical data from station sensors (last 24h/72h);
  - Fixed historical data from personal sensors (last 24h/72h).

- Implementation of a method in the smartphone applications to enable the inclusion of personal perceptions from end users through questionnaires, VGI (Volunteered Geographic Information).

6 Summary

Within the CITI-SENSE project, Work Package 6 strives to develop supporting applications that will help realize the goal of empowering citizens and citizen groups. To this end, we have developed a series of technological solutions, both as products and as services.

These products comprise various aspects, from data gathering systems, data storage, reporting, querying and also visualization and information dissemination. However, they also include end user products such as mobile phone applications which can be used by citizens to contribute their own personal observations as well as providing sensor data directly (for example, the phone can provide data via built in sensors).

Given the wide range of interests served by the project through the empowerment initiatives, the above goals are challenging, necessitating the development of a methodology, or approach that will underpin the needs of the users, and ensure effective use of resources. This is demonstrated by the design of the architecture as well as the method used to develop specifications, naming conventions, source code repository and the common resource platform for design work (confluence).

This approach is a key to ensuring success for the wide-ranging needs of the project stakeholders, whether they be end users such as municipalities or public, or project partners. To create such a comprehensive development support base has proven to be worthwhile, since we are now seeing results, which we confidently expect, will be extended and replicated. The first fruits of this effort are being currently tested, which includes data communication, data storage and retrieval as well as visualization methods, such as data widgets and data dissemination platforms (web portals).

As a result, we have reached a critical stage in Work Package 6, which is the establishment of the process and methods by which we will support the overall goals of the project as well as the development of some of the key end user systems and products.

7 WP Collaboration

The work of developing the end user products and services in WP6 is closely related to other work packages (WPs) in this project. This includes support from resource persons with specific skills related to development and design of the apps. Details are provided in the table below.

Work Package	Main support and input to WP6 end user applications
WP4	For GEOSS approach and integration of Citizen Observatories
WP5	Usability
WP7	**Deliverables** D7.1 Platform and Architecture D7.2 Core ontology network for city observatories applications D7.3 Platform and architecture interim version D7.4 – D7.6 Platform and architecture v2.0-4.0 For suggestions and help with choosing technology to follow the CITI-SENSE architecture; Provide common visualization of sensor data as widgets and plugins; Use case development.
WP2	**Deliverables** D2.1 Pilot study protocol D2.2 Pilot study evaluation and protocol for phase 2 Input on requirements: Collaboration on dissemination platforms; Use case development; Testing of applications.
WP3	**Deliverables** D3.1 Pilot study D3.2 Pilot study evaluation and protocol for phase 2 Input on requirements: Collaboration on dissemination platforms; Use case development; Testing of applications.

References

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