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Citi-Sense-MOB

Conceptual services design document

Hai-Ying Liu (ed.)

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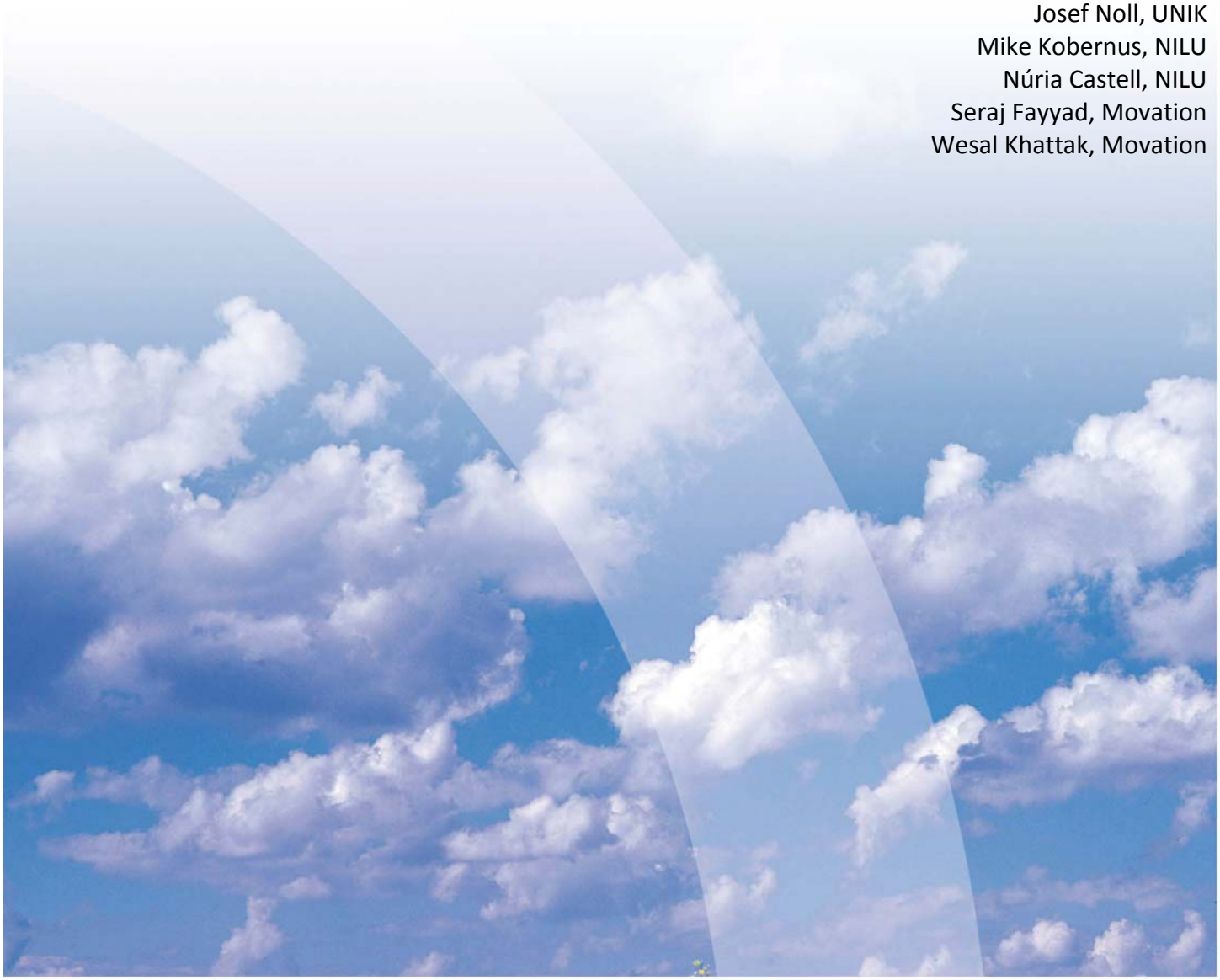

Scientific report

Conceptual services design document

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1 Introduction to citizens' observatories toolbox

1.1 What is citizens' observatories toolbox?

In the broadest sense, a Citizens' Observatory Toolbox (COT) can be any guidance, procedure, software, hardware or services that can be used to support citizens to participate in environmental monitoring programme and enable citizens to contribute to community-based environmental decision making (Liu et al., 2012). Citi-Sense-MOB defines COT as: a collection of tools to support citizens to 1) gather environmentally relevant information; 2) process, display, comment and report on environmentally relevant information; 3) access and receive useful environmental information; and to 4) act on environmental data and data analysis accordingly. It contains a suite of hardware, methodologies and software elements that support the gathering, processing and display of sensor-based and VGI (Volunteered Geographical Information) data. The hardware typically includes personal micro-sensors and smart phones. The methodology suggested is an approach for the development and continuous improvement of innovative citizens services based on a service design approach. The software is configurable tools and services from different service layers – from infrastructure as a service, to platform as a service, to software/apps as a service.

1.2 How does citizens' observatories toolbox support the project goals?

Citi-Sense-MOB will mainly address the EMMIA (European Mobile and Mobility Alliance) strand II: 2: Large-scale demonstrators in support of GMES (Copernicus, 2014) and the Global Navigation Satellite System (GNSS) (Wikipedia, 2013) based services. The main goal of Citi-Sense-MOB is to develop new mobile services to support green growth in the Oslo area by providing citizens and authorities' information related to transport and environmental quality (e.g., air pollution and climate gas emissions). This will be achieved by developing and demonstrating a range of innovative mobile services based on GMES and GNSS systems services from the GEOSS (Global Earth Observatory System of Systems) (GEOSS, 2011) based architecture and platform developed in the CITI-SENSE project (CITI-SENSE, 2012). The downstream applications developed will contribute directly to resolving the HORIZON 2020 challenges related to health, well-being and climate change (EU, 2014) as well as alleviate certain infrastructure pressures experienced within the Oslo regions, for example, by tracking user mobility.

To achieve its main objective, Citi-Sense-MOB will develop a COT comprising a series of methodologies, applications and services which support and complement each other. The different layers of COT can be realized by citizens in different contexts:

- Approach of developed information value chain consisting of sensors (technologies for distributed monitoring), platform (information and

communication technologies), products (information products and services) and users (citizen involvement in both monitoring and societal decisions).

- Data gathered from provided sensors carried by normal citizens to the sensors mounted on vehicles: bus, electric car, bicycles.

- Data processing and visualising methodologies.

- Information displayed for the stakeholders from environmental friendly and eco-driving routes, personalised environmental information to environmental health alert and risk-based behavioural recommendations.

Most often, COT can be considered to be mobile apps, web apps, and the infrastructure created that would be available to create new apps.

2 Services design concept

2.1 Citi-Sense-MOB service design concept

The key principles of Citi-Sense-MOB service design concept are: (1) addressing the needs of stakeholders; and (ii) through the integration of design-thinking into a structured innovation process. Methods and techniques from The Service Design community approach will be applied for the service identification and specification within the Citi-Sense-MOB project. Service Design is a domain that has gained increased popularity during the last 10 years. This is essentially a combined top-down (i.e., concept-driven, knowledge/background/schemata-based) and bottom-up approach (i.e., driven from the user need perspective). This will be combined with an analysis of the technology opportunities coming from the available data sets and the possible sensor measurements from the sensor packages, finding the best possible combination of a top-down and bottom-up approach.

The Citi-Sense-MOB service design method and techniques will use the following:

- Business Model Design – based on the Business Model Canvas
- Service Innovation and design – based on the ATONE methodology
- Service design – focusing on Personas, Stakeholder maps and Service journey maps
- Non-functional requirements with measurable objectives
- Agile User stories with Use case extensions for service journey touch points
- User Interface Mock-ups for selected user stories
- Agile Scrum/Kanban based development
- Minimum Viable Product analysis for Scrum sprint selection

The Service design methodology with corresponding realisation will be executed in an agile way – using the software engineering principles of Scrum and Kanban and with a priority and selection principle focusing on a Minimum Viable Product (MVP) approach after the recommendations of the Lean Start up principles. This implies an incremental development of following:

- Business Model Design – supported by the Strategyzer tool (Strategyzer, 2014)
- Service Innovation and design – based on the ATONE methodology with service design elements
- Service design – focusing on Personas, Stakeholder maps and Service journey maps (Smaply, 2014)

- Non-functional requirements with measurable objectives (Tom Gilb principles and p language)
- Agile User stories with Use case extensions for service journey touch points (Use case models and templates in Confluence)
- User Interface Mock ups for selected user stories (www.balsamiq.com and balsamiq plugin in Confluence)
- Agile Scrum/Kanban based development (using JIRA Agile with plugin for Confluence)
- Minimum Viable Product analysis for Scrum sprint selection (from Lean Start up analysis)

2.2 ATONE methodology in Citi-Sense-MOB service design

ATONE methodology with service design elements will be applied in Citi-Sense-MOB. ATONE (Service Innovation, 2007) is a practitioner-based method for service-design, aimed to maximize the innovation potential at the early stages of service innovation. It was developed from research into innovation methods and from commercial experience in designing services. The method is scalable and works for short projects and major transformations (Figure 1).

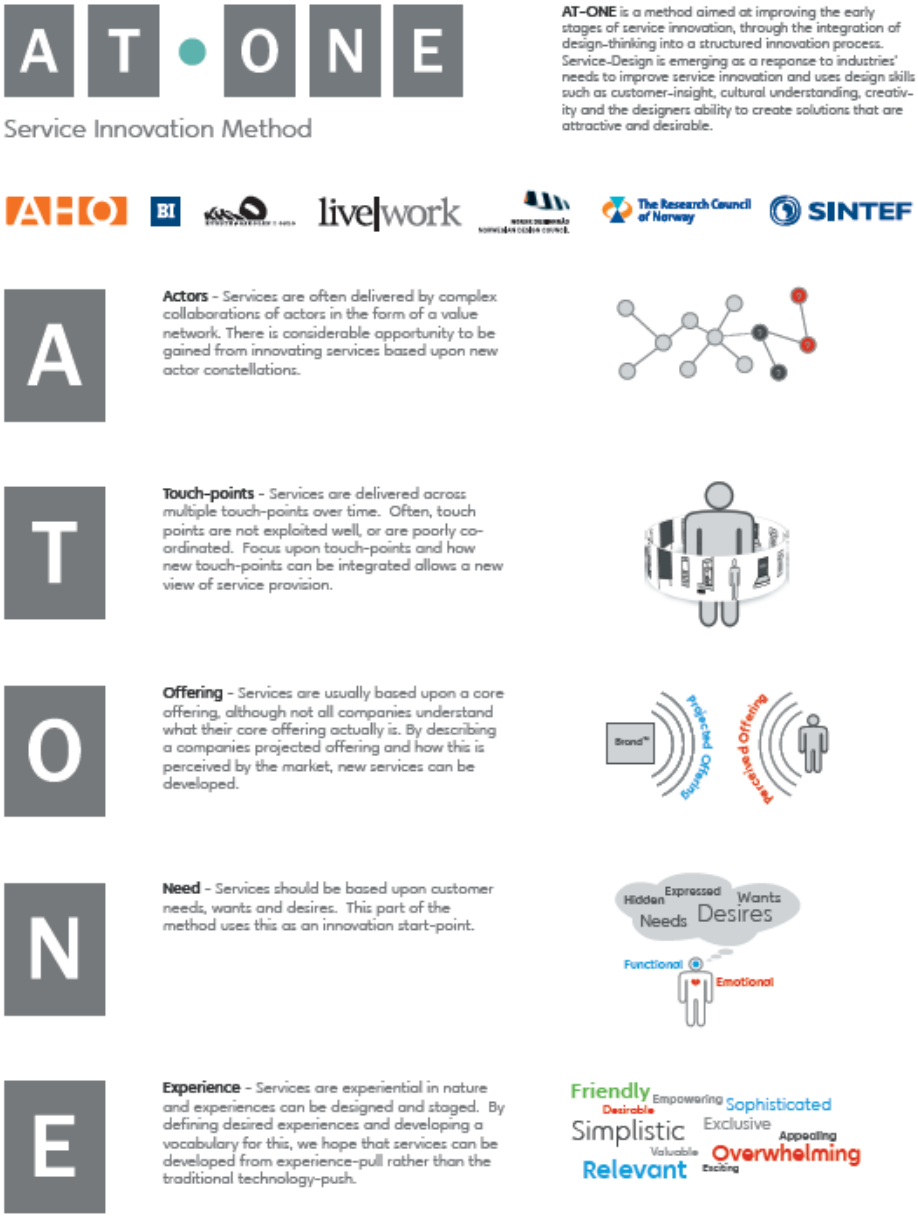

Figure 1: ATONE concept illustration (Source: http://www.service-innovation.org/wp-content/uploads/2007/12/at-one-a3-size-paper.pdf)

ATONE service design elements are described and specified in Citi-Sense-MOB in following sections.

2.2.1 Actors

Actors are those stakeholders and the main customers involved in the service design process. Services are often delivered by complex collaboration of actors in the form of a value network. New actor constellations are often good for innovation. In Citi-Sense-MOB, actors are:

- The general public
- Health interest groups

- Local governments/Public entities
- Transport companies
- Researchers
- Enterprises

2.2.2 Touch-points

Touch points are all kinds of contact points between services users and providers (incl. contact with citizens). Services are delivered across multiple points over time. Focus upon events and how new events can be integrated allows a new view of service provision. In Citi-Sense-MOB, touch-points are:

Documents

- User guides
- Policy recommendation
- Risk mitigation actions

Graphics

- Logo
- Business card
- Newsletters
- Brochure
- Website

Media events

- Radio
- TV
- Facebook/Twitter/YouTube
- Newspaper

Other events/Milestones

- Website launch
- Dissemination activities (brochure, newsletter)

- Seminar/Workshops
- Conferences/Trade shows

App/service

- Information
- Suggestions
- Feedback from users

2.2.3 Offering

What we offer is what we deliver to stakeholders. Need is an innovation start-point for the service design. In Citi-Sense-MOB, what we can offer are as follows:

Core offering: citizens' observatories toolbox, it includes:

- **Methodologies**
  - Data integration
  - Visualization
- **Tools**
  - Mobile apps
  - Web apps
  - Sensor packages
- **Data**
  - AQ-related data and information
  - Data Sources
  - Environmental air quality maps
- **Advice**
  - Policy recommendation
  - Alerts
  - Risk mitigation actions

2.2.4 Need

Stakeholders or project services users' needs, wants and desires. In Citi-Sense-MOB, the difference stakeholders' needs are identified as follows:

- **The General public:** Personalized environmental information.
- **Health interest groups:** Alerting systems when pollution levels exceed a critical threshold, and advice on how to mitigate the effects arising from adverse environmental conditions.
- **Local governments**: Define abatement strategies to reduce air pollution peaks under special circumstances as well as the long-term planning for emission reductions.
- **Transport companies:** Develop green agendas and design better planning to delivery low emissions transport system.
- **Researchers:** Data, information, maps, tools, etc.
- **Enterprises:** High quality micro-sensors; Advanced smart phone services; and Innovative business.

2.2.5 Experience

Services result in user experiences. User experiences can be designed and tested. By defining desired experiences and developing a vocabulary for this, services can be developed from experience-pull rather than the traditional technology-push. This is a user-centric approach, and specified in Citi-Sense-MOB as follows:

- Appealing
- Friendly
- Empowering
- Exclusive
- Overwhelming
- Relevant
- Simplistic
- Valuable

3 Target groups

3.1 Stakeholders, actors and personas

A starting point for both Business Model Innovation and design and for Service Innovation and design is to identify the main stakeholders in terms of Customers and Customer segments and in terms of possible partners in the service delivery. The stakeholders, actors and personas in Citi-Sense-MOB include transport-related agencies in the Oslo area, such as Ruter, Nobina and Statens vegvesen, the general public, health interest groups, local governments, researchers, as well as enterprises.

3.2 Public

3.2.1 The general public

The major reason that impedes the general public from utilizing current air quality related services is the lack of understanding what the data is telling them. For instance, if a user is informed that the Air Quality Index (AQI) in Oslo is poor, what does that mean for him? Sensitivity to airborne pollutants is very different from one person to another and in many cases highly dependent on the individual's patterns of behaviour. Yet, while each individual has a unique relationship to the environment, the information on the state of atmosphere and related hazards available today is entirely generic, and by no means personalised. Citi-Sense-MOB will address this by providing the user with tools that will not only enable him to track the current Air Quality in his/her actual location but also provide him with the means to understand how this data relates to him/her personally.

3.2.2 Health interest groups

Representing public health, groups like the Norwegian Asthma & Allergy Society (NAAF) (NAAF, 2014) provide key services to a substantial number of at risk citizens. These people suffer greatly at certain times of the year due to ambient air quality issues, and consequently have a critical demand for services that could enable them to take actions to mitigate their situation. However, at this time, these services are basic, limited to web based offerings only and do not provide any dynamic capability (e.g., alerts, for example.)

3.3 Local governments

3.3.1 Oslo kommune

For the local government (i.e., Oslo kommune) (Oslo kommune, 2014) the need for improved services is quite different than it is for the general public. By mounting sensors on mobile platforms Citi-Sense-MOB will provide information at spatial-temporal scales related to citizen activity by performing real-time monitoring at the street level. Urban-scale air quality mapping will provide an input to local authorities enabling the management and control of air pollution in the cities to a much finer degree than is currently possible. The data from the project will enhance existing air quality monitoring networks by extending them with a significant increase in spatial data density. Currently the coverage from static networks is insufficient and this new data will enable municipality to define abatement strategies to reduce air pollution peaks under special circumstances (e.g., fast decisions based on current measurements) as well as the long-term planning for emission reductions. The project will further have substantial policy impacts, especially with respect to supporting the European Air Quality legislation application and enforcement. Low-cost sensors may support compliance checking and contribute to an improved development and implementation of environmental policies and strategies with respect to ambient air quality.

Current policies in Oslo have targeted to sustain certain air quality levels, and projects are underway to improve these levels. In order to better understand how air pollution is distributed throughout the city, a project like CITI-SENSE-MOB will answer questions as to what is possible. By seeing a complete and high fidelity geospatial map of air pollution, better measures can be implemented in areas with a higher need. Such a map could in effect increase the efficiency of the solutions that are implemented and offer higher cost-effectiveness. Otherwise, Oslo kommune does not require today a special solution that is targeted towards them, however, they are very interested and supportive in seeing what can be realized with the measurements and the project.

3.3.2 Other cities' Kommune

Just like Oslo, there are other cities in Norway that would like to have an improved vision of air pollution levels throughout the cities. The natural weather change during winter contributes to increased pollution levels in cities. Especially in some cities where the winter is longer and colder than Oslo, pollution levels can be just as difficult to keep in check although their populations are lower (Figure 2 and Figure 3). For these cities, Citi-Sense-MOB provides guidance in what can be achieved from such a project. These cities will be targeted in terms of offering a full scale deployment of the system.

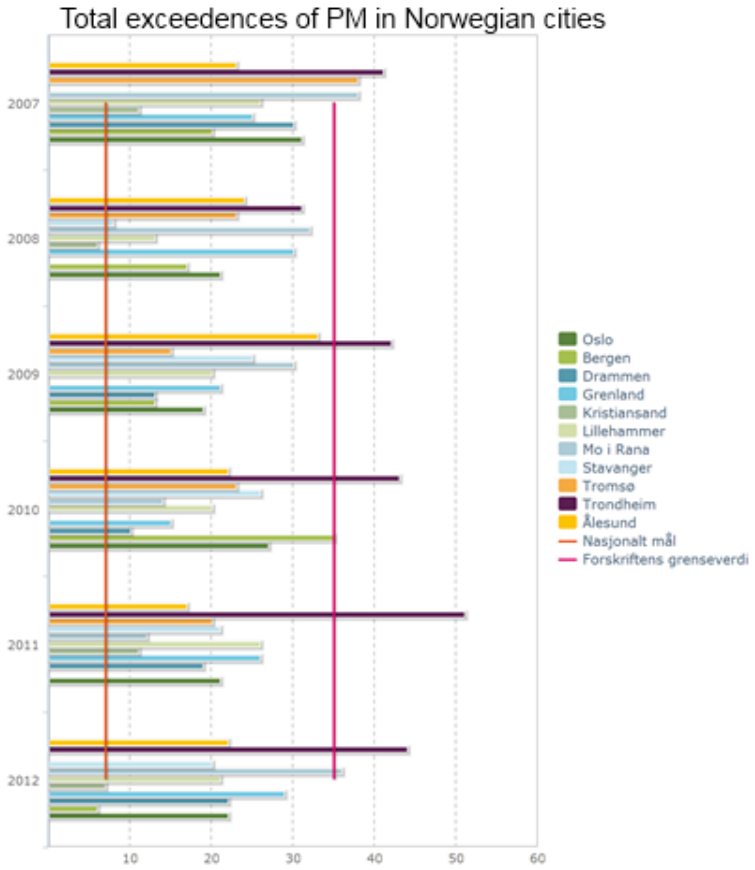

Figure 2: Graph showing national limit target (orange vertical line), and national limit (violet vertical line) on days per year PM limits are exceeded in Norway across the most populous cities. Note that most of the cities in the graph exceed the national target (Source: http://www.miljostatus.no/Tema/Luftforurensning/Lokal-luftforurensning)

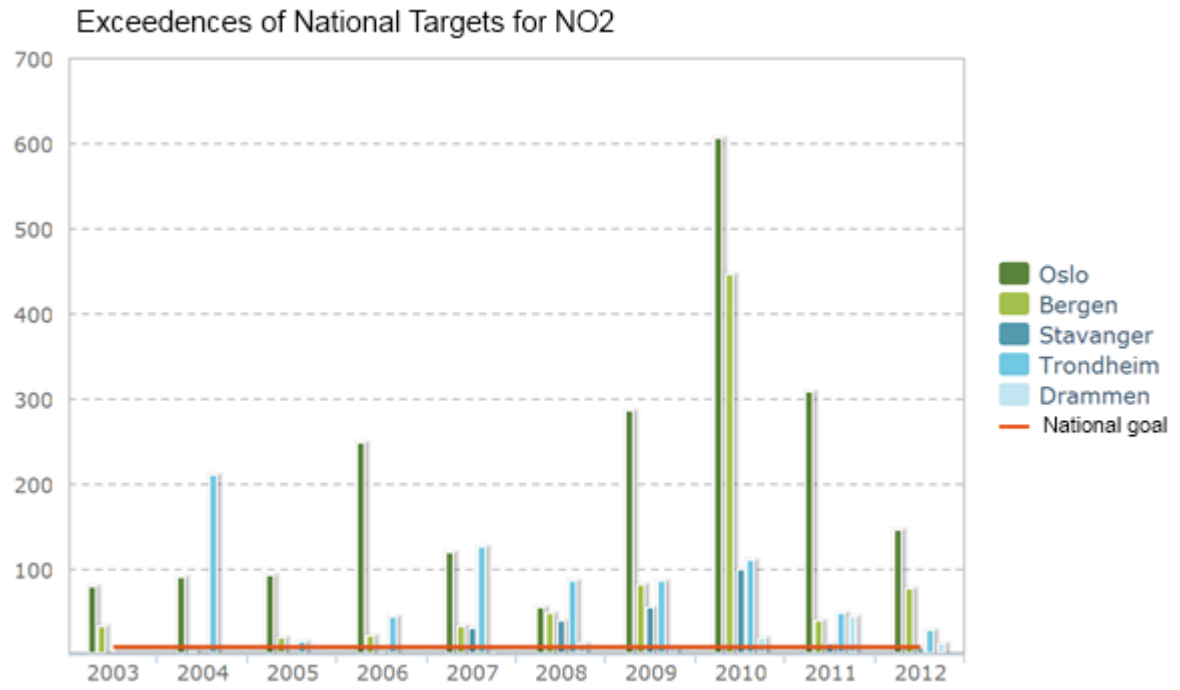

Figure 3: Graph showing the number of hours per year selected cities in Norway exceed NO2 national target limit levels (Source: http://www.miljostatus.no/Tema/Luftforurensning/Lokal-luftforurensning)

3.4 Transport agencies and companies

Transport is responsible for a large part of the overall greenhouse gas emissions in developed countries, and it is one of the sectors where carbon dioxide emissions continue to increase. Moreover, transport also has an impact on air quality, noise, health and quality of life. Transport remains a major source of air pollution causing major harm to both human health and the environment. The Citi-Sense-MOB project will provide an integrated approach by measuring two target gases, CO2 (greenhouse gas) and NOx (traffic-related air pollutants, under certain conditions related to PM, 'particulate matter') as well as PM10 and PM2.5. This integrated method is central to developing a sustainable transport system that takes into account both climate change and air quality emissions. The data gathered in the project will allow transport agencies to develop their green agendas and design better planning to delivery low emissions transport projects that can be licensed by local authorities.

3.4.1 Ruter AS

Ruter AS (Ruter, 2014) is a common management company for public transport in Oslo and Akershus which is owned by Oslo municipality (60 %) and Akershus county authority (40 %). Due to their business, Ruter is mainly interested in increasing the number of passengers they carry through various options of public transportation which they offer. Ruter's objective also aligns with one of Oslo kommune's targets, which is to reduce air pollution from transportation, for which private transportation is the largest cause. In their environmental strategy plan, Ruter also mentioned they would have increasing demands on environmentally conscious driving styles from their service suppliers.

3.4.2 Nobina Norge AS

Nobina Norge AS (Nobina Norge, 2014) is a strategic partner in the project. Whereas Nobina is already a company which is environmentally conscious, since most of their buses run on biogas, they are still interested in reducing their environmental footprint. With the potential benefits of reduced fuel consumption that would arrive with the hardware suppliers, Nobina is further motivated to partake in the project.

3.4.3 Statens vegvesen

The Norwegian Public Roads Administration (Statens vegvesen) (Statens vegvesen, 2014) is responsible for the planning, construction and operation of the national and county road networks, vehicle inspection and requirements, driver training and licensing. Since highly trafficated roads which contribute to the generation of high amounts of air pollution fall within the responsibility of Statens vegvesen, they have a direct interest in knowing the levels of pollution on their networks. Especially the health of workers and employees on construction or maintenance projects on the side or on the section of the motorways are important. In addition, Statens vegvesen has a sectoral environmental responsibility as they are instructed by the government to also maintain an overview of the environmental impact of transportation. Statens vegvesen is currently working together with Oslo kommune on a project for measuring air quality with static sensors, and will be targeted by the Citi-Sense-MOB Consortium for future involvement in the project.

3.5 Researchers

Researchers play an active role regarding environmental health research, supporting relevant policy and decision making, but they often pay little attention to stakeholder dialogue as an institutional strategy for policy support, and are often constrained by a lack of appropriate science-policy dialogues and platforms. Citi-Sense-MOB will initiate dialogue between researchers (i.e., NILU, UNIK, Movation and SINTEF) and stakeholders (i.e., the public, Oslo kommune, Ruter and Nobina) and develop social media platforms to facilitate such dialogue.

The Social Media platform will be targeted towards stakeholders and engage them in a process which will ensure better communication between the various actors in the project. This will make use of the most popular existing platforms, such as Facebook, Twitter and Flickr.

The image inserted (Figure 4) demonstrates the current Citizens' Observatories FaceBook page, which is actively used by a number of CO initiatives. Currently, there is limited employment of the site by end users or the general public, however, it is possible that with targeted campaigns we aim to increase the visibility of the page to the general public. In addition, by adding modules, such as real-time data from the project pilot we will develop a platform that provides key data and information, and enables easy interaction and dialogue with other stakeholders. This will then create the conditions that will lead to further empowerment of the citizens.

Figure 4: Current Citizens' Observatories Facebook Page

3.6 Enterprises

Whilst citizens are the end-users of the information provided, enterprises are potential and important users of the COT itself. The role of enterprises in the project would start with the creation of the COT as this would define the envelope in which enterprises are able to operate. Enterprises could also be a part of

defining the COT, however usually internal resources are not allocated to such activities unless deemed profitable by the enterprise.

3.6.1 Micro-sensor providers

The project has established contact with two sensor platform providers: Dunavnet (Serbia) (DunavNET, 2014) and IA-ADN (Spain). These companies are providing the mobile platforms installed on the bicycles and the buses, respectively.

The role of the sensor and sensor platform providers in the project it is not only as a “provider” but also as a “user” of the results. Due to the novel nature of the systems there are interests from their side in knowing the performance of the sensors. A dialogue with both companies has been established to discuss further improvements on the sensors based on the results.

3.6.2 Business and innovation companies

Business and innovation companies would help to define or discover certain user groups and parties that would have a direct benefit from using the environmental information resulting from the project. When business models and business plans are developed, small enterprises can be formed to further develop the delivery platforms of the services that would be developed. The service delivery platform would be dependent on what the COT has to offer. Business and innovation companies are targeted by the project and are an important part of the dissemination strategy. By providing information service(s), the consortium already will be providing an example of what is possible through the project and the COT.

4 Expected offerings - products and services

4.1 Value propositions and expected offerings

The following describes the initial value propositions (from the Business Model perspective) and also the related expected offerings from the ATONE perspective. During the various projects meetings we reviewed a set with business tools and with idea generation tool. We introduced an own task force to analyse these tools, and to come up with suggestions for the project.

As a result of the recommendations of the task force, we selected the ATONE (AHO, 2007) method for service design of potential services. During several workshops we then created a list of shareholders/actors, and from an analysis of the actors we created a set of service interactions between the actors.

The initial work with the ATONE method generated a list of potential ideas for shareholders. As work is ongoing regarding the grading of the service ideas and the involvement of shareholder, this section only provides examples of ideas. Such examples include:

- The community awareness service, tailored at the Citi-Sense Observatory social network page to empower users in measuring (subjective and objective) air quality. The expected outcome is the social network providing users with data, tools and partnership for demand enhanced air quality in their area.

- The Personalised Environmental Service (PES), envisaged as a mobile app to provide users both with a real-time measure of the air quality while being on the move, and relating this air quality to his personal preferences.

- The service provider app for bus companies, where they can use the air quality measurements as arguments for their customers.

- A more generic toolbox, addressing the needs of service providers, app developers and other people to design services for their needs.

This initial examples are used to show the variety of ideas resulting from the ATONE process. Ongoing work includes the detail specifications of the content of these services.

4.2 Data

This section will provide an initial list of data types and data sources, being the source for service delivery.

4.2.1 Data types

Within the project we will employ electrochemical sensors measuring NO_2, NO, O_3, CO, SO_2 and CO_2 and meteorological sensors measuring temperature, relative humidity and atmospheric pressure. The electrochemical sensors are based on electrochemical reactions that take place within the sensor between the gas to be monitored and an electrolyte. The current produced by these reactions is measured

and related to the gas concentration by means of the Nernst law for electrochemical reactions. Some of these sensors exhibit cross sensitivity to other gases and interferences with temperature, relative humidity and, in some cases, wind speed.

The integration of the sensor within a platform is also very important, as noise from the electronics should be minimised. Moreover, as the sensors need to be in contact with the air, the design of the sensor case is of vital importance, as it should be a compromise between exposing the sensors and protecting them from the external environment.

In the project we will test two sensor platforms, one mounted on buses and the other mounted on bicycles. The sensor platform employed in the buses has been designed and developed by IA-AND (Ingenieros Asesores, 2014). The platform pumps air from outside the bus to a chamber in contact with the sensors through a 6 mm diameter tube located on the top of the bus. The chamber is located inside the bus. The air quality platform is connected with a computer system that collects data directly from the bus, such as, speed, position, use of breaking, etc. Using the General Packet Radio Service (GPRS), the air quality and driving pattern data, together with the position (GPS) information, are transmitted to a central database for storing, retrieving, aggregating, manipulating and presenting of the sensor data.

The sensor platform to be mounted on electrical bicycles and cars has been manufactured by DunavNET (DunavNET, 2007). The platform will be mounted on an electrical bicycle and the power for the platform will be supplied from the bicycle battery. The sensors will be mounted on the back of the bicycle and will be directly in contact with the air. The measurements collected and the GPS data will be transmitted to the same central database as the bus-mounted sensors.

4.2.2 Data standards

With the advent of the European Directive 2007/2/EC, or the INSPIRE (INSPIRE, 2013) standard as it is called, an infrastructure for spatial information in the European Union was conceived. During recent years, this has become enacted in law in Europe and now environmental data needs to conform to the standards. This will lead to:

- Improving the integration and access to existing temporal/spatial data across the European Union at a local, regional, national and international level;
- Facilitating improvements in the sharing of spatial data between public authorities;
- Improving public access to spatial data.

The institutes supporting the project have committed to developing the necessary infrastructure to conform to the INSPIRE standard. This will ensure that the data from the project will be integrated in a manner that is exploitable beyond the life of the project.

4.2.3 Data sources

Data from Citi-Sense-MOB and from CITI-SENSE comprises multiple streams. Data sources are developed in tandem in order to ensure proper management of the data, and control access to it when that is required. Currently, the project makes use of a number of different data streams that have been created to meet the needs of the other initiatives. These are detailed in Table 1, below.

4.2.4 Data services

The Citi-Sense-MOB project will develop a mobile service application system fostering its integration with other, already existing applications (e.g., weather forecast) and with heterogeneous data sources (institutional and user-based information) (Table 1). This service will be a product of Work Package 4, but it will be developed from the work done in Work Package 1.

Table 1: Overview of relevant data services in Norway

Name	Short description	Target group	Who collects/owns it
Pollen index	For a list of locations forecast of different pollen (Grass, Salix, Or, Mugwort, Birch, Hazel) conditions.	Asthma and allergy patients	NAAF Public Portal: www.pollenvarslingen.no/temasider/meldingstjenester/logg_inn.aspx Web service: xml.pollenvarslingen.no/pollenvarsel.asmx
Air quality index	Web service with current AQI for all stations and cities in Norway	Service providers	NILU Public Portal: www.luftkvalitet.info Web service: dataservice.luftkvalitet.info/airqualityindex/area/v2/?area=oslo,&format=xml&hoursback=-24&key=6LNHnePf
Air Quality Measurement data	Air quality data (CO, NO_2, PM_{10}, $PM_{2.5}$, etc.)	Service providers/authorities/Public	KLIF, NILU Public Portal: www.luftkvalitet.info Web service: dataservice.luftkvalitet.info
UV index	The strength of the UV radiation from the sun at a particular place on a particular day. There are five levels (low, moderate, high, very high, extremely high)	Service providers/authorities/Public	NILU Public Portal: http://www.uv.nilu.no/index.cfm Not a web service, but can be converted
Transport information	Public transportation route, travel time	Public, especially drivers	Ruter Public Portal: http://www.ruter.no
Weather conditions and forecast	Information on temperature, rainfall, wind speed and direction	Service providers/authorities/Public	MET Public Portal: http://www.met.no
Data services from CITI-SENSE	Information on outdoor air quality	Public	CITI-SENSE Public portal: http://co.citi-sense.eu

4.3 Tools

4.3.1 Web apps

Within the project, a simple web portal (Citi-Sense-MOB, 2013) was developed in order to provide a face to the public (Figure 5). Intended for publishing news and project related information, such as publications, events, etc., the project web portal does not enable access to the project data, or to data sources in general.

Figure 5: Project Public Portal main page

The project encourages engagement with the public, and project members are easily found on the contact page (Figure 6).

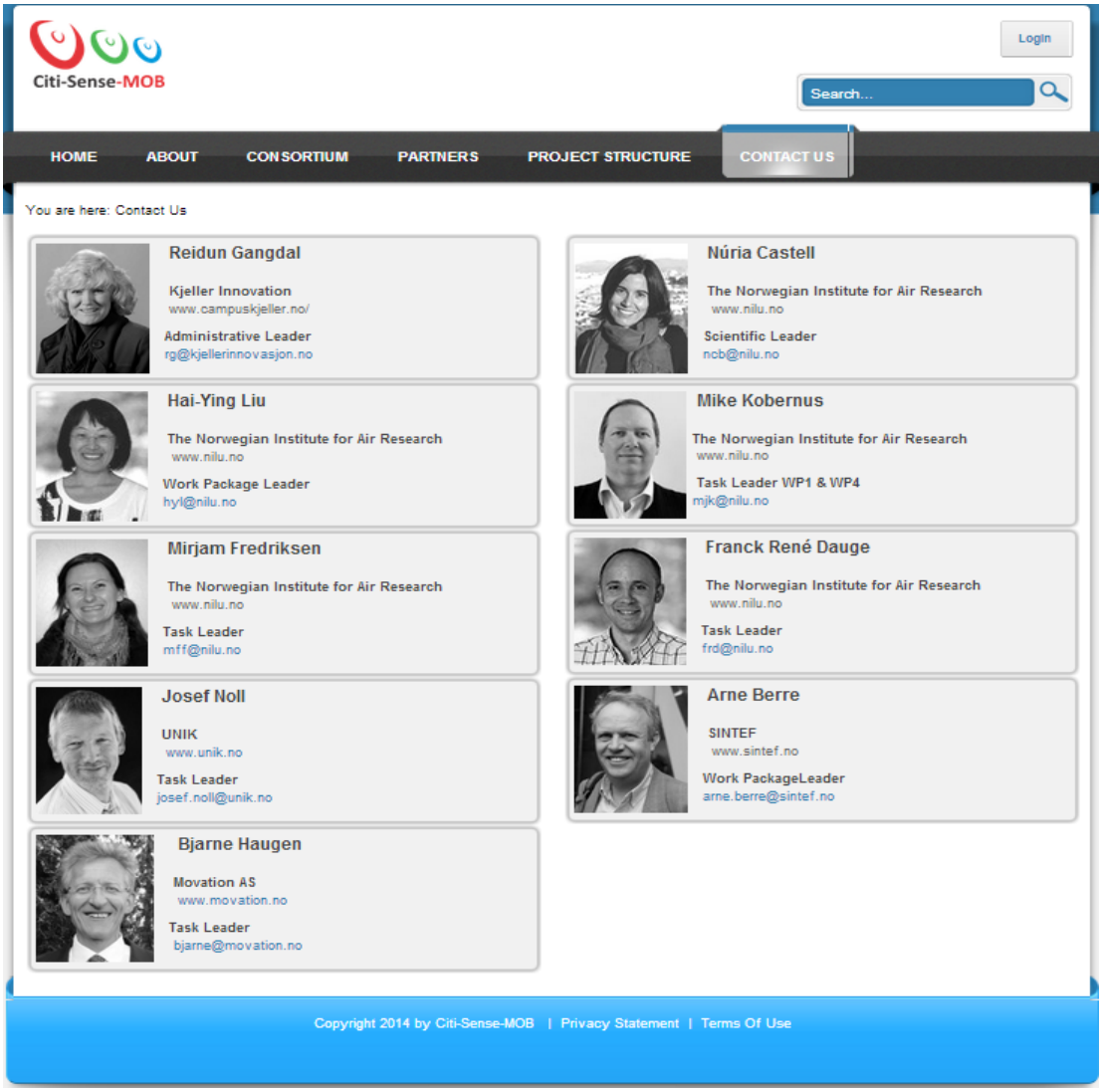

Figure 6: Project portal contact page

4.3.2 Mobile apps

Mobile apps is one of the focus areas for Citi-Sense-MOB, as we expect that users are motivated to join through personalised and real-time apps (Figure 7). User experiences from mobile operators like Telenor have shown that users have an extremely close relation to their phone, and that the phone is the predominant device for “time-killing” on busses, trains and boring meetings.

Web apps for air quality already exist. NILU has developed such an app, showing the air quality index in a certain area. Citi-Sense-MOB adds a new dimension to this kind of app, being the personalised and real-time information in a given location.

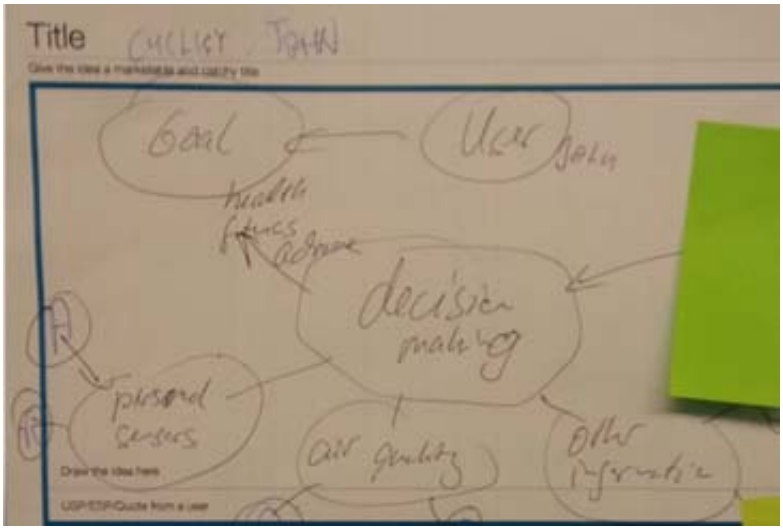

Figure 7: Brainstorming for Personalised Environmental Services

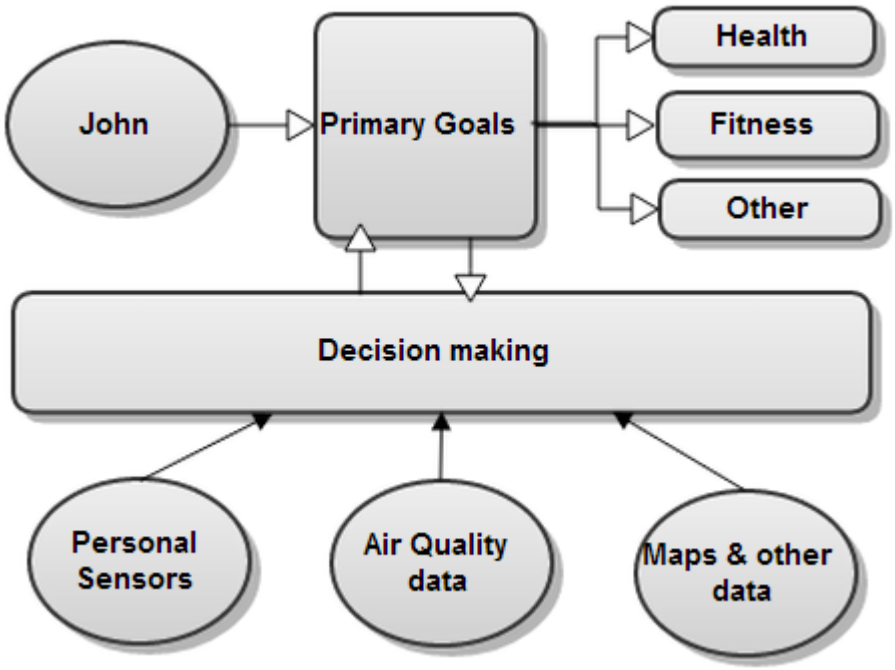

Figure 8: At-One concept for the Personalised Environmental Service (PES) post brainstorming session

The extension from a map with air quality index (AQI) into a personalised service with a personalised environmental information involves the user to a much higher degree. Figure 8 shows the outcome of the ATONE method, where the focus is on helping the user (i.e., John), in making decisions on reaching his personal goals. These personal goals can be related to health, fitness, security or any other goal. The core of the service is decision making, based on information from personal sensors, public maps and models on air quality, or any other information.

The definition phase for the personalised mobile app is ongoing. An initial phase identified the following aspects as being part of the mobile service (Figure 9):

- Personal preferences: The user should be able to bring his preferences into the app, e.g. providing his allergic reactions against grass, birch, or his asthmatic conditions with respect to temperature and humidity

- Real-time values: Bringing real-time measurements into the current location of the user, and thus providing a direct feedback to the user.

- Personalised Environmental Services (PES): Providing the user with the ability to link his personal thresholds with the actual real-time values, and thus provide a personal AQI. An asthmatic user might have a combination of dry air and low temperature to provide a "code red", while an allergic user would like to see information on certain pollen concentrations in the air.

- Map services and routes: Provide the user with information on routes, including both current, historical and alternative routes.

These examples of aspects for a PES might be extended with advanced models for air quality, or with recommendations from the social network. As mentioned earlier, the process is still ongoing, and we expect to have specifications for such a mobile pilot service in place in the upcoming months.

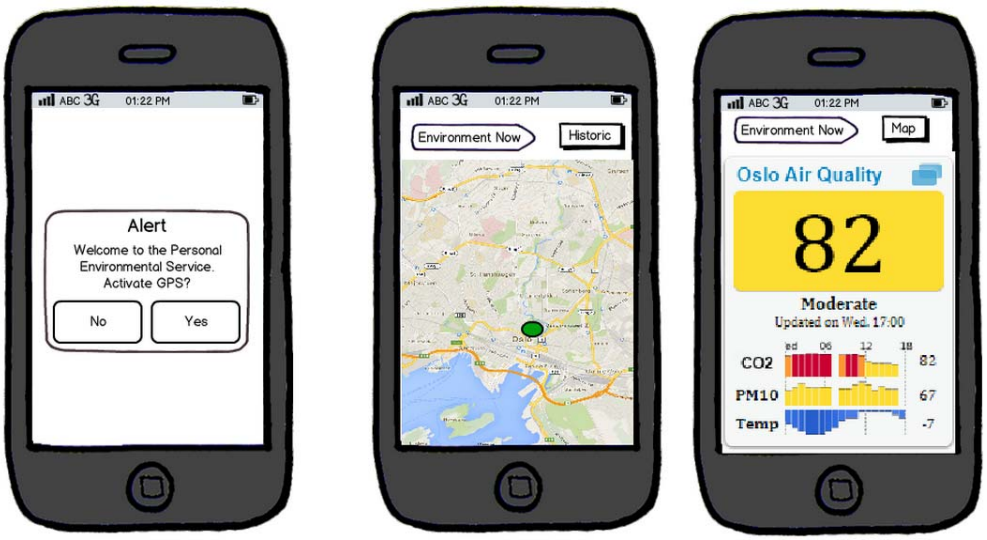

Figure 9: Mock-ups of the Personalised Environmental Services App.

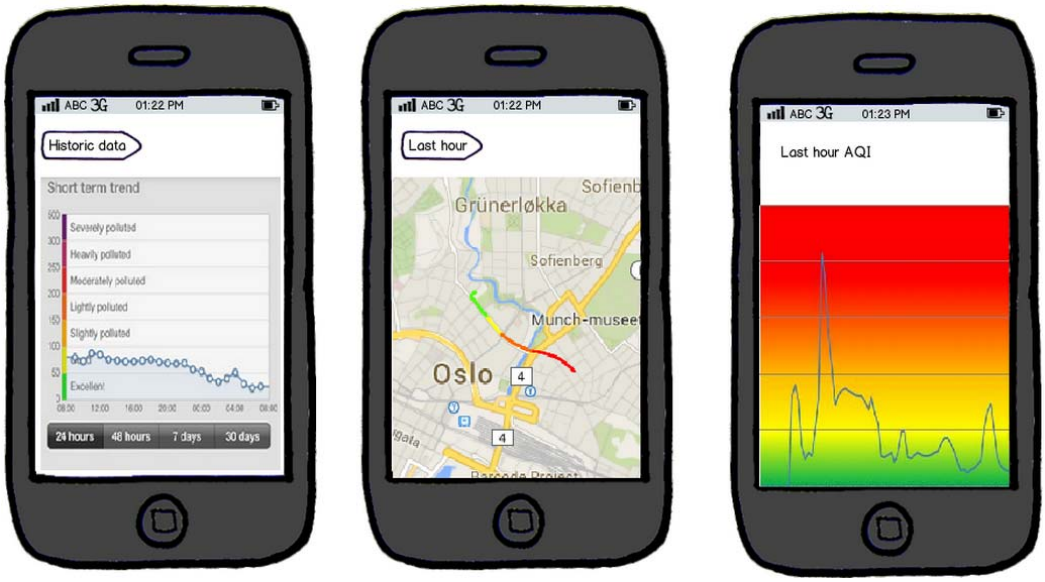

Figure 9 (cont.): Mock-ups of the Personalised Environmental Services App.

4.3.3 The related sensor packages with corresponding apps

Citi-Sense-MOB uses two types of sensor packages, one dedicated to operations on bicycles, and one being a specialised package for the operation on buses. The main difference is that the "bicycle sensor package" is a prototype, while the "bus package" is an operational package.

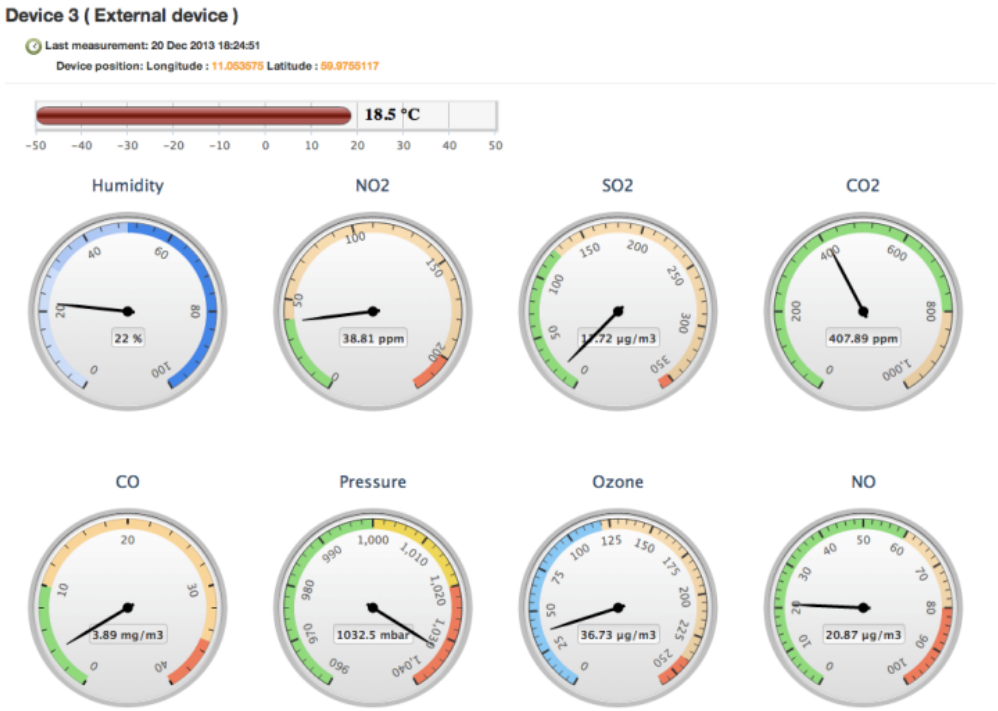

Figure 10: Examples of real-time sensor information from the Dunavnet sensor platform

The bicycle sensor package is delivered by DunavNET, and provides location, temperature, humidity, air pressure, NO_2, SO_2, CO_2, CO, Ozone (O_3) and NO. First examples of measurements are provided in Figure 10.

Though being operational on the Citi-Sense-MOB bicycle, we experienced a serious of problems, which are under further investigation right now. These problems include:

- Insufficient quality of the air quality sensors, leading to erroneous measurements. We have taken contact to the supplier, and will receive an updated sensor board.

- Unstable operations, both in terms of availability and in terms of sensor reporting. We are currently testing the sensor package in the real-life environment of the bicycle, and experience that (i) some sensors do not respond (e.g. position), (ii) the whole board does not transmit data, and (iii) unreliable operations.

  We currently experience under several working conditions in order to see if certain patterns, e.g. vibrations, cause the board to miss function.

- Power supply conditions from the electrical bike: Though initial tests suggest a stable 12 V power supply from the electrical bike, real-time measurements show malfunction of the sensor board. Further analysis has to be undertaken to find reasons for malfunctions.

- Configuration of sampling interval and data provisioning. We are in consultations with the provider DunavNET to understand the sampling strategy, and to adjust to the actual speed of the user.

Further challenges are in the availability of standardised data sets, which we need to integrate in our toolbox for flexible service supply.

The second sensor package used in Citi-Sense-MOB relates to the operational offerings from ADN for the professional market. These sensor packages include both vehicle information like speed, acceleration, fuel consumption, as well as air quality measurements. Negotiations with the actors are ongoing, and an installation of sensor packages is expected in the upcoming 3-4 months. The air quality parameters are similar to the ones provided by the DunavNET package. A detailed description is deferred to later deliverables, and will include the installation information.

We are continuously following the market to identify upcoming sensor platforms, both addressing the needs of mobile users, as well as fixed installations. Results of this market monitoring might influence the selection of sensor platform, or the extension towards novel measurement domains.

4.3.4 Maps

The environmental information of interest to users generated by the project will be visualized in maps that can be accessed through both web and mobile apps. The expected maps that will be produced by Citi-Sense-MOB are:

- Eco-driving route
- Urban scale air quality map
- Personalized AQI map
- Individual trajectory exposure pattern map

4.4 Services

Information of interest to users, e.g., personalized information, exposure assessment, such examples include:

- The community awareness service, tailored at the Citi-Sense Observatory social network page to empower users in measuring (subjective and objective) air quality (Figure 11). The expected outcome is the social network providing users with data, tools and partnership for demand enhanced air quality in their area.

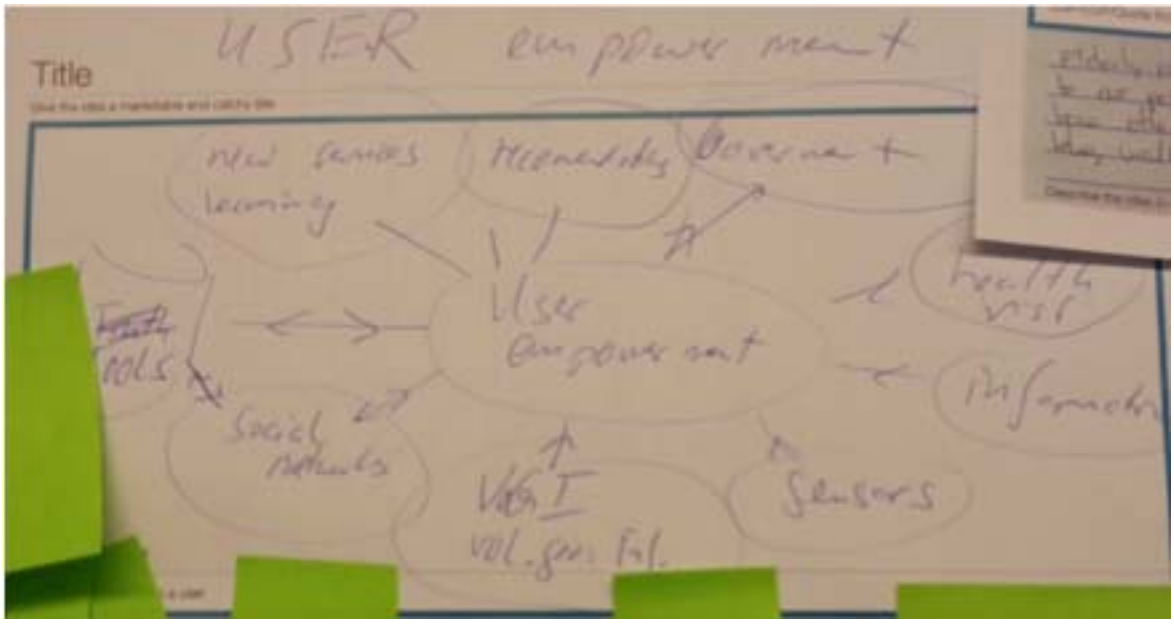

Figure 11: Example service for user empowerment using air quality data

- The personalised environmental services (PES), envisaged as a mobile app to provide users both with a real-time measure of the air quality while being on the move, and relating this air quality to his personal preferences (Figure 12). This image demonstrates the original brainstorming of the mobile app, which is more fully detailed in Figure 9, above.

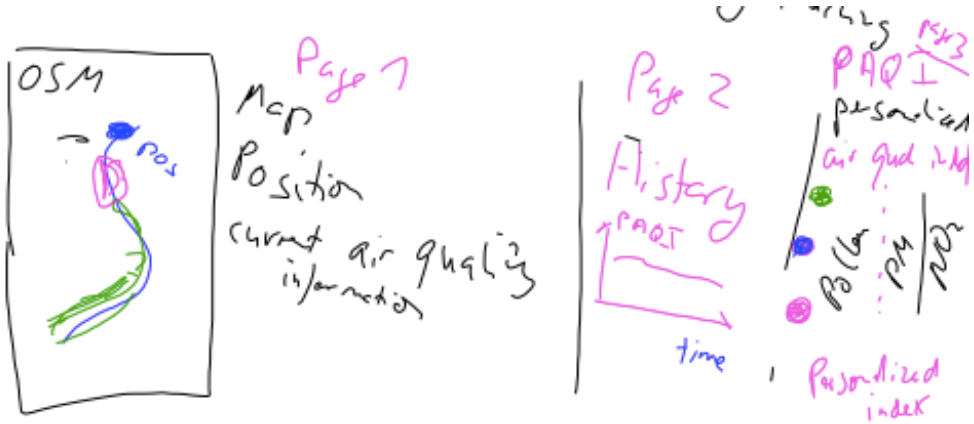

Figure 12: Design aspects of a mobile app introducing the PES

- The service provider app for bus companies, where they can use the air quality measurements as arguments for their customers (Figure 13).

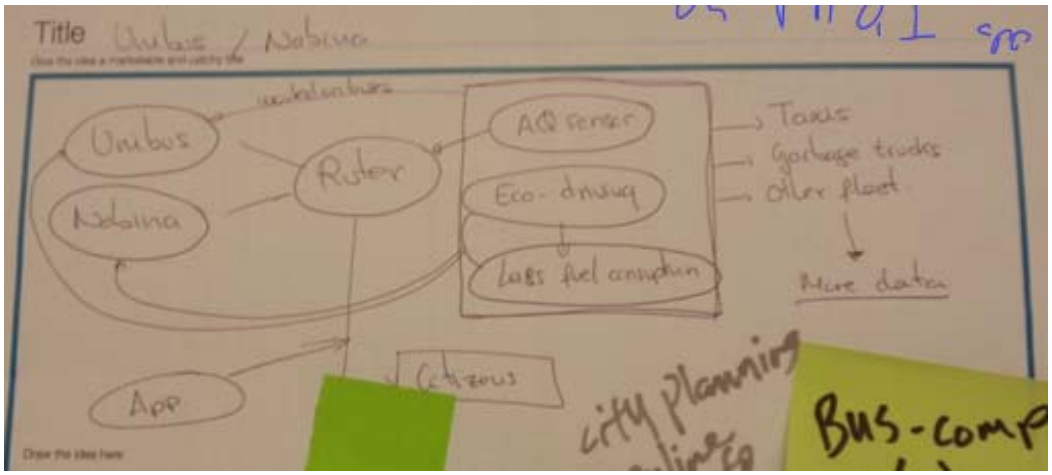

Figure 13: Actors and value proposition for bus companies and city planning based on air quality information

- A more generic toolbox, addressing the needs of service providers, app developers and other people to design services for their needs. Such a toolbox will provide the means for a quick and agile service design, using visualisation techniques for graphs, maps, routes, as well as time-aspects of such services.

These initial examples are used to show the variety of ideas resulting from the ATONE process. Ongoing work includes the detail specifications of the content of these services.

4.5 Methodologies

Visualisation of the data acquired in the CITI-SENSE and Citi-Sense-MOB projects will be performed using a variety of techniques. Initially, for the online visualisation to be carried out in near-real-time, the users will be provided with maps showing the locations and measurements of all currently active sensor nodes. Within the limits of location privacy considerations, the archive of previously collected data will be made available. Online Visualisation will be implemented using the open source GIS (geographic information system) Server Geo-Server application which will be the backend for both web-based and mobile mapping of the data provided by the project. The sensor observations will be shown as points overlaid on a street map (e.g., Google Maps or OpenStreetMap), and thus will provide measurement location information to the users.

For many of the planned applications of the Citi-Sense-MOB project, such as finding the least polluted route through a city, it is necessary to compute a gridded raster of urban air quality fields such as NO2, PM10, O3, etc. This can be accomplished by interpolating the individual observations in an intelligent and objective way. Possible techniques for performing this, ranging from the simple to the more complex, include: a) basic interpolation techniques, such as linear interpolation, natural nearest neighbour interpolation, or inverse distance weighting; b) geo-statistical techniques such as kriging (Goovaerts, 1997; Wackernagel, 2003), which specifically account for spatial autocorrelations between the observations and further allow for the integration of spatially exhaustive auxiliary datasets; and c) data assimilation approaches such as the Ensemble Kalman Filter (Evensen, 2003; Sakov and Oke, 2008), which combines information from a model with observations, including their errors, to interpolate between observations in an objective and physically reasonable way.

5 Customer relationships, needs and touch points

The following describes the establishment of customer relationships (from the Business Model perspective) and also the related analysed needs and touch points from the ATONE perspective.

Through the workshops on service design we identified more than 60 actors being involved. The analysis of the roles is still ongoing, and will be reported in a follow-on deliverable.
The main groups of customers to be addressed include:

- Individual users with specific needs: This group includes sports people, parents with children, elderly people or anyone with specific needs for a personalised service. Their main goal is to get personal advice on outdoor activities.

- Interest organisations, including: cycling associations, alliances for asthma and allergic people. Their main goal is to provide services for their members, e.g. prediction models or recommendations.

- Kinder garden and schools, being able to extend their education with the 3rd wave of health information “what makes us sick”.

- Service providers like app providers, who see an opportunity to extend weather information with air quality information, and thus being able to provide personalised services.

- Bus and other transport companies, being able to provide their customers with arguments for using the public transport

- Citi planners and other authorities, being able to use real-time information for avoiding of air pollution peaks or better transport routes for environmental-friendly transport.

- Researchers correlating air quality with health aspects.

As work on evaluation of the >60 actors in air quality measurements is ongoing, we defer the detailed description to later deliverables.

6 Summary

Citi-Sense-MOB will develop a comprehensive Citizen Observatory Toolbox (COT) which will not only inform the public on current environmental conditions directly to their phone, but also obtain Volunteered Geographical Information (VGI) input from the public either by using their mobile device as a sensor (e.g., taking a photo and submitting it to the project web-based data server, or by using built in sensors (noise, humidity, temperature, etc.) or by their personal physiological responses (such as having a headache, am dizzy, sneezing, etc.) and/or by describing their ambient conditions (e.g., is raining, is snowing, is windy, etc.).

Expected services that will integrate data collected during this project with other data services available from other projects and programmes relate to eco-driving, personalised environmental information and environmental health alerts and various recommendations to different target groups. The existing relevant data services in Norway which are considered for integration into this project are:

1) Pollen index
2) Air quality index
3) Air quality measurement data
4) UV index
5) Transport information
6) Weather conditions and forecast

The potential data that will be generated from this project are near real-time air pollutant concentrations (e.g., O_3, NO_2, NO, CO, CO_2, SO_2, PMopc and UV) and meteorological variables (i.e., relative humanity, temperature, and atmospheric pressure) at city level. The data that will be drawn from other projects (i.e., CITI-SENSE) that is considered synergistic with this project are: 1) thermal comfort index; 2) acoustic index; 3) noise; and 4) physical movement.

The impact of the project is expected both on a general and a specific/local level. The project will contribute both to awareness raising related to links between climate change and air pollution and air pollution impact on health, and a behavioural change towards using less polluting transportation, through providing mobile services related to emissions and concentrations of relevant pollutants. Accordingly, the project target groups are:

1) Public: general public (people) and health interest groups (e.g., NAAF)
2) Local governments and public entities (Oslo kommune, and other city Kommunes in Norway)

3) Transport related agencies (Ruter, Nobina and Vegvesenet (The Norwegian Public Roads Administration))

4) Researchers (NILU, UNIK, SINTEF, and researchers outside of Citi-Sense-MOB consortium)

5) Enterprises: micro-sensor providers and smart phone services providers, and business and innovation oriented companies

This document captures specifications, architecture and creates a conceptual design of the project products and services.

7 Acknowledgements

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ABSTRACT
This report gives an overview of the service system design, requirements, specifications and architecture for the main products – Citi-Sense-MOB Citizen Observatory Toolbox (COT), which comprises of a series of applications that support and complement each other. These include the concept for COT, service design concept and methodologies, the COT target groups, and a set of COT (e.g., data, web apps, mobile apps, maps, services, methodologies, etc.).

NORWEGIAN TITLE

Citi-Sense-MOB
Designdokument for konseptuelle tjenester.

KEYWORDS		
Citizens' observatories	Environmental health	Mobile services

ABSTRACT (in Norwegian)
Denne rapporten gir en oversikt over tjenestenes systemdesign, krav, spesifikasjoner og arkitektur for de viktigste produktene; Citi-Sense-MOB Citizen Observatory Toolbox (COT). Dette består av en serie med programmer som støtter og utfyller hverandre. Disse inkluderer konseptet for COT, service designkonsept og metoder, COT målgrupper, og ett sett av COT (f.eks, data, web apps, mobile apps, kart, tjenester, metoder, etc.).

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