WP4 Pilots, citizen involvement, integration and validation.
D4.3 Integrated use cases and first large-scale deployments and experimentation -Demonstration-

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BIGCLOUT

Big data meeting Cloud and IoT
for empowering the citizen ClouT in smart cities

H2020-EUJ-2016 EU-Japan Joint Call

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ABSTRACT

This deliverable describes the first demonstrators of integrated use cases and large-scale deployments and experimentation of the BigClouT project. Its objective is to show the work of integration of the project partners' achievements. It includes brief descriptions of the demos, as well as other relevant information such as data sources, and ongoing developments in the tasks. The live demonstrations will take place during the 2nd year review meeting of the project.

Disclaimer

Revision history

Revision	Date	Description	Author (Organisation)
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1 INTRODUCTION

This deliverable describes the first demonstrators of integrated use cases, large-scale deployments and experimentation of the BigClouT project. For each city we provide a brief update of the two main trials (based on year 1 use-cases) and then a description of the demonstrator available at the review meeting to showcase the trial.

Where possible, we have highlighted how the planned trials - and demonstrators - are scaling to fullfill our stated focus on large scale. Further, since one of the main objectives is to verify implementation of the applications using BigClouT technology in the real world we have included a section (section 4) which discusses how the trials use the core BigClouT platform and the WP2 and WP3 technologies under development.

This deliverable is presented as an explanatory material of demonstration for the second review meeting planned to be held in September 2018. The details about field trial with BigClouT technologies has been described in the other deliverables of WP4 (D4.2).

2 CITY TRIAL STATUS AND DEMONSTRATORS

All cities are progressing well with this trial activities with continued progress on defining, refining and deploying trials. Outlined below are updates on the development of the use cases, and their current status, along with any important changes in use-case design as a result of experimentation and other factors. Following on from the status update of the trials, is a description of the demonstrator that will be available at the 2nd year review which servers to document and highlight progress of the city trials.

2.1 Fujisawa

Fujisawa have been focusing on two core areas for trials - participatory sensing and infrastructure management. Within these areas are a number of sub-projects each with its own self-contained trial.

2.1.1 Trial 1: Participatory sensing, and optimizing the incidence on local economy

To collect various city information from city officers, we developed MinaRepo in the 1st year. It focuses on allowing city officials to record incidents such as graffiti, problems with garbage etc, and to initiate action by city officials to resolve the issues. In the 2nd year, our main activities we to improve the MinaRepo system to reflect feedback from Fujisawa city officers, e.g. types of incidents, and reporting workflow, and to add functionality such as KML file import functions or report export functions. A second major push was to scale up the field trials by deploying it to other Japanese (and European) cities. To this end, we have replicated the MinaRepo system in other BigClouT partner cities (described later in this document), and we have deployed MinaRepo system to cities outside of the BigClouT project - Chigasaki city and Samukawa town.

A second major push has been to expand the range of the participatory sensing trials. In addition to scaling up the 1st year's field trial, we are also planning a crowd event management field trial towards the 2020 Tokyo Olympics/Paralympics. As described in D1.4, Enoshima island in Fujisawa city is chosen for the sailing competition of the 2020 Olympic/Paralympic games. To understand the real-time congestion of spectators, and also predict future congestion, we will collect and analyse various information around Enoshima island. Figure 1 shows a brief overview of the trial. We plan to gather open data or sensorized web data such as parking lot information, number of people in surrounding stations, SNS information, etc. In addition, we have set up a camera at the observatory in Enoshima island called Sea Candle. The camera has a view over the popular Shonan beach area and will be used to allow us to determine number of people in the beach area. We plan to develop a method to count number of people from high-resolution image which, because of long range nature of the camera, will ensure privacy. In addition, we also plan to use predictive number of people in the area by using NTT Docomo's technology. Combining historical data captured by us and predicted data by docomo, we are planning to generate future image of beach (see Figure 2). By using these data, we are able to make a real-time area management plan with Fujisawa city officers and several stakeholders.

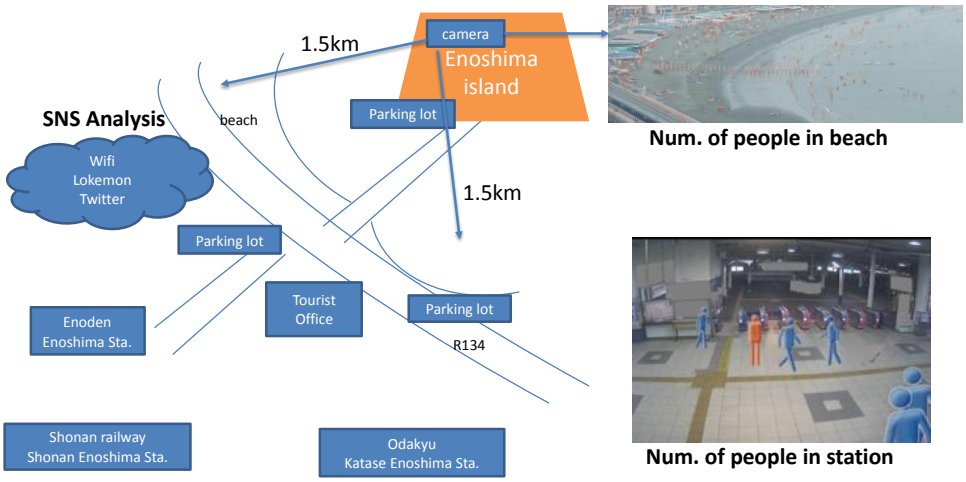

FIGURE 1 : OVERVIEW OF ENOSHIMA MONITORING TRIAL

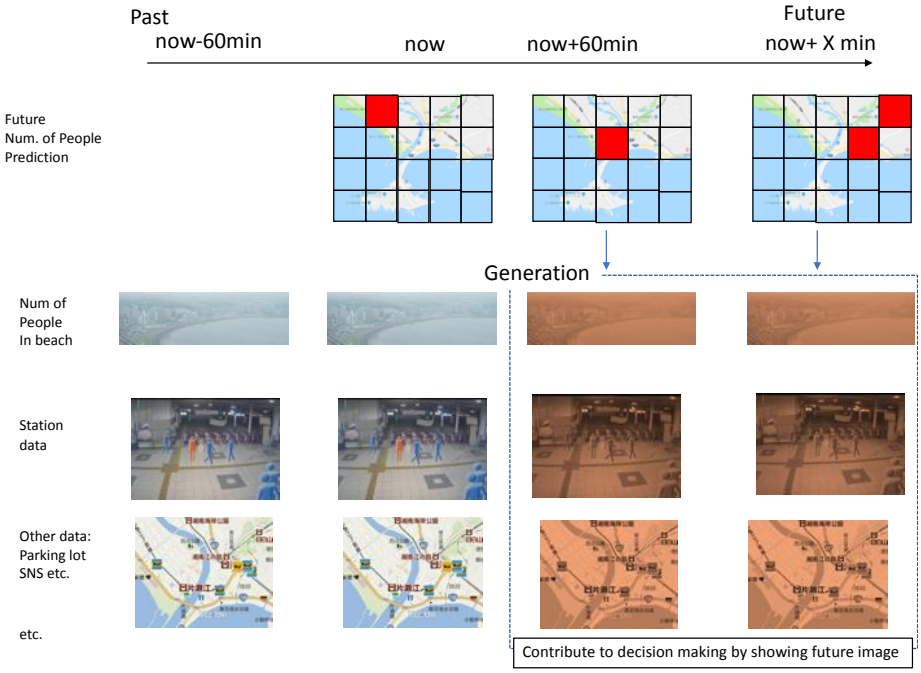

FIGURE 2 : FUTURE IMAGE GENERATION

2.1.2 Trial 2: Fine-grained city infrastructure management

The Use-Case 2 trial is focused on fine-grained city infrastructure management and is an extension of the work we demonstrated in year 1 based on sensors attached to garbage trucks in Fujisawa city. As part of our scale-up efforts we have expanded this trial to use camera data to determine road surface condition, and in particular status of road markings. In addition, we have integrated several BigClouT components from WP2 and WP3 such as D-NR and KNOWAGE to validate the technology.

Our key stakeholder, Fujisawa city have highlighted a concern with the road network that they manage. Road infrastructure in Japan is getting older, with many roads/brofges etc built as part of a significant infrastructure build out 30-40 years ago. As this infrastructure ages, it is necessary to understand the road conditions of the whole city to develop a comprehensive plan for maintenance and repair. Thus, we will deploy sensor box to capture and analyse road condition on the roof of garbage trucks. Currently we have designed and implemented hardware equipment of the sensor box, and also developing software tools for integrating several components of BigClouT.

2.1.3 Fujisawa Demonstrator

The Fujisawa demonstrator will focus on the 2nd use case - infrastructure management - and will demonstrate the newly developed system for road condition monitoring. In the demonstration, we will firstly show the trial scenario which has been driven by stakeholder needs, and the overall system architecture of the Fujisawa trials. Then, we will demonstrate our software components for the trials with recorded sensor data or video.

As part of the demonstration we will focus on two key aspects of the trial - integration of WP2 and WP3 components and resolution of privacy concerns. In particular, we will show:

- Integration of Edge processing and use of the BigClouT application programming tools for Smart Cities (T2.4)

In T2.4 we have developed a programming tool for Smart Cities, Distributed Node-RED (D-NR) that also implements and supports the BigClouT edge processing capabilities. The demonstrator uses D-NR and has developed a program (flow) which manages garbage trucks sensors and analysing/visualizing software components.

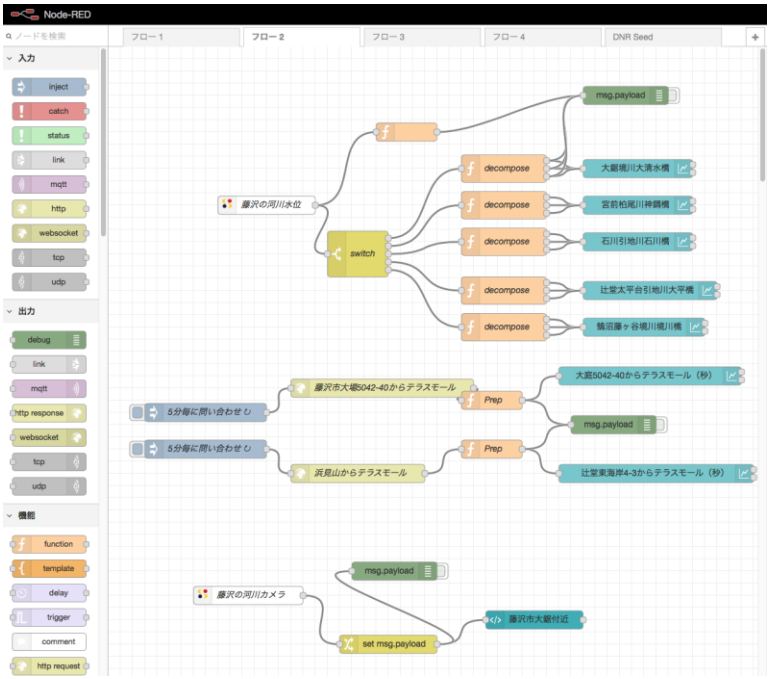

FIGURE 3 : IMAGE OF DISTRIBUTED NODE-RED INTEGRATION

- DeepOnEdge with removing privacy-concern data
Presenting new DeepOnEdge technique which detects road marking blurs from dashcam images. Also, we will present **in-painting** method which removes privacy-concern data from image.

FIGURE 4 : IMAGE OF DEEPONEDGE

2.2 Bristol

2.2.1 Trial 1: Smart Mobility - Walkability and Air Quality trial

Bristol's first use-case trial is designed to provision a citizen with air quality and mobility data in order to help identify the least polluted and safest routes to walk around the city. The initial concept of the use case was to increase the citizen uptake of this information utilising LED screens deployed in the city centre. However, Bristol has had to make some adjustments to this use case based on the viability and cost of installing the LED screens.

As a result of these changes Bristol is now looking to utilise a mobile interface for displaying the data, and will look into the viability of using a public screen accessible in Millennium Square. Further changes to the smart mobility project include the following;

- Incorporation of open data sets on air quality to provide a wider geographic range of air quality across Bristol.
- More data will be collected from the council and open data sets on vehicle congestions in the city, in order to direct walkers from heavily congested areas.

While it is clear that this refocus on mobile devices will result in the reduction in the number of immediate users who will be able to view the air quality data, including the variety in demographic, for instance, people without phones will not be able to utilise the service. We believe that overall, participation is likely to increase because, users throughout Bristol will have access to the data, not just users in the vicinity of the public displays.

Ongoing work is being undertaken to deploy the R & D air quality sensors within Bristol City Centre on available partners rooves and balconies.

To scale up the use case additional travel and traffic data will be shared by the City Council. This will include;

- Traffic count within Bristol City Centre (Oct 2018)
- YoBike bike sharing scheme (Dec 2018)

2.2.2 Trial 2: Smart Home energy consumption

This trial is about exploiting BigClouT's novel data-adaptive machine learning techniques for predictive analysis and the power consumption of users.

The objective of the project is to make householders aware about different phenomenon, that otherwise would have a very difficult detection like 'the phantom load' also known as 'vampire power'. This is the electricity consumed by electronic and electrical appliances while they are switched off (but are designed to draw some power) or in a standby mode. This consumption may be of the order of 10% of the electrical energy used by a typical household.

Saving electricity not only will affect the house holder pocket, but electricity is very often generated by combustion of hydrocarbons (oil, coal, gas) or other substances, which releases substantial amounts of carbon dioxide, implicated in global warming, and other pollutants such as sulphur dioxide, which produces acid rain, so at the same time the user is helping to take care of the planet.

In the smart home trial in Bristol the design of the smart home connectivity has been ongoing. Homeowners Wi-fi will provision connectivity to connect to the BiO cloud. A smart home kit will then be deployed into the houses to monitor electricity usage utilising smart sockets and washing machines. To ensure security of the smart home kit, a Raspberry Pi VPN device will be installed.

The next steps are to install in the remaining houses and test the data flow to the Bristol cloud. The options to scale up this use case would be to provision data analysis of all households to show the collective impact on energy consumption within the specific areas.

2.2.3 Bristol Demonstrator

Bristol will demonstrate both of the use-case trials in the review meeting: Smart Mobility and Smart Home/Energy use cases.

The Smart Mobility trial will present air quality data (both long-term historic records and real-time monitoring) that will be collected from Bristol Open Data platform; latest measured levels from Bristol St Paul's air quality monitoring station data provided by the Environment Agency and data from the air quality IoT device provisioned by BIO. This multi-sourced data, including PM2.5/10, NOx, O3, CO2, etc., will be aggregated and input to the BigClouT data warehouse using the BigClouT application programming tool, based on Node-RED.

The data will be used for route-finding based on air conditions as a pollution-aware smart mobility solution. A data visualisation dashboard for air pollution level will be shown in a public zone.

Smart Home/Energy use cases will present live energy consumption data from smart goods (e.g., Samsung smart washing machines) in residents' houses (the number of houses is dependent on actual deployment progress). The energy consumption data from smart homes will interact with the Energy Demand Management System for optimal/reduced energy usage for daily living. The data will also be streamed into the BigClouT data warehouse via Node-RED.

The following figure shows the system architecture in this trial:

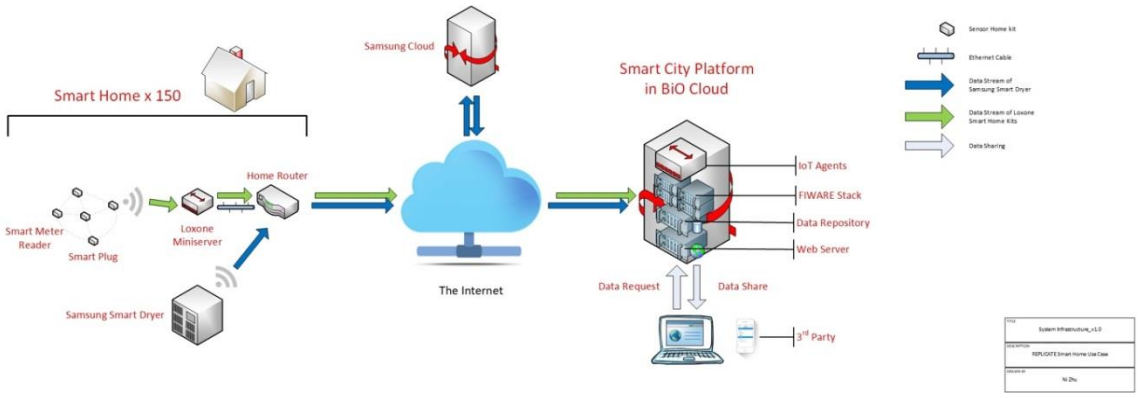

FIGURE 5 : THE SYSTEM ARCHITECTURE OF SMART HOME / ENERGY TRIAL IN BRISTOL

2.3 Tsukuba

We plan to implement two field trials in Tsukuba city that correspond to the two use cases:

- Use Case 1: Provide tourism, traffic and environmental information in real time to visitors
- Use Case 2: Grasp status about foreign visitors to Tsukuba and provide concierge service to them

2.3.1 Trial 1: Provide information in real time to visitors

Tsukuba City is known to be a scientific city where hundreds of public and private research institutes as well as universities are located. Besides, the city has many sightseeing places, including Mt. Tsukuba. For this reason, the city has significant number of domestic and foreign visitors, and the number is considered to be growing. To further increase the number of visitors, it is important to improve the visitors' experiences during their stay in the city.

In this trial, we aim at delivering timely information to visitors through different channels, i.e., smartphone apps, digital signage, etc. More precisely, we plan to use the following media to deliver information:

- Smartphone apps: We exploit the smartphone app developed for Trial 2 (HukuRepo) by extending its functionality in such a way that it supports context-aware/location-based recommendation. To this end, we collect different kinds of information from stakeholders, and deliver to users depending on users' location and/or context.
- Digital signage: We plan to put digital signage at Tsukuba Centre whereby we can deliver information to visitors.

The timeline is as follows:

- System development: April 2018 - September 2018
- City trial: October 2018 - November 2018

2.3.2 Trial 2: Participatory Sensing App (HukuRepo)

In 2017, we carried out the first version of Trial 1: participatory sensing app (HukuRepo) for foreign visitors. Specifically, In Tsukuba City, the city officials have a problem that they do not have comprehensive information regarding foreign visitors, such as the number, gender, country, popular visiting places, etc. Also, they do not know the problems experienced by foreign

visitors. To cope with this problem, in this trial, we developed a participatory sensing system for foreign visitors which used smartphones to collect problems experienced by the users during their stay in Tsukuba. The application allowed users to submit problems along with photos and descriptive texts. In addition, for submitted problems, the system allowed some city volunteers to provide real-time feedback in terms of texts, which are considered to be useful for the visitors to solve the problem.

As reported in D4.2, the first version was successful, but at the same time, we found several problems; i.e., 1) the total number of participants was lower than expected and 2) replies made by volunteers were generated manually. To address these problems, in the next trial, we plan to make the following updates:

- It turned out that major sources of visitors to Tsukuba were China and Korea. To recruit more participants, we add multilingual support for Chinese and Korean, as well as English and Japanese.
- In the previous trial, we only supported Android smartphones. To invite more people who use iPhone, we additionally support iOS version.
- Making responses for submissions manually gives rise to a problem in scalability of the trial. To alleviate this, we introduce a question answering system which partly covers simple/typical questions. To realize it, we construct a dedicated knowledgebase.

Currently, we are preparing for the second version of trial 2 to be run Oct-Nov 2018. More precisely, we have been working on the following developments:

- Extending the HukuRepo app to support multiple languages, namely, Chinese, Korean, and Japanese.
- Developing a knowledgebase for making responses to posts.

The timeline is as follows:

- System/client development: April 2018 - July 2018
- Ethics document submission: May 2018
- Preliminary city trial at "Matsuri Tsukuba": August 2018
- Additional refinement on system/client: August 2018 - September 2018
- City trial: October 2018 - November 2018

In terms of scaling up the trial, we plan to explore two avenues - firstly, ensuring greater participation (as discussed above) and secondly, we are considering the possibility of running a HukuRepo trial in Fujisawa city.

2.3.3 Tsukuba demonstrator

In the demonstration we will show the smartphone apps used in the trial, i.e., HukuRepo post for visitors (Figure 6) and HukuRepo answer for city volunteers (Figure 7).

In addition we plan to demonstrate the web data viewer for HukuRepo whereby city officials can browse the collected data through an interactive map (Figure 8).

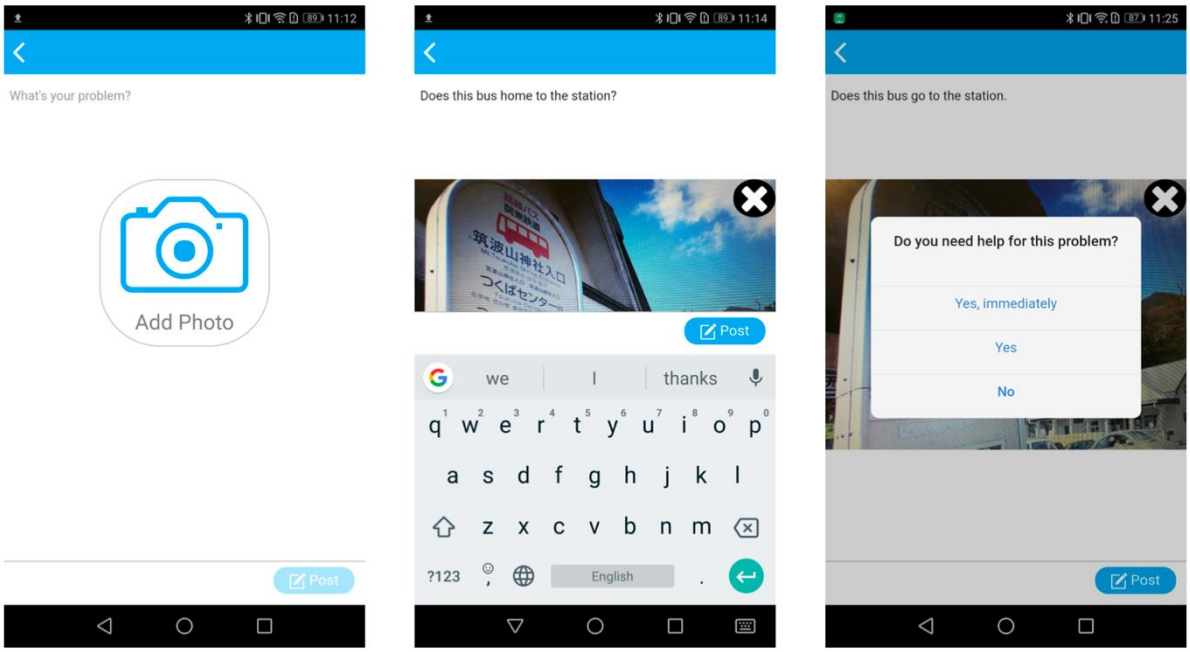

FIGURE 6 : SCREENSHOTS OF HUKUREPO POST SMARTPHONE APP

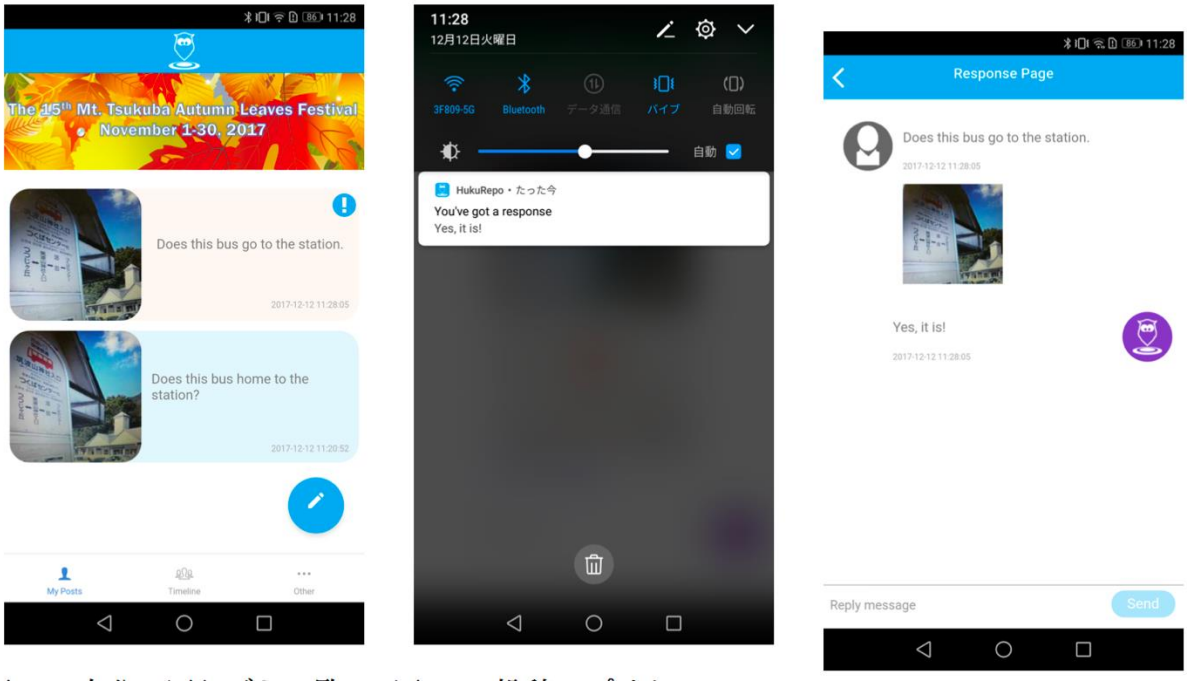

FIGURE 7 : SCREENSHOTS OF HUKUREPO ANSWER SMARTPHONE APP

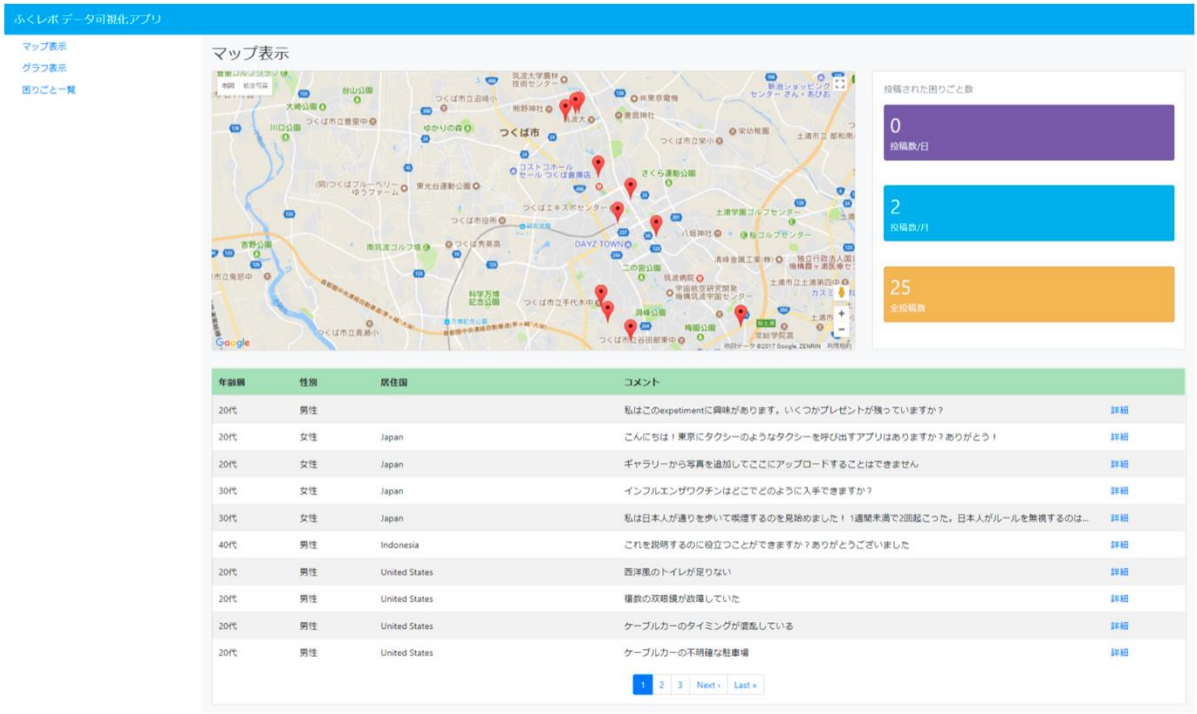

FIGURE 8 : SCREENSHOT OF HUKUREPO DATA VISUALIZER

2.4 Grenoble

2.4.1 Trial 1: Business Events

The first use case identified for Grenoble concerned the creation of a tool that would allow us to better understand the impact of business events on the local economy. The Greater Grenoble City Area is trying to attract more and more business events (trade shows, conferences…) to the area and one of the reasons for doing this is that it creates business for local shops, restaurants and hotels. However, we have no real way of measuring this impact.

Different stakeholders were identified and contacted in 2016 and there was a general consensus that this tool would be useful for a large number of actors besides the Greater City Area. A survey was conducted among people that had visited Grenoble to attend a tradeshow which also gave positive feelings towards the creation of said tool.

Discussions continued with stakeholders to identify that this tool would be a mobile phone app that visitors could download to navigate the event that they were attending (with maps, networking tools, programmes…) and also their free time in the city with information regarding local shops, businesses, restaurants, transport information and with special offers with reductions available.

As the second use case had gained more popularity from various stakeholders, it was decided to concentrate on the development of the app for the second use case as there was insufficient financing available to be able to develop both mobile phone applications.

This use case has therefore been on standby for a year.

2.4.2 Trial 2: Management of industrial estates

The second use case identified by the Greater Grenoble City Area was the management of the different industrial estates managed by the Area, in terms of managing office space, transportation and creating a community of actors in these zones.

Discussions began with different stakeholders and the industrial estate "Inovallée" was very interested in developing a tool that would help them manage the zone. It was decided to create a mobile phone app that would bring together all different questions relating to users of the zone - transport options, dining options, information about the different actors present on the zone, information about business events and various sport clubs etc.

The idea for this project was validated through a survey carried out with the users of the Inovallée zone who were overwhelmingly positive about the creation of an app.

The Greater Grenoble Area, as a local authority, must abide by rules relating to calls for tender when paying for services. This led to some delays in recruiting an app developer who was finally brought on board in April 2018. The creation of the app is currently underway and should be ready for first trials to begin in September 2018.

The developer is working closely with the CEA in order to ensure that the app is entirely integrated to the Sensinact platform.

At the same time as the development of the mobile phone application for the Inovallée industrial estate, discussions have taken place with other industrial estates operated by the Greater Grenoble City Area. The "Espace Comboire", in particular, was identified in 2017 as a site that this app could be adapted for. The different stakeholders around this zone were identified and contacted and approved the idea of developing the app in their zone and surveys among the different users of the zone (employees, shoppers, visitors…) were carried out that also confirmed this interest. Unfortunately, in May 2018, this project was abandoned by the management of the Espace Comboire zone.

The sale-up of this use-case in the Grenoble City Area therefore needs to be re-examined in the near future.

2.4.3 Grenoble demonstrator

In collaboration with the Inovallée industrial estate management team and the CEA, Grenoble-Alpes Métropole drew up technical specifications outlining the requirements for the Inovallée app:

Functional

- Interface with exisiting mobility app – "métromobilité" (real time public transport info and itineraries)
- Interface with car-sharing app "Citiz"
- Interface with different restaurants (opening hours, menus, prices…)
- New ride-sharing tool to allow to plan journeys → to add predictions?
- Interface for following deliveries/ parcels
- Interface with existing data
- Interface for updates concerning sporting & cultural events
- Alerts

Technical

- Tracking of use of app, performance & security
- Protection of personal data
- User satisfaction surveys
- Works with different operating systems
- Management of data exchanging between users
- User friendly
- Easy to update/ add to content
- Continous technical assistance → bug fixes, updates

Following a public consultation, the development of this mobile phone application has been designated to "TheDigitalCompany", a Grenoble-based company. "The Digital Company" has a contract for one year, in order to cover any technical assistance such as bug fixes or updates that need to be done over the launch of the app.
The app should be launched in September 2018, for the "rentrée" (the beginning of the French school year).
Users will be invited to download the app from the Apple and Android app stores via a big communication campaign.
Once downloaded, users have to accept the terms and conditions of using the app, such as geolocalisation. They then have access to a menu of different services:

- Address book

  Users can easily access the address and contact information for all companies based in the Inovallée industrial estate
- Events

  All events (sports, cultural and professional) that Inovallée is associated with can be consulted on the app and users can register for the events directly
- Public Transport

  Real-time information for all bus lines that run through the Inovallée zone can be consulted through the app
- Car-sharing

  Users will be able to consult journeys and to propose to share car rides through the app which interfaces with an existing service
- Restaurant options

  Users will be able to consult the menu options and opening times at the different canteens on the Inovallée site and also consult the location of different food trucks

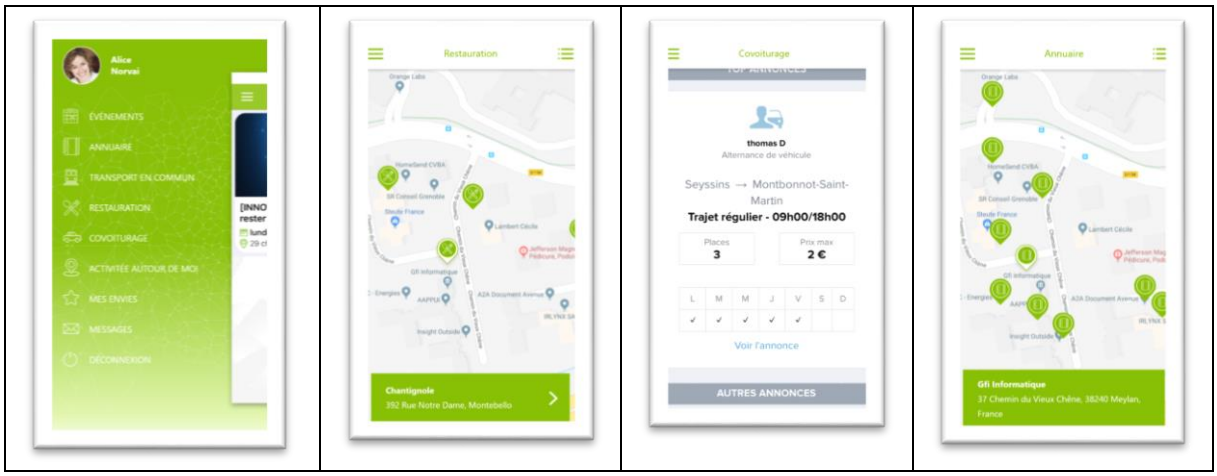

FIGURE 9 : SCREENSHOT OF THE INOVALLEE APP ON 26/06/2018

The application has interfaces with existing services such as the public transport information and the existing car-sharing app. Inovallée also updates the app with their own updates, particularly concerning the address book and events. There is also an interface with the Sensinact platform in order to collect and diffuse data safely to the main stakeholders.

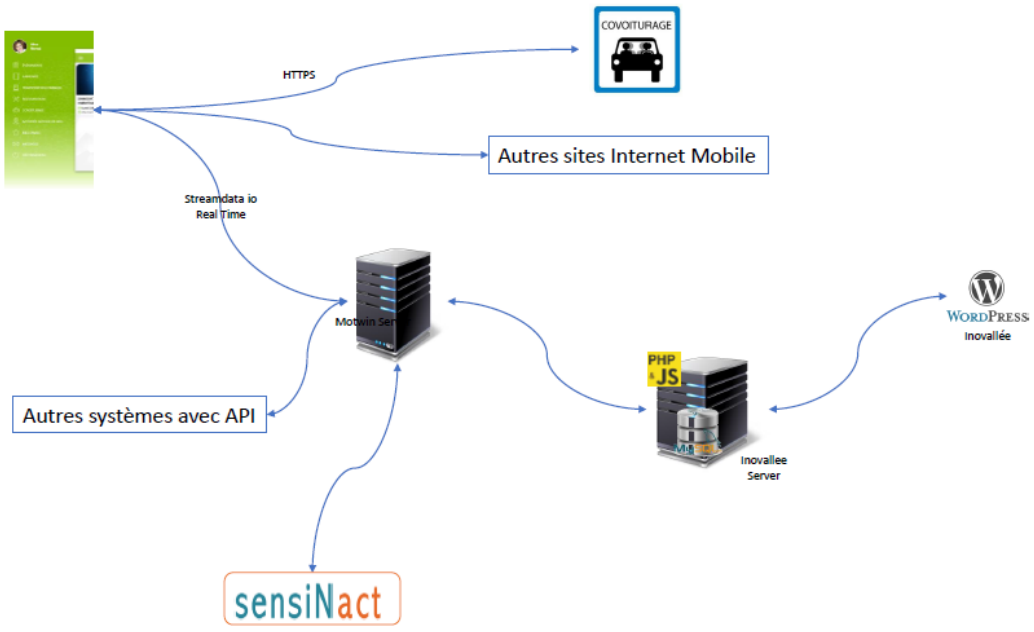

FIGURE 10 : ORIGINAL INTEGRATION PLAN FOR INOVALLÉE APP

The Big ClouT project also allows us to use the sensiNact platform to collect data from users of the app and to present this data to Grenoble-Alpes Métropole and to the Inovallée industrial estate management team. This data allows Grenoble-Alpes Métropole and Inovallée to identify problems on the site and to respond to these problems thereby providing the users of the area a better public service and to attract new companies to set up in the area.
In particular, Grenoble-Alpes Métropole wants to be able to monitor:

- Public transport and car-sharing use in the area → how many people using the zone are using public transport to do so? Is the service adequate? Is the timing adapted to people's needs? Is the use of public transport affected during bad weather or roadworks (for example)?
- Restaurants → Are there sufficient food options? Are they adapted to people's needs? Do some restaurants work better than others?

- Social interaction → Do the different users of the zone interact? How can we develop interactions? How can we encourage more sharing of resources? Are people attending the events proposed? How can we encourage more people to participate in the life of the industrial estate?

In order to evaluate the success of the app, a number of Key Performance Indicators have been established:

KPI or metric	Target
Critical mass of downloads	500 users in first 6 months, 750 in first year
Critical mass of users	300 in first year
Daily active users	150
Average length of time spent using app	10 minutes
Frequency of use	Every working day
Time of day app used	morning
Permission granted (to access other apps/ geolocalisation…)	75%
Different pages visited	3
Shares/ publicity/ recommendations	50
Visits on page describing app on website	50
App searches on different app stores	50
No. of crashed sessions	50
Uninstallations	50
Upgrades downloaded	50
Satisfaction surveys filled in	5%
Satisfaction with app	average 4 stars

TABLE 1: INOVALLEE-KPIS

The app and the BigClouT platform will also be able to provide us with this information once it is being used.

3 EU - JP COLLABORATION TRIAL

As part of WP4 we have been exploring the possibilities of scaling up the city trials via a joint EU-JP trial. While there are a number of possible approaches to this, via discussions with cities, we have settled on a strategy that combines the possibility of reusing applications developed within the project in other partner cities and of sharing data between cities. To that end the partner cities have proposed the following;

- Replicate the MinaRepo trial developed for Fujisawa to Grenoble and Bristol
- Provision an environmental data exchange between the European and Japanese cities.

3.1 Replicated MinaRepoTrial from JP to EU

For scaling up the field trial and exploring synergy between Japan and the EU, we have replicated the MinaRepo system for Grenoble and Bristol. In both cases we have set up the MinaRepo system, via cloud infrastructure, and tailored the interface and report types based on input from the two cities.

The MinaRepo system is currently deployed on a cloud environment. The overall system architecture is illustrated in below (Figure 11)

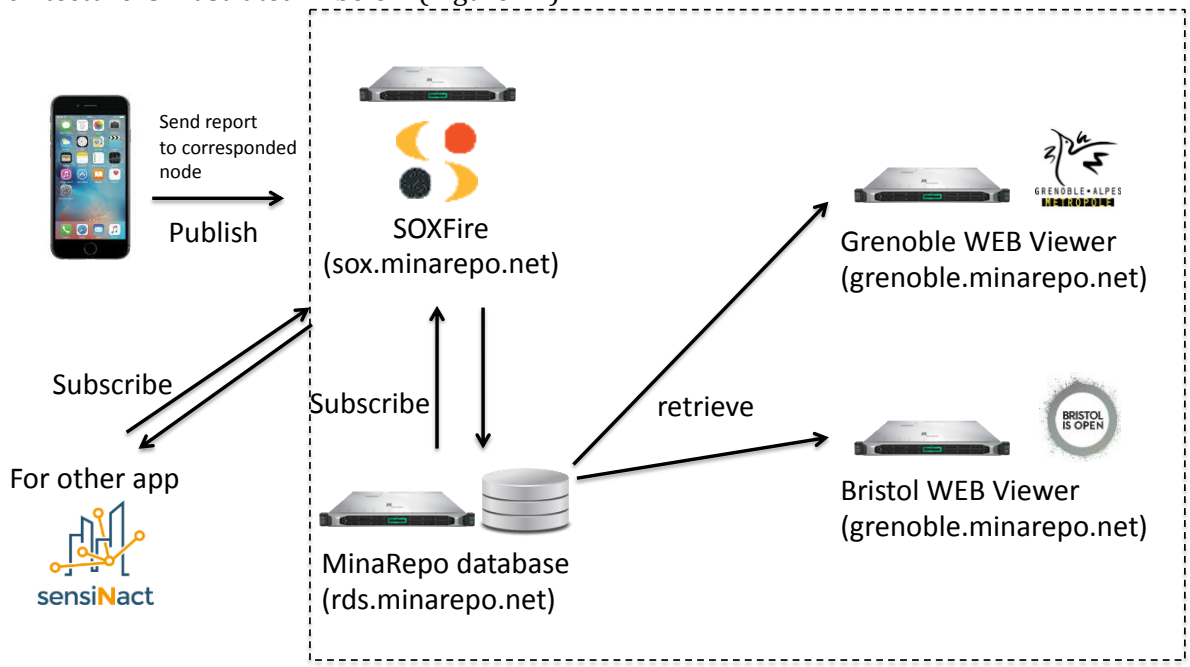

FIGURE 11 : OVERALL ARCHITECTURE OF MINAREPO IN BIGCLOUT CITIES

Each report type is expressed as a virtual sensor node on SOXFire. We have prepared basic types of report for Grenoble and Bristol. In addition, we set appropriate access permission to the nodes to preventing privacy leaks. Table 2 shows virtual sensor node list in Grenoble and Bristol MinaRepo. We are now discussing with several stakeholders in Bristol and Grenoble how we utilize the tool in the field trials.

Type	Node (Grenoble)	Node (Bristol)
Road damage	ps_grenoble_roaddamage	ps_bristol_roaddamage
Street light	ps_grenoble_streetlight	ps_bristol_streetlight
Good	ps_grenoble_good	ps_bristol_good
Animal	ps_grenoble_animal	ps_bristol_animal
Disaster	ps_grenoble_disaster	ps_bristol_disaster
Illegal garbage	ps_grenoble_illegalgarbage	ps_bristol_illegalgarbage
Graffiti	ps_grenoble_graffiti	ps_bristol_graffiti
River pollusion	ps_grenoble_riverpollution	ps_bristol_riverpollution
Other	ps_grenoble_other	ps_bristol_other

TABLE 2 : MINAREPO REPORT TYPE FOR GRENOBLE AND BRISTOL

3.1.1 Bristol MinaRepo Trial

Bristol is working on identifying interest from key city stakeholders to utilise the app in a similar method to Fujisawa or amending the available report types for a different use.

Bristol is engaging with several stakeholders including the Bristol Operations Centre, and Knowle West Media centre.

Bristol is looking into the viability of utilising the app for other means i.e. biological surveying by citizens which can then be collected by the Bristol admin of the app.

3.1.2 Grenoble MinaRepo Trial

The Greater Grenoble City Area agreed to examine the possibility for a trial in the Area. Grenoble-Alpes Métropole has been discussing with the technical services of the Greater City Area (in charge of the management of all different infrastructures and utilities) who expressed interest for the project. However, the principal need expressed by the technical services is to be able to respond to issues highlighted by citizens. In this respect, it is considered that Minarepo does not meet the needs of the City as it only allows problems to be highlighted but not for the problems to be signalled to the correct people who could treat the problem nor for automatic responses to the users who reported the problem. Grenoble-Alpes Métropole will continuously explore possibilities of its utilization with the Greater Grenoble City Area through the trial.

3.2 Environmental Data Exchange between EU and JP

As an alternative to re-using applications between EU side and JP side cities we have also explored the possibility of sharing data between cities. Because of privacy concerns it was not possible to share citizen data, however, it was agreed that environmental data could easily shared between cities and would be useful to allow cities in the project to understand the environmental status, and the actions developed by partner cities. In addition, it was suggested that citizens in the partners cities would also be interested in understanding other cities and this may help develop citizen level links.

Since both Fujisawa and Bristol are gatheing and using enviromental data (primarily pollution data) our first trial will be focused on these data sources.

3.2.1 3.2.1 Fujisawa Environmental Data

In Fujisawa, we deployed environmental sensors on top of garbage trucks. We are collecting various sensor data such as PM2.5, and publishing the data into BigClouT CKAN repository via Node-RED system. A sensor node consists of a sensor module, a 3G-communication-integrated mini computer, a timer-integrated power unit, a usb car charger and cables (Figure 12a). The sensor module is integrated with one acceleration sensor and four environmental sensors as well as a GPS receiver. The mini computer runs a Debian linux and is integrated with a 3G communication module. Both the sensor module and mini computer are powered by the usb car charger that is connected to the timer-integrated power unit which is in turn connected to the fuse box of the host truck. The timer-integrated power unit is used to control power supply. It will shut down the sensor node after 15 minutes the truck's engine is turned off. The power will continue if the truck's engine is turned on back within 15 minutes. A Java program running on the mini computer is developed to control the sensor node and send data to the proxy server via 3G cellular communication in real-time. As shown in Figure 12 b, the sensor module of a sensor node is installed into the roof of a garbage collecting truck. The mini computer is placed into the driver's cabin and reads data from the sensor module via USB 2.0 port as shown in the Figure below.

(a) A Sensor Node (b) Installed Sensor Module (c) Mini Computer

FIGURE 12 : A SENSOR NODE FOR GARBAGE TRUCK

Fujisawa supports the following sensors with sample data

Sensor:Angular Velocity Y rawValue: -0.4272526131074998 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Angular Velocity Z rawValue: -0.4882887006942855 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:UV rawValue: 4.064 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Speed rawValue: 0.02 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Angular Velocity X rawValue: -1.2817578393224995 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Satellite Number rawValue: 12 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Latitude rawValue: 35.377896666666665 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Acceleration Y rawValue: -0.8619257495994508 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Cource rawValue: 67.16 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Acceleration X rawValue: 0.7709446982528421 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Longitude rawValue: 139.4466 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Atmospheric Pressure rawValue: 1043.9006637674524 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Serial Number rawValue: 002 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Acceleration Z rawValue: 9.983973266193637 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Data Index rawValue: 475240 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Atmospheric Humidity rawValue: 134.4375 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:PM2.5 rawValue: 0.0 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Geomagnetism Z rawValue: -28.711375600823988 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Atmospheric Temperature rawValue: 20.38 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Geomagnetism X rawValue: 44.824902723735406 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Geomagnetism Y rawValue: 13.769741359578852 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Illuminance rawValue: 5540.0 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)
Sensor:Altitude rawValue: 38.3 timestamp: Fri Jun 15 2018 14:44:45 GMT+0900 (JST)in the sensor node:

Node-RED flow for publishing data to BigClouT CKAN repository is shown in Figure 13.

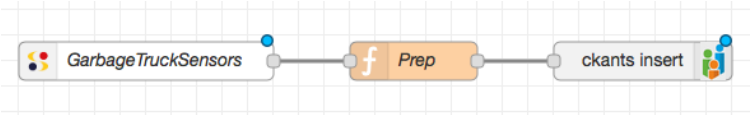

FIGURE 13 : NODE-RED FLOW FOR PUBLISHING GARBAGE TRUCKS DATA TO BIGCLOUT CKAN REPOSITORY

3.2.2 3.2.2 Bristol Environmental Data

Bristol is utilising air quality data within Bristol city centre from various sensors, live and historic data sources provided by the City Council, and from R & D partners.

- Latest measured levels from Bristol St Paul's air quality monitoring station data provided by the Environment Agency https://uk-air.defra.gov.uk/latest/currentlevels?period=current&region=11#levels.
- R&D Air Quality device currently being tested in the lab.
- 3 Sensors in development from R & D partners.

The specific data procured from these sources is detailed in the table below;

Source	Environmental Data Type
Open API - Environment Agency	Ozone, Nitrogen Dioxide, Sulphur Dioxide, PM2.5 , PM 10 particles
R & D Air Quality devices	Temperature, Humidity, Pressure, CO, SO2, O3, N02

TABLE 3 : THE SPECIFIC DATA PROCURED FROM THE SOURCES

The mock-up of a possible dashboard to compare environmental data coming from both Bristol and Fujisawa pilots is reported below (Figure 14, Figure 15 and Figure 16). The mock-up envisages the possibility to compare environmental data such as PM2.5, temperature, humidity, etc.

Using the KNOWAGE tool (from WP3) we have designed a prototype dashboard that display respectively:

- two maps with the Bristol and Fujisawa pilots, and a table that reports a summary of the measurements (PM2.5, temperature, humidity, etc.), depicted in Figure 14. In particular the first two columns of the table reports the registered value of PM2.5 (one column for each pilot): the yellow cells indicate a value that represents a warning, whereas the green ones report normal values.
- three charts used to compare the measurements, depicted in Figure 15Figure 15. The first chart is used to compare Pm2.5 measurements; the second is used to compare Temperature measurements; and the third will provide the comparison of humidity measurements.

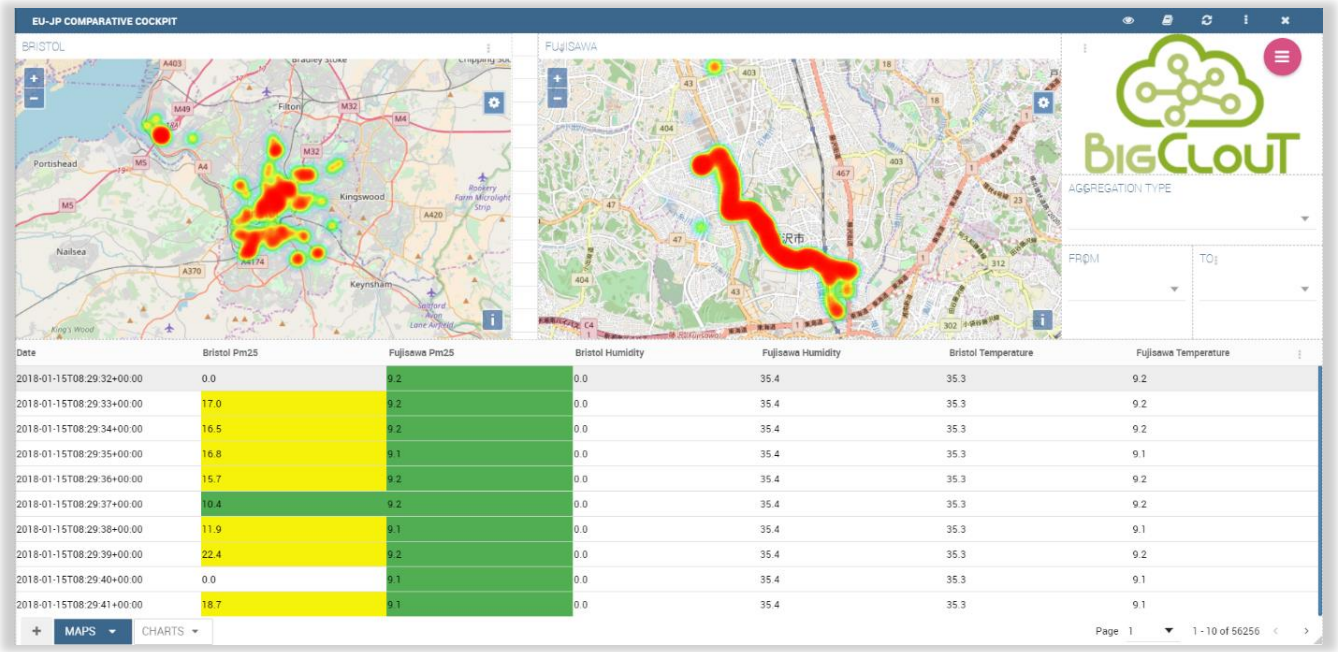

FIGURE 14 : BRISTOL AND FUJISAWA HEAT MAPS

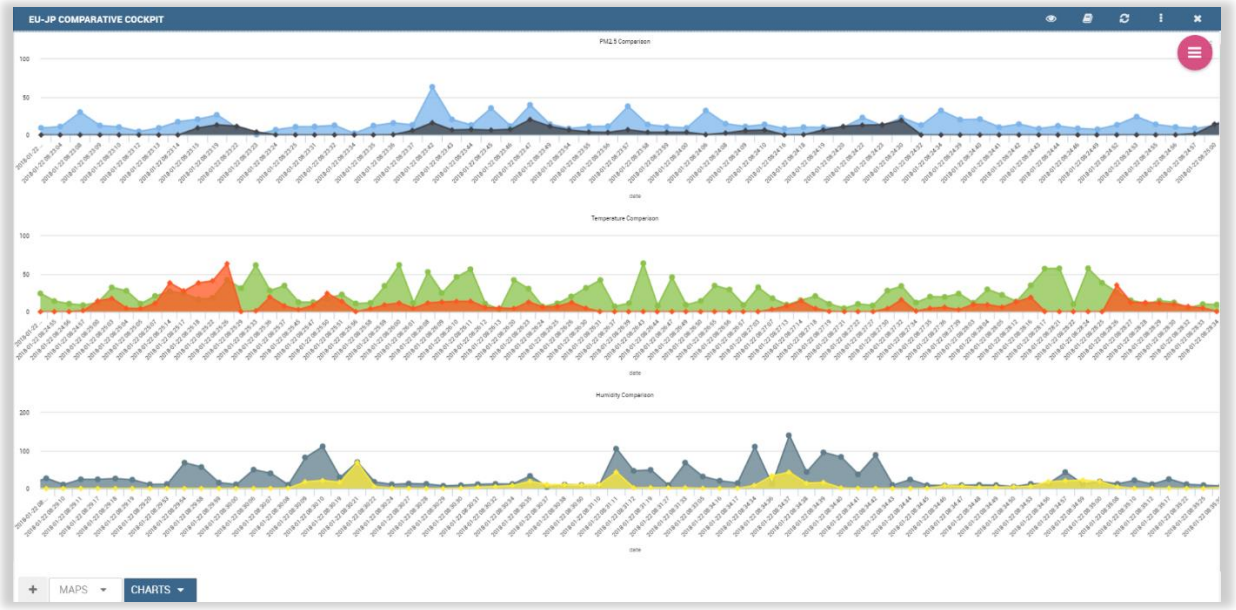

FIGURE 15 : BRISTOL AND FUJISAWA MEASUREMENTS COMPARISON

A user can specify the aggregation type of the data (e.g. daily, weekly, etc.) and the time interval (from, to) which will be used to select a portion of data. These filters are provided in the first sheet of the dashboard and by selecting one of the several options, the widgets can be automatically updated.

Each map displays the locations of measurements through a heat map, in order to provide also info about the registered measurements. Moreover, it provides the possibility to select the information to be visualized in their specific layers (Figure 16); by acting in a dedicated menu it could be possible to enable or disable the visualization of a specific information layer in the map.

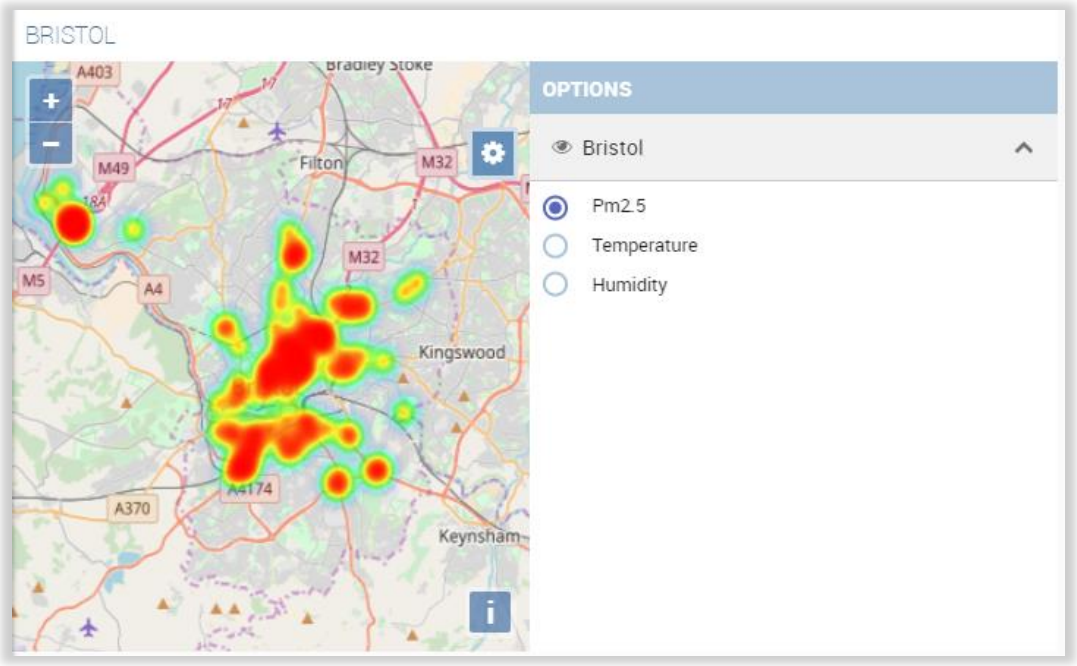

FIGURE 16 : MEASURE SELECTION IN MAP

It is important to underline that the dashboard reported above is a hypothesis made on the basis of data that could be collected by Bristol and Fujisawa; it represents a starting point from which it will be possible to set up a more realistic dashboard thanks to the concrete data that will be collected and provided in the future by both pilots.

4 OVERALL TECHNICAL INTEGRATION FOR FIELD TRIALS

This section provides information about the integration plan of BigClouT tools in each field trials; data flows reported and described in deliverable D1.4 "Updated use cases, requirements and architecture" (BigClouT) have been enriched with technical details, to better understand how to adapt the general BigClouT platform and concepts to support specific requirements and to address specific needs of the pilots.

You can find in the below table the coverage status of requirements that have been identified for the trials.

Code	Requirements Description	Requirements Coverage
R1.2.1	The application for the business tourist should be distributed as a mobile app as an interaction mean with the services based on the BigClouT platform.	Covered in the Tsukuba trial
R1.2.7	The application should protect the privacy of the end-user and propose several levels of management of personal data, and give the possibility of modifying the privacy parameters any time.	Common requirement for the trials. Under development
R1.2.9	The application should provide means to gather satisfaction information from the user.	Common requirement for the trials. Not yet covered. It will be covered in the final demonstrator
R1.2.10	The application should be distributed as a mobile app for the employees of the Innovallée industrial zone.	Not yet covered. It will be covered once we finalise the development of the Innovallée application
R1.2.14	The user may accept to provide some personal information such as profile, location, company, transportation mode used, etc., for receiving customised information.	Not yet covered. It will be covered once we finalise the development of the Innovallée application
R1.2.17	The application should notify the user when interesting events occur and/or customised recommendations to be provided	Under development for Grenoble trial. If users notify the system about their daily transportation choice, the system can make recommendations about the most appropriate transportations to be used according the destination and the operational hours
R1.2.23	Provide tools for comparing citizens' energy consumption scenarios.	Under development for Bristol trial.
R1.2.25	Collect measurements of air quality from sensors deployed around University of Bristol	Under development for Bristol trial.
R1.2.26	Measure concentration of carbon monoxide (CO) in the air as a main pollutant and measurements related to the temperature, humidity and light level which will be processed along with the pollutant concentration.	Under development for Bristol trial.
R1.2.29	NGSI API compliance should be provided.	Under development for Bristol trial.
R1.2.30	A User Management System should be available for citizens to consult only their data and manage their profiles.	Common requirement for the trials. Innovallée mobile app will allows a user to specify a small set of personal information (name, surname, company, etc) that may be punctually shared at its demand when creating an event proposal for example.
R1.2.32	The tourist should install a smartphone app as an interaction with the services based on the BigClouT platform.	Covered in the Tsukuba trial

R1.2.33	The city and BigClouT project should promote/distribute the smartphone application for the tourists.	Covered in the Tsukuba trial
R1.2.40	The foreign tourists should install a smartphone app as an interaction with the services based on the BigClouT platform	Covered in the Tsukuba trial
R1.2.41	The city and BigClouT project should promote/distribute the smartphone application for the foreign tourists.	Covered in the Tsukuba trial
R1.2.44	The application should be able to provide the useful and multilingual information to foreign visitors by their location and time (e.g. SNS, smart phone application and interactive signage).	Covered in the Tsukuba trial
R1.2.51	The citizens and tourists should install a smartphone app as an interaction with the services based on the BigClouT platform	Covered in the JP trials. The apps under development in EU trials
R1.2.52	The city and BigClouT project should promote/distribute the smartphone application for the citizens and tourists.	Covered in the JP trials. The apps under development in EU trials
R1.2.53	Users should be able to report through smart phones various incidents through a dedicated mobile phone application.	Covered in Fujisawa trial (Minarepo)
R1.2.54	Various city stakeholders (from IT or city tourism division) should be able to monitor these incident reporting.	Covered in Fujisawa trial (Minarepo)
R1.2.58	Visualize analysed data effectively and intuitively.	Common requirement for the trials. Partially covered in Fujisawa trial, under development in other trials. WP3 developments will enable this requirement to be covered.
R1.2.59	BigClouT project should install sensors on garbage collection trucks as an interaction with the services based on the BigClouT platform.	Covered in the Fujisawa trial
R1.2.61	City stakeholders should be able to organize and promote various competitions related to garbage saving and or collection.	Uncovered due to the change of trial scenario
R1.2.65	The BigClouT platform should provide a method to share collected data among various stakeholders.	Common requirement for the trials. Partially covered in Fujisawa trial, under development in other trials.
R1.2.67	End users should be able to download the mobile application and learn about the various events that are happening in the area.	Partially covered in the Fujisawa trial (Lokemon), under development for Grenoble trial

TABLE 4 REQUIREMENTS COVERAGE BY THE TRIALS

For each trial, we highlight the technical components used in the trial based on the overall BigClouT technical architecture as shown in Figure 17.

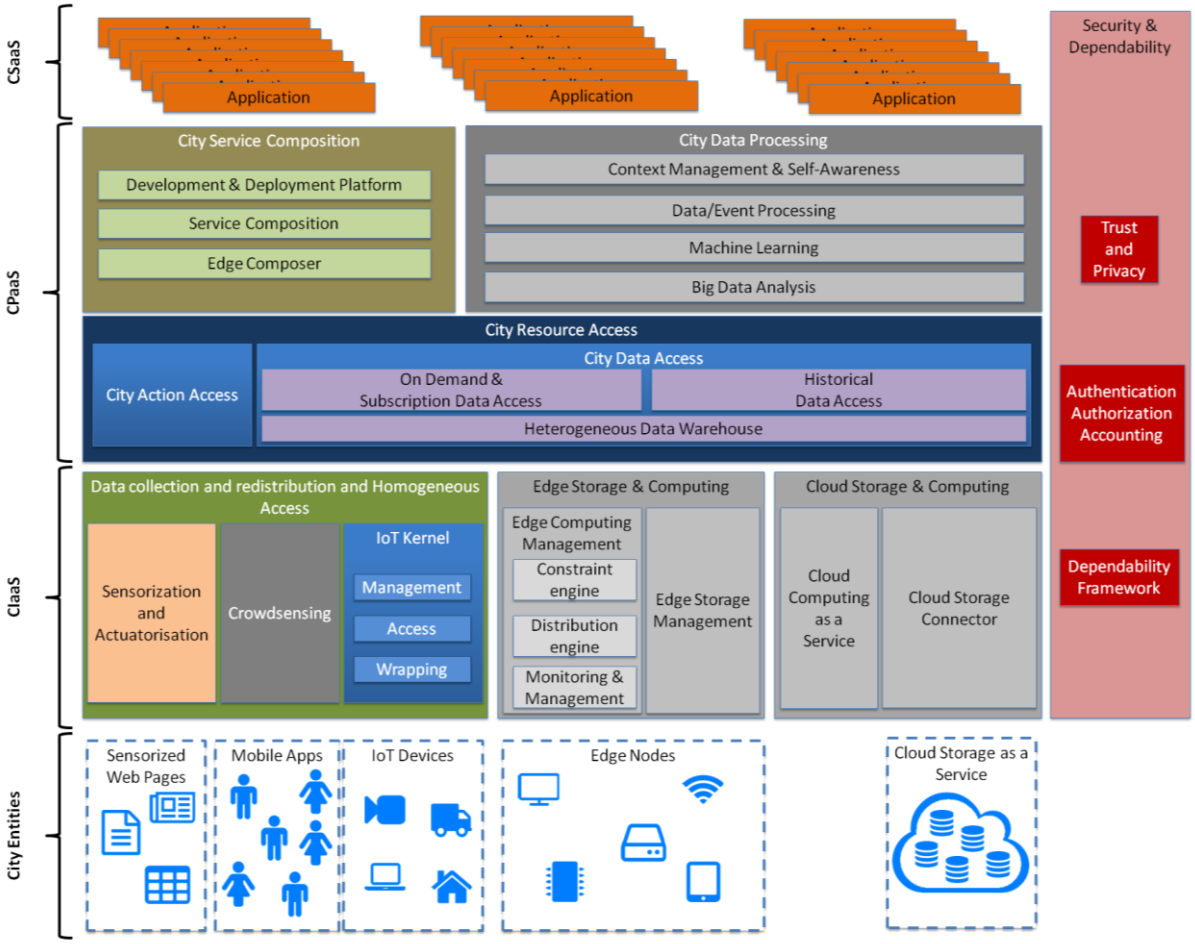

FIGURE 17 : OVERALL BIGCLOUT ARCHITECTURE

4.1 Fujisawa

4.1.1 Enoshima crowd sensing Trial:

The Enoshima Trial use case uses a variety of BigClouT modules including:

Data collection, distribution and homogenous access subsystem

- SOXFire, which is used for getting sensor data from Sensorizer and SNS data.
- Sensorizer which is used for collecting sensor data related to parking lot informaiton, weather information and environmental information near Enoshima area.

City service composition subsystem, Edge storage and Computing Susbsystem and City Resource Access

- Distributed Node-RED is used for combining data from SOXFire. It is also used for combining analytics components which analyze correlation of sensor data.
- BigClouT data warehouse (CKAN repository) is used for saving analyzed data of Enoshima trial.

In addition to these components, we have developed a number of people analysing methods from high-resolution image taken from camera at Enoshima tower. We also use several data sources which are provided by companies collaborating with us for the trial.

4.1.2 Road infrastructure monitoring trial:

Road infrastructure monitoring trial will use the following components:

Data collection, distribution and homogenous access subsystem

- SOXFire is used for getting sensor data from garbage trucks, Sensorizer and SNS data.
- Sensorizer is used for collecting sensor data related to parking lot information, weather information and environmental information in Fujisawa area.

City service composition subsystem, Edge storage and Computing Subsystem and City Resource Access

- Distributed Node-RED is used for combining data from SOXFire. It is also used for combining analytics components which analyse road infrastructure status.

City Data Processing, City Resource Access

- DeepOnEdge is used for analysing road infrastructure damage.
- KNOWAGE is used for analysing garabage truck sensor data, especially for environmental sensor data.
- BigClouT data warehouse (CKAN repository) is used for saving analysed data of Road Infrastructure monitoring trial.

In addition to these components, we develop inpainting method which removes privacy-concern information from image taken by garbage truck camera.

4.2 Bristol (BRI/LAN)

4.2.1 Smart Energy

Data collection, distribution and homogenous access subsystem

- Data is collected from individual sensors, and then forwarded, via the Orion Data broker (Fiware) to the Bristol cloud data storage.

City service composition subsystem, City Resource Access (

- Node-RED is used for accessing data in the Bristol Cloud storage module and sending it to the BigClouT data warehouse.

4.2.2 Smart Mobility

Data collection, distribution and homogenous access subsystem

- Data is collected from individual sensors, and then forwarded, via the Orion Data broker (Fiware) to the Bristol cloud data storage.

City service composition subsystem, Edge storage and Computing Subsystem and City Resource Access

- Node-RED is used for accessing data in the Bristol Cloud storage module and sending it to the BigClouT data warehouse.

City Data Processing

- KNOWAGE is planned to be used for the environmental data exchange (joint JP-EU) app but is currently not used by the smart mobility core app.

4.3 Tsukuba

The system "HukuRepo" used in Tsukuba trials is classified into crowd-sensing application, where 1) users use smartphones to submit problems or to receive any recommendations; 2) the system stores the collected data into a cloud data storage; 3) a knowledgebase that stores city knowledge is also stored in the cloud storage; and 4) the big data analysis tools are used to make analysis/recommendation by exploiting the collected data and/or the knolwedgebase. The following figure shows the mapping between the system components and the BigClouT architecture. More precise descriptions follow.

Data collection, distribution and homogenous access subsystem

- **Crowd-sensing module** is used to collect/deliver information from/to users through a dedicated smartphone app. On the system side, a IoT gateway is sitting to streamline the communication between the system and the client apps.

Cloud storage and computing subsystem, City Resource Access

- **Crowd storage** is used to store different types of information:
  - Data collected from the users. including user profile, submissions (text and images), geographical locations, etc.
  - Knowledgebase including city knowledge, such as transportation, restaurants, shops, sightseeing spots, etc.

City Data Processing, City Resource Access

- **Big data analysis modules** are used to make analysis/recommendations over the collected data and/or knowledgebase. More precisely, for the collected data, city officials later make analysis over them to extract useful insights from the behaviors of foreign visitors. Besides, given a user's request/inquiry, the system exploit the user's context (e.g., location, time, etc.) and the knowledgebase to make timely recommendations/answers.

4.4 Grenoble

The two Grenoble use cases will mainly use the same set of components, among all the ones composing the entire BigClouT platform.

Data collection, distribution and homogenous access subsystem

Data collection task will be first ensured by the sensiNact gateway that is the recipient of usage data provided by the mobile phone application(s), the recipient of data coming from IoT devices, the recipient of data generated by the continuous stream data process, and the collector of dynamic data provided by the Grenoble Metropole's open data system. Sensorizer from Keio will also be used to transform static web data into live data from Innovalée web page. The data collection task will also be handled by the CityHub system, that allows to access to static data provided by the Grenoble Metropole's open data platform. The redistribution task will be handled again by sensiNact that distributes live data and captured events. The data distribution may concern:

- The data consumers, like sensiNact Applications previously created using the sensiNact studio, and the mobile phone application(s).
- JSSpinner, the stream data processing engine
- The Self-Adapter tool
- The CDMI cloud storage that may next dispatch data to CDMI Edge Storage(s) according to their availability

Cloud storage and computing subsystem, Edge storage and Computing Susbsystem and City Resource Access

The data redistribution task is also handled by both the CDMI Storage connector and the BigClouT data warehouse (CKAN) system, which offer respectively an access to historical data and an access to the external Grenoble Metropole's open data system.

City Data Processing, City Resource Access

Cloud and Edge data storage features are the ones offered by the CDMI infrastructure, while the stream data processing tool (that is also in the present case the edge processing tool) is JSSpinner. This last one is used for an experimental public transportation usage forecast, based on usage data coming from the mobile phone application(s). Self-Adapter, providing the self-awareness mechanism is here coupled to Edge storage mechanism, to be able to monitor edge storages and to configure their availability. The long term analyze applying on stored data and targeting the improvement of the resource management by the Grenoble Metropole will be handled by KNOWAGE.

5 ETHICS ISSUES

As reported in D4.2 all trials have developed an ethics plan, addressing the guidelines discussed in D4.2 and ensuring they meet the requirements laid out in internal ethics process described in D7.1

Each trial will raise a number of ethical issues as stakeholders are engaged, data is gathered, opinions sought and trials deployed. It is important that each trial reviews and updates its ethics process and uses the ethics process to guide the trial and its engagement with stakeholders and end users.

6 APPENDIX - TECHNICAL DETAILS

EU-JP trial. Accessing the WebApps for MinaRepo in Bristol and Grenoble

MinaRepo Client: iOS application and Web application is ready to use.

- WebApp Grenoble (access via smartphone):
  - https://www.ht.sfc.keio.ac.jp/~takuro/tmp/GrenobleMinarepo/
- WebApp Bristol(access via smartphone):
  - https://www.ht.sfc.keio.ac.jp/~takuro/tmp/BristolMinarepo/

MinaRepo Viewer: we added multi-language support feature in MinaRepo viewer.

- Grenoble: https://grenoble.minarepo.net
- Bristol: https://bristol.minarepo.net

Flow or application developed using the BigClouT application programming tool to send data from Fujisawa to the BigClouT data warehouse.


```
[
   {
      "id": "d9b0ba56.aa0ef8",
      "type": "function",
      "z": "c7a8fcf7.6156f",
      "name": "Prep",
      "func": "var device = msg.topic;\nvar transducers = msg.payload;\nvar ckanData = {\n    pressure: 0,\n    temperature: 0,       \n    illuminance: 0,\n    pm2_5: 0,\n    latitude: 0,       \n    longitude: 0,       \n    altitude: 0,\n    speed: 0,\n    device: device,\n    ang_velocity_x:0,\n    ang_velocity_y:0,\n    ang_velocity_z:0,\n    uv:0,\n    acc_x:0,\n    acc_y:0,\n    acc_z:0,\n    humidity:0,\n    geomagnetism_x:0,\n    geomagnetism_y:0,\n    geomagnetism_z:0,\n    timestamp: 0\n}\n\n\nfor (var i = 0; i < transducers.length; i++){\n    var trans = transducers[i];\n\n    if (trans.transducerId === \"Atmospheric Pressure\"){\n        ckanData.pressure = parseFloat(trans.rawValue)\n    }\n    if (trans.transducerId === \"Atmospheric Temperature\"){\n        ckanData.temperature = parseFloat(trans.rawValue)\n    }\n    if (trans.transducerId === \"Illuminance\"){\n        ckanData.illuminance = parseFloat(trans.rawValue)\n    }\n    if (trans.transducerId === \"PM2.5\"){\n        ckanData.pm2_5 = parseFloat(trans.rawValue)\n    }\n    if (trans.transducerId === \"Longitude\"){\n        ckanData.longitude = parseFloat(trans.rawValue)\n    }\n    if (trans.transducerId === \"Latitude\"){\n        ckanData.latitude = parseFloat(trans.rawValue)\n    }\n    if (trans.transducerId === \"Altitude\"){\n        ckanData.altitude = parseFloat(trans.rawValue)\n    }\n    if (trans.transducerId === \"Speed\"){\n        ckanData.speed = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Angular Velocity X\"){\n        ckanData.ang_velocity_x = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Angular Velocity Y\"){\n        ckanData.ang_velocity_y = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Angular Velocity Z\"){\n        ckanData.ang_velocity_z = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"UV\"){\n        ckanData.uv = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Acceleration X\"){\n        ckanData.acc_x = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Acceleration Y\"){\n        ckanData.acc_y = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Acceleration Z\"){\n        ckanData.acc_z = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Atmospheric Humidity\"){\n        ckanData.humidity = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Geomagnetism X\"){\n        ckanData.geomagnetism_x = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Geomagnetism Y\"){\n        ckanData.geomagnetism_y = parseFloat(trans.rawValue)\n    }\n    \n    if (trans.transducerId === \"Geomagnetism Z\"){\n        ckanData.geomagnetism_z = parseFloat(trans.rawValue)\n    }\n    \n    \n    ckanData.timestamp = new Date(trans.timestamp);\n}\n\nreturn {payload: ckanData};",
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        "ckan": "http://bigclout.lancaster.ac.uk",
        "name": "takuro"
    },
    {
        "id": "2263f784.b9d178",
        "type": "sox-credentials",
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        "bosh": "http://nictsox-lv2.ht.sfc.keio.ac.jp:5280/http-bind/",
        "xmpp": "nictsox-lv2.ht.sfc.keio.ac.jp"
    }
]
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