ALMANAC

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In this issue

Results from the ALMANAC project

The three-year ALMANAC project officially ended on 31th August 2016. In this newsletter, you can read about some of the main achievements.

The goal of ALMANAC was to develop an IoT platform enabling synergies between existing resources and services in the city for a more efficient and sustainable urban living. With special focus on the waste and water domains, demonstration of selected Smart City services and applications was carried out in the City of Turin, Italy.

The project followed an integrated approach, enabling real-time data connection, management and sharing in a complex urban ecosystem with multiple and heterogeneous devices, systems and services.

Traditional segmentation of stakeholders was overcome by prioritising federations between public and private actors and by engaging citizens in the development of services.

The platform also included a dedicated capillary communication network, linking local sensors and actuators to the platform at a low cost and ensuring their collection in an ETSI M2M compliant service platform.

The result is several smart city components for interoperation of networks and technologies which are presented in the following articles.

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ALMANAC tools and applications for Smart City services

The final ALMANAC Smart City Platform (ALMANAC SCP) consists of several components which can be used to develop and implement Smart City solutions. Five of them are Smart City enablers which developers can freely access to build solutions; two of them offer IoT connectivity, using energy efficient and widely applicable capillary M2M networks and the last three are applications for the water and waste domains.

ALMANAC Smart City Enablers

Smart City Resource Adaptation Layer - SCRAL

The key element of the ALMANAC platform is the SCRAL middleware, based on a service-oriented architecture and supporting semantic interoperability of heterogeneous resources, devices and services and data management. The middleware supports the Smart City applications by dynamically federating private and public networks.

The purpose of SCRAL is to integrate and expose relevant functionalities of heterogeneous physical devices. It provides REST-based, uniform and transparent access to devices, and allows integration of

Meet ALMANAC

IoT 2016
Stuttgart, Germany, November 2016
Partner FIT will be presenting the ALMANAC paper CEML: Mixing and moving complex event processing and machine learning to the edge of the network for IoT applications.

Deliverables released

The following public deliverables have been completed to date:

- D2.1 Scenarios for Smart City applications
- D2.4.1 Updated Requirements Report 1
- D2.4.2 Updated Requirements Report 2
- D3.1.1 System Architecture Analysis & Design Specification 1
- D3.1.2 System Architecture Analysis & Design Specification 2
- D3.1.3 System Architecture Analysis & Design Specification 3
- D4.2 Features of the ALMANAC Platform for sustainable Smart City applications
- D5.1.2 Design of the abstraction framework and models 2
- D6.1 A scalable data management architecture for Smart City environments
- D6.4 Smart City applications SDK
- D7.1 Test and Integration Plan
- D7.3.1 Cloud based APIs for Smart City applications - Developers Guide 1
- D7.3.2 Cloud based APIs for Smart City applications - Developers Guide 2
- D8.2 Application Definition – Water Management
- D8.4 Application Definition – Waste Management
- D8.6 Application Definition - Citizen-centric Application
- D8.9 Final Evaluation Report
- D9.1 Project Website

Smart City resources so that platforms can be seamlessly linked and synchronised with physical IoT resources.

For more information, contact Maurizio Spirito from Istituto Superiore Mario Boella

ALMANAC IoT Resources

The ALMANAC IoT Resources contain a suite of software components for handling IoT resources: the IoT Resource Catalogue, the IoT Storage Manager and the IoT Cloud Service Catalogue.

The IoT Resource Catalogue is a device discovery and management system. It scales with the deployment and can be used both in the home for device discovery with UPnP and in the enterprise as an IoT device catalogue crucial to the IoT platform infrastructure. It acts as a 'control hub' for actuating a set of devices and can communicate autonomously with storage providers to intelligently cache IoT observations.

The Storage Manager is a complete framework that encapsulates the complexities of storing time series data and provides easy-to-use APIs for data retrieval. It is technology agnostic and can use both cloud storage providers and local instances of popular NoSQL database technologies like for example MongoDB.

The IoT Cloud Service Catalogue is a distributed cloud catalogue of storage providers. If several storage services with different pricing are available, a Storage Manager can select to store data where it is cheapest.

The components are available in .net versions at IoTWorldServices, a collection of Open Source LinkSmart components developed for the .net framework.

For more information, contact Peter Rosengren from CNET Svenska AB

The SCRAL and IoT Resources are released as Open Source and are available in the ALMANAC Lab repository.

LinkSmart (Java) Extension Components

The LinkSmart (Java) Extension Components are extensions to the java-based OS LinkSmart middleware. They act as a Federated Cloud Enablers by establishing an overlay network to connect local IoT networks and thus enable the discovery and sharing of IoT services and resources in a federated cloud environment. The federated cloud architecture enables elastic Smart City services that are both provider and domain agnostic.

For more information, contact Marco Jahn from Fraunhofer FIT

LinkSmart® IoT Agent

The IoT Data-Processing and Learning agents are the real-time data processing cores of the ALMANAC SCP. The IoT Processing agent is a lightweight standalone component that provides real-time data fusion, aggregation and rule-based logic as a service. On the other hand, the IoT Learning agent provides additional Machine Learning and advance analytic features as a service.

For more information, contact Marco Jahn from Fraunhofer FIT

Metadata Framework

Based on Linked Data/Semantic web standards, the metadata framework provides a basic infrastructure to easily maintain, query and retrieve semantic models at all levels of ALMANAC. It contains elements such as domain entities and system owned resources (SPARQL-queries, rules and namespace mappings).

For more information, contact Marco Jahn from Fraunhofer FIT

The LinkSmart Extension Components, IoT Agent and Metadata Framework are available through LinkSmart GIT and the Metadata Framework is also available in the ALMANAC Lab repository.

IoT Connectivity

Capillary M2M Network and Gateway

The Capillary M2M Network and Gateway are fundamental when deploying both private and public device cloud infrastructure, allowing devices to communicate with open platforms like ALMANAC or private cloud systems like the Amazon Web Services. Built from the ground up to comply with the OASIS, ETSI and EN1434 standards, they run on both custom hardware and off-the-shelf products supplied by for example Libelium. The Capillary M2M Network and Gateway interface with the ETSI M2M Cloud platform.

For more information, contact Roberto Gavazzi from Telecom Italia

Public deliverables can be downloaded from the project website after they have been reviewed and approved by the EC. Currently, 12 public deliverables are available for download here:
www.almanac-project.eu

The ALMANAC project is co-funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 609081, objective ICT-2013.1.4 'A reliable, smart and secure Internet of Things for Smart Cities'. Duration: 1st September 2013 to 31st August 2016.

Read more at:
www.almanac-project.eu

ALMANAC M2M Cloud Platform

The ETSI M2M service platform is an architectural component of the ALMANAC Project realised as a prototype compliant with ETSI M2M standard. The M2M Platform can be used as PaaS (Platform as a Service) meaning that it exposes cloud APIs that can be used to get ETSI M2M platform services from external applications. This is used in the ALMANAC project to connect WMBus devices over the capillary network.

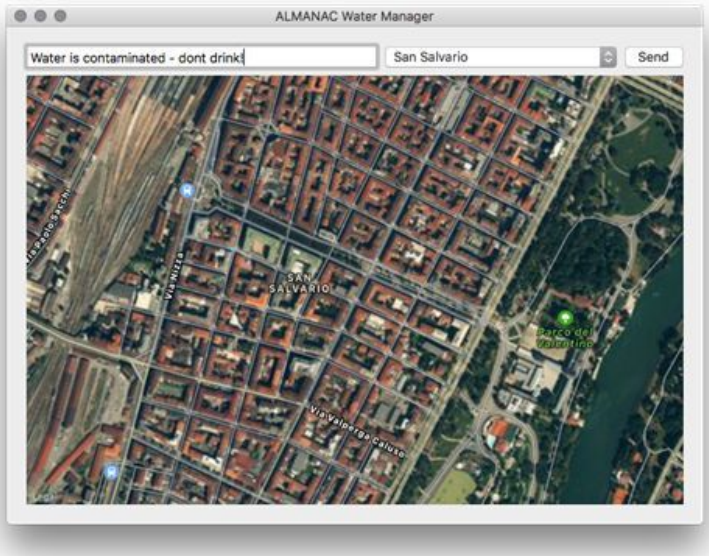
For more information, contact Roberto Gavazzi from Telecom Italia

ALMANAC applications

Water Management Application

The water management application (iOS) supports direct communication between utilities and citizens. It enables users to monitor water consumption in their own homes and uses the complex event processing engine of the ALMANAC SCP to generate alerts when the platform identifies a potential leakage.

The communication component of the desktop water management application also allows the municipality to notify users who have installed the application about issues that are pertinent to their health or current situation. For example, if the water in the area they live in has been contaminated, the municipality has the opportunity to target only the affected group of citizens.



The Water Management Application has several components that work together to fetch data from the ALMANAC SCP and display them to the user. Most of the work is done by a Virtualization Layer Connector that manages the communication between the Water Management Application and the ALMANAC SCP.

For more information, contact Thomas Gilbert from the Alexandra Institute

Waste Management Application

The application supports the waste management company, which can monitor bins and their fill levels and generate routes based on the actual situation. Using their smartphones, citizens can report litter problems which may then be linked to an existing waste collection route.

The application consists of a DriverApp (Android) for the lorry driver collecting waste and a CitizenApp for citizens to report and track waste issues in the public space, such as abandoned waste. Installed on a tablet in the lorry cab, the DriverApp reports fill levels of street waste bins and issues documented by citizens in real time. Based on the current situation, the route is automatically updated. Being able to receive a notification of new issues in real time and having the route plan updated automatically is more time efficient in terms of planning and collection. It also allows the waste management company to meet higher standards for providing a clean city.

The DriverApp can also connect to other web tools enabled by the ALMANAC platform such as a waste management dashboard for the waste service provider in the office, giving an overall view of the city status and waste collection (routes, duration and collected weight). The service can help the operator to detect deviations, predict when the city waste containers have reached their maximum capacity and plan for action.

For more information, contact Marco Jahn from Fraunhofer FIT

The Citizen Application

The CitizenApp supports the citizens in recycling their waste. It contains a calendar with waste collection dates and a notification system which the user can set up to better plan for collection of specific types of waste. The app also includes a recycling guide with search function and an interactive map showing bins near the user and their current fill level.

For more information, contact Maurizio Spirito from Istituto Superiore Mario Boella

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Design that changes behaviour

In ALMANAC, partner ISMB developed a recycling app in collaboration with citizens in Turin for maximum effect. Evaluation of the app is encouraging, showing appreciation of the proposed application but also suggestions for improvements.

How do you design solutions that make citizens change behaviour? Do you appeal to their reason, threaten them with fines or use nudging? ALMANAC's approach was to invite the residents from the housing project SHARING to take part in the development and design of an application that would make it easier for them to recycle properly.

In Torino, waste is gathered in three different ways; door-to-door, in underground ecological islands and via street bins. The recycling rate is low when it comes to the last two collection systems, increasing the city's cost of final waste treatment. So the aim was to find out how to make citizens better at recycling.

During the workshops with the citizens, the reasons for inadequate recycling became clear: the citizens are often unsure how or when to recycle certain materials, leading to frustration and unfortunate recycling habits. And they do not always know what type of waste is collected when. On top of this, they often have to spend time searching for a specific recycling bin when the one near their residence is full, or when they are strolling the streets of the city.

Waste collection calendar and notification, recycling guide and bins nearby

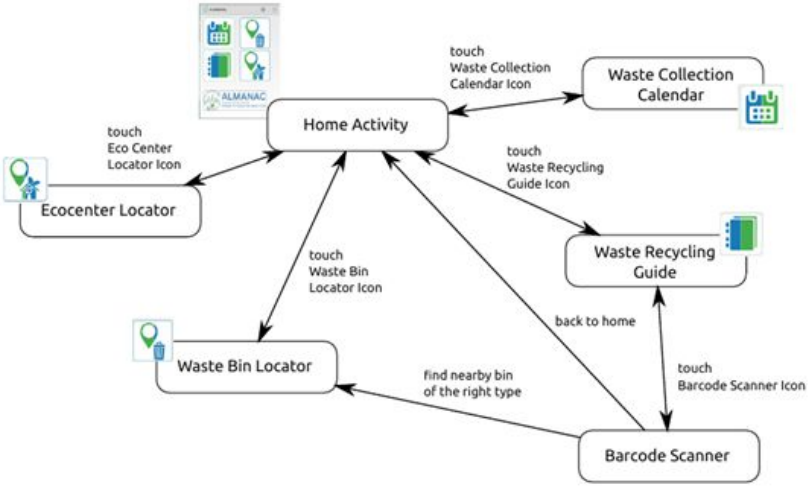
As a result of the collaboration, an application prototype was developed in two iterations, focusing on four main areas which could assist the citizens when disposing of waste:

• a calendar showing waste collection in Torino so that one can prepare and plan for waste sorting

• a notification system so that the user can set up notifications for specific types of waste

• a recycling guide with search function so that one knows in which container the litter belongs and a built-in barcode scanner so that one can scan litter and establish its type

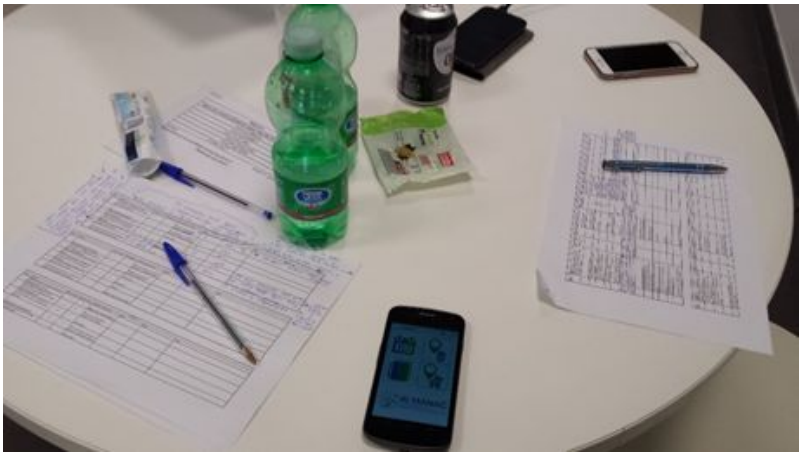
• an interactive map showing bins near the user and their current fill level



Positive reviews but room for improvement

Evaluation and usability testing of the app were conducted with some of the residents, and the results show that in general, the users are positive, appreciating the notification aspect and finding the application easy to use and supportive of their needs. However, a few issues concerning usability of the application also emerged such as accessing the “barcode” scanning feature and easy identification of the right waste categories.

- The results show us that usability issues can very easily hamper the effectiveness and appreciation of an application, even when initial impressions are positive. Such evidence encourages us to carefully address identified problems before going for long-term trials, thus avoiding results heavily biased by actual difficulties in application adoption, explains Maria Teresa Delgado, Research Fellow at Istituto Superiore Mario Boella.



The application is available for download by users involved in the usability tests. The plan is to do more usability tests and then conduct a one-month trial of the application together with the SHARING and CAMPUS San Paolo communities to get a more informed view and establish if there is any effect on the citizens’ recycling habits.

You can read all the evaluation results in the document *D8.9 Final Evaluation Report* which is available as download on the project website, once approved by the European Commission.

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From lab to real life

In the last year of ALMANAC, the waste management prototypes have been further developed and trialed with two of Turin 's large underground waste containers in cooperation with the waste service provider Amiat.

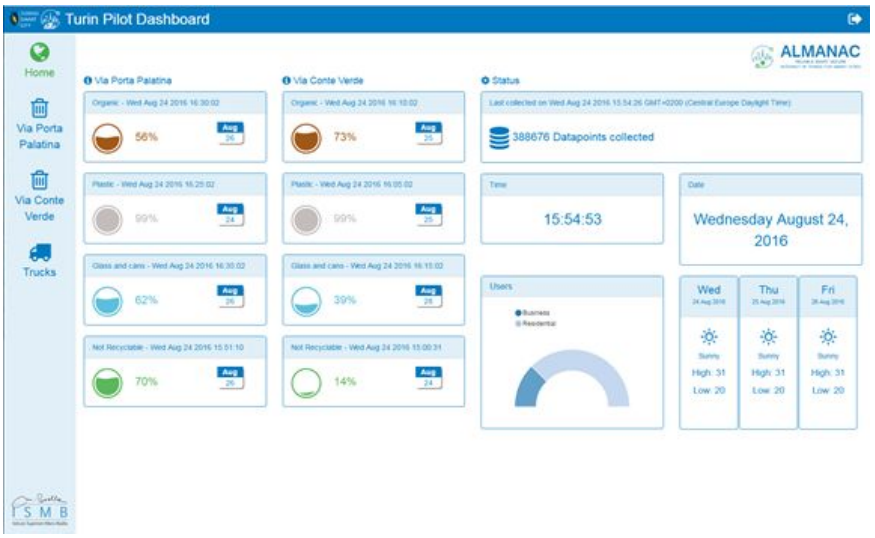
Since August 2015, two of the city’s nine Underground Ecological Islands (UEIs) have been equipped with fill-level sensors and user access control with the aim to improve waste management and motivate users to be better at recycling. ALMANAC Smart City Enablers are used to collect, process and analyse data, allowing Amiat to optimise their waste collection procedures.

Placed in the centre of Turin where door-to-door collection is not possible, the two UEIs service around 300 families and 90 businesses. So far, the installation has generated more than 387,000 observations concerning fill and battery levels and truck collection data from the containers.

These data have been analysed by Amiat, and as expected, initial results show that the collection frequency could be higher since in some instances, the containers have been critically full for 3 days, resulting in litter being scattered outside the containers. In other situations, waste collection may be postponed: data from the organic containers show that fill levels rise and then fall after a few hours due to waste settling and decomposing.

Web tools for waste management

To get an overview of and monitor the collected data, a dashboard has been developed for Amiat who can see current and historical fill level of the containers, weather information and expected time when maximum capacity is reached, making it possible to spot situations which need action.



The dashboard also features a truck view where it is possible to see data from the waste collection truck servicing the two areas, displaying actual and historical collection routes, number of collections and duration. Collected weight is also shown, making it possible to spot deviations for example construction waste which should be brought to dedicated drop centres instead of being placed in the non-recyclable container.

About the deployment

Two locations were chosen in the centre of Turin, servicing around 300 families and 90 businesses. During August 2015, fill level sensors and solar panels were installed in each waste container of the UEIs. The two non-recyclable waste containers were also equipped with RFID access control modules to grant exclusive access to the citizens involved. At the beginning of September 2015, Turin Municipality informed residents and businesses involved, introducing a new procedure for the non-recyclable waste which includes the use of a magnetic key to access the respective containers and stressing the importance of correct recycling. During this time, Amiat validated the correct installation and corroborated the normal functioning of fill level sensors, solar panels, radio modules and RFID controlled access modules, while ALMANAC started the integration of the data generated into the ALMANAC platform and reported to Amiat any anomalies found in the collected data. The trial officially started 28th September 2015 and will last until the end of 2016.

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Read our publications

During the project's lifetime, ALMANAC has had seven scientific papers accepted at conferences, some of which are available for download on the project website.

The publications include:

- TrustMUSE: A Model-Driven Approach for Trust Management

- ALMANAC: Internet of Things for Smart Cities

- Towards a Federation of Smart City Services

- Linked Data Services for Internet of Things

- WasteApp: Smarter Waste Recycling for Smart Citizens

- Block-based Realtime Big-Data Processing for Smart Cities

- CEML: Mixing and moving complex event processing and machine learning to the edge of the network for IoT applications

Currently, ALMANAC partners are also involved in the publishing a chapter on the ALMANAC architecture: *Enabling Smart Cities Through IoT: The ALMANAC Way* in the book *The Internet of Things: Foundation for Smart City, E-health and Ubiquitous Computing*

You can find the publications on the ALMANAC website.

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