ALMANAC

RELIABLE SMART SECURE
INTERNET OF THINGS FOR SMART CITIES

(FP7 609081)

D 8.2 Application Definition - Water Management

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Index:

1. Executive summary

The work-package 8 focuses on evaluation and demonstration activities of the ALMANAC Smart City platform. For this end three types of prototype applications have to be specified, developed, deployed and evaluated within the respective tasks:

- T8.2: Water Management Application
- T8.3: Waste Management Application
- T8.4: Citizen-centric Application

This deliverable provides an informal description, collection of related resources (research projects, concepts, available software) and a formal specification of the "Water Management Application" underlying the implementation of the task T8.2.

Initially an informal analysis and scenario-based application description is presented along with references to related resources. This is followed by a formal specification according to IEEE 42010, intended to guide the prototype development done in 3 iteration steps: ID8.3 Prototype – Water Management (M12, M24, M36). The document concludes with an overview of open issues that could not be clarified because of the theoretical nature and early delivery phase of this document, but are to be resolved during the implementation stage.

2. Introduction

2.1 Purpose, context and scope of this deliverable

This document depicts the results expected from the first prototype of the Water Management application. At the end of the first year of the project, the Smart City Platform ALMANAC will be a platform for gathering information that is able to collect data from a large number of sensors, and with characteristics of interoperability with other Smart City applications.

The development of the Water Management application will be done iteratively. Each iteration will demonstrate the progress in the development of the ALMANAC SCP (Smart City Platform), and furthermore implement more and more end user requirements based on the feedback obtained from requirement engineering process that will be also performed iteratively. The first prototype will be a technical demonstration of the innovations built for the ALMANAC SCP in year 1, while the final prototype will feature an application that could be deployed and evaluated in a real life setting.

The D8.2 Application Definition deliverable is a technical document describing the software prototype implemented in year 1. This deliverable will also give you an idea of how the future characteristics of application prototypes of ALMANAC SCP, to be developed in years 2 and 3..

2.2 Application Vision

ALMANAC delivers a platform that makes Smart City services more sustainable by providing a common IoT infrastructure which can securely be shared by different users and applications. While Smart City services and applications are normally initially deployed to support "professional" business cases, they are also expected to increase the level of engagement of citizens the processes of a Smart City.

The water management application is a good example of a professional application which can be exploited for benefiting the whole Smart City. For the water utilities, the deployment of smart metering devices with a smart flow meters capability can bring huge economical and technical benefits, saving on metering costs and enabling advanced features such as real-time detection of the reverse flow and the detection of tampering.

Once the water management infrastructure is in place, smart metering devices can be used to provide citizens with immediate feedback on consumption, alert them about leakages in private water pipes, etc. As a result, the water application can increase citizens' awareness of the Smart City processes and promote motivational schemes for sustainable behaviour through active engagement in individual and community activities supported by new business models.

3. Application Description

3.1 Introduction

The scenario that has been selected is "Consumption awareness". Research has shown that this scenario is currently not feasible in the city of Turin since an advanced water-metering infrastructure able to monitor individual user consumption is not in place. In fact, the consumption of each individual citizen is currently not monitored because the installation of water meters in individual households has been considered too costly so far: currently consumption is metered at building-level only and performed manually no more than four times a year.

While the local water company does not foresee changes in residential consumers metering in the near future, it considers convenient to introduce more automation for heavy consumers.

Based on this recommendation, ALMANAC has decided to focus the initial application scenario to be implemented on industrial and commercial users that consume large quantities of water. These could be, for example, owners of swimming pools, private manufacturing companies or large public buildings. ALMANAC considers this use case as a first step to demonstrate the feasibility of the concept and foresees the possibility to extend and scale the application so it can be used for monitoring individual home consumption. This approach has been initially validated through workshops with water utilities in Italy and Denmark that have confirm its relevance [D2.1].

The application development process will produce 3 prototypes, one each year. The year one prototype will focus on demonstrating the capabilities of the ALMANAC SCP, while the prototype of year 3 will be a fully functional water management application running on a lab-scale test-bed in Turin.

3.2 Consumption Awareness

Water is consumed by everyone, and is used in all process of life. Close consumption monitoring can benefit both industry and individuals consumers of water. Industry is eager to provide smart metering solutions, communication platforms for smart metering etc. and water utilities are eager to offer services that give added value to customers aside just providing clean water.

Figure 1 Smart meter for household metering

Figure 1 shows a standard smart meter designed for consumption monitoring of individual homes.

According to the Turin water utility, smart metering using a reliable monitoring system will aid the utility in providing frequent billing and faster leakage detection [Workshop 3]. Currently there are a lot of manual process involved in managing water consumption, and smart metering will heighten efficiency [Workshop 1][Workshop 2].

Smart metering is a first step on the path to achieve a sustainable management of the water cycle in urban areas, as put forth by The European Water Platform [D2.1]. It is also a step in the direction of granting users access to both own water consumption, and information on water in general.

The water management application will be a scalable application that can be used both in industry to monitor large installations with a complex water infrastructure, or in ordinary homes with limited water consumption. It will display absolute consumption, historical values and also calculated vales based on own consumption and the consumption of others. If deployed in public buildings the platform can function as an open data platform, granting citizens access to the city's water management information [D2.1].

The water management application will not address actual billing nor events that are managed explicitly by the water utility. This is out of scope of the ALMANAC project.

3.2.1 Related resources

OUTSMART Project	The OUTSMART's use case "Water as a resource" is related to the Water Management Application. OUTSMART attempted to detect leakages in pipes by attaching noise detection sensors on pipes. This is sufficient when dealing with leakages in the water infrastructure, but ALMANAC will provide the possibility to detect leakages in privately owned pipes.

4. Application Specification

4.1 Introduction

Following the IEEE 42010 methodology for architecture description, we specify the target application according to the functional, informational and deployment view. According to the methodology, a "view" represents one or more structural aspects of the architecture that illustrates how the architecture addresses one or more concerns of its stakeholders.

4.2 Functional view

The Water management application enables close monitoring of resource meters. The ALMANC SCP will receive measurements and observations form a range of sources, and the application will allow discovery and viewing of data. For the water management application flow meters will be the main data source, but the ALMANAC SCP supports any type of data source.

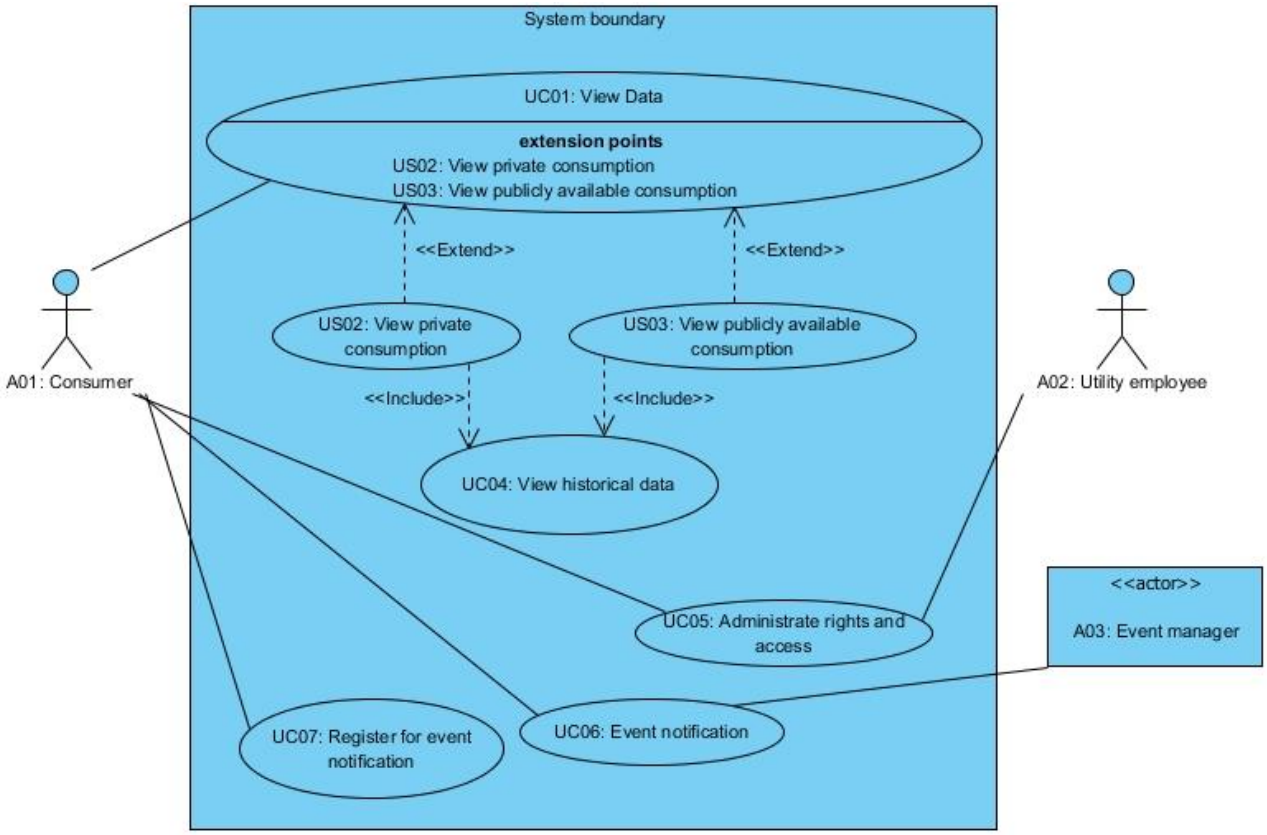

Figure 2 Use case diagram - Water Management Application

Figure 2 shows the main functionalities of the application. The use cases will be elaborated below, and illustrate the main functional requirements of the system. Reliability, performance, supportability etc. are not considered here because they are outside the scope of the use cases, being already documented in performance requirements.

Actor	Needs
A01: Consumer	Stay up to date with water consumption. Receive notification when abnormal water consumption is detected
A02: Utility employee	Manage consumers' access to water meters data.
A03: Event manager	Initiate event notification, when event arises in the ALMANAC SCP

Table 1 List of actors

UC01 View data

Main Success Scenario: The consumer opens the application and is presented with detailed information on own water consumption, and has an overview over water measurements that are publicly available.

Alternative Scenario: The consumer has been granted access to water consumption data of other users, so he can compare the two sets of data.

This UC also includes the possibility to compare own current consumption with historical data.

UC05 Administrate rights and access

Main Success Scenario: The utility employee or consumer wishes to grant access of data to a second party. If the consumer wishes to grant access to a friend, this person will have access to view his (consumer) data. The utility employee will manage the access to data in general, for example when a consumer moves.

UC07 Register for event notification

Main Success Scenario: The consumer wishes to be notified when unusual water consumption is detected, and registers for notification of unusual consumption. This could indicate a leak.

UC06 Event notification

Main Success Scenario: If the consumer has asked to receive notifications, the event manager will be able to detect abnormalities, and notify the consumer.

4.3 Informational view

This chapter shows the concepts of the Water Management Application. It shows the types of information needed by the application, and how they are stored.

4.3.1 Class diagram

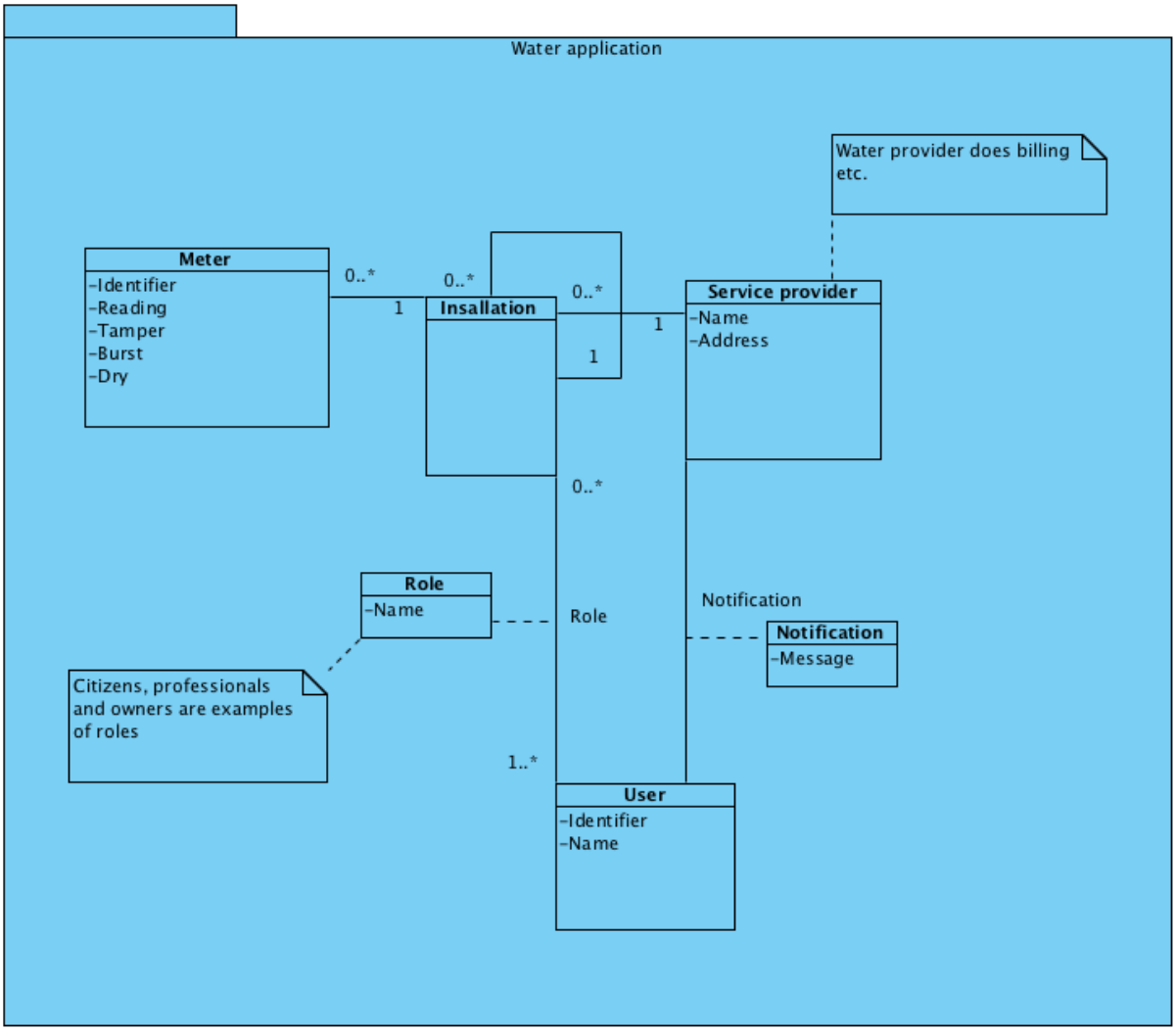

Figure 3 Concepts in water management application

There are several major concepts show in Figure 3. The class diagram is the product of object-oriented analysis, and shows conceptual classes, their associations and relevant attributes.

Name	Description
Meter	The meter is the actual smart metering device. It can register one type of data, or several different types of data at the same time. For example a modern Multical 21[2] flow meter can register both flow and detect leakages.
Installation	An installation is simply a grouping of meters. It does not necessarily have fixed address, but the intent is that many meters can be installed together in a logical unit. There can be a hierarchy of installations, where for example the main inlet to a building is the root installation, and each apartment can be a sub installation of that.
User	A user can have access to one or more installations. Access is defined through roles, and the user can receive notifications form the platform about specific events.
Role	The user can have one or many roles, each with various rights associated

[2] http://kamstrup.com/16678/multical-21

	with the installation.
Service provider	The provider is the entity responsible for all installations, and can provide services including notifications to users.
Notification	A notification message can be sent to a user, when a subscribed event occurs.

Table 2 List of classes

4.3.2 ER diagram

The application loads data from the ALMANAC SCP and caches them internally.

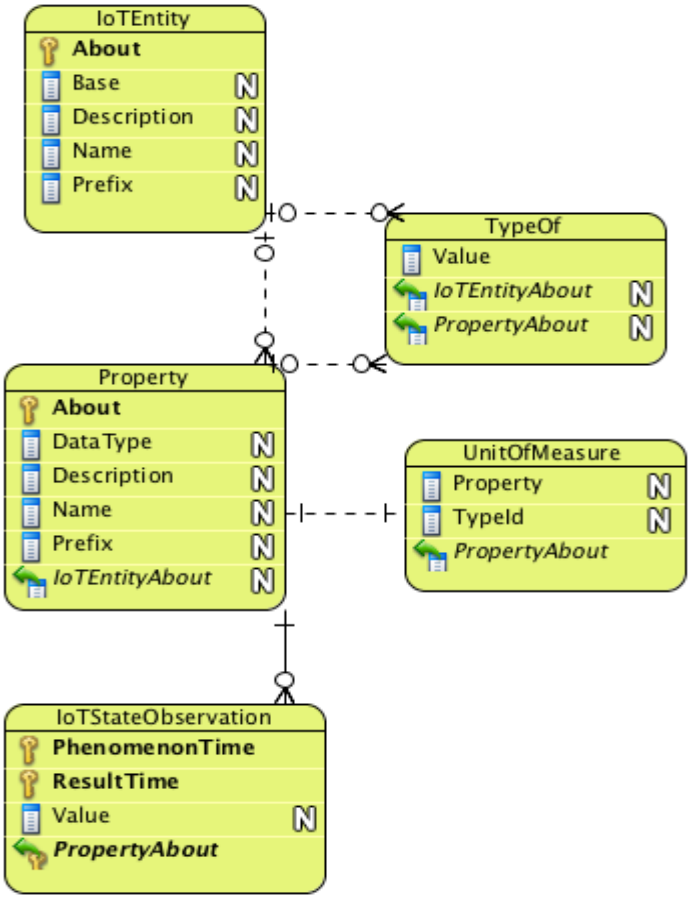

Figure 4 ER Diagram of application cache

Figure 4 shows the database scheme that stores the measurements in the ALMANAC application.

Name	Description
IoTEntity	The IoTEntity is simply the entity or smart meter in question. It has a unique identifier, and can be defined as having one or more types.
Type	A type is an identifier used to group similar IoTEntityes.
Property	The property defines the type of measurement / observation in question. An IoTEntity can have many different properties, for example humidity and temperature. Each has its own property, and unit of measure.
IoTStateObservation	The IoTStateObservation has a value that comes from the sensor and also the time of the phenomenon.

UnitOfMeasure	Indicates the unit of measure implemented by the property. This could be an SI value, but anything is valid.

4.4 Deployment View

The following table summarizes the deployment of hardware (sensors) and software (services) required to implement the consumption awareness scenario.

Hardware	
Smart meter	Smart meters are installed to monitor consumption of water.
Wireless network infrastructure	Transmitter, receivers, network repeaters and gateways required to build up a wireless sensor network.
Mobile device	The mobile devices receives notification on events like leakages, and provides consumption feedback to the consumer.
Software	
ALMANAC platform	The ALMANAC platform handles the integration of sensors, issuing and filtering of events, and forwarding of messages.

5. Conclusion

The Water Management Application prototype developed for the first year demonstrates the ALMANAC platforms ability to collect data from homogenous systems. Future releases of the Water Management application will make use of the Cloud-based APIs for Smart City applications developers, use the goal driven service lookup mechanism features of the SCP [D3.1.1] and even demonstrate the platforms event management system [D3.1.1], by enabling notifications.

The Water Management Application lab-scale prototype though developed for and evaluated in the water domain, will be an application whose components could be reused in other domains.

6. References

(D2.1) D2.1 Scenarios for Smart City applications

(D3.1.1) D3.1.1 System Architecture Analysis & Design Specification

(Workshop 1) MoM 20142606 Consortium Meeting Turin,
Water Workshop with Ing. Quazzo from SMAT

(Workshop 2) MoM 20141103 Consortium Meeting Santander,
Water Workshop

(Workshop 3) 20140218_Almanac_SMATmeeting – MoM,
Water workshop with SMAT, TI and ISMB