Design and methodology of iWIDGET system validation

iWIDGET Milestone MS35

Paula Vieira (LNEC), José Barateiro (LNEC), João Coelho (LNEC), Rita Ribeiro (LNEC), Dália Loureiro (LNEC), Panagiotis Kossieris (NTUA), Enrico Creaco (UNEXE), Lydia Vamvakeridou-Lyroudia (UNEXE), Nicole Taheri (IBM), Ernesto Arandia (IBM), Zoran Kapelan (UNEXE)

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Smart meters
Smart water
Smart societies

iWIDGET

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Author (s): Paula Vieira (LNEC), José Barateiro (LNEC), João Coelho (LNEC), Rita Ribeiro (LNEC), Dália Loureiro (LNEC), Panagiotis Kossieris (NTUA), Enrico Creaco (UNEXE), Lydia Vamvakeridou-Lyroudia (UNEXE), Nicole Taheri (IBM), Ernesto Arandia (IBM), Zoran Kapelan (UNEXE)

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1 Introduction

1.1 The iWIDGET Project

iWIDGET is a FP7 European Commission collaborative project aimed at improved water efficiencies through the use of novel ICT technologies for integrated supply-demand side management. The iWIDGET project focuses on a more integrated approach to water resources management and the project will contribute to delivering a sustainable, low-carbon society, helping progress towards the Europe 2020 targets on Climate and Energy.

The aim of iWIDGET is to advance knowledge and understanding about smart metering technologies in order to develop novel, robust, practical and cost-effective methodologies and tools to manage urban water demand in households across Europe, by reducing wastage, improving utility understanding of end-user demand and reducing customer water and energy costs.

Hence, the iWIDGET system's purpose is twofold: first, it intends to enable householders to better understand their water and related energy use in real-time and to identify inefficient usage and leaks and to support them in changing wasteful behaviours. Second, it intends to enable utilities to better understand the behavioural patterns of their customers through the assembly of data and processed information at much higher resolutions than previously available.

The main scientific challenges for iWIDGET are the management and extraction of useful information from a vast amount of high-resolution consumption data; the development of customised intervention and awareness campaigns to influence behavioural change; and the integration of iWIDGET concepts into a set of decision-support tools for water utilities and consumers applicable in differing local conditions. In order to meet these aims and challenges iWIDGET investigates: (i) how best to provide the dynamic accurate measurement and data transfer of useful information about end-user water consumption, (ii) how best to use consumption data to improve the operation of utilities and influence end-users to modify their behaviour, (iii) how to arrive at the best business model to convert a promising technology into a useful and cost-

effective product, and (iv) how to demonstrate and validate the new methodologies on three case studies in the UK, Portugal and Athens.

1.2 Objective of this document

This report is part of Work Package 3 (WP3) - *Implementation and validation of the iWIDGET systems.* It reports the initial results achieved under Task 3.4: *Design the real-life validations.*

The aim of this WP is to design and carry out real life full scale testing of the iWIDGET systems (prototype developed in WP2) in close collaboration with households and utility stakeholders. Particularly, Task 3.4 develops a methodology for real-time on-line validations of iWIDGET components. Its main objective is to build upon the results achieved in Task 3.3: iWIDGET *off-line tests and validation (*reported on MS33 Implementation of iWIDGET systems with historical data) and test the system under on-line conditions with real users. The results of this on-line testing will be a critical input for the overall review and evaluation of the iWIDGET systems (performed under WP4), especially for the task related with the technical evaluation of the iWIDGET system.

As a consequence, the method proposed to attain the objectives of the real-time on-line validations of iWIDGET components, establish an important connection between the results achieve in off-line testing and the overall system evaluation. In fact, it must ensure that all off-line tests were succeeded and that enough information was produced to execute the overall evaluation.

Finally, we must also refer that the real-time on-line validations depend on the type of users and on the environment where the iWIDGET system is being tested. As a consequence, the validation and verifications must be run as separate activities for the three case studies evaluated in this project. It is not an objective of this task to assess and compare distinct results from distinct case studies.

1.3 Structure of the document

After this introduction, the report includes the following chapters:

- Chapter 2 details the methodology used in iWIDGET for on-line testing and real-life validations of the widgets developed in WP2.
- Chapter 3 details the first step of the proposed method, detailing the set of initial activities that establish the connection between off-line and on-line tests.
- Chapter 4 describes the second step of the proposed method, where on-line tests with real data and real users are performed in a controlled environment by organized focus group for each case study.
- Chapter 5 describes the third step of the method where bug and feedback tracking mechanisms are in place to gather usage information that can be used for technical evaluation.
- Chapter 6 details the execution monitoring activity that is responsible to monitor the end-users behavior in their iWIDGET interactions.
- Chapter 7 show the estimated setup for on-line testing, detailing the plan where each test is performed within the scope of the case studies.
- Chapter 8 lists the main conclusions of the work reported on this milestone.

2 General methodology for on-line testing

Following the off-line testing reported in MS33, the main objective of the on-line testing is to ensure the operational readiness of the iWIDGET system with real-time data in uncontrolled usages (interactions performed by real end-users). Similarly, the specific objectives are:

- Ensure that the system complies with functional and non-functional requirements established in WP1;
- Evaluate the quality of usage and users understandability of the system, using the infrastructure provided for system deployment;
- Maintain an updated set of information that is tracked from the system usage, aiming at continuous system improvement;
- Evaluate the technical resources used to run the system;
- Evaluate the behavioural and water usage impact of the continuous use of iWIDGET.

For that purpose, we must consider that all unit tests were already performed. Also, white box tests (requiring internal knowledge and system analysis) are considered out of the scope for this process. Consequently, we focus on black-box testing, where end-users do not need to know about the internal details and technical software programming, "looking" at the system from an end-user perspective.

Thus, in order to follow an effective on-line testing, from a black-box perspective, using real-time data, we develop a specific methodology as shown in the overview presented in Figure 1. It uses the results already achieved in off-line testing (MS33 – Implementation of iWIDGET system with historical data) and produces results that will feed the overall system evaluation, conducted in the scope of WP4 and initially reported on MS44 – Draft report on technical evaluation of the iWIDGET system.
Note that the off-line test results initially reported on MS33, are being processed and will be further reported in Year 3, D3.3.1 - Design and performance of on-line and off-line testing and validation of iWIDGET Systems: Report on the design and performance of on-line and off-line testing and validation of iWIDGET Systems (Methodology, comments, examples of application for off-line and on line testing and validation, guidelines). Likewise, the iWIDGET technical evaluation initially reported on MS44 will be

further exploited and analysed during Year 3 – D4.4.3 - Final report on the technical evaluation of the iWIDGET system. In fact, the results achieved by the method reported on this milestone will be analysed and reported in WP4 activities.

The on-line testing method execution uses real-time datasets and is performed by real end-users (both for the water utility widgets and consumer widgets).

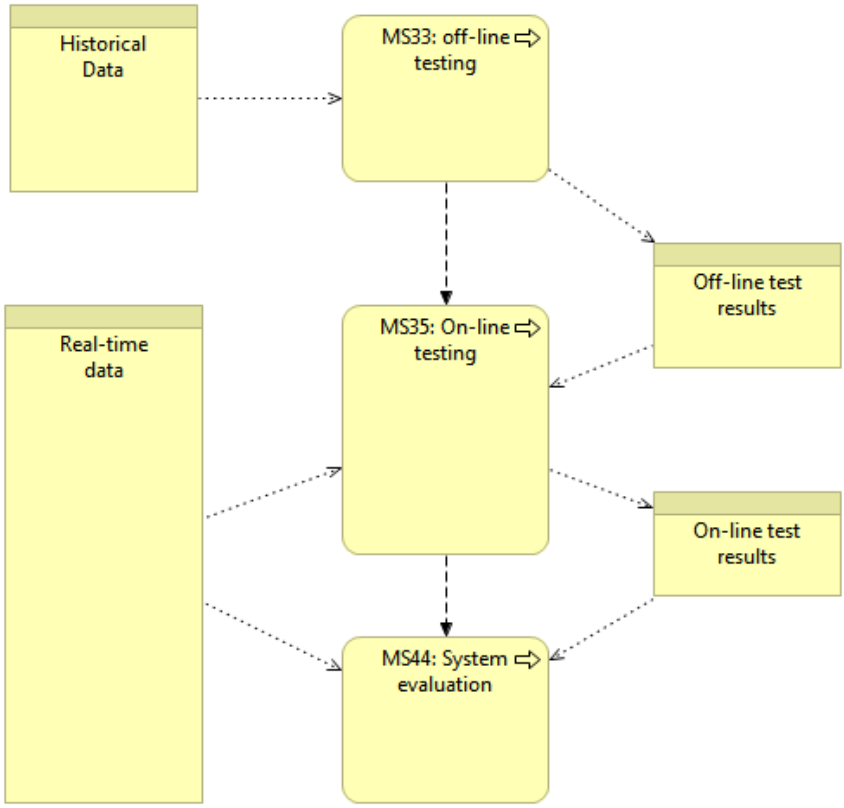

Figure 1 – Methodology overview for on-line testing in WP3

In fact, this task depends on the results achieved by the off-line testing and must rely on the tests that were successful. However, we should not start with on-line tests on functionalities that were not successfully tested in the previous step. Consequently, as shown in Figure 2, the methodology starts with a pre-testing, that is performed by the project partners on real-data, and has the objective of correcting the functional errors detected on off-line tests, develop new test cases to ensure that the corrections were

well implemented and, finally, run the new tests (both functional and non-functional) to ensure the desired quality level of the full iWIDGET system before starting the testing and usage by the final end-users.

After completing the pre-testing phase, the on-line methodology includes a step, where the system usage is evaluated in a controlled environment. This controlled environment is a focus group with real users (consumers using the consumer widgets with their own real data; and water utility users using the water utility widgets with their own data), where project partners monitor their usage. Also, from this phase, questionnaire instruments are used to gather user perception metrics related to the iWIDGET qualities that must be evaluated in WP4 system evaluation.

Finally, the on-line methodology includes two major activities that are continuously running:

- Bug and feedback tracking: mechanisms to support user feedback and bug reporting, where the system timestamps the occurrence, identifies the users and classifies the type of occurrence (note that this mechanism is responsible by the data gathering, which then requires posterior processing);
- Execution monitoring: the system includes monitoring mechanisms that log information about the system usage by each user. For instance, it logs the log-in occurrences (including logged time) functionalities accessed, frequency of usage.

During the on-line test, real data is being continuously used and generated, which means that the results that are produced and on time instance might be different from those produced in a different time instance. In fact, real-time results are fed into the iWIDGET system and results are produced according to the data available at the execution time.

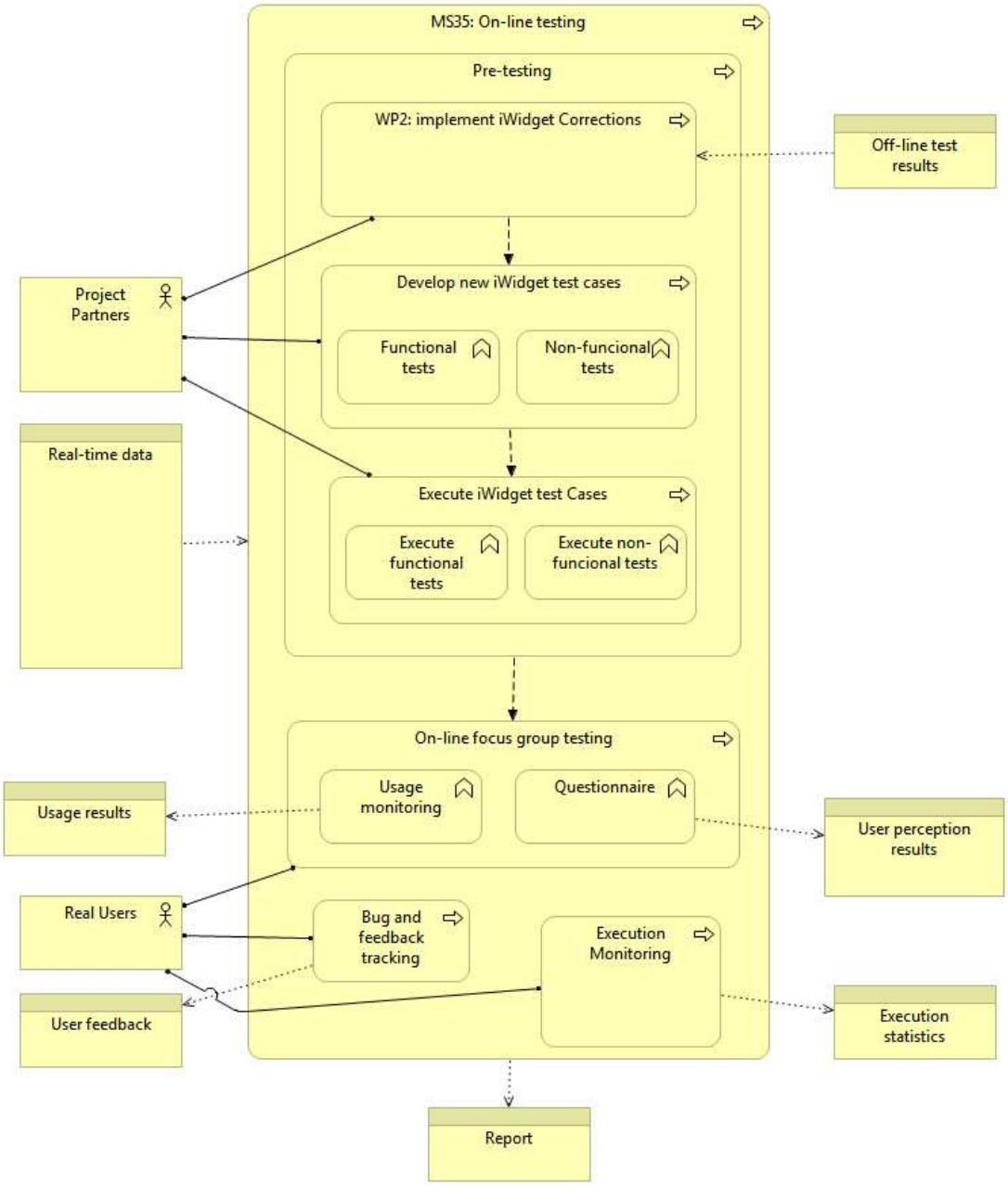

Figure 2 – Detailed methodology for on-line testing in WP3

On-line testing in WP3 assumes that the following **pre-conditions** are fulfilled:

- The set of use cases and the corresponding functional and non-functional requirements exist and are supported by specific widgets;
- Individual components (data management and the analytical components) are ready in the deployment version (accessible from any device with Internet access) [related with WP2];
- Results from off-line testing were already produced. [related with WP2];
-

Real-time data is being collected for the case study users that will be involved on the testing.

3 Step 1 Pre-testing

Figure 3 details the activities that are performed during the pre-testing phase of the on-line testing method. Note that all tests are performed with real-time data and are executed by project partners-
It is decomposed in three main phases:

- Implement iWIDGET corrections: to correct the problems identified during the off-line tests reported on MS33;
- Develop new iWIDGET test cases: in order to ensure that the corrections where adequately implemented, new test cases must be developed;
- Execute iWIDGET test cases: the new test cases defined in the previous step must be executed. These test cases are performed by project partners.

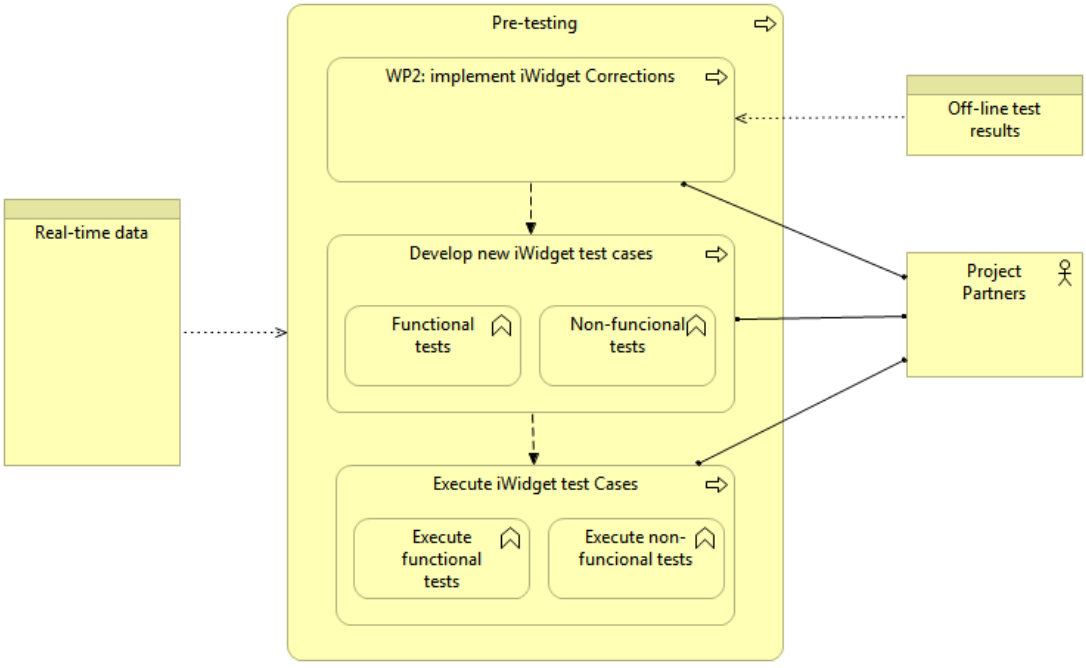

Figure 3: Step 1: Pre-testing method

3.1 Implement iWIDGET corrections

The first stage of the Pre-testing phase is designed to ensure that all widgets are fully functional before being submitted for testing by real users. The starting point is the feedback obtained from off-line tests, which was used by all developer partners to correct and improve their own widgets. The off-line tests that failed during the off-line testing are listed in Table 1 and Table 2. For this purpose, we consider that the implemented corrections were performed in isolated widgets and, as a consequence, do not interfere with the test cases that were successful. Thus, the following tables only list the test cases that failed for the consumer and water utility domains.

Table 1 – Test case failed results from off-line testing – consumer domain

Use Case ID	Test case ID	# Executions	# Failures	# Passes	Status
C_UC01.1	1.1	3	3	0	FAIL
	2.1	3	3	0	FAIL
	3.1	3	3	0	FAIL
	4.1	3	3	0	FAIL
	5.1	3	3	0	FAIL
	6.1	3	3	0	FAIL
	7.1	3	3	0	FAIL
	8.1	3	3	0	FAIL
	9.1	3	3	0	FAIL
C_UC01.2	1.1	1	1	0	FAIL
C_UC02.1	1.1	1	1	0	FAIL
	2.1	1	1	0	FAIL
C_UC02.2	1.1	1	1	0	FAIL
C_UC02.3	1.1	1	1	0	FAIL

Use Case ID	Test case ID	# Executions	# Failures	# Passes	Status
C_UC03.1	1.1	4	2	2	FAIL
	2.1	3	2	1	FAIL
C_UC03.2	1.1	6	5	1	FAIL
C_UC03.3	1.1	6	4	2	FAIL
C_UC03.4	1.1	6	2	4	FAIL
C_UC03.5	1.1	3	1	2	FAIL
	2.1	1	1	0	FAIL
C_UC03.6	1.1	1	1	0	FAIL
C_UC04.1	1.1	5	2	3	FAIL
C_UC05.2	1.1	5	3	2	FAIL
C_UC05.3	1.1	5	3	2	FAIL
C_UC05.4	1.1	5	2	3	FAIL

Table 2 – Test case failed results from off-line testing – water utility domain

Use Case ID	Test case ID	# Executions	# Failures	# Passes	Status
WU_UC1.1	1.1	2	1	1	FAIL
	2.1	2	1	1	FAIL
	3.1	2	1	1	FAIL
	4.1	2	1	1	FAIL
	5.1	2	1	1	FAIL
	6.1	2	1	1	FAIL
	7.1	2	1	1	FAIL
	8.1	2	1	1	FAIL
WU_UC1.2	1.1	2	1	1	FAIL
	2.1	2	1	1	FAIL
	2.2	1	1	0	FAIL
	3.1	2	1	1	FAIL
	3.2	2	1	1	FAIL
	3.3	2	1	1	FAIL
WU_UC02.1	1.1	2	2	0	FAIL
	2.1	2	2	0	FAIL
	3.1	2	2	0	FAIL
	3.2	1	1	0	FAIL
WU_UC02.2	1.1	2	2	0	FAIL
WU_UC02.3	1.1	1	1	0	FAIL
	2.1	1	1	0	FAIL
	3.1	1	1	0	FAIL
WU_UC02.4	1.1	2	2	0	FAIL
	2.1	1	1	0	FAIL
	3.1	1	1	0	FAIL
	4.1	1	1	0	FAIL

Use Case ID	Test case ID	# Executions	# Failures	# Passes	Status
WU_UC03.1	1.1	1	1	0	FAIL
	2.1	1	1	0	FAIL
	3.1	1	1	0	FAIL
	4.1	1	1	0	FAIL
WU_UC04.1	1.1	1	1	0	FAIL
WU_UC04.2	1.1	1	1	0	FAIL
WU_UC04.3	1.1	2	1	1	FAIL
	1.2	2	1	1	FAIL
	1.5	2	1	1	FAIL
	1.6	2	1	1	FAIL
	2.5	2	1	1	FAIL
	2.6	2	1	1	FAIL
	3.1	2	2	0	FAIL
	3.2	2	2	0	FAIL
	3.3	2	2	0	FAIL
	3.4	2	2	0	FAIL
WU_UC04.4	1.1	1	1	0	FAIL
	2.1	1	1	0	FAIL
	3.1	1	1	0	FAIL
	4.1	1	1	0	FAIL
WU_UC07.4	1.1	1	1	0	FAIL
	2.1	1	1	0	FAIL
	3.1	1	1	0	FAIL
	4.1	1	1	0	FAIL

For each of these use cases and correspondent failed test cases, a new test case has been developed, as detailed in section 3.2.

3.2 On-line Test Cases for functional tests

In order to complete the pre-testing phase, new test cases for each test case that failed the off-line testing stage have been developed. Since the purpose of these tests is to assess the system's functionality, previously defined test scenarios were kept

unchanged; however, it is necessary to define new test cases – although they should test the very same requirements – in order to ensure that widget corrections were not tailored specifically to each test case and that they perform adequately in all situations.

In contrast with off-line tests, these will be performed using real-time data, rather than historical data; as before, the partners will carry out the tests in the widgets they developed. Sections 3.2.1 and 3.2.2 present the new functional test cases, for each domain.

3.2.1 Consumer domain

This section details the test cases for the widgets that were corrected for the consumer domain. Table 3 to Table 16 list the test cases that must be performed using real data before proceeding in this method.

Table 3 – Test cases for use case C_UC01.1 Obtain total water consumption and costs using real-time data

Test scenario #1 Obtain information on the 15-minutes total water consumption for a specific day	
Test case ID	**#1.1**
Test case description	Obtain information on the 15-minutes total water consumption for a specific day. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day from calendar (14 December 2014) • Select 15-minutes resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data
Tester profile required	Householder

Test scenario #2 Obtain information on the hourly total water consumption for a specific week	
Test case ID	**#2.1**
Test case description	Obtain information on the hourly total water consumption for a specific week. The system displays the time series graphs and statistics of consumption data.

Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the week under investigation (14 December 2014) • Select hourly resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data
Tester profile required	Householder

Test scenario #3 Obtain information on the cumulative water consumption for a specific month	
Test case ID	**#3.1**
Test case description	Obtain information on the cumulative water consumption for a specific month. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the month under investigation (14 Decemeber 2014) • Select monthly resolution from the time resolution list • Select “monthly water consumption” as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data
Tester profile required	Householder

Test scenario #4 Obtain information on the daily total water consumption for a specific week	
Test case ID	**#4.1**
Test case description	Obtain information on the daily total water consumption for a specific week. The system displays the time series graphs and statistics of consumption data.

Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the week under investigation (14 December 2014) • Select daily resolution from the time resolution list • Select "daily water consumption" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data
Tester profile required	Householder

Test scenario #5 Obtain information on the per capita daily total water consumption for a specific week	
Test case ID	**#5.1**
Test case description	Obtain information on the per capita daily total water consumption for a specific week. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the week under investigation (14 December 2014) • Select daily resolution from the time resolution list • Select "daily water consumption per capita" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data
Tester profile required	Householder

Test scenario #6 Obtain information on the monthly total water consumption for a specific year	
Test case ID	**#6.1**
Test case description	Obtain information on the monthly total water consumption for a specific year. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the year under investigation (14 December 2014) • Select monthly resolution from the time resolution list • Select "monthly water consumption" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data

Tester profile required	Householder

Test scenario #7 Obtain information on the monthly total cost related to water consumption for a specific year	
Test case ID	**#7.1**
Test case description	Obtain information on the monthly total cost related to water consumption for a specific year. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the year under investigation (14 December 2014) • Select monthly resolution from the time resolution list • Select "monthly water cost" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data
Tester profile required	Householder

Test scenario #8 Obtain the allocation of the total water consumption into night and day for a specific day	
Test case ID	**#8.1**
Test case description	Obtain the allocation of the total water consumption into night and day for a specific day. The system displays a pie chart with the allocation.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day from calendar (14 December 2014) • Select hourly resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents the allocation in the form of pie chart and a report with the main statistics and information • Download data
Tester profile required	Householder

Test scenario #9 Obtain the allocation of the total water consumption into summer and winter period for a specific month	
Test case ID	**#9.1**
Test case description	Obtain the allocation of the total water consumption into summer and winter period for a specific month. The system displays a pie chart with the allocation.

Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the month under investigation (14 December 2014) • Select monthly resolution from the time resolution list • Select "monthly water consumption" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents the allocation in the form of pie chart and a report with the main statistics and information • Download data
Tester profile required	Householder

Table 4 – Test cases for use case C_UC1.2: Obtain per appliance water consumption and costs (total water consumption breakdown) using real-time data from smart meters

Test scenario #1 #1 Obtain per appliance water consumption for a specific month	
Test case ID	**#1.1**
Test case description	Obtain information on the breakdown of total monthly water consumption into various water uses.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the information on per appliance water consumption • Select the month and the year under investigation (December 2014) • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the breakdown into uses in the form of pie chart and summary report
Tester profile required	• Householder

Table 5 – Test cases for use case C_UC2.1: Obtain total energy consumption and costs associated with water consumption using real-time data from smart meters

Test scenario #1 Obtain information on the 15-minutes total energy consumption for a specific day	
Test case ID	**#1.1**
Test case description	Obtain information on the 15-minutes total energy consumption for a specific day. The system displays the time series graphs and statistics of consumption data.

Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of energy consumption details • Select a day from calendar (14 December 2014) • Select 15-minutes resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Download data
Tester profile required	• Householder

Test scenario #2 Obtain amount of energy consumption associated with water uses for a specific month	
Test case ID	**#2.1**
Test case description	Obtain information on the monthly energy consumption related to water uses and appliances. The platform presents the results in the form of pie chart and summary report.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the information on energy consumption associated with water • Select the month and the year under investigation (December 2014) • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the amount of energy consumption related to water in the form of pie chart and summary report
Tester profile required	• Householder

Table 6 – Test cases for use case C_UC2.2: Obtain per appliance energy consumption and costs associated with water consumption using real-time data from smart meters

Test scenario #1 #1 Obtain per appliance energy consumption for a specific month	
Test case ID	**#1.1**
Test case description	Obtain information on the breakdown of total monthly energy consumption into various energy uses and appliances. The platform presents the results in the form of pie chart and summary report.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the information on per appliance energy consumption • Select the month and the year under investigation (December 2014) • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the breakdown into uses in the form of pie chart and summary report

Tester profile required	• Householder

Table 7 – Test cases for use case C_UC2.3: Display carbon emissions related to water consumption (carbon footprint for water)

Test scenario #1 Obtain amount of carbon emissions for water and non-water related uses for a specific month	
Test case ID	**#1.1**
Test case description	Obtain information on the monthly carbon emissions related to water and energy appliances. The platform presents the results in the form of pie chart and summary report.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the information on carbon emissions of the household • Select the month and the year under investigation (December 2014) • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the carbon emissions related to energy and water uses
Tester profile required	• Householder

Table 8 – Test cases for use case C_UC03.1 Compare current water use pattern with historical consumption data of the same household

Test scenario #1 Obtain comparative overview information of current water consumption against consumption of previous periods	
Test case ID	**#1.1**
Test case description	Compare the water consumption of last full measured periods (daily, weekly, monthly, yearly) with previous periods of the same length.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status (“homepage” of the platform) • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the comparison of the current consumption with the relevant consumption of the same period of previous years
Tester profile required	Householder

Test scenario #2 Obtain comparative information on the total water consumption of last 7 days	
Test case ID	**#2.1**
Test case description	Compare the daily water consumptions of last full measured 7 days.

Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of comparison of water consumptions • Select daily data resolution • Select last 7 days as time-period under investigation • Select "total" as data resolution • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents comparative graphs and reports
Tester profile required	Householder

Table 9 – Test cases for use case C_UC03.2 Compare water consumption with other consumers (e.g. neighbour, in the same building or street)

Test scenario #1 Compare the daily per capita water consumption with the relevant average consumption of the DMA for a specific day	
Test case ID	**#1.1**
Test case description	Compare the daily per capita water consumption with the relevant average consumption of the DMA for a specific day. The system displays the time series graphs with comparative information.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status • iWIDGET calculates the result • iWIDGET presents time series graphs and a report • Save data
Tester profile required	Householder

Table 10 – Test cases for use case C_UC03.3 Compare water consumption with standard profiles

Test scenario #1 Compare the daily per capita water consumption with users with similar characteristics in the DMA	
Test case ID	**#1.1**
Test case description	Compare water consumption with standard profiles
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status • iWIDGET calculates the result • iWIDGET presents time series graphs and a report • Save data
Tester profile required	Householder

Table 11 – Test cases for use case C_UC03.4 Compare household water consumption with most efficient users

Test scenario #1 Compare the daily per capita water consumption with low consumption users in the DMA	
Test case ID	**#1.1**
Test case description	Compare household water consumption with most efficient users
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status • iWIDGET calculates the result • iWIDGET presents time series graphs and a report • Save data
Tester profile required	Householder

Table 12 – Test cases for use case C_UC03.5 Obtain information on inefficient water uses

Test scenario #1 Obtain information on inefficient water uses	
Test case ID	**#1.1**
Test case description	Obtain information on inefficient water uses. The information is displayed through the iWIDGET eLearning platform.
Test case sequence of steps	• Log on to iWIDGET platform using authentication credentials (username and password) • iWIDGET displays a hyperlink to iWIDGET eLearning platform named “Be Smart with Water in the House” • Access the on-line course that is displayed via a new tab in the browser • Log on to eLearning platform using a password and username • Select the tool “Water Calculator” for the analysis of total consumption into various uses and comparison with water-efficient values • Give the required information • iWIDGET platform analyses data and calculates the results • iWIDGET platform retrieves warnings • iWIDGET eLearning platform displays the results and possible warnings
Tester profile required	Householder

Table 13 – Test cases for use case C_UC 3.6 Receive warnings about faults (leakages, bursts) and unusual water consumptions

Test scenario #1 Receive information on unusual water consumption events (leakages or bursts)	
Test case ID	**#1.1**
Test case description	Obtain warnings about possible unusual water consumption events (leakages and bursts). The platform presents the details about the events (day, time, consumption).

Test case sequence of steps	• Log on to iWIDGET platform using authentication credentials (username and password) • Select the option related to information on unusual water consumption events • iWIDGET platform analyses data and calculates the results • iWIDGET platform retrieves warnings • iWIDGET displays the detected unusual events and provide warnings
Tester profile required	• Householder

Table 14 – Test cases for use case C_UC04.1&5.4 Compare energy pattern associated with water use in the same household; Forecast the component of next energy bill associated with water consumption

Test scenario #1 Compare the water related energy consumptions associated with different periods and forecast of the part of the next energy bill associated with water	
Test case ID	**#1.1**
Test case description	Compare energy pattern associated with water use in the same household; Forecast the component of next energy bill associated with water consumption
Test case sequence of steps	• Log on to iWIDGET using a password • Select time-period of consumer data (energy use) • iWIDGET displays consumer data and energy consumption • Input energy tariff information • Select forecast time-period • iWIDGET presents time series graphs and a report on energy cost • iWIDGET presents time series graphs and a report on water cost • Save data
Tester profile required	Householder

Table 15 – Test cases for use case C_UC05.2 Receive information on specific and alternatives pricing schemes

Test scenario #1 Analyse the extent to which a change in the water tariffs affects the consumer's bill for prefixed consumption	
Test case ID	**#1.1**
Test case description	Receive information on specific and alternatives pricing schemes

Test case sequence of steps	• Log on to iWIDGET using a password • Select water pricing tariff • iWIDGET displays pricing tariff • iWIDGET displays water cost • iWIDGET displays comparative tariff costs • iWIDGET identifies best tariff cost • iWIDGET yields ease of interpreting water cost • iWIDGET yields ease of interpretation • Save data
Tester profile required	Householder

Table 16 – Test cases for use case C_UC05.3 Forecast the next water bill

Test scenario #1 Forecast the next bill on the basis of the bills and consumptions recorded in the past	
Test case ID	**#1.1**
Test case description	Forecast the next water bill
Test case sequence of steps	• Log on to iWIDGET using a password • Select forecast time-period • iWIDGET calculates water use • iWIDGET displays future water bill • iWIDGET displays alternative future bills • Save data
Tester profile required	Householder

3.2.2 Water Utility domain

Similarly to the consumer domain, this section details the test cases for the widgets that were corrected for the water utility domain. Table 17 to Table 28 list the test cases that must be performed using real data before proceeding in this method.

Table 17 – Test cases for use case WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data

Test scenario #1 Obtain the water consumption in all the network sectors for a period of one year per month	
Test case ID	**#1.1**
Test case description	Obtain the monthly water consumption in all the network sectors during the period of one year (01/01/14 until 31/12/14). Overall water consumption components to be calculated are consumption per DMA and consumption per consumption category. The widget presents the bar chart and the time series graph

Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select temporal resolution (last 12 months) • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #2 Obtain the water consumption in all the network sectors for a period of one year per year quarter	
Test case ID	**#2.1**
Test case description	Obtain the quarterly water consumption in all the network sectors during the period of one year (01/01/14 until 31/12/14). Overall water consumption components to be calculated are consumption per DMA and consumption per consumption category. The widget presents the bar chart and the time series graph
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select temporal resolution (last 4 quarters) • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #3 Obtain the daily water flow for MC6 for a series of months	
Test case ID	**#3.1**
Test case description	Obtain the daily water flow for MC8 of Barcelos supply system for the time period between 01/01/14 until 31/12/14. Water overview components to be calculated are inflow and outflow. The widget presents the bar chart and the time series graph
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select meter ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #4 Obtain the hourly water flow for all meters during one day	
Test case ID	**#4.1**
Test case description	Obtain the water flow per hour for all meters of Barcelos supply system, for the time period between 16 November 2014 00:00 and 16 November 2014 23:59. Water overview components to be calculated are inflow and outflow. The widget presents the bar chart and the time series graph.

Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select meter ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #5 Obtain the monthly water consumption for a specific DMA for one year	
Test case ID	**#5.1**
Test case description	Obtain the monthly water flow of DMA 2 of Barcelos supply system, for the time period between 01/01/14 and 31/12/14. Water overview components to be calculated are inflow and outflow. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select meter ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #6 Obtain the daily water inflow for DMA 3 for three weeks	
Test case ID	**#6.1**
Test case description	Obtain the daily water inflow and consumption of DMA 3 of Barcelos supply system, for the time period between 01/11/14 and 21/11/14. Water overview components to be calculated are inflow and consumption. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #7 Obtain the hourly consumption for DMA 1 for two days	
Test case ID	**#7.1**

Test case description	Obtain the hourly water inflow and consumption of DMA 1 of Barcelos supply system, for the time period between 03/12/14 and 04/12/14. Water overview components to be calculated are inflow and consumption. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #8 Obtain the monthly inflow/consumption for all the DMAs for one year	
Test case ID	**#8.1**
Test case description	Obtain the monthly water inflow and consumption of all network sectors of Barcelos supply system, for the time period between 01/01/14 and 31/12/14. Water overview components to be calculated are inflow and consumption. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Table 18 – Test cases for use case WU_UC01.2 Obtain water consumption data per category of consumer using real-time data

Test scenario #1 Obtain the water consumption for a specific consumption category (e.g. Household consumption category) in DMA 2 for a period of three months	
Test case ID	**#1.1**
Test case description	Obtain the daily water consumption from one consumption category (household category) of the DMA 2 network sector of Barcelos supply system, for the time period between 01/09/14 and 31/12/14. The component to be calculated is the consumption per category. The widget presents the bar chart and the time series graph.

Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #2 Obtain the water consumption per hour of all consumption categories in all the DMAs for specific days	
Test case ID	**#2.1**
Test case description	Obtain the hourly water consumption of all the consumption categories out of all the network sectors of Barcelos supply system, for the time period between 20/10/14 and 22/10/14. The component to be calculated is the consumption per category. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #3 Obtain the monthly water consumption of all the network sectors for one year	
Test case ID	**#3.1**
Test case description	Obtain the monthly water consumption of all the consumption categories out of all the network sectors of Barcelos supply system, for the time period between 01/01/14 and 31/12/14. The component to be calculated is the consumption per category. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Table 19 – Test cases for use case WU_UC02.1 Obtain real-time water balance

Test scenario #1 Obtain the system input, the authorised consumption, the water losses, the real losses and the apparent losses in a specific DMA for one month	
Test case ID	**#1.1**
Test case description	Obtain the daily water balance of DMA 3 from Barcelos supply system, for the time period between 01/10/14 and 08/10/14. The components to be calculated are the system input, the authorised consumption, the water losses, the real losses and the apparent losses. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #2 Obtain the system input, the authorised consumption, the water losses, the real losses and the apparent losses of all the DMAs for one day	
Test case ID	**#2.1**
Test case description	Obtain the hourly water balance of all the network sectors from Barcelos supply system, for the time period between 30/09/14 00:00 and 30/09/14 23:59. The components to be calculated are the system input, the authorised consumption, the water losses, the real losses and the apparent losses. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #3 Obtain billed metered consumption and the unbilled metered consumption for a year	
Test case ID	**#3.1**
Test case description	Obtain the monthly water balance of all the network sectors from Barcelos supply system, for the time period between 01/01/14 00:00 and 31/12/14 23:59. The components to be calculated are the billed metered consumption and the unbilled metered consumption. The widget presents the bar chart and the time series graph.

Test case sequence of steps	• Log on to iWIDGET
	• Select data processing options
	  ➢ select network sector
	  ➢ select time period
	  ➢ select temporal resolution
	• Visualize data
	• Exit the application

Tester profile required	• Water utility network operation staff

Table 20 – Test cases for use case WU_UC02.2 Benchmark water losses against reference values

Test scenario #1 Obtain comparative information: Benchmark water losses against reference values	
Test case ID	**# 1.1**
Test case description	Perceive information on water losses through benchmarking
Test case sequence of steps	• Log on to iWIDGET using a password • Go to Water Analysis Tab • Select the option Water Balance • Select Network Sector • Select Temporal Resolution • Annual Billed • Select time interval • Press calculate • Check screen displayed • Exit
Tester profile required	Utility staff

Table 21 – Test cases for use case WU_UC02.3 Obtain information on consumption profiling

Test scenario #1 Obtain information on consumption profiling	
Test case ID	**#1.1**
Test case description	Obtain information on consumption profiling and improve understanding about water demand

Test case sequence of steps	• Login the iWidget system • Go to Water Analysis Tab • Select Consumption Profiling • Select Network • Select Meter • Select Consumer ID • Select Time Series • Select Consumption Category • Select Scenario (weekday) • Select Co-variables • Select Time interval • Press calculate • Check the information displayed in the graph • Save data • Escape the application
Tester profile required	Network operation or utility strategic, tactical and operational planning staff

Table 22 – Test cases for use case WU_UC02.4 Obtain detailed information on operational inefficiency

Test scenario #1 Obtain detailed information on operational inefficiency	
Test case ID	**#1.1**
Test case description	Obtain detailed information on operational inefficiency to improve understanding about water losses components (real losses and apparent losses)
Test case sequence of steps	• Logon to iWidget • Go to Water Analysis • select Operational Inefficiency option • Select Network Sector • Select Time Series • Select Weekday Scenario • Select Time Interval • Press calculate • Check the information displayed for accuracy • Save the information • Escape the application
Tester profile required	Network operation staff

Table 23 – Test cases for use case WU_UC03.1 Obtain information on energy consumption associated with pumping

Test scenario #1 Obtain energy consumption for a selection of: any chosen day, a price per day of €0.08, a pumping schedule of (1, 1, 1, 0) and DMA2	
Test case ID	**#1.1**
Test case description	Obtain the energy consumption for a given day, with a single price per day of €0.08, and the pump on in the first 18 hours of the day, for DMA2. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 3.1 • Select options: ➢ **Day:** Any day ➢ **DMA:** DMA2 ➢ **Energy Price:** Price per day of €0.08 ➢ **Pumps and Hours:** Pumping schedule of (1, 1, 1, 0) • Submit query • Visualize Results ➢ Daily Energy Cost (in Euros) ➢ Daily Power Consumption (in kWh) ➢ Line Plot of Tank Levels • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #2 Obtain energy consumption for a selection of: any chosen day, a tariff price of (€0.05, €0.11, €0,09, €0.05), a pump schedule of (0, 0, 0, 0), and DMA3	
Test case ID	**#2.1**
Test case description	Obtain the energy consumption for a given day, with a tariff price of (€0.05, €0.11, €0,09, €0.05), and a pump schedule of (0, 0, 0, 0), for DMA3. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 3.1 • Select options: ➢ **Day:** Any day ➢ **DMA:** DMA3 ➢ **Energy Price:** Tariff price of (€0.05, €0.11, €0,09, €0.05) ➢ **Pumps and Hours:** Pumping schedule of (0, 0, 0, 0) • Submit query • Visualize Results ➢ Daily Energy Cost (in Euros) ➢ Daily Power Consumption (in kWh) ➢ Line Plot of Tank Levels • Exit the application

Tester profile required	• Water utility network operation staff

Test scenario #3 Obtain energy consumption for a selection of: any chosen day, a price per day of €0.08, a pump schedule of (0, 1, 0, 0), and DMA1	
Test case ID	**#3.1**
Test case description	Obtain the energy consumption for a given day, with a single price per day of €0.08, and the pump on in the first 9 hours of the day, for DMA1. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 3.1 • Select options: ➢ **Day:** Any day ➢ **DMA:** DMA1 ➢ **Energy Price:** Price per day of €0.08 ➢ **Pumps and Hours:** Pumping schedule of (0, 1, 0, 0) • Submit query • Visualize Results ➢ Daily Energy Cost (in Euros) ➢ Daily Power Consumption (in kWh) ➢ Line Plot of Tank Levels • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #4 Obtain energy consumption for a selection of: any chosen day, a tariff price of (€0.07, €0.09, €0.09, €0.10) and the pump schedule (0, 1, 0, 0), and DMA3	
Test case ID	**#4.1**
Test case description	Obtain the energy consumption for a given day, with a tariff price of (€0.07, €0.09, €0.09, €0.10), and pump schedule of (0, 1, 0, 0), for DMA3. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 3.1 • Select options: ➢ **Day:** Any day ➢ **DMA:** DMA3 ➢ **Energy Price:** Tariff price of (€0.07, €0.09, €0.09, €0.10) ➢ **Pumps and Hours:** Pumping schedule of (0, 1, 0, 0) • Submit query • Visualize Results ➢ Daily Energy Cost (in Euros) ➢ Daily Power Consumption (in kWh) ➢ Line Plot of Tank Levels • Exit the application

Tester profile required	• Water utility network operation staff

Table 24 – Test cases for use case WU_UC04.1 Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network

Test scenario #1 Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network	
Test case ID	**#1.1**
Test case description	Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network to improve the water utility response to network faults and unusual water consumptions
Test case sequence of steps	• Logon to iWidget • Go to Performance tab • Select Network Sector • Select Time Series • Select Meter Selection • Select Flow range • Select Consumer ID • Select meter type • Select Time Interval • Press calculate • Check the information displayed • Save the information • Escape the application
Tester profile required	Network operation staff

Table 25 – Test cases for use case WU_UC04.2 Receive warnings about the status and sizing adequacy of water meters

Test scenario #1 Receive warnings about the status and sizing adequacy of water meters	
Test case ID	**#1.1**
Test case description	Receive warnings about the status and sizing adequacy of water meters to improve water meter management and water utility response to meter faults

Test case sequence of steps	• Logon to iWidget • Go to Performance tab • Select Network Sector • Select Time Series • Select Meter Selection • Select Flow range • Select Consumer ID • Select meter type • Select Time Interval • Press calculate • Check the information displayed • Save the information • Escape the application
Tester profile required	Network operation staff, network maintenance staff, customers

Table 26 – Test cases for use case WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption

Test scenario #1 Obtain information on the effect of pressure control on leakage components and on consumption – Pressure Control tab	
Test case ID	**#1.1, #1.2, #1.5, #1.6**
Test case description	Obtain information on the effect of pressure control on leakage components and on consumption – Pressure Control
Test case sequence of steps	• Logon to iWidget • Go to Pressure Control • Select Network Sector • Select Time Series • Select Time Interval • Press calculate • Check the information displayed for accuracy • Escape the application
Tester profile required	Network operation staff

Test scenario #2 Obtain information on the effect of pressure control on leakage components and on consumption – DMA Analysis tab	
Test case ID	**#2.5, #2.6**
Test case description	Obtain information on the effect of pressure control on leakage components and on consumption – DMA Analysis

Test case sequence of steps	• Logon to iWidget • Go to DMA Analysis • Select Network Sector • Select Time Series • Select Time Interval • Press calculate • Check the information displayed for accuracy • Escape the application
Tester profile required	Network operation staff

Test scenario #3 Obtain information on the effect of pressure control on leakage components and on consumption – Campaigns tab	
Test case ID	**#3.1, #3.2, #3.3, #3.4**
Test case description	Obtain information on the effect of pressure control on leakage components and on consumption – Campaigns
Test case sequence of steps	• Logon to iWidget • Go to Campaigns • Select Network Sector • Select Time Series • Select Time Interval • Select number of monitoring campaigns • Select start and end time for all campaigns • Press calculate • Check the information displayed for accuracy • Escape the application
Tester profile required	Network operation staff

Table 27 – Test cases for use case UC_WU04.4 Receive customized suggestions about pressure reducing valve (PRVs) settings

Test scenario #1 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 15, 6 periods per day, deterministic analytics, and DMA2	
Test case ID	**#1.1**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 20, 6 periods per day, and deterministic analytics, for DMA2.Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.

Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:**15 ➢ **Periods Per day:** 6 ➢ **Analytics:** deterministic ➢ **DMA:** DMA2 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes ➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #2 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 22, 4 periods per day, robust analytics with confidence interval of 90%, and DMA3	
Test case ID	**#2.1**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 22, 4 periods per day, and robust analytics with confidence interval 50%, for DMA3. Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:** 22 ➢ **Periods Per day:** 4 ➢ **Analytics:** robust, with confidence interval 50% ➢ **DMA:** DMA3 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes ➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #3 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 25, 2 periods per day, deterministic analytics and DMA1	
Test case ID	**#3.1**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 25, 2 periods per day, and deterministic analytics, for DMA1. Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:** 25 ➢ **Periods Per day:** 2 ➢ **Analytics:** deterministic ➢ **DMA:** DMA1 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes ➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #4 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 20, 1 period per day, robust analytics with confidence interval of 80%, and DMA3	
Test case ID	**#4.4**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 20, 1 period per day, and robust analytics with confidence interval 80%, for DMA3. Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.

Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:** 20 ➢ **Periods Per day:** 1 ➢ **Analytics:** robust, with confidence interval 80% ➢ **DMA:** DMA3 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes ➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff

Table 28 Test cases for use case UC_WU07.4 Determine optimal placement of valves and flow meters on pipes in the network

Test scenario #1 Receive optimal valve placement for a selection of: any chosen day, time of day 17:00, minimum pressure 22, 2 valves, deterministic analytics, and DMA2	
Test case ID	**#1.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 22, 2 valves, and deterministic analytics, for DMA2. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.

Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 17:00-18:00 ➢ **Minimum Pressure:** 22 ➢ **Number of valves:** 2 ➢ **Analytics:** deterministic ➢ **DMA:** DMA2 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #2 Receive optimal valve placement for a selection of: any chosen day, time of day 09:00, minimum pressure 18, 2 valves, robust analytics with confidence interval of 90%, and DMA3	
Test case ID	**#2.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 18, 2 valves, and robust analytics with confidence interval of 90%, for DMA3. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 09:00-10:00 ➢ **Minimum Pressure:** 18 ➢ **Number of valves:** 2 ➢ **Analytics:** robust, with confidence interval 90% ➢ **DMA:** DMA3 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #3 Receive optimal valve placement for a selection of: any chosen day, time of day 12:00, minimum pressure 20, 3 valves, deterministic analytics, and DMA1	
Test case ID	**#3.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 20, 3 valves, and deterministic analytics, for DMA1. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 12:00-13:00 ➢ **Minimum Pressure:** 20 ➢ **Number of valves:** 3 ➢ **Analytics:** deterministic ➢ **DMA:** DMA1 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff

Test scenario #4 Receive optimal valve placement for a selection of: any chosen day, time of day 20:00, minimum pressure 25, 1 valve, robust analytics with confidence interval of 60%, and DMA2	
Test case ID	**#4.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 22, 1 valves, and robust analytics with confidence interval of 60%, for DMA2. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.

Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 20:00-21:00 ➢ **Minimum Pressure:** 25 ➢ **Number of valves:** 1 ➢ **Analytics:** robust, with confidence interval of 60% ➢ **DMA:** DMA2 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff

3.3 Non- functional tests

As with functional tests, it is also of paramount importance that the non-functional requirements of the system remain in place. In contrast with functional tests, non-functional tests should remain exactly the same as in the off-line testing phase; this ensures that the quality standards that were previously met remain untouched by widget improvements which were introduced following the off-line test results and are still observed when using real data rather than historical data. Also, we can verify that the deployment environment (distinct from the test environment used during the offline tests) is capable to conform to the pre-defined non-functional requirements.
Table 29 details the non-functional tests that must be carried out at this stage.

Table 29 – Non-functional tests

Requirement	Test scenario
Load	#1 Test the whole iWIDGET system with 5 users at the same time
	#2 Test the whole iWIDGET system with 20 users at the same time

Performance	#1 Test the iWIDGET system with data from one month of 1 DMA
	#2 Test the iWIDGET system with data from all the period of x DMAs (x is the maximum number available in case studies)
Compatibility	#1 Test the iWIDGET system with 3 different browsers
	#2 Test the iWIDGET system from a mobile device
Scalability	#1 Test the iWIDGET system with extended memory
	#2 Test the iWIDGET system with multiple processors
Usability	#1 Test the iWIDGET system with test objectives (without defining the detailed script)
Documentation	#1 Test the existence of documentation
	#2 Test the execution of UCs with users that used that documentation materials, against users without any training
Security	#1 Test the iWIDGET system accessing a direct link, without previous login
	#2 Test the iWIDGET accessing a functionality not allowed for the logged user
	#3 Test the iWIDGET against SQL injection
Availability	#1 Test the iWidget availability after forced errors (e.g., power failure)

3.4 Test case execution results

The set of functional and non-functional test cases detailed above is designed to ensure that the pre-testing phase of on-line tests is successfully completed, which implies that widgets that were updated in the wake off-line tests results (MS33) are both able to pass previously problematic test cases and also remain fully compliant with non-functional standards previously observed.

Each of the widget developing partners is responsible for executing test cases related to its own widgets. Test details that are specific to each use case, such as loosely

defined test steps and test success/failure criteria, should be defined by each partner upon execution of the tests.

Only following the successful completion of this pre-testing phase will it be possible to proceed to the on-line focus group testing phase, whereupon real users rather than project partners will undertake the relevant tests.

4 Step 2 ▸ On-line focus group testing

The main objective of this step is to perform an on-line testing session, with real end-users using real-time data, assessing metrics to be used in the WP4 iWIDGET system technical evaluation. As a consequence, this session is performed in parallel for each case study (different user communities) and for the consumer and water utility domain (different types of users).

The iWIDGET system technical evaluation is focus on each stakeholder's role (MS44 – Draft report on technical evaluation of the iWIDGET system), and is based on the commonly accepted ISO/IEC 25010 standard, which normalizes the software quality characteristics that must be evaluated in order to evaluate the software product quality.

In order to produce results for the technical evaluation proposed in WP4, the on-line evaluation focus group testing session uses real-time data and real users in a dedicated focus group, as shown in Figure 4.

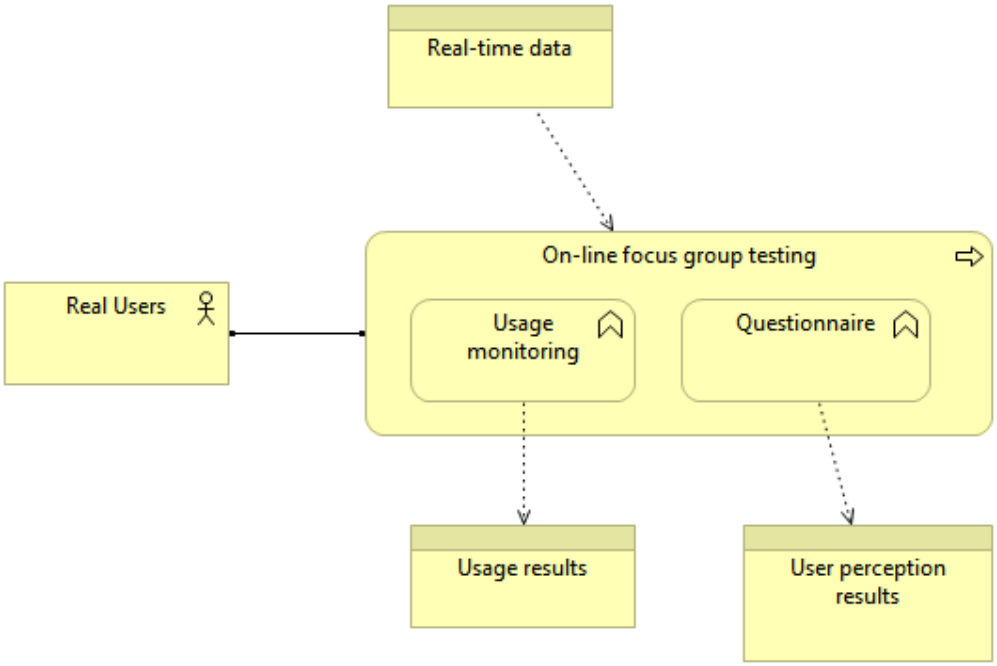

Figure 4 - Step 2: On-line focus group testing

For this purpose, we use two distinct testing instruments:

- Usage monitoring: the session is monitored to gather information related to the users system usage.
- Questionnaire: at the end of the on-line testing session, specific questionnaires are filled by the end users to gather information related to the user perception of the system quality.

Considering the criteria defined for the system technical evaluation, Table 30 details the metrics that will be evaluated by usage monitoring and by on-line test questionnaires. Note that this table lists the full set of metrics and for the technical evaluation. Also, the same metric can be measured by both methods.

Table 30 – list of metrics evaluated with on-line questionnaire and usage monitoring

Criteria	Metric / Measure	Usage monitoring	Questionnaire
Functional completeness	• Functional implementation completeness		x
Functional correctness	• Functional implementation correctness	x	x
Time behaviour	• Response time perception (on-line survey) • Response time with multiple users • Response time variable data volume		x
Capacity	• Memory utilization • Transmission utilization		
Co-existence	• Available co-existence		
Interoperability	• Interface consistency • Interoperability with different browsers • Interoperability with mobile devices • Data exchangeability		x
Data visualization	• Interface element clarity • Visualization compliance • Visualization perception (on-line survey)		x
Error reporting	• Input validity checking		x
Operability	• User operation capability • Operability perception • Operability perception (on-line survey)	x	x
Appropriateness recognisability	• Attractive interaction • Appropriateness recognisability perception • Appropriateness recognisability perception (on-line survey)		x
Learnability (ease of use,	• Completeness of user documentation • Learnability perception • Learnability perception (on-line survey)	x	x
Recoverability	• Restorability • Restoration effectiveness		
Availability	• System web availability perception		x
Confidentiality	• Confidential data encrypted • Non-authorized accesses		

Criteria	Metric / Measure	Usage monitoring	Questionnaire
Integrity	• Integrity protection/detection • Protection to Injection attacks		
Reusability	• Reusable components		
Modifiability	• Change recordability • Change impact		
Adaptability	• Adaptability of data structures • Hardware adaptability • Organizational adaptability • Software adaptability		
Installability	• Ease of Setup Re-try • Installation effort • Installation flexibility		
Replaceability	• Continued used of data • Function inclusiveness		

As shown in the previous table, the on-line testing will focus on metrics related to criteria that can be evaluated by user interaction. On the other hand, those metrics are evaluated by the user perception of the quality of each specific criterion, though questionnaires, or by objective indicators related to the way they use the system (e.g., mouse clicks, time to complete one action, etc.), which are measured by the usage monitoring during the on-line testing session.

5 Step 3 ▸ Bug and feedback tracking

After completing the on-line focus group, the iWIDGET system will remain up and running. From that on, each user's behaviour can be tracked due to the fact that the mapping between a customer and a system user is one-to-one. Consequently, the bug and feedback tracking activity is a continuous activity that intends to collect user usage feedback and also support error/bug reporting that any system might have. Several bug reporting and user feedback mechanisms have the disadvantage of losing the context of the event that users intend to assign to the specific feedback of bug reporting. In order to avoid meaningless reporting (e.g., It is not working), this activity establishes a communication tool between end-user and system managers.
As such, after the on-line focus group testing, the end users should be motivated to continuously use the iWIDGET capabilities. Any barrier that could exist for communication channels must be avoided as part of the focus group users training. Also, it is an objective to add bug reporting capabilities to iWIDGET. This will make it possible to report any bug with specific context (which functionality was being accessed, in which context, by which user, etc.). On the other hand, this will make it possible to centralize all bugs and reports on a unified system (within the controlled context of iWIDGET). Considering that this task is concerned with the method to capture valuable information to the overall iWIDGET evaluation in WP4, such qualitative feedback from users can be further used to assess the performance and behaviour of the multiple widgets, as well as to integrate system and usage information with business information (e.g., water consumption) in order to run mining and analysis techniques that might detect correlations between the system usage and the consumers behaviour with regard to water consumption.

6 Step 4 ▸ Execution monitoring

The execution monitoring activity is similar to the bug and feedback tracking. While the bug and feedback tracking are mechanisms that are passive (they require that the user triggers the reporting event and add information to the information to be reported), the execution monitoring activity is active (it triggers and logs events about the system usage in a transparent way – it does not require any direct input from the end user.

Considering the execution monitoring activities, several types of information can be automatically tracked by the widgets, including, but not limited to the following types of information:

- User login timestamp: for each session, the system logs the timestamp and user information when any users logs into the system;
- User logout: for each session, the system logs the timestamp and user information when any user logs out to the system. This event is also annotated to inform if the log out was triggered by the user – using the log out option, or if it was due to a session time out;
- Widgets accessed: the system logs, for each user, the actions performed in each widget. This logging is also time-stamped and makes it possible to know about all actions that each user had performed.

Apart from this types of information listed above (business events and log in and log out times), several types of information are directly accessible from the iWIDGET database. In fact, all database management systems have logging mechanisms that produce rich logs that can be further used for mining and analysis purposes.

Likewise to the bug and feedback tracking information, the execution monitoring data can be used assess the performance and behaviour of the multiple widgets. In fact, analysis can take advantage of both business data, bug and feedback qualitative information and execution monitoring data to create a reach dataset of information

that should be used any analytics of business intelligence analysis to provide important information about the overall system and business performance.

7 General setup for on-line tests

7.1 Case studies description

7.1.1 Athens case study

The Greek case study is a small scale case study in the City of Athens (Greece) led by the iWIDGET partner NTUA. This pilot program involves the monitoring water and energy consumption at 20 households using high-resolution metering devices, aiming to gather additional data and valuable information on water consumption patterns. The small number of participants allows a detailed monitoring and study of customers' behaviour on water related issues through qualitative surveys, giving the project a more experimental character.

It is envisaged that the pilot will act as an online laboratory in which the developer side is in close connection with the customer side. The participants are selected from a pool of volunteers and form a representative sample that covers a wide range of customer profiles with different socio-demographic characteristics.

In this case study, water and energy consumption are monitored with high-resolution (lower than 15 min) and data are frequent transmitted (more than 2 times a day) offering the "real-time sense" to end-users. It is expected that the combined analysis of water and energy consumption patterns will allow an efficient development of tools and widgets. Specific behaviours will be further analysed via frequent qualitative surveys

7.1.2 Portugal case study

The Portuguese case study is a pilot case study in the City of Barcelos (Northern Portugal) led by the iWIDGET partners AGS and LNEC, alongside with the water utility Águas de Barcelos. This pilot case study consists of 3 District Metered Areas (DMA) within the city area. Network flow and pressure data are available from a SCADA system for these areas, alongside PoU telemetry systems collecting real-time water consumption data for circa 300 households. This study case allows an integrated monitoring and

study of water utility and consumers' water consumption and envisages advancing knowledge and understanding about the potential of integrated management of supply and demand.

It is envisaged that the Portuguese case study will assess the contribution of telemetry systems to successful water loss control at network level and quantify the benefits in terms of billed consumption, energy saving, leaks reduction and capital investment. Another objective of the case study to profile and detect of network-level and household-level leakage events or deviations from an efficient behaviour, and helping the consumer to identify inefficient water usage.

In this case study, the time interval between records for water meters is 1 hour with a minimum time interval of 15 minutes in specific scenarios. The 3 DMA incorporate 390 water meters connected to telemetry system and 5 flow meters connected to a SCADA system. The transmission type is radio, GSM/GPRS.

7.1.3 UK case study

The UK case study is located in the South of England within Southern Water's supply area which covers; Kent, Sussex, Hampshire and Isle of Wight. The south of England is one of high water stress due to high population density and consumption levels.
Of the 4, 000, 000 customers Southern Water cover, the case study will consist of 1500 households which have been selected to form a representative sample including a control group to help establish whether the iWIDGET system assisted with a reduction in household consumption. Daily readings from Southern Water's AMR (Automatic Meter Reading) meters will be recorded and fed into the iWIDGET system in order to provide the customers with regular information about their consumption. In order to provide higher resolution data, a volunteer sample of 35 households will have a water logger installed by iWIDGET partner UPL. This will allow customers to see data recorded at 15 minute intervals.

The trial will take a bottom up and autonomous approach. The customers will be provided with the means to log into the system, but it is entirely at the discretion of the user to log in and use the iWIDGET system, this trial represents a 'real world' scenario. Throughout the trial, customer feedback is an important element; in order to receive

this, an online forum will be conducted as well as a focus group once the trial has commenced.

7.2 Execution plan

Table 31 details the plan to execute the method for on-line testing. From the results of off-line testing, widgets are currently being corrected by project partners' developers. After the release of the new widget versions (corrected widgets), functional and non-function tests (as described in sections 3.2 and 3.3) will be performed by all project partners.

After that, focus group sessions will be organized for each of the three case studies. Note that the Athens case study will only address the consumer domain, the Portugal case study will address both the consumer and water utility domain and, finally, the UK case study will address the water utility domain.

Table 31 - Method execution plan

Method steps	Project partners	Case Studies					
		Athens - Consumer	Athens – Water Utility	Portugal - Consumer	Portugal – Water Utility	UK - Consumer	UK – Water Utility
Implement iWIDGET corrections	Project partner developers						
Execute functional tests	All						
Execute non-functional tests	All						
Focus group usage monitoring		X		X	X		X
Focus group questionnaire		X		X	X		X
Bug and feedback tracking		X		X	X		X
Execution monitoring		X		X	X		X

8 Conclusions

This milestone reports the real-life on-line testing method that relies on real users and real data, from a black-box perspective. This method starts from the results achieve on the off-line testing performed on historical data, implementing the required corrections and re-testing the system with real users and real data sets. The results produced by the execution of the on-line testing method will feed into the overall system evaluation, conducted in the scope of WP4.

The proposed method is decomposed by 4 major steps: (*i*) Pre-testing: includes the implementation of widget corrections and functional and non-functional testing performed by project partners on real data, using the deployed iWIDGET version on both consumer and water utility domains; (*ii*) On-line focus group testing: organized focus groups on the three case studies, where the system usage is assessed by questionnaires and usage monitoring; (*iii*) Bug and feedback tracking: reporting mechanisms where users can "talk" to the iWIDGET consortium, reporting bugs and feedback with adequate context; and (*iv*) Execution monitoring: active monitoring and logging mechanisms that log information about the continuous usage of iWIDGET by any user.

The proposed method is based on current best practices on software testing and quality assurance, and need to be aligned with the technical evaluation proposal from WP4. As such, it is aligned with ISO 25010 to assess the quality dimensions and generate information to be further analysed in the scope of WP4, during Year 3.

As detailed on the general setup for online tests, the first phase of on-line testing is performed by project partners on real data. After that, three case studies (Athens, Portugal and UK) determine the scope of evaluation. The Athens case study focus on the consumer domain, the Portugal case study focus on both consumer and water utility domains and, finally, the UK case study focus on the water utility domain. Indeed, distinct case studies my expose different detail and, although following the same methods, the instruments can be different. For instance, the questionnaire adopted during the on-line focus group testing might be optimized for the purpose and specificities of each case study.

In general, testing activities must be seen as an important process to support the continuous system improvement, where anomalies and users' behaviour must be tracked to provide informed decisions about new or updated versions of any system. In iWIDGET, we follow the same approach, which is reflected by the fact that the final steps of the method (bug and feedback tracking and execution monitoring) are continuous processes that run during the entire system lifecycle.

Finally, we would like to remark that the execution of the method proposed in this report will be executed and analysed during Year 3, being a critical part of the overall system evaluation developed in the scope of WP4. This makes an important connection between the works performed in WP3 and WP4, which adds the requirement to ensure the complete alignment between the activities undergoing on these work packages.

9 References

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iWIDGET

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University of Exeter Centre for Water Systems
LNEC Laboratório Nacional de Engenharia Civil
IBM
National Technical University of Athens
AGS
HR Wallingford Working with water
SAP
UPL Utility Management & Energy Consultants
waterwise