



**envi**sion  
environmental services infrastructure with ontologies

## Deliverable D1.7:

# Real-time Pilot Case Definition and Requirements Specification

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## Executive Summary

The purpose of the ENVISION project is to develop a user-friendly infrastructure for deploying semantic web services and environmental models, supporting users with little technical skills in the process of semantic discovery and adaptive chaining. Two demonstrators were set up in the beginning of the project: the landslide pilot based on landslide risk models (BRGM) and the oil spill pilot based on oil drift prediction models (SINTEF), with the intention to simulate physical phenomena that require large amounts of geospatial and time-dependent input data, observed in the real world.

One of the SISE objectives is the real-time connectivity between multiple environmental resources. More and more environmental resources are being interconnected in real-time; therefore the necessity to integrate and handle this information is crucial. The two existing ENVISION pilots take data fetched from sensors into account, but the real-time aspect is not sufficiently addressed. Another aspect, that could affect the flexibility of ENVISION platform, is the lack of sufficient sources of data from environmental sensors.

In order to address these aspects in the ENVISION platform, a new use case is introduced, designed to focus on web publishing of real-time sensors, on composing real-time data from heterogeneous networks of sensors and the use of this information in environmental models.

This document provides the specification and relevant data sources for a new pilot case: real-time monitoring of floods evolution in trans-boundary context.

## Table of contents

<b>EXECUTIVE SUMMARY .....</b>	<b>3</b>
<b>TABLE OF CONTENTS .....</b>	<b>4</b>
<b>TABLE OF FIGURES .....</b>	<b>6</b>
<b>TABLE OF TABLES .....</b>	<b>7</b>
<b>1 INTRODUCTION.....</b>	<b>8</b>
1.1 INTRODUCTION TO ENVISION PROJECT.....	8
<b>2 REAL-TIME PILOT CASE DEFINITION .....</b>	<b>9</b>
2.1 INTRODUCTION TO ENVISION DECISION PILOT CASES.....	9
2.2 ENVIRONMENTAL DECISION SUPPORT FOR RIVER FLOODS.....	9
2.2.1 Introduction to environmental decision support .....	9
2.2.1.1 Flood monitoring decision support context .....	10
2.2.1.2 User groups in flood monitoring decision making .....	11
2.2.2 Why the ENVISION Infrastructure is needed .....	12
2.2.2.1 Problems in flood monitoring modelling.....	12
2.2.2.2 The ENVISION approach .....	13
2.3 REAL-TIME FLOOD MONITORING (RTFMON) DECISION PILOT .....	13
2.3.1 Services for decision making.....	13
2.3.1.1 Processing services.....	13
2.3.1.2 Data services .....	15
2.3.1.3 Semantics for service integration .....	16
2.3.2 Service composition .....	17
2.3.2.1 Workflows.....	17
2.3.2.2 Service composition execution and adaptation.....	20
2.3.2.3 Uncertainty for hydrological services.....	21
2.3.3 Visualization .....	22
2.3.4 Application to the pilot area (Iron Gates on Danube).....	23
<b>3 REAL-TIME PILOT REQUIREMENTS SPECIFICATION.....</b>	<b>27</b>
3.1 METHODOLOGY FOR ENVISION PILOTS REQUIREMENTS SPECIFICATION .....	27
3.1.1 Description of RM-ODP Framework .....	27
3.1.2 Use of RM-ODP in the ENVISION project .....	27
3.2 REQUIREMENTS SPECIFICATION.....	29
3.2.1 Enterprise viewpoint.....	29
3.2.1.1 A topology based on a central server.....	29
3.2.1.2 A distributed topology.....	30
3.2.1.3 A combined topology .....	30
3.2.1.4 Actors and Roles .....	31
3.2.1.5 Use cases .....	32
3.2.2 Information viewpoint .....	34
3.2.3 Service viewpoint .....	34
3.2.3.1 Components.....	34
3.2.3.2 Collaboration Diagrams .....	45
3.2.4 Engineering viewpoint.....	47
3.2.4.1 Ontologies .....	47
3.2.4.2 Activities .....	47
3.2.5 Technology viewpoint .....	54
3.3 SUMMARY OF REQUIREMENTS.....	54
<b>4 CONCLUSION .....</b>	<b>56</b>
<b>5 REFERENCES.....</b>	<b>57</b>
<b>APPENDIX 1: TERMS.....</b>	<b>58</b>

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<b>APPENDIX 2: ACRONYMS.....</b>	<b>59</b>
<b>APPENDIX 3: SENSOR DATA FROM IRON GATES SCADA NETWORKS.....</b>	<b>60</b>

## Table of figures

Figure 1 – Simplified view of Iron Gates I dam and power generation units ..	15
Figure 2 – Workflows legend.....	17
Figure 3 – Discharge computation workflow (Ps1).....	18
Figure 4 – Water stage prognosis workflow (Ps2).....	18
Figure 5 – Dam water evacuation computation workflow (Ps3) .....	19
Figure 6 – Flood alerting computation workflow (Ps4) .....	20
Figure 7 – RTFMON services composition workflow .....	21
Figure 8 – Danube river basin.....	24
Figure 9 – Main hydrographical network in pilot area.....	26
Figure 10 – Central server topology .....	29
Figure 11 – Distributed topology .....	30
Figure 12 – Combined topology .....	31
Figure 13 – Use case for creating configuration .....	32
Figure 14 – Use case for manual observation insertion .....	33
Figure 15 – Use case for monitoring the real-time statuses.....	34
Figure 16 – Example of physical sensor configuration.....	37
Figure 17 – Example of group config .....	38
Figure 18 – Example of communication protocol config.....	38
Figure 19 – Example of virtual sensor configuration .....	39
Figure 20 – Example of OGC Sensor Observation Service config.....	39
Figure 21 – Example of manual insert observation UI .....	40
Figure 22 – Example of an observations monitoring panel .....	41
Figure 23 – Example of a communication protocols monitoring panel .....	41
Figure 24 – Example of a logs monitoring panel.....	41
Figure 25 – Configuration collaboration .....	45
Figure 26 – Manual insertion of observation collaboration.....	46
Figure 27 – Real-time monitoring collaboration .....	47
Figure 28 – Authenticate sequence diagram.....	48
Figure 29 – Create a configuration sequence diagram .....	50
Figure 30 – Manual observation insertion sequence diagram.....	51
Figure 31 – View the real-time observations sequence diagram.....	52
Figure 32 – View the communication statuses sequence diagram .....	53
Figure 33 – Log viewing sequence diagram .....	54
Figure 34 – Water level sensors upstream Iron Gates I dam .....	60
Figure 35 – Water level sensors downstream Iron Gates I dam .....	60

## Table of tables

Table 1 – RTFMON processing services, inputs and outputs.....	14
Table 2 – Sources for Danube hydrologic data .....	16
Table 3 – The most important tributaries of the Danube River .....	25
Table 4 – Map Viewer Portlet .....	35
Table 5 –Timeline Viewer Portlet.....	35
Table 6 – Chart Viewer Portlet .....	35
Table 7 – Notification Portlet .....	36
Table 8 – Real-time Configuration Portlet .....	36
Table 9 – Manual Observations Insertion Portlet .....	39
Table 10 – Real-time Monitoring Portlet.....	40
Table 11 – Semantic Annotation Proxy.....	41
Table 12 – OGC Web Service .....	42
Table 13 – Event Processing Service.....	42
Table 14 – RxVSWebGateway.....	42
Table 15 – RX Simple Communication Protocol .....	43
Table 16 – Tcl/Tk.....	44
Table 17 – RxDataGateway application .....	44
Table 18 – Authentication to ENVISION portal.....	48
Table 19 – Create a configuration .....	50
Table 20 – Manual insertion of observations.....	51
Table 21 – View real-time observations .....	52
Table 22 – View communication status .....	53
Table 23 – Logs view .....	54

## 1 Introduction

### 1.1 Introduction to ENVISION project

The ENVISION project provides an ENVironmental Services Infrastructure with ONtologies which aims to support non ICT-skilled users in the process of semantic discovery and adaptive service chaining of environmental services by on-the-Web enabling and packaging of technologies, support for migrating environmental models to be provided as models as a service (MaaS), and the use of data streaming information for harvesting information for dynamic building of ontologies and adaptive service execution.

ENVISION focus is on providing the environmental community with better Web-based accessibility to environmental modelling tools and greater flexibility for designing environmental Web applications, through improved connections to distributed sources of information and services.

Three pilot cases are defined in order to offer a clear exemplification of the functionality of the ENVISION platform: Landslide pilot (BRGM), Oil Spill Pilot (SINTEF) – already defined in D1.2 –, and Flood Monitoring (CS).

There has been significant effort in the area of Web service composition. For environmental portals, the addition of OGC services (especially sensor-based ones) will extend the composition capabilities. The purpose of this document is to provide the definition of the real-time monitoring of floods evolution in trans-boundary context pilot case and its associated technical requirements, i.e. similar to D1.1 and D1.2 for the other two pilot cases.

The rest of the document is structured as follows: section 2 presents the motivation and background of the real-time monitoring of floods evolution in trans-boundary context, the services needed for decision making and the service chains. Section 3 contains the requirements specification, structured according to the RM-ODP viewpoints. The present deliverable will be concluded with a brief summary of the flood monitoring pilot case and a set of preliminary requirements and remarks.

Complementary information and more details about previous activities may be found in the other work package related documents:

- D1.1 [1] : Definition of pilot cases
- D1.2 [2] : Report presenting requirements specification
- D2.1 [3] : Architecture specification.
- D3.3 [4] : MaaS Composition Portal – Version 2

## 2 Real-Time Pilot Case Definition

The following section presents the context of the ENVISION pilot cases, the environmental decision support for river floods in 2.2 and also the definition of the real-time flood monitoring decision pilot in 2.3.

### 2.1 Introduction to ENVISION decision pilot cases

The ENVISION pilot cases are **demonstrators** set up during the project and meant to illustrate the capabilities of the ENVISION infrastructure. Their purpose is to present a clear overview of the functionality provided by the platform in terms of end users, actions and goals, models and interactions with the available services.

They identify specific sequences of actions performed by an end user, yielding an observable and meaningful result, according to the corresponding web scenario in execution. The pilot cases better exemplify the users of the ENVISION infrastructure and the functions and services provided, modelling the interactions between end users and the implemented platform, representing a complete flow of information and events.

The pilot cases involve elaborate physically-based models (simulating physical phenomena observed in the real world) which require a large amount of geospatial and time-dependent input data.

**Landslides** constitute one of the major worldwide natural hazards that cause huge damages every year, taking away human lives, affecting therefore the social and economic development. These disasters affect towns and villages, damage roads, railways or farming fields. Landslide hazard and risk assessment strategies are necessary for effective planning and management. 'Hazard' refers to the probability of a human/environment disaster to occur during a certain period of time. The landslide pilot is focused on a section of a major road in Basse-Terre Island called "Route des Mamelles" or RD23, in Guadeloupe (France).

The Prefect of Guadeloupe needs a decision support tool to answer this question: When a tropical storm is forecasted for the following days, should the RD23 road be closed to traffic? To help answer this question, the ENVISION project will provide the tools to allow landslide risk experts create a website which visualizes the probability of the RD23 road being damaged by landslides for the days D and D+1. Landslide hazard and risk assessments are necessary for effective planning and management.

**Oil spills** are one of the most important human disaster affecting the marine coastal environments all over the world, leading often to significant, long-term impacts on ecology and socio-economic activities in that area. Vital natural resources and human enterprises are at risk. It is necessary to have a good method for prevention, control and clean-up way against oil spills pollution.

For deciding how to respond to an oil spill, it is essential to be able to predict the fate and effects of the spilled oil. Fate prediction requires data about the spill (location, time, amount, oil type), the environmental conditions (wind, current), and geography (sea depths, coast line). Effects prediction is based on data about natural resources (e.g. fish populations, protected sites) that may be affected. Traditionally, oil drift applications have mostly been used to support strategic and tactical decision making. Such usage is based on historical input data. Nowadays, oil drift models are also used to aid operational decision-making, which involves up-to-date forecast data.

## 2.2 Environmental decision support for river floods

### 2.2.1 Introduction to environmental decision support

Decision making is a complex process, influenced by human and non-human factors, leading to a selection of a choice from several available options. A good decision is reflected from the

positive and negative aspects of each option or alternative. An effective decision-making process forecasts the outcome of each option and, based on these alternatives, determines the optimal variant for a particular situation.

A decision making system (DSS) may be associated to a process that includes a set of software tools, a methodology and experienced people who use them in defining and choosing between different alternatives. DSS are often defined as integrated, interactive and flexible computer systems that support the phases of decision making processes without replacing them. They usually show a user-friendly interface, data and expert knowledge [5]. DSS are also defined as computer based systems able to improve the ultimate effectiveness of decision making.

Environmental DSS (EDSS) are relatively new tools used to support analyses of decisions for the management of environmental problems. They integrate environmental data (biological, hydrological, physicochemical) with social and economic aspects and simulation models into a single framework in order to achieve geographical site characterization, monitoring and clean-up decisions. A good DSS has a balance between the level of details needed to implement a wide range of conditions and also the ease of usage even for inexperienced users.

Some of the major areas of decision support are: site characterization and site survey strategies (data analysis including visualization of site characterization data and integration of data – nature and extent of contamination analysis or site conceptual models) and ecological risk analysis. Obropta et al. [6] have defined several major complex features of EDSS:

- dynamics: all major components of the ecosystems such as water, land, air, energy and live organisms (including humans) are interrelated and interconnected;
- complexity of physicochemical and biological aspects of the environment: many environmental systems involve the interaction of physicochemical and biological processes;
- stochastic behaviour of environmental systems: many environmental processes involve non-deterministic behaviour, by which the next system state is partially, but not fully determined by the previous system state; in addition, the system variables are uncertain, and their extent of involvement in the whole system is approximate;
- periodicity: many environmental systems occur or change in a specific period of time that adds to the complexity of the systems.

An EDSS must include components like surface and hydrologic structures (EDSS should incorporate surface and hydrologic structures into the model and also be able to graphically reproduce them), data plausibility (EDSS should be able to determine if a data entered is a plausible value for the associated parameter; if not, it should be able to provide guidance or default values), data worth (EDSS should be able to assess the significance of collecting more data as a means of reducing uncertainties in the process of decision making). Important characteristics of DSS include accessibility, flexibility, facilitation, learning, interaction and easy to use.

### **2.2.1.1 Flood monitoring decision support context**

Floods are hydrological events characterized by significant discharges and water levels; according to Simonovic [7], during floods, streams and channels are unable to convey the amount of water that has been generated through the runoff process and the water is unable to escape downstream due to high levels in the receiving streams.

Flood management is usually a unique process for every river due to: the national / international character of watershed (responsibility of different agencies; differences in decision making process; different level of dependence on government decisions, etc.); physical features of the watershed and land use; geographical location and climate of the region. The most recent practice defines flood management as a broad spectrum of water resources aimed at reducing the loss of life and property damage and in the same time obtaining the social, environmental and economic benefits from the floodplains [7].

Flood forecasting decision support comprises the processes of flood forecasting, flood warning, flood monitoring and real-time decision making. The primary elements of real-time flood forecasting systems must include information from: real-time data acquired from sensors

reflecting current hydrological and meteorological conditions – river discharges and water levels, drainage attributes, dams' capacity and operational information, runoff behaviours, weather forecasts, state of the river catchment, hydrological and/or hydraulic simulation models. Several types of models are already available on the market today, each one bringing partial solutions to flood problems:

- ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) is a satellite launched in 1999 as a part of NASA's Earth Observing System (EOS), whose task is to produce detailed maps of land surface temperature, elevation and reflectance<sup>1</sup>;
- TOPKAPI (TOPographic Kinematic Approximation and Integration) is a hydrological model that may be used in real-time operational flood forecasting and rainfall-runoff simulations, either as a standalone application, or integrated in a complex system. It allows the simulation of the hydrological behaviour of a river catchment, together with water balance at catchment scale for water management, including flood forecasting and superficial soil moisture content simulation<sup>2</sup>;
- SOBEK represents a 2D hydraulic modelling suite for flood forecasting, ground-water level control, drainage systems, water quality<sup>3</sup>;
- MIKE11 is a complex application allowing flood analysis, real-time flood forecasting, and dam break analysis<sup>4</sup>.

Sometimes they are used together with software applications for meteorological data processing and interpolation, like RAINMUSIC who creates 2D maps that are further used as input for numerical models. Several software applications perform also models for effective reservoir operations strategies to minimize the damage produced downstream, maintaining also the safety of the dams and maximizing the water volume stored at the end of the flood. These types of systems are usually used on isolated river segments, seldom defined by administrative unit borders, and not on the entire river basin.

New research in the domain emphasizes the need to build a flood forecasting system with an open architecture, able to connect different isolated applications, to provide hydrologic and/or hydraulic models or to integrate existing ones, and to standardize certain tools for flood forecasting and management. Considering that flood models integrate large temporal and spatial datasets (including operations like acquisition, storage and manipulation), an efficient data management is very important. A significant challenge is represented by data linking, analysis and modelling tools across different organisations and applications inside a river basin.

An inter-organisational collaborative environment may be obtained using Web-based decision support systems (WDSS). Existing WDSS represent suites of software, model and data dedicated to a specific decision problem [8]. For the moment, there are no generic tools to support model sharing, and most WDSS use different types of Internet technologies and frameworks. Defining a standardized framework would improve information and knowledge exchange, environmental emergency management and solution planning.

The final purpose is to obtain a system able to provide a functional prevention mechanism used to eliminate as much as possible natural disasters and to reduce the consequences of environmental hazards.

## 2.2.1.2 User groups in flood monitoring decision making

The users of flood monitoring decision making models are mainly stakeholders in natural risk management and scientists in hydrology:

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<sup>1</sup> <http://asterweb.jpl.nasa.gov/>

<sup>2</sup> <http://www.progea.net/>

<sup>3</sup> <http://delftsoftware.wldelft.nl/>

<sup>4</sup> <http://www.mikebydhi.com/>

- Research institutes  
E.g. To understand / predict hydrological phenomena (INHGA - National Institute for Hydrology and Water Management)
- Hydroelectric power plants  
E.g. To integrate real-time environmental models with a particular focus on water management and flood monitoring (Hidroelectrica Romania, Electric power industry of Serbia, Djerdap Branch)
- Governmental bodies  
E.g. To determine the flood risk in a specific region, when incoming water levels are high and/or precipitations are forecast and/or the available capacity of storage reservoirs is low. ("Romanian Waters" National Administration)
- University teachers and students  
E.g. To teach and understand important processes within the flood domain (Faculty of Hydrotechnics, Geodesy and Environment Engineering)
- Civil security agencies, NGOs  
E.g.. To determine the possible disaster scenarios and to prepare emergency plans.
- General public  
E.g. To determine how flood risks may affect the daily life.

Depending on the domain expertise of the user, the interaction with the models will be different. The users of the Portal should be domain experts, but the users of the websites may have no knowledge about flood risk modelling.

## 2.2.2 Why the ENVISION Infrastructure is needed

The ENVISION infrastructure will facilitate the publication of the models on the web, encapsulating them into services (MaaS). This will enhance data and model interoperability between interested parties.

Hereafter examples of specific problems in flood monitoring and forecasting and how they are addressed in ENVISION are presented.

### 2.2.2.1 Problems in flood monitoring modelling

The most common problems in hydrologic modelling in general and flood monitoring in particular, are:

- the modelling is hydrographical basin-specific, so existing theoretical models must be tailored to the targeted area
- for a higher accuracy of model behaviour, decomposition of a hydrographical basin in sub-basins is often required
- usually hydrographic basins are managed by subsidiaries of national hydrologic agencies; for large hydrographical basins (case of rivers crossing multiple countries – that is, trans-boundary context) – there can be many heterogeneous hydrographical models (in terms of data, theoretical models used, etc.),
- data availability (terrain model, historical data, real-time measurements, flood – risk maps)
- cooperation between relevant stakeholders for preventing and in case of risky events

## 2.2.2.2 The ENVISION approach

ENVISION addresses the problems presented in the former paragraph by the key features of the platform:

- publication of environmental models as Web services which the user can interact with (MaaS)
- composition and adaptation of services (addressing decomposition of complex or heterogeneous models in smaller / simpler models)
- standardisation of input / output data
- semantic annotation and service discovery
- easy to use for non-ICT skilled users

## 2.3 Real-Time Flood Monitoring (RTFMON) decision pilot

### 2.3.1 Services for decision making

This section presents the services involved in RTFMON pilot case. They are grouped in model-based services (2.3.1.1) and data-based services (2.3.1.2). At the end an introduction to domain terminology is given (2.3.1.3).

#### 2.3.1.1 Processing services

According to the ENVISION approach (MaaS), the processing services represent the modelling services simulating the real phenomena.

For the RTFMON pilot case both hydraulic and hydrologic models of the interest area are needed. In the case of Danube River, such models require domain expert participation and an international collaboration.

For demonstration purposes, RTFMON pilot case uses simplified models based on stage-discharge relation of the interest gauge stations. For prognosis, a simple neural algorithm trained on historical data will be used.

Table 1 lists processing services used by RTFMON pilot case:

Input Data		Processing service	Output Data	
Description	Format		Description	Format
In1.1 Water Stage	O&M observation	Ps1 Discharge computation	Out1.1 Discharge	SOS observation
In1.2 Stage-discharge relation	Numeric data series			
In 2.1 Water Stage	O&M observation	Ps2 Stage n-days prognosis	Out2.1 Stage prognosis	2D time series
In 2.2 Upstream stations stage	O&M observation			
In 2.3 Historical water stages	2D time series			
In 3.1 User input (planned energy production)	Numeric	Ps3 Dam water evacuation	Out3.1 Water evacuation plan	3D time series
In3.2 Discharge prognosis	2D time series			

Input Data		Processing service	Output Data	
Description	Format		Description	Format
In3.3 Dam parameters	Numeric			
In3.4 Upstream / Downstream water stage constraints	Numeric			
In3.5 Discharge	Numeric			
In3.6 Dam water stage	O&M observation			
In4.1 Water Stage	O&M observation	Ps4 Flood alerting	Out4.1 Flood alerts map	Vector map
In4.2 Stage prognosis	Numeric			
In4.3 stage thresholds	2D time series			

**Table 1 – RTFMON processing services, inputs and outputs**

Ps1 Discharge computation

Compute the water discharge (Out1.1) for a given observation station. The computation is based on the current water stage (In1.1) and the stage-discharge relation of the observation station (In1.2).

Ps2 Stage n-days prognosis

This processing service predicts water stage (Out2.1) for a given observation station based on: current stage (In2.1), upstream stations water stages (In2.2), historical stage values for given observation station and a set of upstream observation stations (In2.3).

The output is a time series of water stage for following n days (lead time). For each day within lead time, an uncertainty level is provided.

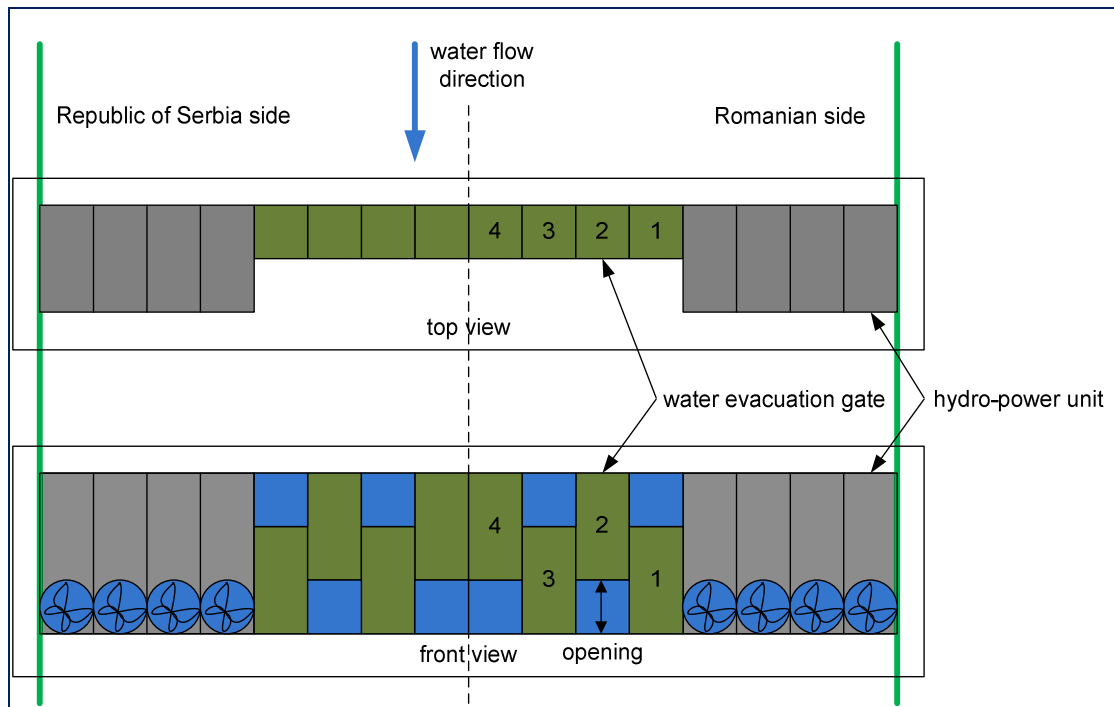
Ps3 Dam water evacuation

Dam water evacuation service proposes an evacuation plan (Out3.1) depending on following inputs: discharge prognosis (In3.2), planned energy production (3.1), dam constraints (volume, minimum and maximum water levels, gates characteristics : width, opening, etc.) – In3.3, upstream and downstream water stages (In3.4), water discharge (In3.5) and dam water stage (In3.6).

Figure 1 shows a simplified view of dam and hydropower plant at Iron Gates |

The evacuation plan will propose: the gates that have to be open, the opening of each gate and the opening time interval ,

The water is evacuated through evacuation gates and / or hydro-power units (producing electrical power) and is strictly ruled by a joint (Romanian-Serbian) hydro-power plants regulation.



**Figure 1 – Simplified view of Iron Gates I dam and power generation units**

## Ps4 Flood alert

Flood alert service evaluates the current water stage and the prognosis (In4.1, In4.2) and depending on stage thresholds (In4.3) in the observation points outputs a flood grade alert. This could be graphically represented on a map.

### **2.3.1.2 Data services**

This section describes the data services (input and output) involved in the RTFMON pilot case....

#### **2.3.1.2.1 Input data**

The RTFMON pilot case uses input data in the following categories:

- sensor data from SCADA<sup>5</sup> networks of Iron Gates<sup>6</sup> hydro-power plant
- watershed hydraulic parameters (stage-discharge relation or rating curve / table)
- hydrological data from publicly available websites
- dam parameters
- water level thresholds (flood-risk maps if available)
- user-input

Country	Entity	Update interval	Comment
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<sup>5</sup> Water level sensors are shown in Appendix 3

<sup>6</sup> Details on Iron Gates hydro-power plant are given in §2.3.4

Country	Entity	Update interval	Comment
Austria	Civil Service of Upper Austria Government <sup>7</sup>	Daily, 7 a.m	1-year historic data available
Slovakia	Slovak Hydrometeorological Service <sup>8</sup>	Daily, 5 a.m.	Flow rate available
Hungary	VITUKI – Environment and Water Management Research Institute <sup>9</sup>	Daily, 9 a.m.	4-days forecast (AM and PM values) available
Croatia	Croatia Meteorological and Hidrological Service <sup>10</sup>	Daily update	Flow rate available
Serbia	Republic of Serbia Hydrometeorological service <sup>11</sup>	Daily, 11.30 am	-
Romania	Iron Gates (Ro) / Djedap (RS) SCADA network <sup>12</sup>	Real-time (about every 10 minutes)	Hydropower-plants water level sensors

**Table 2 – Sources for Danube hydrologic data**

### 2.3.1.2.2 Output data

Output data provided by RTFMON pilot case as data services are:

- real-time water levels from Iron Gates SCADA networks and public available sites listed in Table 2
- water levels (n-day prognosis)
- water discharge (real-time computed and n-day prognosis)
- dam discharge schedule
- flood warnings / alarms

### 2.3.1.3 Semantics for service integration

A flood ontology needs to be established in the ENVISION project. This could be done semi-automatically by parsing available flood literature, or manually by interviewing flood experts, as there are no international standards concerning the vocabulary related to flood management.

However, different groups focused on flood management may use different terms and concepts to represent basically the same information received. Therefore, conceptual and terminological conflicts must be resolved, based preferably on common backbone taxonomy, providing thus a format that can be used by software agents used to find, integrate and share information – operations that would have previously required human intervention.

<sup>7</sup> <http://www2.land-oberoesterreich.gv.at/internethydro/Wasserstand/Start.jsp>

<sup>8</sup> [http://www.shmu.sk/sk/?page=1&id=ran\\_sprav](http://www.shmu.sk/sk/?page=1&id=ran_sprav)

<sup>9</sup> <http://www.hydroinfo.hu/html/hidelo/duna.html>

<sup>10</sup> [http://hidro.hr/hidro\\_e.php?id=hidro&param=Podaci\\_e](http://hidro.hr/hidro_e.php?id=hidro&param=Podaci_e)

<sup>11</sup> <http://www.hidmet.gov.rs/eng/hidrologija/radio.php>

<sup>12</sup> Water level sensors are shown in Appendix 3

Another option to define a flood ontology for ENVISION is to use an existing flood ontology, like the one developed by SemsorGrid4Env<sup>13</sup> for the flood ontology network supporting use-cases on flood and surge management.

## 2.3.2 Service composition

In the RTFMON pilot case simple processing services are composed in a more complex workflow.

Generally, service composition allows creation of a new service based on existing services. Service composition is suitable when a complex model can be decomposed in sub-models which are easier to develop or are already available. Services selected for composition need to have compatible Inputs and Outputs; if this is not the case, an adaptation of interfaces is needed.

Through the ENVISION infrastructure, composition can also be used to build a new model (MaaS) by chaining existing data services and processing services. Section 2.3.2.1 presents the RTFMON pilot case workflows; section 2.3.2.2 presents aspects of interface adaptation and composition execution.

### 2.3.2.1 Workflows

According to the ENVISION approach, users can build custom workflows using existing resources registered in the platform. This section shows four simple workflows created for RTFMON pilot case (the processing services in Table 1). The workflows presented in this section use the symbols depicted in Figure 2.

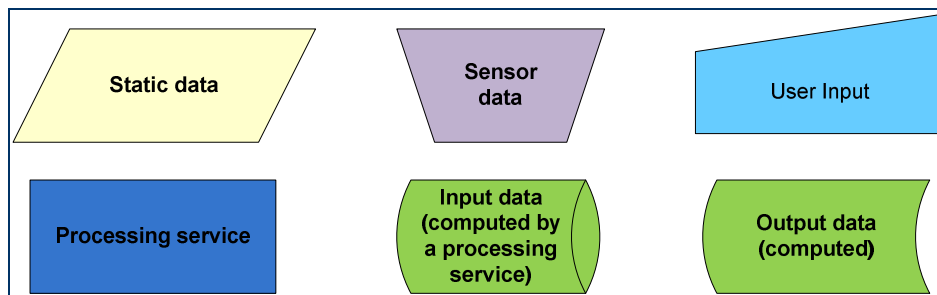
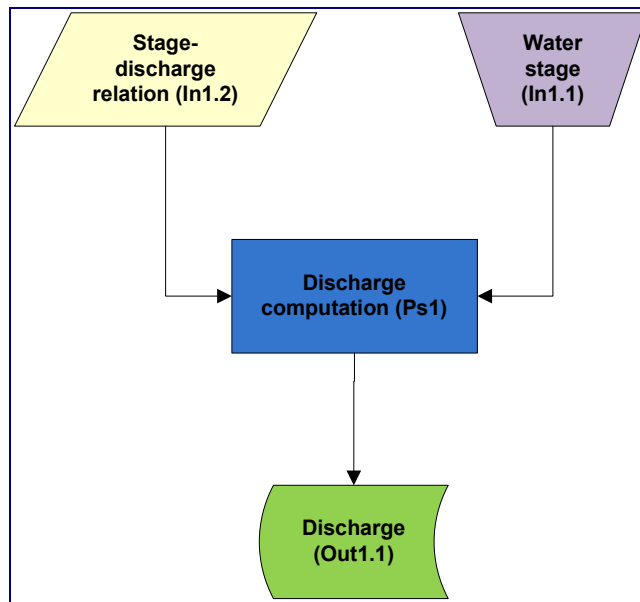


Figure 2 – Workflows legend

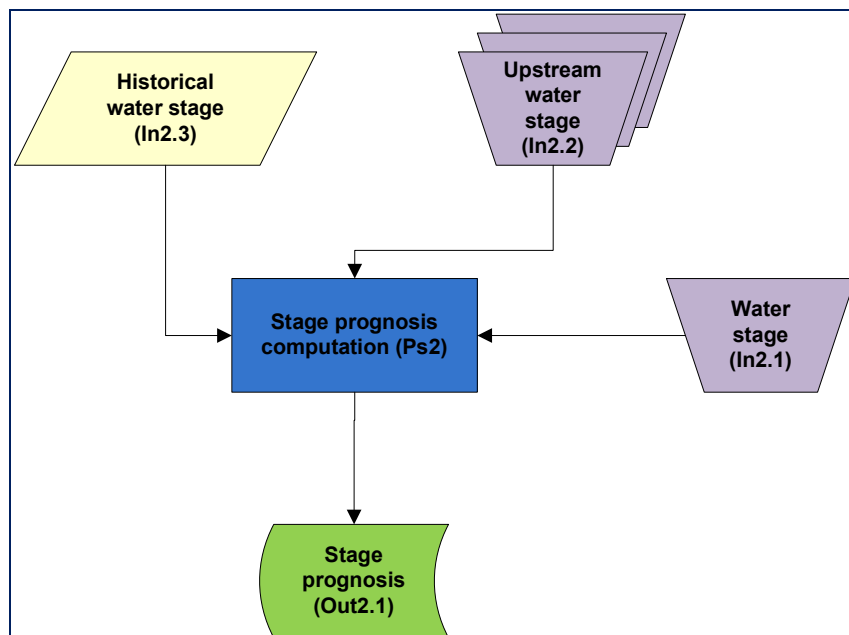
The first workflow shown in Figure 3 presents the *Discharge computation service*. The discharge computation is based on stage-discharge relation (static data) and water stage (real-time data) of the concerned observation point.

<sup>13</sup> [www.semsorgrid4env.eu](http://www.semsorgrid4env.eu)



**Figure 3 – Discharge computation workflow (Ps1)**

The next workflow (Figure 4) depicts the *Stage prognosis processing service*. For simplicity, a simple algorithm trained on historical data was used. The prognosis is computed using the values of upstream water stages and the current water stage of the observation station. At this point the prognosis window (number of upcoming days) and the accuracy are not yet defined and evaluated.

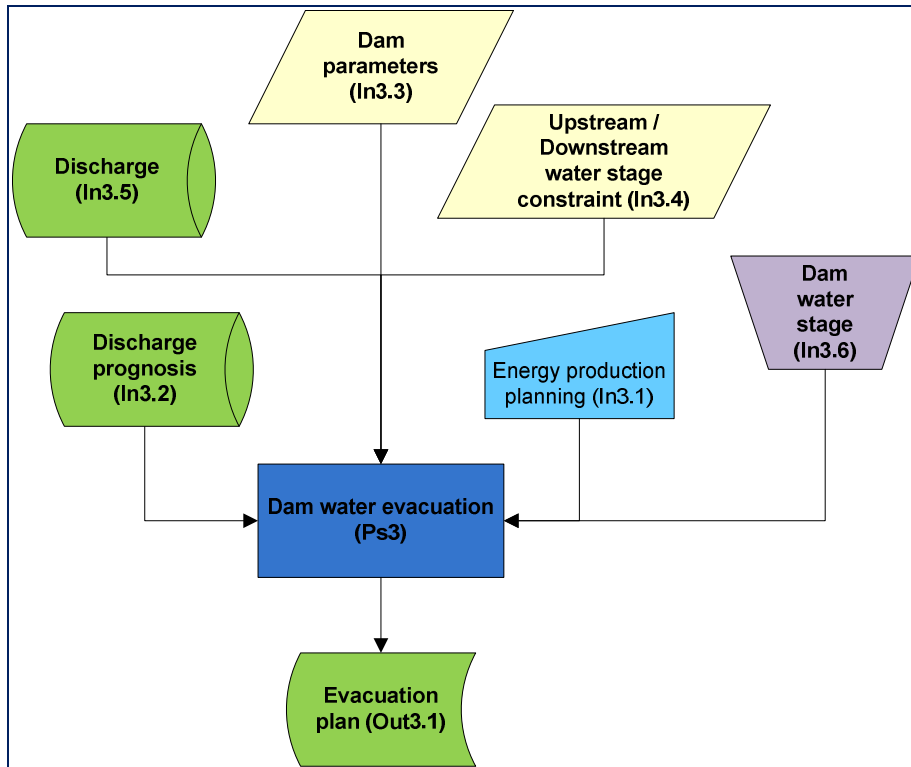


**Figure 4 – Water stage prognosis workflow (Ps2)**

Figure 5 depicts the workflow for *dam water evacuation service*. In case of a high waters prognosis, the dam water evacuation and hydro power-plant energy productions have to be adjusted on medium term (couple of days) such that upstream and downstream (with respect to the dam) water stages are below flood warning / alert levels.

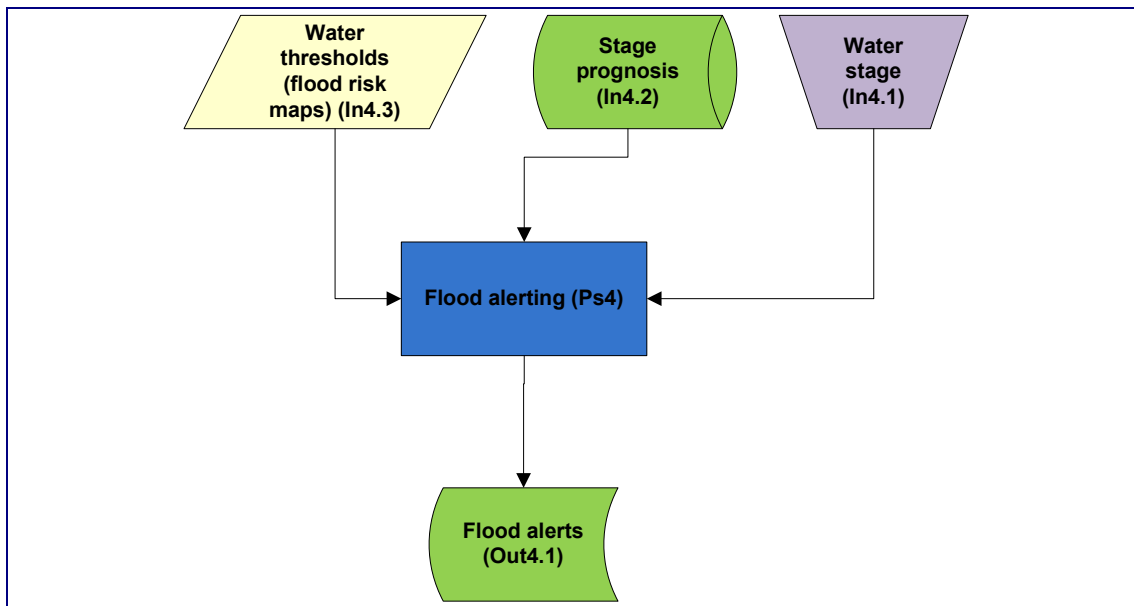
This sample processing service computes the water evacuation plan using following inputs:

- upstream discharge prognosis
- upstream and downstream water stage constraints
- dam parameters (gates characteristics)
- dam water stage



**Figure 5 – Dam water evacuation computation workflow (Ps3)**

Depending on the stage prognosis the user input for energy production is taken into account or not (from our perspective, energy production means water evacuation through hydro-generators turbine). The water evacuation plan is a time table indicating which gate is open for what amount of time. The last workflow sample presented in Figure 6 is for flood alerting.



**Figure 6 – Flood alerting computation workflow (Ps4)**

In this workflow, the processing service evaluates the current water stage and the prognosis and rise flood alerts accordingly. The flood alerts are presented to the end-user on a graphical map.

### 2.3.2.2 Service composition execution and adaptation

The processing services presented in the previous section need to be chained since the output of some services are input for other processing services.

In our sample case, the output of "Stage prognosis computation" service is used for both "Flood alerting" service and "Dam water evacuation" service. Also, the "Discharge computation" service is used twice, once for current discharge computation and once for discharge prognosis computation, both being inputs for "Dam water evacuation" service.

The composition workflow is presented in Figure 7.

Due to different types and formats some adaptations of the outputs are needed. For example, the "Discharge computation" service takes as input a scalar "water stage" but when used for discharge prognosis, an adaptation is needed since the "Stage prognosis" service has a time series as output.

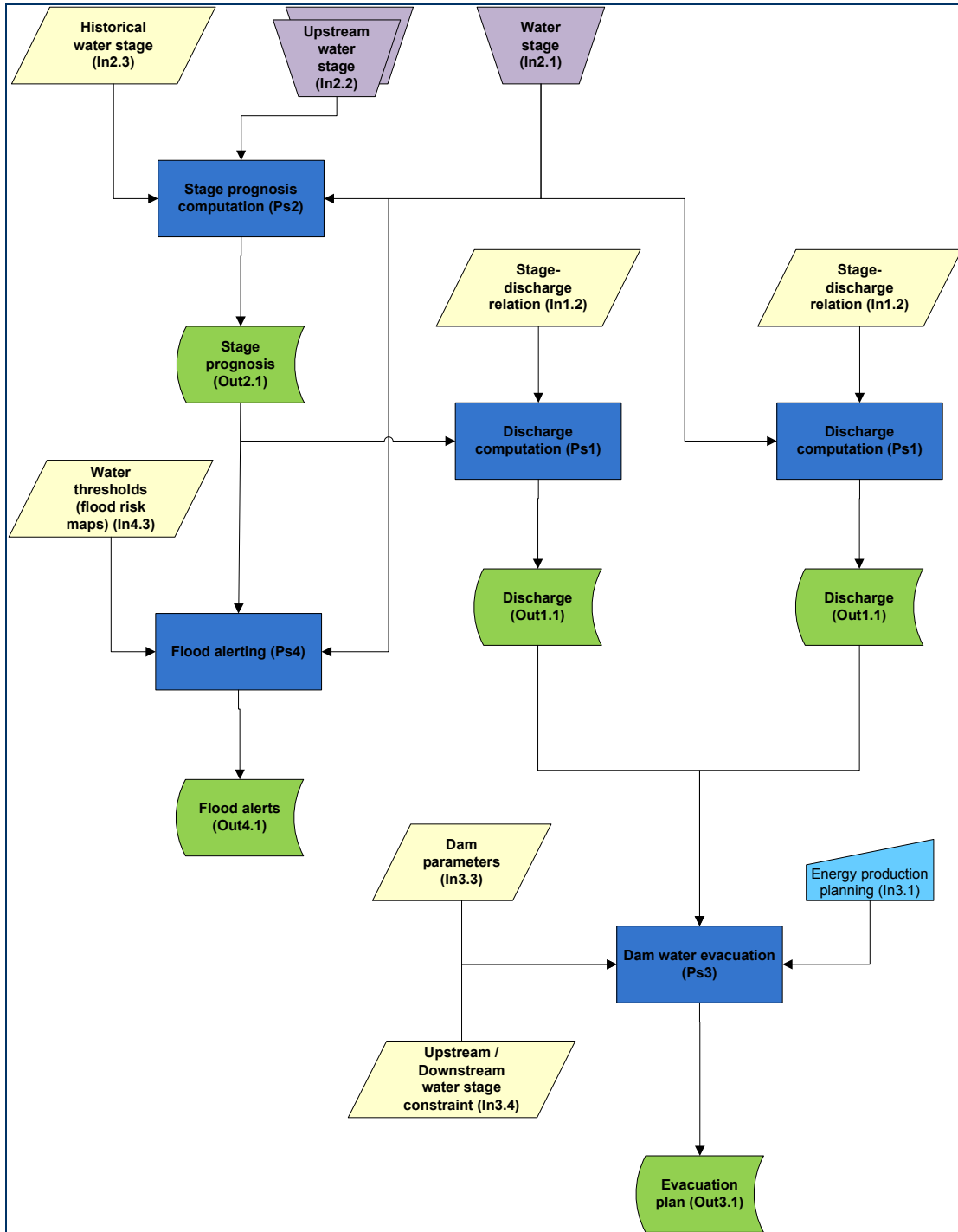


Figure 7 – RTFMON services composition workflow

### 2.3.2.3 Uncertainty for hydrological services

According to [9] there are multiple sources of uncertainty for flood forecasting systems. Systems trying to model hydrologic/hydraulic phenomena are complex systems consisting in many different components, each of which having its own uncertainty issues.

Among the components with higher level of uncertainty are:

- initial conditions for study area
- model parameters
- period used for forecast lead time

Real-time data from sensors also implies uncertainty, though it has lesser level (that is, more accuracy). Typically, the measurement of a physical phenomenon requires the following chain of subsystems:

- transducer : e.g. transformation of float movement into an electrical value (voltage or current)
- filters, amplifiers, insulation
- conversion : transformation of the electrical input into digital output

Each of these subsystems has its own level of uncertainty. Water level sensors could have uncertainty levels varying from few mm to few cm. The water level sensors from SCADA networks used in ENVISION platform will have included in their description the level of uncertainty as quality<sup>14</sup> parameter.

As described in [4] (Chapter 7 – Uncertainty), ENVISION platform integrates uncertainty management (sensors uncertainty and / or service compositions uncertainty).

The RTFMON pilot case aims to highlight ENVISION's platform capabilities and does not rely on high accuracy complex hydrological models but on simple models. Thus a lower uncertainty level of the whole system or higher forecast accuracy is not our main concern. However the uncertainty information is available for the end-user.

### 2.3.3 Visualization

The visualization requirements in the ENVISION platform are different depending on user's role [3]:

- composition (workflow) designer:
  - o search for / visualize available resources
  - o visualize input / output data of existing services
  - o visualize and edit composition diagram
  - o execute composition and visualize results
  - o configuration of Real-Time component for SCADA sensors access
- end-user:
  - o form for user-input
  - o reach GUI for visualisation of services output, typically: map viewer, chart viewer, timeliner, table data grid
  - o visualization of communication status with respect to field sensors, remote sites data

In particular, for RTFMON pilot case, flood-specific maps need to be provided. Such maps will highlight risk zones and show alert icons in zones with water level overflows warnings and alerts with reached thresholds.

The geographical maps used within the RTFMON pilot case will be provided as an OGC WMS compatible service<sup>15</sup>. These maps will contain a hydrological layer built with data<sup>16</sup> compliant with the INSPIRE directive [10].

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<sup>14</sup> As described in OGC SensorML specification : <http://www.opengeospatial.org/standards/sensorml>

<sup>15</sup> <http://www.opengeospatial.org/standards/wms>

<sup>16</sup> Source of hydrological data : <http://ccm.jrc.ec.europa.eu/php/index.php?action=view&id=24>

## 2.3.4 Application to the pilot area (Iron Gates on Danube)

The Danube, Europe's second longest river, was swollen with spring snowmelt and rains for much of April 2006. Floods along the river caused extensive damage in several European countries including Romania, Bulgaria, Serbia, Hungary and Austria. Further damage was caused in other Central European countries when other rivers, such as the Tisa, filled with spring runoff. Many of those rivers are tributaries to the Danube.

The floods from April 2006 along the Danube River were caused by rains on a large area in Central and South-Eastern Europe. More than 5,000 Romanians were forced to leave from their damaged homes between April 25 and April 26, 2006. The biggest part of evacuations was in the section of south-western Romania located downstream of Iron Gates hydro power plants area.

The disaster caused by the floods of April 2006 could have been diminished or even avoided if the reservoirs from Iron Gates hydro power plants area would have been discharged before the arrival of the flash flood, in order to attenuate the impact.

The Romanian Dispatching Centre of Iron Gates hydropower plants area has the necessary knowledge to schedule and manage the timely discharge of reservoirs to avoid upstream and downstream inundation. Based on the riverbed profile, constraints of exploitation, weather forecast and information about water levels, inflows, weather parameters etc. a model of flash floods and the time of propagation could be created to support the reservoir discharge management. Unfortunately, this activity is done most of time without real-time, sufficient and reliable input data from the Serbian company and local authorities involved in the management of the emergency situations. Even if the Romanian and Serbian companies have their proprietary SCADA systems, containing real-time meteorological data and water level sensors, these systems aren't fully interoperable and a lot of data are exchanged hourly by phone.

The management of water, in order to attenuate or even avoid the effects of floods, would be better handled if a dependable information system for decision support would be in place, able to update dynamically the model based on sufficient and reliable real-time input data from environmental sensors from Danube Basin. The required real-time data from sensors for such system is already hosted by a lot of existing, but not interoperable, information systems: SCADA Systems from hydro power areas, SCADA component of River Information Systems implemented / under implementation in many countries from Danube Region, floods supervision systems on many rivers in Danube basin, etc.

Danube's basin is Europe's second largest river basin (after the river Volga), with a total area of approximately 800000 km<sup>2</sup>, the river itself having a total length of 2857 km, a long-term daily mean discharge of about 6500 m<sup>3</sup>/s and about 120 tributaries [11]. An overview of the Danube basin is shown in Figure 8 <sup>17</sup>

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<sup>17</sup> [http://waterwiki.net/index.php/Sharing\\_water\\_in\\_the\\_Danube\\_River\\_Basin/Map](http://waterwiki.net/index.php/Sharing_water_in_the_Danube_River_Basin/Map)



**Figure 8 – Danube river basin**

A good monitoring application of the Danube River requires knowledge of the hydrological properties of the river itself and also of its tributaries in the entire catchment basin. There are 25 major tributary rivers, each one having its own sub-basin. Tisa's basin is the largest sub-basin, its total area being 157186 km<sup>2</sup>. It is also the Danube's longest tributary, having 966 km in length. In terms of discharge, it is the second largest after the Sava River which is the largest Danube tributary (with an average of 1564 m<sup>3</sup>/s) and the second largest by catchment area (95719 km<sup>2</sup>). Inn is the third largest by discharge and the seventh longest Danube tributary. [12]

Tributary	Area of the catchment basin (km <sup>2</sup> )	Long term mean discharge (m <sup>3</sup> /s)	Length (Km)	Intersection with the Danube (km)
<b>Sava</b>	<b>100590</b>	<b>1564</b>	<b>861</b>	<b>1170</b>
<b>Tisa</b>	<b>157186</b>	<b>813</b>	<b>966</b>	<b>1214</b>
Inn	26130	727	515	2225
<b>Drava</b>	<b>40076</b>	<b>670</b>	<b>893</b>	<b>1382</b>
Siret	44000	300	520	159
<b>Morava (RS)</b>	<b>37597</b>	<b>238</b>	<b>430</b>	<b>1103</b>
Enns	6080	190	349	2112
Isar	8964	173	283	2282
Olt	23282	160	542	604
Vah	19131	152	398	1766
Traun	4277	118	146	2125
Morava (CZ)	26658	110	340	1880
Raba	14830	80	240	1794
Jiul	9200	80	240	692
Arges	9200	80	270	432
Ialomita	9900	70	270	244
Naab	5508	54	191	2384
Hron	5439	54	260	1716
Sio	14800	30	124	1498
Iskar	8437	28	400	636
Yantra	7850	24	271	537
Ipel	5145	17	140	1708

Tributary	Area of the catchment basin (km <sup>2</sup> )	Long term mean discharge (m <sup>3</sup> /s)	Length (Km)	Intersection with the Danube (km)
Timok	4600	15	180	846

**Table 3 – The most important tributaries of the Danube River**

Precipitation variation are determining Danube's hydrological regime, the main contribution being the humid air masses transported from the Atlantic Ocean and Mediterranean Sea. The upper regions in the west part are characterised by high precipitations, in contrast with the eastern river with lower precipitation levels and cold winters. The precipitation quota ranges from 500 mm to 2000 mm per year, according to the analysed area. The average annual precipitation is above 3000 mm in the mountains and less than 400 mm in the delta region.

The lower part of the Danube River was prone to floods, but the major part is now protected by dams. Most barrages serve both for power generation (from power plants) but also for flood protection (as the storage reservoirs may withhold a volume of the incoming water excess). Two dams (and the associated power plants) are influencing the water level right after the Danube enters Romanian territory: Iron Gates I (Km D. 943) and Iron Gates II (Km D. 863). It is compulsory to respect several restrictions, tolerations and short-term variations of Danube's levels:

- maximum 69.59 mdMA (meters above the level of Adriatic Sea) and minimum 63.00 mdMA at Iron Gates I;
- maximum 41.00 mdMA and minimum 39.40 mdMA at Iron Gates II.

However, the beneficiaries may agree to go below 39.40 mdMA (ensuring that the depth of 3.5 m for the navigation channel is respected), but no more than 38.50 mdMA.

In case the level of incoming waters is increased, the beneficiaries must evacuate in safety conditions the water from the storage reservoirs, in order to prevent floods in the riverbank areas.

The pilot area is the area influenced by Iron Gates Hydropower and Navigation System (HNS). This is the largest hydropower dam and reservoir system along the entire Danube and is located at the 117-km-long Djerdap Gorge. The average flow rate of the Danube here is 5,500 m<sup>3</sup>/sec, and the river drops a total of over 34 metres.

The Iron Gates system has trans-boundary effects. The reservoirs have a total volume of 3.2 billion m<sup>3</sup>, and a total length of 270 km. They trap some 20 million tonnes of sediment per year, serving both as an important nutrient sink and a sizeable deposit of hazardous and toxic pollutants originating upstream of the dam. The corresponding absence of natural sediments downstream has created erosion problems since the dam was put into operation in 1970.

The Iron Gates Dams I and II, both located where the Danube forms the boundary between Romania and Serbia, impound the Danube as far upstream as Novi Sad<sup>18</sup>.

Iron Gates HNS is composed from<sup>19</sup>:

**Iron Gates I HNS** - consisting of two hydropower plants and two locks (one for Romania and one for Serbia). Considering the head and dimensions of chambers, the locks (310 m x 34 m) are among the biggest constructions of its kind in the world.

Each power plant within Iron Gates I HNS is equipped with 6 vertical Kaplan turbines with double adjustment. Subsequent to the refurbishment works, the installed capacity of each hydro-unit increased from 175 MW to 194.5 MW.

**Iron Gates II HNS** – consisting of two basic hydropower plants and two additional plants, namely the Romanian one and Serbian since 2000. The two basic plants at the Iron Gates II,

<sup>18</sup> [http://www.icpdr.org/icpdr-pages/dams\\_structures.htm](http://www.icpdr.org/icpdr-pages/dams_structures.htm)

<sup>19</sup> [www.hidroelectric.ro](http://www.hidroelectric.ro)

located on the main branch of the Danube, are equipped with 8 hydro-units. Subsequent to the refurbishment works (in progress, expected to finish in 2013) the capacity of Iron Gates II hydropower plant will be 251.2 MW.

Additional plants, located on the main and secondary branch of the Danube, each equipped with two hydro units are the same as the interior settlement and constructive characteristics each plant having an installed capacity of 54 MW. Gogosu plant whose hydro units will be refurbished by 2015, will reach an installed capacity of 62.8 MW.

The aim of the RTFMON pilot case is to monitor water level and flow in the pilot area, to provide a n-day prognosis for monitored parameters making possible generation of flood alerts and plan dam water evacuation in order to prevent high waters upstream and downstream the dam.

Figure 9 shows the main hydrographical network in the pilot area and the localisation of Iron Gates I and II HNS.



**Figure 9 – Main hydrographical network in pilot area**

## 3 Real-Time Pilot Requirements Specification

### 3.1 Methodology for ENVISION Pilots requirements specification

The baseline for the methodology used for ENVISION Pilots requirements specification is the Reference Model of Open Distributed Processing (RM-ODP)<sup>20</sup> - an international standard for architecting open, distributed processing systems. It provides an overall conceptual framework for building distributed systems in an incremental manner.

The RM-ODP is a reference model<sup>21</sup> based on precise concepts derived from current distributed processing developments and on the use of formal description techniques<sup>22</sup> for specification of the architecture<sup>23</sup>. The RM-ODP model is structured on five viewpoints that identify the top priorities for architectural specifications and provide a minimal set of requirements to ensure system integrity.

#### 3.1.1 Description of RM-ODP Framework

The concept of RM-ODP viewpoints framework is to provide separate perspectives into the specification of a given complex system. These viewpoints each satisfy an audience with interest in a particular set of aspects of the system:

- The **Enterprise** viewpoint focuses on the purpose, scope and policies for the system. It describes the business requirements and how to meet them.
- The **Information** viewpoint focuses on the semantics of the information and the information processing performed. It describes the information managed by the system and the structure and content type of the supporting data.
- The **Service** (Computational) viewpoint enables distribution through functional decomposition on the system into objects which interact at interfaces. It describes the functionality provided by the system and its functional decomposition.
- The **Engineering** viewpoint focuses on the mechanisms and functions required to support distributed interactions between objects in the system. It describes the distribution of processing performed by the system to manage the information and provide the functionality.
- The **Technology** viewpoint focuses on the choice of technology of the system. It describes the technologies chosen to provide the processing, functionality and presentation of information.

A viewpoint represents a subdivision of the specification of a complete system, established to bring together particular pieces of information relevant to some particular area of concern during the design of the system. Although separately specified, the viewpoints are not completely independent; key items in each are identified as related to items in the other viewpoints. However, the viewpoints are sufficiently independent to simplify reasoning about the complete specification.

#### 3.1.2 Use of RM-ODP in the ENVISION project

The RM-ODP offers a conceptual framework and an architecture integrating aspects related to the distribution, interoperation and portability of software systems, in such way that hardware heterogeneity, operating systems, networks, programming languages, databases

<sup>20</sup> <http://en.wikipedia.org/wiki/RM-ODP>

<sup>21</sup> [http://en.wikipedia.org/wiki/Reference\\_model](http://en.wikipedia.org/wiki/Reference_model)

<sup>22</sup> [http://en.wikipedia.org/wiki/Formal\\_methods](http://en.wikipedia.org/wiki/Formal_methods)

<sup>23</sup> [http://en.wikipedia.org/wiki/Enterprise\\_architecture](http://en.wikipedia.org/wiki/Enterprise_architecture)

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and management systems are transparent to the user. It also offers a coordinating framework for the standardization of ODP, able to integrate current and future standards, and maintain consistency among them. RM-ODP provides a short, clear and explicit specification of concepts and constructs that define semantics, independently of the representation, methodologies, tools and processes used for the development of open distributed applications.

To graphically support the expression of the specification, the ENVISION project uses concepts maps and UML diagrams. The UML case diagrams are used to overview the usage of the system from the different actors perspectives. It gives the possible actions. UML sequence diagrams extend the graphical notations and allow describing the flows of logic within the system and between the modules.

## 3.2 Requirements Specification

### 3.2.1 Enterprise viewpoint

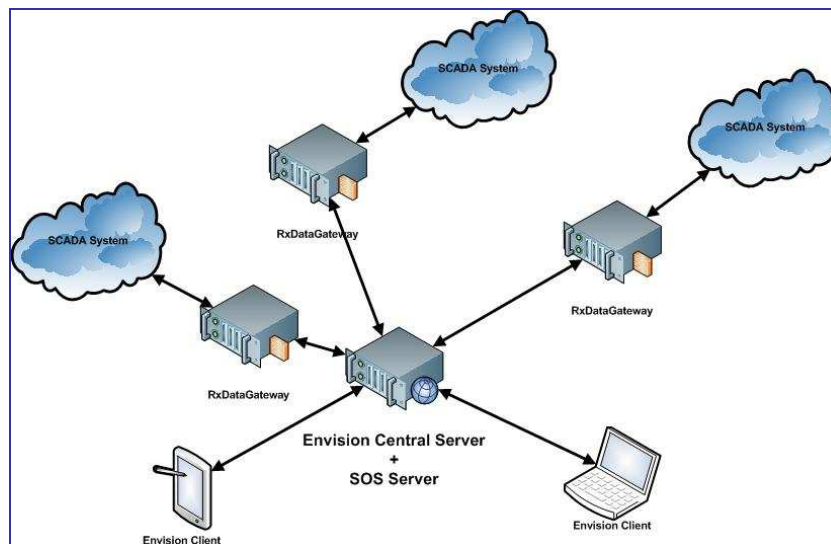
In a trans-boundary context there exists the need to exchange data in a heterogeneous manner between the involved organizations depending on their collaboration agreements.

Using the ENVISION platform along with the RxDataGateway application, several types of topologies can be created. For more details on RxDataGateway application see section 3.2.3.1.4.

#### 3.2.1.1 A topology based on a central server

This structure is based on a central ENVISION server where all the other ENVISION clients can subscribe for sensor values and also push the data into this central server. This topology has the advantage that the interconnections between the organizations are diminished and all the data from all the participants are accessible to everyone.

In Figure 10 is presenting an example of this kind of topology.



**Figure 10 – Central server topology**

In this topology, the RxDataGateway application will perform real-time acquisitions from the existing SCADA system of each organization and will push the real-time data (periodically or on change) to the central ENVISION server. If some organization needs some information from other partners in their SCADA system, the RxDataGateway can be configured to retrieve the desired data. The organizations members can create their models on the central ENVISION server.

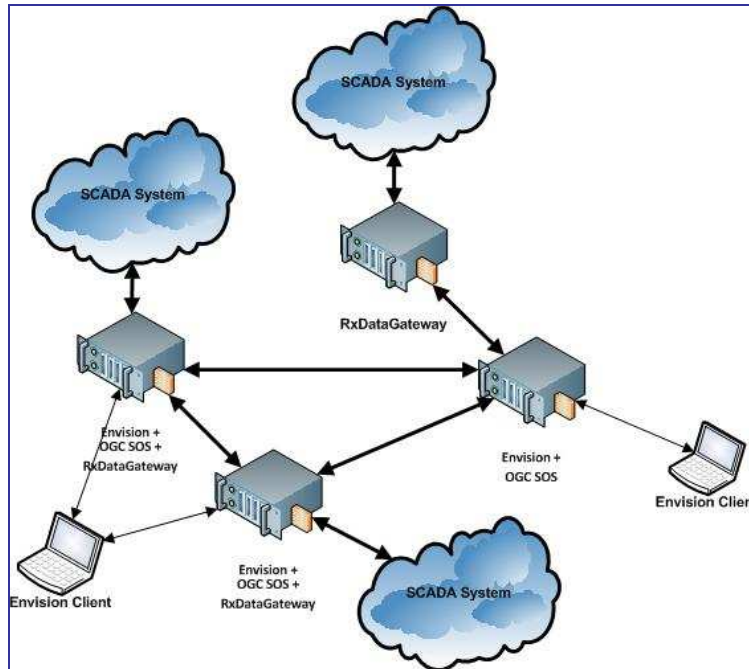
Such a topology might be used in the following situation:

- Each organization has their own data that want to be exposed to the other partners and are in the same time interested for data from all the other partners.
- They can create and use the other existing models from the central ENVISION server.

## 3.2.1.2 A distributed topology

This structure allows an organization to use the ENVISION platform for creating their own models and expose only the results of the models to the other organizations depending on their collaboration agreements.

In Figure 11 is presenting an example of such topology.



**Figure 11 – Distributed topology**

In this topology, the RxDataGateway application will perform real-time data acquisition and insert the observations in the ENVISION platform of the current organization. The designers from the current organization can create their own models on their platform and produce new data that are exposed via the local OGC Sensor Observation Service. They can also decide which data should be exposed for the other partners. Such a topology might be used when:

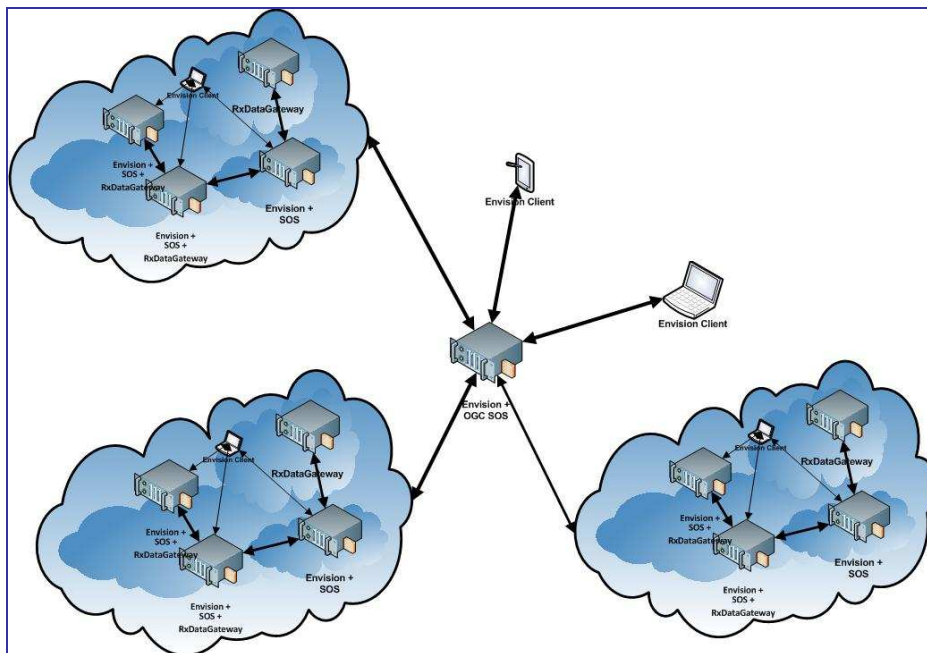
- Some restrictions and regulations are between the partners.
- The data are not public and the exchanges are in a private network.
- Each partner wants to create its own model and provide via the OGC Sensor Observation Service only the results of his model.

## 3.2.1.3 A combined topology

This structure is based on:

- A centralized ENVISION server.
- Groups of organizations that have their own ENVISION platforms where they can create their own private models. Not all their observations are exposed to the central server.

Figure 12 is presenting an example of such topology.



**Figure 12 – Combined topology**

This is basically a combination of the above two topologies.

Such a topology might be used in the following situations:

- In a trans-boundary collaboration, each group of organizations can belong to a particular country where the collaboration between the organization is much permissive than between the organizations from different countries.
- Each organization or group of organizations have their own internal models but do not want to be public but only the results of their models.
- They are interested in the published observations from other partners.

### 3.2.1.4 Actors and Roles

Generally speaking, actors involved in the system are environmental data services providers (government agencies, academics, research Institutes ...) and scientists providing Environmental Models. General public may also be interested by the resulting information delivered on the web.

In the ENVISION Portal, the following primary user roles are considered for the real-time pilot (one user can take up multiple roles):

**Configuration-designer:** uses the ENVISION portal to create the configuration for a certain data source in order to perform the data acquisition and convert the physical sensors into SensorML sensors.

**Process-supervisor:** Uses the ENVISION portal in order to monitor the real-time data acquisition status and observations.

**Operator:** uses the ENVISION portal to manually insert observations when an automatically data acquisition cannot be performed..

**End-User:** uses Scenarios and may be able to visualize the real-time observations

## 3.2.1.5 Use cases

This chapter presents the key activities of the users of the system.

### 3.2.1.5.1 The Configuration Designer

The configuration designer produces configurations for the real-time applications. The produced configurations are based on the existing physical sensors that are available in one or more organizations.

The configuration portlet is used to create two configurations. The first configuration is specific to the RxDataGateway application in order to be able to connect to third party SCADA systems and gather real-time observations from the physical sensors. The second configuration is specific for the SensorML sensors and defines the mapping to the physical sensors and the connections to the OGC Sensor Observation Services.

The key activities for the Configuration Designer are:

- Start creating a new configuration.
- Create the physical sensors descriptions that will be associated with the real-time sensors from SCADA.
- Create the physical sensors groups that will be used for communication with the real-time SCADA modules.
- Create SensorML virtual sensors descriptions that will be used as the generic sensors in the whole system.
- Create the SensorML virtual sensors groups that will be used in the communications with the OGC Sensor Observation Services.
- Create RxDataGateway station configuration (communication protocols).
- Create the configuration for the connections with the OGC Sensor Observation Services.

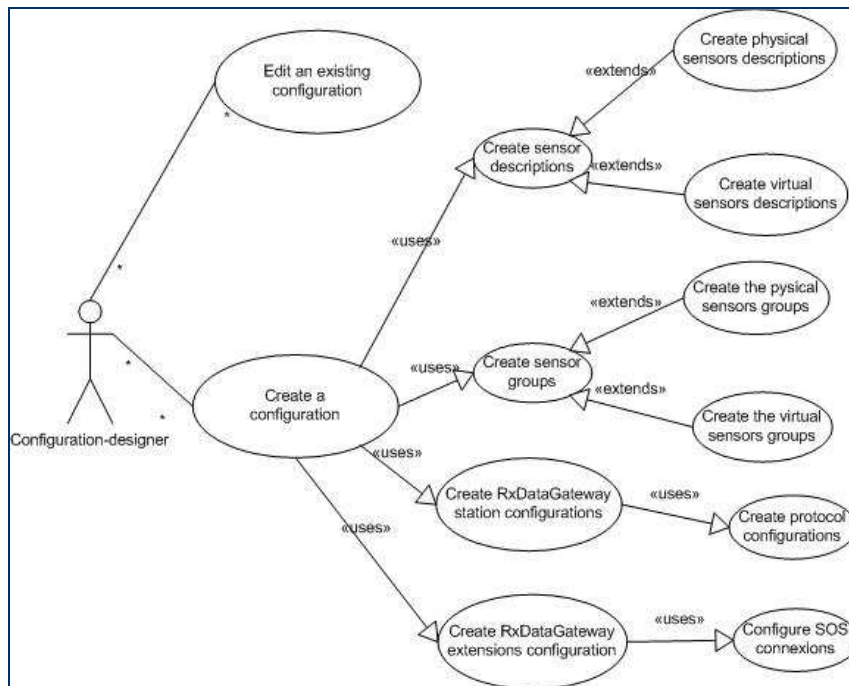


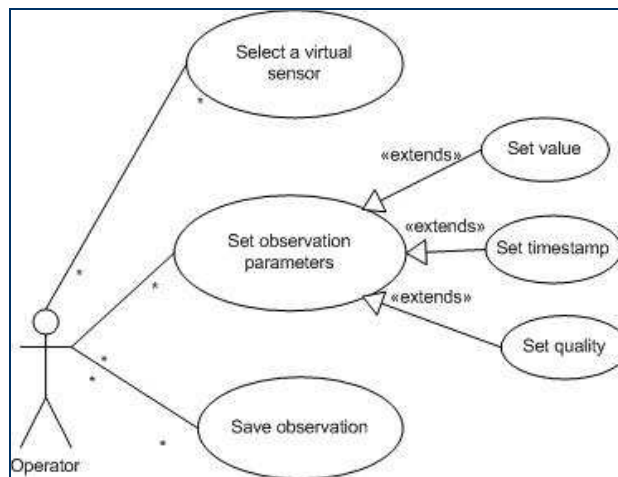
Figure 13 – Use case for creating configuration

## 3.2.1.5.2 The Operator

The operator inserts into the system observations for which there are no physical sensors installed so no automatically data acquisition can be made (the observations are made by persons that read and note various environmental parameters). The produced observation(s) are based on the values took from the environment and their association with an existing configured sensor.

The key activities for the Operator are:

- Select a configured sensor.
- Set the observation parameters (value, timestamp, quality).
- Save the observation.



**Figure 14 – Use case for manual observation insertion**

The operator also can supervise and monitor the real-time application statuses and the real-time observations. It has the role to validate the validity and the quality of the real-time process observations and to correct any communications problems that can occur in an industrial process.

## 3.2.1.5.3 The Process Supervisor

The key activities for the Process supervisor are:

- Monitor the real-time observation close to the place where they are produced.
- Monitor the communication modules statuses and the logs of the applications that are in the neighbourhood.

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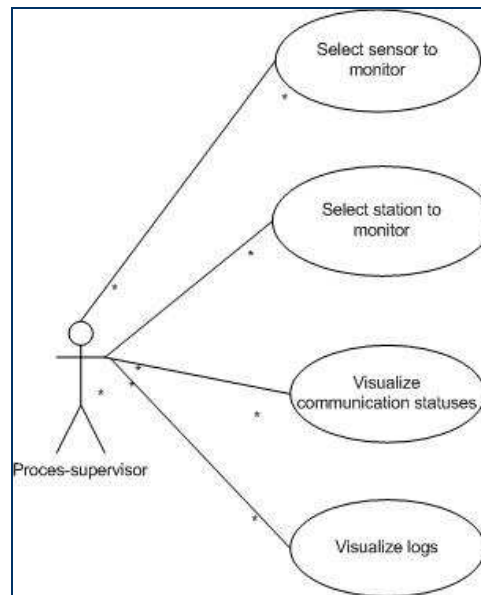


Figure 15 – Use case for monitoring the real-time statuses

## 3.2.2 Information viewpoint

The Information viewpoint focuses on the information and the processing performed. It describes the information managed by the system and the structure and content type of the supporting data.

The Table 1 summarizes the pilot oriented processes and information (inputs and outputs).

## 3.2.3 Service viewpoint

The service viewpoint enables distribution through functional decomposition on the system into objects which interact at interfaces. This chapter summarizes the modules of the system.

### 3.2.3.1 Components

The components of the ENVISION infrastructure are divided in four parts: the portlets, the web services, the libraries and the applications.

#### 3.2.3.1.1 Portlets

This section presents the portlets used in the RTFMON pilot case:

- Map Viewer Portlet – visualisation of scenario maps
- Timeline Viewer Portlet – time navigation in connected portlets
- Chart Viewer Portlet – visualisation of historical or real-time data
- Notification Portlet – configuration of the events and subscriptions
- Real-Time Configuration Portlet – editor for configuration of the real-time system
- Manual Observations Insertion Portlet – add manual observations
- Real-time Monitoring Portlet – monitoring (logs, communication status, etc.) of the real-time system

The first four portlets are already developed for “Landslide” and “Oil spill” pilot cases [2] and are not detailed here. The last three are new portlets that will be developed for RTFMON pilot case and are detailed later in this section.

Aspect	Description
Service name	Map Viewer Portlet
Project Category      Service	Portlets
Standard reference	WMS(-T) ( <a href="http://www.opengeospatial.org/standards/wms">http://www.opengeospatial.org/standards/wms</a> ) WFS ( <a href="http://www.opengeospatial.org/standards/wfs">http://www.opengeospatial.org/standards/wfs</a> ) WCS ( <a href="http://www.opengeospatial.org/standards/wcs">http://www.opengeospatial.org/standards/wcs</a> ) SOS ( <a href="http://www.opengeospatial.org/standards/sos">http://www.opengeospatial.org/standards/sos</a> )
Description	The Map Viewer Portlet is a map with standard interaction techniques like panning, zooming. It has a legend that displays information depending of the current content of the map. It also proposes some tools to interact with the map (draw profile lines, ask for Sensor status...)
Format	XML, Images
Comment	This portlet will be used for having a spatial display of the sensors. It will allow selecting a sensor and visualize the observations in the Chart Viewer.

**Table 4 – Map Viewer Portlet**

Aspect	Description
Service name	Timeline Viewer Portlet
Project Category      Service	Portlets
Description	The Timeline Viewer Portlet allows navigating within scenario and/or time steps. It is used to control data displayed by the Map Viewer, Chart Viewer and Profil Viewer Portlets.
Comment	The need in the pilot of this portlet is described in the Description part of this table.

**Table 5 –Timeline Viewer Portlet**

Aspect	Description
Service name	Chart Viewer Portlet
Project Category      Service	Portlets
Standard reference	SOS ( <a href="http://www.opengeospatial.org/standards/sos">http://www.opengeospatial.org/standards/sos</a> )
Description	The Chart Viewer Portlet allows to view features (like time series) displayed as charts.
Format	XML
Comment	The portlet will be used for displaying real-time sensor observations as charts.

**Table 6 – Chart Viewer Portlet**

Aspect	Description
Service name	Notification Portlet
Project Service Category	Portlets
Description	The Notification Portlet is used to subscribe to a model and to retrieve some notification when certain conditions are reached by the results of the model.
Comment	The need in the pilot of this portlet is described in the Description part of this table.

**Table 7 – Notification Portlet**

Aspect	Description
Service name	Real-time configuration portlet
Project Service Category	Portlets
Description	Configuration portlet is used for creating the configuration of the real-time system.
Comment	See below.

**Table 8 – Real-time Configuration Portlet**

In this moment already exists a configuration application for RxDataGateway. This is a Windows desktop application that allows creating full configurations for one or more stations including RxDataGateway applications configurations and also the configurations for GUI clients presenting the observations in the synoptic schemes.

In order to satisfy the needs of the ENVISION project regarding the configuration of the virtual sensors and the OGC Sensor Observation Services and also to have uniformity in the tools used, a configuration component that will be implemented as a portlet will be developed for:

- Creating the RxDataGateway specific configuration that will define:
  - The physical sensors offered by the company
  - The communication protocols used for retrieving the process real-time parameters and their specific communication parameters along with the process sensors to be interrogated via the configured protocol
- Creating the Virtual Sensors specific configuration that will define:
  - The virtual sensors exposed by the web application via the OGC Sensor Observation Service and the additional attributes used to enrich the virtual sensor descriptions (ex. the GPS location of the sensors is not needed in a power-plant process but are needed in trans-boundary context)
  - The mapping between the created virtual sensors and the physical sensors.
  - The addresses of the OGC Sensor Observation Services where the observations will be pushed (along with the list of sensors to be pushed and the manner to do this: periodically at a specified interval or on data change).
  - The addresses of the OGC Sensor Observation Services to be interrogated for the virtual sensor observations (along with the time interval of the polling and the sensors to be interrogated).

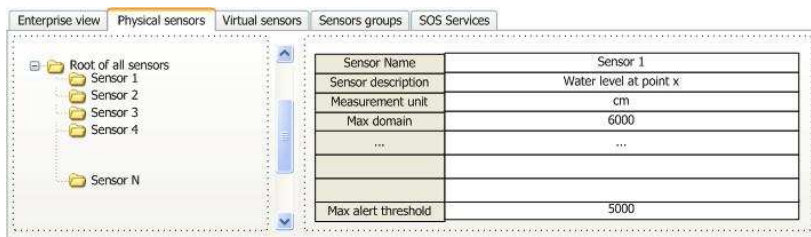
- The external virtual sensors that will eventually be interrogated and used as input parameters in the SCADA system of the current user.

In this manner, two separate configurations will be produced by the configurator and attached to each configured application.

## Creating the RxDataGateway configuration

The configuration portlet will have the following features for creating one or many RxDataGateway configurations (for one or more machines with RxDataGateway that it might have in its own SCADA system):

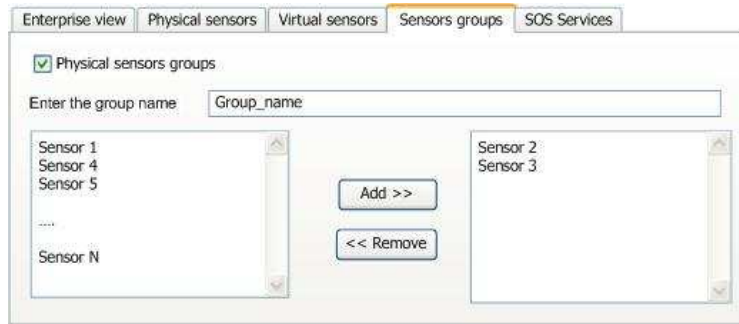
- A section for configuring the physical sensors that will be used in the real-time database of the RxDataGateway. For each physical sensor the user will have the possibility to insert the following information:
  - The physical sensor name as it appears in the SCADA system
  - The type of the sensor: Analog Input sensor, analog output sensor, binary input or binary output sensor.
  - The description of the sensor
  - The measurement unit.
  - The maximum domain – this is the maximum domain allowed for this sensor in engineering units.
  - The minimum domain – this is the minimum domain allowed for this sensor in engineering units.
  - The maximum ADC units domain (used for the analog to digital or digital to analog conversions in some protocols or data acquisition drivers)
  - The minimum ADC units domain (used for the analog to digital or digital to analog conversions in some protocols or data acquisition drivers)
  - The minimum warning threshold (the minimum level below which there is a warning situation)
  - The minimum alert threshold (the minimum level below which there is a critical alert situation)
  - The maximum warning threshold (the maximum level above which there is a warning situation)
  - The maximum alert threshold (the maximum level above which there is a critical alert situation)



**Figure 16 – Example of physical sensor configuration**

- A section for configuring the physical sensors groups that will be used. This section will allow to the user to select and group the sensors that will be used later by one of the communication protocol. The items in a group are usually took/sent from/to the same communication partner.

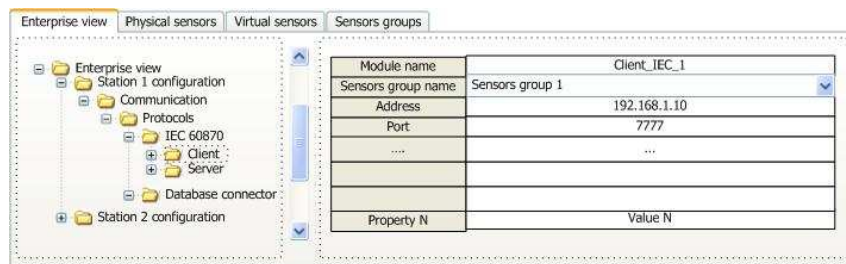
An example of a section allowing for creating groups of sensors is given in Figure 17.



**Figure 17 – Example of group config**

- A section for configuring the communication protocols. This section will configure the protocols used and their specific attributes:
  - Address of the communication partner
  - Communication port
  - The group of physical sensors that will be used in the communication
  - Attributes like the timeout delay, communication intervals and other protocol specific parameters.

An example of a section configuring a communication protocol is given in Figure 18.

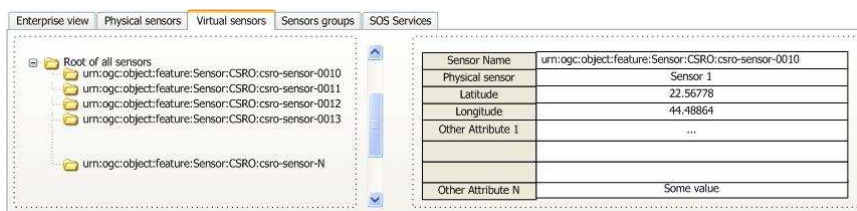


**Figure 18 – Example of communication protocol config**

## Creating the RxDataGateway extensions configuration

The configuration portlet will have also the following features for creating the configurations for the RxDataGateway extensions:

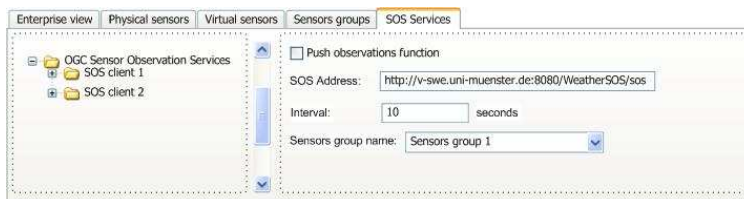
- A section for creating the virtual sensors along with their properties. This section will allow to:
  - Create a new virtual sensor starting from the properties of a physical sensor (description, measurement unit, etc.). Automatically mapping will be made from the new created sensor to the physical sensor.
  - Edit the virtual sensor attributes.
  - Enrich the virtual sensor with new attributes like the GPS location of the sensor.



**Figure 19 – Example of virtual sensor configuration**

The section can also allow the creation of groups of virtual sensors that can be further used in the OGC Sensor Observation Services interrogations.

- A section for configuring the OGC Sensor Observation Service(s) from which the sensors will be retrieved. This section will have:
  - A list of addresses of the OGC Sensor Observation Services. For each OGC Sensor Observation Service, the groups of virtual sensors to be interrogated will be defined
  - The time interval used for interrogations
- A section for configuring the OGC Sensor Observation Service(s) to which virtual sensors from the current server will be pushed. This section will have:
  - A list of addresses of the OGC Sensor Observation Services. For each OGC Sensor Observation Service the groups of sensors that will be pushed into the server will be defined.
  - The time interval used for pushing the observations.



**Figure 20 – Example of OGC Sensor Observation Service config**

Aspect	Description
Service name	Manual observations insertion portlet
Project Service Category	Portlets
Standard reference	SOS ( <a href="http://www.opengeospatial.org/standards/sos">http://www.opengeospatial.org/standards/sos</a> )
Description	Manual observations insertion portlet is used in collaboration with the Configuration portlet, RxVSWebGateway and RxDataGateway application to insert environmental observations manually.
Comment	See below

**Table 9 – Manual Observations Insertion Portlet**

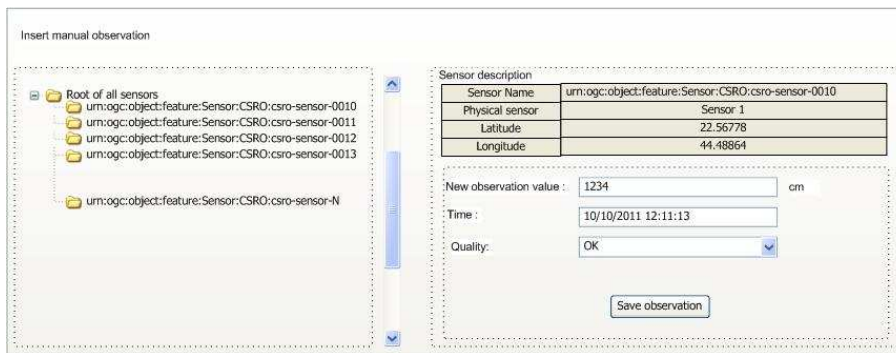
In some cases there exist no physical sensors that can perform automatic data acquisition. In these situations the observations need to be provided in a different manner and the results of the observations can be manually inserted into the ENVISION platform. The users that will need to insert new observations into the system will use the manual observations insertion portlet.

- The virtual sensor to be updated in the system should have been previously configured and normally should not belong to a group of sensors that are part of an automatically update process (i.e. it does not belongs to a group of sensors that have other acquisition source).

This portlet will offer the possibility to:

- Select an existing virtual sensor.
- Set the value of the sensor.
- Set the time at which the observation was performed.
- Set the quality of the measurement (optional).
- Save the measurement.

For “offline” systems that have no automatically manner to gather the observations it can be designed an option for uploading a file containing multiples observations for different sensors obtained as an export from another application or manually edited.



**Figure 21 – Example of manual insert observation UI**

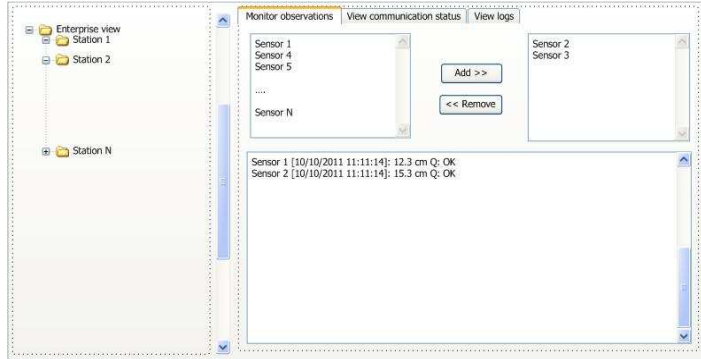
Aspect	Description
Service name	Real-time monitoring portlet
Project Category	Service Portlets
Description	Real-time monitoring portlet is used in collaboration with the Configuration portlet, RxVSWebGateway and RxDataGateway application to monitor the local status information like the observations from the physical sensors, the communication modules statuses from an RxDataGateway or the logs of a certain RxDataGateway application.
Comment	See below.

**Table 10 – Real-time Monitoring Portlet**

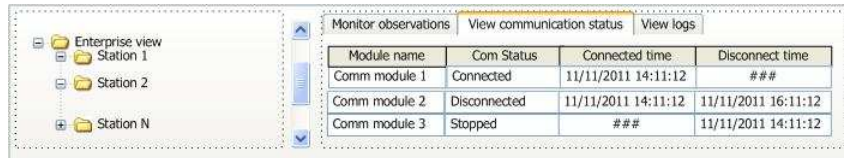
The SCADA systems and the data-acquisition devices are usually working in environments with high electromagnetic fields or industrial environment that can lead to failures of communication. Therefore, the portlet will offer the possibility to see the status of the communications with the peripheral devices, the observations and the logs from the RxDataGateways that are between ENVISION platform and the acquisition process. In this way, the communication problems can be solved faster by the local operators if they are observed earlier. Also, the acquisition of fake data can be avoided if transducers failures are observed by the local operators.

The portlet will offer the following possibilities:

- To visualize an observation (see Figure 22).
- To visualize the status of the communication modules (see Figure 23).
- To visualize the logs from a selected RxDataGateway application (see Figure 24).



**Figure 22 – Example of an observations monitoring panel**



**Figure 23 – Example of a communication protocols monitoring panel**



**Figure 24 – Example of a logs monitoring panel**

### 3.2.3.1.2 Web services

Aspect	Description
Service name	Semantic Annotation Proxy
Project Category	Service Web services
Description	The Semantic Annotation Proxy is used by Semantic Discovery Service to fetch annotated capabilities. It's also used by the Resource API to register annotated Web Services.
Comment	

**Table 11 – Semantic Annotation Proxy**

Aspect	Description
Service name	OGC Web Service
Project Service Category	Web services
Standard reference	OWS <a href="http://www.opengeospatial.org/standards/common">http://www.opengeospatial.org/standards/common</a> WMS <a href="http://www.opengeospatial.org/standards/wms">http://www.opengeospatial.org/standards/wms</a> WFS <a href="http://www.opengeospatial.org/standards/wfs">http://www.opengeospatial.org/standards/wfs</a> WCS <a href="http://www.opengeospatial.org/standards/wcs">http://www.opengeospatial.org/standards/wcs</a> SOS <a href="http://www.opengeospatial.org/standards/sos">http://www.opengeospatial.org/standards/sos</a>
Description	The OGC Web Services are used to retrieve geospatial information. They can be presented as Maps (WMS), Features (WFS), Coverages (WCS) i.e. Grid, or it can be Sensors available as SOS.
Format	XML, Images (WMS)
Comment	

**Table 12 – OGC Web Service**

Aspect	Description
Service name	Event Processing Service
Project Service Category	Web services
Standard reference	
Description	The Event Processing Service uses the Event Message Bus to allow the Notification Portlet to register Notification/Event links. It also allows the Event Management Tool to register some event pattern. It uses the Reasoning API to populate Event Ontology.
Comment	

**Table 13 – Event Processing Service**

Aspect	Description
Service name	RxVSWebGateway
Project Service Category	Web services
Description	The RxVSWebGateway is used as a virtual sensors gateway in collaboration with the RxDataGateway application.
Comment	See below

**Table 14 – RxVSWebGateway**

For the organizations where the usage of a database for exchanging observations is not satisfactory due to the requirement for any particular security reasons or a high speed of communication (at hundreds of millisecond level), a component RxVSWebGateway that will be executed at the web server level for exchanging observations with the RxDataGateway will be created.

# envision

The RxVSWebGateway web component will perform the following operations:

- Interrogation or observations insertion to a remote or local OGC Sensor Observation Service.
- Translate the physical sensors descriptions/observations into SensorML sensors descriptions/ observations and vice versa.
- Exchange configuration with one or more existing RxDataGateway

### 3.2.3.1.3 Libraries

The libraries are parts of the ENVISION Infrastructure, they are components that facilitate some specific capabilities to the rest of components (both portlets and web services).

Aspect	Description
Service name	RX Simple Communication Protocol
Project Service Category	Libraries
Description	The RX Simple Communication Protocol is used for communicating with an RxDataGateway application.
Comment	<p>The protocol will support the following functions:</p> <p>Exchange configuration</p> <p>Browsing through the real-time database</p> <p>Read process parameters values :</p> <p>By single request – single response. A read request will be made and the observations at that moment of time will be returned for the requested sensors.</p> <p>By request for periodic update of observations. A request specifying the sensors to be refreshed periodically and the refresh rate will be made. At the specified refresh rate, periodically, the partner will send the observations for the requested sensors.</p> <p>By request for observations only on change. A request specifying the sensors to be refreshed on change will be made. The request will contain also the minimum refresh rate necessary for a notification. At the specified refresh rate, only the modified sensors observations will be sent. If no observation changed since the last refresh, then no notification will be performed.</p> <p>Write process parameters values</p> <ul style="list-style-type: none"> <li>- Monitor the status of the communication of the remote RxDataGateway (status of the communication protocols and log messages).</li> </ul>

**Table 15 – RX Simple Communication Protocol**

Aspect	Description
Service name	Tcl/Tk (Tool command language)
Project Service Category	Libraries

Description	Tcl/Tk is a flexible, dynamic, string oriented scripting language having several advantages: allows rapid development, cross-platform, easy to learn, mature, easy to extend and to deploy. It is used to retrieve periodical or on change observations from RxDataGateway or any other application, to insert/retrieve observations in a database or to insert observations in an OGC Sensor Observation Service.
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**Table 16 – Tcl/Tk**

### 3.2.3.1.4 Applications

The applications are some external tools available in the ENVISION Infrastructure but not integrated in the ENVISION Portal.

Aspect	Description
Service name	RxDataGateway
Project Service Category	Application
Description	RxDataGateway is used for retrieving real-time observations from the physical sensors inside a SCADA system. It offers a large variety of communication protocols and modules that allow performing real-time data acquisition from various data sources. Since it has a pluggable structure, new communications protocols or data source adapters can be added on demand depending on the particular needs of an organization.
Comment	<p>The protocols supported in this moment are:</p> <ul style="list-style-type: none"> <li>- IEC 60870-5-101 and IEC 60870-5-104 – Standard protocol for telecontrol</li> <li>- Modbus and ModbusTCP - Master/slave protocol for communicating with equipments like PLCs, RTUs or SCADA systems.</li> <li>- OPC (OLE for Process Control) – Client/server protocol using DCOM (Windows only)</li> <li>- IronBus – proprietary communication protocol largely used by the Iron Gates for their internal real-time data exchange</li> <li>- S7 TCP protocol – used for communications with the Siemens Simatic PLC</li> <li>- DataAcquisition module – module that can be used for directly performing data acquisition at high speeds directly from the transducers using acquisition boards attached into the acquisition station.</li> <li>- Sql database adapter for exchanging (reading or writing) acquisition data using databases</li> <li>- Notifications module for sending mails or SMS messages containing data or alerts.</li> <li>- TCL Scripting for performing various operations (like executing SQL statements or to compute additional process parameters from a set of other parameters).</li> </ul> <p style="color: red;">As the RxDataGateway is a product of CS Romania it will be used in the ENVISION project “as is” and used freely by the participants to the project under some agreement rules.</p>

**Table 17 – RxDataGateway application**

## 3.2.3.2 Collaboration Diagrams

The following diagrams present the different collaborations between all components described above.

### 3.2.3.2.1 Configuration portlet

The configuration portlet is used by the Configuration designer at the design time to create the configurations for the RxDataGateway application and its extensions and also for the RxVSWebGateway.

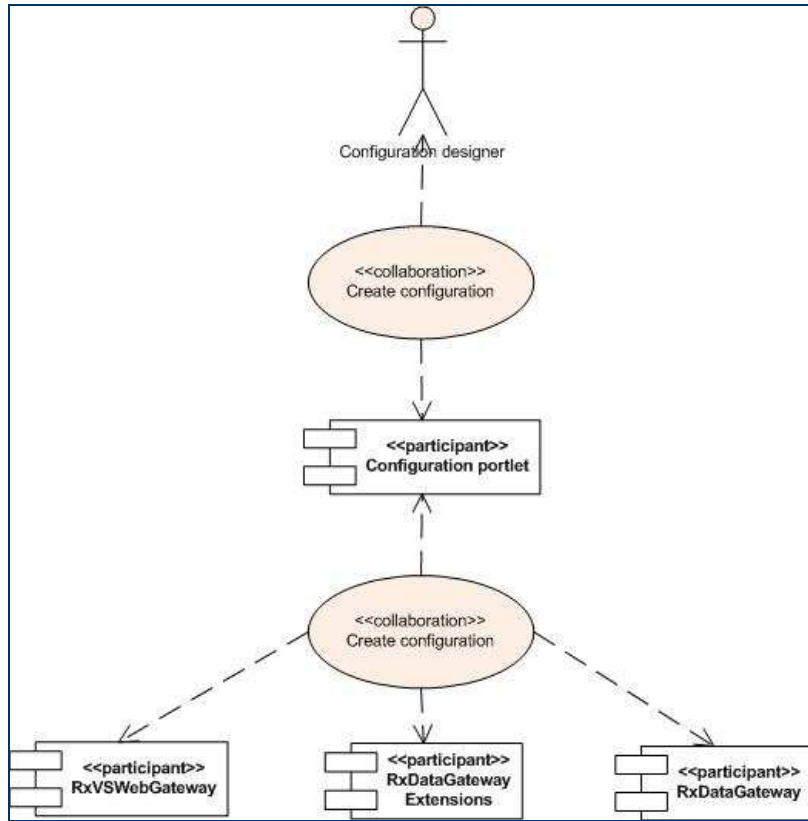
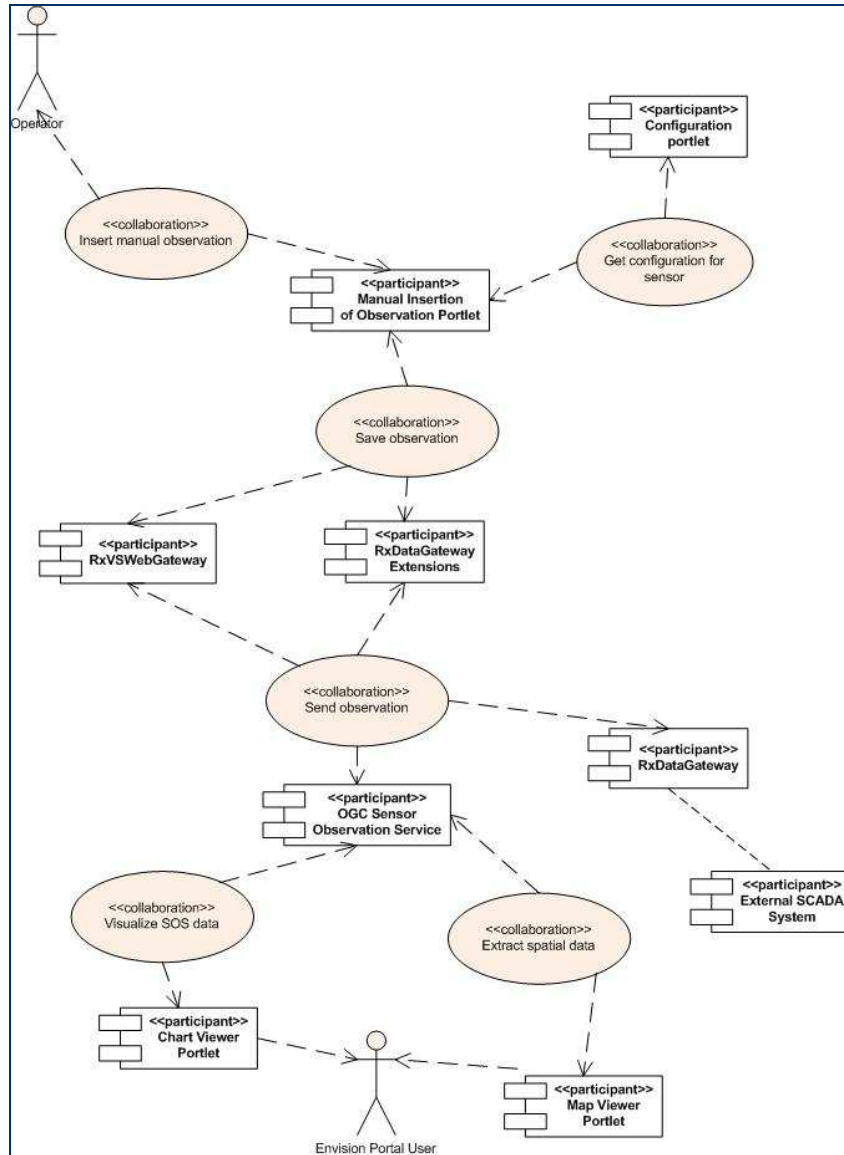


Figure 25 – Configuration collaboration

### 3.2.3.2.2 Manual insertion of observations portlet

The manual insertion of observations portlet is used by the Operator to insert new manual observations which will be available in any OGC Sensor Observation Service accessible by the Chart Viewer Portlet or Map Viewer Portlet. He can select from the configuration the sensor to be updated with the new observation. The new observation is sent to the RxDataGateway that can send the new observation into an existing SCADA system, to the RxDataGateway extensions or to the RxVSWebGateway that will insert the observation to one or more OGC Sensor Observation Services.



**Figure 26 – Manual insertion of observation collaboration**

### 3.2.3.2.3 Real-time monitoring portlet

The Real-time monitoring portlet is used by the Operator to monitor the real-time observations, the status of the RxDataGateway's communication modules and the logs. He can select the one or more sensors to visualize, the station to visualize the communication statuses and/or the logs for each station.

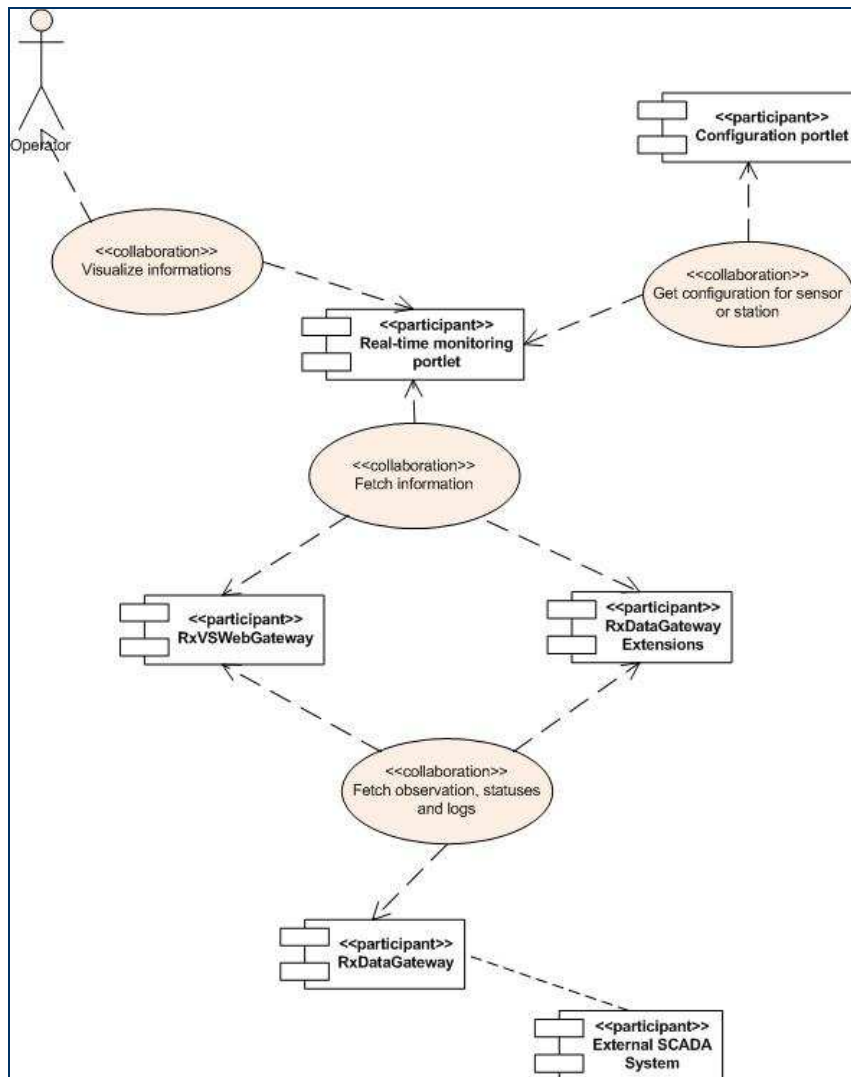


Figure 27 – Real-time monitoring collaboration

## 3.2.4 Engineering viewpoint

The engineering viewpoint focuses on the mechanisms required to support distributed interactions between modules in the system.

### 3.2.4.1 Ontologies

This aspect was already studied in the document “Environmental Services and Models Scenarios and Pilots - Requirements specification” – D1.2 [2] and will not be covered again in this document.

### 3.2.4.2 Activities

#### 3.2.4.2.1 Authenticate

The authentication is related to account management through the portal. This allows the portal to apply restrictions on the operations allowed for the real-time components.

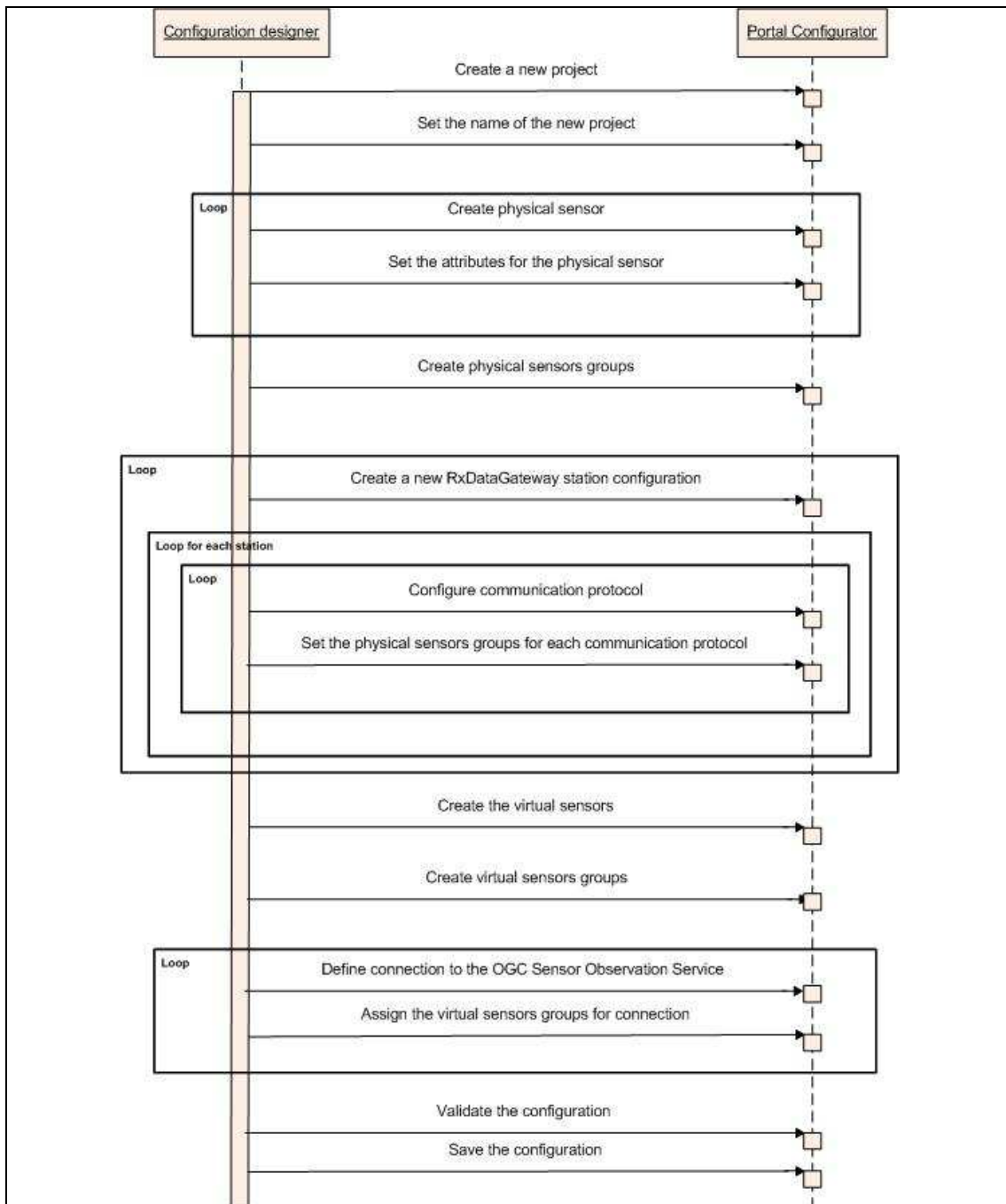
Overview	
<b>Title</b>	Authentication to ENVISION portal
<b>Description</b>	The authentication is related to account management through the portal. This allows the portal to apply restrictions on the operations allowed for the real-time components.
<b>Actors and Interfaces</b>	<ul style="list-style-type: none"> <li>• ENVISION User</li> <li>• User Module</li> </ul>
<b>Initial Status and Preconditions</b>	ENVISION User is not logged in
Basic Flow	
<ol style="list-style-type: none"> <li>1. The user opens the portal.</li> <li>2. He uses the menu to select the 'Sign In' option.</li> <li>3. He enters its login and password and then clicks on 'Sign In' button.</li> <li>4. Two cases can be reached:               <ol style="list-style-type: none"> <li>1. The couple login/password is not valid for the portal. So the authentication failed and an error message is displayed explaining what the problem is.</li> <li>2. The couple login/password is valid for the portal. The portal returns to the home page for the current user.</li> </ol> </li> </ol>	
Sequence diagram	
<pre> sequenceDiagram     actor User as Envision portal user     participant Module as User module     User-&gt;&gt;Module: Enter login and password     activate Module     Module--&gt;&gt;User: Authentication failed     deactivate Module     User-&gt;&gt;Module: Enter login and password     activate Module     Module--&gt;&gt;User: Authentication successful     deactivate Module     </pre>	
<b>Figure 28 – Authenticate sequence diagram</b>	
Post Condition	
The ENVISION user is now logged in and identified.	

**Table 18 – Authentication to ENVISION portal**

## 3.2.4.2.2 Create a configuration

Whenever a new system is built, a new configuration has to be created. This allows configuring the physical and virtual sensors, the communication modules and the OGC Sensor Observation Services connexions.

Overview	
<b>Title</b>	New configuration creation
<b>Description</b>	Whenever a new system is built, a new configuration has to be created. This only task is allows the configurconfiguration of the individual modulesthe physical and virtual sensors, the communication modules and the OGC Sensor Observation Services connexions.
<b>Actors and Interfaces</b>	<ul style="list-style-type: none"> <li>• The configuration designer</li> <li>• The portal configurator</li> </ul>
<b>Initial Status and Preconditions</b>	The Configuration Designer is logged in and is allowed to create new Configuration
Basic Flow	
	<ol style="list-style-type: none"> <li>1 Create a new configuration project. A unique name (that do not exists yet) for the project is given.</li> <li>2 In the physical sensors page of the configuration, create the physical sensors introducing for each sensor its attributes. The name of each item should be unique in the project.</li> <li>3 In the virtual sensors page of the configuration, create the virtual sensors starting from the physical sensors introducing for each sensor its attributes. The name of each item should be unique in the project.</li> <li>4 In the sensor groups' creation page, create the groups of physical or virtual sensors.</li> <li>5 Create a new RxDataGateway station configuration</li> <li>6 For the new created RxDataGateway configuration, create the communication modules</li> <li>7 For each created communication modules, set the communication parameters specific for that module and assign to it a group of physical items</li> <li>8 In the OGC Sensor Observation Service's page, create the connections to the desired servers and define their communication parameters.</li> <li>9 Assign to each OGC Sensor Observation Service connexion a group of virtual items.</li> <li>10 Save the configuration</li> </ol>
Sequence diagram	



**Figure 29 – Create a configuration sequence diagram**

**Post Condition**

A new configuration is available.

**Table 19 – Create a configuration**

**3.2.4.2.3 Insert manual observations**

Whenever the automatic data acquisition is not possible, the portlet allows inserting manual observations for the water levels or other environmental observations.

Overview	
<b>Title</b>	Manual observations insertion
<b>Description</b>	Whenever the automatic data acquisition is not possible, the portlet allows inserting manual observations for the water levels or other environmental observations. It allows for the situations when an automatically data acquisition is not possible to insert manual observations for the water levels or other environment observations.
<b>Actors and Interfaces</b>	<ul style="list-style-type: none"> <li>• The ENVISION Portal user</li> <li>• The manual insert observations portlet</li> </ul>
<b>Initial Status and Preconditions</b>	The ENVISION Portal User is logged in and is allowed to create insert manual observations
Basic Flow	
<ol style="list-style-type: none"> <li>1 In the manual insert observations portlet, select the virtual sensor to be updated.</li> <li>2 For the selected sensor set the observation attributes (value, timestamp, quality).</li> <li>3 Save the observation into the system</li> </ol>	
Sequence diagram	
<pre> sequenceDiagram     actor Operator     participant MIE as Manual Insertions Editor     participant CP as Configuration portlet     participant RDX as RxDataGateway Extension      Operator-&gt;&gt;MIE: Select sensor to update     activate MIE     MIE-&gt;&gt;CP: Get sensor description     activate CP     CP--&gt;&gt;MIE: The sensor infos are displayed     deactivate CP     Operator-&gt;&gt;MIE: Set the timestamp     deactivate MIE     activate MIE     Operator-&gt;&gt;MIE: Set the timestamp     deactivate MIE     activate MIE     Operator-&gt;&gt;MIE: Set the quality     deactivate MIE     activate MIE     MIE-&gt;&gt;RDX: Save the observation     deactivate MIE     activate RDX     deactivate RDX     </pre>	
<b>Figure 30 – Manual observation insertion sequence diagram</b>	
Post Condition	
The new observation is available in the system.	

**Table 20 – Manual insertion of observations**

#### 3.2.4.2.4 Observations view

Allows viewing real-time (without the need of refreshing manually) the current status and values of observations from RxDataGateway.

Overview	
<b>Title</b>	Observations view
<b>Description</b>	. Allows viewing real-time (without the need of refreshing manually) the

	current status and values of observations from RxDataGateway.
<b>Actors and Interfaces</b>	<ul style="list-style-type: none"> <li>• The ENVISION Portal user</li> <li>• The Real-time Monitoring Portlet</li> </ul>
<b>Initial Status and Preconditions</b>	The ENVISION Portal User is logged in and is allowed to view the observations and the status of the RxDataGateway applications.
<b>Basic Flow</b>	
<ol style="list-style-type: none"> <li>1 In the Real-time Monitoring Portlet select the page for viewing the observations.</li> <li>2 Select one or more physical or virtual sensors and add them to the list of sensors to be viewed.</li> <li>3 Select the refresh period for viewing the sensors observations and the manner for the refresh (periodically for all the selected sensors or on modifications only).</li> <li>4 Start the monitoring of the sensors.</li> </ol>	
<b>Sequence diagram</b>	
<pre> sequenceDiagram     actor Operator     participant Observations viewer     participant Configuration portlet     participant RxDataGateway Extension      Operator-&gt;&gt;Observations viewer: Select sensor to monitor     Observations viewer-&gt;&gt;Configuration portlet: Get sensor description     Configuration portlet--&gt;&gt;Observations viewer: The sensor summary info are displayed     Observations viewer-&gt;&gt;Observations viewer: Set the refresh interval     Observations viewer-&gt;&gt;Observations viewer: Start monitoring     activate Observations viewer     Observations viewer-&gt;&gt;RxDataGateway Extension: Request observations     RxDataGateway Extension--&gt;&gt;Observations viewer: Observations     deactivate RxDataGateway Extension     deactivate Observations viewer     </pre> <p>The sequence diagram illustrates the process of viewing real-time observations. It involves four participants: Operator, Observations viewer, Configuration portlet, and RxDataGateway Extension. The process begins with the Operator selecting a sensor to monitor, which triggers the Observations viewer to request sensor descriptions from the Configuration portlet. Once the sensor summary information is displayed, the user sets a refresh interval and starts monitoring. This leads to a loop where the Observations viewer requests observations from the RxDataGateway Extension, which returns the observations to the viewer.</p>	
<b>Figure 31 – View the real-time observations sequence diagram</b>	
<b>Post Condition</b>	
The observations for the physical sensors or from the SensorML sensors are displayed and refreshed periodically.	

**Table 21 – View real-time observations**

### 3.2.4.2.5 Communications statuses view

It allows viewing the status of the communications modules from the RxDataGateway..

<b>Overview</b>	
<b>Title</b>	Communications statuses view
<b>Description</b>	Allows viewing the status of the communications modules from the RxDataGateway.
<b>Actors and Interfaces</b>	<ul style="list-style-type: none"> <li>• The ENVISION Portal user</li> <li>• The Real-time Monitoring Portlet</li> </ul>
<b>Initial Status and</b>	The ENVISION Portal User is logged in and is allowed to view the status

<b>Preconditions</b>	of the RxDataGateway communication protocols.
<b>Basic Flow</b>	
<ol style="list-style-type: none"> <li>1 In the Real-time Monitoring Portlet select the page for viewing the status of the communication modules.</li> <li>2 Select one of the RxDataGateway applications that are registered.</li> <li>3 Start the monitoring of the statuses of the communication modules.</li> </ol>	
<b>Sequence diagram</b>	
<pre> sequenceDiagram     actor Operator     participant Observations viewer     participant Configuration portlet     participant RxDataGateway Extension      Operator-&gt;&gt;Observations viewer: Select station to inspect     Observations viewer-&gt;&gt;Configuration portlet: Get station configuration     Configuration portlet--&gt;&gt;Observations viewer: The station infos are displayed     Observations viewer-&gt;&gt;Observations viewer: Set the refresh interval     Observations viewer-&gt;&gt;Observations viewer: Start monitoring     activate Observations viewer     activate Configuration portlet     Observations viewer-&gt;&gt;RxDataGateway Extension: Request communication modules statuses     RxDataGateway Extension--&gt;&gt;Observations viewer: Statuses     deactivate Configuration portlet     deactivate RxDataGateway Extension     deactivate Observations viewer             </pre>	
<b>Figure 32 – View the communication statuses sequence diagram</b>	
<b>Post Condition</b>	
The statuses of the communication modules are displayed and refreshed periodically.	

**Table 22 – View communication status**

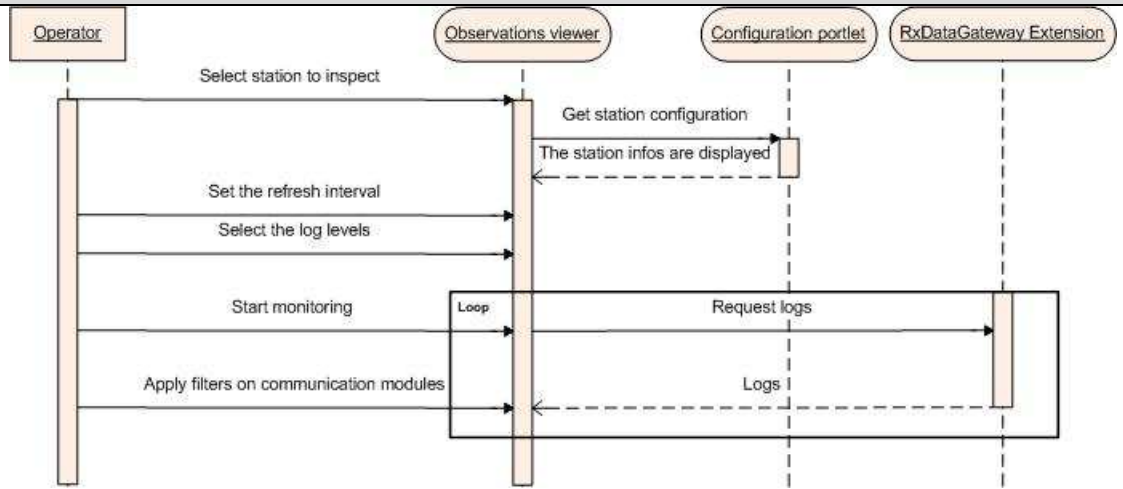
### 3.2.4.2.6 Log messages view

It allows viewing the logs generated by the various modules (internal services or communication modules) of the RxDataGateway application.

<b>Overview</b>	
<b>Title</b>	Log messages view
<b>Description</b>	Allows viewing the logs generated by the various modules (internal services or communication modules) of the RxDataGateway application.
<b>Actors and Interfaces</b>	<ul style="list-style-type: none"> <li>• The ENVISION Portal user</li> <li>• The Real-time Monitoring Portlet</li> </ul>
<b>Initial Status and Preconditions</b>	The ENVISION Portal User is logged in and is allowed to view the logs of the RxDataGateway applications.
<b>Basic Flow</b>	
<ol style="list-style-type: none"> <li>1 In the Real-time Monitoring Portlet select the page for viewing the logs from the RxDataGateway application.</li> <li>2 Select one of the RxDataGateway applications that are registered in ENVISION.</li> </ol>	

- 3 Select the Log levels to be viewed or the communication module whose log is intended to be viewed.
- 4 Start the monitoring of the log for the configured level/communication module.

### Sequence diagram



**Figure 33 – Log viewing sequence diagram**

### Post Condition

The logs are displayed and refreshed periodically.

**Table 23 – Logs view**

## 3.2.5 Technology viewpoint

The technology viewpoint focuses on the choice of technology of the system. The main point to be considered at this stage of the project is that we target portals build on components compliant to the JSR 286 standard<sup>24</sup>. All modules (excepting the existing RxDataGateway application and the extensions for RxDataGateway) have then to be implemented using the portlets approach. Portlets have to be developed using JDK6 for JRE1.6 and have to be in compliance with JSR 286 standard.

We have also to consider that all data, treatments have to be delivered online and have to be exposed on the web through OGC standards (WFS, WPS, SOS ...)

## 3.3 Summary of requirements

In order to provide a synthetic requirements list as input for the next task of the work package, the following table summarized the main topics from section 3.2.

Id	Description
R_1	RxDataGateway application will be used for retrieving physical sensors observations from the existing SCADA systems.
R_2	RxDataGateway application will be able to retrieve physical sensors

<sup>24</sup> <http://jcp.org/aboutJava/communityprocess/final/jsr286/index.htm>

# envision

	observations at various time intervals (in terms of minutes, seconds or milliseconds according to the needs).
R_3	The RxVSWebGateway and the RxDataGateway extensions will convert the physical sensors observations into observations exposed via the OGC Sensor Observation Services.
R_4	The OGC Sensor Observation Services will be updated periodically or on value changes by the RxVSWebGateway and the RxDataGateway extensions.
R_5	The configuration portlet can allow the creation of RxDataGateway, RxVSWebGateway and the RxDataGateway extensions configurations and also the mappings between the physical and virtual sensors.
R_6	The Manual Insert Observations Portlet will allow inserting manual observations into the system.
R_7	The Real-time Monitoring Portlet will allow viewing the instantaneous values offered by the physical sensors via RxDataGateway, the statuses of the communication modules and the logs within the RxDataGateway application
R_8	Any ENVISION Portal module (Portlets) conforms to JSR286
R_9	Any Data, Sensor, or Processing service is delivered online using OGC standards

## 4 Conclusion

This deliverable concludes the additional work performed in tasks T1.1 and T1.2 which adds a new pilot case and its related components to the ENVISION platform.

The MaaS approach in hydrological modelling allows publication and high-level of re-use for models, different levels of access, interoperability between models, a real-time decision making process, and a shared modelling infrastructure.

The Real-time Flood Monitoring pilot case shows advantages of the ENVISION infrastructure, bringing together real-time data and the MaaS concept, providing valuable tools for environmental decision-making

The pilot case requirements specification is presented using the RM-ODP framework. The different viewpoints are used to identify the requirements.

Further work will consist in the implementation and integration of the software components for building the Real-time Flood Monitoring scenario website.

## 5 References

- [1] D1.1 : Definition of pilot cases
- [2] D1.2 : Report presenting requirements specification
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- [4] D3.3 : MaaS Composition Portal – Version 2
- [5] Pourvakhshouri S.Z., Mansor S., Ibrahim Z., Mohamad M.I., Daud M., *Oil Spill Management Supporting System In Malaysian Marine Environments*, ISPRS Congress Istanbul 2004, Proceedings of Commission II.
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- [10] INSPIRE Thematic Working Group Hydrography, *D2.8.I.8 INSPIRE Data Specification on Hydrography – Guidelines*
- [11] Hoftos K., *Co-operation in hydrology of the Danube countries*, Hydrology for the Water Management of Large River Basins (Proceedings of the Vienna Symposium, August 1991). IAHS Publ. no. 201, 1991.
- [12] Danube Regional Project, *The Danube and its network*, <http://www.undp-drp.org>

## Appendix 1: Terms

The following table contains the description of the main terms used in the document project.

Term	Description
The Infrastructure ENVISION Infrastructure	Terms the hardware and software set up in order to fulfil the project objectives.
The Pilots ENVISION Pilots	Terms the demonstrations that will be set up during the project to illustrate the capabilities of the infrastructure.
The Portal ENVISION Portal Environmental semantic Web Portal	Describes the front-end application of the infrastructure
Website User Website Scenario Website	A Website produced by the portal for a dedicated purpose and a given community.
Module	A user interface module is used to perform a certain task, or to convey a certain message. A module has a standard view, and can be configured through dialogs. Changing the content of module can (but does not have to) have an effect on the content of other components.
Service Web Service	Web services are typically a web API that are accessible via HTTP and executed on a remote system hosting the requested services
Composition	The executable combination of existing web services. A Web service by itself.
Model Computer Model	Computer simulation of real world processes to make forecasts of certain behaviour of natural phenomena.
Model as a Service (MaaS)	A model made available as a web service. A composition the user can interact with.

## Appendix 2: Acronyms

The following list contains the definition of the main current acronyms used in the document project.

BPEL	Business Process Execution Language
BPMN	Business Process Modelling Notation
CAP	Common Alerting Protocol
CSW	Catalogue Service for the Web
EIP	Enterprise Information Portal
FTP	File Transfer Protocol
HTTP	Hyper-Text Transfer Protocol
ICT	Information and Communication Technologies
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
MasS	Model as a Service
OGC	Open Geospatial Consortium
OWS	OGC Web Services
RM-ODP	Reference Model of the Open Distributed Processing
RTFMON	Real-Time Flood Monitoring
SCADA	Supervisory, Control and Data Acquisition
SEIS	Shared Environmental Information System
SISE	Single Information Space in Europe for the Environment
SOS	Sensor Observation Service
UML	Unified Modelling Language
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
WPS	Web Processing Service
WSDL	Web Service Description Language

### Appendix 3: Sensor data from Iron Gates SCADA networks

Figure 34 and Figure 35 shows the water level sensors available from Iron Gates SCADA networks. All measures are in centimetres above Adriatic sea level.

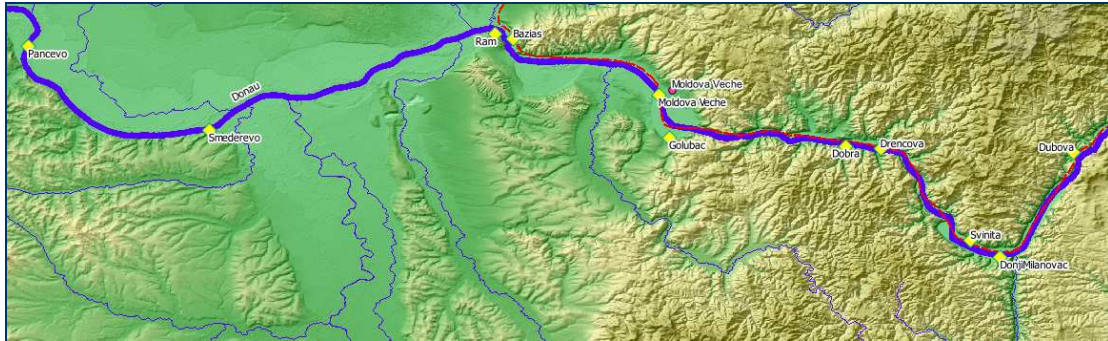


Figure 34 – Water level sensors upstream Iron Gates I dam

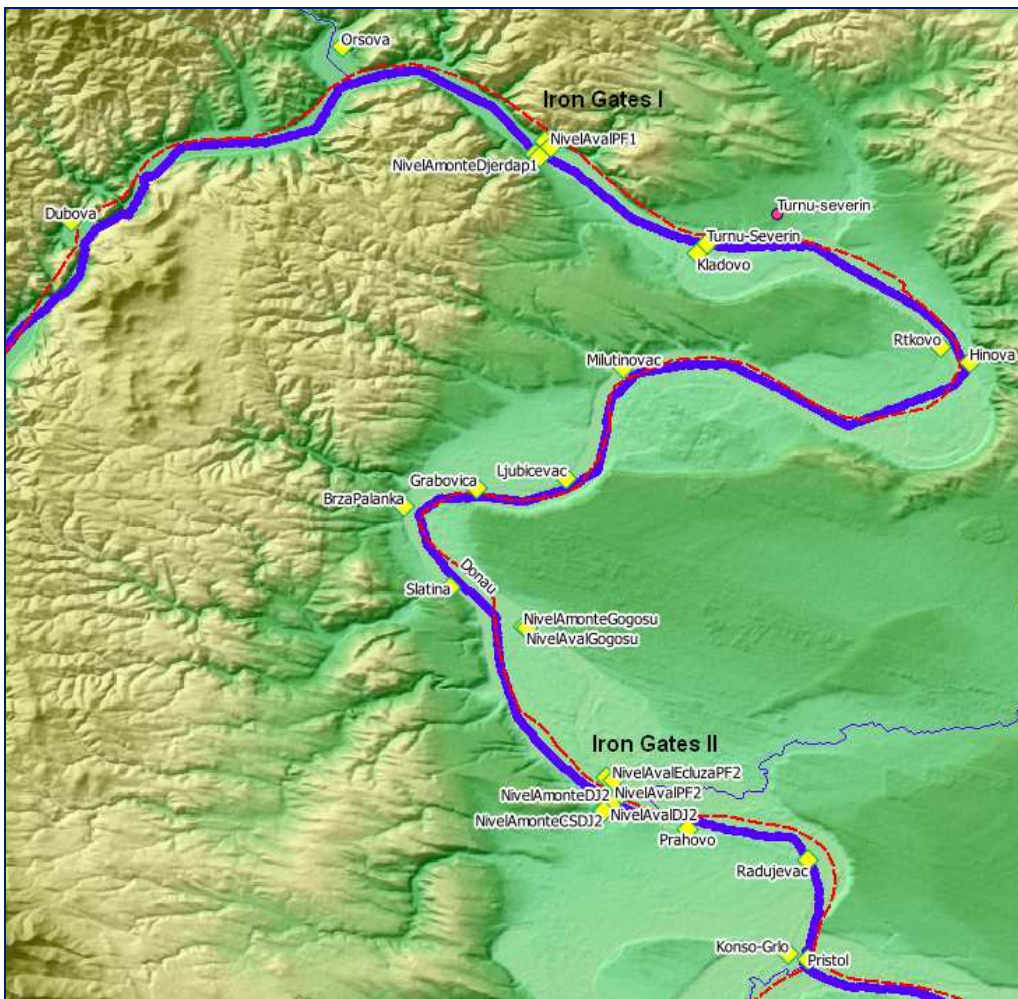


Figure 35 – Water level sensors downstream Iron Gates I dam