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## NRG4CAST

### Deliverable D6.1

#### Conceptual Architecture and Design Specifications Of NRG4CAST Toolkit

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## Executive Summary

The purpose of this deliverable is to present the conceptual architecture and detailed specifications of the integrated NRG4CAST toolkit.

Deliverable 1.3 presented an early view of the NRG4CAST toolkit software architecture which was designed according to a multi-tiered Web Service approach. Based on the requirements for the case studies and the associated use cases which were gathered on Deliverable 1.2 this document further elaborates on the NRG4CAST toolkit architecture by mapping the use cases into a set of software components which constitute black boxes providing realisations for the required NRG4CAST functionality.

The outcome of this work is a component architectural model which depicts how the software components are wired together to form the NRG4CAST toolkit. Each component is presented in with regard to its functionality, its exposed service interfaces and its user interface where applicable. The level of detail of each component description depends on its corresponding implementation phase according to the work plan.

Specifically, the NRG4CAST toolkit comprises of the following software components which span across multiple tiers of the architecture:

- 1. Data Access and Integration Platform**
- 2. User & Role Management**
- 3. Sensor & Information Source Registry**
- 4. Report Management & Visualization**
- 5. Event / Alert Processor**
- 6. Prediction Manager**
- 7. Real-time Visualization**

The Sensor & Information Source Registry, Real-time Visualization, Report Management & Visualization, Event / Alert Processor and Prediction Manager components consume services provided by (1) the User & Role Management component in order to acquire authorization and by (2) the Data Access & Integration platform in order to configure and gain access to the data resources. Real-time Visualization, Report Management & Visualization, Event / Alert Processor and Prediction Manager components consume services provided by the Sensor & Information Source Registry component in order to acquire several characteristics related to the identification, geographical location and grouping of both sensor and information sources that will enable them either to invoke the appropriate data services from the Data Access & Integration platform or to appropriately visualize sensor measurements.

Based on the feedback from the prototype development and validation, the specifications of the integrated NRG4CAST toolkit will be finalized in Deliverable 1.4 (Final Toolkit Architecture Specifications).

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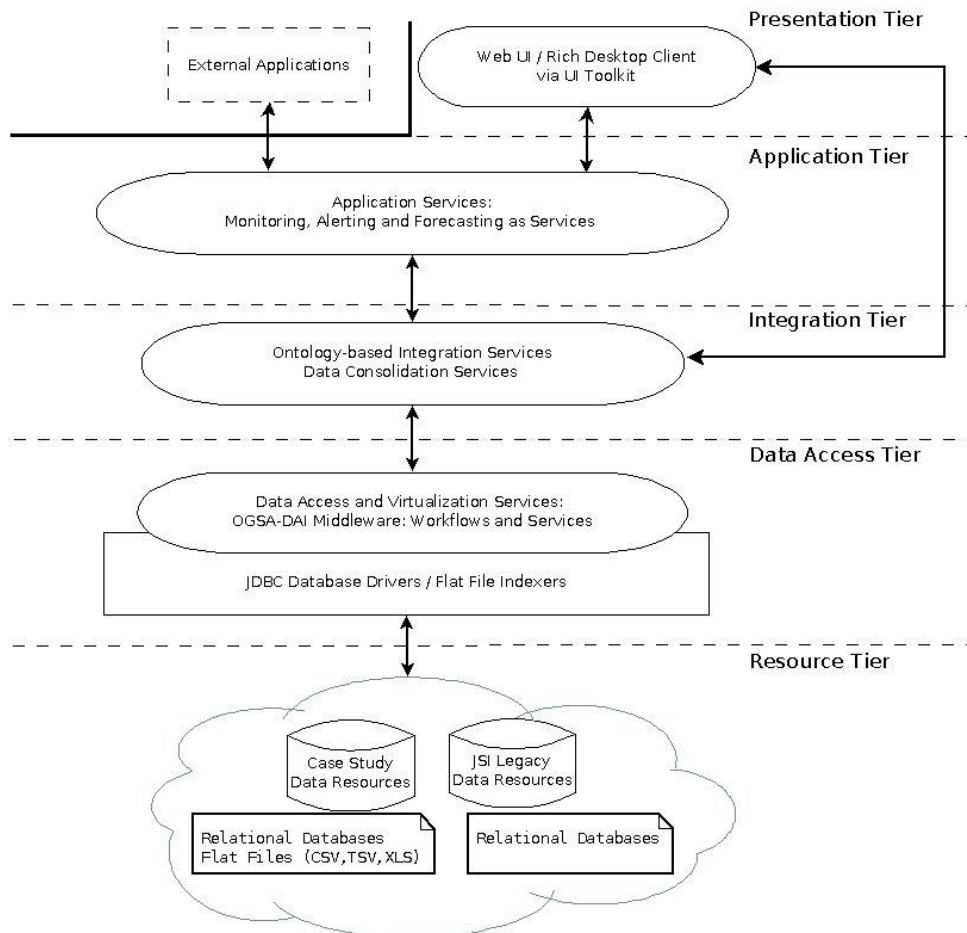
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## Abbreviations

API	Application Programming Interface
HTTP	Hypertext Transfer Protocol
IDP	Identity Provider
LDAP	Lightweight Directory Access Protocol
OGSA-DAI	Open Grid Software Architecture – Data Access and Integration
REST	REpresentational State Transfer
SAML	Security Assertion Markup Language
SOAP	Simple Object Access Protocol
SSO	Single Sign On
STS	Secure Token Service
UI	User Interface
UML	Unified Modelling Language
URL	Uniform Resource Locator
WSDL	Web Services Description Language

# 1 Introduction

Deliverable 6.1 provides the conceptual architecture and detailed specifications of the integrated NRG4CAST toolkit. In Deliverable 1.3 we have already described the multi-tiered Web Service approach for the NRG4CAST toolkit architecture (see Figure 1) based on the main objectives and requirements of the NRG4CAST project.



**Figure 1. The NRG4CAST toolkit multi-tiered Web Service architecture (Deliverable 1.3)**

According to the elaboration of the requirements for the case studies gathered in Deliverable 1.2, the corresponding use cases have been mapped into a set of software components which constitute black boxes providing realisations for the required functionality. In this way, a component model of the NRG4CAST toolkit architecture has been devised.

The mapping of the use cases led to the identification of seven (7) components, namely: (1) *Data Access and Integration Platform*, (2) *User / Role Management*, (3) *Sensor & Information Source Registry*, (4) *Report Management & Visualization component*, (5) *Event / Alert Processor*, (6) *Prediction Manager*, (7) *Real-time Visualization*.

The “Data Access & Integration Platform” component provides homogeneous and uniform *access* to a number of heterogeneous data resources through a set of application-specific data services. The “User/ Role Management” component is responsible for the management of users and roles as well as for the enforcement of the access control policy according to a Role-based access control approach. The “Sensor & Information Source Registry” component provides the mechanism for registering sensors and other information sources within the NRG4CAST toolkit. The “Report Management & Visualization” component is responsible for the management and visualization of reports related with energy monitoring. The “Event / Alert Processor” component is responsible for the definition of rules for various types of alerts and events as well as for the notification of the users. The “Prediction Manager” component provides the energy



forecasting functionality. The “*Real-time Visualization*” component provides users with a possibility to display information of different sensors on the energy consumption map.

Section 2 provides a detailed view of the component architectural model of the NRG4CAST toolkit. Subsequently each component is described through an overview of its functionality and dependencies as well as through an outline of its service interfaces and its user interface where applicable. The level of detail in the description of each component varies according to the corresponding phase of its implementation as defined in the work plan.

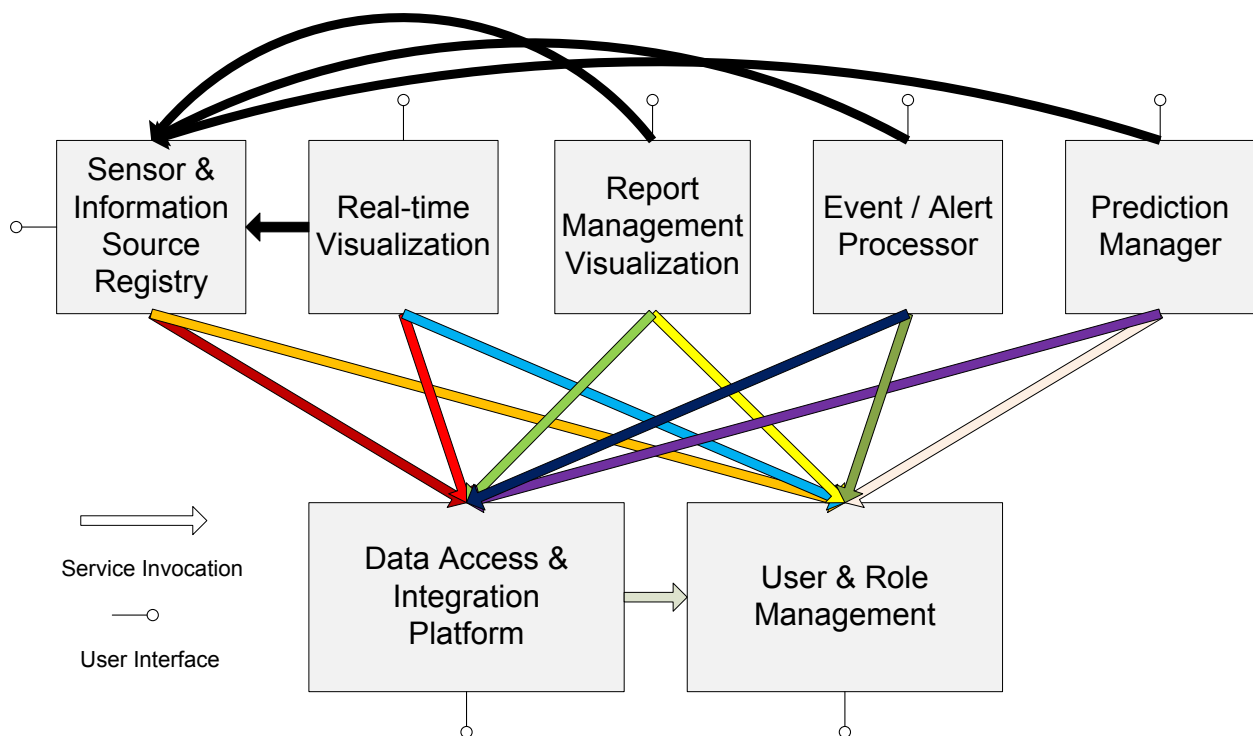
Section 3 presents the main conclusions and results of this deliverable.

## 2 NRG4CAST Toolkit Components

This section describes the set of software components which comprise the NRG4CAST toolkit. The description of each component includes the specification of the services they provide to other components and / or to external systems, their dependencies on services provided by other components as well as an abstract representation of the interactions between the users and the software components which are derived from the use cases presented in Deliverable 1.2 where applicable.

The interfaces of the provided services (operations, inputs / outputs, and faults) are described schematically according to the WSDL specification. The interactions between the users and the components are specified through abstract black box UML sequence diagrams or through mock-up screenshots.

Figure 2 depicts the global component diagram of the NRG4CAST toolkit. Since the software components may span across multiple tiers of the architecture, this section is not organized on a per-tier basis.



**Figure 2. NRG4CAST toolkit Component Diagram**

The Sensor & Information Source Registry, Real-time Visualization, Report Management & Visualization, Event / Alert Processor and Prediction Manager components consume services provided by (1) the User & Role Management component in order to acquire authorization and by (2) the Data Access & Integration platform in order to configure and gain access to the data resources. Real-time Visualization, Report Management & Visualization, Event / Alert Processor and Prediction Manager components consume services provided by the Sensor & Information Source Registry component in order to acquire several characteristics related to the identification, geographical location and grouping of both sensor and information sources that will enable them either to invoke the appropriate data services from the Data Access & Integration platform or to appropriately visualize sensor measurements.

## 2.1 Data Access & Integration Platform

**Table 1. Data Access & Integration Platform Component Overview**

<b>Component Name</b>	Data Access & Integration Platform
Identifier	C-1
Description	<p>This component provides homogeneous and uniform <i>access</i> to a number of heterogeneous data resources through a set of application-specific data services (Data Consolidation services). The Data Consolidation services hide low-level details and complexity. They reside on the Integration tier of the toolkit architecture and consume low level data services provided by the OGSA-DAI platform which is the core of the component.</p> <p>This component also provides the Sensor / Data Resource Registry with services for the integration of new data resources (i.e. sensors, meteorological data, energy prices, etc.).</p>
Source Code Repository	svn://83.212.107.133/svn/nrg4cast/NRG4CASTServices/
Implemented Services	<p>Available at:  <a href="http://83.212.123.209:8080/NRG4CASTServices/services/Nrg4CastServicesPort?wsdl">http://83.212.123.209:8080/NRG4CASTServices/services/Nrg4CastServicesPort?wsdl</a></p> <p>Synchronous &amp; Asynchronous</p> <ul style="list-style-type: none"> <li>• queryNTUAMeteoHumidity</li> <li>• queryNTUAMeteoWindDirection</li> <li>• queryNTUAMeteoPressure</li> <li>• queryNTUAMeteoTemp</li> <li>• queryNTUAMeteoRain</li> <li>• queryNTUATotalElectricityConsumption</li> <li>• queryNTUATotalGasConsumption</li> <li>• queryNTUASensorData</li> <li>• querySIGITResource</li> <li>• querySICEEResource</li> <li>• queryENERCADResource</li> <li>• queryCSIWeather</li> <li>• queryPrices</li> <li>• getResourceIds</li> </ul>
Pending Services	<ul style="list-style-type: none"> <li>• registerRelationalResource</li> <li>• registerFileResource</li> <li>• Data consolidation services for the complete set of data resources</li> </ul>
Services Used (Dependencies)	OGSA-DAI Platform Services (see D1.3)
Additional Information	None
Notes	None

### 2.1.1 Service Interfaces

This section presents the operations (inputs, outputs and faults) of the implemented services.

Parameters (1)	
Parameter Name	Parameter Type
<b>query</b>	<b>java.lang.String</b>

Output	
Return type: gr.singularlogic.nrg4cast.webservices.ResultData	

Faults (13)	
Parameter Name	Parameter Type
<b>ClientExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.ClientExceptionFault</b>
<b>DataSourceUsageExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.DataSourceUsageExceptionFault</b>
<b>DataStreamErrorFault</b>	<b>gr.singularlogic.nrg4cast.webservices.DataStreamErrorFault</b>
<b>IOFault</b>	<b>gr.singularlogic.nrg4cast.webservices.IOFault</b>
<b>MalformedListBeginExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.MalformedListBeginExceptionFault</b>
<b>MalformedURLExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.MalformedURLExceptionFault</b>
<b>RequestExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.RequestExceptionFault</b>
<b>ResourceUnknownFault</b>	<b>gr.singularlogic.nrg4cast.webservices.ResourceUnknownFault</b>
<b>SQLFault</b>	<b>gr.singularlogic.nrg4cast.webservices.SQLFault</b>
<b>TimeoutExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.TimeoutExceptionFault</b>
<b>TupleBinaryDataStreamParseExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.TupleBinaryDataStreamParseExceptionFault</b>
<b>UnexpectedDataValueFault</b>	<b>gr.singularlogic.nrg4cast.webservices.UnexpectedDataValueFault</b>
<b>UnsupportedTupleTypeExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.UnsupportedTupleTypeExceptionFault</b>

**Figure 3. queryNTUAMeteo - \* / queryCSIWeather / queryNTUATotalElectricityConsumption / queryNTUATotalGasConsumption Synchronous Operations**

Parameters (3)	
Parameter Name	Parameter Type
<b>query</b>	<b>java.lang.String</b>
<b>timeInterval</b>	<b>int</b>
<b>moreData</b>	<b>boolean</b>

Output	
Return type: gr.singularlogic.nrg4cast.webservices.ResultData	

Faults (13)	
Parameter Name	Parameter Type
<b>ClientExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.ClientExceptionFault</b>
<b>DataSourceUsageExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.DataSourceUsageExceptionFault</b>
<b>DataStreamErrorFault</b>	<b>gr.singularlogic.nrg4cast.webservices.DataStreamErrorFault</b>
<b>IOFault</b>	<b>gr.singularlogic.nrg4cast.webservices.IOFault</b>
<b>MalformedListBeginExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.MalformedListBeginExceptionFault</b>
<b>MalformedURLExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.MalformedURLExceptionFault</b>
<b>RequestExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.RequestExceptionFault</b>
<b>ResourceUnknownFault</b>	<b>gr.singularlogic.nrg4cast.webservices.ResourceUnknownFault</b>
<b>SQLFault</b>	<b>gr.singularlogic.nrg4cast.webservices.SQLFault</b>
<b>TimeoutExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.TimeoutExceptionFault</b>
<b>TupleBinaryDataStreamParseExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.TupleBinaryDataStreamParseExceptionFault</b>
<b>UnexpectedDataValueFault</b>	<b>gr.singularlogic.nrg4cast.webservices.UnexpectedDataValueFault</b>
<b>UnsupportedTupleTypeExceptionFault</b>	<b>gr.singularlogic.nrg4cast.webservices.UnsupportedTupleTypeExceptionFault</b>

**Figure 4. queryNTUAMeteo - \* / queryCSIWeather / queryNTUATotalElectricityConsumption / queryNTUATotalGasConsumption Asynchronous Operations**

Asynchronous operations take 2 additional input parameters: `timeInterval` which defines the polling time interval in seconds and `moreData` which determines if the call will start a new asynchronous invocation or if it will continue a previous one. For the following operations, we omit the asynchronous versions for the sake of brevity. The `query` input parameter follows the Apache Lucene query syntax [1]. However, operations with pre-defined queries (e.g. `fetchAllCSIWeather` records) may be added as necessary.

The screenshot shows the 'queryPrices' operation interface. It has a title bar with 'queryPrices' and standard window controls. Below the title bar, there are three main sections: Parameters, Output, and Faults.

**Parameters (4)**

Parameter Name	Parameter Type
energy	java.lang.String
area	java.lang.String
before2007	boolean
query	java.lang.String

**Output**

Return type: gr.singularlogic.nrg4cast.webservices.ResultData

**Faults (13)**

Parameter Name	Parameter Type
ClientExceptionFault	gr.singularlogic.nrg4cast.webservices.ClientExceptionFault
DataSourceUsageExceptionFault	gr.singularlogic.nrg4cast.webservices.DataSourceUsageExceptionFault
DataStreamErrorFault	gr.singularlogic.nrg4cast.webservices.DataStreamErrorFault
IOFault	gr.singularlogic.nrg4cast.webservices.IOFault
MalformedListBeginExceptionFault	gr.singularlogic.nrg4cast.webservices.MalformedListBeginExceptionFault
MalformedURLExceptionFault	gr.singularlogic.nrg4cast.webservices.MalformedURLExceptionFault
RequestExceptionFault	gr.singularlogic.nrg4cast.webservices.RequestExceptionFault
ResourceUnknownFault	gr.singularlogic.nrg4cast.webservices.ResourceUnknownFault
SQLFault	gr.singularlogic.nrg4cast.webservices.SQLFault
TimeoutExceptionFault	gr.singularlogic.nrg4cast.webservices.TimeoutExceptionFault
TupleBinaryDataStreamParseExceptionFault	ngularlogic.nrg4cast.webservices.TupleBinaryDataStreamParseException
UnexpectedDataValueFault	gr.singularlogic.nrg4cast.webservices.UnexpectedDataValueFault
UnsupportedTupleTypeExceptionFault	r.singularlogic.nrg4cast.webservices.UnsupportedTupleTypeExceptionFau

Figure 5. queryPrices Operation (EUROSTAT data)

The “queryPrices” operation retrieves pricing data for Gas and Electricity from the web site of EUROSTAT. The `energy` input parameter defines whether Gas or Electricity prices will be fetched. The `area` input parameter defines whether industrial or domestic prices will be fetched. The `before2007` input parameter is a Boolean flag denoting whether prices before or after 2007 will be fetched. The `query` input parameter follows the Apache Lucene query syntax. However, operations with pre-defined queries may be added as necessary.

The screenshot shows the 'querySICEEResource' operation interface. It has a title bar with 'querySICEEResource' and standard window controls. Below the title bar, there are three main sections: Parameters, Output, and Faults.

**Parameters (0)**

No Parameters.

**Output**

Return type: gr.singularlogic.nrg4cast.webservices.ResultData

**Faults (13)**

Parameter Name	Parameter Type
ClientExceptionFault	gr.singularlogic.nrg4cast.webservices.ClientExceptionFault
DataSourceUsageExceptionFault	gr.singularlogic.nrg4cast.webservices.DataSourceUsageExceptionFault
DataStreamErrorFault	gr.singularlogic.nrg4cast.webservices.DataStreamErrorFault
IOFault	gr.singularlogic.nrg4cast.webservices.IOFault
MalformedListBeginExceptionFault	gr.singularlogic.nrg4cast.webservices.MalformedListBeginExceptionFault
MalformedURLExceptionFault	gr.singularlogic.nrg4cast.webservices.MalformedURLExceptionFault
RequestExceptionFault	gr.singularlogic.nrg4cast.webservices.RequestExceptionFault
ResourceUnknownFault	gr.singularlogic.nrg4cast.webservices.ResourceUnknownFault
SQLFault	gr.singularlogic.nrg4cast.webservices.SQLFault
TimeoutExceptionFault	gr.singularlogic.nrg4cast.webservices.TimeoutExceptionFault
TupleBinaryDataStreamParseExceptionFault	ngularlogic.nrg4cast.webservices.TupleBinaryDataStreamParseException
UnexpectedDataValueFault	gr.singularlogic.nrg4cast.webservices.UnexpectedDataValueFault
UnsupportedTupleTypeExceptionFault	r.singularlogic.nrg4cast.webservices.UnsupportedTupleTypeExceptionFau

Figure 6. querySICEEResource / querySITResource / queryENERCADResource Operations

The “querySICEEResource” / “querySIGITResource” / “queryENERCADResource” operations retrieve all the records from the respective data resources (see Deliverable 2.1).

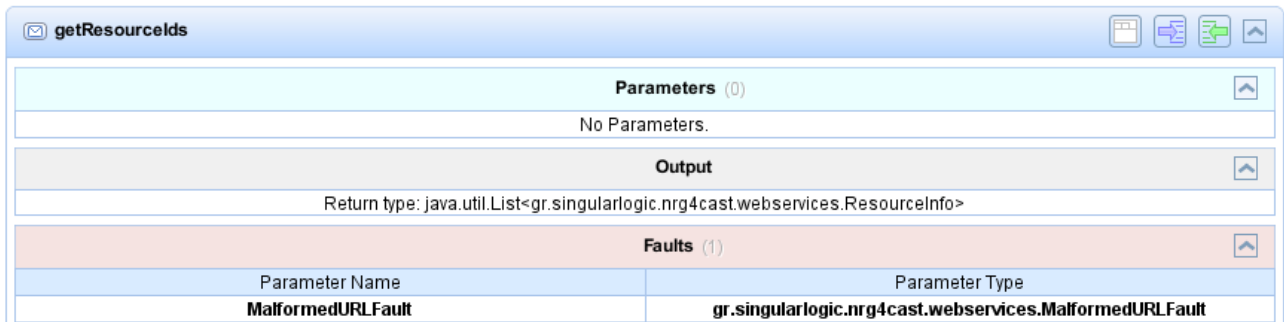


Figure 7. getResourceIds Operation

The “getResourceIds” operation retrieves a list of the internal Data Resource identifiers from the OGSA-DAI platform.

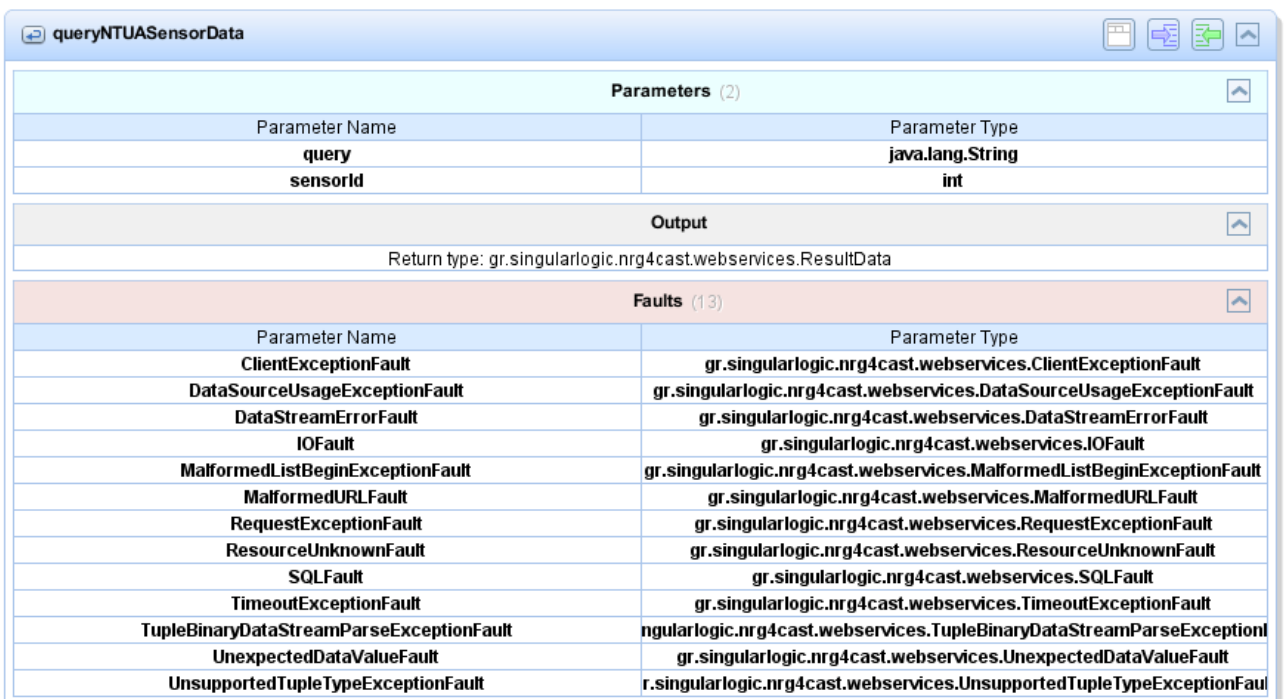


Figure 8. queryNTUASensorData Operation

The “queryNTUASensorData” retrieves data from the sensors installed in the NTUA campus according to their identifier which is fetched by the Sensor & Information Source Registry. The query input parameter follows the Apache Lucene query syntax. However, operations with pre-defined queries may be added as necessary.

### 2.1.2 User Interface

The Data Access & Integration platform component provides the NRG4CAST Administrator with a user interface to execute queries on the Data Resources which are registered in the toolkit. In order to access this component the Administrator must be authenticated and authorized according to the steps described in Section 2.2.

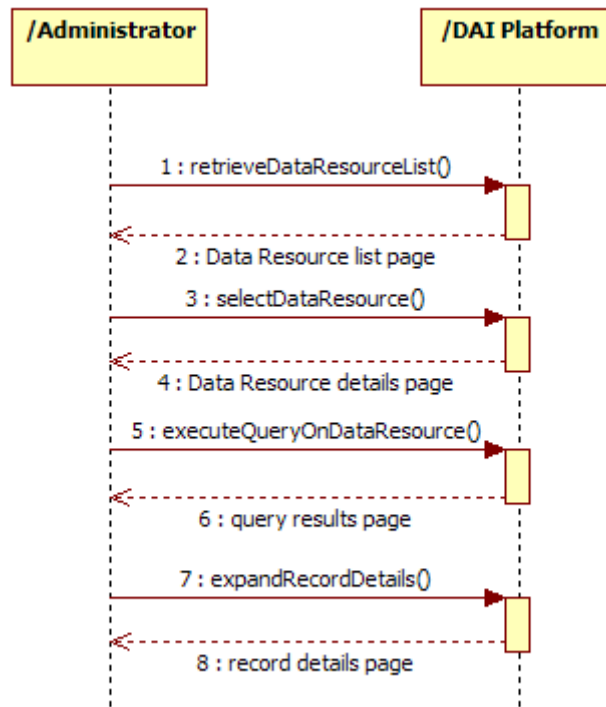


Figure 9. Query Data Resource Sequence Diagram

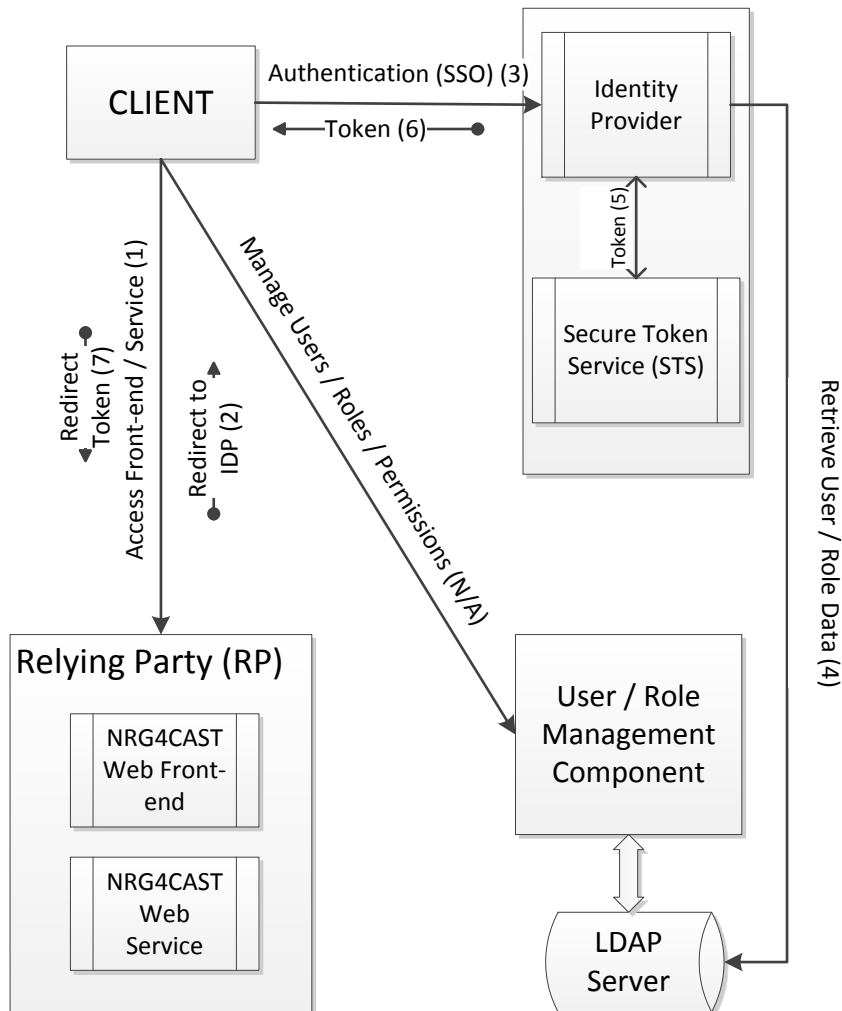
## 2.2 User / Role Management

**Table 2. User / Role Management Component Overview**

<b>Component Name</b>	User / Role Management Component
<b>Identifier</b>	C-2
<b>Description</b>	<p>This component is responsible for the management of users and roles as well as for the enforcement of the access control policy according to a Role-based access control approach (RBAC). In the context of the NRG4CAST project this is a very important requirement due to the proprietary nature of the data. Further, the loosely coupled architecture of the NRG4CAST toolkit poses significant technical challenges, i.e. (1) how to effectively and flexibly integrate the software components of the toolkit and the services they provide with the authorization mechanism, (2) how to develop a single-sign-on mechanism (SSO) [2][3].</p> <p>In order to meet this challenges we propose the adoption of the WS-Federation paradigm (Passive Requestor Profile) and specifically the implementation Apache CXF Fediz [3] enhanced with User / Role management software component which utilizes an LDAP server to accomplish both authentication and authorization functionality. The Apache CXF Fediz implementation is compatible with both J2EE and .NET web applications and services.</p> <p>Figure 10 depicts schematically the architecture of the authentication / authorization mechanism of the NRG4CAST toolkit as well as the message flow between the client (user / service) and the NRG4CAST toolkit. The message flow can be described by the following steps:</p> <ol style="list-style-type: none"> <li>1. The client accesses the web front-end (application) or the service.</li> <li>2. If the request does not provide a token or a session cookie the client is redirected to the Identity Provider (IDP).</li> <li>3. + 4. The Identity Provider authenticates the client by accessing an LDAP server. If necessary it prompts the client to authenticate herself with a username / password.</li> <li>5. If the user is authenticated the IDP transforms the sign-in request of the client into a SOAP request for the Secure Token Service (STS). Secure Token Service responds to the IDP with a SAML 2.0 token.</li> <li>6. The IDP attaches the token to the sign-in response.</li> <li>7. The client is redirected to the application server providing the web front-end or the service which validates the SAML token. If the token is validated a session is created.</li> <li>8. The web application / service analyze the token and retrieves client, role and other claims attributes. According to those it decides to authorize or not the client.</li> </ol> <p>The management of users, clients and their roles is performed by the default Administrator user of the NRG4CAST toolkit who is hard-coded within the LDAP. In order to access the user / role management component the Administrator must be authenticated and authorized according to the previous steps. The Administrator may create new users, clients, roles and their permissions via the web front-end. The appropriate data are stored within the Directory through the LDAP server.</p>
<b>Source Code Repository</b>	To be published at: <a href="svn://83.212.107.133/svn/nrg4cast">svn://83.212.107.133/svn/nrg4cast</a>
<b>Implemented Services</b>	N/A
<b>Pending Services</b>	N/A



Services Used (Dependencies)	Fediz Identity Provider (Fediz IDP) Fediz Secure Token Service (Fediz STS)
Additional Information	None
Notes	None



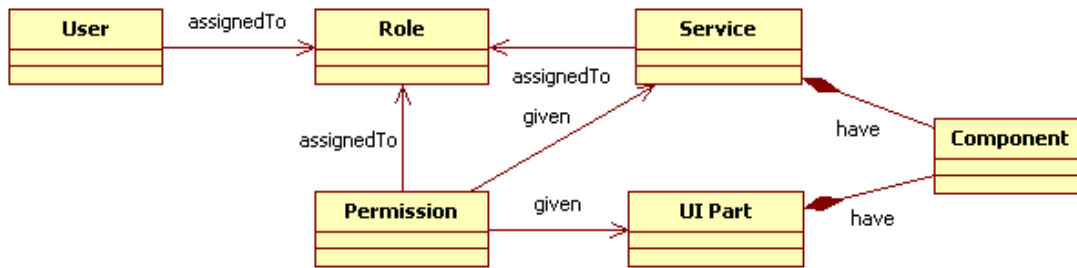
**Figure 10. NRG4CAST Authentication / Authorization Architecture**

**2.2.1 Service interfaces**

Not applicable

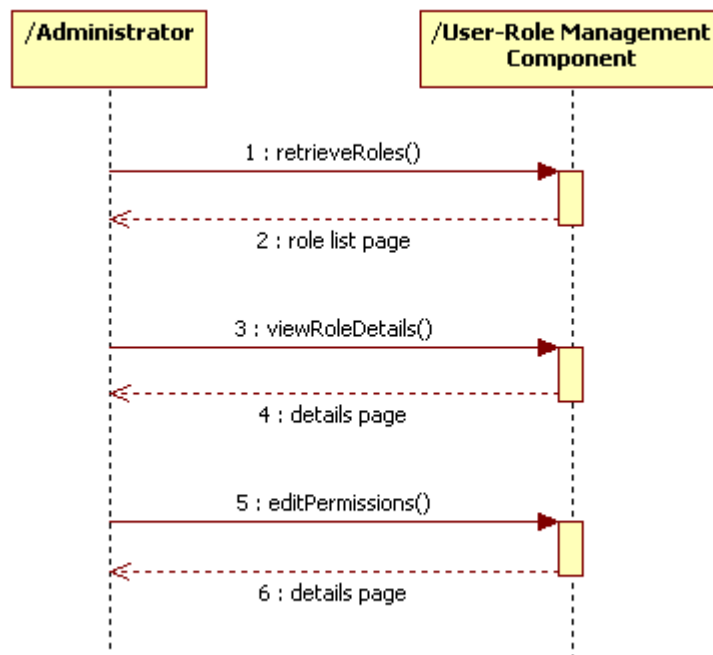
**2.2.2 User Interface**

Figure 11 depicts the abstract class diagram for Role-based Access Control within the User / Role management software component [4]. A user or a service may be assigned to a specific role. Specific permissions are assigned to a role for accessing a service (accept / deny invocation) or a UI part (view / manage / deny). A software component provides a number of services and / or User Interface parts.

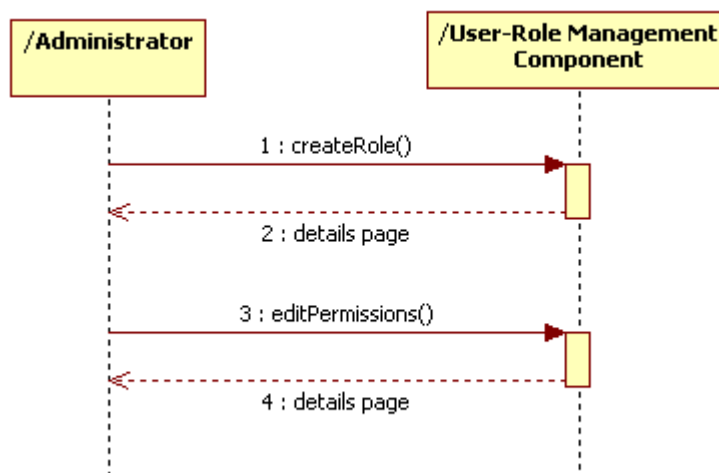


**Figure 11. Class diagram for Role-based access control**

The black-box interactions between the Administrator of the NRG4CAST toolkit and the User / Role management component are depicted through a series of sequence diagrams in Figures 12 to 19 [5].



**Figure 12. Browse / Edit Roles Sequence Diagram**



**Figure 13. Create Role Sequence Diagram**

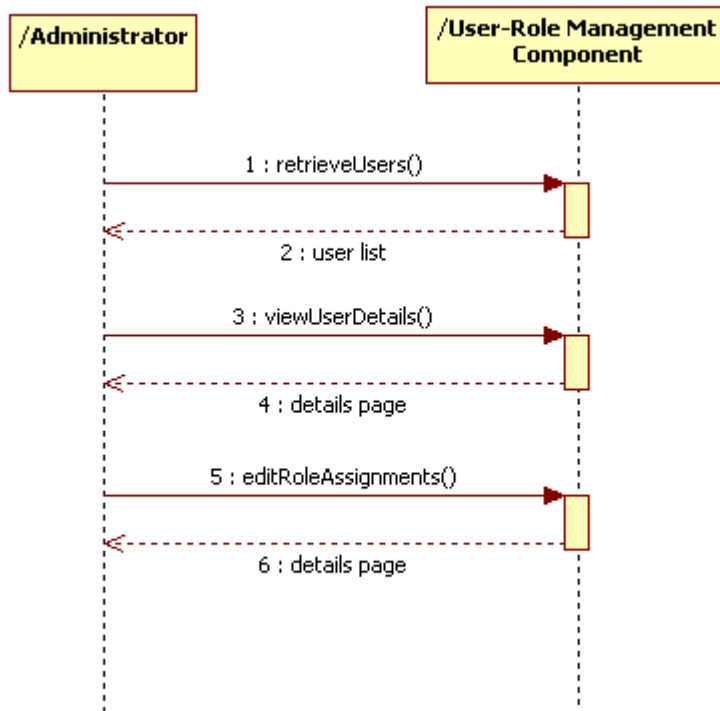


Figure 14. Browse / Edit Users Sequence Diagram

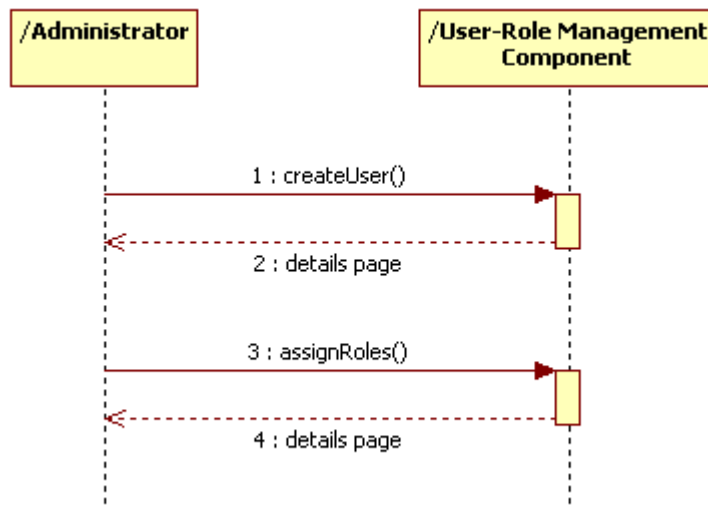


Figure 15. Create User Sequence Diagram

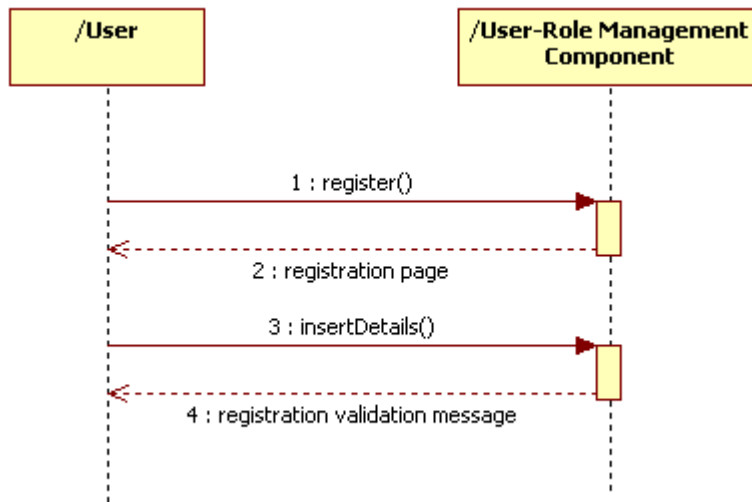


Figure 16. User Registration Sequence Diagram

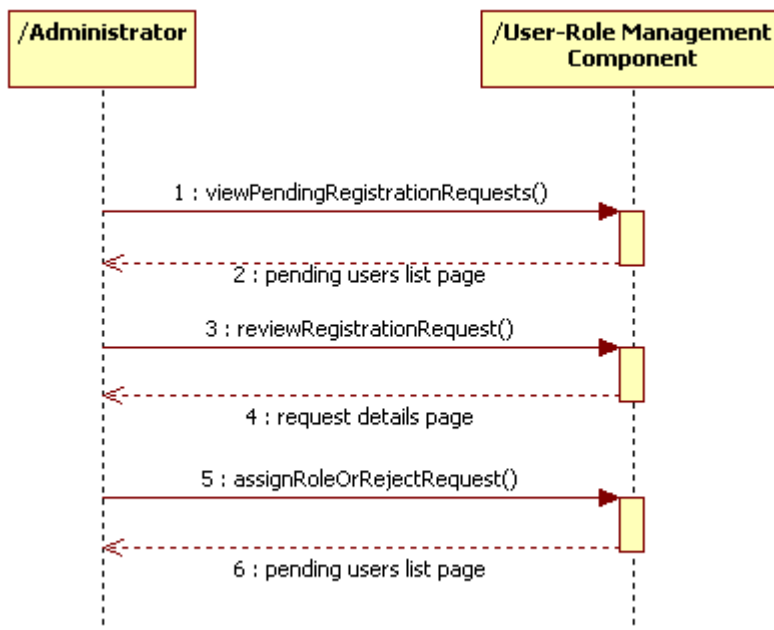


Figure 17. Registration Acceptance Sequence Diagram

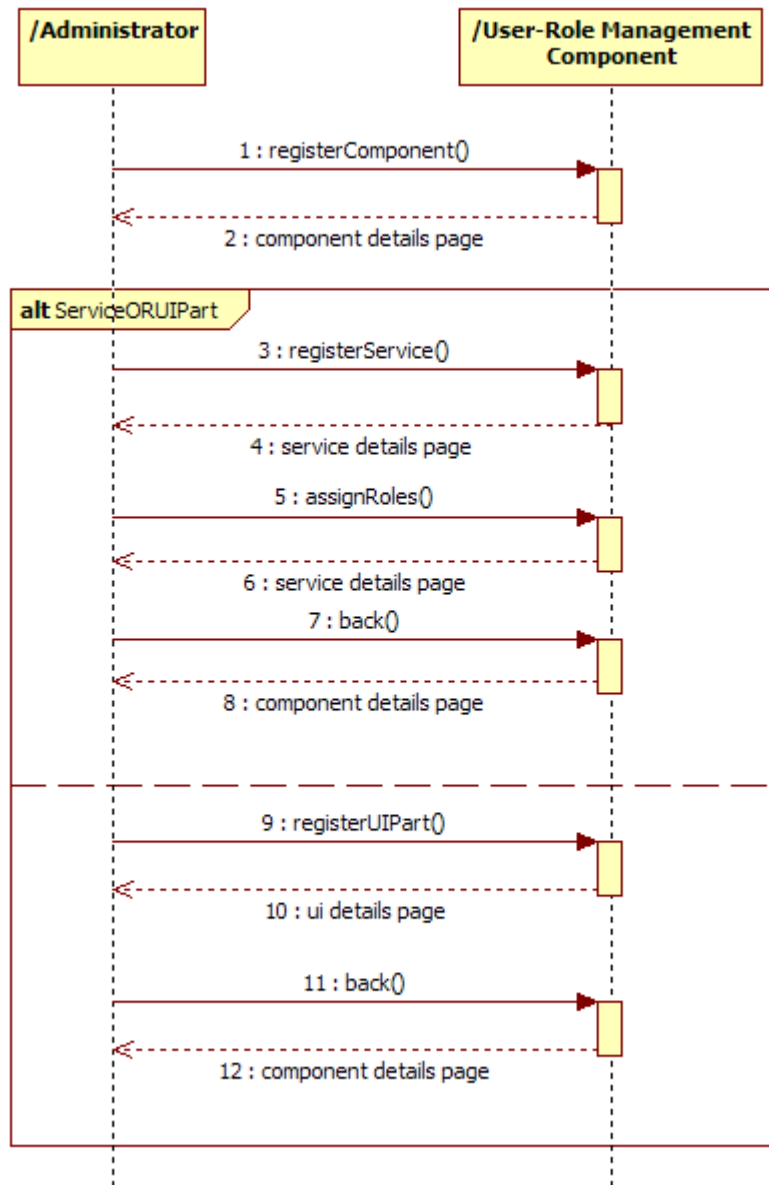
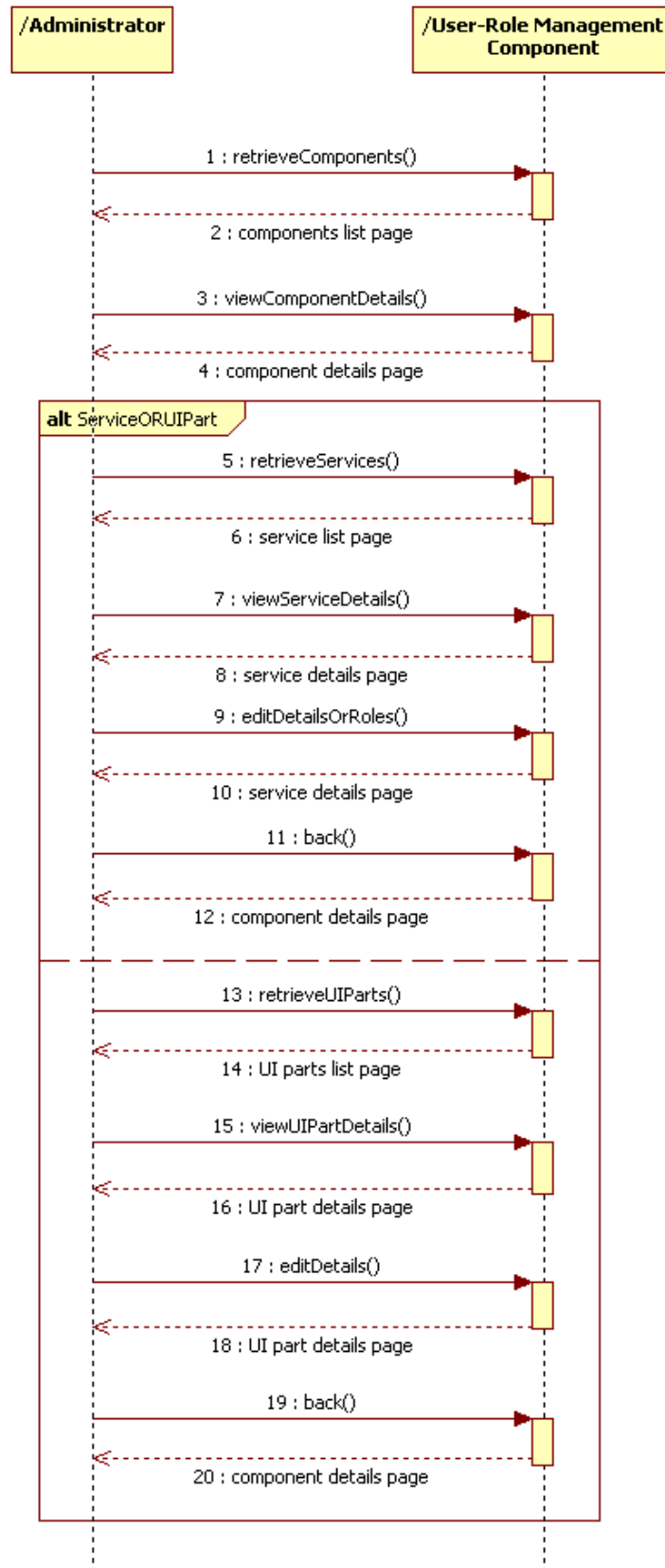


Figure 18. Register Component Sequence Diagram



**Figure 19. Browse / Edit Components Sequence Diagram**

Apart from the above user-toolkit interactions, the Administrator may also delete users, roles, UI parts, services and components if and only if the deletion will not lead to database inconsistencies. Relevant sequence diagrams are straightforward and thus omitted.

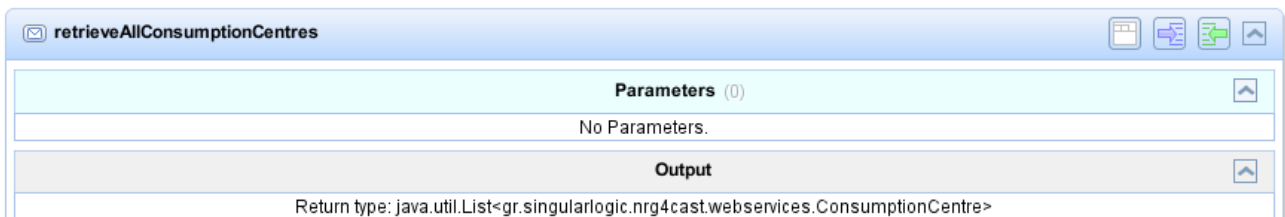
## 2.3 Sensor & Information Source Registry

**Table 3. Sensor & Information Source Registry Component Overview**

<b>Component Name</b>	Sensor & Information Source Registry
<b>Identifier</b>	C-3
<b>Description</b>	This component provides the mechanism for registering sensors and other information sources. All the information sources including the sensors are grouped into specific consumption centres and consumption points in a hierarchical fashion. Several attributes of the consumption centres and points are also registered such as geographical coordinates, name, description, etc.
<b>Source Code Repository</b>	To be published at: svn://83.212.107.133/svn/nrg4cast
<b>Implemented Services</b>	None
<b>Pending Services</b>	retrieveAllConsumptionCentres retrieveConsumptionCentresNearCoordinates retrieveConsumptionPointsOfConsumptionCentre retrieveConsumptionPointsNearCoordinates retrieveSensorsNearCoordinates retrieveSensorsOfConsumptionCentre retrieveSensorsOfConsumptionPoint retrieveInformationSources
<b>Services Used (Dependencies)</b>	registerRelationalResource (C-1) registerFileResource (C-1) getResourceIds (C-1)
<b>Additional Information</b>	None
<b>Notes</b>	None

### 2.3.1 Service Interfaces

This section presents the operations (inputs and outputs) of the services which are going to be provided by the Sensor & Information Source Registry to the other components of the NRG4CAST toolkit. The details of the input and output parameters are going to be further elaborated when the early prototype of the NRG4CAST toolkit will be prepared.



**Figure 20. retrieveAllConsumptionCentres Operation**

Figure 20 depicts the interface of an operation which retrieves the list of all the consumption centres which are registered. All the information is conveyed through the attributes of the ConsumptionCentre object (boundary coordinates, description, identifier, etc).

The screenshot shows a window titled "retrieveConsumptionPointsOfConsumptionCentre". It contains a "Parameters (1)" section with a table:

Parameter Name	Parameter Type
consumptionCentreId	long

Below the parameters is an "Output" section with the text: "Return type: java.util.List<gr.singularlogic.nrg4cast.webservices.ConsumptionPoint>"

**Figure 21. retrieveConsumptionPointsOfConsumptionCentre Operation**

Figure 21 depicts the interface of an operation which retrieves the list of all consumption points within a consumption centre. All the information is conveyed through the attributes of the ConsumptionPoint object (boundary coordinates, description, identifier, etc).

The screenshot shows a window titled "retrieveSensorsOfConsumptionPoint". It contains a "Parameters (1)" section with a table:

Parameter Name	Parameter Type
consumptionPointId	long

Below the parameters is an "Output" section with the text: "Return type: java.util.List<gr.singularlogic.nrg4cast.webservices.Sensor>"

**Figure 22. retrieveSensorsOfConsumptionPoint Operation**

Figure 22 depicts the interface of an operation which retrieves the list of the sensors which are associated with a consumption point. All the information is conveyed through the attributes of the Sensor object (coordinates, name, identifier, unit of measurement, type of measurement, etc.).

The screenshot shows a window titled "retrieveSensorsOfConsumptionCentre". It contains a "Parameters (1)" section with a table:

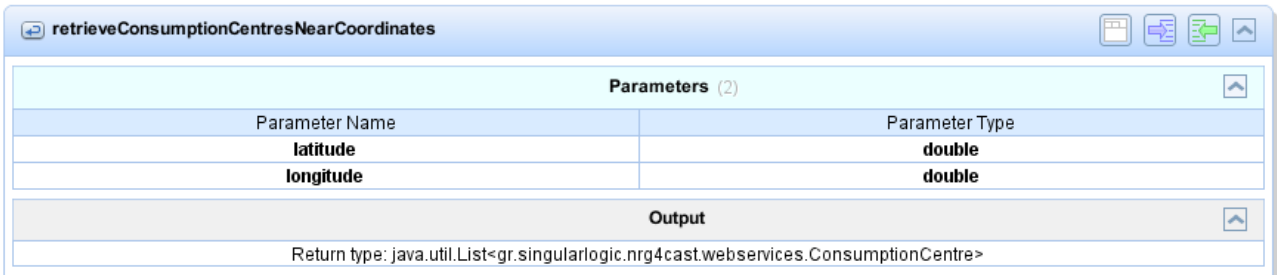
Parameter Name	Parameter Type
consumptionCentreId	long

Below the parameters is an "Output" section with the text: "Return type: java.util.List<gr.singularlogic.nrg4cast.webservices.Sensor>"

**Figure 23. retrieveSensorsOfConsumptionCentre Operation**

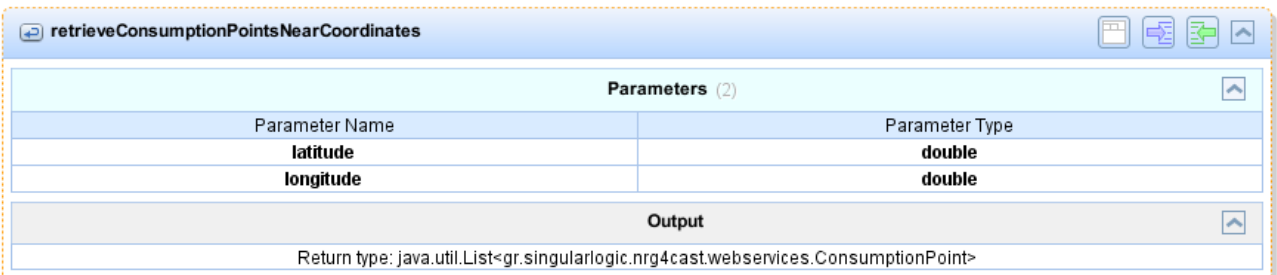
Figure 23 depicts the interface of an operation which retrieves the list of the sensors which are associated with a consumption centre.





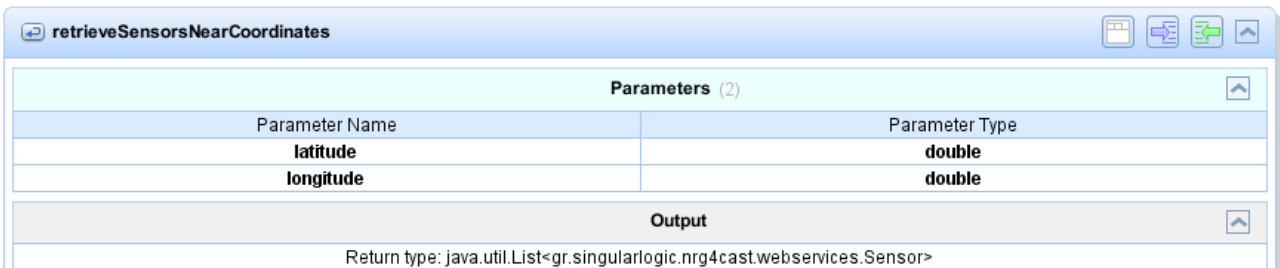
**Figure 24. retrieveConsumptionCentresNearCoordinates Operation**

Figure 24 depicts the interface of an operation which retrieves the list of the consumption centres which are near specific coordinates according to a predefined radius.



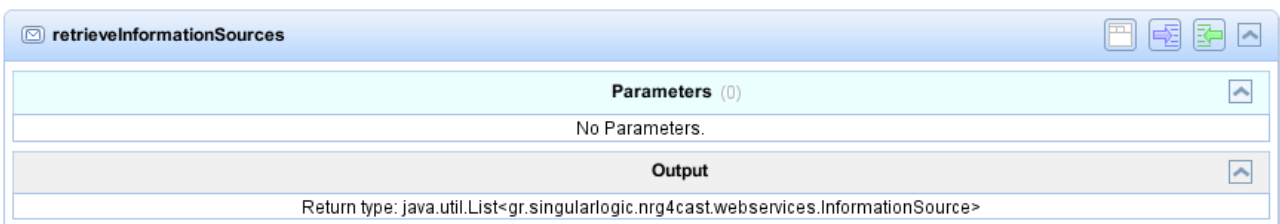
**Figure 25. retrieveConsumptionPointsNearCoordinates Operation**

Figure 25 depicts the interface of an operation which retrieves the list of the consumption points which are near specific coordinates according to a predefined radius.



**Figure 26. retrieveSensorsNearCoordinates Operation**

Figure 26 depicts the interface of an operation which retrieves the list of the sensors which are near specific coordinates according to a predefined radius.



**Figure 27. retrieveInformationSources Operation**

Figure 27 depicts the interface of an operation which retrieves the list of all information sources associated with the customer deployment of the NRG4CAST toolkit. All the information is conveyed through the attributes of the InformationSource object (name, identifier, description, etc.).

### 2.3.2 User Interface

The Sensor & Information Source Registry component provides the NRG4CAST Administrator with a user interface to register sensors and information sources. The interactions between the users and the components are depicted through the sequence diagram in Figures 28 and 29.

As shown in Figure 28, in order to register a sensor, it is first necessary to localize at least one consumption centre containing one consumption point that will be associated with the sensor. Apart from specifying geographical coordinates, the localization of consumption centres and points as well as the registration of new sensors includes the definition of relevant characteristics such as name, description, type of measurement, unit of measurement, technical specification of the sensor, etc. Further, the Administration provides necessary data resource type (e.g. Relational Database vendor) and connection details in order to register the sensor as a new data resource through the invocation of the appropriate service provided by the Data Access & Integration Platform component.

Figure 29 depicts the registration of information sources which are not related with a specific consumption centre or point but which are associated with the specific customer (e.g. pricing data).

Apart from the presented interactions, the Administrator may also edit and delete information sources, sensors, consumption points and consumption centres. Deletions and edits will be possible only if they will not lead to database or logical inconsistencies (e.g. changing the boundaries of a consumption centre may push an associated consumption point out of bounds). Relevant sequence diagrams are straightforward and thus omitted.

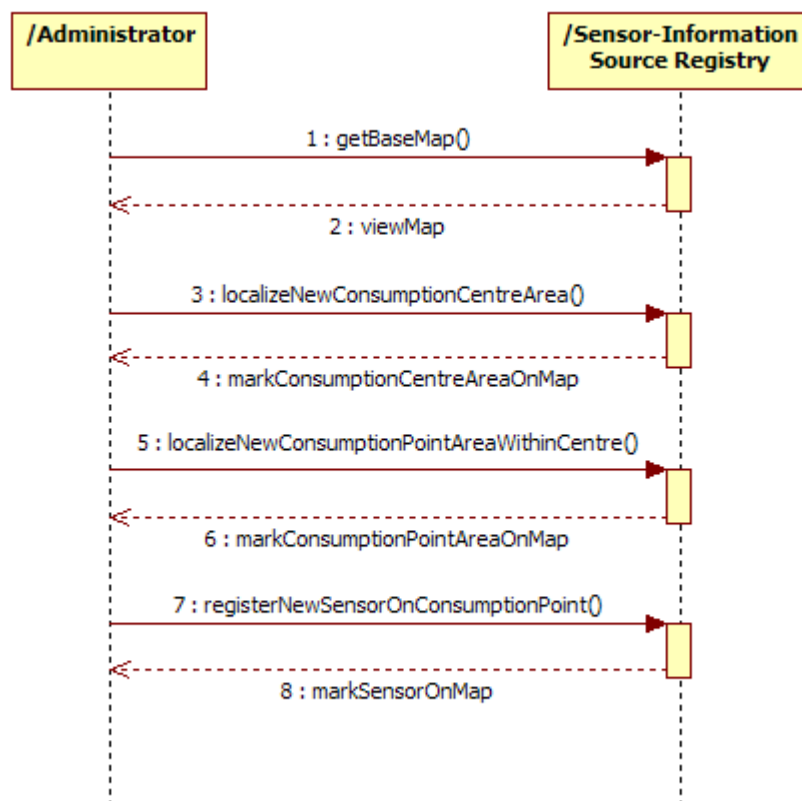


Figure 28. Register New Sensor Sequence Diagram

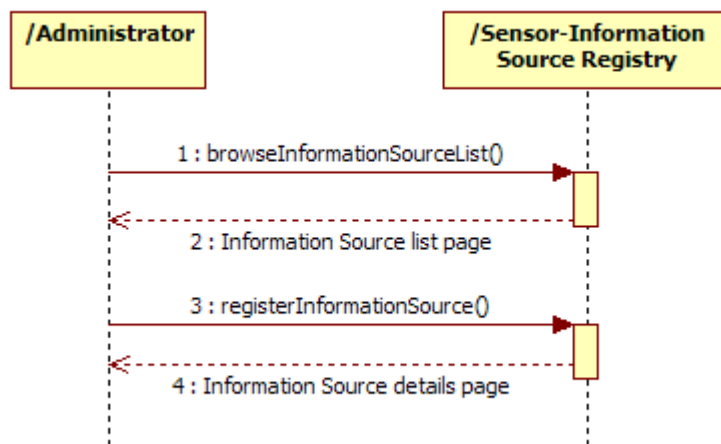


Figure 29. Register Information Source Sequence Diagram

## 2.4 Report Management / Visualization

Table 4. Report Management Component Overview

<b>Component Name</b>	Report Management / Visualization The Real-time Visualization software component
Identifier	C-4
Description	This chapter describes the <b>Report Management / Visualization</b> component of NRG4CAST toolkit. This software component provides users with a possibility to display/report information of different sensors on the energy consumption map. The information of consumption from different objects will be displayed within a user interface (map). User will be able to navigate through different topologies/ groupings of consumption centres/ points.
Source Code Repository	Not yet available
Implemented Services	Not yet available
Pending Services	N/A
Services Used (Dependencies)	This component is dependent on services provided by the Data Access & Integration Platform, User Role Management and the Sensor / Information Source Registry software components.
Additional Information	None
Notes	None

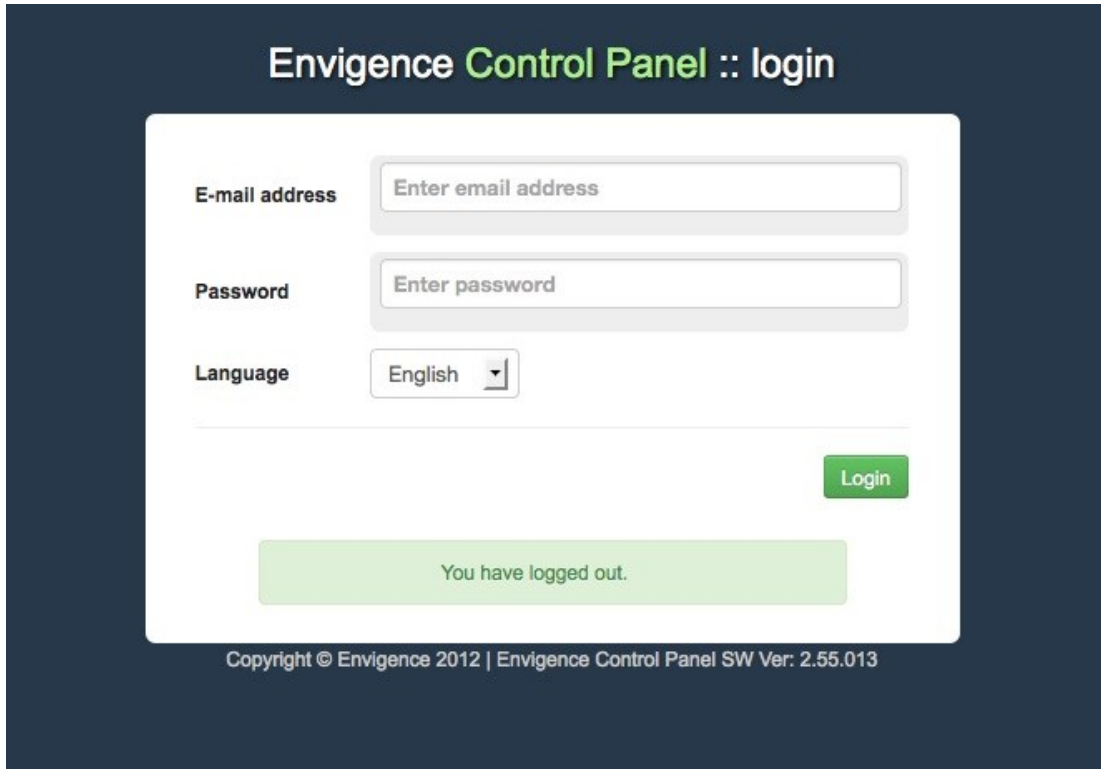
The Report Management / Visualization Interface will generate reports about different information and events from the sensor network logs, tasks, notifications, consumption and power usage.

### 2.4.1 Service Interfaces

Not Applicable

### 2.4.2 User Interface

The User will be able to choose what information will appear on the report (depending on type of user and available data). Each type of user will have different reporting options.



**Figure 30. Sample user interface LOGIN screen**

We will define 5 types of users

#### Test user (Level 4)

A user who has a time-limited access and just sees the basic functionality.

#### Viewer user (Level 3)

A user who has access to the system, but no option to change the settings. Viewer can see the basic reports from the system such as:

- report on the operation of the end point consumer (consumption, working hours, defects);
- report on the operation of the consumption points (consumption, working hours, defects);
- report on the all consumption in municipality (consumption, working hours, defects);
- report on the current settings of end point objects;
- report on forecasts (consumption, working hours).

#### Operator user (Level 2)

A user who has access to the system, has the option to change the setting (of the sensor/actuator, adding / removing sensor/actuator, adding / removing outlets. User has a possibility to make changes (replacement equipment). All changes will be recorded in a log file.

The reports available for this type of user are:

- report on the operation of the end point consumer (consumption, working hours, defects) on hourly basis;
- report on the operation of the consumption points (consumption, working hours, defects) on hourly basis;
- report on the all consumption in municipality (consumption, working hours, defects) on hourly basis;
- report on the current settings of end point objects;
- report on forecasts (consumption, working hours);
- report on the operation of the system;
- maintenance report.

**Administrator (Level 1)**

A user who has access to the system, has the potential to change the setting of complete system (adding / removing objects, adding / removing outlets, adding / stripping municipalities. User can make changes (replacement equipment).

**Developer/Super administrator (Level 0)**

A user who has administrative access to the system.

All interactions will be recorded in a log file.

ACTIVE LOG FILES							
Event	Severity	Device ID	Date	Device IP	User IP	SCID	Description
Device registration	Informational	0010.0001.0003	2013-05-14 10:17:23	10.11.4.121	10.11.4.121	8938670010012838067	Device registered ok
Device registration	Informational	0010.0001.0001	2013-05-14 10:00:12	10.11.4.228	10.11.4.228	8938670010012838042	Device registered ok
Device registration	Informational	0006.0014.0506	2013-05-13 20:41:45	10.11.4.3	10.11.4.3	8938670020006232730	Device registered ok
Device registration	Informational	0006.0014.0505	2013-05-13 20:41:45	10.11.4.16	10.11.4.16	8938670010012838109	Device registered ok
Device registration	Informational	0006.0014.0507	2013-05-13 20:41:44	10.11.4.145	10.11.4.145	8938670010012838117	Device registered ok
Device registration	Informational	0006.0014.0504	2013-05-13 20:41:41	10.11.4.51	10.11.4.51	8938670010012838471	Device registered ok
Device registration	Informational	0006.0014.0508	2013-05-13 20:41:41	10.11.4.130	10.11.4.130	8938670010012838455	Device registered ok
Device registration	Informational	0006.0012.0404	2013-05-13 20:35:06	10.11.4.134	10.11.4.134	8938670020006244933	Device registered ok
Device registration	Informational	0010.0001.0001	2013-05-13 10:54:50	10.11.4.156	10.11.4.156	8938670010012838042	Device registered ok
Device registration	Informational	0006.0012.0404	2013-05-13 05:44:16	10.11.4.238	10.11.4.238	8938670020006244933	Device registered ok
Device registration	Informational	0006.0014.0508	2013-05-12 20:20:20	10.11.4.79	10.11.4.79	8938670010012838455	Device registered ok
Device registration	Informational	0006.0014.0506	2013-05-12 20:20:20	10.11.4.75	10.11.4.75	8938670020006232730	Device registered ok
Device registration	Informational	0006.0014.0507	2013-05-12 20:20:18	10.11.4.147	10.11.4.147	8938670010012838117	Device registered ok
Device registration	Informational	0006.0014.0504	2013-05-12 20:20:17	10.11.4.97	10.11.4.97	8938670010012838471	Device registered ok
Device registration	Informational	0006.0014.0505	2013-05-12 20:20:16	10.11.4.132	10.11.4.132	8938670010012838109	Device registered ok
Device registration	Informational	0006.0012.0404	2013-05-12 20:16:42	10.11.4.131	10.11.4.131	8938670020006244933	Device registered ok
Device registration	Informational	0006.0014.0507	2013-05-11 20:29:33	10.11.4.135	10.11.4.135	8938670010012838117	Device registered ok
Device registration	Informational	0006.0014.0505	2013-05-11 20:29:15	10.11.4.116	10.11.4.116	8938670010012838109	Device registered ok
Device registration	Informational	0006.0014.0508	2013-05-11 20:29:06	10.11.4.126	10.11.4.126	8938670010012838455	Device registered ok
Device registration	Informational	0006.0014.0506	2013-05-11 20:29:05	10.11.4.140	10.11.4.140	8938670020006232730	Device registered ok

Figure 31. Sample of the active log files

WARNING LOG FILES							
Event	Severity	Device ID	Date	Device IP	User IP	SCID	Description
Device dimm	Warning	0008.0002.0003	2013-04-18 08:29:19	10.11.4.237	89.212.198.38	8938670010012838463	Connection to device failed
Device dimm	Warning	0008.0002.0003	2013-04-18 08:28:24	10.11.4.237	89.212.198.38	8938670010012838463	Connection to device failed
Device dimm	Warning	0008.0002.0003	2013-04-18 08:28:09	10.11.4.237	89.212.198.38	8938670010012838463	Connection to device failed
Device dimm	Warning	0008.0002.0003	2013-04-18 08:27:54	10.11.4.237	89.212.198.38	8938670010012838463	Connection to device failed
Device dimm	Warning	0008.0002.0003	2013-04-18 08:26:30	10.11.4.237	89.212.198.38	8938670010012838463	Connection to device failed
Device dimm	Warning	0008.0002.0003	2013-04-18 08:25:08	10.11.4.237	89.212.198.38	8938670010012838463	Connection to device failed
Device dimm check	Warning	0010.0001.0005	2013-04-16 10:46:16	212.235.226.26	212.235.226.26	8938670010012838026	Cannot connect to device
Device dimm check	Warning	0010.0001.0005	2013-04-16 10:42:15	212.235.226.26	212.235.226.26	8938670010012838026	Cannot connect to device
Device dimm check	Warning	0010.0001.0003	2013-04-15 23:35:33	89.212.68.22	89.212.68.22	8938670010012838067	Cannot connect to device
Device dimm	Warning	0008.0001.0002	2013-04-10 12:41:30	10.11.4.88	188.196.31.240	893867001001283805998002	Connection to device failed
Device dimm	Warning	0008.0001.0002	2013-04-10 12:38:33	10.11.4.88	188.196.31.240	893867001001283805998002	Connection to device failed
Device dimm	Warning	0008.0001.0002	2013-04-10 12:38:25	10.11.4.88	188.196.31.240	893867001001283805998002	Connection to device failed
Device dimm	Warning	0008.0001.0002	2013-04-10 12:38:18	10.11.4.88	188.196.31.240	893867001001283805998002	Connection to device failed
Device dimm	Warning	0010.0001.0005	2013-03-27 15:32:46	10.11.4.77	176.76.38.105	8938670010012838026	Connection to device failed
Device dimm	Warning	0010.0001.0005	2013-03-27 15:32:25	10.11.4.77	176.76.38.105	8938670010012838026	Connection to device failed
Device dimm	Warning	0010.0001.0005	2013-03-27 15:32:02	10.11.4.77	176.76.38.105	8938670010012838026	Connection to device failed
Device dimm	Warning	0010.0001.0005	2013-03-27 15:30:49	10.11.4.77	176.76.38.105	8938670010012838026	Connection to device failed
Device dimm	Warning	0010.0001.0005	2013-03-27 14:10:57	10.11.4.132	176.76.38.105	8938670010012838026	Connection to device failed
Device dimm	Warning	0010.0001.0005	2013-03-26 15:21:24	10.11.4.130	176.76.52.165	8938670010012838026	Connection to device failed
Device dimm	Warning	0008.0001.0002	2013-03-22 15:35:08	10.11.4.79	188.230.247.183	893867001001283805998002	Connection to device failed
Device dimm	Warning	0008.0001.0002	2013-03-22 15:35:02	10.11.4.79	188.230.247.183	893867001001283805998002	Connection to device failed
Device dimm	Warning	0008.0001.0002	2013-03-22 15:34:49	10.11.4.79	188.230.247.183	893867001001283805998002	Connection to device failed

Figure 32. Sample of different types of log files

The user will have the option to filter the log files. Filter could be deviceID, Event or description.

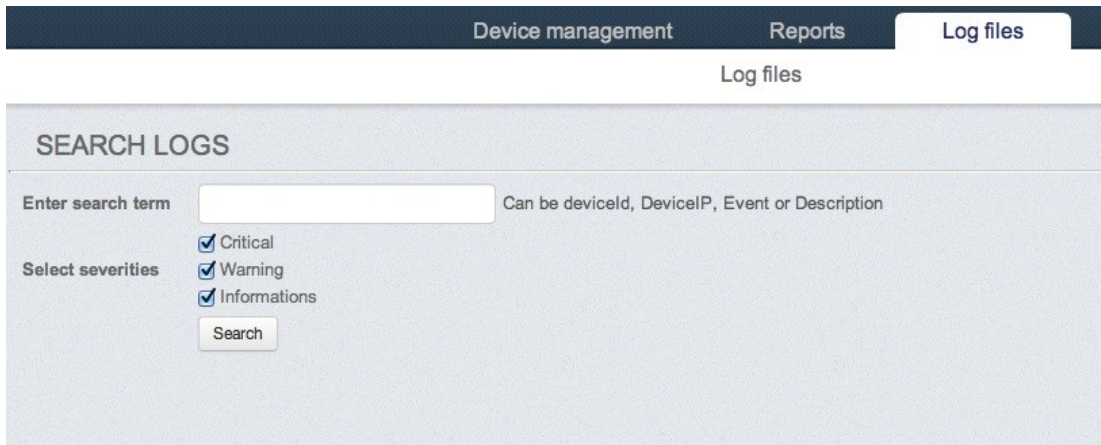


Figure 33. Sample of search engine

User will choose from the Report tab which report will be shown on the screen for a specific time period. To reduce the impact of reporting on the system performance, we will use filters to limit the scope of the report.

Sections/logs/measurements that are completed between certain dates will be reported: Completion time between: to\_date('2011.11.01.00:00:00','yyyy.mm.dd.hh24:mi:ss') and to\_date('2011.11.30.23:59:59','yyyy.mm.dd.hh24:mi:ss').

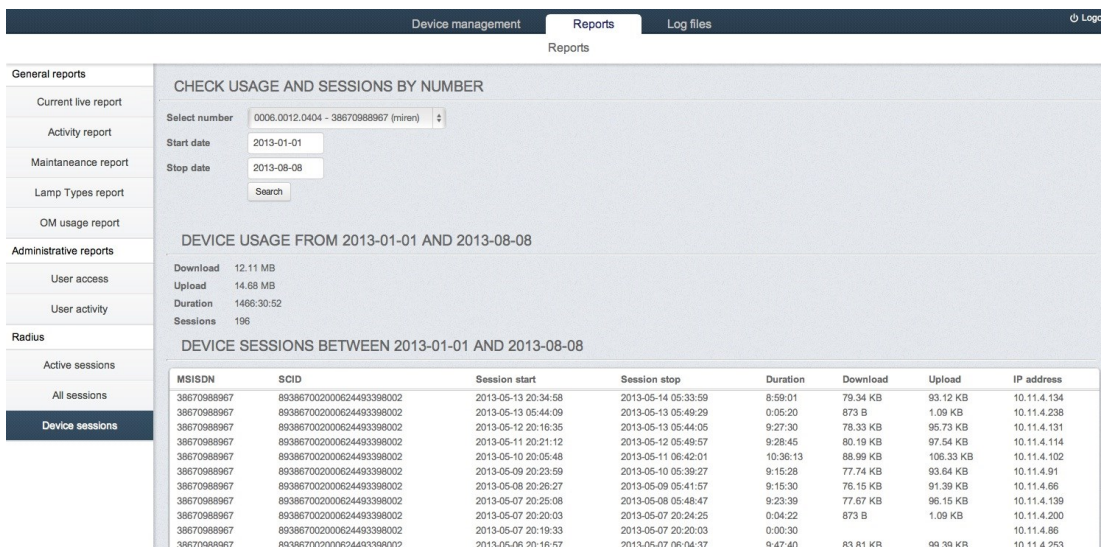


Figure 34. Sample of searching the section report

ACTIVITY REPORT FOR LAST 24 HOURS						
Device ID	Status	Online time	Sessions	Data transferred	Last registration	Last update
<b>Miren-Kostanjevica - SI-Miren-Kostanjevica</b>						
1	0006.0014.0504	Error - No sessions	0:00:00	0	14.05.2013 05:23:27	13.05.2013 20:41:41
2	0006.0012.0404	Error - No sessions	0:00:00	0	14.05.2013 05:28:49	13.05.2013 20:35:06
3	0006.0014.0506	Error - No sessions	0:00:00	0	14.05.2013 05:27:07	13.05.2013 20:41:45
4	0006.0014.0508	Error - No sessions	0:00:00	0	14.05.2013 05:26:48	13.05.2013 20:41:41
5	0006.0014.0507	Error - No sessions	0:00:00	0	14.05.2013 05:23:37	13.05.2013 20:41:44
6	0006.0014.0505	Error - No sessions	0:00:00	0	14.05.2013 05:23:15	13.05.2013 20:41:45
<b>Ljubljanski grad - SI-SmartCity presentation</b>						
1	0007.0001.0004	Error - No sessions	0:00:00	0	27.09.2012 09:03:58	21.09.2012 00:27:47
2	0007.0002.0006	Error - No sessions	0:00:00	0	27.09.2012 09:03:58	20.09.2012 22:25:10
3	0007.0002.0007	Error - No sessions	0:00:00	0	27.09.2012 09:03:58	20.09.2012 22:41:55
4	0007.0002.0008	Error - No sessions	0:00:00	0	09.11.2012 08:34:58	09.11.2012 08:34:55
5	0007.0002.0009	Error - No sessions	0:00:00	0	27.09.2012 09:03:58	20.09.2012 22:47:22
6	0007.0002.0010	Error - No sessions	0:00:00	0	27.09.2012 09:03:58	20.09.2012 21:11:18
7	0007.0003.0011	Error - No sessions	0:00:00	0	14.12.2012 14:57:58	14.12.2012 14:54:00
<b>Envigence office - SI-Envigence test</b>						
1	0008.0003.0001	Error - No sessions	0:00:00	0	14.05.2013 19:40:29	22.04.2013 07:15:18
2	0008.0002.0003	Error - No sessions	0:00:00	0	18.04.2013 19:00:11	18.04.2013 15:46:00
3	0008.0001.0002	Error - No sessions	0:00:00	0	12.03.2013 12:52:17	10.12.2012 13:26:49
<b>Hella Saturnus - SI-Hella test</b>						
1	0009.0001.0001	Error - No sessions	0:00:00	0	13.02.2013 13:29:43	19.09.2012 02:58:42
2	0009.0001.0002	Error - No sessions	0:00:00	0	13.02.2013 13:29:44	18.10.2012 11:30:27

Figure 35. Sample of activity report for last 24 hours

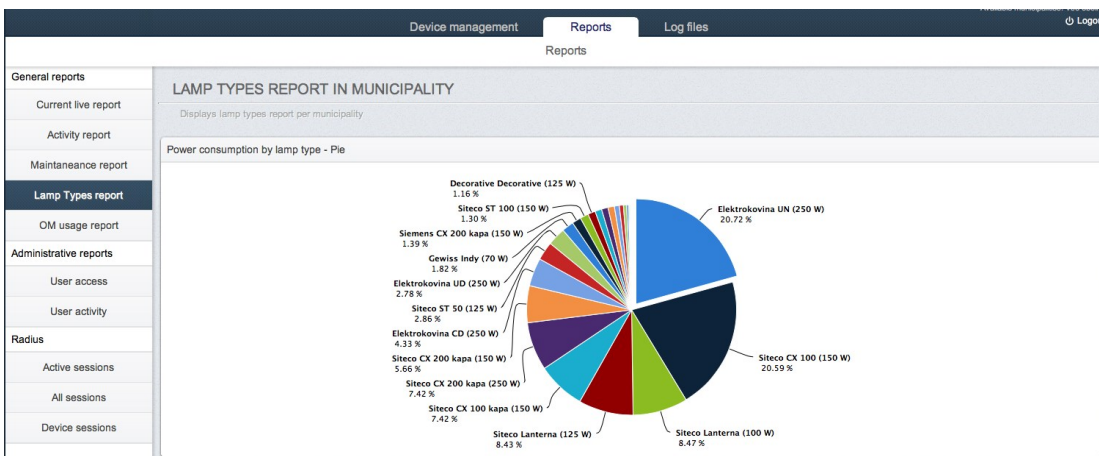


Figure 36. Sample of the report of types of objects

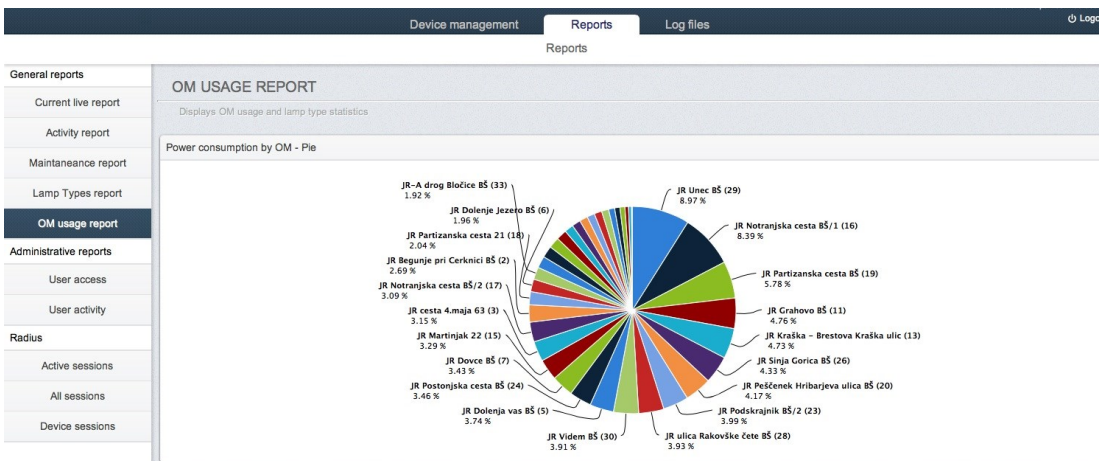


Figure 37. Sample of the report of power consumption

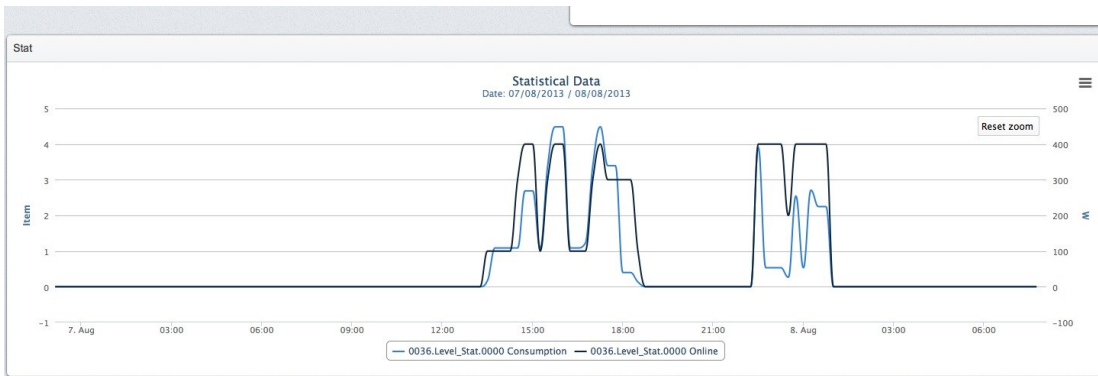


Figure 38. Sample of the report of consumption and number of connected devices for last 7 days

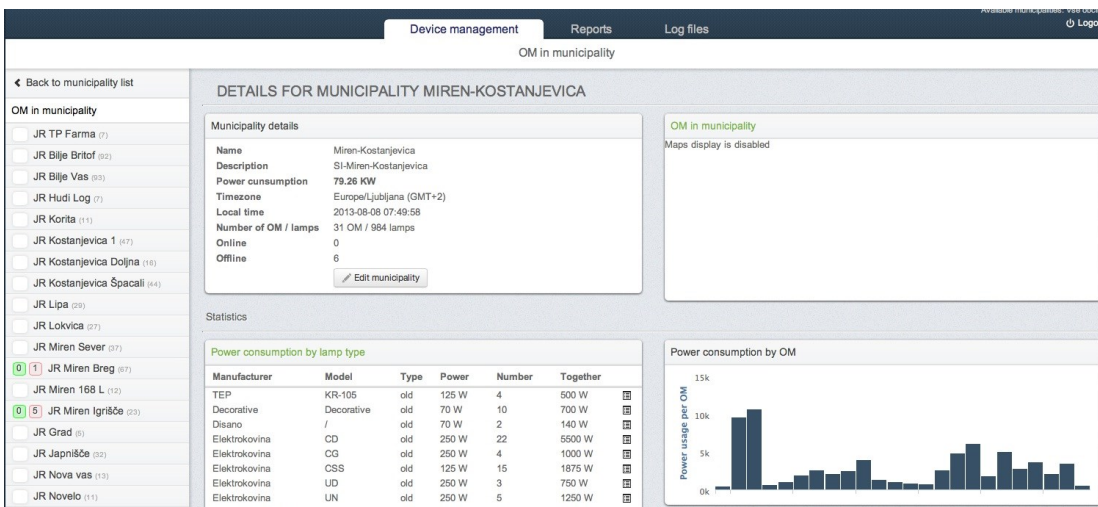


Figure 39. Sample of the report of all devices

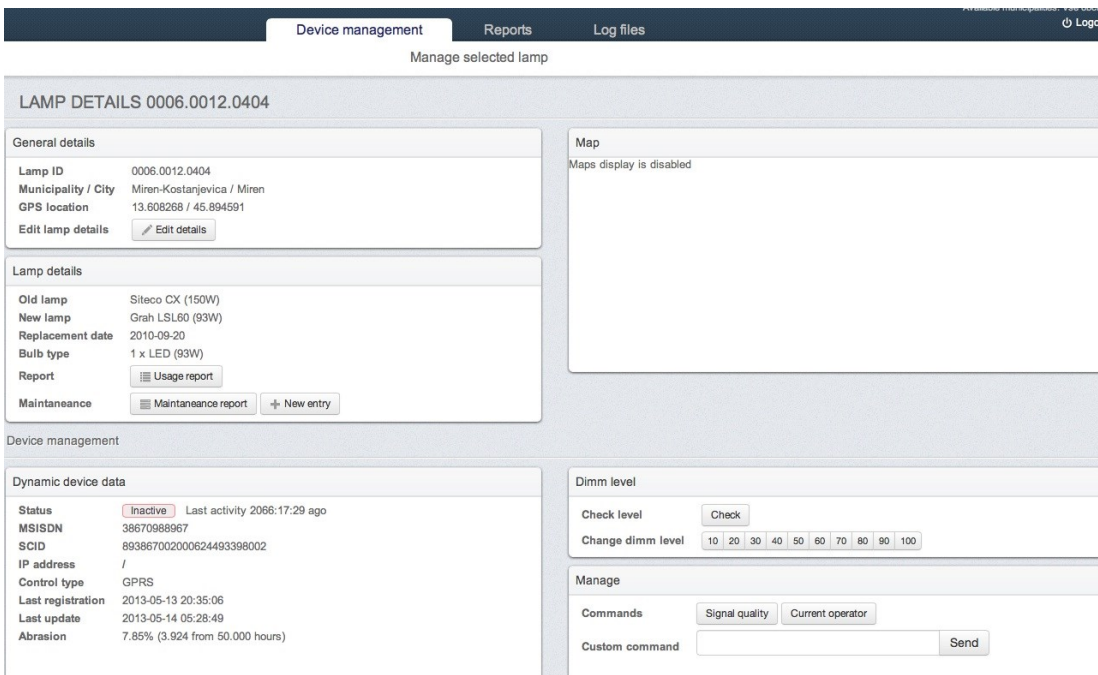


Figure 40. Sample of the report of object details



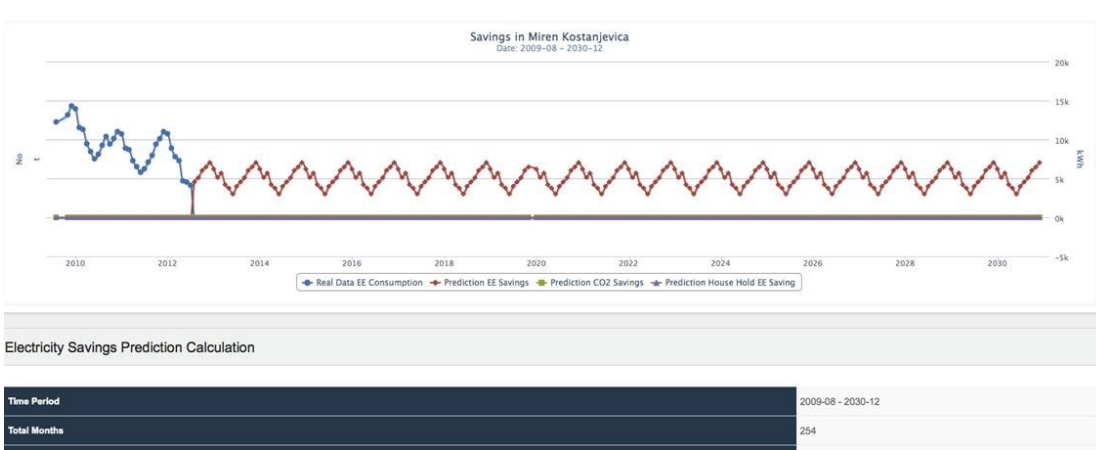


Figure 41. Sample of the report of savings

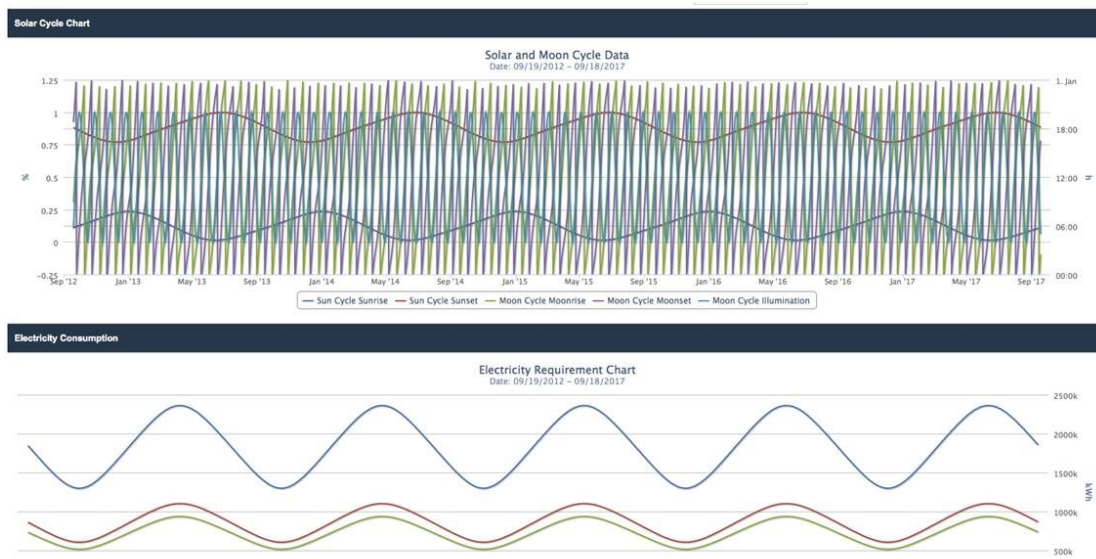


Figure 42. Sample of the report of dependency of moon cycle

## 2.5 Event Processor

The following description of the Event Processing component is based on the currently available information and is therefore on a higher conceptual level. The core of the component is based on data driven methods, and will be defined in more detail during the implementation phase, which starts in year 2.

**Table 5. Event Processor Component Overview**

<b>Component Name</b>	Event Processor
Identifier	C-5
Description	This component provides event detection capabilities to the platform. It will be able to process complex event definitions and evaluate them on the streaming data. Rules will be based on the current measurements and several aggregates of the measurements. Component will be able to send an alarm trigger to the web-service endpoint.
Source Code Repository	Not yet available
Implemented Services	Not available.
Pending Services	<ul style="list-style-type: none"> <li>• registerAlarmRule</li> <li>• deleteAlarmRule</li> <li>• registerEndPoint</li> </ul>
Services Used (Dependencies)	OGSA-DAI Platform Services (see D1.3)
Additional Information	None
Notes	None

### 2.5.1 Service Interfaces

This section describes planned API to be used for event detection/alerting services. Developed API is planned to be REST-like and based on HTTP protocol. The output formats will be defined in detail once the early prototype for event detection/alerting is prepared. For the same reason also input parameters of the API functions can be adjusted.

The API comprises of the following functions:

**Table 6. Event / Alert Processor Service Interfaces**

Function	Parameters	Output
<i>registerAlarmRule</i>	<ul style="list-style-type: none"> <li>• <b>name</b> = unique rule identifier (name)</li> <li>• <b>rule</b> = rule encoded in the rule language</li> </ul>	Returns ID of the rule. We expect to use JSON encoded rules. Also used for updating the rule.
<i>deleteAlarmRule</i>	<ul style="list-style-type: none"> <li>• <b>name</b> = unique rule identifier (name)</li> </ul>	Deletes/deactivates rule in the rule data table.
<i>registerEndpoint</i>	<ul style="list-style-type: none"> <li>• <b>resource</b> = endpoint web-service URL</li> </ul>	Subscribes an endpoint web service to receive alarms to the Alarm Component. This web-service retrieves

triggered alarm information.

### 2.5.2 User Interface

User interface allows user to define the rules and register them into the Event Detection System (Alarm Component). It allows simple manipulation of the rules (activation, deactivation). Registered endpoints receive notifications about the triggered alarms.

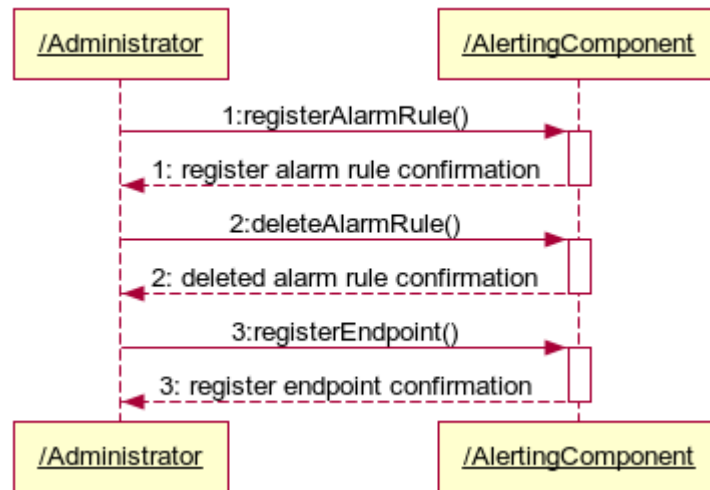


Figure 43: Event/Alarm Processor sequence diagram.

## 2.6 Prediction Manager

The description of the Prediction Manager component is based on currently available information and is on a higher conceptual level, which defines the final functionalities, but does not provide details on the core structure, since it is based on data driven methods, and will be defined in more detail during the implementation phase, which starts in year 2.

Table 7. Prediction Manager Component Overview

<b>Component Name</b>	Prediction Manager
Identifier	C-6
Description	This component provides prediction capabilities for different objects, instances and dimensions. It will be able to make prediction for a particular dimension of the system or for a higher aggregated instance/dimension. Prediction will be based on different data mining models as it should be able to predict consumption and similar continuous physical quantities. The service will also provide trend prediction.
Source Code Repository	Not yet available
Implemented Services	Not yet available

Pending Services	<ul style="list-style-type: none"> <li>• <code>getPredictionObjects</code></li> <li>• <code>getPredictionInstances</code></li> <li>• <code>getPredictionDimensions</code></li> <li>• <code>getStatus</code></li> <li>• <code>getPrediction</code></li> <li>• <code>getTrend</code></li> </ul>
Services Used (Dependencies)	OGSA-DAI Platform Services (see D1.3)
Additional Information	None
Notes	None

### 2.6.1 Service Interfaces

This section describes planned API to be used for prediction services. Developed API is planned to be REST-like and based on the HTTP protocol. The output formats will be defined in detail once the early prototype for prediction is prepared, due to uncertainty of which information is required for learning prediction models and which prediction scenarios are possible. For the same reason also input parameters of the API functions can be adjusted.

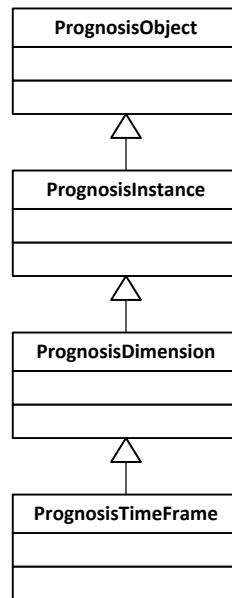
The API comprises of the following functions:

**Table 8. Prediction Manager Service Interfaces**

Function	Parameters	Output
<i>getPredictionObjects</i>	no parameters	Returns a list of all the objects, for which prediction is possible.
<i>getPredictionInstances</i>	<ul style="list-style-type: none"> <li>• <b>id</b> = ID of the object</li> </ul>	Returns a list of all the instances for the specified object, for which prediction is possible.
<i>getPredictionDimensions</i>	<ul style="list-style-type: none"> <li>• <b>id</b> = ID of the instance</li> </ul>	Returns a list of all the dimensions for the specified instance, for which prediction is possible.
<i>getStatus</i>	<ul style="list-style-type: none"> <li>• <b>id</b> = ID of the dimension</li> </ul>	Current state of the dimension, for the purpose of computing features for machine learning. We expect the status to contain at minimum the statistics of measurements for several time windows.
<i>getPrediction</i>	<ul style="list-style-type: none"> <li>• <b>id</b> = ID of the dimension</li> <li>• <b>wnd</b> = prediction time window</li> </ul>	Returns prediction of a given parameter (dimension) for the given time window. Parameter and time window need to be specified in the configuration file.
<i>getTrend</i>	<ul style="list-style-type: none"> <li>• <b>id</b> = ID of dimension</li> <li>• <b>wnd</b> = trend time window</li> </ul>	Returns current trend of a given dimension (parameter) based on the history from given time window. The parameter and time window need to be specified in the configuration file. The trend is defined by direction (increasing, stagnating, decreasing) and the corresponding derivate (e.g. increase in per day/week/month).

### 2.6.2 User Interface

Figure 44 depicts the hierarchy of a prognosis. A user specifies the forecast type by first selecting the type of prognosis object, and by afterwards selecting a specific instance of the object, defining the dimension of prognosis and finally limiting the time frame. Examples can be found in Table 9.



**Figure 44: Hierarchy of Objects**

**Table 9: Examples of Object instances**

	Example 1	Example 2
<b>PrognosisObject</b>	Vehicle	Building
<b>PrognosisInstance</b>	eCar1, eCar2, eBike1	Building1, Building2
<b>PrognosisDimension</b>	Range, destinations, electricity consumption	Electricity consumption, gas consumption
<b>PrognosisTimeFrame</b>	Today, tomorrow, 7 days, specific frame	Today, tomorrow, 7 days, specific frame

Figure 45 shows an example of an interaction between a user and the prediction manager. The User is logged in the system and requests a prognosis object, the prediction manager provides the variety of objects which could be provided. In several iterations the variety of objects, instances, dimensions and time frame (compare Table 9) is provided by the prediction manager and selected by the user. After these selections the specified prediction is calculated and provided.

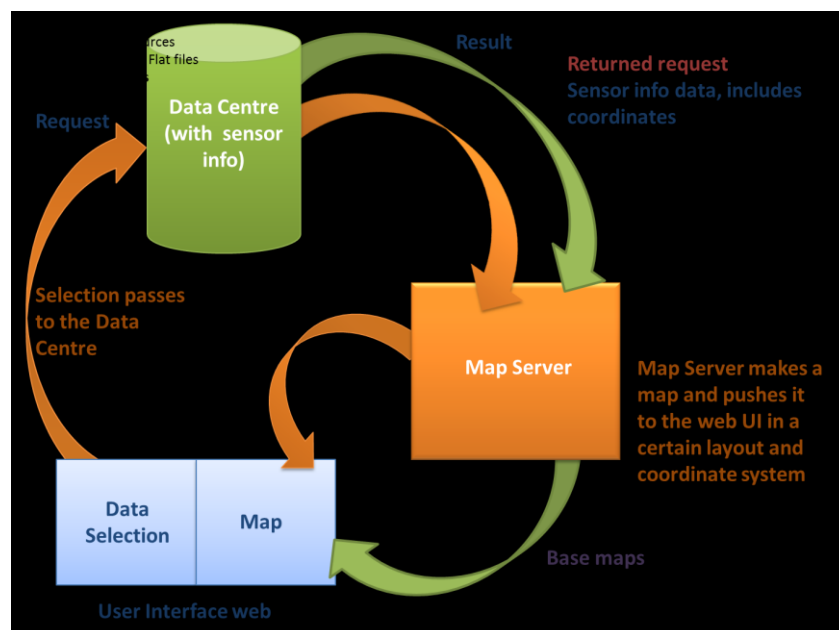


**Figure 45: Overview of the user interaction with the Prediction Manager for requesting a specific prognosis**

## 2.7 Real-time Visualization

**Table 10. Real-time Visualization Component Overview**

<b>Component Name</b>	The Real-time Visualization software component
<b>Identifier</b>	C-7
<b>Description</b>	<p>This chapter describes the Real-time Visualization component of NRG4CAST toolkit. This software component provides user with a possibility to display information of different sensors on energy consumption map. The information of consumption from different consumption centres and points (sensors) will be displayed within a user interface (map).</p> <p>Another service available is navigation through consumption centres/points on the energy consumption map. User will be able to navigate through different topologies/ groupings of consumption points/ centres.</p>
<b>Source Code Repository</b>	To be published at:
<b>Implemented Services</b>	N/A
<b>Pending Services</b>	N/A
<b>Services Used (Dependencies)</b>	This component together with the Report Management/Visualization component (Chapter 2.4) is dependent on services provided by Data Access & Integration Platform User Interface, User Role Management User interface and the Sensor / Information Source
<b>Additional Information</b>	<p>The data needs to be stored preferably in WGS84, so it can be projected (the sensor location/consumption points are to be stored in lat/long).</p> <p>The sensor locations/consumption points can also be stored as a point class. Sensors are constantly added, so it is better to make the points 'on the fly' (as an alternative).</p>
<b>Notes</b>	None



**Figure 46. Real-time Visualization component**

**2.7.1 Service Interfaces**

Not Applicable

**2.7.2 User Interface**

The UI For Real-Time visualization has a base energy consumption map and some selection options. The interactions between the user and the component are specified through an abstract black box UML sequence diagram (Figure 47).



**Figure 47. UML sequence diagram for User-Real time Visualisation System interaction**



### 3 Conclusions

This deliverable has presented the conceptual architecture and specifications of the integrated NRG4CAST toolkit. In this context, the software components which form the NRG4CAST toolkit use cases as well as the relationships between them have been identified and described according to the requirements of the case studies and the corresponding use cases. The level of detail of each component specification varied according to the phase of its implementation as defined in the work plan.

The software components which have been identified and constitute the NRG4CAST toolkit are enumerated by the following list. Each component may span across multiple tiers of the early view of the NRG4CAST architecture (Deliverable 1.3).

- 1. Data Access and Integration Platform**
- 2. User & Role Management**
- 3. Sensor & Information Source Registry**
- 4. Report Management & Visualization**
- 5. Event / Alert Processor**
- 6. Prediction Manager**
- 7. Real-time Visualization**

The relationships between the software components are presented schematically in Figure 2.

The description of each component includes: (1) an overview of its functionality, implemented and pending services, source code repository, dependencies and additional information; (2) a description of the service interfaces at a higher or lower level of detail through the specification of their operations (input/output parameters and faults); and (3) a description of its user interface through UML sequence diagrams or mock-up screenshots.

The specifications of the integrated NRG4CAST toolkit will be finalized based on the feedback from the prototype development and validation in Deliverable 1.4 (Final Toolkit Architecture Specifications)

## References

- [1] Lucene Query Language, available at: [http://lucene.apache.org/core/2\\_9\\_4/queryparsersyntax.html](http://lucene.apache.org/core/2_9_4/queryparsersyntax.html) (last accessed at 30/8/2013)
- [2] K. Sohr, T. Mustafa, X. Bao, G-J. Ahn, "Enforcing Role-Based Access Control Policies in Web Services with UML and OCL", In *Computer Security Applications Conference, 2008. ACSAC 2008. Annual*, pp. 257-266. IEEE, 2008.
- [3] Apache CXF Fediz Architecture, available at <http://cxf.apache.org/fediz-architecture.html> (last accessed 3/8/2013)
- [4] M. Fowler, *UML Distilled*, Addison-Wesley, 2003.
- [5] P. Haumer, "Use Case-Based Software Development", book chapter in "Scenarios, Stories, Use Case", edited by Ian Alexander and Neil Maiden, Wiley, 2004.