D3.3 – GloNet Platform V2
Software prototype: providing advanced GloNet functionalities

Edited by
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Deliverable summary

This report describes three main enhancements that have been designed and implemented to the GloNet platform:

i. Collaboration Space functionality, providing sharing concept among members of VO and the VBE.

ii. plug-in extensions with the integration of the VBE functionality to the GloNet platform.

iii. infrastructure for invocation of external services through the integration of the iPLON sensor data extraction module to the GloNet platform.
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This deliverable presents the GloNet platform V2 software prototype containing advanced GloNet functionalities. WP 3 is conceived to be iterative. The implemented functionalities are based on the identified and described services of the previous deliverable D3.1 (GloNet Platform Design Specification).

The deliverable describes the additional concepts of the GloNet platform implemented as part of the second prototype release of the platform, which includes the collaboration space feature, VBE integration feature from WP5 to the software prototype release and mechanism to invoke external VE manufacturing services to the platform.
1 INTRODUCTION

This document describes the enhancement features to the GloNet platform V1. It contains three additional modules namely the design and implementation of the collaboration spaces, plugin extensions with the integration of the VBE functionality to the platform, and generic infrastructure for invocation of external services.

The GloNet platform is a cloud-oriented technology platform. It allows the creation and modification of scalable, extensible SaaS solutions for the collaborative development and operation of highly customised and service-enhanced products. A GloNet system is a system operated as a software-as-a service solution (SaaS) tailored towards the end users, such as participants in a collaborative project, a virtual organisation (VO) or a virtual breeding environment (VBE).

The rest of the document is structured as follows: Chapter 2 describes a number of design concepts and the implementation of collaboration spaces; in Chapter 3, we describe the plugin extension required to integrate the VBE implementation to the platform. Finally, in Chapter 4, we describe the external service plugin functionality, using the case of data extraction from the IPLON system to the GloNet platform as example.
2 COLLABORATION SPACES MODULE

2.1 Overview

Collaboration is a recursive process where two or more co-participants, groups or organisations bring their knowledge and experience together by interacting toward a common goal in the best interests of their customers and to improve their organisation's success (Martinez-Moyano, 2006) (Wagner, 2005).

A collaboration space (CS) involves interaction within a virtual space whereby users are able to interact irrespective of their geographic location, through sharing of knowledge, information, exchange of information to carry a given task. Within a CS, VOs, organisations, companies can cooperatively work as a group to construct and share knowledge in one particular working environment. In addition, using the CS, external members can be invited to join the CS to collaborate and work together.

2.2 Collaboration Spaces

In the first GloNet software platform release 1, the architecture employs a one schema per tenant approach whereby each of the tenants is mapped into separate logical unit, called schema, within a single physical database.

Multi-tenancy is the capability of a software system to serve multiple customers or tenants (which in turn comprise multiple users) from a single consolidated software system. In essence, cloud solutions have to address two potentially conflicting requirements: On one hand they need to leverage the economy of scale principle by employing a consolidated architecture that handles all customers uniformly, on the other hand customers demand that the software they use can be tailored to meet their specific requirements and match with their highly-individual business and the processes they work with. This implies that both data and customisations have to be isolated on a tenant-based level as shown in Figure 1.

![Figure 1: Tenant specific database schemas](image)

This approach has the advantage of clearly separating data from different customers. In collaborative scenarios, sharing information between different organisations is a key concept.
The GloNet platform therefore introduces a mechanism called *collaboration spaces*. From the information management point of view, a collaboration space is a shared space in the database that is accessible by an arbitrary number of tenants at the same time. All collaboration spaces are placed in some dedicated tenant, as illustrated in the following Figure 2, for instance collaboration between Tenant Ta and Tb, Tb and Tc and Ta and Tc.

![Figure 2: Sharing data with collaboration spaces](image)

To share information (e.g. data object or documents) between tenants and collaboration spaces, replicas of the object are created in each tenant and in each collaboration space. The platform implementation maintains links between all replicas of the object. The platform can be configured to automatically propagate changes between the replicas; alternatively changes can be propagated in an on-demand mode. The concept of project collaboration spaces introduces a flexible mechanism for sharing data between organisations, VBE and VOs. The infrastructure supports sharing existing data among tenants and to create dedicated shared objects. In addition, for shared data objects permissions can be set for selected operations (read permission and write permissions).

### 2.3 Collaboration Space Implementation

There are two possibilities in implementing the CS. The first option is to have all CSs’ in one tenant and the second option is to have a tenant for each CS. When there are many CSs’ with little data in each one of the CS, the best option is to have a single Tenant holding all the CS, because then there is little overhead for every one of the CS. But the downside of this, the operations performed on the CS are more expensive as additional restrictions are required on the data. On the other hand, having a single tenant for each CS is expensive in the creation but is a better design on expecting few CSs’ with lots of data in each one of them. To make the CS implementation scalable and consistent, the first option is more feasible and has been chosen for implementation. Figure 3, illustrates the collaboration space (CS) architecture.
The EIMInterface in GloNet is the main interface to communicate with the server. In order to support the CS, the EIMInterface has been enhanced to support a context mechanism. This is due to the fact that CS Tenant differs from the standard Tenant, as in the CS Tenant additional restrictions are required for instance to check the user permission access to CS Tenant. The context mechanism restricts data exposed to the user by providing access only to the data contained in his CS.

At the server side, the context mechanism uses a number of key-value pairs bound to the EIMInterface which can contain for example, a collaboration space identifier and value represents the name identifier of the collaboration space. On the client side, the EIMInterface provides context through the EIMInterface that is add context meta-information in a key-value pair structure while invoking the server EIMInterface. The business layer contains three main components, the Data-Object-DAO, SQL processing and BOs. To support data object processing transparently, each of the components have corresponding plugins. The Data-Object-DAO component processes meta-information received through the EIMInterface in using three plugins.

i. Assign-plugin, which is responsible to assign data to the collaboration space;
ii. Right-plugin provides additional extensions to the server's native access rights management.
iii. SQL-plugin uses context information (which can be provided directly by the EIMInterface or by annotations to the SQL statement to help identify which CS the data belongs to. The sync plugin helps keeping data synchronised in multiple tenants. If data is shared between some standard tenant and a CS, then the sync plugin synchronises that data.

The Business Object layer gives the user a set of business operations he can execute on the server, for instance to create an appointment. For the CS additional BO are required, for instance:

- to copy and share data between standard tenants and collaboration spaces;
- inviting users to collaboration spaces;
- management operations of the collaboration spaces themselves (CRUD).

These BOs are provided using the CS-BO plug-in.
2.4 Collaboration Space Management

2.4.1 User Management

A global user registry has been implemented so that users only have to log into an environment once instead of having to login more than once to access different services and resources. Each time a user sign-on a call to the user registry is made to ensure the user credentials allows him to access the collaboration space and other tenants, as shown in Figure 4.

![Figure 4: User Single Sign-on](image)

Four types of CS user invitation are supported:
- invitation of an existing user of the CS;
- users’ who not part of a CS and inviting them to join a new CS;
- users’ who are part of a CS and inviting them to join new CS.
- new members outside of GloNet tenant.

All the four invitations types are accomplished using email invitation whereby existing tenant users can send invitations to the new members by email. Once an invitation is received, invited users can provide their profiles, similar to regular VO members, and the information kept in the User Registry.

2.4.2 CS Management

To support CS four new CS management functionalities have been implemented:
1. Creation of CS from existing tenants.
2. Deactivating collaboration spaces. A CS can be deactivated whereby users part of VO have their credentials set to a deactivate mode. A deactivated collaboration space can be restated with users’ profiles of members screened at the activation time, with new members added or removed.
3. Deleting collaboration spaces. Once a CS is deleted, all data in the tenants are removed. However, users registered within the user registry are kept.
4. Billing for collaboration spaces. This feature is not currently implemented and it future CS can be billed for usage e.g. per-storage, per-user.

2.5 CS Data Object Sharing

In the CS three different types of data objects replication model are supported:
1. Copy of data object.
2. Share data object through Read Access
3. Share data object through Write Access

2.5.1 Copy of Data Object Model
In this replication scheme, the data object is copied from the Tenant to the collaboration space. Once the data object is copied over to the CS as shown in Figure 5, the CS owns the data object copy and responsible to maintain the data object permissions to users within the CS.

Figure 5: Copy Data Object Sharing

2.5.2 Share data object through Read Access Model
The share data object through read access replication involves sharing a copy of the data object with read permission to the CS. In this model the data object is kept as a master in the Tenant (as shown in Figure 6) and the CS can access the data object through read permissions only. Consequently, the data object can only be changed within the tenant and CS users access the data object through read permissions.

Figure 6: Read Access Data Object Sharing

2.5.3 Share data object through Write Access Model
The share data object through write access replication involves sharing a copy of the data object with write permission to the CS. In this model the data object is kept as a master in the Tenant (as shown in Figure 7) and the CS can access the data object through write permissions as well. Consequently, the data object can be changed within the tenant and CS as well. Once the data object is changed in either the Tenant or CS, the data object is synchronised across.

Figure 7: Write Access Data Object Sharing
3 EXTENSION PLUGIN

3.1 Introduction

The GloNet platform is based on the OSGi technology. Due to this technology, every extension of the platform is realised as an OSGi plugin to the platform. To incorporate the VBE Management module a number of plugin extensions have been used:

- server schema extension plugin to extend data objects—extends database tables (see Section 3.1);
- server extension plugin—extends server behavior. It is used for DAO extensions or for business operation extensions. Web service interface is implemented as business operation (see section 3.2);
- client extension plugin—extends GUI, (see section 3.3).

3.2 Server Schema Extension Plugin

Data-object in the Glonet platform covers a database table and the two types of extensions are supported:

- existing data objects extension; and
- adding new data objects.

All data objects of the platform are specified in server schema plugins (see Figure 8). Plugin name convention is:

dataobject_name -> plugin: de.cas.open.glonet.server.dataobject_name.schema

![Server schema plugin structure](image)

Figure 8: Server schema plugin structure

3.2.1 Existing data objects extension

Existing platform data objects are extended with new information represented by columns in the database. The extended data objects are:
• ADDRESS:
  o extension specified in new de.cas.open.glonet.server.addresses.schema plugin integrated to platform;
  o plugin extends built-in ADDRESS dataobject specified in the platform de.cas.open.server.addresses.schema plugin; and
  o adding new columns, filters and views to the ADDRESS dataobject.

• DOCUMENT:
  o extension specified in new de.cas.open.glonet.server.document.schema plugin integrated to platform;
  o plugin extends built-in DOCUMENT dataobject specified in the platform de.cas.open.server.documents.schema plugin; and
  o adding new columns, filter and view to the DOCUMENT dataobject.

3.2.2 Adding new data objects
Adding new data objects requires to integrate new server schema plugins to the platform. All new added data objects specify their own table schema with columns, their own filters and views. Every new data object has its own server schema plugin with specification.
New plugins integrated to platform:
  • de.cas.open.glonet.server.capability.schema;
  • de.cas.open.glonet.server.comptaxonomy.schema;
  • de.cas.open.glonet.server.performance.schema; and
  • de.cas.open.glonet.server.value.schema.

3.3 Server Extension
Server extension plugin (Figure 9) adds new server functionalities to the GloNet platform. The types of server extension are:
  • DAO – Data Access Object
  • Business operation implementation – web services extensions
Plugin name convention is: dataobject_name -> plugin:
  de.cas.open.glonet.server.dataobject_name.
3.3.1 DAO

There are two types of DAO:

- data object DAO, used for adding functionalities before or after data object manipulation (e.g. create, save, delete); and
- group DAO, used for adding functionalities before or after group manipulation (e.g. create, save). Extension specified in new de.cas.open.glonet.server.group plugin integrated to platform.

3.3.2 Business operation implementation

Business operation adds new server functionality to the GloNet platform. This operation is exposed as a web service and should be accessible by external systems. All new web service interfaces in GloNet are implemented as business operations.

The GloNet platform web service execute() is used to pass appropriate request object as execute() method parameter. The result of execute() service call is the corresponding response object.

The current implementation contains a simple client application in Java, which demonstrates the way of calling the implemented services. New plugins integrated to platform:

- de.cas.open.glonet.server.addresses;
- de.cas.open.glonet.server.capability;
- de.cas.open.glonet.server.document;
- de.cas.open.glonet.server.performance; and
- de.cas.open.glonet.server.value.

Example of ViewVMembProf call:

```java
EIMInterfaceProvider eimInterfaceProvider = 
    EIMInterfaceFactory.getEIMInterfaceProvider("http://localhost:8080/eim.wsdl", true);
EIMInterface eimInterface = eimInterfaceProvider.getEIMInterface(
    new UsernamePasswordAuthenticationProvider("glonet/Administrator", "*****");
ViewVMembProfRequest request = new ViewVMembProfRequest();
```
request.setMemberId("9729C0BF4F0F37D09AB2FC7B5F393A74");

ViewVMembProfResponse response = null;
try {
    response = (ViewVMembProfResponse) eimInterface.execute(request);
} catch (BusinessException e) {
    System.out.println("*** BusinessException: " + e.getMessage());
} catch (DataLayerException e) {
    System.out.println("*** DataLayerException: " + e.getMessage());
}
System.out.println(response);

Output:

de.cas.open.glonet.server.addresses.types.ViewVMembProfResponse@1ee743d[
    profile=de.cas.open.glonet.server.addresses.types.Profile@1156e9[
        memberId=9729C0BF4F0F37D09AB2FC7B5F393A74
        name=iPLON GmbH
        address=Karl-Kurz-Str. 3, Schwäbisch-Hall, Baden-Württemberg, DE
        industrySector=Energy/Supply/Disposal
        legalStatus=Public Limited Company
        contactPerson=Victor
        creationDate=2012-09-13T13:36:00Z
        baseTrustLevel=60.0000
    ],
    competence=[de.cas.open.glonet.server.addresses.types.Competence@36f21d[
        name=O&M support services - PV Panels Cleaning
        capacityDesc=Square meters per day
        capacityAmount=222.0000
        costItem=Fixed costs
        costValue=10.0000
    ], de.cas.open.glonet.server.addresses.types.Competence@1518ea7[
        name=Manufacturing - Production of cables
        capacityDesc=Meters per day
        capacityAmount=234.0000
        costItem=Fixed costs
        costValue=54.0000
    ]],
    valueItem=[de.cas.open.glonet.server.value.types.ValueItem@16c9b8c[
        id=B97E1F8FCF64B38B6AA3D83BB25507A
        priority=1
    ], de.cas.open.glonet.server.value.types.ValueItem@1580929[
        id=A3351B2B9374534AAD58DE68D3A3B7C
        priority=1
    ]]
]

3.4 GUI extension

GUI extension is realised as a client side GloNet platform plugin (see Figure 10). Plugin name convention is: dataobject_name -> plugin: de.cas.open.glonet.rapclient.dataobject_name.
To integrate a new GUI to the GloNet platform, the developer needs to:

- register business object (CapabilityBO) to `de.cas.open.pia.rapclient.contributions` `plugin.xml` to `registeredbusinessobjects` section (see Figure 11).

- create and register command bar specification for GUI to `de.cas.open.pia.rapclient.contributions.commandbar` `plugin.xml` to `commandbar` section (see Figure 12).
register record tab (CapabilityMainRecordTab) to
de.cas.open.pia.rapclient.contributions.recordtabs plugin.xml to record tabs section (see Figure 13).

This results in an integrated new part of the GUI as shown in Figure 14.
The following new plugins have been integrated to GloNet platform:
- de.cas.open.glonet.rapclient.capability;
- de.cas.open.glonet.rapclient.comptaxonomy;
- de.cas.open.glonet.rapclient.document;
- de.cas.open.glonet.rapclient.performance; and
- de.cas.open.glonet.value.value.
4 EXTERNAL SERVICES

In order to support interoperability, we have enhanced the GloNet platform with a well-defined generic infrastructure for invocation of external services. To test this capability, the business activities of the iPLON GmbH has been used to show how the GloNet platform can invoke external VE services. The processes (see Figure 15) during the planning, construction, and operational phase of the photovoltaic system at iPLON include the production, processing and archiving the data to the GloNet platform.

Figure 15: iPLON GloNet Sensor Extraction to GloNet platform

4.1 Modelling the imported sensor data to the GloNet system

The imported sensor data is based on the Plant Extract Specification Document the Sun Spec Alliance. The specification includes information about:

- Name
- Description,
- Characteristics (e.g., direct current installed capacity),
- Properties (e.g., constant watts control option)
- Operational data,
- Location and
- Organisations involved a solar power plant.

The SunSpec specification uses the XML standard as shown in Annex 2. The sunSpecExtract element is used as a wrapper for information about a solar power plant and uses a time of creation (t) attribute. The sunSpecExtract element contains sub-elements containing information about the detailed description needed by a solar power plant in terms of:

- Name (name),
- Description (description),
- Date of commissioning (activation date),
- Location (location),
- Organizations involved (participant),
- Characteristics (nameplate) and
• Properties (capabilities)
Furthermore, the SunSpecData element provides a description of the operational data in terms of:
  • Device Element (d) providing data points elements;
  • (p) describing the model; and
  • Element (m) describing the semantic.

The timestamp attribute t can also be used to provide operating data. Data points describe different values using the id attribute which describe device-specific model element (m).

4.2 Modelling of operational data

In order to calculate performance indicators for analytical purposes, both the Plant and weather data are recorded. Figure 7 shows the data extract of the indicators in the Excel CSV template extracted from the iPLON photovoltaic Plant in India. The columns give the following data back (left to right):
  • Date of measurement
  • Time of measurement
  • Solar radiation monitoring station 1: \( \frac{W}{m^2} \)
  • Solar radiation monitoring station 2: \( \frac{W}{m^2} \)
  • Ambient temperature? [°C]
  • Total energy generated? [kWh]
  • AC power [kWh]

Since the actual measurement point of a sensor is not always exactly on the boundary of the 5-minute intervals falls, the 5-minute-values are calculated by linear interpolation. Figure 16 illustrates this approach.

From the operating system and data, the performance ratio can be calculated. It describes the ratio of energy actually produced a PV system to the theoretically producible energy at test conditions and an inverter with an efficiency of 100%. Formula 1 shows the calculation of the performance ratio.

\[
PR = \frac{\text{Energy Generated}}{\text{Module Surface} \times \text{module efficiency} \times \text{Sunlight}}\left[\frac{\text{kWh}}{m^2 \times 1 \times \frac{\text{kWh}}{m^2}}\right]
\]

\[
PR = \frac{\text{Energy Generated}}{\text{Module Surface} \times \text{module efficiency} \times \text{Sunlight}}\left[\frac{\text{kWh}}{m^2 \times 1 \times \frac{\text{kWh}}{m^2}}\right]
\]
Sensor Data can be imported using the Import Tab from the Product menu, as shown in Figure 17. The user can specify a range of dates and times the data is required.
Once the dates selected, on clicking import the data are fetched from the iPLON databases and uploaded to the GloNet database. On successful import, a success dialog is shown and the user can then visualise the imported data as shown in Figure 18.

Figure 18: Viewing Imported Sensor Data by date
5 CONCLUDING REMARKS

The GloNet platform is designed and implemented as a framework that helps creating the GloNet applications and services as SaaS offerings.

In the second platform release, the GloNet platform has been enhanced with three additional functionalities:

- An infrastructure for sharing information using collaboration spaces. The design and implementation of the collaboration space module has been done transparently, that is without affecting the existing GloNet implementation and scalability design principles to support a cloud based infrastructure.
- A number of plugin extensions to support integration of the VBE functionality to the GloNet platform.
- Integration of external systems and services to the GloNet Platform using a plugin-based mechanism for integrating external web services. This has been demonstrated using the iPLON sensor data by importing data to the platform from various solar plants.
public interface ProjektraumContextProvider {

    /**
     * @return The id of the projektraum the current operations shall be carried out in.
     */
    String getProjektraumId();

    /**
     * @return true, if a projektraum context has been set.
     */
    boolean isProjektraumContextActive();
}

ANNEX 1: INTERFACE OF CONTEXT PROVIDE
ANNEX 2: EXAMPLE OF PLANT EXTRACT DOCUMENT

```xml
<sunSpecExtract t="2012-11-14T08:40:50Z" seqId="1" lastSeqId="1">
  <plant id="?" v="1" locale="en">
    <name>UNITY POWER PVT LIMITED</name>
    <description>India, Gujarat, Kutch, Anjar, Khirasara village</description>
    <activationDate>2012-10-25</activationDate>
    <location>
      <latitude>23.683333</latitude>
      <longitude>70.166667</longitude>
      <line1>Near Khirasara village</line1>
      <line2></line2>
      <city>Anjar</city>
      <stateProvince>GJ</stateProvince>
      <country>IN</country>
      <postal></postal>
      <elevation>83m</elevation>
      <timezone>+05:30</timezone>
      <property id="mapURL" type="url">http://upload.wikimedia.org/wikipedia/commons/6/04/Gujarat_locator_map.png</property>
    </location>
    <participant type="operator">
      <property id="name" type="string">Welspun</property>
      <property id="contact" type="string">Sitanshu S. Pati</property>
      <property id="phone" type="string">+91 129675 0000</property>
      <property id="email" type="string">sitanshu_pati@welspun.com</property>
    </participant>
    <namePlate>
      <property id="installedDCCapacity" type="float">250</property>
      <property id="installedACCapacity" type="float">240</property>
      <property id="installedPanelArea" type="integer">4000</property>
      <property id="nominalPowerRating" type="float">255.4</property>
    </namePlate>
    <capabilities>
      <property id="fixedWatt" />
      <property id="voltVar" />
      <property id="freqWatt" />
      <property id="dynamicVar" />
    </capabilities>
  </plant>
</sunSpecExtract>
```
6 REFERENCE


7 CONSORTIUM

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