Development of knowledge-based web services to promote and advance Industrial Symbiosis in Europe (**eSymbiosis**) LIFE09/ENV/GR/000300



ACTION 2: Service architecture and implementation D2.4 Design and implementation of semantic web service portal



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Revision History

1 INTRODUCTION

1.1 WEB SERVICE PORTAL OF INDUSTRIAL SYMBIOSIS

This document examines in depth the design and implementation of the semantically enriched web portal that enables participants to register and to participate in the IS ecosystem (*Activity 2.4: Design and implementation of semantic web service portal*). The high level modules that materialize this aspect of functionality are the Information Portal, the CRM, and the Search facility.

Before examining in detail the aspects of the platform that refer to Activity 2.4, it is worth presenting the overall high level architecture and the consisting components of the platform from a functional perspective.



1.2 HIGH LEVEL ARCHITECTURE AND COMPONENTS

Figure 1: High level architecture of eSymbiosis platform

The above diagram is a technical diagram based on a number of assumptions following the SOA philosophy. It identifies mainly two categories of services:

- 1. Application Services and
- 2. (Platform) Core Services.

These services use a number of Infrastructure services provided by the various technologies that are used in the project, including semantic technologies (e.g. Jena), RDBS (e.g. SQL Server), Communication (e.g. WCF) etc.

The high level functional components of the eSymbiosis platform are presented in the diagram of Figure 1.



Figure 2: Functional components of eSymbiosis platform

The components and their services, as demonstrated in the above figure, are:

- 1. Semantic Component
- 2. Information Portal
- 3. CRM

- 4. Search Facility
- 5. Information Management
- 6. Synergy Tracking & Reporting

The current document focuses on the components of Information Portal, of CRM, and of Search Facility. A more detailed analysis of the aforementioned components follows.

2 INFORMATION PORTAL

The Information Portal component includes all modules that support the eSymbiosis Portal.

2.1 NEWS ARTICLES

Using this module the user is able to publish and view news articles. News is categorized using tags, so that users can browse directly to news relevant to a particular subject area. The ability to publish items is controlled by the security model.

An example of a News Article is shown in Error! Reference source not found.

View Article
A News Article
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Phasellus ac sodales turpis. Fusce eu orci id nulla portitor convallis vitae quis libero. Sed vitae ligula id nulla posuere sagittis sed non purus. Pellentesque portitor nunc turpis, eget mollis neque. Quisque scelerisque posuere orci, in dignissim enim rhoncus in. Aliquam aliquam mattis vehicula. In aliquam nunc non purus venenatis porta. Nullam orci turpis, suscipit id ultrices id, venenatis non magna. Nunc sit amet mattis quam.
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Phasellus pretium egestas semper. Aenean at imperdiet lorem. Donec vitae justo vel libero feugiat tempor. Cras sit amet elementum nisl. Suspendisse potenti. Maecenas bibendum dolor nec neque tristique tristique. Duis at nunc ut sem sollicitudin dignissim quis vel tellus. Vivamus a venenatis tortor. Vivamus sit amet elit purus, a euismod mi. Phasellus quis libero massa. In hac habitasse platea dictumst. Nam eu nulla et lectus semper feugiat vitae id tortor.
two
19/09/2011
energy reuse,symbiosis
More News

Figure 3: A sample News Article.

2.2 KNOWLEDGE BASE

The knowledge base includes a collection of the success stories of the project, which are based on the case studies of completed synergies. The case studies are generated by the system, (see the description of **Error! Reference source not found.** below), with minimal input from the IS Practitioner, and can be used as a reference point for the purposefulness of the overall project.

2.3 COLLABORATION

The system promotes the collaboration of participating organisations in multiple ways. This dedicated collaboration component handles the communication of participants or IS Practitioners that are cooperating within the context of a Synergy in two ways (which are presented in the runtime context in the respective section **Error! Reference source not found.**):

• <u>Notification system</u>, which informs the Organisation/IS Practitioner about important changes of a Synergy that he/she is involved in.

• <u>Comments</u> that the user provides for the other actors of the Synergy, in order to coordinate activities or resolve potential pending issues. The other users is notified about the new comments by notifications.

3 CRM

The CRM functionality is focused on the management of:

- IS Practitioners
- Member Organisations
- Member Sites
- Contacts
- Users

Depending on the access rights for the management of the aforementioned entities, the functionalities of CRM can be categorized into Public registration (for Organisation/Site/Resource) and Administrator registration.

3.1 PUBLIC REGISTRATION

The CRS component provides a public registration functionality, which is used to register as a member user and to define Organisations, Sites, and Resources. Each organization has an online 'record card', which will display a wide range of information about it, such as:

- Name
- Branch/Site
- Status (active member/dormant member/stakeholder etc.)
- Addresses (mail including postcode, email and web)
- Phone and fax numbers
- Region/area of Greece
- Associated matches
- Associated resources (haves/wants)
- Events which contacts within the organization have attended
- Recent activity (emails, documents, etc.) associated with the Organization

This organisation list provides live links to other details within the system. Lists of synergies, matches, etc. also include hyperlinks to referenced information. A security layer controls all access to the system's information so that detailed information of a commercial or confidential nature can be shared by an appropriate, controlled group of users.

eSymbiosis	A Platform to enable and promote Industrial Symbiosis			
Dear John ,				
Please click the link below to verify your registration	on as Member at eSymbiosis:			
http://dev1.clmsuk.com/CLMS_eSymbiosis_2_0_pda_NewTheme/Forms/PersonEmailVerificationForm/ValidateCode?code=AF9E7B58BF9F				
Your login information is provided below:				
Username : jjjsss123 Password : 1234				
Thank you, The eSymbiosis team				
4/26/2013 10:54:41 AM	Copyright 2011-2013 © eSymbiosis			

Figure 4: Example of the verification email sent to a new registrant

First, the CRM component handles the registration of a new member. Then, the CRM is responsible for the participant Organisation registration process. When a user first creates an account, a confirmation email is sent to the user, containing a URL that verifies the registration (see Figure 4). If the user accesses the link, the member user account is verified and the user can log in to the platform. After logging in, the portal allows the creation of a new Organisation under this user. As a consequent step, the user adds the Site information that belongs to this Organisation and the resources that are provided or requested by each Site. As the Site and Resource data need to be recorded in the ontology of the Semantic Component, the CRS system communicates via web services with the Semantic Component, to register the relevant information and to acquire a summary of each property of the resource. Communication with the semantic component is shown in the relevant sequence diagram (the CRM invokes two services of the Semantic Component, to register Site and Resource; the semantic component returns the stored resource summary by



Figure 5: The sequence diagram of CRM and Semantic Component communication

invoking a service of the CRM).

The resource properties are provided by the semantic component in an xml string (which is named *resource summary*), in order to maintain a dynamic list of properties for each resource. An example of the resource properties xml is provided below.

<object type="ResourceProducer" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns"></object>				
<pre><property name="confidentialityFlag" rdf:type="http://www.w3.org/2001/XMLSchema#boolean"></property></pre>				
False				
<output type="ResourceByType"></output>				
<property name="hasInterval" type="Random"></property>				
<label xml:lang="el">Tυχαίο</label>				
<label xml:lang="<b">"en">Random</label>				
<property name="hasStorageMethod" type="Open_topped_tank"></property>				
<label xml:lang="en">Open Topped Tank</label>				
<label xml:lang="el">Ανοιχτή Δεξαμενή</label>				
<property name="hasUnitOfMeasurement" type="m2"></property>				
<label xml:lang="en">Square metres (m2)</label>				
label xml:lang="el">Τετραγωνικά Μέτρα (m2)				
<property name="hasPatternOfSupply" type="Seasonal"></property>				
<label xml:lang="el">Εποχιακή</label>				
<label xml:lang="<b">"en">Seasonal</label>				
<property name="hasDeliveryMethod" type="Tipper"></property>				
<label xml:lang="en">Tipper</label>				
<label xml:lang="el">Ανατρεπόμενο Όχημα</label>				
<property name="isBatch" rdf:type="http://www.w3.org/2001/XMLSchema#boolean"></property>				
False				
<property <="" name="deliveryCapability" pre=""></property>				
rdf:type="http://www.w3.org/2001/XMLSchema#boolean"> True				
<property <="" name="validFrom" pre=""></property>				
rdf:type="http://www.w3.org/2001/XMLSchema#date">2012/12/03				
<property <="" name="validTo" pre=""></property>				
rdf:type="http://www.w3.org/2001/XMLSchema#date">2012/10/03				
<property <="" name="hasName" pre=""></property>				
rdf:type="http://www.w3.org/2001/XMLSchema#string">ResourceName1				
<property <="" name="hasQuantity" pre=""></property>				
rdf:type="http://www.w3.org/2001/XMLSchema#float">3				
<property name="isHazardous" rdf:type="http://www.w3.org/2001/XMLSchema#boolean"></property>				
True				
<property name="hasQuantityType" type="Solid"></property>				
<label xml:lang="<b">"el">Στερεό</label>				
<label xml:lang="en">Solid</label>				
<property <="" name="needsSpecialHandling" pre=""></property>				
rdf:type="http://www.w3.org/2001/XMLSchema#boolean">True				
<property <="" name="hasStorageCapacity" pre=""></property>				
rdf:type="http://www.w3.org/2001/XMLSchema#float">34				

Each property has an XPath element, in order to extract the particular property's value from the xml of the resource summary. In this way, a dynamic set of properties can be provided for each resource by the semantic component. Moreover, the resource and its properties are maintained only in the Semantic Component and any changes are replicated to the other related components that need to access the resource details. The list of the resource properties is maintained by the administrator, within the eSymbiosis platform, with a user-friendly interface (see Figure 7 and Figure 6).

In addition, a member of an Organisation can invite other users in the same Organisation (i.e. an Organisation can be managed by multiple users). The process is as follows: the member user sends an invitation to a person using the platform; the invitation recipient receives an email with a unique registration URL; if the user proceeds to clicking the URL and filling the requested user account data, a new member is added as representative of the Organisation. Moreover, the Organisation user can review at any time the status of the sent invitations from the respective web form *My Invitations* of the system.

·		🔁 📽 🦷 🛛 🗖	fault View					
Sho	ow rows	25 T Pa	ge 1 of 1 📢	Total Records 19			Modi	fy
[Drag	g columns	here to group]						
7	Property Id ▲	Name (Greek)	Name (English)	XPath	Is Visible (in search results)	ls Visible (in summary)	Display Order Index ▼	
1	483	Τύπος	Туре	/object	1	V	-1	-
2	53	Περιγραφή	Description	//node()[local-name()='input' or local- name()='output' or local-name()='input'][1]			0	
3	20	Όνομα	Name	//object//property[@name='hasName']	V	V	1	
4	2	Εσωτερικό Όνομα	Internal name of the semantic concept	//object/@type		7	2	
5	15	Έναρξη Διαθεσιμότητας	Start of availability	//object//property[@name='validFrom']	¥.	V	3	•
6	16	Λήξη Διαθεσιμότητας	End of availability	//object//property[@name='validTo']	V	V	4	
7	17	Διαβαθμισμένες Πληροφορίες	Confidential Information	//object//property[@name='confidentialityFla			5	
8	24	Επιβλαβές	Hazardous	//object//property[@name='isHazardous']			6	
9	27	Χρειάζεται ειδικό Χειρισμό	Needs Special Handling	//object//property[@name='needsSpecialHa		V	7	
10	25	Δυνατότητα παράδοσης	Delivery Capability	//object//property[@name='deliveryCapabilit			8	
11	29	Τρόπος Παράδοσης	Delivery Method	//object//property[@name='hasDeliveryMeth			9	-

Figure 7: The list of defined resource properties (accessible only by administrator)

roperty Info			
Property Id	2	Creation Date	25/04/2013
Name (Greek):	Εσωτερικό Όνομα		
Name (English):	Internal name of the semantic concept		
(Path:	//object/@type		
Appear in summary:			
Appear in result list:			
Display Order:	2		

Figure 6: Editing a resource property (accessible only by administrator)

3.2 Administrator Registration

The registration of Administrators and IS Practitioners is done only by the Administrator, for security purposes. Thus, the CRM component also offers the functionality of registering new IS Practitioners in the system and for assigning the regions for the IS Practitioners. In more detail, these two processes are explained below.

3.2.1 PRACTITIONER REGISTRATION

The Administrator registers a new IS Practitioner by completing the respective form, which contains the person details, as well as the credentials for logging into the system. The process that is followed after the Administrator registers someone as a Practitioner is similar (the user is notified by an email, which contains the registration link – see Figure 4). After the new Practitioner user clicks the link, the registration is completed and the user can log into the system with the provided username and password.

3.2.2 Assignment of Regions to Practitioners

The Administrator is also responsible for assigning regions to IS Practitioners. A region can have multiple Practitioners and one Practitioner can be responsible for multiple regions. The relevant functionalities are provided in separate tabs and are listed below:

- Assignments by Region: is this tab, the Administrator can view a listing of all regions and the assigned Practitioners for each region. From this tab, the Administrator can also unassign a Practitioner from a region.
- Assignments by Practitioner: from this tab, the Administrator views a listing of all Practitioners, with the Regions that are assigned to each one. The Administrator can unassign a region from the selected practitioner and can block/unblock the access of the specified Practitioner to the portal.
- Create New Region: from this tab, the Administrator can register a new region into the system, by specifying its geographical data.

4 SEARCH FACILITY

This is the starting point for many users of the system once they have completed the registration process. It provides a quick way of finding contacts, companies, resource matches and any of a wide range of predefined types of information. Typical searches might include such examples as:

- search for (Matches) in (Central Greece) in the last (month) containing (*text*)
- search for (Contacts) in (all) in the last (month) containing (*text*)
- search for (documents) in (Viotia) in the last (week)

From the search results list, users will be able to select individual items as links to detailed records.

4.1.1 SEARCH FOR RESOURCE MATCHES

An important functionality of the search component is the resource match functionality, which is the first step to a synergy creation.



Figure 8: The sequence diagram of searching for compatible resources

There are two ways that potential matches for a selected resource can be identified:

- By semantic relevance of the resources (the Semantic Component calculates and returns a relevance value, i.e. a number that indicates compatibility of the two resources based on reasoning)
- By specific criteria that the user submits

The resource matches are managed by the Semantic component and more precisely by the dedicated Matches Identification module that directly communicates with the Reasoning Engine. From a technical perspective, the Search Facility component receives the potential matches' list from the Semantic Component via a web service. As analysed in the relevant section (see Section CRM), the returned resources have a dynamic list of properties, provided from the semantic component in xml format. The user can select one of the returned matches in order to initiate a new synergy, if the user considers this matched resource as compatible. This user action starts the synergy lifecycle, which is managed from this step on by the dedicated component (see Section **Error! Reference source not found.**).

5 TECHNICAL ARCHITECTURE AND DESIGN

In this section, we analyze in depth the technical architecture of the eSymbiosis platform, in terms of architectural design, design patterns used for the materialization of the platform, and technologies on which the implementation was based.

5.1 IMPLEMENTATION STRATEGY

The eSymbiosis platform follows a three-tier architecture:

- the first tier is the client workstation that accesses the application from a web browser;
- the second tier is the web server and can be further decomposed into 4 layers:

Browser			
Neb Server			
Presentation			
UI Component	s	UI Pro	ocess Components
Services			
Service Interfac	œ	UI	Message Types
Business			
Business Entities	Business V	Vorkflows	Business Components
Data			
Data Access	Data Helpe	rs/Utilities	Service Agents
Components			
Database Server			
Database			

Presentation (for accepting user input and managing the user interface content that is sent to the client application), services (implements the interfaces and messages that expose the core processes of the eSymbiosis platform to the external components), business (implements the core functionality of the system, and encapsulate the relevant business logic), and data layer (provides access to data that is hosted within the boundaries of the system, and data exposed by other back-end systems);

• the third and final tier is the database server, which directly writes/reads the eSymbiosis data entries stored in the corresponding database.

5.2 ARCHITECTURAL PATTERNS

The implementation strategy uses a number of architectural patterns, as the following diagram displays.



Figure 10: The design patterns that are used

For each of the three tiers presented in the previous Section (see Implementation Strategy), the respective Architectural Patterns are selected to define a best-practice

approach that will guide the actual implementation. A summary of the important points that the Architectural Pattern diagram demonstrates is the following:

- User Interface processing is handled by a Supervising Controller pattern.
- The Template View pattern is used to define a common look and feel.
- Controls are bound to objects that contain data.
- The business layer uses a Facade pattern to implement a message-based interface between the presentation and business layer.
- The Domain model pattern is used to model the application domain.
- The Unit of Work pattern is used to keep track of everything you do during a business transaction that can affect the database. When you're done, it figures out everything that needs to be done to alter the database as a result of your work.
- A Repository pattern is used to access the Data Mapper entities.
- A Data Mapper pattern is used to map domain entities to the database schema and make the Domain Model persistence ignorant.

These patterns are described in more detail in the following sections, where they are categorized according to the tier and the layer they refer to.

Supervising Controller					
User Interface processing is divided into three separate roles.	The three roles are Model, View, and Presenter. The Model represents data, the View represents the user interface, and the Presenter is responsible for processing requests.				
The web page handles requests and passes them off to a controller	Requests are sent to the View (web page), which then passes control to a provider that is responsible for initializing the Model, returning control back to the View, or passing control on to a different View.				
M-V-P do not depend directly on each other (Dependency inversion)	M-V-P do not depend directly on each other. Instead, they depend on interfaces (e.g. IView, IPresenter)				
Template View					
An ASP.NET Master page is used to provide a common look and feel.	Common elements such as background, page layout, menus, header, and footer are defined in the master page.				
ASP.NET pages focus on content that is specific to each page	Each page is associated with the master page, which renders the common content. As a result, the page only needs to contain user interface elements that are not common across all pages.				
Bound Data Control					
ASP.NET Server and User controls are bound to business entities returned from the business layer.	Business entities returned from the business layer can be bound to web controls, which will use data from the entity when rendering the display.				

5.2.1 Web Server – Presentation Layer

5.2.2 WEB SERVER – BUSINESS LAYER

Domain Model	
The domain model is comprised of POCOs (Plain Old CLR Objects)	The Domain Model consists of POCOs that are related and fully describe the application domain. POCOs are "ordinary classes where you focus on the business problem at hand without adding stuff for infrastructure-related reasons The classes should focus on the business problem at hand. Nothing else should be in the classes in the Domain Model." (Nilsson, 2006)
POCOs also contain domain logic.	The POCOs also have methods that implement the business logic.
The POCOs are completely Persistence Ignorant (PI)	 This allows us to : Design the Domain Model independently from the Database Model. Design, build, and test any business logic relatively independently of the database and the persistence infrastructure code.
Unit Of Work	
The Unit of Work keeps track of changes during a business	When you're pulling data in and out of a database, it's important to keep track of what you've change. Similarly you have to insert new objects you create and remove any objects you delete.
operation, and saves the changes to the database.	You can change the database with each change to your object model, but this can lead to lots of very small database calls, which ends up being very slow. Furthermore it requires you to have a transaction open for the whole interaction, which is impractical if you have a business transaction that spans multiple requests. The situation is even worse if you need to keep track of the objects you've read so you can avoid inconsistent reads.
	A Unit of Work keeps track of everything you do during a business transaction that can affect the database. When you're done, it figures out everything that needs to be done to alter the database as a result of your work.
Used for business operations that need to be executed as a single unit.	Within the Unit of work operation all changes a tracked, one or more business operations are performed, and the changes are only propagated to the database depending on the outcome of the business operations.
Can also be used to manage context information.	This pattern can be used to implement a single point of entry for each request where context can be initialized and used throughout the request processing.
Functional Decon	nposition
Business Processes are implemented using the Functional Decomposition pattern. Each process is broken down to sub- processes and modeled using IDEF0 models.	A function is achieved by a sequence of sub-functions. A combination of a super-function and its sub-functions is called a functional decomposition pattern. Its definition consists of a super-function, sub-functions, functional relations among sub-functions, and behavioral conditions. These functions are described in terms of the functional concepts. For example, a super-function "heat object" has two sub-functions; "generate heat" and "give heat". There should be a proportional-type functional relation among them. The behavioral condition is that the objects receiving the heat are identical. In general, a function has some functions by specifying something related to the ways to achieve it. (In the task context of the functional hierarchy understanding, the reverse operation of the functional decomposition, the information is lost.) According to what is specified, we can categorize the functional decomposition patterns as follows (the notation of the examples in the list is that super-function \rightarrow sub-function + sub-function2, if any):

5.2.3 WEB SERVER – DATA ACCESS LAYER

Repository				
A repository provides an in- memory representation of domain entities.	In systems with a complex Domain Model, it can be worthwhile to build another layer of abstraction over the mapping layer where query construction code is concentrated. This becomes more important when there are a large number of domain classes or heavy querying. In these cases particularly, adding this layer helps minimize duplicate query logic. A Repository encapsulates the set of objects persisted in a data store and the operations performed over them, providing a more object-oriented view of the persistence layer.			
A repository provides clean separation between layers.	Repository also supports the objective of achieving a clean separation and one-way dependency between the domain and data mapping layers.			
Criteria objects can be used by the repository to generate database queries.	In cases where you have multiple complex queries to retrieve an entity, a criteria object can be used to define selection criteria that are passed into a single get operation.			
Data Mapper				
Impedance mismatch between the Domain Model and relational data require mapping layer.	There are several factors that cause a mismatch between object and relational database structures. As a result, a mapping layer can be used to map object structures to database schemas. This allows developers to perform operations against the objects without having to know the database schema.			

5.3 TECHNOLOGIES

In this Section we present how the aforementioned Architectural Patterns are replaced with technologies, interfaces, or objects, on the actual implementation level.

Windows, Linux, Mac	, Os	
Explorer, Chrome, S	afari, Firefox	
HTML	JavaScript	Css
IIS 7.0		
Presentation		
ASP.NET Controls	ASP.NET Master	Supervising
	Pages	Controller (MVP)
Services		
Services	WCE	_ /
	WG	
Business		
POCO/IPOCO	IDEF0 Models	NHibernate Sessions
Data		
NHibernate	Re	pository Objects
MSSOL Server 2008 I		
MDB files		
חשמיו ששמי		

Figure 11: The technologies used for each tier of the eSymbiosis platform

The following is a summary of the technologies, interfaces or objects shown above:

- Any web browser can be used for accessing the eSymbiosis platform (IE, Firefox, Chrome, Safari).
- MVP libraries are used to implement the Model-View-Presenter pattern.
- ASP.NET Master Pages are used to define a Template View.
- ASP.NET Page, Server, and User controls are used to define the user interface.
- Ajax technologies are used to provide a richer user experience.
- POCOs are used to implement the Domain Model.
- Repository objects are used to provide a data access interface.
- NHibernate is responsible for mapping the Domain Model to the database schema.
- Mapping xml files are used to provide Domain Model's mapping information to NHibernate.
- The database used for this implementation is the Microsoft SQL Server 2208 R2.

5.3.1 Web Server – Presentation Layer

Technology Description	Example
MVP	
Events in the view, ASP.NET Page, are passed onto the presenter, which is responsible for processing actions from the view.	<pre>protected override void OnInit(EventArgs e) { base.OnInit(e); presenter = new CustomerPresenter(this, new CustomerController()); } protected override void OnLoad(EventArgs e) { base.OnLoad(e); action = GetFormArgument("action"); requestedEditCustomerCustomerID = Request.QueryString["ID"]; if(!IsPostBack) { presenter.OnViewInitialized(); } presenter.OnViewLoaded(); }</pre>
The presenter class is responsible for interacting with a controller, which then interacts with the business layer. Operations in the presenter are associated with events from the view to perform different actions.	<pre>public void OnViewLoaded() { //Add handlers to View Events view.ControlChanged += view_ControlChanged; view.cmdCustomerSaveClicked += view_cmdCustomerSaveClicked; view.cmdDeleteCustomerClicked += view_cmdDeleteCustomerClicked; view.CustomerTypes_DataBound += view_CustomerTypes_DataBound; view.CustomerTypes_PreRender += view_CustomerTypes_PreRender; PerformAction(view.RequestedAction); }</pre>



Ajax	ASP.NET's Update panel Control is used to provide the user with a richer UI experience.
technologies are	
used for a richer	
user experience.	

5.3.2 WEB SERVER – BUSINESS LAYER

```
Technology
              Example
Description
Domain Model
              public class Region : INotifyPropertyChanged, ICloneable
The Domain
Model is
              {
implemented as
                  #region Region's Fields
POCOs which
                  [DataMember(Name="RegionID")]
are completely
                  private int regionID;
persistence
ignorant.
                  [DataMember(Name="RegionDescription")]
                  private string regionDescription;
                  #endregion
                  #region Region's Properties
                  public virtual int RegionID
                  {
                      get
                      {
                           return regionID;
                      }
                      set
                      {
                           regionID = value;
                           OnPropertyChanged("RegionID");
                      }
                  }
                  public virtual string RegionDescription
                  {
                      get
                       {
                           return regionDescription;
                       }
                      set
                       {
                           regionDescription = value;
                           OnPropertyChanged("RegionDescription");
                      }
                  }
                  #endregion
                  Region's Participant Properties
                  Constructors
                  INotifyPropertyChanged Members
                  Implementation of ICloneable
              } //Class: Region
```

```
POCOs also
              public class InventoryTransaction : INotifyPropertyChanged, ICloneable
contain domain
              {
logic.
                  InventoryTransaction's Fields
                  InventoryTransaction's Properties
                  InventoryTransaction's Participant Properties
                  Constructors
                  INotifyPropertyChanged Members
                  #region Business Logic
                  private decimal UpdateDebit(decimal value)
                  {
                      if (this.inventory == null) return value;
                      this.inventory.Balance = this.inventory.Balance - this.debit;
                      this.inventory.Balance = this.inventory.Balance + value;
                      return value;
                  }
                  private decimal UpdateCredit(decimal value)
                  {
                      if (this.inventory == null) return value;
                      this.inventory.Balance = this.inventory.Balance + this.credit;
                      this.inventory.Balance = this.inventory.Balance - value;
                      return value;
                  }
                  #endregion
                  Implementation of ICloneable
              }
IDEF0 Models
```



Business operations that need to be included in a transaction are handled by the Unit of Work pattern.	<pre>public void SaveProductCategory(NWS.BO.ProductCategory productcategory) { if(productcategory == null) { throw new ArgumentNullException("productcategory",</pre>
Unit of Work can be used to initialize a data context that spans across multiple requests.	<pre>This approach allows you to maintain context with one object while processing a long business operation. This ensures that all updates to business entities are saved when the operation is completed. The context is the NHibernate session object and Unit Of Work takes care of holding that context until the long operation is completed. if (UnitOfWork.IsStarted && UnitOfWork.InLongConversation) { UnitOfWork.EndLongConversation(); UnitOfWork.StartLongConversation(); }</pre>

5.3.3 WEB SERVER – DATA ACCESS LAYER

Technology Description	Example
Repository Ob	ject
The repository contains methods for each parent business entity in the Domain Model	Parent objects represent the top level object in a in a group of objects that are related. public class Repository : IRepository { #region Implementation of IRepository #region ProductCategory Methods public NWS.BO.ProductCategory GetProductCategory(int CategoryID) public void SaveProductCategory(NWS.BO.ProductCategory productcategory) public void UpdateProductCategory(NWS.BO.ProductCategory productcategory) public void DeleteProductCategory(NWS.BO.ProductCategory productcategory) #rendregion Supplier Methods Shipper Methods CustomerType Methods
For objects that can be retrieved using multiple complex queries generic methods are supplied by the repository which accept criteria expressed in Linq.	<pre>public List<t> Get<t>(Expression<func<t, bool="">> predicate) public List<t> Get<t>(Expression<func<t, bool="">> predicate,</func<t,></t></t></func<t,></t></t></pre>
NHibernate Ma	apping Files

XML files provide mapping information of the Domain model POCOs to NHibernate.	<hibernate-mapping <br="" xmlns="urn:nhibernate-mapping-2.2">schema="CLMSApps_NWSample_Alpha_Northwind.dbo" default-lazy="true" auto-import="false" assembly="NWS.BO" namespace="NWS.BO"> <class <br="" name="Region">table="region">> <l-r key=""> name="RegionID" column="RegionID" type="Int32"> <generator class="assigned"></generator> <!--/id--> <l- properties=""> <property <br="" name="RegionDescription">column="RegionDescription" type="String" /> <l- relationships=""> <l- relationships=""> </br></l-></l-></property></l-></l-r></class></hibernate-mapping>
---	--

5.4 DATABASE SCHEMA



Figure 12: Database schema of main eSymbiosis tables

The main tables of the database tier for the eSymbiosis application are interconnected as shown in the relevant diagram, above.

	Name	Data Type	Max Length (Bytes)	Allow Nulls	Identity
٩	Synergield	int	4		1 - 1
	CreationDate	datetime	8		
	IsCompleted	bit	1		
٩,	SynergyCurrentStatus	int	4		
	DbTimestamp	timestamp	8		
	isBlocked	bit	1		
	FirstReadyToProceed	bit	1		
	SecondReadyToProceed	bit	1		
	Relevance	decimal(18,8)	9		
9,9,	FirstResourceld2	int	4		
<i>°</i> , <i>°</i> ,	SecondResourceld2	int	4		
	isCancelled	bit	1		
	ReasonForBlocking	nvarchar(500)	1000		
	BlockingReason	int	4		
٩,	CurrentCommentId	int	4		
	CompletionDate	datetime	8		

Synergy

Organisation

			Max Length		
	Name	Data Type	(Bytes)	Allow Nulls	Identity
٩	OrganisationId	int	4		1 - 1
	OrganisationName	nvarchar(255)	510		
	OrganisationWebAddress	nvarchar(50)	100		
	OrganisationNotes	nvarchar(max)	max		
	OrganisationDateAdded	datetime	8		
	CreatedByUserId	nvarchar(50)	100		
	OrganisationAFM	int	4		
	NumberOfEmployees	int	4		
	Turnover	decimal(18,2)	9		
	DbTimestamp	timestamp	8		

Synergy M	letrics
-----------	---------

			Max Length		
	Name	Data Type	(Bytes)	Allow Nulls	Identity
	Our and Matrice I.I.				4 4
	SynergyMetricsId	int	4		1 - 1
	BusinessesAssisted	int	4		
	JobsCreated	int	4		
	JobsSafeguarded	int	4		
	NewBusinessesCreated	int	4		
	NewBusinessesSurviving	int	4		
	TrainingOutcomes	int	4		
	CO2Reduction	decimal(8,2)	5		
	HazardousWasteReduction	decimal(8,2)	5		
	MaterialDiverted	decimal(8,2)	5		
	WaterSavings	decimal(8,2)	5		
	VirginMaterials	decimal(8,2)	5		
	AdditionalSales	decimal(18,2)	9		
	CostSavings	decimal(18,2)	9		
	PrivateInvestment	decimal(18,2)	9		
	DbTimestamp	timestamp	8		
٩,	SynergyId	int	4		
	OrganisationId	int	4		
	isVerified	bit	1		
	isFinalised	bit	1		
Si	te				
----	------------------	---------------	-----------------------	-------------	----------
	Name	Data Type	Max Length (Bytes)	Allow Nulls	Identity
٩	SiteId	int	4		1 - 1
	SiteName	nvarchar(255)	510		
	ISPractitionerId	int	4		
	SitePostCodeId	int	4		
	SiteSICCode	nvarchar(50)	100		
	SiteSectorId	int	4		
	SiteAddress	nvarchar(255)	510		
	SitePostalCode	nvarchar(50)	100		
	SiteTown	nvarchar(50)	100		
	SiteCounty	nvarchar(50)	100		
	SiteCountryId	int	4		
	SiteTelephone	nvarchar(50)	100		
	SiteFax	nvarchar(50)	100		
	SiteWebAddress	nvarchar(50)	100		
	SiteNotes	nvarchar(256)	512		
	SiteDateAdded	datetime	8		
	Latitude	decimal(10,6)	9		
	Longitude	decimal(10,6)	9		
	OntologyOwnerId	nvarchar(200)	400		
9	OrganisationId1	int	4		

Case Study

	Name	Data Type	Max Length (Bytes)	Allow Nulls	Identity
٩	CaseStudyId	int	4		1 - 1
	DateCreated	datetime	8		
	CreatedBy	nvarchar(100)	200		
	Title	nvarchar(1000)	2000		
	Summary	nvarchar(max)	max		
	AttachmentDoc	nvarchar(500)	1000		
	DbTimestamp	timestamp	8		
	SynergyId	int	4		

Synergy Comments

	Name	Data Type	Max Length (Bytes)	Allow Nulls	Identity
٩	CommentId	int	4		1 - 1
	CommentText	nvarchar(1000)	2000		
	CreationTime	datetime	8		
	CreatedBy	nvarchar(100)	200		
	DbTimestamp	timestamp	8		
	Synergyld	int	4		

5.5 DOMAIN MODEL

In this section we present a number of the most important Business Objects of the eSymbiosis platform.

5.5.1 ORGANISATION

The business object *Organisation* represent a member of the eSymbiosis ecosystem that either has resources to offer ("haves") or requests resources of other participants ("wants"). An organization has multiple member sites, which need or produce the relevant resources. From the usability point of view, the organization is represented by a user, who accesses the relevant functionalities of the platform.



Figure 13: The domain model of the Organisation business object

5.5.2 SITE

The Site business object represent an industrial unit of the eSymbiosis ecosystem, which belongs to one particular Organisation. The site also belongs to a specified region and an IS Practitioner is responsible for facilitating the synergies that the Site is involved into.

Site (State Class)		SICCodeInfo (Value Class)	ISPractitioner (State Class)	
			5 ISPractitioner	
Attributor		⊟ Attributes		
Attributes		SICCode : string	Attributes	
		Name : string	💡 👩 ISPractitionerId : int	
SiteSICCode: SICCodeInfo		Operation String	ISPractitionerTitle : string	
O SiteAddress: string	*		ISPractitionerFirstName : string	
SitePostaiCode: string			ISPractitionerLastName : string	
VI site I own: string		Basian (State Class)	ISPractitionerTelephone : string	
SiteCountry: CountryInfo		Region (State class)	ISPractitionerMobile : string	
Site relephone : string			ISPractitionerFax: string	
QU SiteFax: string		Attributer	ISPractitionerEmail: string	
SiteWebAddress: string	* 1	Co Decise Iduict	ISPractitionerPhoto: string	
SiteNotes: string		S DecionName string	<pre>@DbTimestamp:byte[]</pre>	
SiteDateAdded : Date fime		All atitude: dermal	EU Sites : Site	
SiteSector: SectorInfo		All positude decimal	SPractitionerAddresses : ISPractitionerAddress	
o Site Vame : string		S ISPractitionerDegion : ISPractitionerDegion	Supervisional State Stat	
VI SiteCounty: string		ago an racadance region tan racadance region	EUUser: User	
VI Latitude : decimal			岐UPractitionerNotification : PractitionerNotification	CountryInfo (Value Class)
QU Longitude : decimal	1			
OntologyOwnerid: string				
ResourcesTable String		SiteContact (State Class)	·	- Attributes
 Resources Labieneader : string 		- Steedontaet	Resource (State Class)	Se CountryId: int
Elifected Contacts : Site Contact	1 *	C Attributes	5 Resource	ISOCode: string
Tureprochitecer Jeprochitecer		Attributes		All Name : string
Supersurger Dessurge		Vi Contactio : Int	⊟ Attributes	V 0
Surveyor Cesting Crassing tion		O Contact lite: string	OntologyResourceId: int	
ago gansatori. Organisatori		Contact-Instivame : string	OntologyInstanceId: string	
		ContactLastvame: string	Q Name: string	
		Contact Leephone : string	I XmlDescription : string	
		Contactividolie: string	MatchesCount: int	
SectorInfo (Value Class) 🖄		Contact=ax:string	ResourcePropertiesRow: string	
		Ontactemail: string	IsLocked: bool	
		Contactuop rite: string	🗐 Site : Site	
Attributes		Contactivotes: string	ResourceMatches: ResourceMatch	
💡 👔 Sector Id : int		VI ContactuateAdded: Date I me	ResourceMatch : ResourceMatch	
I SectorName : string		VU Ismannesponible: Dool	ResourceProperties : ResourceProperty	
		Contacti ypeinto: Contacti ypeinto		
		VI Contactstatusinto : Contactstatusinfo		
		El Cita Canta de Addense a Cita Canta de Addense		
		agu she contact Addresses : She contact Address		

Figure 14: The domain model of the Site business object

5.5.3 SYNERGY

The Synergy business object represents the process of the collaboration between a member site that offers a resource to a member site that needs a resource.



Figure 15: The domain model of the Synergy business object

5.5.4 SYNERGY METRICS

The Synergy Metrics business object represents a set of metrics that are submitted by each synergy participant in relation to the measurable results of the process.



Figure 16: The domain model of the SynergyMetrics business object

5.5.5 CASE STUDY

The Case Study business object represents the summary that is produced after the successful completion of a synergy, from the input of the IS Practitioner, the synergy details, and the related synergy metrics.



Figure 17: The domain model of the Case Study business object

6 SUMMARY AND CONCLUSIONS

The semantic web service portal offers a wide range of functionalities that allow to the user to become part of the Industrial Symbiosis (IS) ecosystem and take advantage of the existing sources of IS knowledge stored in the portal. The purpose of this deliverable is to introduce these functionalities to the reader and familiarize them with the underlying technical infrastructure of the portal.

In more detail, this document summarized the architecture and the design of the eSymbiosis platform modules that implement the semantic web portal functionalities (Activity 2.4). The relevant components are:

- the Information Portal, which provides and manages access to the various knowledge sources in the portal,
- the CRM, which manages the profiles of the Organisation Member Users, the IS Practitioners, and the Administrators with the relevant managerial functionalities, and
- the Search Facility (which allows the user to search for and navigate to the requested information sources or functionalities).

The corresponding components were examined both from a functional and from a technical perspective.

Moreover, the portal was presented from a technical point of view: from the abstract level of implementation strategy to the specific technologies that were used. The domain model and its data representation were introduced and analysed, in order to cover all aspects of the technical infrastructure that materialize the provided portal functionalities.

7 ΠΕΡΙΛΗΨΗ ΚΑΙ ΣΥΜΠΕΡΑΣΜΑΤΑ

Η σημασιολογική δικτυακή πύλη παρέχει ένα μεγάλο εύρος από λειτουργικότητες, οι οποίες επιτρέπουν στο χρήστη να συμμετάσχει στο οικοσύστημα Βιομηχανικής Συμβίωσης (ΒΣ) και να αξιοποιήσει τις υπάρχουσες σχετικές πηγές γνώσης της πύλης. Σκοπός αυτού του παραδοτέου είναι να παρουσιάσει αυτές τις λειτουργικότητες στον αναγνώστη και να τον εξοικειώσει με την υφιστάμενη τεχνική υποδομή της πύλης.

Πιο αναλυτικά, αυτό το έγγραφο συνοψίζει την αρχιτεκτονική και το σχεδιασμό των λειτουργικών μονάδων της πλατφόρμας eSymbiosis που υλοποιούν τις λειτουργικότητες της σημασιολογικής διαδικτυακής πύλης (Δραστηριότητα 2.4). Οι σχετικές λειτουργικές μονάδες είναι:

- η Πληροφοριακή Πύλη, που παρέχει και διαχειρίζεται την πρόσβαση στις διάφορες πηγές πληροφοριών της πύλης,
- η Διαχείριση Πελατολογίου, που διαχειρίζεται τα προφίλ των χρηστών των συμμετεχόντων Οργανισμών, των Υπευθύνων ΒΣ, και των Διαχειριστών με τις σχετικές λειτουργικότητες διαχείρισης, και
- η Λειτουργία Αναζήτησης (που επιτρέπει στον χρήστη να αναζητά και να προηγείται στις ζητούμενες πηγές πληροφοριών ή λειτουργικότητες.

Οι σχετικές λειτουργικές μονάδες εξετάστηκαν τόσο από λειτουργική όσο και από τεχνική πλευρά.

Επιπλέον, η πύλη παρουσιάζεται από την τεχνική σκοπιά: από το γενικότερο επίπεδο της στρατηγικής υλοποίησης ως τις συγκεκριμένες τεχνολογίες που χρησιμοποιήθηκαν. Το μοντέλο των οντοτήτων και η αναπαράσταση του σε επίπεδο δεδομένων παρουσιάζονται και αναλύονται, ώστε να καλυφθούν όλες οι πλευρές της τεχνικής υποδομής, οι οποίες υλοποιούν τις παρεχόμενες λειτουργικότητες της πύλης.

APPENDIX: USER MANUAL

Step 1: Create account for first time user

A user visits the site for the first time and needs to register, so they select "Start Participating!"

Start Participating!	Have an account? Login! 📁 🕅
Home Information Centre Research News Success Stories About	
	-
States and the states of the s	100
and the second sec	
Reduce the natural resource consumption	
welcome	Tag Cloud
eSymbiosis is a web-based platform which enables users, to participate in industrial symbiosis (IS) activities that improve resource efficiency across the economy.	energy energy reuse Industrial symbiosis is life plastic process symbiosis

In the screen that follows, the user that represents the Organisation registers his/her user account, by providing his basic information.

eSymb	piosis	5				
omote Industrial Symbi	iosis					
Home Inform	ation Centre	Research	News	Success Stories	About	
Member Reg	sistration*					
litle:	Mr	•				
First Name:	Alexander		*			
First Name: Last Name:	Alexander Mathewson		*			
First Name: Last Name: Email:	Alexander Mathewson a.mathewson@	@gmail.com	* *			
First Name: Last Name: Email: Username:	Alexander Mathewson a.mathewson(a.mathewson)	@gmail.com	* * *			
First Name: Last Name: Email: Username: Password:	Alexander Mathewson a.mathewson a.mathewson	@gmail.com	* * * *			
First Name: Last Name: Email: Username: Password: Confirm Password:	Alexander Mathewson a.mathewson a.mathewson	@gmail.com	* * * * * *			

Right after this page, the user receives the following email message with a link to verify the specified email address.

eSymbiosis Platform Regi	stration Step 1: Verify your email address 😑 🔤	(1° SHARE RAPPORTIVE 🖕 🗐 🖉
info.esymbiosis@gmail.com		1:40 PM (3 minutes ago) 📩 🔺 👻
	eSymbiosis A Platform to enable and promote Industrial Symbiosis	
	Dear Alexander,	
	Please click the link below to verify your registration as Member at eSymbiosis:	
	http://dev1.clmsuk.com/CLMS_eSymbiosis_2_0_pda_NewTheme/Forms/PersonEmail/VerificationForm/ValidateCode? code=529CE9109CFD	
	Your login information is provided below:	
	Username : a.mathewson Password : 1234	
	Thank you, The eSymbiosis team	
	31/5/2013 11/40/20 πμ Copyright 2011-2013 C	eSymbiosis

Clicking on the link, will navigate the user to the website, and the email address will be registered as verified.



A second email message is received informing the user regarding the email address verification success and the registration completion.

info.esymbiosis@gmail.com to me ▼		1:40 P	M (2 minutes ago) 🙀 🔺 👻
	eSymbiosis A Platform to enable and promote Industrial Symbiosis		
	Dear Alexander, Thank you for completing your registration as Member at eSymbiosis. You may log in <u>here</u> using your username and password. Thank you. The eSymbiosis team		
	31/5/2013 11:40.49 πμ	Copyright 2011-2013 © eSymbiosis	

The User may now login with his/her credentials, in order to start using the website to a greater extent.

					Start	Participating!	Have an ac	count? Login!	
Sym	DIOSIS	5					_		
mote Industrial Syn	na Ibiosis								
Home Infor	mation Centre	Research	News	Success	Stories	About			
Log In									
Log In Please enter	a valid usernam	e and pass	word to lc	ogin		You don'	t have a	n accour	nt vet?
Log In Please enter	a valid usernam	e and pass	word to lo	ogin	,	You don'	t have a	n accour	nt yet?
Log In Please enter Username:	a valid usernam a.mathewso	e and pass	word to lo	ogin	,	You don'	t have a	n accour Register	nt yet? r Now!
Log In Please enter Username: Password:	a valid usernam a.mathewso	e and pass	word to lo	ogin		You don'	t have a	n accour Registei	nt yet? r Now
Log In Please enter Username: Password:	a valid usernam a.mathewso	e and pass	word to lc	ogin	,	You don'	t have a	n accour Registei	nt yet? r Now
Log In Please enter Username: Password:	a valid usernam a.mathewso	e and pass) on me next time. Login	word to lc	ogin	,	You don'	t have a	n accour Registei	nt yet? Now

The User is provided with suggestions based on the current state of completion regarding their profiles.



Step 2: Register Organisation

In the following screen, the user has to provide the basic Organisation information.

• •				Change Password	🕅 Logout 🛛 🗮 💥		
Symb latform to enable and note Industrial Symb) IOSIS ^a iosis		Register Organisation Start taking advantage of eSymbiosis by registering your or				
Home Inform	ation Centre Research	News	Success Stories	About			
ew Organis	sation*						
ame:	Mathewson Ltd	*	Web Address:	www.mathewsoncor	p.com		
umber of employees:	101-500 Employees	•	T				
ontact Person							
Use my details a	s the Contact Person of this Organi	sation					
Title:	Mr 👻						
First Name:	Tyler		Last Name:	Fings			
Telephone:	+45 665388772		Fax:				
Mobile:			Email:	t.fings@mathewso	ncorp.com		
Address:			PostalCode:				
Address:			PostalCode: County:				



Organisation name, web address, size of the organisation, as well as some contact details.

After registering an organisation, the User is suggested to add sites to the newlycreated organisation.

	ation Centre	Research	News	Success Stories	About	_
dit Organis	ation					
lame:	Mathewson Ltd		*	Web Address:	www.mathewsoncorp.com	
umber of employees:	101-500 Employ	ees	•			
AT Number:	3233543442			Turnover:	0.00	
Title	Mr	-				
Title: First Name: Telephone:	Mr Tyler +45 665388772	2		Last Name: Fax:	Fings	
Title: First Name: Telephone: Mobile:	Mr Tyler +45 665388772	2		Last Name: Fax: Email:	Fings t.fings@mathewsoncorp.com	
Title: First Name: Telephone: Mobile: Address:	Mr Tyler +45 665388772	2		Last Name: Fax: Email: PostalCode:	Fings t.fings@mathewsoncorp.com	
Title: First Name: Telephone: Mobile: Address:	Mr Tyler +45 665388773	2		Last Name: Fax: Email: PostalCode: County:	Fings t.fings@mathewsoncorp.com	

Step 2: Add Sites

The following screen in used for adding the Sites of the Organisation that participate in the eSymbiosis project. Apart from the Site details, such as name and activity sector, the user provides the geographical information of the site. The corresponding location is shown in the provided map.

Site Info					
Site Name:	Mathewson UK *				
Sector:	[Please Select]				-
Activity Sector:	5ηροτροφία	*			
ddress					
Search:	35 Hursley Road, Chandler's F	Ford, Ήστλι, Χαμσάιρ S	SO53 2FS, Ηνωμένο Βασίλειο		
6.14	Google	Bristol Cardiff Barnstaple Sol Exeter o Torquay Plymouth Guernsey Jerso	London sLeigh-on-	Brugge Ant Gento Tournato Br	
Address:	Hursley Road	35	Postal Code:	SO53 2FS	
Area:			Town:	Χαμσάιρ	
County:			Country:	Great Britain (UK)	
atitude:	50.9860989333936		Longitude:	-1.38427734375	
Region	[Please Select]	-			
Celephone:			Web Address:		

Upon saving the Site information, the user can then start registering and/r requesting Resources. The user may also access the Sites' details at any later point by clicking the corresponding menu item *My Sites* at the upper right of the screen.

oSymbiocic	_	Change Password	🕯 Logout 🛛 🗮 💥
A Platform to enable and promote Industrial Symbiosis	My Organisation My S	Sites My Synergies My Notifications Continue by adding or requestin	My Invitations g resources for your sites!
Home Information Centre Research	News Success	Stories About	

In the "My Sites" page, the user may modify each Site's details and also view how Sites are placed geographically, on a map.



Step 3: Add Further Site Details

For the selected Site, the user can submit the Resources of the Site. For the Resources that this Site needs/provides, the Organisation user can select the corresponding option as shown below.

Resources										
Add Resource	1									
	Туре	EWC Code	Name	Start of availability	End of availability	Quantity Type	Quantity	Unit of Measuremei	Locked	Number of Matches

This action initiates the Resource Registration process for the selected Site, as explained in the following section. And upon saving the changes, the resource is shown in the "Edit Site" page as in the following form

Resources										
Add Resource										
	Туре	EWC Code	Name	Start of availability	End of availability	Quantity Type	Quantity	Unit of Measuremei	Locked	Number o Matches
🖍 Q	I have a resource to offer		AnimTissue	2012/01/01	2018/01/01	Emulsion	2.00	Litres	-	0

Step 4: Add resource

Once the user has registered a site, a resource can be added using the *Add Resource* button at the bottom of the site details page, as mentioned previously.

Re	sources										
	Add Resource										
T		Туре	EWC Code	Name	Start of availability	End of availability	Quantity Type	Quantity	Unit of Measuremei	Locked	Number of Matches

This button then takes the user to the resource registration page which allows them to follow a sequence of prompts that are designed to first classify and then add details to the resource they would like to register.

This page originally has multiple sections, as the Organisation user can specify if the Organisation's site is:

- 1. Offering a resource
- 2. Having a Technology, or
- 3. Wanting a Resource

>	I have a resource to offer	Is this information confidential?	🔘 Yes 💿 No
$\mathbf{\Sigma}$	I have a Technology	Industry Sector (NACE)	(choose)
\triangleright	I want a Resource	Located in Region	Greece
		Needed Expertise	(choose)
		Type of Resource you can Supply	* (choose)

Selecting each option will change the right-hand pane, which allows to the user to specify the Resource details for the selected need.

By selecting the Back button the user will return to this view.



Under this is the current section, which allows the user to identify the resource that is closest to theirs using the list to the left. The user has the option of searching this list using the search box above – in this example the word "Iron" shows 10 entries and the highlighted numbers show where these can be located.

To the right of the classification list can be seen the properties that have been associated with the chosen item, where red asterisks represent those fields that are required to be filled in before the registration can be approved.

Finally the user can choose to store their responses using the "Apply" button, discard unsaved responses using the "Cancel" button, or both save and return to the site overview page using the "Save" button.

Search for Resource Matches

From the Site's screen, where the Resources of the Site are displayed, the user can initiate a search for potential synergy matches with other available Resources. For this action, the user has to click on the Search button, in the Resource details, as shown below.

Edit Site								
Step 1 Register Organisa	ation	Step 2 Add Sites		Step 3 Contact Info		Ste Site	p 4 e Resources	
Site Info								
Site Name:	Mathewson U	к *						
Sector:	[Please Selec	t]						•
Activity Sector:	😰 Σηροτρο	φία	*					
	Type I have a resource to offer	EWC Code	Name Sta avai AnimTissue 2012	rt of End of ability availability /01/01 2018/01/01	Quantity Qu Type Qu Emulsion 2	uantity Mea 2.00 Li	nit of Locked suremei	Number o Matches
ddress								
Search:				7-18 × /1 \: A 💌				
		• <u>+</u>	Birminghamo	Coventry	Χάρτης Δορ	υφόρος Haarl Leid Rotterda		

When this action is selected, the Resource is locked until the completion of the search process and the mechanism retrieves matching Resources for potential Synergies.

Resource Matches

For a selected Site, the user can see the retrieved matches for each of the Site's available resources, by clicking the View List of Matches button from each row of the Resources table. Also, note that the resource is now locked

For example, the following screen shows that for each of the Site resources, there are multiple potential resource matches.

.ure site										
Step 1 Register Organi	isation	Step 2 Add Sites			Step 3 Contact Info			Step 4 Site Resourc	ces	
Site Info										
Site Name:	Mathewson U	Ж ∗								
Sector:	[Please Selection of the selection of th	ct]								•
Activity Sector:	😰 Σηροτρ	οφία	*							
Add Resourc	e									
Add Resourc	e Type	EWC Code	Name	Start of	End of	Quantity	Quantity	Unit of	Locked	Number of
Add Resourc	e Type I have a	EWC Code	Name	Start of availabilit	End of y availability	Quantity Type	Quantity	Unit of Measuremei	Locked	Number of Matches
Add Resourc	e Type I have a resource to offer	EWC Code	Name AnimTissue	Start of availabilit 2012/01/0	End of y availability 11 2018/01/01	Quantity Type Emulsion	Quantity 2.00	Unit of Measuremei Litres	Locked	Number of Matches
Add Resourc	Type I have a resource to offer	EWC Code	Name AnimTissue	Start of availabilit 2012/01/0	End of y availability 11 2018/01/01	Quantity Type Emulsion	Quantity 2.00	Unit of Measuremei Litres	Locked	Number of Matches
Add Resourc	Type I have a resource to offer	EWC Code	Name AnimTissue	Start of availabilit 2012/01/(End of y availability 11 2018/01/01	Quantity Type Emulsion	Quantity 2.00	Unit of Measuremei Litres	Locked	Number of Matches
Add Resourc	e Type I have a resource to offer	EWC Code	Name AnimTissue	Start of availabilit 2012/01/(End of y availability 11 2018/01/01	Quantity Type Emulsion	Quantity 2.00	Unit of Measuremei Litres	Locked	Number of Matches
Add Resource	Type I have a resource to offer	EWC Code	Name AnimTissue	Start of availabilit 2012/01/0	End of y availability 11 2018/01/01	Quantity Type Emulsion	Quantity 2.00	Unit of Measuremen Litres	Locked	Number of Matches
Add Resourc	e Type I have a resource to offer	EWC Code	Name AnimTissue	Start of availabilit 2012/01/0 Leic	End of y availability 11 2018/01/01 ester	Quantity Type Emulsion	Quantity 2.00 Δορυφόρος Η	Unit of Measuremei Litres	Locked	Number of Matches
Add Resourc	Type I have a resource to offer	EWC Code	Name AnimTissue Birmingh	Start of availabilit 2012/01/(Leic nam© ac	End of y availability 11 2018/01/01	Quantity Type Emulsion	Quantity 2.00 Δορυφόρος Ηα Rotter	Unit of Measuremen Litres	Locked	Number of Matches

By clicking *View*, the user sees the details for the retrieved matches of the selected Site resource. If a resource match seems compatible, the Organisation user can select the *Create Synergy action* with the specific resource match.

C	hing	:-				Change Pa	ssword 🤶 L	.ogout 🛅 🕌
Platform to enable pmote Industrial S	DIOS e and Symbiosis	IS	My Organis	ation My Sit	es MySyn	ergies My Not	ifications M	y Invitations
Home In	formation Cent	re Research	ı News	Success St	ories A	bout		
Resource	Matches							
Туре	EWC Code	Name	Start of availability	End of availabili	ty Qua	ntity Type Qu	uantity	Unit of Measurement
I have a resource to offer	_	AnimTissue	2012/01/01	2018/0)1/01	Emulsion	2.00	Litres
Resource Mat	ches							
	Туре	EWC Code	Name	Start of availability	End of availability	Quantity Type	e Quantity	Unit of Measuremen
Create Synergy	False	R	esourceName1	2012/12/03	2012/10/03	Solid	3.00	Square metre (m2)
Create Synergy	I want a Resource							
Back								

This action creates a new Synergy and the corresponding Synergy form is shown to the user, as explained in more detail in the following section.

Synergy Lifecycle

In the Synergy form, the two participating Organisations can:

- View details about the other participant
- View details about the resource match, the properties of the resources, etc.
- Submit their agreement to proceed to the next step of the Synergy lifecycle.
- Block the Synergy process for a specified reason, so that the IS Practitioner will have to be involved to resolve the issue and unblock the Synergy.
- Submit comments for the other participating Organisation.

First Participant		Second Participant	
Organisation:	Generic Power Supply Organisatic	Organisation:	New Materials Organisation
Web Address:	http://www.google.com	Web Address:	www.newmaterials.gr/
Organisation Notes:	This is the organisation that focuses mainly on energy production from gas or oil.	Organisation Notes:	Created for Demo purposes.
Date Added:	02/11/2012	Date Added:	05/07/2012
From Site:	Κεντρικη Ενεργειακη Μοναδα	From Site:	Νεα Επεξεργαστική
Address:	Βασιλίσσης Σοφίας 39	Address:	Κουμουνδουρου 74
Postal Code:	15136	Postal Code:	18545
Fown:	Αθήνα	Town:	Πειραιας
County:	Αττικής	County:	Αττικης
Felephone:	2105465465	Telephone:	2104625785
FAX:	2105465465	FAX:	2104625785
Site Web Address:	http://www.powerSupply.com/Cen	Site Web Address:	www.newmaterials.gr/Sites/FirstS
Notes:	Ξεκινησε πειραματικα τη λειτουργια του το 2010.	Notes:	

Resource Match						
Relevance:	75.67 %					
First Resource			Second R	esource		
Resource Id:	142		Resource Id:	2	75	
Matches Count:	6		Matches Co	unt: O		
Locked:			Locked:]	
Name	boxes		Name	li	ianocellulosic Feedstock	
Start of availability	2001/01/01		Start of avail	ability 2	012/08/09	
End of availability	2012/01/01		End of availability		015/12/08	
Quantity Type	Solid		Quantity Type		Emulsion	
Quantity	1		Quantity		50	
Unit of Measurement	Tonnes (kg*1000)		Unit of Measurement		onnes (kg*1000)	
Synergy Information						
Synergield:	768		CreationDate	09/	11/2012	
IsCompleted			isBlocked:			
First Party ready to proceed to next Status:	V		Second Party r next Status:	eady to proceed to		
Step 1: Idea Ste	p 2: Discussion	Step 3: Ne	egotiation	Step 4: Implementation	Step 5: Complete	
Description of Current Status: The part Proceed To Next Step	ties discuss in more detai	il (costs, quantitie	es, critical path,	etc).		
Block Synergy						
Reason for blocking Synergy Progress:						
Block Synergy Progress						

The Synergy lifecycle has the following steps, as indicated in the corresponding screen:

- 1. Idea
- 2. Discussion
- 3. Negotiation
- 4. Implementation
- 5. Completion

To progress from one step to the next, both Organisations have to agree that they

Synergield:	768	CreationDate	C	9/11/201
IsCompleted		isBlocked:]
First Party ready to proceed Status:	I to next 🕡	Second Party next Status:	ready to proceed to]
Step 1: Idea	Step 2: Discussion	Step 3: Negotiation	Step 4: Implementatio	n

are ready to proceed, by selecting the corresponding checkbox (i.e. *First party ready to proceed to next Status*) and clicking *Proceed to Next Step*.

Then a notification is sent to the other Organisation user, in order to review the Synergy and maybe agree to the continuation of the process. When this agreement is mutual, the Synergy progresses to the next step and a notification is sent to both parties. A notification is also sent to participants when the Synergy has been updated or blocked.

An example of the notification is shown below:

Notification Information	n		
NotificationId:	432	OrganisationName:	Generic Power Supply Organisation
Header:	Synergy saved.	Creation Date:	12/11/2012
Content:	Synergy has been saved. F	Please visit Synergy List to view details.	
View related item:	~/Forms/SynergyForm/Edit	Synergy?ID=767	
isRead:	\lor		
Delete			

The participating organisations can access all their Synergies from the corresponding option of the upper right menu:

latform to enal mote Industrial	ble and I Symbiosis	WyO	iganisation my	Siles My Synerg	ies my nouncations	
Home I	nformation Centre	Research Nev	ws Success	Stories Abo	ut	
All Synergies	Completed Synergies	Pending Synergies	Blocked Synerg	ies		
		Synergy Details				
Creation Date	a 31/05/2013	Cur	rent Status	Idea		
Blocked		Con	npleted			
		First Resource				
Name		Mat	ches Count	3	View Synergy	
Site Name	Mathewson U	K Org	anisation Name	Mathewson Ltd		
		Second Resource	e			
Name		Mat	ches Count	3		
Site Name	Μοναδα Επεξεργασιας	Org	anisation Name	Generic Power Supply Organisa	ation	

Also, the Notifications can be viewed at any point, from the upper right menu as well:

eSymbi A Platform to enable and promote Industrial Symbiosis	osis	My Organisation	My Sites 1	My Synergies	Change Password My Notifications 3	R Logout 🚈 🕅
Home Informatio	on Centre Research	News S	Success Stori	es About		

Blocking/Unblocking Synergy

Block Synergy	
Reason for blocking Synergy Progress:	
Block Synergy Progress	

As mentioned previously, the participating Organisations can block the Synergy progress from the corresponding option.

In case one of the two participants selects to block the Synergy progress, the IS Practitioner is notified about the issue. [Note that the IS Practitioner users are created from the Administrator].

NotificationId:	474		
ISPractitionerFirstName:	kostasTestName	ISPractitionerLastName:	kostasTestName
Header:	Synergy blocked.	CreationDate:	13/11/2012
Content:	Synergy with id: 767 was b	ocked for the following reason: Could not ag	ree on quantity with the other party.
relatedURL:	~/Forms/SynergyForm/EditS	Synergy?&ID=767	
isRead:	V		

The IS Practitioner is responsible for resolving the issue and can then unblock the Synergy from the corresponding button in the Synergy screen. After the Synergy is unblocked, its lifecycle can continue as normal.

sCompleted				
		isBlocked:	V	
First Party ready to proceed to n Status:	ext 🖉	Second Party ready to next Status:	proceed to	
Step 1: Idea	Step 2: Discussion	n Step 3: Negotiation Ste	p 4: Implementation	Step 5: Complete
lock Synergy	· 			

eSy A Platform to e promote Indus	mbiosis Inable and Irial Symbiosis	;	My Organisati	on My Sites	My Synergies	Change Password My Notifications 3	A Logout	ions
Home	Information Centre	Research	News	Success Sto	ories Abou	t		
	Statistics							
	Member Sites							

The IS Practitioner can access his/her list of Blocked Synergies through the Synergies page accessible through the upper right menu option and then in the last tab of that page.

Home In	ormation Centre Rese	earch News Suc	cess Stories A	bout	_
All Synergies	Completed Synergies Pend	ing Synergies Blocked S	ynergies		
	Syner	gy Details			
Creation Date	31/05/2013	Current Status	Blocked		
Blocked		Completed			
	First	Resource		View Synergy	
Name		Matches Count	3	Them Synergy	
Site Name	Mathewson UK	Organisation Name	Mathewson Ltd		
	Second	1 Resource			
Name		Matches Count	3		
	Μοναδα	Organisation Name	Generic Power Supply		

Metrics

From Organisation user's perspective: The Organisation users have to submit a number of metrics, in relation to the Synergy. These metrics can be updated during the synergy progress (by clicking the "Review Metrics" button in the Synergy form) and they have to be finalised when the Synergy is completed; then, the Organisation user submits the finalised version of the metrics to the IS Practitioner for review (in the metrics form, the user clicks "Submit Metrics As Final").

Synergy ID	768			
Creation Date	09/11/2012	Completion Date	05/12/	2012
Blocked		Cancelled		
Step 1: Idea	Step 2: Discussion	Step 3: Negotiation	Step 4: Implementation	Step !
Review Metrics	- ,			

Jobs Created:	435	Businesses Assisted:	0
Jobs Safeguarded:	0	New Businesses Created:	43
New Businesses Surviving:	0	Training Outcomes:	252
CO2 Reduction (in Tonnes):	0.00	Material Diverted (in Tonnes):	48.50
Hazardous Waste Reduction (in Tonnes):	0.00	Virgin Materials (in Tonnes):	34.00
Water Savings (in Tonnes):	234.00	Additional Sales:	0.00
Cost Savings:	0.00	Private Investment:	165.00
Final version of metrics: Reviewed and Verified by IS Practitioner:			

From IS Practitioner's perspective: The IS Practitioner can review both metrics' info that the two members of the Synergy provide.

Synergy ID	768			
Creation Date	09/11/2012	Completion Date	05/12/	/2012
Blocked		Cancelled		
Step 1: Idea	Step 2: Discussion	Step 3: Negotiation	Step 4: Implementation	Step 5: Complete
escription of Current Status:	Synergy process completed succ	essfully.		

The IS Practitioner is notified that the user has submitted a finalised Metrics version for review. If the Metrics seem valid, the IS Practitioner confirms them by clicking "Verify"; otherwise, the Practitioner requests a revision from the Organisation user, by providing comments on the points that need correction and then clicking "Request Revision". This action will unlock the metrics' form the Organisation user, so that the metrics can be corrected and resubmitted. The platform informs each respective user (Organisation user or Practitioner) when an action is needed, with a notification.

	ter en due la contra l'actuale			
user:	nos need to be revised, pie:	ase submit details for Organis		.:
			~	

When both participants of the Synergy have completed the metrics submission and the IS Practitioner has validated them, the Practitioner can proceed to the generation of a case study based on the metrics, as the following section explains in detail.

Case Study

After the Synergy has been completed and the metrics of the two participating organisations have been validated, the IS Practitioner can create a new Case Study based on the Synergy and its relevant metrics.

The IS Practitioner can access the case study form from the synergy form, as shown below (please note that the synergy must have been completed and both submitted metrics must have been verified by the IS Practitioner first).

Synergy ID	768		
Creation Date	09/11/2012	Completion Date	05/12/201
Blocked		Cancelled	
Step 1: Idea	Step 2: Discussion	Step 3: Negotiation	Step 4: Implementation
Description of Current Status:	Synergy process completed succ	essfully.	
escription of Current Status:	Synergy process completed succ	essfully.	

In the case study form, the Practitioner can view the metrics of the Synergy (first screenshot below) and can add descriptive details in relation to the Synergy's

New Materiale Organization							
New Businesses Created	3	Jobs Created	0				
Businesses Assisted	23	Training Outcomes	0				
New Businesses Survivina	23	Jobs Safeguarded	4				
Hazardous Waste Reduction	12.40	CO2 Reduction	0.00				
Water Savings	0.00	Material Diverted	0.00				
Additional Sales	0.00	Virgin Materials	0.00				
Private Investment	0.00	Cost Savings	0.00				
Generic Power Supply	Organisation						
New Businesses Created	43	Jobs Created	435				
Businesses Assisted	0	Training Outcomes	252				
New Businesses Surviving	0	Jobs Safeguarded	0				
Hazardous Waste Reduction	0.00	CO2 Reduction	0.00				
Water Savings	234.00	Material Diverted	48.50				
Additional Sales	0.00	Virgin Materials	34.00				
Private Investment	165.00	Cost Savings	0.00				

successful outcomes (second screenshot).

 Case Study Info							
Title:	Case Study for Process materials						
Created by:	pract1						
Creation Date:	15/09/2011						
	Lorem ipsum dolor sit amet, consectetur adipiscing elit. Phasellus ac sodales turpis. Fusce eu orci id nulla portitor convallis vitae quis libero. Sed vitae ligula id nulla posuere sagittis sed non purus. Pellentesque portitor nunc turpis, eget mollis neque. Quisque scelerisque posuere orci, in dignissim enim rhoncus in. Aliquam aliquam mattis vehicula. In aliquam nunc non purus venenatis porta. Nullam orci turpis, suscipit id ultrices id, venenatis non magna. Nunc sit amet mattis quam.						
Summary:							
	ii.						
Attachment Doc:	Αναζήτηση						
Save Exit							

Statistics

The Organisation user can view Statistics in relation to the Synergies created, the matches, the Sites per county, and the Sites per code. To access this screen, the Organisation user clicks from the top menu: *Information Center* > *Statistics*.

~						Change Password	🔒 Logout	≝ ₩
eSymbiosis		5	My Organisation My Sites		My Synergies	My Notifications 3	tifications <mark>3</mark> My Invitations	
promote Indus	trial Symbiosis							
Home	Information Centre	Research	n News	Success Sto	ories About	:		
Home	Information Centre Statistics	Research	n News	Success Sto	ories About	:		

A view of the statistics is provided below:



Member Sites

Moreover, the user can go to: *Information Center > Member Sites*, to see the Sites located on a map and search for sites with specific criteria.

	a Cvy	mhiocid	~				Change Password	🔒 Logout	## ##
A	Platform to e			My Organisation	My Sites	My Synergies	My Notifications 3	My Invitati	ons
P	romote Indus	trial Symbiosis							
	Home	Information Centre	Research	News	Success Sto	ories About	:		
		Statistics	_						
		Member Sites			-				
	eSym	nbiosis	_			1	Establish IS	networks	
	A Know ∢Platfor	vledge based m for Industrial		22			* Prepare and to embark or	train indu 1 IS	stries >
	Symbic	osis (IS)				7	* integrate be with valuable	est practic e knowled	es ge on IS



As shown in the relevant screen, the criteria that can be specified by the user are:

- 1. Industrial Activity
- 2. Site Town
- 3. Site County

The user can also select one specific Industrial Activity (by clicking on the corresponding Activity rectangle), to view only the Member Sites of this type of Activity, or select multiple Activities (by holding Ctrl and clicking multiple activity rectangles), to filter the displayed Member Sites for the selected Industrial Activities.

An example is shown below, where three Industrial Activities have been selected and only the corresponding Member Sites are shown on the map:

