Development of knowledge-based web services to promote and advance Industrial Symbiosis in Europe (**eSYMBIOSIS**)

LIFE09/ENV/GR/000300

END-OF-ACTION REPORT

ACTION 3

SERVICE ARCHITECTURE & IMPLEMENTATION

June 2014

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1. INTRODUCTION

1.1 MANAGEMENT FRAMEWORK AND PROCEDURES

NTUA is the overall Project Coordinator supervising the progress of all the actions in close collaboration with all the associated beneficiaries. In project Management, NTUA:

(i) has the global view on the project;

(ii) ascertains the progress;

(iii) manages the priorities during the project;

(iv) secures the flow of information between the project actions/activities as well as between the project beneficiaries as required for the implementation of the project..

The Executive Committee composed from representatives of all beneficiaries of the project with the Project Coordinator manage the progress of the project, resolve issues, enhance communication among the participants and to inspect the quality and deliverables and reports. For each Action / Activity there has been assigned a Leader amongst the beneficiaries.

The end-of-Action Reports are internal management quality reports of eSYMBIOSIS, as described in the technical Annex of the project and conform to the standard of the Life+ Programme for monitoring project progress via reports/deliverables.

The end of action report is produced in the scope of Action 7, which is responsible for the monitoring and evaluating the project's progress and performance and is running during the whole duration of the project

The general procedures of Action 7 mandate that the coordinating beneficiary (NTUA) together with all the associated beneficiaries perform their monitoring tasks assessing progress of each Action with respect to the expected results and the performance indicators.

For each Action - Activity a managing representative is responsible to prepare a short end-of-Action report and submit it to the Executive Committee assessment. The end-of-Action reports contain information on the work done within the Action under the scope of the Action objectives and the Indicators set.

1.2 END OF ACTION 3 REPORT

Summary

The present document is the *End-of-Action* report of Action 3, “Integration, validation and demonstration”.

Action 3 involves 3 Activities: A3.1, A3.2 and A3.3 as follows:

- Activity 3.1: Web service platform integration;
- Activity 3.2: Testing and validation of service performance;
- Activity 3.3: Demonstration of service in operation;

Action 3 of eSymbiosis had the following targets:

- Integration and deployment of the knowledge based support for user description in both waste stream and solution provider domain; Integration and deployment of the inference engine and the service matchmaker; Integration and deployment of the system tools, the semantic web service and the web portal;
- Integration and Deployment of the semantic web service platform to support matching between users.
- Integration and deployment of the feedback interface tools
- Deliver Demonstrations to the users

The main indicators for the performance of Action 3 are:

- Results from the validation of the service operation; Target: minimum of 80% of satisfactory (positive) results;
- Number of people, companies and agencies participating in the demonstration workshops; Target: minimum of 30 companies, 15 agencies and 40 people included;
- Quality of feedback from targeted users; Target: minimum 90% of satisfactory feedback;
- Number of distributed copies of demonstration material. Target: minimum of 500 copies distributed.

Action 3 of eSymbiosis integrated and deployed in the cloud all architecture components, efficiently supporting the Industrial Symbiosis processes. The platform has achieved and surpassed the initial implementation scope and targets.

2. ACTION ASSESSMENT AND EVALUATION

2.1 WORK PERFORMED

This action had originally been planned with a duration of 11 months (start date: 01/11/2012 and end date: 31/09/2013). The action started "unofficially" July 2012, in order to prepare the demonstrators for the "launch" event in Viotia, March 2013.

After the project extension, the action duration was extended until the end of February 2014; however, it essentially kept shifting until June, to incorporate the changes following the feedback of the "focus groups" and the domain experts of Industrial Symbiosis. The details of Action 3 are shown in Figure 1.

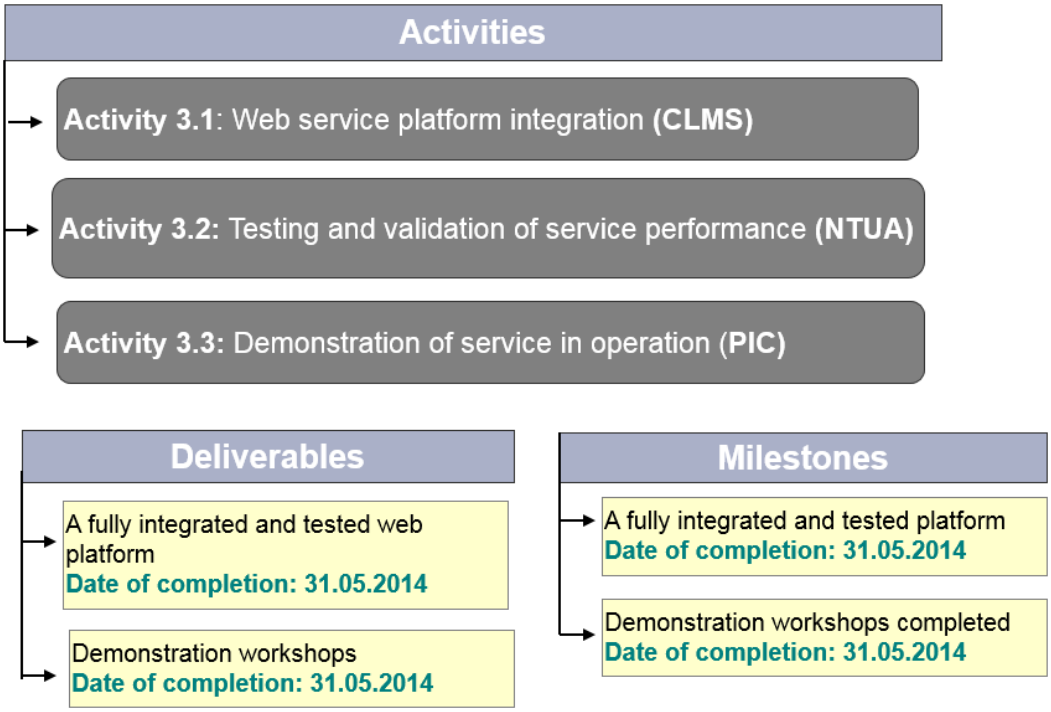

Figure 1: Action 3

According to the Management / Monitoring Procedures Framework of eSymbiosis as previously described, the following responsibilities scheme applied:

> **Activity A3.1 Web Service Platform Integration:** Beneficiary CLMS was responsible for this activity. The platform services were implemented in English. After the successful completion of the tests and validation, the translation was made to Greek.

Activity A3.2 Testing and Validation of Service Performance: beneficiary NTUA was responsible to lead the testing activity. NTUA coordinated the testing and validation, by producing data sets, and subsequently, validated and tested the platform using known cases selected, the sound integration of all components.

Activity A3.3 Demonstrations of Service in Operation: beneficiary PIC was responsible for the activity of the demonstrations organizing with ENVIRECO the training material, involving the Industrial Symbiosis concepts and processes.

Action 3 started earlier on July 2012, involving the following activities:

a. **Activity 3.1 Web Service Platform Integration**: The activity involves the packaging / integration of all functionality of the platform and the deployment of the platform to the cloud facility. In this diagram it is noticeable the separation between the Portal functions and the Intelligent Support components, and their interaction which is delivered seamlessly to the users.

   For this reason, a server has been setup in the Cloud (Greek Ministry of Education / GRNET). The server is hosting all eSymbiosis applications and Portal. The Portal is accessible in the eSymbiosis server as: http://www.esymbiosis.eu/islive.

   The Platform enabled the production of innovative solutions in synergy making and Industrial Symbiosis matches, going beyond currently established practice with a view to take the platform to advanced functionality levels.

   The integrated web-portal offers a wide range of functionality which supports the objectives of the eSymbiosis project extending but not limited to the marketing and promotion of the concept of Industrial Symbiosis, member registration and collaboration, resource registration and discovery, synergy initiation and management, reporting and presentation of successful synergies.

b. **Activity 3.2 Testing and Validation of Services Performance: As regards the** Ontology components, validation testing involved the validation of all aspects of the ontology and the matchmaking process. This was done by using the matching results of several manual and automated case studies, which were then compared in order to evaluate the efficiency and accuracy of

the ontology and the match-making engine. As regards the platform, the consortium Business Experts continuously reviewed the ongoing work on the platform; the feedback was passed to developer partners on functionality and 'look and feel'. The portal functionality was assessed and constantly monitored by a team of experts in the project. To this end, the platform portal was between February and May tested and deployed under a continuous deployment scheme, using agile development methods. In every validation cycle, validation test results were incorporated, resulting to significant changes as regards the look and feel, robustness and performance. The Experts feedback was used by the Integrators (AVCO and CLMS), to constantly update the portal functionality.

c. **Activity 3.3 Demonstration of service in operation**: The development cycle of eSymbiosis had to be run rapidly, this achieved using agile development methods, and in close co-operation with the business experts of the eSymbiosis consortium.

   PIC has been working very closely with AVCO and CLMS to bring the demonstration platform together in advance of the ‘demonstration’ event. All communications and preparation were via Skype. This work was also supported by the UoS and NTUA, who have been developing the demonstration data, business cases and ontologies to support the tests underpinning the demonstrations and trainings.

   With the deadlines of the Workshops rapidly approaching, in both demonstrations, the team focused on getting a suitable environment set up, and configured.

   The Industrial Symbiosis Experts (PIC and Envireco) have brought together an agenda for the demonstration events and prepared presentations and supporting materials. CLMS has produced the platform user manual for training, and setup a number of training cases.

   The demonstrations took place in two rounds:

   a) In the project workshop in NTUA
   b) In a number of repeating workshops (3) during the eSymbiosis Conference.

2.2 PROGRESS ACHIEVED

The successful integration in Action 3, of the functions and features developed under Action 3 is evidenced by the team’s ability to demonstrate it a number of times, to different audiences once the integration had taken place.

A very thorough validation was undertaken once the system was able to be presented as a complete, single 'package', the planning of the testing started in February 2014, and this went through several cycles before the functionality and performance was felt to be what would be necessary to meet the project's objectives, virtually lasting until the end of the Project, however, in the between after April, many workable releases were available.

This process of testing followed what would normally be expected in the development of a new (and unique) software product, while occasionally frustrating to all concerned, it enabled a number of changes and improvements to be made and represented excellent value in terms of the quality of the finished system.

PIC and ENVIRECO worked closely to design and deliver an industry event in April 2014 that was able to attract an appropriate audience (with a focus on regional SMEs) and engage them with the prospect of the final outcome of the eSymbiosis project in June 2014.

The event also included a live demonstration of the platform as a 'work in progress'. The way the project had been compressed during its final six months meant that preparing, organizing and delivering in such a short time was very challenging, but regardless of this we feel that (from the positive feedback and questions about both the system and IS that were received) the event worked well and met its objectives.

All of the events held during the project promoted the concept of Industrial Symbiosis with the focus on industrial by-products and waste, advantages and ease of use of the developed web platform, as well as the benefits to potential customers.

SMEs were particularly targeted for all demonstrations, and the team were able to gain the active support of several key leaders from local industry and the local authority in order to support our engagement activities with industry. The demonstrations and workshops were supported by appropriate written material and leaflets demonstrating the system operation, and highlighting the potential environmental and economic benefits of a well-supported, active IS network.

Feedback received from demonstrations was used to further improve the system during the final months of the project, including some 'fine tuning' of the ontologies and leading to the formal 'release' of the eSymbiosis platform at the final project Conference.

2.3 DEADLINES AND DELIVERABLES

The deliverables of Action 3 were performed as planned, considering the required project extension, so that a mature solution to be delivered as the Platform or eSYMBIOSIS.

The benefit for the time extension was the enrichment of the ontologies with concepts, far beyond the original planned targets, the maturity of user interfaces using latest evolutions of UI web development standards, the robustness of the integration between the User oriented Portal services, and the Intelligent Services based on algorithms for Matching based on the ontologies content.

The Action Deliverables are the platform and the demonstrations. There are also Action 4 deliverables, (the user feedback, and the user manuals) related to the deliverables of this action.

Table 1: Action 3 Deliverables

Name of the Deliverable	Status	Planned[1]	Actual
3.1 A fully integrated and tested web platform	Delivered	31/03/2013	31/05/2014
3.2 Demonstration workshops	Delivered	31/07/2013	30/6/2014

The Milestones related to Action 3 have been achieved at the end of the project. The functionality of the portal was demonstrated to a large audience during the Conference and the training events.

Table 2: Action 3 Milestones

Name of the Milestone	Status	Planned	Actual
A fully integrated and tested web platform	Reached	31/03/2013	31/05/2014
Demonstration workshops	Reached	31/07/2013	30/6/2014

After the modification the project was extended by nine (9) months. The platform integration tests by the users were delayed, mainly because of cash flows problems, as the second payment of the project was released in December 2013. For this reason the events could not be performed earlier, thereby, this has affected the testing plan of the platform. The final Platform and Services exceed the initially planned quality, as the concepts knowledge base is has been enriched to cover a

[1] In the original Plan, i.e. before the project's nine (9) months extension.

large number of possible matches, in terms of processes and technologies. The User Interface components are using latest technologies to support a rich interaction environment over the Web.

2.4 PROGRESS INDICATORS

The overall assessment of Actions is performed on the basis of evaluating the level of target figures reached. As regards Action 3, all four Activities have been completed successfully regarding expected results and progress indicators as presented in the following tables.

Table 3: Action 3 Results

Expected Results	Status	Comments
Successful integration and validation of the service with minimum one service implemented as well as the demonstration of its benefits to a wider community.	Complete	Delivered, presented in European Wide Conference. Strong Dissemination via Papers, Conferences, Media and Social Media

Table 4: Action 3 Progress Indicators

Indicators of Progress	Status	Comments
Results from the validation of the service operation to a minimum of 80% of satisfactory (positive) results;	Complete	The Platform is supported by the Regional Industry, and has been introduced at European Level receiving warm reception and positive comments
Number of people, companies and agencies participating in the demonstration workshops to a minimum of 30 companies, 15 agencies and 40 people included;	Complete	Numbers exceed original Plan (53 registered in the event in March 2012, 43 registered in April 2014, more than 350 registered in the SYMBIOSIS 2014 Conference)
Quality of feedback from targeted users to a minimum 90% of satisfactory feedback;	Complete	The feedback received was 100% positive. In the conference NISP was present, seemingly impressed.
Number of distributed copies of material with a minimum of 500 copies distributed.	Complete	In total 2,140 copies, as presented in description of Action 5 of the final report

As shown above in Table 3 and Table 4, the targets for the action have been achieved or exceeded by far. The platform achievement is that it accurately and realistically represents and captures all details of the Industrial Symbiosis processes, enhancing the easiness to engage and interact, perform waste resources interests matching and exchanges, and support learning and process improvement. The platform supports realistic business interactions scenarios, and ready to be used with

the necessary adaptation, in extended National and International applications of eSymbiosis.

2.4 OVERALL ACTION EVALUATION

Overall, Action 3 was very successful. The project had strong technology content, and the actions triplet (Action 1, Action 2, Action 3) have produced a streamlined set of deliverables, fitting together, resulting a Platform and a Set of Services for Industrial Symbiosis, as originally envisioned.

The principal project conception was that it will result to a web accessible utility to enhance the Industrial Symbiosis Activities, using the Region of Sterea Ellada as the testing field. This was convincingly achieved. The platform used to the best effect Intelligent Technologies, integrating Ontologies and algorithms for Semantic Matching. This field is evolving, especially when projected to applications for the Industry and the Environment. The high number of publications and the international interest shown, strengthens this position.

Finally, the results of Action 3 were timely ready for the execution of Action 4. The platform implementation academic teams NTUA and UoS have ensured that the models created are sufficient for the goals of the project addressing the local implementation of IS scenarios in Viotia. PIC as very closely co-operating with both CLMS and AVCO leading the development from the Business and Domain expert user's viewpoint. AVCO and CLMS have worked closely to achieve the integration of different subsystems, with different scope and utility, providing to the end user a seamless execution environment. AVCO has worked closely with UoS, implementing the matching algorithms for the ontologies. NTUA has supported and provided the Industrial process and technologies knowledge, as well as the regional perspective and industry requirements, which have been embedded in the ontologies.

The region of Sterea Ellada provided the industry database, and supported all interactions with the end users. All these inter-partner relations have worked to the best effect leading to the end result as described above.

3. RISKS, PROBLEMS ENCOUNTERED, REMEDIATION

In Action 3 the main risks for the platform production of were that the:

- **a.** data for the region would not be sufficient,
- **b.** Industrial Symbiosis process is complicated and not well documented,
- **c.** technologies used would not match well,
- **d.** region would not provide required infrastructures and support,
- **e.** semantic knowledge would not suffice for realistic process support,
- **f.** results would be perceived as simply an academic exercise not capable to be used in Industrial applications,
- **g.** partners had not previously collaborated.
- **h.** work was underestimated,
- **i.** time required to develop would not suffice for the proper demonstrations.

The above during the process of the platform integration and deployment

a. Initially the progress was slow, due to the lack of information in sufficient detail to be useful for the database creation. The consortium finally got access to a reliable source of environmental Industry information, and used it to construct and expand the ontologies definitions as explained previously. Further accessing process and Industrial Symbiosis use cases information, has assisted the definition of the advanced ontologies, and also has constructed realistic testing scenarios which were used in this Action.

b. The requirements task was covered in Action 1, and in this action the final trimming and tuning of the applications, and the definition and enhancements of the user environment were driven by PIC which has sound knowledge and understanding on the process. At the same time, this knowledge has been used to improve the documentation existing for the processes.

c. The technology development of the platform and the creation of the Intelligent Platform components, were developed as two loosely coupled systems. However, late integration techniques using web services were used, and the final result allows rich user interaction in a seamless to the user way.

d. To solve the infrastructure problem and embarking on the nowadays prevailing cloud momentum the consortium has deployed all interworking components to a cloud facility, to allow scalability, and flexibility. This facility is hosted in the Greek Educational Network, GrNet. So, no upfront additional investments were required on server technology, and the available network

bandwidth for the project doe by far exceed the Regional Industrial Symbiosis setup.

e. The semantic knowledge introduced in the Ontology database does by far exceed the initial plan, covering more than 2000 concepts.
f. The platform has been developed using a highly sophisticated development environment (zAppDev[2]), including all previsioned user functions, and using the latest User Interface design and implementation components, passing significant testing.
g. The well-defined set of roles per partner and the clear set of tasks and responsibilities, with the frequent partner communication using Skype, have produced the conditions for excellent teamwork.
h. The work performed was indeed more than originally planned, the partners have invested significant resources and efforts. Every partner has god a good exploitation plan and interest, and the work performed by partner directly aligns with each partners' business and scientific interests.
i. The time planned was more than sufficient, however at the end was too much pressure, due to the delay in capacity building actions, so to include user's feedback, which was delivered late. The reason for this delay was that the cash flows of the project were very much behind schedule, caused by unforeseen events. Rapid development and oversourcing at the end on the side of the development teams has allowed to complete the project in within the project timeframe.

During all the performance of Action 3 tasks, there were weekly regular teleconference meetings for the Technical Platform Developments, go co-ordinate and align development.

The worst problem as explained elsewhere was the cash flows situation affecting the projects' ability to perform the capacity building actions, as those were not possible to be internally absorbed (e.g. development) by the consortium.

During the same time, the development work continued. However, the delay affected activity 1.3 for demonstrations, and the user feedback actions.

When finally this issue was resolved, the project fast-tracked development, and capacity building actions, so that all was well towards the final project Conference.

[2] http://www.clmsuk.com/platform/