Jornada de Seguimiento de Proyectos, 2010
Programa Nacional de Tecnologías Informáticas

Service Oriented Semantic Architecture (SOSA) TIN2007-60440

Carlos Juiz * Main Researcher
Isaac Lera † Researcher
Mehdi Khouja ‡ Researcher

Abstract

In this last decade, a technological and social change, known as Ambient Intelligence (AmI), has been created due to the integration of computational devices in our daily life to speed up tasks. The change was initiated by devices' low cost and the increase in mobile user abilities. AmI requires ubiquitous attention and demands a greater participation of all resources that surround us. The integration involves issues such as availability, security, context interpretation, etc. However, an issue less mentioned but relevant is man-machine interaction. Human´s communication language is based on the semantics of its representation, however, machines use a syntactic language. This syntactic representation causes a drawbacks in the interaction, interpretation and automation of expected services in intelligent environments. This project proposes the construction of a Service Oriented Semantic Architecture (SOSA). The originality of this architecture is the semantic representation of its service knowledge. The communication process, the cooperation and the service description will be taken into account in order to increase interaction and all its underlying sub processes. This will allow the investigation of computational paradigms, such as automatic and evolutive learning in the area of artificial intelligence, in order to carry out service interpretations more adapted to the user´s profile of the environment at any place and at any time; but also in the area of computer architecture and technology through a transparent integration of devices and users.

SOSA´s construction process consists on the analysis of service requirements in AmI, the integration process of devices (cell phone, portable computer, sensors, PDA, etc.), man-machine interaction language and finally the improvement of automation and inference processes.

Keywords: Semantic Architecture, Ambient Intelligent, Ontology, Ubiquitous Systems

1 Projects Goals

1.1 Original goals

Nowadays it is being required at any place and at any situation, the maximum number of computational services that can adapt to the demands of users. However, the integration cost

*Email: cjuiz@uib.es
†Email: isaac.lera@uib.es
‡Email: mehdi.khouja@uib.es

of a significant number of IT systems from different vendors increases the budget of Information Technology (IT). That makes up the concept of service-oriented architecture (SOA), which makes more effective the cooperation between devices in traditional architectures. This cooperation is essential in the implementation of AmI systems,where it is requested access to all services, anywhere when we needed, with a variety of devices and services that they are able to adapt to context, user preferences and environment constraints.

To make more effective the implementation of AmI systems and the real application integration in any architecture, it is necessary that all involved information and the processes are defined and managed through semantic representations. This semantic representation enrich the level of relations among users and devices via human natural language. For that, it is necessary to develop a Service Oriented Semantic Architecture (SOSA). SOSA will permit to the interactive elements in the context to improve their AmI interpretation, understanding, cooperating, and interacting, using different technologies and systems, getting cut costs, facilitating the tasks to the system users and growing, as a result, the benefits of information technology on our society.

The main project goal can be summarized in the development of Semantic Architecture which permits the service management in AmI. Furthermore, it must be able to facilitate the understanding of the context and to take advantage the Web Service features. This development will be performed with free and open source platforms, so it improves its distribution in the research community.

From this main goal we can extract multiples secondary goals. Also, these goals can be view as a logic sequence of development phases:

1. Since a new way of the communication between elements is necessary, we should define a new semantic communication protocol which should provide basic constructors for that. This protocol should require the definition of primitives through a semantic language. For that, it would be necessary to take into account existent semantic languages such as: OWL, OWL-S, WSDL, and SOAP.

2. The definition of service for the auto-management of elements through logic rules using inference engines such as: RACER, PELLET or the engine that incorporates JENA´s API.

3. The development of an architecture emulator which will be able to validate and to check the good performance of SOSA´s architecture in several environments.

4. Previous emulator should permit the extrapolation of the architecture in a real case. In this phase, we should apply our SOSA prototype in an specific AmI context. In principle, it has raised the possibility of building a prototype for museums (a museum visit guide: an interactive guide for the visitant and a management tool for the museum personal), and also, another specific ambient will be the taking of decisions in water treatment plants. The EPO has been interested in this special case.

1.2 Modified goals

Due to several reasons, among others, discovering new aspects of the topic to be researched, the current goal of the development of Semantic Architecture which permits the service man-

agement in AmI and it must be able to facilitate the understanding of the context and to take advantage the Web Service features, was modified as follows:

1. The first phase of SOSA´s goals has been achieved through Lera´s research line. The transparent communication among devices or agents is carry out via OWL-M which provides basic constructors for that semantic communication. During the phase of OWL-M development was necessary to construct some tools to facilitate mapping tasks. These tools and their results still being analyzed with the aim of publishing the results in a short period of time. It is the reason that we have a some publications regarding mapping algorithms. It was necessary to understand the necessities of the user-transparent communication to develop OWL-M. OWLM language is specifically designed to support the common rules in inference process. So, It is widely compatible with Pellet and Jena's engine.

2. Building a service oriented architecture requires exploring different aspect of the architecture: service description, discovery, invoking and storage. We mainly focused on the discovery task. First, we had to explore the various mechanism of service discovery. Then, we discussed their adaptability to ambient intelligent systems taking into account various aspects such as distribution and semantics. This research work will be published in book chapter [13].

2 Level reached in the project

2.1 Ontology Matching(OM)

During the development of goals project, we had observed that a crucial point to improve the interpretation of the semantic data by the devices requires data mapping functionality. The ontology mapping (OM) problem is crucial to efficient useful information exchange. Thus, our work was focused in ontology mapping discipline as you can see in the SOSA´s publications.

With SOSA project we have able to confirm that if the representation is of high quality then the knowledge blend is easy and reliable. Semantic mapping though ontologies is better than classical syntactical mapping e.g. XML.The problem solution, its evaluation and its reliability set the frontier of the communication exchange. A lot of solutions have been proposed but have never tried to look for the purpose. The purpose is the rationale of the ontology development. The same concepts can be defined in two different ontologies but this does not imply that they have the same purpose. So, we show in different approaches [2, 4] two goals. The first one is to reduce the compared information by adding to the structure of the ontology a header with the concepts that represent the purpose. The second one consists of improving the quality of the results, by adding additional information to these concepts. This increment is achieved by the definition of new relationships. The domains limits, fixes the purpose and, therefore, it diminishes the possible comparisons that can produce undesired coincidences.Metaphorically speaking, the ontologies adopt the form of a card puzzle. When two cards are joined it is due to coincidences with the borders. The edges of the card can be useful to sharpen the efficiency but the process will be faster if the card puzzle edges are ignored.

In the last phase, Lera focuses efforts on the OM line. Thus, in their last paper published [9] develop an extension of OWL to represent alignment between ontology elements, it is

called OWL-M. OWL-M is a set of constructors of high level of abstraction to restrict the definition of concepts regarding their context information to facilitate matching tasks.OWL-M offers the context of the alignment and a set of annotations to define the assumptions taken by algorithms. Thus, we made a more informed decision about the accuracy or the truthfulness of the correspondence. It can be applied in fields such as: ontology versioning, importing and enrichment, knowledge discovery, service composition and discovery, clustering and classification techniques, data integration and decisions in autonomous systems.

2.2 Ontology-based model of context (CoxEl)

We adopted the ontology-based model for context modeling. This is because we have not only to describe the context but also relate the different elements composing the ambient, in order to facilitate the interactions between them. Our ontology-based model is based on the concept of the context element (CoxEl). The **CoxEl is the atomic component of pervasive environment that has awareness and uses resources to perform specified tasks [1]. The context model incorporates SOA main functionalities.

2.3 Service discovery mechanism (SDM)

Since we are building a service oriented architecture, we focused on a feature of SOA: Service discovery. This process is crucial in SOA because the client and the service provider are not aware of each other at start up. This mechanism interested industry consortium as well as research teams. First, we explored the industry supported models for service discovery such as Jini,UPnP, SLP, Salutation and Bluetooth SD and some research initiatives. From these studies, we concluded that service discovery model for pervasive system require a decentralized design approach. Services should be described with a structured language that gives a semantic add-on to the description. Our solution for service discovery consists on using semantic information to organize services [13].

We specified a set of semantic interactions within a context-aware system. The Context elements (CoxEls) use a core ontology to perform interactions. These interactions permit to the CoxEls establishing groups within the context and offering tasks. The concept of group is a way to organise the context information within the ambient. In fact, the CoxEls form groups depending on criterion such as sensing information, resource availability or common tasks. The task interactions give the system architecture a service-oriented characteristic [8].

3 Results' Indicators

During the development of the project have been published papers in several conferences. In all of them the main researcher has participated in the training of various researchers and also, has used SOSA knowledge to guide two doctoral students in their respective research lines. This knowledge transference has permitted the publication of several articles, participation in meetings and collaboration with other international research groups. Lately, two master students have been joined to the research team to boost SOSA. Results appearing in some of these sections are due mainly for the three authors of this report. The rest of members of the research group are mainly involved in other results, also reported below. In some

way, the first goal is partially achieved. We do not need a protocol of communication, its function can be made by a specific language, for that reason, we have developed OWL-M and some algorithm to improve data comparison tasks. According to the second goal, about the definition of services, OWL-M was designed to increase the richness of the representation in order to facilitate inference tasks among others functions. However, actually, we do not have obtained reliable results when we try to integrate the services, defined in OWL-M, and the reasoner in a specific case of study. The construction of SOSA is partially completed. In fact, description an discovery components were designed. Thus, the design of service repository structure is an ongoing process. The structure depends on the physical architecture were the SOSA will be deployed and tested. According to the first two goals, mainly the first, the publications have been accepted in different conferences with a good greeted Of course, the final results are yet to come, since we have almost one year to finish our project and two additional researchers are joined to it. The design of SOSA use a novel approach through the integration of semantic. The context is described via an ontology that incorporate SOA principles. The discovery mechanism is fulfilled through semantic interactions.

3.1 Scientific and technological production

The project has produced 7 papers related directly with the SOSA objectives (including 2 articles in journals) corresponding to references [1, 2, 3, 4, 5, 8, 9], and [7] indirect related with the topics of the project and edited one book [6, 10, 11, 12].

3.2 Training human resources

SOSA project is training two PhD. students (Mehdi Khouja and Isaac Lera) and two masters (Sonia Gómara and Jaume Vicens) supervised by the main resarcher. Additionally, Dr. Carlos Juiz has been supervisor of Dra. Katja Gilly from UMH and he is also supervising two PhD. students and one master in Spain and two PhD. students and one master from abroad.

- **Isaac Lera** After obtaining his Research sufficiency during the development of the project, he is continuing his tasks, started in SOSA, towards his PhD thesis. He is Profesor Ayudante at the Universidad de las Islas Baleares.

- **Mehdi Khouja** After obtaining his grant from Govern de les Illes Balears during the development of the project, he is continuing his tasks, started in SOSA, towards his PhD thesis. He is Becario predoctoral at the Universidad de las Islas Baleares.

- **Jaume Vicens** He has been working, as graduate student, in this project since January 2010. He has obtained his degree of Informatics Engineer during her stay in the research group and has participated in several publications. He is contracted as technician by another project.

- **Sonia Gómara** She has been working, as graduate student, in this project since January 2010. She has obtained her degree of Informatics Engineer during her stay in the research group and has participated in several publications. She is currently working in ICTS OceanBit research institution.

3.3 Joint Actions and Projects

- *Internet basada en servicios y aplicaciones distribuidos (INTERESAD) (TIN 2007- 29683-E)* This EXPLORA action was financed by the "Comisión Interministerial of Ciencia y Tecnología" during 2008 and 2009. It aims to explore new possibilities in systems architecture and web applications.The responsible of the project was C. Juiz. Participants of the project in the current group were I. Lera and M. Miró

- *Evaluación y Gestión de la Calidad del Servicio de Redes inalámbricas* Cooperation project with Universidad Nacional de Asunción (Paraguay) financed by Govern de les Illes Balears, developed from October 2008 until December 2009.

- *Formatos de intercambio de modelos de rendimiento de sistemas informáticos y de comunicaciones* This cooperation action with the Université Abderrahmane Mira de Bejaia (Algeria) financed by the Spanish Agency of International Cooperation and Development (A/020297/08) has been developed during the year 2009 and was renewed by 2010 .

- *Implantación de asignaturas de postgrado en el master de informática de la Facultad Politécnica de la Universidad Nacional de Asunción.* Cooperation project with Universidad Nacional de Asunción (Paraguay) financed by Govern de les Illes Balears, developed from November 2008 until December 2010.

- *COST IC0804 Energy efficiency in large scale distributed systems* COST IC0804 is an European initiative for energy efficiency. It tries to foster original research initiatives addressing energy awareness/saving and to increase the overall impact research in the field of energy efficiency in systems.Participants in the current working group: C. Juiz, I. Lera, M. Khouja, S. Gómara and Jaume Vicens.

3.4 National and International cooperation

- **ARTEMISIA**. SOSA project and its results has allowed us to participate and to join as members of ARTEMISIA Association. ARTEMISIA is the association for R D actors in ARTEMIS: Advanced Re-search Technology for Embedded Intelligence and Systems. We participated in various events: ARTEMISIA kick-off meeting and International Conference 2007, ARTEMIS spring event 2009, ARTEMISIA setting the scene, 2009, ARTEMIS AUTUMN EVENT CO-SUMMIT 2008 and 2009, ARTEMIS BROKERAGE EVENT 2008, 2009 and 2010 of the ARTEMIS-JU. Carlos Juiz is member of the Chamber B of ARTEMISIA.[1]

- **PROMETEO** This mirror Spanish platform of ARTEMIS was set up as such on 12th May 2005 in Madrid at a meeting sponsored by the European Software Institute and the Group Telvent at the behest of Ministry of Industry, Tourism and Trade. UIB is member through the activities related with SOSA.[2]

[1] www.artemisia-association.org
[2] www.prometeo-office.org

- **NESSI** It corresponds to the Networked European Software and Services Initiative platform. UIB is member through the activities in NEXOF framework. Carlos Juiz is member of the standarisation commitee.[3]

- **ITU** ITU´s role as creator of the world´s most universally-recognized infocommunications standards dates back as far as the organization itself. Carlos Juiz is invited expert at International Telecommunications Union and participates in group 12 about Performance, QoS and QoE.[4]

3.5 Relevant Participation Meetings

- *5th European Performance Evaluation Workshop, EPEW 2008.* The workshop was held in Palma, UIB from 23 to 25 September 2008. He had financial support from the UIB. The accepted contributions were published in Lecture Notes in Computer Science (no. 5261) with the title of the workshop (ISBN 978-3-540-87411-9), edited by N. Thomas and C. Juiz. The program co-chair was C. Juiz.

- *7th Mediterranean Workshop on Ad Hoc Networking, Med-Hoc-Net 2008* The workshop, sponsored by IFIP, was held in Palma, UIB from 25 to 27 June 2008. The accepted contributions were published in the IFIP series, the publisher Springer Science + Business Media, under the title Advances in Ad Hoc Networking (ISBN 978-0-387-09489-2). Several members of the group help to organisation.

- *WOSP/SIPEW is established as a joint meeting of the ACM Workshop on Software and Performance (WOSP) and the SPEC International Performance Evaluation Workshop (SIPEW). C. Juiz was the Program co-chair and I. Lera presented a poster.*

3.6 Other relevant participation in meetings

Carlos Juiz has been program committee member or scientific committee member in the following international conferences (since 2007):

- **2007**: WOSP, 40th, 41st Advanced Simulation Technologies Conference, SPECTS, WEBIST, SARP, SERP, WORLDCOMP, EPEW, SEASS, UMSS, UCAMI, IWSSA, ISCIS, CERMA, CIAWI, and IPCV.

- **2008**: WOSP, WEBIST, SARP, SERP, EPEW, SEASS, UMSS, UCAMI, IWSSA, CIAWI, QoS-IP, HPCC, WMS, and CLEI

- **2009**: SPECTS, WEBIST, EPEW, SEASS, IWSSA, CIAWI, WMS, CMC, ICDT, CPI, IWAAL, ITU Kaleidoscope, APS2PS, 3as Jornadas RFID, Evolving from IT Service Management to IT Governance, EUNIS, and BSBT

- **2010**: WOSP, SPECTS, WEBIST, UCAMI, CLEI, CMC, ICDT, IWAAL, ITU Kaleidoscope, APS2PS, BSBT, ICIW, PAEWN, AMSTA, AICT, INGRID, ISAMI, TEMU, DCNET, ITCS, and CIT.

[3] www.nessi-europe.eu
[4] www.itu.int

References

[1] Khouja, M.; Juiz, C.; Lera, I.; Puigjaner, R.; Kamoun, F. *An Ontology-based Model for a Context-aware Service Oriented Architecture.* SERP'07. CSREA Press. Vol.: 2 Pages: 608-612. 2007. ISBN: 1-60132-033-7

[2] Lera, I.; Khouja, M.; Juiz, C.; Puigjaner, R. *Introduction to Semantic Axis Header Mapping Algorithm.* UCAMI'07. Thomson editores Spain, Paraninfo S.A. Vol.: 1 Pages:193-199. 2007. ISBN: 978-84-9732-605-6

[3] Khouja, M.; Juiz, C.; Puigjaner, R.; Kamoun, F. *Semantic Interactions for Context-Aware and Service-Oriented Architectures.* Lecture Notes in Computer Science. Vol.: 5333 Pages: 407-414. 2008. ISSN: 0302-9743

[4] Lera, I.; Juiz, C.; Puigjaner, R. *Quick Ontology Mapping Algorithm for Distributed Environments.*SWWS'08. CSREA Press. Vol.: 1 Pages:107-113. 2008. ISBN: 1-60132-089-2

[5] Guerrero, C.; Juiz, C.; Puigjaner, R. *Web performance engineering based on ontological languages and semantic web.* International Journal of Computer Applications in Technology. Vol.: 33(4) Pages: 300- 311. 2008. ISSN: 0952-8091

[6] Guerrero, C.; Juiz, C.; Puigjaner, R. *Using Ontologies to Improve Performance in a Web System. A Web Caching System Case of Study.* Fourth International Conference on Web Information Systems and Technologies. Insticc press (1)117-122. 2008. ISBN: 978-989-8111-26-5

[7] Gilly, K.; Alcaraz, S.; Juiz, C.; Puigjaner, R. *Analysis of burstiness monitoring and detection in an adaptive Web system.* Computer Networks-the International Journal of Computer and Telecommunication Computer Networks. (53)100-111. 2009. ISSN: 1389-1286

[8] Khouja, M.; Juiz, C.; Puigjaner, R.; Kamoun, F. *Semantic Interactions for Context-Aware and Service-Oriented Architectures.* Ambient Intelligence Perspectives. IOS Press 2009. ISBN: 978-1-58603-946-2

[9] Lera, I.; Juiz, C.; Puigjaner, R. *OWL-M extension for semantic representations of ontology alignments* 3rd IEEE International Workshop on Ontology Alignment and Visualization (OnAV'10). 2010 (pending publication)

[10] Lera, I.; Puigjaner, R.; *Semantic Layered Architecture to integrate FR/NFR in Software Performance* Engineering. WOSP/SIPEW 2010, poster

[11] Gilly, K.; Thomas, N.; Juiz, C.; Puigjaner, R. *Scalable QoS content-aware load balancing algorithm for a Web Switch based on classical policies.* IEEE 22th International Conference on Advanced Information Networking and Applications, 2008, ISSN: 1550-445X

[12] Thomas, N.; Juiz, C (eds.).*Computer Performance Engineering.* Lecture Notes in Computer Science, vol.: 5261, 2008, ISSN: 0302-9743

[13] Khouja, M.; Juiz, C.; Puigjaner, R. Kamoun, F. (2010), *Pervasive Computing and Networking.*John Wiley Sons, chapter Models for Service and Resource Discovery in Pervasive Computing.