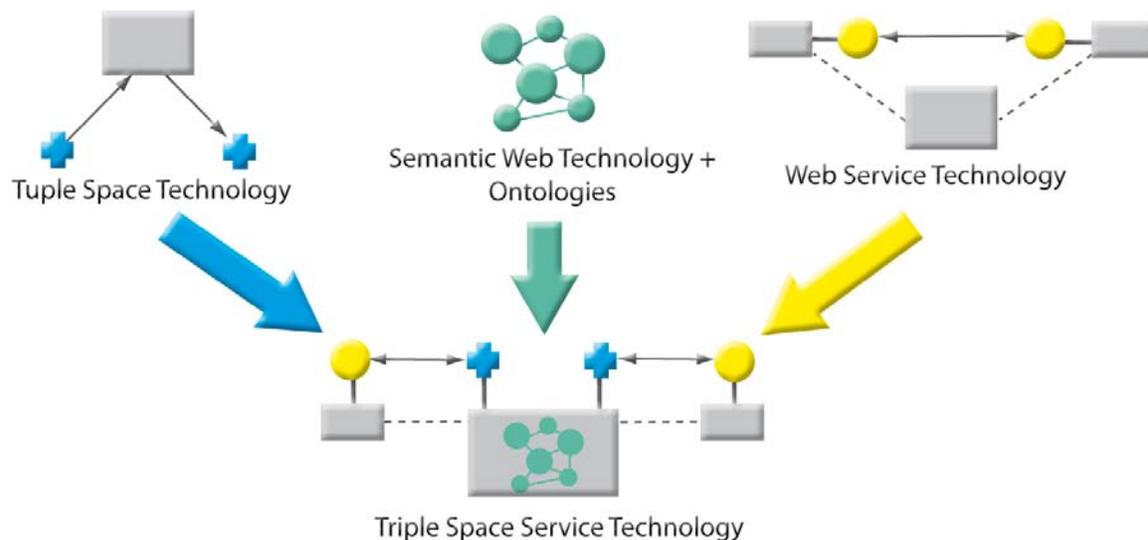


## Annual Public Report

*"TripCom will change the Internet usage through computers just as the Web revolutionized the Internet usage through humans"*



Triple Space Communication is about a new paradigm for machine-to-machine interaction based on the core design principles of the Web. TripCom is the first important initiative aiming to implement the core ideas of Triple Space Communication in a European setting to bring the Web into Web services. We aim to realize a middleware for Web services to communicate based on the Web principle of 'persistently publish and read' as a pre-requisite for this technology to scale at the size of the Internet. The middleware integrates and extends several well-known technologies, Tuple Space Computing, RDF and, of course, (Semantic) Web services.

### < Summary of Activities >

TripCom has kicked off with a highly innovative vision for future machine-to-machine communication on the Web. After a first very successful 2006 in which we defined the core conceptual and technical building blocks of the platform and specified the use cases in which it will be evaluated, the work in the second year of the project continued in these two areas in the same efficient and effective manner. We have been made important progress towards the completion of the key milestones of the project: the implementation of a fully-fledged TripCom prototype and the realization of the three use cases, Semantic Web services, eHealth and EAI. A distributed Triple Space architecture has been designed and its components have been specified in

detail, prototypically implemented and integrated. The scalability of the platform to be built has received particular attention. We analyzed the impact of functional and non-functional properties and architectural design decisions on the scalability of the overall system and proposed trade-offs as a first step to predict the scalability of Triple Space in different application scenarios. At use case level a concept for the integration of Triple Space and Web services has been elaborated and components have been specified. The eHealth use case implementation focused on the finalization of the use case description, the generation of use case data and the development of a detailed ontology for managing patient summaries in a Triple Space. The EAI use case defined the Digital Asset Management (DAM) Marketplace Architecture and developed the user interface layer as a first step towards the realization of this use case.

From a dissemination perspective we were present at several major scientific and industry events of the three target communities identified to be critical for the success of our project. Notably we successfully organized a workshop on Triple Space Communication at the European Semantic Technology Conference. Further on, a paper describing the eHealth use case best paper award at the 20th IEEE International Symposium on Computer-Based Medical Systems (CBMS 2007).

The Project Management Board, the Technical Management Board and the Exploitation Board are fully operational, collaboration among partners runs smoothly, and work is progressing according to the plan.

To summarize, after successfully laying the foundations of our work in the first year, in this second year the consortium has lived up to its expectations, realizing a functional Triple Space platform as a baseline for reaching scalability and for the implementation of the three use cases.

### < Important work areas >

#### **Triple Space Architecture and components**

The Triple Space (TS) is a global repository of semantic data, spread over a multitude of computers (TS kernels) worldwide and shared by all users of the TS (TS clients). Clients can access the Triple Space through connecting to one of the kernels, read and write semantic data from/into the space, and also interact with each other. A space as a logical entity is addressed by a client via a unique URL and is physically stored on a single kernel, or shared by several kernels. The kernels are connected among each other in a Peer-to-Peer network.

The kernel system is built from several self-contained components, which communicate via a space based coordination middleware and are responsible for persistently storing semantic data (Triple Store Adapter), processing queries (Query Processor), handling transactions (Transaction Manager), semantic mediation (Mediation Manager), security (Security Manager), knowledge about the Triple Space

structure (Metadata Manager), communication with remote kernels (Distribution Manager) on the one hand and with TS clients (TS-API) on the other hand. The components are developed in an independent manner, based on an agile software development process, and ultimately integrated to form the whole kernel system.

The TS is also integrated with Web service technologies via particular Web Service Invocation, Discovery, and Registry components, in order to expose the TS functionality to Web service clients.

### **Triple Space Distribution**

In order to enable a global space of semantic data, the Triple Space needs to be distributed across machines. We call the software component realising the Triple Space functionality on a particular machine a kernel. Kernels will not exist in isolation but will be connected with other Triple Space kernels, forming together the global Triple Space. Hence interaction with the Triple Space may take place on a particular kernel yet the data which is required may be on one or more other kernels in the network. To solve the distribution problem - finding where the requested data is on a large scale network - Triple Space will use a combination of novel methods: on one hand, a semantically aware Distributed Hash Table approach to look up potentially relevant spaces, on the other hand metadata stored on kernels will guide and optimize this look up. As a result, we aim to support large scale distribution of data across Triple Space kernels, while continuing to offer clients the benefits of time and space autonomy.

### **Triple Space Scalability**

Service orientation is becoming a dominant computing paradigm. However, current technologies are still restricted in their application context to in-house solutions of companies' internal problems. The potential of service-oriented computing in the large is only achievable if there are solutions to the fundamental challenges that arise if current technologies are applied to open, large scale, heterogeneous, distributed, and highly dynamic environments like the Web. Service computing requires scalable communication and coordination for billions of service providers and consumers in such environments.

The functionality of a space and the non-functional properties – e.g. completeness of results, response time – clearly influence the scalability of Triple Space implementations. The management of trade-offs between the functional and non-functional properties and the definition of respective system configurations is a major step towards scalable Triple Space infrastructures. In fact, the more functionality an installation provides, the less can be guaranteed about the non-functional aspects and in particular also scalability.

### **Security aspects in the Triple Space**

The first version of TripCom security model has been designed. The core of the model is the Triple Space policy, which governs access to triplespaces by defining access control rules and trust and attribute mapping rules. Using TripCom security functionalities, a triplespace administrator can specify access control policies for

his/her space, defining who is allowed to do what in that space. Access control policies can be expressed in terms of roles (e.g. 'front office staff'), so that the administrator can focus on operations which are meaningful in his/her organization, rather than on assigning privileges to single users. Moreover, an 'attribute mapping' feature is provided, so that users can provide more general-purpose attributes about themselves, certified by external trusted authorities, and these attributes can subsequently be mapped to application-specific roles.

## < User Involvement > < Promotion and Awareness >

### **Exploitation Board**

The TripCom Exploitation Board looks into application scenarios where TripCom configurations, providing different levels of scalability and functionality, can demonstrate its technical benefits compared to other communication and coordination technologies. Besides, industry-oriented material has been developed so that TripCom is being presented to industries as a potential solution in many integration problems, during the events already planned by the Exploitation Board. As a first step, TripCom presentations have been made within Telefónica, and we are looking forward presenting a demonstration during next year's Telefónica Innovation Fair (which will be scheduled for October-November 2008).

### **Co-operations**

TripCom is participating in STI International <http://www.sti2.org/>. This initiative is a continuation of the European Semantic Systems Initiative <http://www.essi-cluster.org/> and is organized as a collaborative association of interested scientific, industrial and governmental parties of the world wide Semantic Web and services community. STI International coordinates and actively contributes to major research and education activities in Europe and worldwide and promotes greater awareness and faster take-up of semantic technology in full synergy with these activities.

### **Presentations at international events, publications, press and media coverage**

The consortium identified three target communities - namely 'Semantic Web', 'Web services' and 'Tuple Spaces' - all of which were already covered by papers and presentations at international conferences in the first year of the project. In the second year, the project team further published extensively based on this strategy and was present at all major events for the identified target communities. The list of events includes: ACM SAC, ISWC, ESTC, CollaborateCom, EDOC, SKG, ASWC, ICWI, SBPM, Coordination, COCOON, BIS, CBSM (best paper award) and ICDE. A full list of published papers that is frequently updated is available from the project website: <http://tripcom.org/publications.php>. Furthermore, TripCom organized a first workshop targeted at an industrial audience co-located with the European Semantic Technology Conference, which is the annual industry-oriented event of the Semantic Web community in Europe.

Additionally, the following talks and keynote speeches were given by consortium members to further promote awareness of the project:

- D. Fensel and E. Simperl. Space-based computing. In 12th IEEE Conference on Emerging Technologies and Factory Automation ETFA 2007, 2007.
- D. Fensel. WI'07 and IAT'07 Joint Keynote: Service Web 3.0. International Conference on Web Intelligence (WI 07), Silicon Valley, USA.
- Eva Kühn. Space-based computing. Invited talk by Telefónica, Spain, 2007.

### < Future Work >

In the next year we will complete the implementation, dissemination and exploitation activities undertaken so far. The TripCom platform will mature and the use cases will provide prototypes applying Triple Space Communication in both technologically and more business-oriented settings. We will be able to perform an overall evaluation of Triple Space technology, particularly its scalability, and of our work throughout the entire duration of the project, to intensify exploitation efforts and to define a roadmap for further directions of research and development in this field.

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