

iNET: Large-Scale Intelligent Open Service Environments

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Abstract

Many of today's information technology research and development initiatives arguably share a common long-term vision of next generation Internet Environments as open networks of interacting software components able to interact in rich ways and coordinate their activities to achieve user and business goals. Major challenges remain to achieve these visions and this EOI submission describes our strong interest in establishing an Integrated Project to create a global scale, open, live, research and development network for advanced intelligent services:

- Acting as a live, prototype next generation network enabling 100s of research and business organizations all over Europe deploy, develop and test their own intelligent systems by connecting them to the network.
- Co-evolving research / technology development with business take-up measures and the exploration of the emerging business, legal, social and ethical issues.
- Creating a potential sustainable cross-action substrate for the development/deployment of IST systems addressing key challenges identified by the IST program – aiming to form a significant part of the global information/business infrastructure by 2010.

The network would be based on the increasingly successful Agentcities test network and build on existing standard technologies (Web Services, Semantic Web, GRID services, ebXML and the others) and aim to make very significant contributions to the evolution of these through wide-scale deployment experience in innovative applications.

Context

This document was submitted to the European Commission's call for Expressions of Interest for the use of New instruments (Networks of Excellence and Integrated Projects) under the upcoming 6th framework project. Details of the call can be found at: <http://www.cordis.lu/fp6/eoi-instruments/>. This cover note replaces the administrative details provided to the European Commission in the submission.

Contact / Details

For the latest details of the iNET initiative please see: <http://www.agentcities.org/iNET>.
For the latest details of the Agentcities initiative please see <http://www.agentcities.org/>.
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1 Introduction

What will the Internet look like in 2010? How will organizations interact with one another? How will users interact with business and government? Many of today's research and development initiatives arguably share a common long-term vision:

Future on-line environments as open networks of automated software components deployed to achieve business/service goals on behalf of their organization/users, interacting with one another in a rich/flexible manner and able to dynamically coordinate their activities without human supervision as opportunities arise

While many of today's technologies address aspects of the problems involved in constructing such an environment major challenges remain: How can fully automated systems be effectively managed? How will they interoperate? How will systems belonging to different organizations be able to dynamically create, maintain and fulfil service relationships? Finally and crucially how will the huge array of diverse technology solutions, models and theories co-evolve to create a viable global intelligent environment?

This Expression of Interest (EOI) submission describes our strong interest in establishing an Integrated Project to extend and evolve the on-going Agentcities initiative¹ to create a global scale, open, live, research and development network for advanced intelligent services:

- Acting as a live, prototype next generation network enabling 100s of research and business organizations all over Europe deploy, develop and test their own intelligent systems by connecting them to the network.
- Co-evolving research / technology development with business take-up measures and the exploration of the emerging business, legal, social and ethical issues.
- Attracting a critical mass of research, investment and commitment to establish an environment suitable for mission critical systems – forming a significant part of the global information/business infrastructure by 2010.

Europe is well positioned to exploit a critical strategic advantage by leveraging initiatives such as Agentcities (which already brings together researchers from 100 organizations worldwide), its leadership in key areas such as Agent technology as well as its integrated approach to research and development. We believe that the project proposed here would have a significant impact on European Scientific and Economic development by:

- Combining a long-term focused research vision with a real, ongoing deployment to generate both valuable knowledge and establishing a critical mass of innovative public network infrastructure in the process.
- Driving standardization, understanding, tool/product development, education and deployment experience for next generation Internet technologies.
- Creating a potential sustainable cross-action substrate for the development/deployment of IST systems addressing key societal and economic challenges identified by the IST program.

2 Rationale for the Research Action

Information technology development over the last 10 years has moved rapidly from single use, centralized systems to distributed, multi purpose systems which are now increasingly embedded in a fully interconnected world. Advances in both development and deployment are being made

¹ Agentcities is supported by the European Commission 5th Framework program under the Agentcities.RTD (IST-2000-28385) and Agentcities.NET (IST-2000-28385) projects and is establishing a first-cut global testbed for advanced intelligent systems. Partner projects are now active or planned in 15 countries worldwide

through machine readable content (Semantic Web), massively parallel distributed computing (GRID computing), novel system-system interaction models (Peer-to-Peer computing), dynamic discovery and description of web enabled software applications (Web Services), XML based business process infrastructures (rosettaNET, ebXML), web development environments (Microsoft .NET and Sun ONE) and powerful visualization tools (DigitalCities).

Technology development by itself however is not enough to bring about the vision outlined in the introduction. In particular, this new generation of on-line systems must deal with the challenges raised by deployment in a truly open environment. In particular from our experience in Agentcities and other developments we believe there are four categories of long-term challenges:

- **Automation (Management of Autonomy)**: understanding how to effectively automate systems in an open environment – how to implement/optimize individual strategies, how to ensure globally/group-based coherent behavior, how to establish/maintain trust relationships and how to control/manage deployed automated systems. This must draw on work from mathematical control theory to distributed systems and agent technology.
- **Interoperability (Communication)**: how to enable on-line software systems to interact with one another in increasingly flexible ways: configurable interaction sequences, communication about arbitrary domains, determine the intended meaning of any message or datum in the context of its usage. This requires the coherent integration of technologies from traditional knowledge representation, databases, semantic models, ontologies (e.g. Semantic Web), Agent Communication Languages (e.g. FIPA-ACL, KQML), increasingly prevalent web syntaxes (such as XML and RDF) and protocol formalisms.
- **Coordination (Multilateral Trade)**: putting in place frameworks that enable automatic creation, maintenance, execution and monitoring of contracts and agreements between automated systems to fulfill their business objectives – even with unknown parties and without the necessary supervision of human operators. This would enable the dynamic creation of supply chains, virtual companies and other organizational structures for the fulfillment of user and business goals. Successful systems are likely to require the integration of security, management, multi-agent organization/coordination techniques such as negotiation and distributed problems solving with existing/future industrial strength e-Business suites.
- **Knowledge Acquisition (Interfaces between worlds)**: enabling the automatic or interactive elicitation of requirements and instructions from system users, system programmers and other systems. This requires smart user interfaces, interactive knowledge tools, automatic categorization or knowledge capture systems.

Each of these areas has been the subject of extensive research and development over many years (much funded by European Commission R&D programs). However many technologies have yet to be tested in a truly open environment, and require such an environment to migrate research technologies into exploitable commercial propositions. We believe that a crucial part in the development of the next generation environment will be played by combining pure and applied research with business usage to explore the opportunities and challenges increasingly open environments create. Furthermore, the combination of heterogeneous technologies from these spaces to create viable environments, which support high levels of autonomy, flexible system-system communication and advanced dynamic composition of services, remains a great challenge and will continue a strong research tradition and extend our know-how.

2.1 Objectives

The overall objectives of the project are as follows:

- O1.To significantly advance the state of the art of European and world knowledge on the management of large-scale open systems (in particular in the 4 key areas: autonomy, communication, coordination and Knowledge Acquisition) - building up a large body of knowledge, tools and real deployment experience across Europe's research and business organizations on how to develop, manage and exploit future open service environments.
- O2.To create a European shared resource that will link a large percentage of Europe's research and industrial research community over a common advanced service infrastructure, providing a sustainable substrate for IST applications and systems

O3.To develop and extend the network to establish an environment suitable for mission critical systems – forming a significant part of the global information/business infrastructure by 2010.

3 Outcomes

The expected long-term benefits of the types of services that would be possible in such future service networks are well documented but include:

- Automated, highly proactive and intelligent services have the potential to reduce the operational cost of systems and improve access for European citizens.
- Increasingly flexible interoperation between online services has the potential to promote integration within supply chains, reduce the operational cost of systems and promote accessibility from various devices and contexts.
- Coordination technologies are key enablers in making supply chains more flexible and responsive to the needs of their participants and users, rapidly revising agreements in the face of dynamic market conditions.
- Improved KA techniques for service development in open dynamic environments will reduce the time required to develop systems, increase their uptake and reduce the opportunity cost to organizations that are prevented from entering markets due to antiquated systems.

The impact of the project activity itself during the first half of this period (around 3-4 years from the start of the project) would include:

1. Wide-scale deployment of advanced network components, services and prototype applications across a large number (250-500 or more) of European and world organizations (business and research) on an advanced prototype basis
2. Very significant development of understanding as well as practically useful/implemented solutions, standards and tools related to the three core areas outlined in the previous section (knowledge acquisition, automation, communication and coordination).
3. Very significant development of tools, technologies, theories and models in areas related to these core technologies (visualization, modelling, social, ethical, legal etc. considerations).

In short, the objective is that even in the first 3-4 years of its lifetime the network should become a worldwide reference for next generation of on-line environments and demonstrate the potential for real commercial use by 2010.

4 General Approach

The proposed project structure is that of an “*open research program*” focused on a common project vision and agreed strategic goals. The project will be managed by a small but representative *core group* of partners responsible for administration and strategic direction, with research, development and take-up activity carried out by project *member organizations* who have expressed interest in the network development. The project would also be supported by one or more advisory boards to maintain the technical excellence and coherence of the effort. The basic mechanism used in the project will be based on *open calls for projects* contributing to research, development and take-up in the network. Example project types include:

- Core Research & Development: supporting projects that address key problems in network development and connect valuable research and development from a diverse range of fields, including a strong emphasis on linking to European, national and world research efforts.
- Connector/Take-Up projects: support to research and business organizations wishing to participate in the network – either simply by contributing to technology costs (small grants) or through support of trials/demonstrators or other take-up measures of novel relevant technology/services (larger grants)
- Standardization, tool development, open source, outreach and analysis: Managing input from experiences and requirements in the network to evolve core technologies, methodologies and specifications over time (and inputting these to relevant standards bodies as well as supporting the development of Open Source tools to enable free access to the network).
- Training and education: supporting knowledge transfer to business and building core competences for next generation networks in the European workforce

- Business, user and social studies: analyzing the development of the network from various perspectives to develop viable business strategies, evaluate legal, social and ethical impact

iNET would build on existing standard technologies (Web Services, Semantic Web, GRID services, ebXML and the others) and aim to make very significant contributions to the evolution of these through wide-scale deployment experience in innovative applications. Secondly it would aim to work with other European and worldwide activities (in particular GRID computing efforts and Networks of Excellence such as Agentlink) in a highly integrated way – in particular through the provision of bridging “connector” grants (see above) which support groups transferring technology into/out of the environment or in exploiting the environment for research or development purposes.

5 Need and relevance

An activity such as iNET would have a deep structuring effect on European (and potentially World) scientific and economic development. It crosses three of the 5 sub-thematic areas identified in the IST area (1.1.2) of the call: 1.1.2.1 (IST for major societal and economic challenges) as a test substrate for next generation services for the citizen (**e-Health, e-Inclusion, environmental services, trust and security**) and business (**e-Business, e-Government, M-commerce** and others) 1.1.2.2 (Communication and software technologies) through new, innovative service creation environments and 1.1.2.4 (Knowledge and Interface technologies) through the development of a **dynamic, evolving** user and business **information environment**. We believe that addressing this research area at the European level is critical for a number of reasons. A common, advanced research infrastructure spanning Europe would:

- Generate sufficient critical mass for investment by national/regional institutions and industry to concentrate investment, tools and services into a common framework (creating potential standards advantages).
- Be large enough to impact and lead world technology development.
- Provide equal access opportunities to many different parts of Europe to participate in technology evolution, incrementally improving their own level of technology development and industry.

6 Scale of Ambition and Critical Mass

The ultimate aim for the network described here is to evolve from research testbed into a commercially viable next generation service environment – fusing with current Internet, Web and e-Business networks. For this transition to be feasible the project must:

- Support a high percentage of interested European research from SMEs to large corporations in participating in its evolution.
- Be open and accessible worldwide – to stimulate early take up and showcase European leadership in this area.

We would hope that by the end of the project (2006/7) it would enable the direct involvement of between 250 and 500 organizations (half research, half business) - providing access to a large percentage of Europe’s research and business organizations. Based on the project structure incorporating from many small take-up style activities to significant core research sub-projects we expect the total cost of the project to be between 40 and 50 million Euros. In addition we expect such a large scale, pervasive activity to generate significant third party (external) activity both in Europe and Worldwide. As a measure of current/potential scale see details of the current Agentcities initiative below.

7 Integration

We believe that a coordinated program of research centred around and open, publicly accessible testbed will be a critical factor in the development of next generation open service environments. Integration is required along three axes:

- Technology: bringing together technologies, solutions and theories from many different domains (technology, legal, social, ethical issues) and different research fields.

- Deployment & Research: Ensuring that technology development is equally matched by efforts in (for example) standardization, tool development, trials, training, best practice analysis and development of viable business/service models.
- Application domains: enabling applications in a wide range of domains – from healthcare, life-sciences, e-Government, e-Learning and environmental services to dynamic supply-chains, financial services, and community/social support systems.

This integration process is likely to occur through a complex co-evolution of solutions that is difficult to achieve without focused effort and reference to a common testbed resource. The following activities are considered important to the success of the project:

- Pure research: developing new theories, technologies and models for the new environment.
- Applied research: adapting and applying existing theories, technologies and models to the new environment.
- (External) Technology Transfer support: supporting groups from related but different research areas (e.g. virtual reality interface design) to adapt and deploy their systems in the environment.
- Tool development: supporting the development of both research and industrial strength toolsets for managing and accessing the network.
- Deployment/Trials/Best Practice Analysis: development of guidelines and methodologies and building deployment experience and innovative services.
- Training & Education: supporting the teaching of related theories and models in University course (undergraduate and graduate) and in professional settings (e.g. developers courses)

8 Project Basis, Support, Partners and Roles

The project initiative has a large and very active base of support through the established Agentcities initiative that is developing a first cut testbed environment based on the FIPA Agent standard, integrating Semantic Web and Web service technology. Since the initial deployment of 14 Agent platforms in October 2001, 30 more platforms have been deployed around the world (from Japan and China to Australia and the USA as well as many in Europe). The activity now involves upwards of 100 organizations, two large scale projects funded by the current 5th Framework program (Agentcities.RTD / Agentcities.NET) and there are approximately 15 partner projects planned or active worldwide.

We therefore expect the Agentcities network to grow and provide a solid starting point (in terms of technology frameworks, tools and organizations) for iNET. Establishment of the type of project described here requires a long-term effort to establish consensus on scope, objectives and structure within the research and business community that might participate:

- Statement of intent: public release of this Expression of Interest submission in early June.
- Workshops: one or more workshop style discussion events in the period September – December (specifically to engage a number of different communities in discussion).
- Release of proposal draft: One or more public drafts project for comment (to be decided)
- Concentration activities: to consult the research and business community in various ways to establishing programs for the most relevant challenges to be addressed in the effort
- Coordination: we will be working closely with related activities – in particular Agentlink (see relevant EOI), Agents & GRID (see relevant EOI), as well as world standards/technology bodies.
- Consortium building: to ensure broad based representation, including all regions of Europe, Newly Associated States and Worldwide participation.

Since these more detailed discussions are just beginning the roles of individual partners are not discussed here but will be established on the basis of discussion generated by this EOI. The EOI is supported by the Agentcities.RTD, Agentcities.NET project consortia and by a significant number of other groups that have been involved in discussions. Please consider the document authors as contact points for the activity.