Future Networks & Services

Developing the
Future of the Internet through European Research

SEVENTH FRAMEWORK
PROGRAMME

European Commission
Information Society and Media

The Internet has profoundly changed our perception of society and our approach to everyday life. Today with billions of transactions streaming on the web, the Internet has certainly become the most powerful tool to share information.

As DG Information Society and Media, our mission is to **increase awareness,** not only of the key role of the Internet in commerce and society, but also to face the difficult matter of security and control of such a powerful tool.

Fostering innovation and competitiveness in Europe through excellence in ICT research and development, several world-class research initiatives set out to lead the developments on Future Internet research. While built on technological advances, aspects such as security, governance, an adequate regulatory framework ensuring accessibility for diverse users and the promotion of wider uptake become key success factors.

In this brochure we will explore four essential aspects for the Future of The Internet.

First comes the challenge of more powerful generations of networks and Internet infrastructures, which will give on-the-move high speed access to users, with rapid growth of mobile broadband Internet. They will strengthen our networked society economy and allow access to future Internet services and applications from billions of mobile users.

Second, there is the development of software and services architectures. The foundation of new software and services, of platforms and structures is directed to supporting the European industry and endorsing its global competitiveness.

Third, the debate concerning the **Internet of Things,** such as

Radio Frequency Identification systems (RFID), moves centre stage. Large scale implementations using RFID provoke critical debates regarding security and the protection of privacy.

Finally, there is the increasing exploration of 3D technologies in relation to possible new applications. In the near future 3D Media Internet will guarantee users a more intuitive, higher and enhanced level of interaction thanks to the possibility of creating realistic virtual web environments.

These are the chief areas of concern for promoting European industry and taking a lead in the global economy. However, the future evolution of the Internet is only partially predictable; continuous research makes this matter something constantly *in fieri*. Therefore this book is a portrayal of the present research-work. It aims to give concrete examples of each area of interest.

Several summits and conferences are investigating future opportunities for co-operation between different European actors, to help the industry in developing the right service infrastructures, but also to secure and enhance its position in the global market of the new technologies.

"The imperative role of Europe is, and will be, in **broadening the borders of information** and communication technologies (ICT) and in promoting a wide-spread use of the Internet".

The collaboration between our EU centres of excellence, such as academia, industry and public institutions is leading to a prosperous Europe where the keyword "co-operation" represents the future, the Future of The Internet.

Viviane Reding
Member of the European
Commission responsible for
Information Society and
Media

FUTURE NETWORKS & SERVICES
Developing the Future of the Internet through European Research

"This handbook is an outline of European ICT research activities in the area of Converged Networks and Services. Hundreds of projects are undertaken and thousands of researchers work everyday to broaden knowledge and innovation in order to build European competitiveness in the global market".

João da Silva
Director for
"Converged Networks & Services"

INTRODUCTION

The Future of the Internet – a federating theme for activities on future networks, software and service architectures, networked media systems and the Internet of Things.

The Internet world as we know it today has undergone far-reaching changes since its early days while becoming a critical communications infrastructure underpinning our economic performance and social welfare.

With more than 1 billion users world-wide, today the Internet is poised to become a fully pervasive infrastructure providing anywhere, anytime connectivity and services. With the further deployment of wireless technologies, the number of Internet users is expected to jump to some 4 billion in a few years.

As the Internet serves an ever growing population of users and intelligent devices, new innovative services are introduced, demanding an environment which supports innovation, creativity and economic growth.

Over the last 20 years society, economy and technology evolved in many directions and into new areas. Many of these evolutions have created opportunities which must be taken into account when crafting future Networks.

These new opportunities concern:

- **Mobility** – 3 billion mobile devices go online as we speak.
- **No/low access barriers** – Standardisation of technology and low cost.
- **Easy and safe use** - More secure, safer use and more trust for making business, shopping or leisure, and for everyone including children.
- **Growth & Jobs** – A future Internet will be able to participate in every business process in service and production. As a key economic factor and a vector in globalisation it drives productivity, new business and trade.
- **Empowering the user** – Social networking with its wealth of user generated networking turns the Internet into a true peer-to-peer network with much more audiovisual content.
- **Services** – The Future Internet will enable a very different experience with service providers, be they public authorities or private businesses.
- **Education** – Opportunity for people to grow and develop.
- **Entertainment** - Virtual worlds in a 3D Internet for leisure, shopping and gaming.
- **More and high-volume traffic** – Text, voice, images, video (tinned and live).
- **A public good** – The Internet is a critical infrastructure much like electricity or water. Global oversight, no daily politics oversight, open and fair access to the entire world.

The ICT theme of the 7th Framework Programme for research and technological development provides a key opportunity to place a bold European effort regarding the "Future Internet". In particular the FP7 offers to investigate a number of technological domains, as well as associated policy domains, which have a bearing on the network and service infrastructure elements of the Internet of tomorrow.

Above all this research programme provides a unique collaborative platform for academia, research institutes and industry. It can be mobilised to address the multiple facets of a Future Internet, taking advantage of the existence of key European Technology Platforms, such as eMobility (http://www.emobility.eu.org), NEM (http://www.nem-initiative.org) and NESSI (http://www.nessi-europe.eu).

The Internet has become a true mirror of our society

In the i2010 policy framework (http://ec.europa.eu/information_ society /eeurope/i2010/) the European Commission acknowledges and reaffirms its support to the openness, interoperability and end-to-end principles governing the Internet.

At the same time, it is anticipated that the current Internet may in the long term not be fully capable of supporting the ever larger set of usages, constraints and requirements that it will have to face. Hence the issue of a "Future Internet" is attracting more and more attention and other regions in the world have already launched strategic exploratory initiatives.

Future Internet is vital to sustainable economic growth in Europe

In the future, even more users, objects and critical information infrastructures will be connected to the Internet, and it will become a critical factor for supporting and improving the European economy.

It is therefore time to strengthen and focus European activities to maintain Europe's competitiveness in the global marketplace.

The Future Internet needs new concepts and technologies if it is to support our future society in an effective way.

Europe has committed €9.1 billion to fund ICT research in FP7. We must ensure that enhanced and focused attention is given to the design of the Future Internet.

It is a matter of strategic importance for Europe to fully engage in the conception, development and innovation of the Future Internet to ensure the long term growth of the ICT sector in Europe and support the multitude of applications and services relying on continued innovation in the Internet infrastructure.

This book gives you an overview of the key research areas on future networks & services along with examples of recently launched projects.
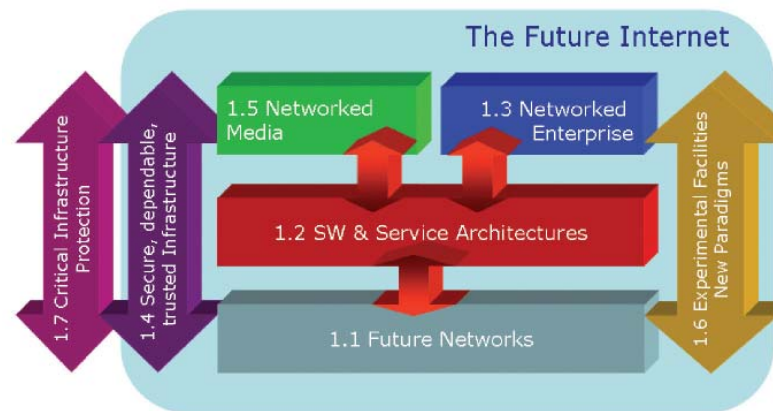
1.
NETWORK OF THE FUTURE

NETWORK OF THE FUTURE

What do we expect of the Network of the Future ? How would the network of the future look like ? Why would that interest me ?

We will live in a Networked Future. In a world where we will be connected at any time (networks will allow us to stay permanently connected), anywhere (from personal to global environments and everything in between), to anything (all kind of objects and artefacts, and also software virtual objects).

User expectations on what we can get from networks continue to grow and evolve and users will demand it. Society has accepted the new technologies that allow easy to use network services which deliver multi-sensory experiences and contents, thanks to the increased level of integration of intelligence, transmission speed and device storage capacities, forming together the Future Internet.

Today, network and service infrastructures underpin economic progress and the development of our societies. Mobile communications and broadband Internet access were the main contributors to growth in the telecom sector and were identified as one of the most positive, overall market developments. Three billion mobile terminals in use and more than one billion use the Internet.

Research in mobile communications and broadband access was tackled separately but as networks grow together it now merged in one objective "The Network of the Future" in the 7th Framework Programme (7FP).

The goal is the development of a converged communication and service infrastructure that gradually will replace the current Internet, mobile, fixed, **satellite** and audiovisual networks. This infrastructure would not only be pervasive, ubiquitous, and highly dynamic. It will also offer almost unlimited capacities to users, by supporting a wide variety of nomadic and mobile interoperable devices and services, a variety of content formats and a multiplicity of delivery modes.
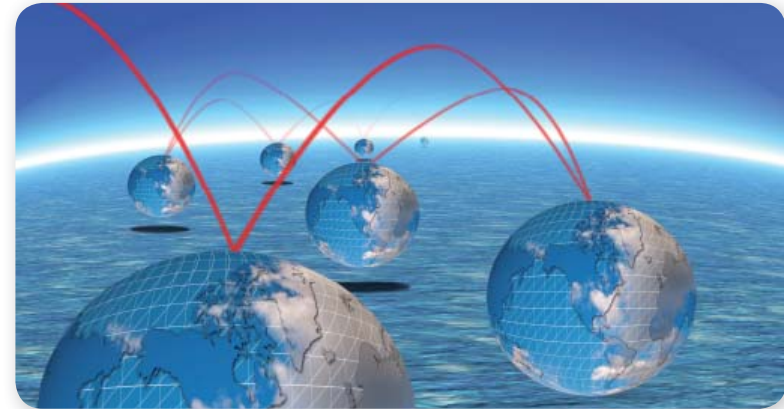
Challenges

Furthermore, Future Networks will probably have novel characteristics respect to today's networks. These are some examples:

- They would use **flexibly and efficiently radio access,** allowing ubiquitous access to broadband nomadic and mobile services;
- They will manage **in real time new forms of ad-hoc communications** with intermittent connectivity requirements and time-varying network topology;
- They will **integrate sub-networks** at the edge, such as personal and sensor networks, toward the Internet of Things for the benefit of humans;
- They will **eliminate the barriers to broadband** access and will

enable intelligent distribution of services across multiple access technologies with centralised or distributed control;

- They will **enable seamless end to end network** and service composition and operation across multiple operators and business domains;
- Finally, to **support high-quality media** services and support critical infrastructure, (e.g., for energy and transport), the existing Internet will be significantly enhanced or even gradually replaced.

This vision requires addressing the evolution from today's large legacy infrastructures to new infrastructures by striking a balance between backward compatibility requirements and the need to explore disruptive architectures to build future Internet, mobile, broadband, and associated service infrastructures.

To support these ambitious goals, 46 research projects were launched within the Network of the Future objective in the first quarter of 2008, for a total European Commission contribution of 200 millions Euros. This launch is the fruit of an intense collaboration between leading European industry, universities, research institutes, European Technology Platforms (mainly eMobility, NEM and ISI), member states and the European Commission. It was possible thanks to the innovation capabilities, the modernism and the attractiveness of European Research in the area of Network and Communications.

These projects, with the potential given by their cooperative research, are one more opportunity for Europe to deliver a new generation of telecom infrastructure, network and internet technologies that will be used in some years as fundamental building blocks for health, governmental, transport, entertainment, environmental, educational applications and services.

This effort reinforces European industrial leadership in wired and wireless networks, develops more and better Intellectual Property Rights (IPR) for European companies, stronger synergies between various sector actors and contributing to new business models.

It should also give new industrial and service opportunities in Europe, especially in the field of Internet technologies, where Europe has not yet reached a position commensurate to its technological potential.

Finally, it should also impact in the development of global standards to support convergence and full interoperability, for the new services and complex user requirements.

Each project has its own goals, but no project can succeed alone. Every project also contributes to the overall objectives of the Future Network, and the synergies between groups of projects working on similar topics are vital to the overall success of the research.

The projects have therefore been organised into three clusters: Converged and Optical Networks, Radio Access and Spectrum, and Future Internet Technologies, which will be further described below.

Future Internet Technologies

Internet infrastructure has been extraordinarily successful and is now a critical part of our economy's infrastructure. However its limitations due to the design made in the seventies start hampering its potential.

Evolutionary improvements to the current network will help sustaining up to a point the growth of the Internet, but are not seen as being enough to face the deep rooted weaknesses of Internet as regards mobility, scalability, wireless generalisation, broadband evolution, multiplicity of services, environments and contexts to serve, security and trust to name a few.

Indeed the Future Internet should be able to sustain by one or many orders of magnitude higher the number of people, devices and objects connected (billions, perhaps even hundreds of billions of users, sensors, tags, processes, micro controllers), ensure **efficiency**, **security** and **trust** in transaction for new services, incorporate mobility and universal connectivity in its conception, cater for various connectivity schemes, include the technical features for easy operations and management including guarantees for privacy, multiparty governance and delivery of new services.

Given that the limitations of the Internet are deeply rooted in the architectural design and its protocols and mechanisms, the expected work aims at complementing/ revisiting the network science foundations of the Internet, not only for its novel system components like wireless or sensors networks, but aiming at advanced approaches as appropriate to architectures and protocols driven by the need for general mobility, scalability, new forms of routing, connectivity in a generalised wireless environment, to be coupled later with their validation in large scale testing and interconnected environment.

The work of exploratory nature is expected to address how various classes of new requirements constrain the foreseeable evolution of the internet and identify the corresponding long term solutions.

Research Activities

The Future Internet networking research activity in ICT in FP7 is largely reflected in the objectives of "Challenge 1" under the 2007-2008 work programme and the first call of early 2007. A coherent set of projects has started in 2008 to cope with the identified technical challenges.

Several STREPs (Specific Targeted Research Project) and IPs (Integrated Project), completed by one Network of Excellence (NoE) on next generation Internet networks EuroNF and one Think Tank on Future Internet architecture an technologies, (EIFFEL), will constitute the structuring scientific and technological basis for a renewal of the Internet. The ETP e-mobility is also focusing stronger support on Future Internet networks activities.

Amongst the 15 projects representing a community funding of about 80 million €, two IPs presented here, Trilogy and 4WARD, are at the heart of the research to reshape the networks foundations, from an evolutionary and from a clean slate approach.

4WARD
Architecture and Design for the Future Internet

Today's network architectures are stifling innovation, restricting it mostly to the application level, while the need for structural change is increasingly evident. The absence of adequate facilities to design, optimise and interoperate new networks currently imposes an architecture that is suboptimal for many applications, and that cannot support innovations within itself, the Internet.

4WARD overcomes this impasse through a set of radical architectural approaches built on our strong mobile and wireless background. We improve our ability to design inter-operable and complementary families of network architectures. We enable the co-existence of multiple networks on common platforms through carrier-grade virtualisation of networking resources. We enhance the utility of networks by making them self-managing. We increase their robustness and efficiency by leveraging diversity. Finally we improve application support by a new information-centric paradigm in place of the old host-centric approach. These solutions will embrace the full range of technologies, from fibre backbones to wireless and sensor networks.

Technical and economic impacts

The 4WARD results will allow new markets to appear, redefining business roles, and creating new economic models. We will collaborate with related European and other region's projects, and establish the Future Internet Forum, enabling new markets and opening them for old and new players' alike, increasing opportunities for competition and cooperation, and creating new products and services. To achieve these goals we have gathered a strong, industry-led consortium of the leading operators, vendors, SMEs, and research organisations, with the determination, skills, and critical mass to create cross-industry consensus and to drive standardisation.

The project is designed for multiple phases; the first one will establish the core concepts and technologies and last for two years. The project effort of about 2200 person months corresponds to the strategic importance of this endeavour.

Strategic Objective

4WARD aims to increase the competitiveness of the European networking industry and to improve the quality of life for European citizens by creating a *family of dependable and interoperable networks providing direct and ubiquitous access to information*.
These future wireless and wire-line networks will be designed to be readily adaptable to current and future needs, at acceptable cost. 4WARD's goal is to make the development of networks and networked applications faster and easier, leading to both more advanced and more affordable communication services.

Technical Approach

In our approach, we combine on one hand innovations needed to improve the operation of any single network architecture and on the other hand multiple different and specialised network architectures that are made to work together in an overall framework.

We will work on innovations overcoming the shortcomings of current communication networks like the Internet; in a framework that allows the coexistence, inter-operability, and complementarity of several network architectures, in an integrated fashion, avoiding pitfalls like the current Internet's "patch on a patch" approach. This work is structured into six work packages: three of them consider innovations for a single

network architecture (Generic Path, In-Network Management and the Network of Information), one work package studies the use of Virtualisation to allow multiple networking architectures to co-exist on the same infrastructure, another work package looks at the design and development of Interoperable Architectures, and finally one work package that ensures that all envisaged developments take proper account of essential Non-Technical Issues.

Key Issues

The Network of the Future must be based on a new set of architectural principles, formulated below as four programmatic tenets:

Tenet 1: Let 1000 Networks Bloom

We will explore a new approach to a multitude of networks: the best network for each task, each device, each customer, and each technology. We want to create a framework in which it will be easy for many networks to bloom as part of a family of interoperable networks that can co-exist and complement each other.

Tenet 2: Let Networks Manage Themselves

What we would like to have is a "default-on" management entity, which is an inseparable part of the network itself, generating extra value in terms of guaranteed performance in a cost effective way, and capable of adjusting itself to different network sizes, configurations, and external conditions.

Tenet 3: Let a Network Path Be an Active Unit

We want to consider a path as an active part of the network that controls itself and provides customised transport services. An active path can provide resilience and fail-over, offer mobility, simultaneously use multiple different sequences of links, secure and compress transmitted data, and optimise its performance all by itself.

Tenet 4: Let Networks Be Information-Centric

Users are primarily interested in using services and accessing information, not in accessing nodes that hosts information or provide services. Consequently, we want to build a network as a network of information and services where services and information are mobile and may be distributed.

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Partners

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"4WARD takes a long-term approach to research towards the Future Internet. Compatibility with existing network technologies is less important while innovation and bright new ideas are more important. This approach is needed to create the network of the future which can overcome the obstacles of current technologies".

Henrik Abramowicz
(4WARD Coordinator)

Trilogy
Re-Architecting the Internet

Future growth to meet these challenges will require not only new technologies from the leading edges of networking research, but also architectural changes which may be subtle but far reaching. The Trilogy project has a vision of a coherent, integrated and future-proof architecture that unifies the heterogeneous network, offering immediate deployment rewards coupled with long-term stability.

Architecture for Change

There are two key ideas behind the Trilogy Concept. The first key idea is technical; the traditional separation between congestion control, routing mechanisms, and business demands (as reflected in policy) is the direct cause of many of the problems which are leading to a proliferation of control mechanisms, fragmentation of the network into walled gardens, and growing scalability issues. Re-architecting these mechanisms into a more coherent whole is essential if these problems are to be tackled.

The second key idea is more abstract, but fundamental. It recognises that the success of the Internet derives not directly from its transparency and self-configuration, but from the fact that it is architected for change.

The Internet seamlessly supports evolution in application use and adapts to configuration changes; deficiencies have arisen where it is unable to accommodate new types of business relationship. To make the Internet richer and more capable will require more sophistication in its control architecture, but without imposing a single organisational model.

Therefore, our key principles are to retain the ubiquity enabled by the hourglass model, and take the self-configuration philosophy one level further: we seek control architecture for the new Internet that can adapt in a scalable, dynamic, autonomous and robust manner to local operational and business requirements.

Technical Approach

At the core of the Trilogy workplan lies the realisation that internetworking functions can be broadly categorised into two classes. First, functions that establish and control a scalable, dynamic, autonomic and resilient internetwork ('reachability'). Second, functions which allow a diverse set of parties to use and share this internetwork to communicate according to their dissimilar needs ('resource control'). Consequently, Trilogy places the emphasis of its work around these two topic areas.

Trilogy explicitly addresses the contention between suppliers and users of internetworking functions through the introduction of a third key topic area. It investigates the socio-economic, commercial and strategic factors that influence the interplay between the technical internetworking functions in order to architect an integrated solution that is 'designed for tussle'.
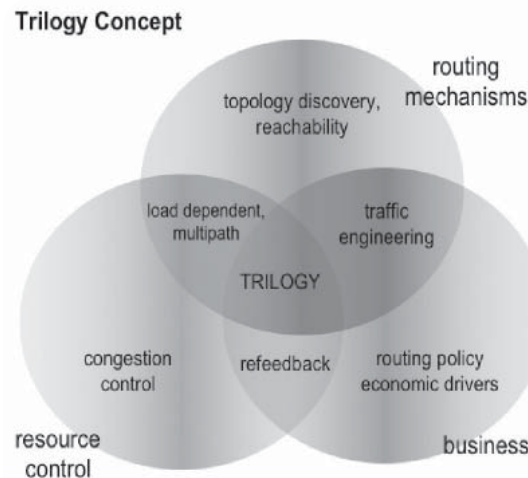
This activity will drive the design of the more technical work in the two main work areas in an ongoing manner, and is key for ensuring that the results of Trilogy will not only operate correctly at a technical level but also satisfy the broader goal of actively enabling changes.

Trilogy Concept

Expected Impact

Trilogy takes a holistic view of the fundamental design principles for next generation Internet architecture, derives novel solutions for the dominant technical and economical challenges and disseminates the gained knowledge to the interested and affected parties.

In particular, Trilogy will significantly enhance the reliability, robustness, manageability and functionality of the Internet, and will create new and varied business opportunities based around common core architecture.

The key is to allow the Internet to be different things in different places without hindering interoperability. In enabling tussles to play out within the architectural framework (as opposed to working against the architecture, as often happens today), Trilogy will permit differentiation, allowing greatly increased robustness for customers who really need it and have the means to pay.

In addition, the enhanced flexibility and improved manageability will simultaneously allow service providers to reduce costs and provide additional services; two aspects that are critical in a world of falling communications margins where service providers are wondering where the money to upgrade their networks will come from in ten years time.

Contact the project

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Partners

BT (UK), Deutsche Telekom (DE), NEC Europe (UK), Nokia (FI), Roke Manor Research (UK), Athens University of Economics and Business (GR), Universidad Carlos III de Madrid (ES), University College London (UK), Université Catholique de Louvain (BE), EURESCOM (DE), Stanford University (USA).

Next Generation Mobile Technologies

In Framework Programme 6 (FP6), research in the area of mobile and wireless systems has been funded by the EU with approximately 263 million euros for 52 FP6 projects. Driven by this programme, European industry has federated in the Wireless World Initiative (WWI) toward a common technological, industrial, regulatory, and service approach to systems beyond 3rd generation (B3G).

As a result, activities in the mobile communications field have made significant progress toward advanced communication technologies, systems, and services, enabling seamless mobile and wireless access solutions across a range of heterogeneous network infrastructures.

In a business environment based on technology standards that are typically associated with very high intellectual property value, the associated goal of FP7 is to maintain a strong European leadership on mobile radio technologies.

Building on the success of mobile telephony and text messaging as a mass market, third-generation mobile broadband services are now becoming increasingly available, with UMTS/HSPA terminals hitting the market and UMTS/LTE prototypes being demonstrated. In addition, IEEE 802 fixed wireless technologies, such as WIFI and WIMAX, have become popular in recent years, especially for laptop users in "hot spots". Beyond that, envisioned advanced mobile and satellite communication systems are expected to offer broadband mobile applications with access to high-quality multimedia content and offer communication with and among objects, machines, and devices. These systems are aimed to be operated in both available and future candidate frequency bands.

During the World Radio communications Conference 2007, in total "only" 392 MHz additional radio spectrum for mobile communications in Region 1 (Europe, Greenland, Africa, the Middle East west of the Persian Gulf and including Iraq, the former Soviet Union and Mongolia) in relatively small fragmented bands has been agreed on with some remaining uncertainty concerning the availability of these bands.

For new radio access schemes that are aimed to be integrated with other existing radio access networks, ITU has set the target of 100 Mbit/s for truly mobile applications, and 1 GBit/s for fixed/portable radio access.

These objectives are framing the research and the characteristics of the test beds that are currently being developed in various regions of the world.

The fragmentation and shortage of available radio frequency bands and the multiplicity of standards for wide area, local area, and short range communication have raised the demand for better spectrum efficiency, new system topologies, inter-working, and multi-mode systems that might be realised with flexible radio technology.

Micro- and nano-electronics have made significant progress towards nano-scale devices and will enable radio transmission techniques that seemed unrealistic a few years ago.

European research and future activities

The European Technology Platform (ETP) eMobility has been established as an action forum where all stakeholders, led by industry, have come together to define a Strategic Research Agenda (SRA) on mobile and wireless communications for the next seven years.

As stated by eMobility, future research activities should aim at "the improvement of the individual's quality of life, achieved through the availability of an environment for instant provision and access to meaningful, multi-sensory information and content". Realisation of this vision demands a major shift from the current concept of "anywhere, anytime" to a new paradigm of "any network, any device, with relevant content and context in a secure and trustworthy manner".

The future system is seen to be complex, consisting of a multitude of service and network types ranging across Wireless Sensor Networks (WSN), Personal Area, Local Area, Home Networks, Moving Networks to Wide Area Networks. The increasing dependency of society on such communication infrastructure requires new approaches and an emphasis in European research captured in a new concept called the "SET Concept" that underscores the need for a 3-dimensional vision of research activities that will deliver Simplicity, Efficiency and Trust.

A total of 22 projects in the area of mobile and wireless communications have been corresponding to 100 M€ of EU funding in the first phase of FP7 covering the Work Programme 2007-2008. In the centre of this topic is the Network of Excellence (NoE) NEWCOM++ that is integrating medium-long term complex, interdisciplinary, fundamental research structures in the field of wireless communication networks.

One important focus topic is 'cognitive radio systems'. Apart from three STREPS (SENDORA, ARAGORN, PHYDYAS) that are developing key enabling technologies for cognitive radio, the flagship project E3 is introducing cognitive wireless systems in the beyond 3G world from a technical, regulatory, standardisation and business perspective.

Related to this topic of cognitive radio are a number of projects focusing on Ultra-Wideband (UWB) radio systems. Besides specific tools like interference monitoring (UCELLES) and UWB test beds (WALTER) that are being developed, the integrated project EUWB is strengthening European key industrial sectors by ICT innovation of manifold cutting- edge short range radio solutions based upon advanced UWB.

To enable an ubiquitous radio access a large number of STREPS are focusing on specific radio technologies (MIMAX, CODIV, DAVINCI, REWIND, WIMAGIC, HURRICANE) and innovative deployment concepts (ROCKET, EU-MESH, CARMEN).

Finally, the integrated project SENSEI is exploring how heterogeneous wireless sensor and actuator networks can be integrated into a common framework of global scale and made available to services and applications via universal service interfaces.

In satellite communication the ETP Integral Satcom Initiative (ISI) has been established to integrate satellite networks in a seamless service provisioning across networks, with increasing focus on the design of end to end wireless systems for heterogeneous connectivity solutions that are increasingly being considered for several market and crisis management scenarios.

NEWCOM++

Network of Excellence in Wireless COMmunications++

NEWCOM++ is an NoE drawing inspiration and shape from its predecessor NEWCOM, and aims at addressing medium-long term complex, interdisciplinary, fundamental research problems in the field of wireless communication networks through identification, placement in the right modelling perspective, and characterization of information-theoretical bounds of achievable performance.

Main objectives

- Enhance the already good cooperation level among research groups reached by NEWCOM and push it to a degree where it will reach an irreversible, steady-state nature.

- Form a generation of young European researchers fully free of any scientific provincialism and accustomed to common work under major, frontier scientific challenges.

- Encourage a fair and vital competition among researchers via the NEWCOM++ Achievement Awards.

- Disseminate its results across the scientific community through jointly written papers, special session and journal issues, and offer to the European industry the benefit of long-term, fundamental research achievements through dedicated events (NEWCOM++ Dissemination Days) and via a number of *affiliate partners*.

- Identify a selective set of scenarios characterised by a reasonably-sized set of parameters which take into account users' and applications' requirements.

- Define suitable performance measures that take into account the wireless channel nature (ergodic and outage capacity, bit-frame error rate, etc.).

- Perform a detailed analysis of the main theoretical results available in the context of theoretical bounds for multi-user, multi-antenna systems.

- Evaluate information-theoretical bounds on the achievable performance of today's and tomorrow's technologies, such as multiple antennae, co-operation and relaying, source-, channel- and network-coding (separate plus "joint" versions), adaptive radio resource management, constructive interference handling, and so on. Mathematical tools such as Random Matrix Theory, Game Theory, Stochastic Geometry, Percolation Theory, Convex Optimization, etc. will be extensively used.

- Design and analyse transmitting/receiving algorithms and protocols in order to approach those limits. This will encompass efficient coding (turbo-like and low-density parity-check codes), iterative techniques applied in various receiver functionalities such as decoding, synchronization, multi-user detection, robust pre-coding techniques and channel state information feedback, joint source and channel coding, network coding, adaptive cross-layer radio resource management.

- Analyse implementation aspects of the above algorithms in flexible, energy-aware user terminals.

Technical Approach

The JPA of NEWCOM++ is articulated into the traditional four main NoE activities, namely, Integration, Research, Spreading of Excellence, and Management. The overall organisation of the NoE is shown in the figure: it encompasses 11 core research work-packages (WP R.1-11) spanning physical layer communications (PHY), networking (NET) and cross-layer interaction (X-LAYER). The number of work-packages in X-LAYER combining both concepts from networking and from physical-layer communications is substantial, allowing for a guarantee that the objectives of spectral efficiency and robustness are properly and jointly addressed. The so-called "transversal" work-packages (WPR.A, WPR.B, WPR.C) interact with many core research WPRs and provide tools for realization of

fundamental concepts (WPR.C), for provision of secrecy and security features at all levels of the communication process (WPR.A), and for location information processing to enhance both end-user quality-of-service and system spectral efficiency and robustness (WPR.B). They all naturally involve aspects stemming from PHY, NET and X-LAYER.

The Consortium strength

The present Consortium of 17 partners has been chosen (down-selected) from a much larger pool of participants in former NEWCOM. In the area of *iterative/adaptive modulation and coding,* NEWCOM++ has some of the best known researchers world-wide, such as the GET group who invented turbo codes, and Politecnico di Torino group (under CNIT) who provided fundamental contributions to the theory and practice of iterative decoding and reception, and the group in Technion which obtained in a unified way tight upper bound to the codes performance.

Expected Impact

The first expected impact concerns the contribution to global standards for a new generation of ubiquitous and extremely high-capacity network and service infrastructures.

The second expected impact concerns the reinforced European industrial leadership in wireless networks.
The third expected impact comes out of a peculiarity on the NoE structure. From this standpoint, the choice has been to act as a "network of networks", in order to avoid the fragmentation of many small partners and to implement this overarching-network vision.

At the same time, by cherry-picking the excellence dispersed within them, we have identified CNIT (a Consortium formed by all Italian universities active in telecommunications research) as the "collection partner" for researchers from the best Italian universities, and similarly we have identified the (only) French partner CNRS as the "collection partner" of researchers from CNRS, the GET University system, Eurecom and Supelec. Under FTW, This choice will eventually have an impact at the national level, favouring the establishment and promotion of similar national networks, and will also have an impact at the European level, by associating the "best of the best" researchers with a selection involving many national institutions.

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E3
End-to-End Efficiency

"E3 contribue à developper l'efficacité globale du réseau sans fil hétérogène en garantissant l'interopérabilité des systèmes existants et futurs et en définissant les solutions de management d'un point de vue technique, business, standard et réglementaire".

—

"E3 enhances the end-to-end efficiency of the heterogeneous wireless network, guaranteeing interoperability between existing legacy and future wireless systems and defining the management solutions from technical, business, standardisation and regulatory perspectives".

Didier Bourse
(E3 Coordinator)

The goal of E3 is to strengthen Europe's leadership in the global effort of transforming current wireless system infrastructures into an integrated, scalable and efficiently managed Beyond-3rd Generation (B3G) cognitive system framework. This objective will help to ensure seamless access to applications and services and to exploit the full diversity of corresponding heterogeneous systems.

The approach favoured by E3 addresses this goal in a non-disruptive way by integrating existing and future wireless radio standards into a common framework and contributing to on-going/emerging standardisation bodies with a focus on key convergence enablers. In particular, IMT-Advanced related radio and cognitive system oriented standardisation bodies are targeted.

The E3 consortium will develop and showcase the B3G convergence beyond state-of-the-art and introduce cognition and self-x principles into the different parts of the communication systems. It will contribute to development, regulation and standardisation of the corresponding system following an end-to-end approach. Aspects ranging from self-x and multi-standard functions of the access and backbone network, over corresponding enablers such as a cognition supporting pilot channel, to the self-x functions on the terminal and network sides are studied from a technical and its complementary economic and regulatory viewpoints.

The E3 consortium brings together major key European players in the domain of cognitive radios and networks, self-organisation and end-to-end reconfigurability. E3 builds on several key achievements from the successful FP6 E2R programme, pursuing research into the most promising directions towards removing walls (current technical and regulatory limitations) and building bridges (technical) in order to facilitate the vision of true end-to-end connectivity being as efficient as possible.

Technical Approach

The E3 vision of the future framework, consists of a multitude of heterogeneous standards, building on CR/CN principles where several operators are supposed to be present, each controlling multiple air interfaces, such as cellular (UMTS, HSDPA and LTE, a future 4G, etc.), metropolitan area (WiMAX, next generation WiMAX based on IEEE 802.16m, etc.), short-range (WiFi systems based on IEEE 802.11a/b/g/e/etc., next generation WiFi systems based on IEEE 802.11n, etc.). In this context, mobile terminals are expected to have the possibility of maintaining links to one or several of the air interfaces simultaneously.

To optimise the usage of existing and future radio access resources, the E3 consortium has set out four top level objectives:

- Design a cognitive radio system exploiting the capabilities of reconfigurable networks and self-adaptation to a dynamically changing environment,
- Enable a gradual, non-disruptive evolution of existing wireless networks in accordance to user requirements,
- Define means to increase the efficiency of wireless network operations, in particular by optimally exploiting the full diversity of the heterogeneous radio eco-space,
- Increase system management efficiency for network operation and (re)configuration by building on cognitive system and distributed self-organisation principles.

Key Issues

The key issues addressed by E3 cover:

- Validation and quantitative analysis of cognitive radio systems related business

models including market assessment,

- Extension of state-of-the-art towards a functional and implementation architecture enabling the exploitation of the full benefits of highly heterogeneous, cognitive radio systems,

- Development of collaborative (network-terminal, network-edges) and autonomous distributed decision-making related algorithms targeting an efficient operation of the heterogeneous, cognitive system by self-organising principles in terms of fast reactivity to any context change, low parameterisation overhead and distribution of computational complexity,

- Development of cognitive enablers with the objective to efficiently exchange context information and related optimisation constraints subject to which resource usage optimisation tasks are performed,

- Development of a reference prototyping system based on cellular, metropolitan area and short-range systems in order to implement and showcase the performance of cognitive decision-making algorithms in various scenarios.

E3 is definitely engaged in a strategy for openness, economical efficiency and technological excellence thanks to strong standardisation and regulatory commitments.

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Converged and Optical Networks

The objective of the group of Projects in the cluster "Converged and Optical Networks" is to meet the challenge of developing the technologies for realising the deployment of the ubiquitous infrastructures and architectures of future networks and future Internet services.

Future network infrastructures will support the convergence and interoperability of heterogeneous mobile and broadband network technologies. Barriers to ubiquitous fast broadband access will be eliminated and networks will provide ultra high speed end-to-end connectivity, with optimised protocols and routing, and optimised traffic exchange between heterogeneous core, metro and edge networks, wired and wireless, in multiple operator domains.

The expected outcome of this FP7-funded research is to deliver reliable, scalable, reconfigurable network infrastructures, which will be an absolute pre-requisite to deliver the upcoming generation of ICT services in a seamless manner.

There is a continuous trend in demand for faster broadband access. In most European Member states typical speeds for home broadband access are today in the 2-4 Mbit/s range. However, in the mid-term future, new services such as HDTV and 3D video will necessitate speeds of up to 100 Mbit/s and later up to Gbit/s, both for the access link between home and network and around the home. This will require the optimised exploitation of a full range of technologies, including cable (CaTV), optical fibres, high-speed wireless, satellite, powerline (PLC) and xDSL lines.

To assist in structuring the work of the Cluster, the projects in the cluster can be further sub-divided into four (overlapping) sub-areas: Ultra High-Speed Broadband Access; Core and Metro Network Concepts; Satellite Technologies; and Enhancement of Broadband Mobile Communications.

Ultra High-Speed Broadband Access is addressed by the IP projects ALPHA and OMEGA and by the STREP projects ReDeSign and SARDANA.

New concepts for ultra high-speed broadband GBit/s access to, and around, the home will be developed, supporting mobile-based services as well as video services, integrating wired, fibre and wireless links. Ring architectures and remote nodes will be developed as an evolution of current FTTH technology, and migration paths will be created from existing cable networks towards future hybrid optical infrastructures.

Novel Core and Metro network concepts are developed by the STREP projects DICONET and ETNA, and the IP project FUTON. They develop new network planning and routing tools, new architectures based on low cost and secure Ethernet technology, and fixed-mobile integration, using radio-over-fibre technology.

The contribution of Satellite Technologies to the future European broadband infrastructure is developed in two Support Actions (sISI, and SFERA), supporting the Integral Satcom Initiative Technology Platform, and addressing opportunities to use the EU Structural Funds in the deployment of broadband, particularly in rural areas. Enhancement of Mobile Broadband Mobile Communications in future networks is addressed by three STREP projects: Multi-Base, C-CAST and WHERE, in support of context-awareness, multi-casting and new location-related services, with enhanced usability of terminals and interfaces between the user and the network.

The collaboration work amongst the group of projects within the "Converged and Optical Networks" Cluster is supported by the BONE Project. BONE is a Network Of Excellence, building on the results of the FP6 ePhoton/ONe NoE, by stimulating a more intensified collaboration, exchange of researchers and building

use multi-mode multi-standards capabilities to reach higher data rates (both in core, metro and access networks), how to adapt bit rate to the requirements at the edge of the network, defining end-to-end requirements in terms of quality of service, data rate, unified signalling across heterogeneous networks, which network technology is making the most sense depending on the deployment scenario

Answering these questions in a collaborative and concerted approach will help to set some agreed fundamentals among academic and industrial researchers to build further the networks of the future in Europe.

on Virtual Centres of Excellence that can serve European industry and support the final "Network of the Future" with education and training, research tools and test labs, to pave the way to new technologies & architectures.

By fostering collaboration among very heterogeneous projects researching on a wide spectrum of network technologies, the "Converged And Optical Networks" cluster will enable to answer some fundamental questions, like at which network layer convergence is suitable, what is efficient convergence, how to

OMEGA

Home Gigabit Access

The future Internet will require an extremely high-bandwidth "core" and "access" network, along with the associated developments in transmission and switching that are required to achieve this.

Home access networks play a critical role in achieving broadband penetration, as they act as a communications segment that enables end-to-end services. Extending access into the home and to individual devices is the only way to ensure the success of the future Internet.

The future Home Access Networks must also enrich the lives of consumers, for example by allowing visual communications with their friends or relatives, by enabling interactive experiences through entertainment, by assisting the consumers in maintaining their independence as they age, for example by offering remote healthcare and by allowing them to communicate with their family to reduce any sense of isolation they may have. In essence, they must have the ability to control their virtual as well as their physical environment.

The OMEGA project is centred on the needs of the user: gigabit radio frequency and optical links, combined with more robust wide-area radio and visible-light communications will provide wireless connectivity within the home and its surroundings. Combined with power-line communications this provides a home backbone "without new wires."

A technology-independent MAC layer will control this network and provide services as well as connectivity to any number of devices the user wishes to connect to it in any room of a house or apartment. Furthermore, this MAC layer will allow the service to "follow the user" from device to device. In order to make this vision come true, substantial progress is required in the fields of power

line, optical-wireless and radio frequency physical layers, in protocol design, and in systems architecture.

Technical Approach

The general objective of the OMEGA is to distribute in all rooms 1 Gbps over heterogeneous technologies. Three main technologies without need of new wires in the home will be investigated and optimised in order to meet this challenging target.

Radio Communications
The multitude of systems operating in a single home network and using the overcrowded frequency bands will create coexistence problems. These issues have already appeared; causing difficulties in the standardisation process of IEEE 802.11n, because of the larger bandwidth employed in certain operation modes.

These difficulties will be potentially solved with the complementary deployment of systems such as ultra-wide-band (UWB). Therefore, improving the coexistence and cooperation between these legacy systems is a necessity for reliable communication within the home network. Convergence at the radio layer will consequently be a key concept to be investigated by the project.

Power line communications
OMEGA aims to increase the bandwidth for power line communications up to 100 MHz, as well as develop new understanding of electromagnetic interference and other impairments. This will provide a foundation for new wide-bandwidth power line transceivers that can substantially increase the data rates available by means of advanced modulation schemes

based on multi carrier approaches.

Optical Wireless
OMEGA aims to combine optical wireless communications techniques in order to provide a range of communications channels, which together can provide robust optical wireless communications. Infrared optical wireless will be used to provide Gbps line-of-sight communications, while visible light communications (VLC) will provide broadcast coverage at lower data rates. In addition, a complete hybrid wireless optic prototype will be incorporated into the OMEGA platform.

Inter-MAC Convergence

The OMEGA project will pioneer a new method of inter-MAC convergence, identifying the advantages and the limits of such an approach in terms of performance, reliability, stability, backward compatibility, costs, and potential impacts onto existing standards.

Continuity from the Access Network

The aim of OMEGA is to build a network that 'extends' the access network into the home to make it penetrate to the furthest home device. Access network continuity has therefore a key role to play. It will require novel methods for managing the interconnection of the HAN with various existing networks, as well as novel methods for the interoperability of the different media renderers with the proposed services.

Expected Impact

OMEGA will demonstrate a proof of concept ultra broadband Home Area Network in a scale one apartment and evaluate roll-out

scenarios with actual services. The disruptive capabilities of such a network will open up new business opportunities for the entire value chain, from manufacturers to network operators, service and content providers up to the end users.

In terms of impact on the European society the OMEGA project addresses several important challenges. Firstly it will ease and encourage the development of new advanced integrated services to the benefit of both the academy and industry. The expected impact for the citizen is the availability of new services due to ultra broadband penetration to the device.

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SARDANA

Scalable Advanced Ring-based passive Dense Access Network Architecture

"El uso intensivo de la transparencia óptica y de las últimas tecnologías opto-electrónicas permite extender los rendimientos y las funcionalidades de las redes ópticas pasivas, minimizando al mismo tiempo los requisitos de las infraestructuras tanto urbanas como rurales".

—

"The intensive use of optical transparency and the latest opto-electronic technologies enables to expand the Passive Optical Networks (PON) performances and functionality, while minimizing the infrastructure requirements at both urban and rural areas".

Josep Prat
(SARDANA Coordinator)

SARDANA project aims at extending the limits of passive FTTH networks in terms of scalability, resilience and minimum infrastructure requirements

Main Objective

Fibre-to-the-Home networks constitute a fundamental segment with the required potential to match the huge capacity of transport networks with the new user communication demands, where deeper research is still to be performed. Network access infrastructure investments are driven by increased number of users requiring broadband access to services enabled by the Internet infrastructure and applications. Fixed access to homes, hotspots, base stations is best served digitally via fibre optic capacity that provides a fundamental boost over the last mile copper solutions.

Dense FTTH Passive Optical Networks (PONs) is a cost efficient way to build fibre access and SARDANA is a way to demonstrate how the huge bandwidth available through the fibre access can be exploited in a cost efficient and reliable manner. The key performances that SARDANA project aims at radically improve are the scalability and the robustness, since constitute pillars of such a cost-sensitive segment:

- Scalability is reached by means of cascadable remote nodes in a new hybrid architecture, allowing smoothest grow and migration, and the new adoption of remotely-pumped amplification, WDM/TDM overlay, and cascadable remote nodes in a new hybrid architecture, while keeping the passiveness of the PON and reducing civil work investments.

- The resulting network is able to serve more than 1000 users with symmetrical several hundred Mbit/s, spread along distances up to 100 km, at 10Gbit/s, in a flexible way, also supporting multi-operator service.

- Robustness is achieved by means of the development of new monitoring and electronic compensation strategies over the PON, as well as by the passive central-ring protection.
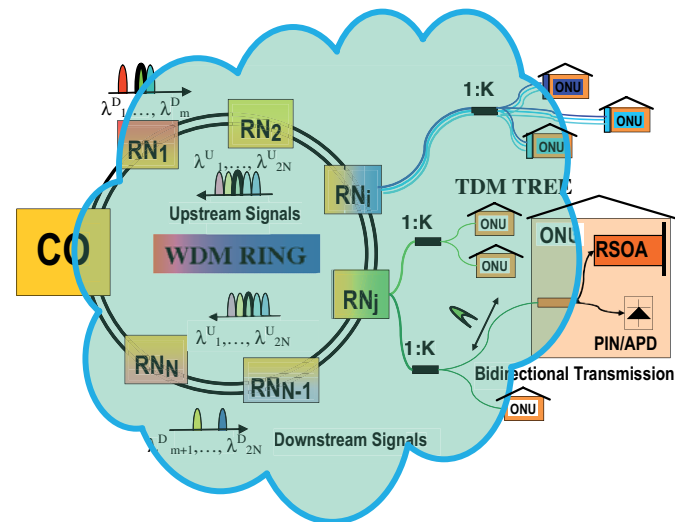
The intensive use of the optical transparency and of the latest opto-electronic technologies enables to expand the PON performances and functionality while minimizing the infrastructure requirements at both urban and rural areas. SARDANA will set an evolutionary path for G/E-PON and incorporate functionalities of metropolitan networks, envisaging access-metro convergence.
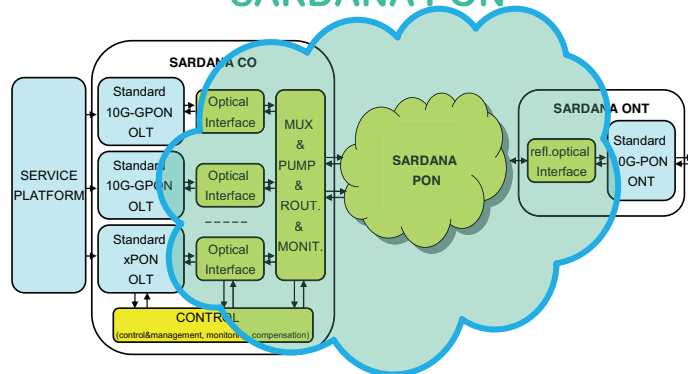
Technical Approach

The pursued novel SARDANA network transparently combines the WDM (Wavelength Division Multiplexing) and the TDM (Time Division Multiplexing) dimensions to reach the extra-large user-density.

The proposed completely passive resilient FTTH network is based on a WDM ring for the transport of the large amount of downstream and upstream information (up to 1.2Tbit/s if using 64 wavelengths for 2000 users) and TDM trees, transmitting several wavelengths from corresponding operators, sharing a common infrastructure. Passive Remote Nodes (RN), which implement cascadable 2-to-1 fibre optical Add&Drop functions distribute different wavelengths to each of the access trees; remote amplification is introduced at the RN by means of Erbium Doped Fibres (EDFs) to compensate add/drop losses; optical pump for the remote amplification is provided by pumping lasers located at the Central Office (CO), also providing extra Raman gain along the ring. Regarding the digital terminals, the SARDANA project aims at reuse, as much as possible,

$\lambda^D_1, \dots, \lambda^D_m$

RN$_2$

RN$_1$

$\lambda^U_1, \dots, \lambda^U_{2N}$

RN$_i$

Upstream Signals

CO

WDM RING

RN$_j$

$\lambda^U_1, \dots, \lambda^U_{2N}$

RN$_N$

RN$_{N-1}$

$\lambda^D_{m+1}, \dots, \lambda^D_{2N}$

Downstream Signals

1:K

ONU

ONU

ONU

ONU

TDM TREE

1:K

ONU

ONU

ONU

RSOA

PIN/APD

1:K

Bidirectional Transmission

ONU

SARDANA PON

SARDANA CO

SERVICE PLATFORM

Standard 10G-GPON OLT

Standard 10G-GPON OLT

Standard xPON OLT

Optical Interface

Optical Interface

Optical Interface

MUX & PUMP & ROUT. & MONIT.

SARDANA PON

SARDANA ONT

refl.optical Interface

Standard 10G-PON ONT

CONTROL
(control&management, monitor. & compensation)

standard G/E-PON equipment of current and next-generation 10G-versions, performing a quasi-transparent overlay between TDM and WDM layers.

The work in SARDANA is organised into several inter-related Work-Packages:

- WP-Mg: Project Management and Outcomes.
- WP-Ar: Network Architecture.
- WP-Mc: MAC and Higher Layers.
- WP-Tr: Transmission and modulation formats.
- WP-Sy: Network Subsystems.
- WP-Im: Monitoring and adaptive compensation of PON Impairments.
- WP-Dm: Demonstrator and Field-trial.

During the project live, a Sardana Network demonstrator will be built, engineered and multi-layer operated; its main features will be also demonstrated in a field trial, delivering new generation bidirectional services to residential users.

In order to fulfil the multi-disciplinary tasks and to reach the challenges, the SARDANA partners join their expertises:

- UPC: Coordination, subsystem design.
- FT: Architecture definition, ONU, Field-trial, Technical management, Techno-Economic studies.
- Tellabs: GPON equipment, MAC, lab-demonstration.
- IntraCOM: Management &Control plane, Service platform.
- IT: Monitoring system, non-linear transmission.
- ISC: Remote nodes, non-linear amplification.
- AIT: Electronic PON impairment compensation, Techno-Economic studies.

Expected Impact

The Objectives and expected Impact of SARDANA are:

- One order-of-magnitude extension of current PON performances, "aimed at overcoming the expected long term limitations of current internet capabilities, architecture and protocols".
- Smooth and increased scalability and backwards compatibility migration from currently deployed PONs. Since operators face a high degree of uncertainty at this level (take rates, user demands, etc) and the necessity of feasibly deferring the investments, incremental scalability has become a major objective, as denoted in the FP7 Target Outcomes.
- Establishment of new intelligent monitoring and compensation strategies to combat impairment and faults for a trusted robust PON.
- Implementation of the MAC, the Control and Management planes, to demonstrate basic resiliency, wavelength balancing and improved service-aware traffic control.
- Economic effectiveness of the extended PON approach.
- Demonstration and field-trial of the SARDANA network.
- Recommendation for a technical solution of a multi-operator shared infrastructure as an input to European and National Regulatory bodies.
- SARDANA will result with experience and IPR that helps European industry and research to develop a competitive advantage.
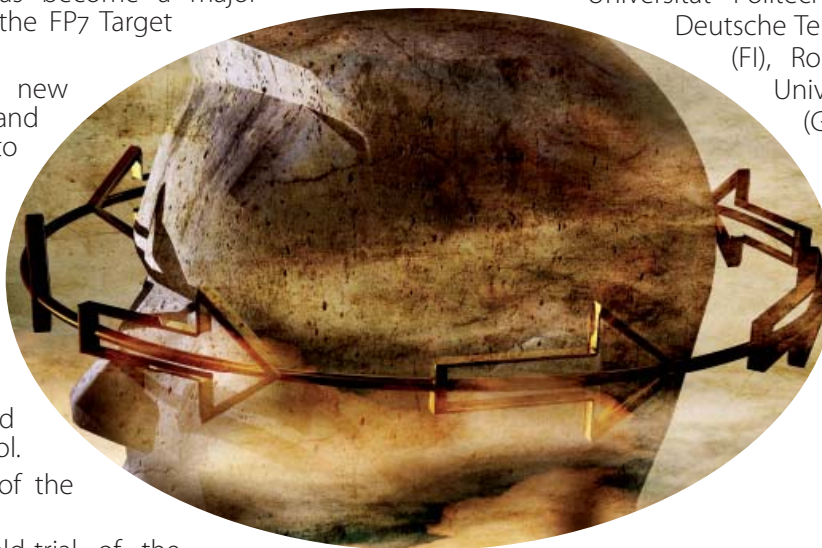
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ReDeSign - Research for Development of Future Interactive Generations of Hybrid Fibre Coax Networks
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Outlook

Current Trends

The existing research activities envision a *Future Internet,* which will feature almost unlimited bandwidth capacity, magnitudes of higher computing performance, wireless access anywhere, trillions of devices interconnected, integrated security and trust for all parties, and adaptive and personalised services and tools. This vision emerges as a federating research theme globally, as the ever growing number of networked applications and business models bring novel challenges in terms of scalability, flexibility, security, and robustness of networks and services.

From the network perspective, broadband and mobility will remain key research drivers. The introduction of High Speed Packet Access technology in 3G networks has prompted a 40% increase of mobile data usage. Still, current mobile technology does not meet the ambitious targets set in the global context of 4G systems.

For fixed access, a four fold increase beyond current state of the art represents an imperative. Cognitive/reconfigurable radio and networks are essential technologies capable of meeting the objectives of the EU spectrum policy whilst bringing down networks' capital and operational expenditure. Sensor networks and machine-to-machine communication systems emerging at the edge of networks bring about important architectural perspectives for the underlying network and service infrastructure. User-controlled (home) networks notably based on femtocells (and community networks) bring new architectural and management challenges.

Altogether, the proliferation of end-user devices, the heterogeneity of network types, the range of mobile and broadband demands, and the imperative for stronger security call for a reappraisal of the current Internet protocols and architecture.

Towards the Network of the Future

With the first call of FP7 the research areas of Broadband Access and Mobile communications were brought together. Now the combined Network of the Future area will provide a major contribution in three areas:

- Future Internet Architectures and Network Technologies, with target outcome of novel Internet architectures and technologies, and frameworks for flexible and cognitive network management and operation.
- Spectrum-efficient radio access to Future Networks, with target outcome of next-generation mobile radio technologies; cognitive radio and network technologies reducing the management complexity and enabling seamless service provision in a radio environment with a large number of heterogeneous radio access technologies; and novel radio network architectures enabling the innovative usage of licensed, unlicensed or unused radio spectrum.
- Converged infrastructures in support of Future Networks, with work in ultra high capacity optical transport networks based on photonic technologies and transparent core-access integration; and converged service capability across heterogeneous access.

This contribution is expected to enhance the positioning of EU industry in the field of Internet technologies and to reinforce European leadership in developing Future Network technologies for integrated wired and wireless networks. The projects will contribute to global standards and develop more and better Intellectual Property Rights (IPR) for European companies European.

Our Directorate

DG – Information Society and Media
The Information Society and Media Directorate General supports the development and use of Information and Communication Technologies for the benefit of everyone.

For more information on INFSO activities visit:
http://ec.europa.eu/information_society

Directorate D "Converged Networks & Services"
Director: João da Silva
The directorate engages in research on converged networks and explores new possibility of development in Europe, considering economic and social impact.
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Unit D1 "Future Networks"
Head of Unit: Rainer Zimmermann
The Unit "Future Networks" invest on research activities in the area of the next generation of converged network infrastructures for communications and media services.
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Further Information

CORDIS – Community Research & Development Information Services
CORDIS is the portal of research and technological development of the European Commission.

To find out more on FP6 and FP7 visit:
http://cordis.europa.eu/

European Future Internet Portal
European Future Internet is the central discussion forum for European activities on the theme The Future of the Internet.

For more information visit:
http://www.future-internet.eu

ICT Event 2008
Lyon 25-27 November 2008

Find out about this and other events at:
http://ec.europa.eu/information_society/events/ict/2008/

Unit AGENDA
Forthcoming events in December 2008

Visit:
http://www.fi-madrid.eu
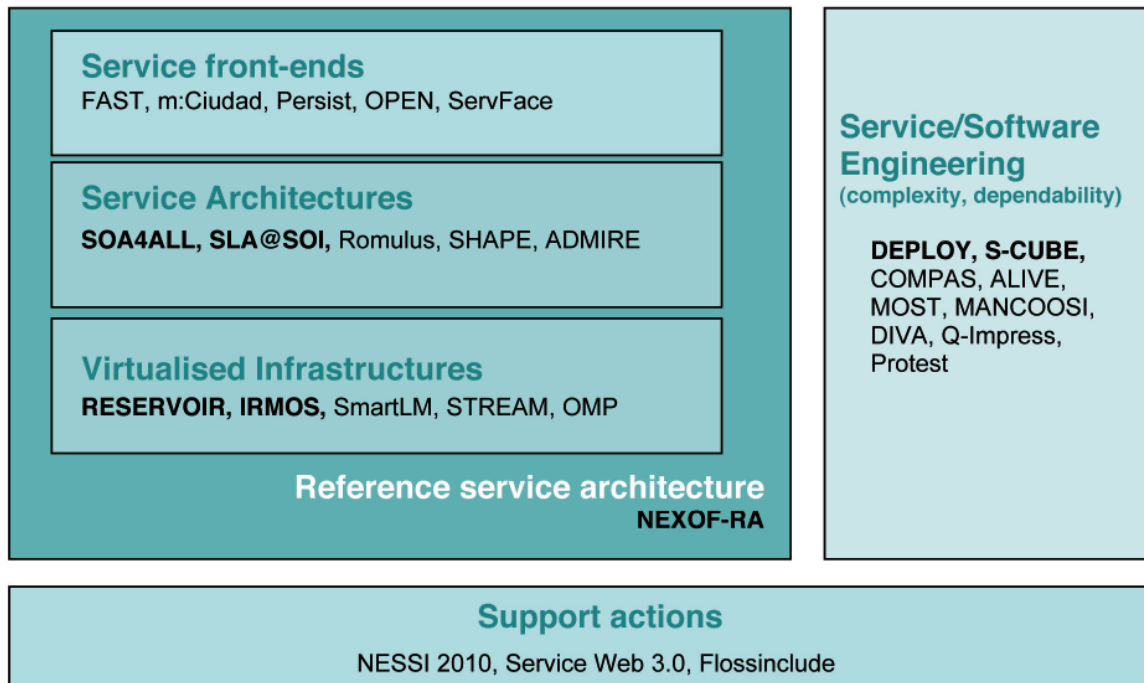
2.
INTERNET OF SERVICES

2. INTERNET OF SERVICES

Research funded under Objective 1.2 "Service and Software Architectures, Infrastructures and Engineering" can be summarised by the theme "Internet of Services". The collective aim is to provide software engineering technologies, service architectures and virtualisation technologies that will support the Future Internet.

The following figure shows these projects and their research areas.

Objective 1.2 "Service and Software Architectures, Infrastructures and Engineering".

Service front-ends
FAST, m:Ciudad, Persist, OPEN, ServFace

Service Architectures
SOA4ALL, SLA@SOI, Romulus, SHAPE, ADMIRE

Virtualised Infrastructures
RESERVOIR, IRMOS, SmartLM, STREAM, OMP

Reference service architecture
NEXOF-RA

Service/Software Engineering
(complexity, dependability)

DEPLOY, S-CUBE, COMPAS, ALIVE, MOST, MANCOOSI, DIVA, Q-Impress, Protest

Support actions
NESSI 2010, Service Web 3.0, Flossinclude

Service Front Ends

The web is already an important tool for social interaction, and users expect the web to support their life. They want to be in control of the applications they use and they want to mix services and data to compose services which are truly useful for them, matching their needs for that moment and in that context. An example of this composition of services and data is provided by so-called mashup technology. Empowering the user to develop their own services implies that the user should be, much more than before, at the centre of attention of developers of software tools. The "Service Front Ends" section describes this trend in more detail, and will also provide a short description of the relevant projects.

Service Architectures

The projects classified in the "Service Architectures" area are working on the topics of service oriented architectures and service oriented computing. These approaches allow pieces of software to be made available as "services" that can be easily reused and composed into applications. The vision is that, given specific user requirements, applications can be composed from loosely coupled services. If changes occur in the environment, the application can dynamically (on the fly) recompose itself to address the new needs. Before this vision is reached a lot of research still needs to be done. Section "Service Architectures" describes in more detail this research.

Virtualised Infrastructures

The goal of the research done by the projects classified under the topic of Virtualised Infrastructures is to efficiently manage and synchronise IT resources to match fluctuating business requirements and to enable businesses to provide optimal infrastructure service at a justifiable cost. It addresses the whole range of challenges

of many of the individual projects will fit. Through NEXOF-RA it should be possible to integrate the results of projects working in the three areas mentioned before into a so-called service platform. Especially the results of the NESSI Strategic Projects SOA4All, SLA@SOI and Reservoir will be integrated, but through open calls also the results of other projects will be considered.

NEXOF-RA will be one of the important outcomes of the NESSI, the European Technology Platform on software and services. NESSI (www.nessi-europe.eu) groups more than 250 organisations from industry and academia that share a common long term strategy on software and services to contribute to Europe's competitiveness.

Service/Software Engineering

The challenges of developing good quality and reliable software and services for the Future Internet are getting bigger and bigger. Just think for instance about the fact that users will do matching and mixing of services or develop their own services, which will run on the internet and be accessible by millions of people. Of course this software should not have any negative side effects, so that requires new research into validation and verification. Another question is how to ensure an overall quality of experience to users when an application is composed of services that are developed by somebody else and of which you only know the interface? How can you depend on these base-services? The Section "Service/Software Engineering" describes these and other related issues in more detail.

Support actions

NESSI 2010, Service Web 3.0 and Flossinclude are Support Action projects. They support the community and the European Funded Projects in reaching the goals of Objective 1.2.

in providing computing, storage, communication, data, and information as services. In the last 10 years, with the advent of key technologies such as grid, virtualization and web services, the idea of managing an infrastructure with the ability to share resources has moved closer to reality. However, important research questions are still open. This is further described in Section "Virtualised Infrastructures".

Reference Service Architecture

Within the project portfolio of objective 1.2 NEXOF-RA is a project with a special nature. By means of intensive collaboration, it aims at delivering a reference service architecture in which the results

Service Front Ends

The software technologies that will be developed for the Future Internet put the user at the centre of attention. The projects classified in "Service Front Ends" share the aim of empowering users to do things which they can't currently do with software technology.

Some of the projects (FAST and m:Ciudad) go as far as enabling the user to develop their own services, whereas others support the user's mobility (Persist and Open). ServFace will develop a methodology for developing stable and consistent user interfaces for service oriented architectures, to optimise the quality of experience for the user.

Creation of services by the end-user

Web 2.0 is the trend in the use of internet technology that aims to facilitate creativity, information sharing, and, most notably, collaboration among users. Going beyond this, research into "Service Front Ends" aims to enable users to adapt, customise and control services according to their needs. Several projects are working in this area, producing software toolkits to support service users.

A simple example of such a toolkit is Google Gadgets - interactive mini-applications that can be placed anywhere on the user's desktop to show new email, weather, photos, and personalized news. Advanced users can program such gadgets and make them available to others.

The project FAST is extending the notion of gadgets to business process management services, enabling users to build gadgets that can connect with the back end systems of an enterprise. This project is described in more detail in the following pages.

The project M:Ciudad gives users the possibility to create, with

their mobile devices, instant services, that will provide useful information to other, remote users. Specific research questions they are addressing are: What tools are required to allow each user with a mobile device to become a service provider? How should the mobile platform behave to make it simple to use and efficient? How can this type of distributed, volatile services and their associated knowledge or information be achieved? And how can the business opportunities this new scenario brings about are exploited?

Supporting users that are on the move

Users are increasingly mobile and require wire-free and nomadic access via a growing number of diversified communications devices and appliances. The project Persist will develop a personal smart space that is associated with the portable devices carried by a user.

It contains the user's profile and preferences and functionality for exchanging information with other smart spaces. When it comes in touch with another smart space, systems and applications might be adapted to the preferences of the user and relevant information might be exchanged. Just consider a not uncommon situation at a bus stop – Andy approaches the stop and would like to connect to the internet to discover when the next

bus is due but he has no connectivity. Meanwhile, Betty, another passenger waiting for the bus, is accessing the internet via her UMTS connection.

Betty's personal smart space automatically offers to act as a broker between Andy and her internet service provider, so she becomes a micro-operator for internet service provision. Another example of use is when you fall ill on vacation; the local doctor might access your health records stored in your personal smart space.

An entirely different approach to supporting users moving about freely is envisioned by the project OPEN. Their research will make it possible that users can continue the interaction with applications through a variety of interactive devices (including cell phones, PDAs, desktop computers, digital television sets, and intelligent watches).

People can start an application on one device and when they need to move they can continue their session on another suitable device. So-called migratory interactive services can support continuous task performance, implying that interactive applications are able to follow users and adapt to the changing context of use while maintaining their state.

Methodology for developing user interfaces for service oriented applications

The projects described so far focus on the end-user. The project ServFace distinguishes itself from that by focusing on the software developers. It will provide them with a methodology and tools to develop consistent user interfaces for applications developed in a service oriented manner. Such interfaces need to give the user a good quality of experience, even though the basic building blocks of the application (the individual services) have been designed in

a loosely coupled way. ServFace will look at this process from two different perspectives:

First, the development of single services with corresponding user interface descriptions.

Second, the development of user interfaces for a composition of existing services. The methodology will be based on model driven development.

FAST aims to provide an innovative visual programming environment that will facilitate the development of next-generation composite user interfaces. It constitutes a novel approach to application composition and business process definition from a top-down user-centric perspective.

Nowadays, business process management technologies are not user-centric. Currently, they try to define businesses processes by invoking back-end services, i.e. conceiving them as a kind of structured program.

Therefore, current graphical process-definition notations tend to be quite similar to programming flow charts. This has two drawbacks. First, the promise of enabling users with little or no IT skills to design processes is broken. Second, it is difficult to model user interaction with flow charts, since they are too structured to deal with frequent small changes in the execution flow.

In addition, following the Web 2.0 phenomena, the front-end layer in the next generation of Service Oriented Architectures will rely on the existence of gadgets (i.e. a portable chunk of code that can be installed and visualised by an end-user as a part of a mash-up-oriented user interface, with no additional compilation).

Nowadays, there is no comprehensive solution for developing complex gadgets, involving multiple screens and process-execution flows. Europe needs such a platform to keep pace with the latest developments and to stay at the forefront of the future internet.

Innovative Approach

The main objective of FAST is to provide an innovative visual programming environment that will facilitate the development of next-generation composite user interfaces. It will also set out the basis for a new approach to application composition from a top-down user-centred perspective.

By leveraging FAST, software designers will automatically create final applications by endowing user interface elements (gadgets) with the enterprise's back-end. Semantics plays a relevant role in this promising approach. It is expected to act as the 'glue' to bridge the gap between the technical vision of back-end resources, where its power has already been demonstrated, and the user vision of the front-end.

In the context of digital administration, citizens expect to be able to locate and manage most of their administrative procedures – such as tax payments, tax declarations or administration issues – easily by themselves, thanks to government web portals and services.

However, most transactions and tasks demand recurrent browsing, searching and discovering through a variety of websites and services allocated in disparate government portals. All this disparate information and functionality would be more useful and valuable if it was presented together in a unique mash-up-based interface.

Nevertheless, to achieve this, dynamic mash-up-based user interfaces are required which are made up of a number of screens, along with support for the underlying process flow.

This would be a tough task in the absence of specifically tailored visual development environments suitable for modelling such powerful mash-ups, and for deploying them on current mash-up platforms.

Experience and Benefits

FAST partners are contributing their own experience, knowledge and technologies to drive the project. The project team offers a well-balanced presence of both industry and academia providing complementary skills and expertise.

In the course of three years, FAST will deliver relevant economic and societal benefits, including bridging the gap between people, business and IT by putting a visual face on Service Oriented Architecture. It will also cover the 'long tail' in enterprise application by empowering users from service consumer to producer.

By leveraging FAST results, software development will benefit from concealing the complexity of programming, and from greater support for modelling loosely structured user-centric orchestrations, thereby surmounting the limit-actions of current business process engine approaches.

The project will also contribute to software industrialisation by shortening time-to-market and improving the cost-effectiveness of application development.

The partners will benefit from the increased agility, versatility and reusability of existing IT applications that is required in today's fast-paced business environment. They will also be able to build the technological basis for service market places that can be provided, operated and used by the partners to increase market reach. The outcome of the project will be released as open source in the context of the Morfeo Community (http://www. morfeo-project.org).

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Today, it is almost impossible to remember what life was like with no computer, no mobile phone, and no Internet for exchanging emails and data. Organisations are doing business with each other by exchanging information via the Internet. People are filling in tax declarations online. Micro computers are present these days in almost every electrically-powered device we buy and use; most are controlled with dedicated forms of software, which often enable the device to be adapted, configured or upgraded in some way.

New application areas and the expansion of numbers and types of devices increase the demand for more and new services. Society is progressively using (and dependent on) software and services running on computers, connecting mobile phones and other devices, and exchanging information on the Internet.

People like to shop and choose. Businesses and public administrations do this also. Today, they obtain the most cost-effective or most 'optimal' solution to meet their needs, even if the solution does not match the needs perfectly. Tomorrow, they may no longer have to compromise in this way.

Just imagine from a consumer demand viewpoint, software that is provided as a service and computing power that is provided on request – and both of these provided via a communication network. Such an approach allows individuals and organisations to tap into, and to effectively harness the immense wealth of information, knowledge and analytical resources as and when they need them, paying only for what they use.

Changes in the demand side will influence changes in the supply side as well. As changing demands from society influence what software is developed and how, one can expect the markets and the structure of the IT service industry to evolve. Is it not true that patterns of competition and business are changing rapidly? The software industry itself is also rapidly restructuring. For example, new business models are emerging as an alternative to the buying and selling of 'traditional packaged software'.

Services and service-oriented architectures

This changing landscape of supply and demand is largely made possible by service-oriented architectures (SOA). Service-oriented computing decomposes the logic of an information system into smaller units of functionality, services. These services can be used as building blocks in the composition of larger systems.

The philosophy of SOA is to build software applications by connecting different building blocks of software, i.e. services, together in a loosely coupled way. The services are made available for use by publishing their interfaces. They can be provided in-house or by external parties. Service-oriented architectures hold the potential to be an effective solution to let software systems work together, even when they are developed by different organisations and spread across the world.

Addressing barriers to service-oriented computing

Obviously developing services is not a silver bullet. There are also some barriers to overcome before the SOA paradigm can realise its full potential. For example, the effort to develop services is

too high at the moment, especially in an ever changing world. Therefore, the ROMULUS project aims to increase productivity in Java Web development. Java is the most popular software language in Europe. Out of 4.5 million Java developers in the world, Europe has 1 million. ROMULUS will promote an open paradigm for development of web systems using Java technology. The project will provide an open source Java meta-framework for developing web applications. This will increase productivity of software development and reduce the time to develop services.

Another barrier is the integration of new functionality in existing IT environments. In organisations, you typically find a variety of infrastructure technologies, such as web services, P2P, Grid, and agents.

The SHAPE project will provide support for such heterogeneous architectural styles, including Web Services, agents, peer-to-peer, Grid and Components, under a unified service-oriented approach. This way, a new and better basis for meeting the business requirements of enterprise-wide systems will be formed. SHAPE will also apply the model-driven approach so that automation and abstraction of the technical issues are eased.

Furthermore, we should not forget the data aspects, or the information and knowledge that can be extracted from data. Organisations are collecting massive amounts of data but they find it hard to get any information from it. The volume of data collected and the number and complexity of data repositories is growing, and this trend is expected to continue in future.

The project ADMIRE will accelerate access to data exploitation. It will achieve this by delivering consistent and easy-to-use technology for extracting information and knowledge. To cope with complexity, change and heterogeneity of services, data, and

processes, an abstract view of data mining and integration will be provided. This will support users and developers of data mining and integration processes.

Towards a Web of billions of services

Now picture a world where organisations and even citizens start developing services and making them available. SOA4All (see page 48 for an extensive description) will provide the tools to deal with and to realize 'a Web of billions of services', a world where billions of parties are exposing and consuming services.

Finally, services will not be used if consumers do not trust the service providers. Consumers need mechanisms to make agreements with providers, i.e. they need to establish Service Level Agreements (SLA) with providers.

SLAs should allow the quality characteristics of services to be predicted and enforced at run-time. SLAs should define the exact conditions under which services are provided and consumed. They should be managed in a way that is transparent to both provider and consumer. The project SLA@SOI will deliver exactly the predictability and transparency both parties need. This project is described in the following pages.

SLA@SOI

Empowering the Service Economy with SLA-aware Infrastructures

"Ein durchgängig automatisiertes Management von Dienstgütevereinbarungen erlaubt die Bereitstellung von Diensten nach sowohl technischen als auch betriebswirtschaftlichen Gesichtspunkten. Es bietet somit die Basis für Dienste die als ökonomisches Gut in einem zukünftigen Internet der Dienste gehandelt werden können".
___
"A truly automated management of Service Level Agreements will allow for provisioning of services according to business and IT policies and will pave the way for trading of services as goods within the future Internet of Services".

Wolfgang Theilmann
(SLA@SOI Coordinator)

SLA@SOI is an Integrated Project (IP) researching the systematic management of of service-oriented infrastructures on the basis of formally specified service level agreements (SLAs). SLA@SOI is a NESSI strategic project realizing one core pillar of the overall NESSI vision.

The ongoing transformation of a product-oriented economy towards a service-oriented economy has come to a critical point. IT-supported service provisioning has assumed major relevance in all industries and domains.

However, the nature of these set-ups is typically quite static because it requires significant effort to create service offers, to negotiate provisioning details with customers, and to manage and control provided services. The research project SLA@SOI will provide a major milestone for the further evolution towards a service-oriented economy, where IT-based services can be flexibly traded as economic goods, i.e. under well-defined and dependable conditions and with clearly associated costs.

Eventually, this will allow for dynamic value networks that can be flexibly instantiated, thus driving innovation and competitiveness.

SLA@SOI will provide three major benefits as regards the provisioning of services:

• Predictability and dependability: the quality characteristics of service can be predicted and enforced at run-time;

• Transparent SLA management: Service Level Agreements (SLAs) defining the exact conditions under which services are provided/consumed can be transparently managed across the whole business and IT stack;

• Automation: the whole process of negotiating SLAs and provisioning, delivery and monitoring of services will be automated enabling highly dynamic and scalable service consumption.

Business Benefits

Eventually, all the main stakeholders in a service-oriented economy will benefit from the project results.

Software providers will be empowered to produce components with dependable behaviour for arbitrary scenarios. Service providers can offer services (possibly stemming from different software providers). This can be done flexibly according to different customer needs but always balancing these with IT capabilities and business strategies. Service aggregators can offer composed services which are well managed according to IT and business needs.

Infrastructure providers will be empowered to allocate infrastructure elements exactly according to higher-level customer needs. And last but not least, service customers are empowered to specify precisely and negotiate the actual service level, according to which they buy a certain service.

Expectations and Relevance

SLA@SOI will provide its results in three complementary ways.

First, an open-source-based SLA management framework will enable realisation of the benefits of predictability, transparency and automation in an arbitrary service-oriented infrastructure.

Second, in-depth guidance for industrial stakeholders will be given explaining the best practice on how to transform their service business into an SLA-driven one.

Finally, SLA@SOI will provide an open reference case which allows for stakeholders to re-run, revalidate and even modify SLA experiments in the context of a concrete application.

The project's technical approach will be to define a holistic view for the management of Service Level Agreements (SLAs) and to implement an SLA management framework that can be integrated easily into a service-oriented infrastructure (SOI). The main innovative features of the project are: (1) an automated e-contracting framework; (2) systematic grounding of SLAs from the business level down to the infrastructure; (3) exploitation of virtualisation technologies at infrastructure level for SLA enforcement; and (4) advanced engineering methodologies for creation of predictable and manageable services.
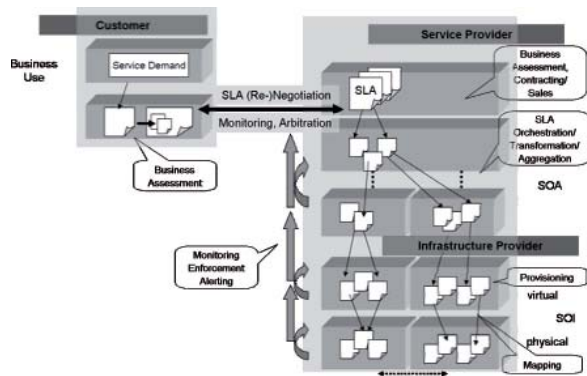
The research topic of this project is highly relevant for many industrial domains. Therefore, SLA@SOI is based on various highly relevant but also complementary industrial use cases. These use case studies will drive the project in terms of requirements and will also serve to validate project results.

The industrial use cases include scenarios from hosted Enterprise Resource Planning systems, Enterprise IT management, and service aggregation in telecommunication, eGovernment and finance industries.

Apart from use case-specific evaluations, the project will also derive an overall industrial assessment which then can be used in arbitrary domains for establishing an SLA-driven business.

The project consortium comprises world-class players in academia and industry representing all the relevant industrial and technical perspectives required for achieving the vision of this ambitious project.

NESSI Contributions

The project seeks to contribute its results to the NESSI Open Framework. These include:

- an e-contracting platform between service consumers and providers;
- a framework for mapping, planning and coordination within multiple levels in an organisational/IT structure;
- access and provisioning layer for SLA-aware infrastructure.

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SOA4All
Service Oriented Architectures for All

Computer science is entering a new generation. The emerging generation starts by abstracting from software and sees all resources as services in a service-oriented architecture (SOA). SOA4All will help to realize a Web of billions of services, a world where billions of parties are exposing and consuming services via advanced Web technology.

In a world full of services, it is the service that counts for a customer rather than the software or hardware components which implement the service. Service-oriented architectures are rapidly becoming the dominant computing paradigm. However, current SOA solutions are still restricted in their application context to being companies' in-house solutions.

While service orientation is widely acknowledged for its potential to revolutionise the world of computing by abstracting from the underlying hardware and software layers, its success depends on resolving a number of fundamental challenges that SOA does not address today.

The outcome of the SOA4All project will be a comprehensive framework and infrastructure that integrates four complementary and revolutionary technical advances into a coherent and domain-independent service delivery platform:

- Web principles and technology as the underlying infrastructure for the integration of services on a global scale;
- Web 2.0 as a means of structuring human-machine co-operation in an efficient and cost-effective manner;
- Semantic web technology as a means of abstracting from syntax to semantics, as is required for meaningful service discovery;
- Context management as a way of processing in a machine-understandable way user needs that facilitate the customisation of existing services for the user.

Measuring the Impact

The impact of SOA4All will be substantial and broad ranging in terms of new frameworks, new platforms and new infrastructures transforming the web into a web of billions of services.

Dynamic services at web scale
Through the application of web principles, SOA4All will transform the web into a domain where billions of services are exposed and consumed in a dynamic, transparent fashion analogous to the document-centric web of today. Scalability is also supported through semantics which mechanises core tasks associated with creating service applications, namely, discovery, invocation, mediation and orchestration.

Service usability
The exponential increase in mash-ups clearly indicates that web 2.0 technologies are orders of magnitude easier to use than standard web service platforms. By reusing web 2.0 principles, SOA4All will lower the entry barriers to the service world ensuring that the main activities associated with the consumption, production and personalisation of services are open to non-IT experts. One consequence of increasing usability is that we gain benefits in terms of productivity and efficiency.

Open standard service platform
The web, and its success, is founded upon a platform that is non-proprietary and based upon a set of open standards. Following the same approach, SOA4All will ensure a service platform that is truly open over and above existing and new web standards.

Integration of service worlds

The amalgamation of SOA with the web, utilising a web 2.0 approach, will bring services out from behind the enterprise walls into the mainstream. In addition, we will integrate machine and human-based services blurring their distinctions and enabling them to be used in an interchangeable fashion. This integration will provide a significant benefit to the key players in the service market, including SMEs, large corporations and end-users (citizens).

Service adaptation to local contexts

A main contribution of SOA4All will be that of providing mechanisms to support the adaptation of services to a local context. The impact on users will be that the services they use will be aware of the local setting, such as the specific device used, the user's geographic location and personal preferences, to name but a few.
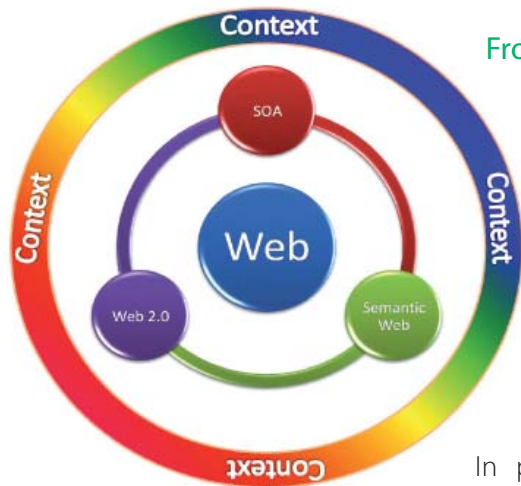
From R&D to Real Business

In order to maximise the project's impact, requirements will be gathered from 'real world use' case studies. The deployment of SOA4All within the case study will validate the project's technologies in terms of usability, re-usability, added value, interoperability, scalability and breadth of scope.

In particular, the usefulness of the SOA4All platform will be illustrated through collaboration with leading European enterprises, such as British Telecom and SAP, aligned with the emergent industry-adoption of IP-based service infrastructures as well as ongoing standardisation efforts in the service arena. SOA4All is also a NESSI project. The results of SOA4All will be integrated into NEXOF-RA.

Contact the project

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"Today, the Web contains just around 25,000 Web services, a minuscule amount in comparison to the 30 billion Web pages constituting its content. SOA4All will transform the Web into a domain where billions of parties are exposing and consuming services in a seamless transparent fashion, facilitating a new Web of billions of services".

Santiago Ristol Jorba
(SOA4ALL Coordinator)

Virtualised Infrastructures

Services available on the internet are running on a network of computers making use of particular devices and storage capability. Virtualisation technology makes it possible that companies roll out new services and applications without investing in and maintaining an expensive IT infrastructure.

In fact, through virtualisation, IT resources can be made available as a service (this is sometimes called Resource as a Service) and depending on the needs of the moment, for instance how many users are simultaneously accessing an application, the necessary amounts of resources can be used. Service Oriented Infrastructure or SOI is a system for describing and delivering IT infrastructures as a service.

Service Oriented Infrastructures

Service Oriented Infrastructures enable organizations to move from allocating dedicated resources to each application to dynamic resource allocation in which virtual processing, storage and network resources are assigned to the applications as needed. By providing better resource utilization costs are reduced. Also the reliability of applications will be increased since in case of hardware failure other resources can take over easily. The infrastructure can automatically allocate additional resources in real time as an application's workload increases. Thus, SOI delivers bottom-line benefits to the enterprise. A good working SOI is one of the essential elements of the Future Internet.

Virtualisation of resources

A service oriented infrastructure delivers infrastructures as a service from a pool of shared virtualized resources. Shared resources are aggregated, secured and presented as services across a network. The SOI model consists of two parts: hardware resources and infrastructure services. Hardware resources include: network, storage, sensor networks and computing. Infrastructure services include: Security, data management services, computing services, directory, provisioning, capacity planning, fault monitoring, metering, and billing. To increase use and efficiency, the hardware resources need to be pooled and made dynamically available. Infrastructure services help with the provisioning, monitoring, scaling, and secure operation of hardware resources.

Although the most immediate motivations for virtualization of resources are improved resource utilization and lower costs, the ultimate goal is to use the abstraction between applications and the underlying resources to manage IT infrastructure as a service. This provision of infrastructure services supporting different levels of abstraction and virtualisation of resources, dynamic monitoring of SLAs and the dynamic reallocation of services are at the core of the future research that is required to foster the Internet of Services.

The following projects are contributing to the Virtualised Infrastructures area.

RESERVOIR addresses the area of service-oriented infrastructures. It will develop and demonstrate an architecture and reference implementation for reliable and effective delivery of services as utilities. By harnessing virtualization and grid technologies across administrative domains, RESERVOIR will provide a foundation for a cost-competitive

service-based online economy where resources and services are transparently and flexibly provisioned and managed like utilities. Instead of static over provisioning, RESERVOIR will allow for the nimble relocation of resources while at the same time ensuring Service Level Agreement (SLA) compliance and security guarantees. This project is described further in more detail.

IRMOS aims to design, develop, integrate and validate a service-oriented infrastructure that meets the requirements of interactive real-time applications. IRMOS will apply emerging real-time methodologies and technologies that are suitable for soft real-time systems in the context of SOIs, for the purpose of building foundations of the next-generation SOA-oriented interactive real-time applications, that will benefit of both the location independence and robustness typical of SOIs, and the predictability in timing behaviour (interactivity and response time, throughput) typical of soft real-time systems. IRMOS (further described), addresses the possible issues that are brought up when virtualization is used in the context of real-time applications.

SmartLM addresses the fact that traditional software licensing methods are not suitable when resources are shared, since the software is no longer tied to one particular computer. SmartLM will provide a new generic licensing virtualization framework based on standards, and integrate it in major Grid middleware solutions. The overall approach consists of treating and implementing software licenses as Grid services thus providing platform independent access just like other virtualized resource.

Licenses will become Grid services; a promising approach to overcome the limitations of current monolithic licensing models. Licenses will be managed as agreements, extending the conventional Service Level Agreements (SLAs) which are made today between sellers and buyers in the market. Licenses will be dynamic in order to support agreements that may change over time and where the dynamic negotiation between service provider and consumer is needed.

STREAM aims at producing a highly scalable infrastructure for processing in real time massive data streams such as the IP traffic of an organization, the output of a large sensor network, the e-mail processed by an ISP, the market feeds from stock exchange and financial markets, the calls in a telco operator, credit card payments, etc. STREAM aims at scaling system size by an order of magnitude, and providing unsupervised (autonomous) operation which will allow for much broader deployment of such data intensive services to areas that need to manipulate large amounts of information in a cost-effective manner. This will enable a myriad of new services and applications in the upcoming Internet of Services.

OMP develops technologies and standards which facilitate dynamic composition of media-rich services for mobile devices and scale with device performance and network capability. OMP will deliver the essential tools, components, algorithms, methods and standards, necessary for Europe to develop the infrastructure necessary to enable new media-rich services. OMP combines component based methodology with efficient runtime engines able to execute the same binary on a large variety of platforms. Users will be able to create and share their own mobile content, and interact in novel ways.

Mobile devices will be capable to intelligently operate with an array of networks and web services, dynamically composing content to deliver the most engaging experience possible. This new enriched network environment will facilitate creative business models for users and service providers alike.

RESERVOIR

Resources and Services Virtualisation without Barriers

The goal of the RESERVOIR project is to increase the competitiveness of the EU economy by introducing a powerful ICT infrastructure for the reliable and effective delivery of services as utilities. This infrastructure will support the setup and deployment of services on demand, at competitive costs, across disparate administrative domains, while assuring quality of service.

As today's ICT technologies move to Web 2.0, companies supplying internet-based hosting typically need to over-provision their servers by as much as a 500% to handle peak loads. However, over-provisioning is expensive in terms of capital costs, as well as the cost of housing, cooling and supplying electricity to the mainly idle spare machines. In addition, service deployment is an expensive and often very time-consuming operation – machines need to be set up with an operating system, configured with network and storage capabilities, and software must be deployed.

As a result, entrance costs for a service provider are very steep, a factor which not only acts as a barrier to small and medium-sized enterprises, but also results in higher costs to citizens.

RESERVOIR research aims to harness the power of virtualisation and grid technologies across administrative domains, and to provide a foundation for a cost-competitive service-based on-line economy where resources and services are transparently and flexibly provisioned and managed like utilities. The project team comprises outstanding researchers from both industry and academia across Europe who are supplying the expertise required in a wide range of technical areas to make the RESERVOIR vision a reality.

Gathering Clouds

Today, the vision of hosting applications and data off the desktop and on the web is being enabled by the emerging 'cloud computing' model. However, these clouds tend to be hosted by large companies with vast resources. Currently, technology does not exist to allow smaller service providers to co-operatively provide resources on-demand to compete with these giants, while still guaranteeing security and quality of service to their customers.

By merging virtualisation, grid and business technologies, RESERVOIR plans to provide the means to allow the migration of resources across geographies and administrative domains, maximising resource exploitation, and minimising costs to the European citizen.

Achieving the RESERVOIR Vision

The main goal of RESERVOIR is to supply architecture and a reference implementation for a service-oriented infrastructure, which will be built on open standards and new technologies. The aim is to provide a scalable, flexible and dependable framework for delivering services as utilities.

Four of the industrial partners will analyse the performance of 'actual use' cases from their core business in the RESERVOIR environment. Not only will this supply feedback to the researchers, but it will help guide all partners in the development of their next-generation applications.

Using virtualisation techniques, physical resources across the cloud will essentially be pooled. Users will be allotted a virtual execution environment (VEE) such as a virtual machine and storage, without needing to be aware where physical resources are physically

located. Research will develop the infrastructure required to support and manipulate these VEEs, such as techniques for allowing relocation of a VEE across sub-network boundaries while retaining connectivity to underlying storage.

A virtual execution environment Management Layer will be developed to provide dynamic deployment and reallocation of VEEs on underlying physical resources, based on quality of service requirements coming from a Service Level Agreement (SLA). This layer will provide mechanisms to federate management domains, allowing the management of VEEs across administrative domains, such as multiple-service sites.

Finally, a Service Management Layer will provide the interface for requirements from the business world, including support for billing for services used, composition of the definition of the service required, and the monitoring of SLA compliance. RESERVOIR is also a NESSI project. Its results will be integrated into NEXOF-RA.
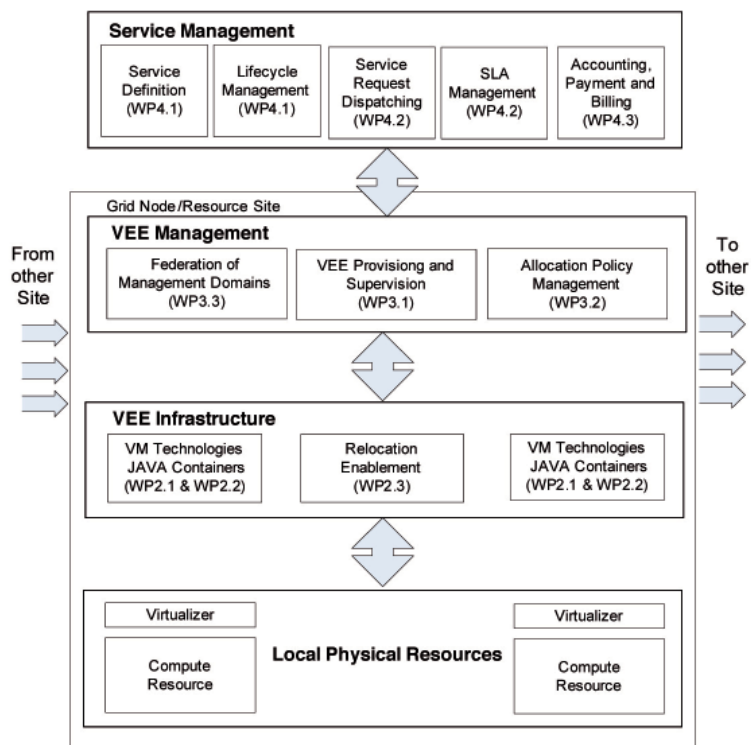
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IRMOS

Interactive Real-time Multimedia Applications Service Oriented Infrastructures

The overriding objective of IRMOS is to enable 'real-time' interaction between people and applications over a Service Oriented Infrastructure, where processing, storage and networking need to be combined and delivered with guaranteed levels of service.

Today's Service Oriented Infrastructures (SOIs) are inadequate for the rapid growth and provision of many interactive real-time applications. Soft real-time applications are traditionally developed without any real-time methodology or run-time support from the infrastructure on which they run. The result is that both expensive and dedicated hardware has to be purchased to ensure good interactivity levels and performance, or that general-purpose resources are used as a compromise.

For example, commodity-operating systems and internet networking may be used with no way to guarantee or control the behaviour of the application. IRMOS aims to break this mould by enabling 'soft real-time' applications to be delivered through value chains that span organisational boundaries by an SOI that enables the real-time interaction of a distributed set of people and resources.

A Unique Approach

IRMOS is set apart from an SOI through a set of key features. It will provide a real-time framework as a single infrastructure with real-time attributes at all levels (network, processing, storage, application, workflow and business) plus provision of Quality of Service Guarantees.

Furthermore, while this infrastructure is considered to be cross-organisational, allowing the distribution of interactive real-time applications, at the same time it provides inter-organisation confidence. This means that all participants in inter-organisation value chains can be confident that interactive real-time applications will be delivered in a predictable, reliable and efficient way.

The aforementioned framework also allows for business processes automation by providing services that enable the quick and efficient assembly of businesses without the need for protracted manual negotiations or service provisioning by using the IRMOS services.

Promoting Innovation

The following innovations will be contributed by the IRMOS project:

- Network overlay enabling automated Service Level Agreement (SLA) negotiation and monitoring.
- An application platform that is Quality of Service aware and able to participate in automated SLA negotiations.
- Software tools and associated modelling environments to enable real-time interactive applications to be written to target the IRMOS framework.
- An integrated optimisation approach at various levels from inter-organisation business processes and SLAs to intelligent networking and virtualisation techniques.
- Specific services within SOIs that support applications with real-time attributes.
- An intelligent network infrastructure that provides efficiency through autonomous deployment of services.
- Specification languages that unify various parameters and

characteristics used to describe real-time applications on SOIs, and allow value chain participants to collaborate on the design, deployment and execution of networks of services.

Aiming at Significant Impacts

The expected impact is envisaged to be significant in multiple sectors. More precisely IRMOS will advance the business models of real-time applications with the benefits that come from SOAs; it will increase the competitiveness of those involved through low cost implementation and broader market accessibility.

The project will lower the entry level for SMEs to participate in virtual organisations in the market of real-time interactive services (such as multimedia processing).

IRMOS will strengthen efficiency and productivity of organisations by advancing SOIs' resilience, work on standardisation and extend the state of the art with the provision of open APIs to be used in the development of real-time interactive applications.

Finally it will provide tools to write software with predictable performance, resilient to the changes of the environment in SOIs.

Demonstrators

Although IRMOS results will be independent from applications, they will be validated through three different application scenarios (demonstrators): Digital Film Postproduction, Virtual and Augmented Reality, and Interactive Real-time e-Learning.

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Service / Software Engineering

The demands and expectations from the future Internet will be many and diverse. Availability, adaptability, usability and easy access are among the principal expectations from the final user. At the same time, competition amongst providers of services will drastically increase their needs to be able to deploy and deliver innovative services faster and more easily. The capability to effectively adapt very fast to different and rapidly changing user needs will be a key success driver in the Internet of Services.

As a consequence, given the paramount importance of flexibility, the practical feasibility of the Internet of Services will depend on overhauling software engineering to face new challenges. Software engineering has been greatly improving the effectiveness of systematically developing systems meeting very complex requirements. Under the various system lifecycle development models, the basic approaches are always relying on the fact that what the systems should do is known at design time. This fundamental hypothesis is being revised in the world of the Internet of Services.

The needs for fast adaptation and re-configuration driven both by context changes and contingent user needs mean that a lot of decisions that were taken at design time have to be made or changed dynamically at run-time, while being able to guarantee stability properties representing boundary conditions put on adaptive software systems.

Flexibility and adaptability are addressed from different angles by the current FP7 projects in the area of software and services, with techniques for mastering the complexity stemming form distributed and context-driven changes.

The projects are also making strides in bringing development and change closer to the stakeholders, typically by bridging software engineering concepts with organisational concepts and real-world semantics. Service oriented architecture (SOA) is being established as a framework on which new development methods and techniques for service based systems are being elaborated. The S-CUBE network of excellence is coordinating European R&D in that domain.

Software Engineering to match compliance issues and organisational constraints

A major shortcoming in today's approach to the design of service oriented systems is the lack of clear and effective technological means to realize, enforce, or validate various compliance concerns pertaining to business rules or more general regulations. Techniques for ensuring the compliance in SOA are developed by COMPAS (further described).

Sound and strong interconnections between the socio-organizational aspects of a service based application and its actual implementation is needed to allow a more dynamic adaptation of the services to the organizational environment in which they run. This is addressed by project ALIVE which considers the integration of organisational and coordination mechanisms used by enterprises with model driven engineering (MDE), thus easing the development and composition of services.

Semantics driven engineering process

Current model driven software development techniques rely on transformation of system models at different levels of abstraction –corresponding to the main decisions taken during the development. Yet, automatic transformations are essentially limited to a syntactic level, and most of the design decisions have to be manually specified. Being able to capture more semantics,

by allowing the expression of architectural and design decision in a form suitable to be reasoned upon, would allow for more automatic support and guidance in this process. The MOST project is integrating ontology technology with model driven software development to enable the capture of more knowledge about software artefacts, and thus facilitate their evolution and (re-)use.

Engineering adaptive systems for improved quality of services

Context aware applications and services that can automatically adapt to changes in their environments are one of the expectations from the Internet of the Future. To build such systems, the running services and supporting platforms should be provided with reasoning capabilities that make them aware of the impact of their possible dynamic modifications in response to adaptation required by new, emergent features of the running-context. Managing dynamic variability and reconfiguration in adaptive systems at run-time through the combination of aspect-oriented and model-driven approaches is the goal of the DIVA project. One of the aims of the project is to provide well-tuned techniques for monitoring the Quality of Service (QoS) so to allow dynamic adaptation of the running system, and to maintain a constant and seamless match with respect to the required qualities.
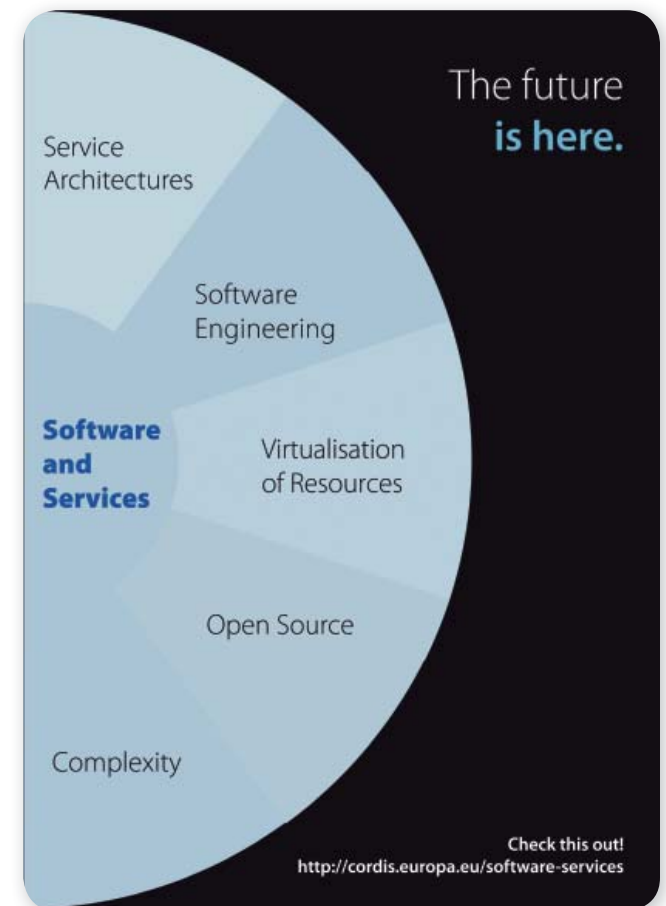
Managing complexity and dependability

The complexity of managing the consistency of large systems whose components evolve in a distributed way and exist In multiple versions is a daunting problem. Project MANCOOSI is developing the theory, models, algorithms and tools to support the evolution of such systems.
Another problem is related to designing systems for which it is necessary to guarantee a certain quality of service (QoS). Q-IMPRESS

aims at enabling service orientation for critical systems by creating a tool supported quality-driven software development method which allows to perform what-if analyses during software evolution. Within the project approach, developers shall be able to foresee the impact of software design decisions and maintenance actions on the QoS, so to assure predictable end-to-end quality.

Dependability in large, complex systems, is increasingly important as they support more and more mission critical uses. Complementary approaches are used for ensuring reliability: appropriate testing strategies, and formal methods.

The project PROTEST is developing software engineering approaches for automating fault-finding and diagnosis. The project DEPLOY aims at making major advances in formal methods that can be realistically deployed in a wide range of systems development.

The future is here.

Service Architectures

Software Engineering

Software and Services

Virtualisation of Resources

Open Source

Complexity

Check this out!
http://cordis.europa.eu/software-services

S-Cube
Software Services and Systems Network

S-Cube, the Software Services and Systems Network, will establish an integrated, multidisciplinary, vibrant research community which will enable Europe to lead the software-services revolution, thereby helping shape the software-service based Internet which is the backbone of our future interactive society.

Research expertise and intense collaboration by researchers in the field of software services and systems need to be combined to address the following key problems:

- Research fragmentation: Current research activities are fragmented and each research community (e.g., grid computing or software engineering) concentrates mostly on its own specific techniques, mechanisms and methodologies. As a result the proposed solutions are not aligned with or influenced by activities in related research fields.

- Future Challenges: One challenge, as an example, is to build service-based systems in such a way that they can self-adapt while guaranteeing the expected level of service quality. Such an adaptation can be required due to changes in a system's environment or in response to predicted and unpredicted problems.

Expected Impact

S-Cube will pursue objectives that will have a long-lasting impact on European research; it will re-align, re-shape and integrate research agendas of key European players from diverse research areas. Synthesising and integrating a range of knowledge will build a long-lasting foundation for steering research and for achieving innovation at the highest level.

The project will inaugurate a Europe-wide common programme of education and training for researchers and industry. This will create a common culture that will have a profound impact on the future of the field. S-Cube will establish a proactive mobility plan to enable cross-fertilisation. This will foster the integration of research communities and the establishment of a common software services research culture.

Moreover, it will establish trust relationships with industry. Via European Technology Platforms (specifically NESSI), the project will have a catalytic effect in shaping European research, strengthening industrial competitiveness and addressing major societal challenges.

Finally S-Cube will define a broader research vision and perspective. This will shape the software-service based Internet of the future and will accelerate economic growth and improve the living conditions of European citizens.

Technical Approach

To reach the above objectives, S-Cube brings together over 70 researchers and over 50 Ph.D. students from 15 institutions, which jointly carry out the following three types of activities: Integration activities, Joint Research Activities and Spreading of Excellence Activity.

Integration Activities

Integration activities tackle fragmentation and isolation of research by different means.

First, a knowledge model will be developed that captures terminology and competences of the S-Cube partners and their research. This will help to eliminate the duplication of research efforts, to fine-tune the research activities of beneficiary institutions and to restructure already existing research agendas.
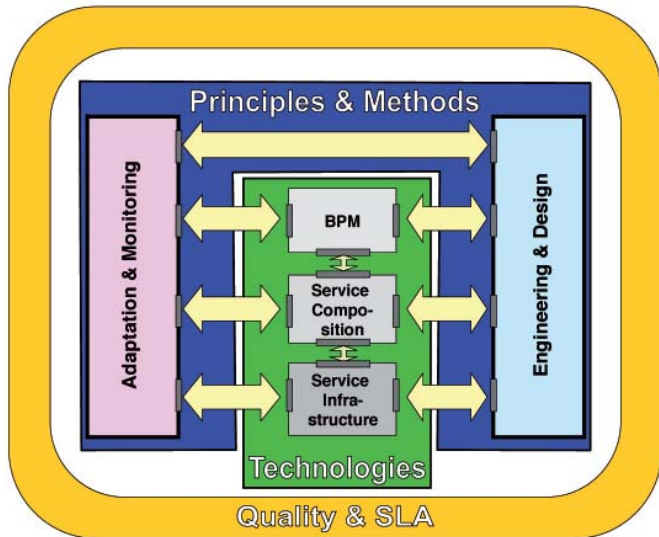
Further, a Pan-European Distributed Service Laboratory will be established as a high-quality research infrastructure to provide access to state-of-the-art collaboration facilities. Finally, by providing a diverse and dynamic programme of education, training and specialist courses for researchers as well as an intensive mobility plan within the network, a cross-fertilisation of knowledge and durable research integration will be achieved.

Joint Research Activities
Work in S-Cube will be guided by the S-Cube research framework (see figure above), which clearly distinguishes between principles and methods for engineering and adapting service-based systems and the technology which is used to realise those systems while taking into account cross-cutting issues like Quality of Service (QoS) and SLA compliance.

Spreading of Excellence Activity
This activity will ensure a broad dissemination of research results, stimulate industrial and commercial interest, and enhance the public visibility of the research conducted within the network. This includes – among a range of initiatives – the S-Cube Web Portal, the organisation of international conferences and specialised workshops and summer schools, as well as a European Ph.D. programme.

An Open Invitation

S-Cube invites organisations, research groups or researchers to join S-Cube as associate partners on the basis of the identified research gaps. Associate partners will be paid travel and subsistence. They will gain access to S-Cube internal information and may participate in S-Cube meetings. The admission process will be published on the S-Cube Web Portal.

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"S-Cube, the European research network of excellence on technological and methodological foundations of services, will enable Europe to lead the software-service revolution and will lay the groundwork of the Future Service-based Internet".

Klaus Pohl
(S-Cube coordinator)

COMPAS
Compliance-driven Models, Languages, and Architectures for Services

"COMPAS beschäftigt sich mit dem Entwurf und der Verwendung von Modellen, Sprachen und einem architektonischen Software-Framework, um Compliance von Software-Diensten zu Entwurfsregeln und Regulierungen sicherzustellen".

—

"COMPAS designs and implements novel models, languages, and an architectural software framework to ensure compliance of software services to design rules and regulations".

Scharam Dustdar
(COMPAS Coordinator)

COMPAS will use model-driven techniques, domain-specific languages, and service-oriented infrastructure software to enable organizations to develop business compliance solutions easier and faster.

Service-Oriented Computing and Architecture

Service-oriented computing (SOC) is an emerging computing paradigm which uses services as the basic constructs to support the development of the rapid and easy composition of distributed applications. Service-Oriented Architecture (SOA) is the main architectural concept in the SOC field.

COMPAS addresses a major shortcoming in today's approach to SOA design. Various compliance concerns must be considered throughout the architecture, but to date the SOA approach has not provided a clear technological strategy or concept as to how to realise, enforce, or validate them.

A number of approaches, such as business rules or composition concepts for services, have been proposed, but none offer a unified approach to tackling all kinds of compliance rules. This is partly due to the fact that compliance rules are often pervasive throughout the SOA. That is, they have to be considered in all the SOA components, as well as at different development times, including analysis, design, and run time.

Compliance Concerns in SOAs

Compliance refers to any explicitly stated rule or regulation prescribing any aspect of an internal or cross-organisational business process. Examples include: service composition policies, service deployment policies, service sequencing or ordering policies, information sharing/exchange policies, security policies, Quality of Service policies, business policies, jurisdictional policies, preference rules, and intellectual property and licences.

In an ideal world, it would be possible to provide a software framework to automatically enforce compliance to such legislation or provisions by an organisation's entire IT set-up. However, this is difficult because it is usually impossible to formally encode all the details of, for example, a legal document.

Today, business compliance is often reached on a per-case basis. For instance, rather than having a generic strategy for business compliance, companies use ad hoc, handcrafted solutions for specific rules to which they must comply.

Clearly, all of these concerns are driven by business requirements. However, until now there has been no concept for a comprehensive SOA business-compliance software framework that enables a company to express these compliance concerns using one and the same software framework and SOA enhancement, e.g. set of languages and models, technological mapping on to the service-oriented architecture, and technologies that develop such a compliance software framework.

Model-driven Solution

The COMPAS project will design and implement novel models, languages, and an architectural framework, including required software components and services, to ensure dynamic and ongoing compliance of software services to business regulations and design rules.

This will be achieved using the model-driven software development (MDSD) approach to enable organisations to develop custom business-compliance solutions faster, cheaper, and with less skilled

programming. Domain-specific languages will be used to enable non-programmers to work with and understand the compliance models in their domain.


The Compliance Life Cycle

The project team is devising a 'design-for-compliance' technology framework which will be used to ensure compliancy of the composition of business processes and services. This will enable specification, validation, and enforcement of comprehensive compliance policies related to these processes and services.

COMPAS will enhance business process languages, such as the Business Process Execution Language (BPEL), with enforceable compliance concepts and policies. Furthermore, it will develop specification languages and models for expressing typical compliance concerns. A behavioural model for services and service composition will be provided enabling the formal validation of the compliance of composed services with the specifications.

The project will develop monitoring and management tools for tracking and validating those compliance concerns that can only be verified at run time, thus enabling the governance of compliance concerns.
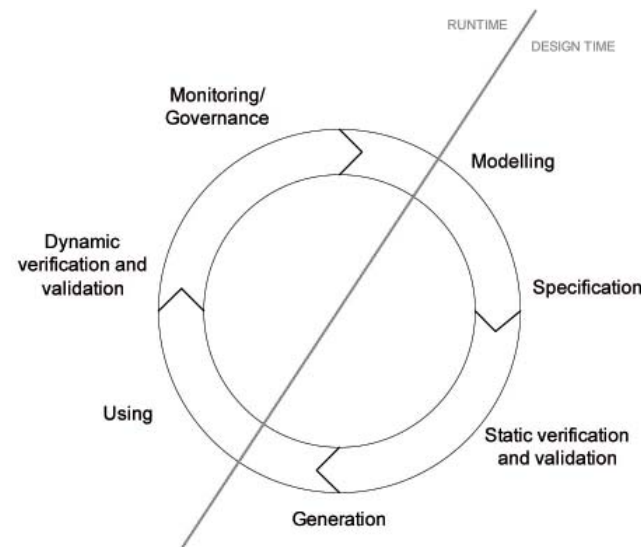
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List of all the projects

ADMIRE - Advanced Data Mining and Integration
Research for Europe
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Project number: 215024

ALIVE - Coordination, Organisation and Model Driven
Approaches for Dynamic, Flexible, Robust Software
and Services Engineering
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COMPAS - Compliance-driven Models, Languages,
and Architectures for Services
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DEPLOY - Industrial Deployment of Advanced
System Engineering Methods for High Productivity
and Dependability
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DiVA - Dynamic Variability in Complex, Adaptive
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FAST - Fast and Advanced Storyboard Tools
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Flossinclude - Free/Libre and Open Source Software
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IRMOS - Interactive Realtime Multimedia
Applications on Service Oriented Infrastructures
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MANCOOSI - Managing the complexity of the open
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m:Ciudad - A Metropolis of Ubiquitous Services
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MOST - Marrying Ontology and Software Technology
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NESSI 2010 – Networked European Software &
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NEXOF-RA - NESSI Open Service Framework -
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OMP - Open Media Platform
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OPEN - Open Pervasive Environments for migratory
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PERSIST - PERsonal Self-Improving SmarT spaces
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ProTest - Property-based Testing
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Project number: 215868

Q-ImPrESS - Quality Impact Prediction for Evolving Service-Oriented Software
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RESERVOIR - Resources and Services Virtualisation without Barriers
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ROMULUS - Domain Driven Design and Mashup oriented development based on Open Source Java Metaframework for Pragmatic, Reliable and Secure Web Development
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ServFace - Service Annotations for User Interface Composition
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Service Web 3.0
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SHAPE - Semantically-enabled Heterogeneous Service Architecture and Platforms Engineering
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SmartLM - Grid-friendly software licensing for location independent application execution
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SOA4ALL - Service Oriented Architectures for All
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STREAM - Scalable Autonomic Streaming Middleware for Real-time Processing of Massive Data Flows
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Outlook

Current Trends

The Service/Software industry structure continues to evolve rapidly. The growing pervasiveness of Software, together with the move towards digital content, leads new players and industries to join in the creation of Services for the Future Internet. Patterns of competition are changing. Software players of all sizes will need to actively pursue new alliances and partnerships to create value for a wide range of new end-customers.

New entrants are arriving as global software capabilities continue to increase. Open software and service platforms will make it possible to deliver services for the internet, mobile phones, television sets, consumer electronic devices etc.

A variety of players – including media content producers, advertisers, cable/satellite businesses and consumer electronics companies – are combining to create integrated digital media. Telcos and manufacturers of hand-held devices and other equipment are increasingly involved through mobile devices, wireless applications and the search for the services of the future, under the pressure of technological convergence.

Demand for new services will drive development of the Internet, and the future Internet will provide increased capacity to support these services. And yet the demand will remain unsatisfied, and increases in capacity under used, unless we develop the necessary service and software technology.

Towards the Internet of Services

With the first call of FP7 the research areas of Grid and Software Technologies were brought together. Now the combined Software and Grid area will provide a major contribution to the Future Internet in terms of service design, management and interoperability. The design of research work in this area of the programme follows two strategic directions: 1) to contribute to the Future Internet, including supporting IT, telecom and media industrial convergence, and 2) to meet the emerging software and service RTD challenges in order to position European industry to compete in the service economy of the Future Internet.

The services infrastructures for the Future Internet will address the convergence of IT service infrastructures with those for communication and content and media while bridging to the internet of things and building above the network layer.

The traditional distinction between design-time and run-time of software will be further blurred due to later decision making supported by dynamic composition. It seems likely that a service-oriented architecture supporting a services layer needs a "Service Front End (SFE)". A Service Front End allows generic services to be adapted to different users and situations.

Open Source Software has established itself as a viable approach to producing high quality software and is in wide use in commercial products and mission-critical systems. It offers an alternative to other ways of developing and selling software, and promotes the tendency towards a commoditisation of software.

This amplifies the tendency towards a commoditisation of software, reducing prices and increasing ubiquity. Virtualisation of infrastructure is expected to show how a Service Oriented Infrastructure can work in large scale open environments like the Internet of Services as well as to address new types of resources as sensor networks or RFIDs. An exciting opportunity is offered to meet users' needs for new services on new devices.

Our Directorate

DG – Information Society and Media
The Information Society and Media Directorate General supports the development and use of Information and Communication Technologies for the benefit of everyone.

For more information on INFSO activities visit:
http://ec.europa.eu/information_society

Directorate D "Converged Networks & Services"
Director: João da Silva
The directorate engages in research on converged networks and explores new possibility of development in Europe, considering economic and social impact.
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Unit D3 "Software & Service Architectures and Infrastructures"
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Further Information

CORDIS – Community Research & Development Information Services
CORDIS is the portal of research and technological development of the European Commission.

To find out more on FP6 and FP7 visit:
http://cordis.europa.eu/

European Future Internet Portal
European Future Internet is the central discussion forum for European activities on the theme The Future of the Internet.

For more information visit:
http://www.future-internet.eu

ICT Event 2008
Lyon 25-27 November 2008

Find out about this and other events at:
http://ec.europa.eu/information_society/events/ict/2008/

Unit AGENDA
Madrid, 8-12 December 2008
ServiceWave
NESSI is promoting a new week-long event on the topic of services, ServiceWave.

For more information visit:
http://www.servicewave.eu

3.
INTERNET OF THINGS

3. INTERNET OF THINGS

Imagine an Internet of Things, where everyday objects, rooms, and machines are connected to one another and to the larger digital world. Like we begin to see it today, mobile phones would pay for things like subway fare or cosmetics from a Web site, and Radio Frequency Identification (RFID) tags would be used to monitor access to VIP clubs and passes for ski lifts.

But also sensors, robotics and nanotechnologies would enable a balanced lifestyle and independent living by supporting seamless digital life recording, active stress prevention, well-being and fitness, and assisted living.

Sensors on expensive factory equipment would tell you when the machinery is about to fail; cargo shipping containers could search their contents for nuclear material or other hazards; every office could report its temperature and humidity and whether its lights are on or off; each foot of a geographical area's streets and highways could monitor traffic flow; and in the home environment, the fridge could talk to the microwave, the microwave to the nearby toaster, and the toaster to the stove.

Therefore, when we talk about an Internet of Things, it is not just putting Radio Frequency Identification tags on some dull thing so we *smart* people know where that dull thing is. It is about embedding intelligence so things become smarter and do more than they were proposed to do.

From the Internet of Machines to the Internet of Things

The move from today Internet of Machines to tomorrow Internet of Things reflects several visible shifts: from systems to software-based services, from passive RFID tags to wireless sensors, from Web 2.0 to the Semantic Web, from high-tech to trusted tech, from features and options to experienced sense and simplicity, from always-on to always-responsive, and from exposure to privacy.

The Internet of Things means the fusion of the physical and digital worlds: physical entities have digital counterpart; objects become context-aware – they can sense, communicate and interact; immediate responses can be given to physical phenomena; instant information can be collected about physical entities; intelligent real-time decision making becomes possible, thus opening up new opportunities to handle incidents, meet business requirements, create new services based on real-time physical world data, gain insights into complex processes and relationships, address environmental degradation (pollution, disaster, global warming), monitor human activities (work, criminal, health, military), improve infrastructure integrity (civil, energy, water, transport), and so on.

We can foresee that as the connected world weaves an ever-growing web of interconnections, anything that can be connected to the Internet will be connected. And with those things connected, our daily lives could change radically. The focus of the network will shift from human interaction to machine-machine connectivity. When machines can communicate directly with each other, people can focus on the major issues, not routine activities.

The Internet of Things will lead to increased use of technology and new levels of service and productivity.

Challenges

The challenges relating to the Internet of Things are tremendous:

- What are the constraints that a massive deployment of things and devices at the network periphery put on network capabilities and architectures?
- How to compress a massive amount of data into discrete pieces of information in a secure timely manner through the right medium and appropriate granularity?
- Which applications will first become typical and under which business models will they operate? Will they emerge first in a professional environment (e.g. real-time enterprise) or private environment (e.g. home, lifestyle)?
- How will Internet of Things applications affect users control over their own privacy and how will they react? Which security requirements will emerge on the network infrastructure and the service infrastructure? How can privacy and security features be integrated from the early stages of system design?
- How to address the issues of naming, addressing and querying of the physical world? More specifically, how the service discovery platforms that will be needed to deploy sensor networks may impact the overall governance of the Internet of Things?
- How can the principle of 'right to silence' or 'silence of the chips' that allows individuals to disconnect from any application be integrated into the Internet of Things systems?

It is also important to stress that when things are networked they become social actors. They are not of course human social actors, but they are things with social activity.

Therefore, the question is: "What sort of world will we inhabit with networked social actors that are things?"
This invites to include ethics into the reflection on the Internet of Things.

The European Commission has started reflections and discussions among stakeholders for reaching mutual understanding about the Internet of Things and its relationship to the Internet of the Future, foster multidisciplinary collaboration in science and technology, favour the discussion between existing EU-funded research projects, and encourage international dialogue towards the exchange of information and best practices.

The projects presented in this section are some of the trailblazers which embrace the variety and complexity of the challenges and opportunities relating to the Internet of Things.

Integrated Interoperable Services

Future businesses will be more competitive, innovative, agile, and value creating. Future enterprises will require new technologies, applications and services to enable them to work as networked knowledge-based businesses. Enterprise Interoperability, as a means for European Enterprises to work together, aims at fulfilling this vision.

To understand the major achievements so far in the domain of the interoperability of enterprise applications and software, it is worth recalling the recent events under which the relevant EU-funded research projects have carried on their mission. Under the Sixth Framework Programme (FP6), the unit "Networked Enterprise & Radio Frequency Identification" brought these projects together into an Enterprise Interoperability (EI) Cluster.

Enterprise Interoperability Cluster

The Cluster not only has reinforced collaboration and synergy between the projects, but has also become a European hub for stimulating and catalysing fresh ideas, concepts and solutions in the field by including external stakeholders. The unit managed over 8 projects in the EI domain, with a responsibility for approximately 36 million Euros. The portfolio included 3 large projects (ATHENA, INTEROP and TRUSTCOM), which gives an indication of the importance of the shift from small projects in FP5 (mainly technology take-up measures) to larger RTD projects with ambitious and clearly defined objectives for the domain. Additionally, the trend towards these larger Integrated Projects (IP) was confirmed by the mobilisation and cohesion of a community and hence, the potential structuring of the research area.

Among the cluster achievements lies the Enterprise Interoperability Research Roadmap, published by the European Commission in July 2006, updated this year and which will continue to evolve.

The Roadmap targets breakthrough research for stimulating and catalysing business innovation. It is a major reference document in 2007 for European research in Enterprise Interoperability by establishing the domain as a capability for the purpose of business and not only as an ability of entities to work together.

The scope of Enterprise Interoperability was not anymore restricted to the 'integration' problem encountered by enterprises, but would significantly offer a new, radical approach to Enterprise Interoperability as a vehicle for innovation requiring new services, new approaches and new frameworks to be developed.

The strategic positioning of new projects along the Grand Challenges defined in the Enterprise Interoperability Research Roadmap clearly confirms their adherence to the vision defined in the document, with a specific focus on the first Grand Challenge called Interoperability Service Utility.

Another important work instigated in parallel to the establishment of the Seventh Framework Programme is the analysis of the Informal Study Group (ISG) on Enterprise Interoperability which resulted in a report called "Unleashing the potential of the knowledge economy".

It started with the identification of the lack of a business case for Enterprise Interoperability in the problem space of our Roadmap. It was recognised that various technologies and tools resulting from research needed follow-up beyond (further) research and that we lacked understanding where most value is created through EI research.

Innovation for Enterprises

Addressing the above considerations was perceived critical as

we stressed on the importance of value innovation for enterprises, and on the fact that the mechanism and the nature itself of innovation are changing.

The Roadmap positions future enterprises as nodes in innovation ecosystems, where interoperability spans all enterprises throughout and across entire innovation ecosystems. The "Value Proposition for Enterprise Interoperability" (VPEI) report further suggests that disruptive innovation at the enterprise level needs to be matched by disruptive innovation for enterprise systems of the future. So, in defining our priorities for future research in the EI domain we should aim at solutions that contribute to the EI field as a whole, rather than value-added EI solutions highly context-dependent (and making use of specific technologies).

Furthermore, a number of initiatives established to complement and support market-driven interoperability adoption need to be mentioned.

A major one is due to the INTEROP Network of Excellence which completed at the end of the project the establishment of a sustainable structure called the Interop-VLAB aiming at stimulating the scientific activity at the European level and beyond. The iVLAB acts today as a reference in the Enterprise Interoperability domain, and is consulted by international bodies like the "Laboratoire d'Intégration du Matériau au Système" (IMS) organisation or the "International Federation for Information Processing" (IFIP).

This initiative was complemented by the creation of the IEKR (Interoperability Explicit Knowledge Repository), welcoming the public deliverables of our past and future Enterprise Interoperability projects. Last but not least, a European Master Programme in Enterprise Interoperability was set-up by the INTEROP partners and continues to attract students from all over Europe.

Finally, it goes without saying that the domain constantly follows and integrates the relevant results obtained by neighbouring domains such as software and services architectures and infrastructures, content and knowledge, interaction and interfaces, etc, with which it maintains fruitful relationships.

Although the bulk of the new FP7 projects is still in progress, we can already conclude, based on the various developments described above, that the results recently obtained by the community constitute the foundation of the future European research in this area. To promote innovation, to support SMEs in adopting ICT, and to contribute to the competitive dimension of our enterprises, we need to target research priorities supporting novel concepts, approaches, techniques and tools for a new generation of interoperable enterprise systems required by the emerging "Semantic Economy". To adapt to this new context, no doubt that the Enterprise Interoperability domain will evolve (under the next FP7 calls), diversify (new paths will be taken) and specialise (along the Future Internet priorities).

COIN

Enterprise Collaboration & Interoperability

The mission of the COIN IP is to study, design and develop an open, self-adaptive, generic ICT integrated solution to support the above 2020 vision, starting from notable existing research results in the field of Enterprise Interoperability and Enterprise Collaboration.

COIN business-pervasive open-source service platform will be able to expose, integrate, compose and mash-up in a secure and adaptive way existing and innovative to-be-developed Enterprise Interoperability and Enterprise Collaboration services, by applying intelligent maturity models, business rules and self-adaptive decision-support guidelines to guarantee the best combination of the needed services in dependence of the business context, as industrial sector and domain, size of the companies involved, openness and dynamics of collaboration.

The Information Technology vision of Software as a Service (SaaS) will find its implementation in the field of interoperability among collaborative enterprises, supporting the various collaborative business forms, from supply chains to business ecosystems, and becoming for them like a utility, a commodity, the so-called Interoperability Service Utility.

Background and Motivation

Enterprise Collaboration (EC) and Enterprise Interoperability (EI) have been the two major research catalysts for DG INFSO D4 Networked Enterprise & Radio Frequency Identification (RFID), and aggregated tens of projects and hundreds of researchers in their projects clusters initiatives. COIN is rooted in the previous initiatives.

EC comes from a business perspective and identifies the process of enterprises – mainly SMEs - to set-up and manage cross-enterprise

win-win business relations in response to business opportunities; EI originated by the ICT world and identifies a capability of enterprise software and applications to be integrated at the level of data, applications, processes and models. COIN promoters believe that EC and EI are different concepts which cannot be merged or confused but that they are so interdependent and simultaneously present in every networked enterprise, that they can be really considered as the *two sides of the same COIN*.

Scientific Objectives

Service Platform

The first main objective of COIN is to design and develop a pervasive, adaptive service platform to host Baseline and Innovative COIN services for Enterprise Interoperability (EI) and Enterprise Collaboration (EC) and make them available under innovative on-demand, utility-oriented business models to European enterprises and Small and Medium enterprises (SMEs) in particular for running their business in a secure, reliable and efficient way. Such a service platform, including business and knowledge interoperability models and tools, represents the innovative glue to fully exploit pre-existing and new services in the overall COIN mission.

Baseline Services

COIN aims to consolidate and stabilise the ICT results of both Enterprise Collaboration and Enterprise Interoperability FP6 research into some Baseline Services (free or charged; open-source or proprietary) which constitute the service foundations for COIN in the

form of a solid service-oriented Technology Platform for Enterprise Interoperability and Collaboration. Such a reference Platform would be enriched by new services developed in COIN and will tremendously improve its usability and accessibility (mostly by SMEs) in different business and knowledge contexts.

Innovative Collaboration and Interoperability Services

The Baseline Services are further enlarged, extended and improved by developing other more Innovative Services in the Enterprise Collaboration and Enterprise Interoperability fields, which could taking into account the most recent and promising technology challenges (in the field of Web 2.0, semantic web, space computing) and put them at service of EC and EI purposes.

In the field of Enterprise Collaboration, COIN believes essential for Small and Medium enterprises to have configurable and flexible services for collaborative product development, distributed and participative production planning, cooperative multi-project management and finally some standardised services for user interaction and co-operation.

In the field of Enterprise Interoperability COIN will develop services for semantic, web-enabled business documents interoperability; for Knowledge interoperability and for Business models and policies harmonisation and combination.

Software as a Service

COIN explores the reference concept of Software as a Service Utility - SaaS-U - intended as a further specification and substantiation of the ISU Grand Challenge of the EI Research Roadmap, positioned especially in respect of delivery of IT functions as services.
Within COIN SaaS-U will be addressing new business strategies

and models, in complement to the technical RTD of the COIN ICT service platforms and services as described under the previous objectives. The overall result will be: new business models for Enterprise Interoperability, an integrated EI value proposition, and scenarios of Open Innovation for EI.

The trial industrial scenarios represent a wide spectrum of collaboration contexts varying from supply chains, to collaborative networks, and to the most dynamic form of enterprise business ecosystems.

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SYNERGY

Knowledge Oriented, Adaptive Enterprise Collaboration

"SYNERGY addresses the need to help companies, especially SMEs, to build and manage collaborative networks rapidly to exploit product opportunities together by providing web-based services for knowledge management and sharing, and learning".

Keith Popplewell
(Synergy Coordinator)

The main objective of SYNERGY is to enhance support of the networked enterprise in successful, timely creation of and participation in collaborative Virtual Organisations by providing an infrastructure and services to discover, capture, deliver and apply knowledge relevant to collaboration creation and operation.

The next phase of enterprise interoperability is the sharing of knowledge within a Virtual Organisation (VO). Such knowledge will be a driver for new enhanced collaborative enterprise, able to achieve the global visions of enterprise interoperability.

The SYNERGY project envisages the delivery of Collaborative Knowledge services through trusted third parties offering web-based, pay on demand services, exploitable through Interoperability Service Utilities (ISUs)

Specifically SYNERGY aims to provide semantic ontology-based modelling of knowledge structures on collaborative working; develop the service-oriented self-adaptive SYNERGY holistic solutions for knowledge-based collaboration services; and facilitate the testing and evaluation of the efficiency and effectiveness of the SYNERGY solution in concrete case studies.

Motivation

The recent decades show clear trends in business - away from big, comprehensive trusts which can cover all stages of a value creation chain and also away from long standing, well established, supply chains that have been stable over many years.

Instead companies are increasingly focusing on their core business and core competencies and entering more into more agile and flexible alliances for value creation and production.

This growing demand for flexible interaction and efficiently integrated businesses and services already led to a huge amount of scientific and technological work in enterprise interoperability, in particular in the ICT area.

Although the work so far has achieved promising results and partially led to the first commercial products and service offerings, they remain at the level of process and *data* interoperability, and *information* exchange, they hardly reach the level of *knowledge* integration, and certainly fall short of knowledge-based collaboration.

Main target organisations are Small to Medium Enterprises (SMEs), though not exclusively as large organisations are involved in Virtual Organisations with SMEs. Given the importance of SMEs to the European economy (SMEs make up 99.7% of companies in Europe, accounting for approximately 50% of Europe's GDP) clearly the growth of the Small to Medium Enterprises sector and its greater adoption of ICT would make Europe progress significantly towards the Lisbon objectives.

Impact & Benefits

An expected impact is to improve the competitiveness of enterprises in Europe by fostering the creation of new networked applications and services capable of interoperation across a wide variety of business domains and organisations of all sizes.

By allowing easy access to, and flexible integration with, collaboration services through application or specialisation of tried and tested collaboration patterns, organisations of all sizes will have the ability to rapidly and successfully form and operate networks sharing knowledge and combining competencies to exploit product and service opportunities.

Moreover, SYNERGY will have an impact on international cooperation between EU member states and beyond. In the developing global economy, many, perhaps most, enterprise networks are EU and world-wide and enterprises will benefit from the application of SYNERGY results by enhancing their participation in international networks.

Consortium

The SYNERGY consortium is comprised of 8 partners in 6 European countries (4 EU Member States and 2 Associated Countries) each bringing a wealth of experiences and skills to the project which will ensure the achievement of the ambitious project objectives. It would be very difficult, if not impossible, to set up such a consortium and acquire the necessary critical mass at a national level.

The complementary expertise of the SYNERGY partners enables the transfer and internal exploitation of scientific, application and technical know-how developed in 6 European countries. Moreover, the European dimension of the consortium enables the exchange of experiences and knowledge amongst numerous end-user SMEs brought into the consortium by the partner networks of Douglas Connect and TANET, and also CIM's and EBM's customers and business partners.

In this way, different user perspectives from different European regions and industry branches will be integrated in the project approach, facilitating the wider adoption and acceptance of the project final results.

Contact the project

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Partners

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Next generation RFID

The Objective "ICT in support of the Networked Enterprise" of Call 1 of the ICT part of the 7th RTD Framework Programme (2007-2013) has resulted in 10 new projects, of which 6 are dealing with some aspects of RFID and networked devices.

All these projects address, with a different focus, the architectures and platforms that are required to make available networked devices and systems for the integrated enterprise. An important goal here is to develop a European open source Radio Frequency Identification platform (ASPIRE). There is for the moment little coverage of Enterprise Resource Planning (ERP) integration; data management of massive amounts of real-world data and novel applications (CuteLoop has started work on this).

The standardisation efforts (CASAGRAS) focus almost exclusively on networks of Radio Frequency Identification (RFID) devices, while a broader perspective on real-world integration of all sorts of networked contact-less devices – an embryo of the future "Internet of Things" – will be needed for comprehensive progress in the field.

A lot of research work is carried out in the world on the next generation of RFID technologies, including hardware, software and networks.

Vision of an Internet of Things

The Internet of Things is going to be based on information about objects in the real world and their respective surroundings. This information will be provided by the things, as they obtain and reveal the information through RFID and a huge variety of sensors and wireless communication devices mounted in different environments, embedded in systems or worn by users.

The Internet of Things era reflects a gradual evolution from *ICT around us to ICT on us*. This vision of an Internet of Things powered by next generation RFID has many potential advantages. It presents new industrial opportunities to the ICT market, and creates unique opportunities for breakthrough improvement in process efficiency and product/service quality in many application sectors (logistics, retail, banking, transport). Moreover it increases the perceived and real usefulness of the Internet to the majority of EU citizens, who are interested not only in navigating and retrieving information, but also in getting physical support to their daily needs (for all citizens, and particularly for citizens with special needs, such as disabled and elderly).

Research challenges for next generation RFID and its applications

Regarding the future of RFID technologies, with a time horizon between medium-term (5-10 years) and long-term (10-20 years), it is obviously difficult to determine where vision supersedes realism. What seems clear is that we are witnessing a paradigm change from the "identification of objects at a distance" to the more challenging "communication between objects", which implies that besides the next generation of RFID technology there must be a scalable, efficient, reliable, secure and trustworthy infrastructure able to link all involved objects.

Technological issues relating to laws of physics must clearly be addressed. In particular, although radio waves can pass through most articles, the combination of materials, operating frequencies, associated power and environment can prove to be problematic. As tags and readers attempt two-way communication, there are multiple sources of potential interference and a proliferation of wireless devices may create electromagnetic interference with RFID systems.

Since RFID operates in bands that are shared with other users, this might become a serious problem deteriorating the accuracy of RFID systems. Future RFID applications will increasingly need to take electro-magnetic (or radio) interference from other devices into account.

The ensuing research targets include the hardware aspects (tags, readers, and embedded systems), the software/system aspects and the networking aspects.

Hardware

The RFID devices themselves need more capabilities to broaden the range of applications. They need to acquire larger memory, local intelligence, encryption and security features, extended functionalities such as integrated sensors, and much more. To support this functionality, new breakthroughs in battery technology are needed, in particular to enable more energy, less space (or printing on the tag), and more reliability than ever before.

Today almost all conventional RFID devices contain a silicon-based microchip. The potential in low cost RFID is split between chip-based technologies and "chip-less" tags. These chip-less tags can still be interrogated through a brick wall and hold data; although more primitive in performance than silicon-based chip tags, they hold the potential of much lower production costs and other advantages that will become clear as the technology matures.

Further miniaturisation of the tag antennae and more efficient and reliable antennae connecting technologies are seen as another priority before mass introduction is affordable.

Interoperability issues are also very important because RFID tags increasingly travel across a large number of different geographical and organisational environments, together with the object which they identify, thereby imposing new technical requirements such as multi-protocol, multi-frequency integrated circuits and appropriate antenna solutions for tags.

Software/Middleware

Research not only applies to the RFID tag and/or reader themselves, but also to the information systems which process the RFID events. Using RFID events within enterprise applications, such as Enterprise Resource Planning (ERP) or Customer Relationship Management (CRM), requires new RFID middleware and reorientation of these business applications. Research on RFID software is needed to ensure data security, integrity and quality in large networks. It is also needed to provide solutions enabling a reduction of counterfeit.

Networks

For open or online systems, such as in a supply chain application, where multiple entities have the ability to access RFID tag related information that is shared across geographic or organisational boundaries, there are issues which need to be addressed through R&D and that are of a different kind than those addressed by the RFID hardware or middleware.

They include notably look-up services for efficient data retrieval; business models for data sharing among multiple partners (selective data retrieval, access rights); support for distributed decision-making further than just data sharing; networked RFID systems; interoperability requirements and standards; and network security (access authorization, data encryption, standards).

Advanced Sensors and lightweight Programmable middleware for Innovative RFID Enterprise applications

"ASPIRE vil ændre den nuværende måde, hvorpå RFID bliver brugt ved at introducere royalty fri RFID software og ved at lave software i hjertet af RFID infrastrukturen med speciel henblik på Små og mellemstor virksomheder med lav pris hardware. Aspire vil udvikle og aflevere en, letvægt, royalty fri, programmerbar, sikker, og i henhold til standarder, intelligent software platform som vil sikre en billig og fuld automatisk RFID løsning".

Thomas Christiansen
(ASPIRE Administrative Manager)

European networked enterprises in general and Small and Medium Enterprise (SME) in particular are still reluctant to adopt Radio Frequency Identification (RFID), since they perceive it as unprofitable or too risky. This is largely due to the fact that the adoption of RFID technology incurs a significant Total Cost of Ownership (TCO).

ASPIRE will significantly lower SME entry costs for RFID technology, through developing and providing a lightweight, royalty-free, innovative, programmable, privacy friendly, middleware platform that will facilitate low-cost development and deployment of innovative RFID solutions. This platform will act as a main vehicle for realising the proposed swift in the current RFID deployment paradigm.

Portions (for example specific libraries) of the ASPIRE middleware will be hosted and run on low-cost RFID-enabled microelectronic systems, in order to further lower the TCO in mobility scenarios (for example mobile warehouses, trucks). Hence, the ASPIRE middleware platform will be combined with innovative European developments in the area of ubiquitous RFID-based sensing; towards enabling novel business cases that ensure improved business results. The ASPIRE RFID middleware paradigm, as well as the unique and novel characteristics of the ASPIRE middleware platform are thoroughly described in this proposal.

Privacy Protection and Privacy Friendliness

The ASPIRE middleware will by design to be "privacy-friendly". The principles of privacy protection and privacy-friendliness will be incorporated in the logic of the middleware. The specific principles are:

• Removing data unnecessary for the business (for example tags identities after the object has been sold).
• Separation of personal data and object data (for example different databases and/or different transactions).
• Establishment of certification programs to verify compliance for example through independent auditing of the RFID infrastructure and middleware.
• Establishment of guidelines for adopters, with special focus on SMEs. These guidelines will cover not only technical aspects associated with consumer privacy, but also recommended business procedures to maximize privacy-friendliness.
• Creation of a "seal" to provide adopters with a marketing tool to promote the advantages of their privacy-friendliness.
• In coordination and with the support of UEAPME, dissemination through specialised events and conferences aiming mostly at SMEs.

Ubiquitous Added-Value Sensing and Low-Cost Readers

A primary focus of the ASPIRE added-value sensing activities will be the new generation of battery-assisted RFID-tags that incorporate physical sensors, such as temperature, humidity, pressure and acceleration meters.

These sensors have been proven extremely beneficial in a variety of business cases, for example, where the position of tagged merchandise and its physical conditions are of extreme important. Nevertheless, these sensors are up-to-date voluminous and expensive to facilitate common business cases, involving large amounts of low-cost tagged items.

The ASPIRE deployment paradigm aims at leveraging the intelligence of the core middleware platform to enable lower-cost deployment of these added value sensors.

Applications and Scenarios

The ease of development and cost-effectiveness enabled by the platform will be manifested across different application domains, such as:

- Cold Chain Management for food and diary products.
- Asset Management for Pharmaceuticals.
- Product Packaging, Tracking and Traceability.
- Health care.
- Pharmaceutical.

The developments of the ASPIRE will be validated in the scope of Pilot Trials involving European SMEs. Innovative RFID scenarios showcase and pilots will be built around the following axes:

- Fully automated reading and processing functionality. Applications will run without human intervention.
- Mobility scenarios involving several mobile warehouses in the scope of the supply chain.
- Measurement of added-value parameters such as temperature, humidity or pressure.

ASPIRE Pilots

In relation to the overall objectives of the project, the objectives of the two pilots will in general be the following:

1. To verify that the developed middleware is programmable to be used by SMEs (e.g., health, food, industry...).
2. To verify ease of deployment of ASPIRE Middleware on SMEs IT infrastructure, on low-cost hardware (i.e. to validate the lightweight nature of the middleware).

3. To verify that the ASPIRE middleware is able to work with 500 RFID tag detections but also with 500 000 tag detections (Scalability).
4. To verify the ASPIRE middleware is easy to use (based on feed back from the SMEs regarding the programmability and the difficulties to use the middleware).
5. To verify that the use of RFID and ASPIRE middleware results in true really cost savings for SMEs.
6. To verify that the ASPIRE middleware can be effectively adapted for mobility RFID solutions with low-cost (significant lower than the cost required today).

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CUTELOOP

Customer in the Loop

CuteLoop is exploring how Intelligent Networked Devices such as enhanced RFID-based systems and Global Navigation Satellite Systems, can be used to effectively "integrate customers within an Integrated Enterprise" so providing an important step towards a highly Integrated Real Time Enterprise

Intelligent Networked Devices

When aiming at supporting the networked enterprises to provide ICT enabled added-value services to their actors as well as to realise a new dimension of networked applications and services capable of interoperation across a wide variety of business domains and organisations of all sizes, a key enabler are Intelligent Networked Devices.

Such "Networked Devices" are providing their own computing capability, becoming more advanced as well as less expensive and can be combined with an increasing number of other devices. Examples are mobile phones, PDAs, notebooks, digital pens, displays, or even passive/active Radio Frequency Identification (RFID) tags and many others. They are generally neither easily inter-connectable nor interoperable; often lacking required ICT related environment and infrastructure. Key challenge is to facilitate an industrial uptake as well as to improve the required technology infrastructure and environment for development of business specific services and applications.

Key Objectives

It is intended to realise a novel approach for promoting and facilitating the realisation of highly flexible and dynamic business interconnections for agile coordination in business networks, having customers as key drivers. Specifically, the project is aiming at research on distributed asynchronous interaction of actors and exchange of knowledge among Large Enterprises (LEs), Small and Medium Enterprises (SMEs) and customers.

The CuteLoop project intends to explore how to radically improve the interaction of diverse actors in an integrated enterprise, based on an approach which will facilitate the inclusion of customers as an integral part of complex relationships in such business networks.

A special emphasis will be put on the elaboration of a new approach for employing a "Networked Devices Enabled Intelligence" for distributed and asynchronous control of business processes.

Key issues to be taken into account for such an approach are: decoupling of decentralised message routing from subsequent processing in complex business networks; distributed asynchronous optimisation of tasks in workflows of loosely coupled actors; decentralised approach for creation of communities of interest and trust in networks with unstable composition of actors and innovative interactions among actors (especially with customers) addressing a horizontal and vertical supply chain integration.

Technology vs. Application Potentials

Specifically customers and the public audience have a reluctant perception of potentials and threats of massively distributed networked devices, such as Radio Frequency Identifications (e.g. concerns about security, privacy, radiation, health, environment) jeopardising establishment and acceptance of RFID supported supply chains, especially when bringing the RFID tags in the customer's home.

Research is needed to find appropriate methodologies for modelling

complex interaction patterns within distributed business networks, where enhanced RFID based systems for distributed networks are promising to deliver business benefits. Such methodologies need to comply with technical challenges as well as enabling end-users, representing non-experts in those technologies, to identify most appropriate implementations for a human and customer centred business improvement.

Infrastructure and Environment for using RFID and GNSS

From technology point of view, the CuteLoop consortium specifically addresses on how to better exploit the potentials of enhanced RFID-based systems and Global Navigation Satellite Systems (GNSS), starting from the assumption that a combination of these two technologies is a promising way to support the integration of customers in the Integrated Enterprise.

Therefore, the research targets for a realisation of an infrastructure and environment which will directly facilitate the realisation of a new dimension of added-value services to support especially the decentralised and asynchronous interaction in complex networks of the integrated enterprise, supporting distributed networked devices, usable by any size of acting entity.

In particular, the CuteLoop partners will elaborate a corresponding architecture, agent based software services and a security framework. The application scenarios involved in the CuteLoop project are from food and construction industry.

RTD Cluster and Experience Exchange

CuteLoop established already contacts with other research projects and is continuously searching for potential cooperation and experience exchange. A key initiative for such cooperation are clusters on the European Level, while CuteLoop already joined the Cluster of European RFID Projects (CERP).

Additional opportunities for cooperation of the CuteLoop team are also provided by the work of the European Telecommunications Standards Institute regularly organising events and maintaining diverse standards related working groups as well as in the scope of the frequently organised events of The Open Group providing excellent educational and networking opportunities.

Contact the Project

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Partners

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CASAGRAS
Coordination and Support Action for Global RFID related Activities and Standardisation

CASAGRAS aims to achieve several objectives such as to provide a platform for international collaboration on all the aspects of standards and regulations relating to Radio Frequency Identification tags.

Moreover it means to offer a framework and supporting documentation for incisive and analytical review of international RFID standards and recommendations with respect to applications methodologies and positioning.In terms of future research the project is aiming to bring up recommendations for future research and development and international collaboration, to encourage participation of Small and Medium Enterprises (SMEs).

Work Packages

1. Standards and Procedures for International Standardisation in Relation to RFID, Including Applications and Conformance Standards.

2. Regulatory Issues in Respect of RFID Standards.

3. Global Coding Systems in Relation to RFID Standards.

4. RFID In Relation to Ubiquitous Computing and Networks.

5. Functional, Including Sensory, Developments in RFID and Associated Standards.

6. Areas of Application, Existing and Future, and Associated Standards.

7. Socio-Economic Components of RFID Usage.

Approach

The following are the main characteristics of CASAGRAS approach :

1. Holistic (parts better definable by reference to the whole), independent, framework.

2. Non-interfering, but supportive and contributory to the standardisation and regulatory processes.

3. Mapping and gap analysis to identify international roadmap for harmonised global solutions to RFID open systems.

4. Ability to embrace new developments in technology, principles, concepts and prospects for new standards.

The Internet of Things viewed as a network for communicating devices and based upon four degrees of sophistication, involving:

- Purely passive devices (RFID) that yield fixed data output when queried.
- Devices with moderate processing power to format carrier messages, with the capability to vary content with respect to time and place.
- Sensing devices that are capable of generating and communicating information about environment or item status when queried.
- Devices with enhanced processing capability that facilitate decisions to communicate between devices without human intervention – introducing a degree of intelligence into networked systems.

The framework studies will draw particular attention to Objective ICT-2007-1.3: ICT in support of the networked enterprise and the call within that objective for a Support Action (SA) for global RFID-related standardisation activities involving in particular organisations from China, Japan, Korea and the USA.

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AIM UK (UK), YRP Ubiquitous Networking Laboratory (JP), Hong Kong Science and Technology Parks Corporation (CN), AIDC UK (UK), Electronics and Telecommunication Research Institute (KR), FEIG Electronic (DE), ETSI (FR), QED Systems (USA).

List of all the projects

ASPIRE - Advanced Sensors and lightweight Programmable middleware for Innovative RFID Enterprise applications.
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COIN - COllaboration and INteroperability for networked enterprises.
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Project number: 216256

Commius - Community-based Interoperability Utility for SMEs.
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CuteLoop - Customer in the Loop.
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GRIFS - Global RFID Interoperability Forum for Standards.
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iSURF - An Interoperability Service Utility for Collaborative Supply Chain Planning across Multiple Domains Supported by RFID Devices.
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Project number: 213031

K-NET - Services for Context Sensitive Enhancing of Knowledge in Networked Enterprises.
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SPIKE - Secure Process-oriented Integrative Service Infrastructure for Networked Enterprises.
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Project number: 217098

SYNERGY - Supporting Highly Adaptive Network Enterprise Collaboration Through semantically enabled knowledge services.
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Project number: 216089

In the previous Work Programme (2007-2008), the Objective 1.3 "ICT in support of the Networked Enterprise" of Challenge 1 "Pervasive and Trusted Network and Service Infrastructures" marked a transition between the Electronic Business (e-business) research era (1995-2005), and the emerging era of the Hyper-Connected Enterprise (2005-2015 and beyond).

While the benefits of this are clear, the risks are also emerging. In particular, one of these risks is to secure the data and communication which are becoming more distributed and will become more dominant.

Collaborative R&D during FP5 (1998-2002) and FP6 (2002-2006) has contributed to the maturation of e-business activities of large companies. These companies, and also a growing segment of the small and medium-sized enterprise population (0-249 employees), have today powerful ICT systems for linking business processes, improving customer service, and competing more directly and effectively on the global market.

Therefore, e-business is no longer a priority for public sector support to research but instead it is a priority for policies that aim to accelerate the adoption of ICT and e-business practices among companies, including among small and medium enterprises.

Within the Objective 1.3 in the ICT-FP7 Work Programme 2007-2008, 10 new projects were funded and included in the project portfolio of the unit "Networked Enterprise and Radio Frequency Identification (RFID)". Together with the ongoing IST-FP6 projects, these new projects have been included in two Clusters, namely Networked Devices and Enterprise Interoperability & Collaboration.

Towards the Internet of Things

Indeed, new network and service infrastructures will emerge replacing the current Internet. This Future Internet will feature almost unlimited bandwidth capacity, magnitudes of higher computing performance, wireless access anywhere, trillions of devices interconnected, integrated security and trust for all parties, and adaptive and personalised services and tools.

These developments are driven by wider and different forms of use of the Internet and Web technologies some of which we see already emerging with Web 2.0 applications, the "Internet of Services" and "Internet of Things".

Expect outcome includes the development of architectures and technologies enabling novel Internet-based applications for business and the enterprise and integrated business solutions with emphasis on collaboration and interoperability. This work will reflect the clear need to re-appraise the state-of-the-art from the perspective of new enterprise systems required to support the changing nature of organisations and business-level innovation in the emerging Internet of Things.

Find More About

Our Directorate

DG – Information Society and Media
The Information Society and Media Directorate General supports the development and use of Information and Communication Technologies for the benefit of everyone.

For more information on INFSO activities visit:
http://ec.europa.eu/information_society

Directorate D "Converged Networks & Services"
Director: João da Silva
The directorate engages in research on converged networks and explores new possibility of development in Europe, considering economic and social impact.
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Unit D4 "Networked Enterprise & Radio Frequency Identification (RFID)"
Head of Unit: Gérald Santucci
The Unit "Networked Enterprise & Radio Frequency Identification (RFID)" promotes and manages research, development and innovation activities related to the application of ICT to support the networked enterprise model.
http://cordis.europa.eu/fp7/ict/enet/
http://ec.europa.information_society/policy/rfid/index_eu.html

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Further Information

CORDIS –
Community Research & Development Information Services
CORDIS is the portal of research and technological development of the European Commission.

To find out more on FP6 and FP7 visit:
http://cordis.europa.eu/

European Future Internet Portal
European Future Internet is the central discussion forum for European activities on the theme The Future of the Internet.

For more information visit:
http://www.future-internet.eu

ICT Event 2008
Lyon 25-27 November 2008

Find out about this and other events at:
http://ec.europa.eu/information_society/events/ict/2008/
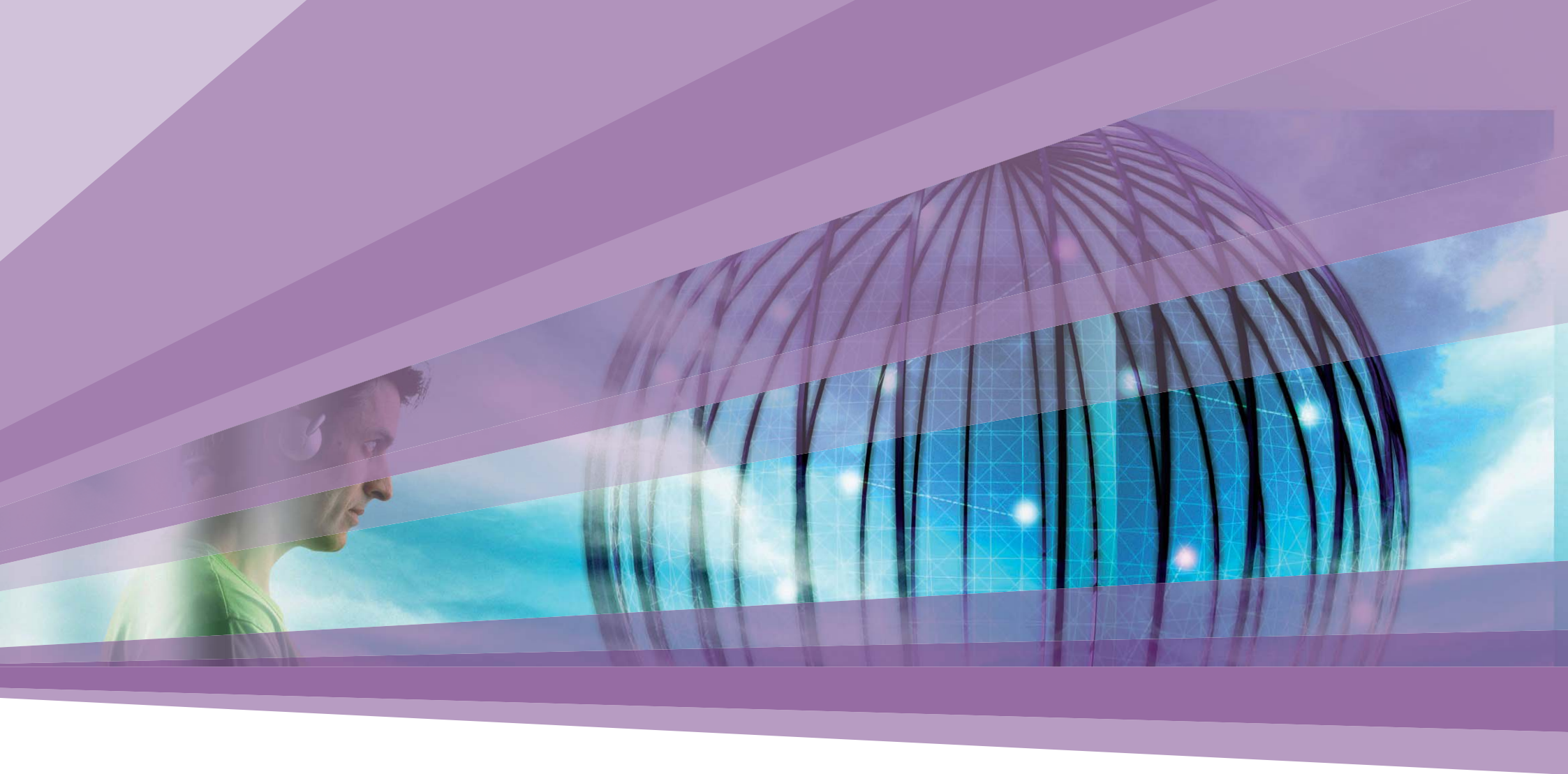
Unit AGENDA
Nice, 6-7 October 2008
Internet of Things French EU Presidency Conference
The conference will include expert presentations and panel discussions on topics related to the development of the Internet of Things.

For more information visit:
http://www.internet2008.eu

4.
3D AND MEDIA INTERNET

4. 3D AND MEDIA INTERNET

The Internet and Media landscapes are undergoing a revolution. The Internet of 3D Media will not only radically change the entertainment industry, but it is also expected to stimulate and enhance creativity, productivity and community relations in the professional sphere. User-generated/centric content as well as community networks and the use of peer-to-peer (P2P) systems are expected to generate new business opportunities.

In this context, the interaction of content combined with interactive search capabilities across distributed repositories and P2P networks (also mobile), and the dynamic adaptation to characteristics of multiple terminals are expected to contribute towards such a vision. Advances in 3D processing will give rise to innovative applications such as massive multiplayer games and virtual environments accessible also on mobile devices, which will increase the amount and the variety of traffic, but also the total demand. As a consequence additional constraints will be placed on network architectures. These environments coupled with their usage rules hold the promise of a "3D Media Internet" revolution forming the basis of future networked and collaborative platforms in residential and professional domains (including creation, delivery and rendering), in virtual/gaming applications, and in digital and electronic cinema.

The research carried out by the projects funded under Challenge 1.5 "Networked Media" address some of the crucial challenges of the "3D Media Internet". The projects are clustered around four technical areas, *Multimedia Search, 3D Media, User Centric Media* and *Media Delivery Platforms*. As depicted in the figure, the scope of the research encompasses various aspects of the value chain ranging from creation to presentation, including , the research, the delivery and the necessary enabling technologies.

Evolution of 3D Media Internet

The evolution of "3D Media Internet" is determined by an increasing participation of users (User Generated Content), by the use of new forms of media (3D Virtual Environments) and by the need to find the content we are looking for (Multimedia search).
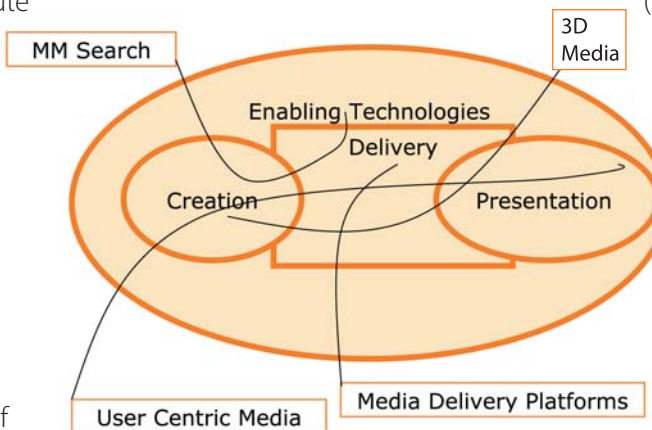
Media experts have identified the lack of 'true' interaction between the users and the media as the most significant challenge faced when utilising the Internet. This problem is essentially caused by the restrictions imposed by limited network capabilities (e.g. bandwidth, time delay, latency, etc.) that preclude a full appreciation of the immersive media applications relying on the deployment of **3D virtual environments.**

These experts have also highlighted the lack of efficient **multimedia search** and retrieval mechanisms, the lack of truly collaborative environments and the lack of 'emotional communication' among

users and communities as related issues. Furthermore, it is widely accepted that the future "3D Media Internet" is bound to be intelligent, able to adapt to the users' preferences, devices and access networks, fundamentally 3D (either real-time or otherwise) including visual, sound, haptic features and interactivity as to achieve a maximum level of collaboration between users and user communities.

The vision of a future Internet based on **User Generated Content** poses many technological challenges. In particular, the future Internet should provide mechanisms embedded into the network to ease the personalisation, adaptation, accessibility and search, but also the protection and the enforcement of intellectual property rights of user generated content. In addition it should facilitate a smooth transition from 2D content to 3D content and ease the user participation in 3D content generation and fruition within enhanced 3D collaborative environments. Furthermore, the future

Internet ought to empower communities for a dynamic content creation and provision.

As far as delivery mechanisms are concerned, it is believed that the future "3D Media Internet" will rely on service-centric networks in order to allow end-users to efficiently request, find and retrieve information regardless of its location; also it will enable users to transport multimodal 3D objects and support integrated multifunctional devices able to render multimodal media formats. Finally, service-centric networks will allow the creation, modification, search and sharing of the media objects.

In one of her latest public intervention (Bled, Slovenia, 31 March 2008), Commissioner Reding has recalled that *"if today's Internet is a crucial element of our economy – the future Internet will play an even more vital role in every conceivable business process…*
In the longer term, we have to prepare the future Internet, including for example, a 3D Internet. This has already been pioneered through virtual environments, such as Second Life".

Therefore, the European Commission is spearheading new areas of research, from basic technologies to service integration and applications, especially in domains such as video or 3D object search, next generation P2P, end-to-end 3D video delivery and 3D virtual environments. These technological breakthroughs are bound to lead to new business opportunities so as to ensure that Europe plays an important role in the future networked media world and addresses a major economic and cultural challenge.

User Generated Content

The Internet and Media landscapes are undergoing a revolution driven by a more active participation of users and the exponential growth of user generated media content. This user control on multimedia content and on the Internet allows a more efficient and gratifying user experience while imposing new challenges of the Future Internet of User Generated Media Content.

Evolution and convergence of networking, broadcasting and consumer electronic industries play a key role by allowing the participation of end user in the Future Internet.

The advances of networking, broadcasting and consumer electronic technologies pave the way to **new Internet multimedia services where dynamically evolving applications are continuously adapting to users' needs and to whenever users contribute their user generated content, including 3D content.** This will bring new solutions that will enhance human creativity by enabling a digital media-world which, while being associated with the physical experience, is revolutionary in terms of human creativity. *A Future Internet of User Generated Content* will support inventive and creative practices in arts, science, engineering, education and leisure by enabling entirely new types of creative media production, delivery and experience.

Challenges

Challenges for the Future Internet

Internet was designed and primarily used by scientists for networking research and for exchanging information between each other. However due to the explosion of the centralised World Wide Web (which has started as a document repository) and its successful descendants (Web 2.0 and P2P), along with the

dramatic increase of net-based audiovisual material (networked media) that has been produced by professional and amateur users, Internet is rapidly transforming to a full fledged virtual collaborative environment that facilitates media services, interaction and communication. Therefore the vision that the Future Internet will be an Internet of User Generated Media Content is about to be a reality soon.

The vision of a Future Internet of User Generated Content poses many technological challenges. In particular, the future Internet should provide mechanisms embedded into the network to ease the personalisation, adaptation, accessibility, search and intellectual property protection of user generated content. In addition it should facilitate a smooth transition from 2D content to 3D content and ease the user participation in 3D content generation and enjoyment within 3D collaborative augmented environments. Furthermore, the Future Internet ought to empower communities for a dynamic content creation and provision.

Challenges for the Media industry

The move towards a Future Internet of User Generated Content also poses challenges for the Media industry when having to adapt the Media value chain to the user control and the new role of users as content creators and distributors, as it involves new business models far from the traditional broadcasting approaches.

Obviously, besides user generated content, content produced and released by traditional broadcasters will continue to exist, but they will have to evolve in order to survive the epochal turning point of Future Internet. Preferences and sensibility of the audience will change and content creators will have to capture this new trend and modify their offers; cinema and TV industries, for instance, will

have to offer new experiences, much more immersive and interactive. At the same time the electronic industry should also adjust its services, launching on the market immersive 3D devices (such as haptic and virtual reality devices) to enhance user enjoyment and participation.

EU RTD projects to meet the challenges

Research on Future Internet of User Generated Content has been very active recently, with EU projects focused on the research of new technologies and methods to enhance the user participation in the media value chain. Eighteen collaborative European projects specifically focus on developing innovative user centric media solutions. These projects are members of the User Centric Media cluster organised by the Networked Media Unit of the Information Society and Media Directorate General of the European Commission.

CITIZEN MEDIA is an industry lead integrated project which unites preeminent creative and technology experts form across Europe on research, development and validation of A/V systems to enable multiple non-professional users to co-create networked applications and experiences based on their own user-generated content. Based on user-generated media recorded by different users at different times, CITIZEN MEDIA is an open and flexible architecture allowing the creation of novel networked application and/or experiences each time a user uploads new content.

Two other innovative projects are presented in more detail in the next pages: *TA2* and *P2P-Next*.

TA2 seeks to explore how technology can nurture family-to-family relationships by supporting group to group communication. TA2 media and communication experiences will be characterised by their naturalness; clear relaxed voice communication and intelligently edited video. Through the TA2 system, stories are automatically generated from home-related content, the personal home video or from the antics of a lively game.

P2P-Next develops a personalised, user-centric, and participatory television and media delivery system with social and collaborative connotation using the emerging Peer-to-Peer (P2P) paradigm. The use of Audiovisual Media is moving from a collective and passive approach to personal active behaviour. In such heterogeneous and demanding environments, P2P-based technology is considered an essential ingredient for future efficient and low-cost delivery of professional and user generated content.

Together Anywhere, Together Anytime

For many people, families form the key social unit. Many of our enduring experiences, holidays, celebrations and moments of fun and laughter are framed as family events. This is something that current technology does not address well: modern media and communications serve individuals best, with phones, computers and electronic games devices tending to be individually owned and providing individual experiences. TA2 seeks to redress this imbalance, by exploring how technology can support group to group communication.

Family letters are often written from one family to another; family games are played between families. Memories in the form of videos and photographs are often shared within families. TA2 wants to enhance and support these processes; enabling people to share their stories, pass digital photos and videos around, add comments to them, and to pass them back. TA2 wants to build systems that allow people to play games with each other, seeing and hearing each other as they laugh with, and at, each other, as they struggle with games like Ludo, Labyrinth or Pictionary.

And TA2 also wants to find ways in which modern sensors and IT equipment can support the family to gain better awareness of each others activity, whilst maintaining each individual's right to privacy.

TA2 media and communication experiences will be characterised by their naturalness; clear relaxed voice communication and intelligently edited video. Through the TA2 system, stories are automatically generated from home-related content, the personal home video or from the antics of a lively game. TA2 will run for 4 years and finish in January 2012.

The challenge

TA2 will improve the ways that end-users engage in meaningful social contact, even when they are not physically co-located. The project recognises that technology-led approaches often do not lead to user-centric solutions; as a consequence, TA2 adopts a strong focus on people. TA2's seminal challenge is that of using information and communications technology to support the social interactions between families who are already firm friends. The reason for this is that between friends, the privacy and trust issues that often emerge with the use of services supported by video communication are less problematic. A community of 'friends' also increases the ability to automatically extract, process and generate information on the individuals that interact with the TA2 concept demonstrators.

TA2's ambition is to make it easier for friends and families, whilst physically separated, to share moments of fun and laughter. It will make it easier for them to keep in touch and to pursue the important incidental activities we enjoy when together and which help nurture our valued relationships of friendship and love.

The challenge in TA2 is framed in the development of five application concept demonstrators that highlight the area of investigation of the project, but that also represent real-world forms of inter-personal communication: applications that are seen as useful, natural and fun. Our goal is to define a set of applications that are simple and obvious to users and where the underlying advanced technology is either invisible, or of such recognisable benefit, that people will make the investment – in human and financial terms – required to make the experience work.

Instead of attempting to impose existing communication paradigms, such as the video conference, TA2 will develop capabilities that enable innovative implementations of communication, interaction and publishing activities which have familiar analogues in the lives of families today. It will, for example, help friends to identify another friend's preparedness to begin some from of social contact, it will enable families, whilst separated, to have a form of interaction that replicates or even surpasses that of a friendly visit, including support for the playing of social games, the sharing of recorded memorabilia, with narratives automatically generated by the TA2 system, all with the intimacy and informality of a kitchen-table chat.

Approach

The TA2 project brings together experts in fields such as game-play, in the use of personal media and in human interaction; together, these partners will define and build an open architecture that will enable the development of five representative applications ("concept demonstrators"). The intent will be to realise a component-based platform that enables many different applications to be built quickly by third parties re-using capabilities residing in the network.

The concept demonstrators will be evaluated in user trials (some of which will be long term), supporting informed design decisions within and beyond the project. In the course of the

project, application developers and service providers will examine how commercial opportunities could be exploited through an evaluation of the value chain and of the most likely sustainable roles that different parties could take as the ideas develop.

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"P2P-Next hankkeessa kehitettävällä sisällönjakelualustalla pyritään nopeuttamaan sisällönjakeluarvoketjun muutosta digitaalisessa konvergenssissa mahdollistamalla uusien business- ja palvelumahdollisuuksien luomisen ammattimaisille ja yhteisöllisille sisällöntuottajille".

—

"P2P-Next will deliver a Peer-to-Peer (P2P) based content delivery platform which can accelerate the change of content distribution value chain by enabling new business and service opportunities for professional and user generated content creators".

Jari Ahola
(P2P-Next Coordinator)

The current infrastructure of the Internet is not suited to simultaneous transmission of live events to millions of people (i.e. broadcasting). With millions of potential users, this will easily congest the Internet. Also, the use of Audiovisual Media is moving from a collective and passive approach to personal active behaviour.

At the same time use patterns are moving away from the classic model of linear broadcast TV. The TV set no longer has the monopoly of delivery of audiovisual content; the PC and mobile devices are also becoming increasingly important.

In such heterogeneous and demanding environments, P2P-based technology is considered an essential ingredient for future efficient and low-cost delivery of professional and user created content. This development will have important consequences for the existing business models and institutions, as well as for content production, content distribution, and end user experience. In response to these challenges, the objective of P2P-Next is to move forward the technical enablers to facilitate new business scenarios for the complete value chain in the content domain. P2P-Next will develop a platform that takes open source development, open standards, and future proof iterative integration as key design principles.

Project Objectives, Mission, and Motivation

The digital convergence is about to drastically change the Audiovisual media landscape. This will give rise to the following disruptive shifts:

- From classical linear TV with a monopoly in AV consumption to non-linear, on-demand, anytime-anywhere, cross device patterns that will change the roles of publishers and consumers.
- From passive collective, linear media consumption to personal active behaviour at home and in mobility situations.
- From highly popular AV content to selective disclosure of "long-tail" content, servicing communities with varying and diverse interests.
- From awareness-building, non-interactive, expensive, interruptive TV advertisements to targeted, non-disruptive, sales channel oriented forms of promotion.

The use of Audiovisual Media is moving from a collective and passive approach to a personal active approach, at home and in mobility situations outside the home. At the same time, use patterns are shifting towards non-linear usages and away from the classic models of linear broadcast TV. The TV set no longer has the monopoly of delivery of audiovisual content, the PC and related media centres, mobile phones, and potentially new devices are all becoming increasingly important.

Impact on Business Ecosystem

With our aim of "world leadership for multimedia distribution & advertising" it is hard to overstate P2P impact on the media landscape. The media environment is changing because of digital convergence, and old structures are becoming weak, and new structures are emerging. This development has a big societal importance because in the end, media is where society thinks.

Therefore, crafting new end-to-end solutions for the media environment is a very powerful way to influence society. P2P- Next proposal aims to influence society through the technological, economical, and social development we aim to do in a direction that increase the individuals', communities', and companies opportunities to be equal. Barriers to market entry are removed and access to a potential audience of million is enabled for small

companies due to P2P-Next.

While the internet and P2P technology on top of it have already taken this development quite far – e.g. the distribution of audio and video has already become a key components of the daily life of people – it has not yet formed the commercial cornerstone of the media industry as a whole, because of several technological, economical, social, legal, and design issues that we address in P2P-Next.

It is clear that a phenomenon that involves over 66% of all Internet traffic is vital to information society and needs to be investigated to unlock further potential. The strategic impact of a project that successfully exploits the Peer-to-Peer paradigm equals the impact of the invention of the web and definition of the GSM standard. During 1998, web traffic still dominated the Internet backbone. Now P2P took over and is gaining dominant. P2P is making inroads in the telephony market with Skype and P2P could grow as the new delivery mechanism for Television. P2P- Next has the potential to define the way in which people consume audiovisual content in the next decade.

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3D Networked Virtual Environments

In order to enable 3D virtual environments, technical advances are necessary in the following areas:

• Architectures and technologies for a future Media Internet and 3D processing enabling mass distribution, caching, filtering, aggregation and networking of 3D content leading to maximum user quality of experience. Optimisation of real time rendering of complex scenes from personalised user perspectives and minimisation of latency experienced through the network and associated edge processing platforms.

• Technologies for 3D content representation with configuration/ adaptation capabilities in multiple virtual worlds, with user controlled management of ownership, identification, trading, rights associated to presence in (possibly multiple 3D) domains.

• Architectures and technologies ensuring that 3D augmented worlds are tightly coupled to the physical world, for commercial or social applications, beyond games.

The electronic media sector currently features an explosion of massively distributed digital objects, an increasing share of user generated content, together with very high quality and professionally created content (digital cinema, ultra HDTV, immersive games and 3D virtual environments). These trends are compounded by new user consumption modes and by the demand for new innovative services, such as: ubiquitous access, social and community media, content personalisation, as well as user-friendly methods of content creation and retrieval.

3D Environments

3D Content Creation

The production of linear and interactive video content (e.g. games,

virtual training applications) requires more and more that reality is augmented, refined or even substituted by synthetic models. Realistic 'virtual characters' or 'avatars' are key elements of 3D virtual environments. These avatars can be used as assistants or companions, capable of dialogue and non-verbal behavior; they can also be used to represent humans for inter-personal, collaborative applications (ranging from professional applications e.g. training/simulation to massive multiplayer games). In any case they must convey information and be believable in the human-machine multimodal interaction and in their relation with other virtual characters. Their use in interactive networked environments will certainly increase in the future.

Some interactive avatars already exist, but lack realism and credibility in co-articulation and gestures when they have to be rendered in real time, as required for interaction with humans.

However further advances are still needed in order to achieve a better co-articulation rendering and synchronization of audio and body language to make avatars acceptable in multicultural contexts. Intelligent, context-aware and semantic-based control of avatars needs more investigation. Scalable rendering depending on the context (human interaction, network, display), including mobile and immersive 3D displays should also be addressed.

3D Media Presentation

The rendered media output should appear as similar as possible to the original or to the intended 3D scene. The emphasis should be on video reproduction devices (displays) since immersive sound reproduction has been already available for many years.

Reproduction technologies have always played a vital role as

key enablers for services. Enhancements are expected in spatial resolution, in integration of 3D, or in the development of portable devices allowing reproduction of 3D content for users on the move, in a better adaptation to home environments with multiple displays and other reproduction devices.

Mobile displays have been seriously limited by the technology available. So there should be a special emphasis on innovative display concepts (e.g. 3DPHONE and MOBILE3DTV).

Users may wish to view multiple media sources at the same time, replacing many existing forms of communication and media, such as telephony, broadcasting, e-mail and leading to a federated system of distributed, high resolution, large displays with integrated common interface capabilities to allow multiple media sources to be reproduced at the same time.

Display technologies have to evolve up to a level where displays can replace paper in terms of visual quality. This will foster the wide adaptation of even higher resolution content (2-4 times HDTV resolution and up) to visualize maps, radar, high resolution pictures, medical applications, used for sharing and collaborative work. These displays will grow from standard computer display size to wall size, depending on the number of users. These displays have not only to support multimodal interfaces, but also concurrent multi-user interfaces.

Virtual reality uses immersive 3-D displays (including transducers for audio and other senses as these become available) to create the illusion of presence in a virtual world.

Tele-presence services provide a virtual environment for humans to control devices, robots, etc., in a virtual or remote real environment through body-operated remote actuators.

Multimodal interactivity with remote environments is a great challenge in respect to the growing needs in efficient remote collaboration within companies. For an efficient remote interactivity, topics to be addressed are:

- 3D capture and manipulation of multimodal stimuli ;
- Network latency: multimodal interactivity providing immediate and secure feedback ;
- Mutual awareness: new devices and software (audio, video, tactile) able to reproduce a natural peripheral awareness of a remote or imaginary site.

3D Networked Virtual Environments means Real Business

In the recent past, companies have rushed to set up storefronts and show rooms in Second Life, even though commercial profits are evasive. Rather than selling goods and services to avatars, companies are now turning to virtual environments as effective work tools for employees and business partners in order to collaborate and learn (increase productivity).

"Queremos brindar emoción y proximidad a los media, tanto en las salas como en la casa, a través de imágenes y sonidos tridimensionales".
—
"We would like to bring the immediacy and excitement to media, in public and the home, by presenting sounds and images in three dimensions".

Eugenia Fuenmayor
(2020 3D Media Coordinator)

2020 3D Media will research, develop and demonstrate novel forms of compelling entertainment experiences based on new technologies for the capture, production, networked distribution and display of three-dimensional sound and images.

The goal is to explore and develop novel technologies to support the acquisition, coding, editing, networked distribution, and display of stereoscopic and immersive audiovisual content providing novel forms of compelling entertainment at home or in public spaces. The users of the resulting technologies will be both media industry professionals across the current film, TV and 'new media' sectors producing programme material as well as the general public.

Motivation

The market for entertainment products continually evolves in the search for ways to improve the audience experience and sense of involvement. 2-D representations no longer give the sensation of presence (even with wide screen and Dolby sound).

There are different approaches to increasing the sense of presence by using the third dimension: one involves stereoscopic display, to give the illusion of three-dimensionality to the scene, another is to immerse the viewer in a three dimensional environment.

Both these approaches are difficult and neither has yet been widely adopted by the media industry. Most '3-D media' currently exhibited is artificially processed 2-D material and the dimensionalisation process gives varying quality and depth representation: it is hard to get beyond the sensation of rather flat objects with depth separation. The special spectacles needed to view most current 3-D are uncomfortable and cause headaches (which are not experienced by people viewing real 3-D scenes). They also only give a true perspective vision for one viewer location. Despite 3-D CGI being widely used for films shown in 2-D, virtual reality and immersive methods have so far only found a limited application in simulation-based entertainment.

However, the media industry knows that astonishing the public is still a route to large audiences and financial success. It is believed that high quality presentations of stereoscopic and immersive images at home and at public entertainment spaces (such as cinemas) will offer previously unimagined levels of experience.

Challenge

The project will result in new compelling and thrilling entertainment experiences. We will demonstrate and evaluate experimental productions along with the enabling hardware and software technology. Standardisation initiatives will help to establish an 'open' (non proprietary) data format and process framework for industry-wide development of spatial media and media technologies, with application potential further than purely leisure functions.

Innovation

The innovation from 2020 3DMedia project consists of new and engaging 3D media forms, creating the technologies for producing and presenting these 3D *surround audiovisual media* as a viable product. Through the project an end-to-end system will be developed and demonstrated, consisting of capture, post production, secure network transmission, play-out, and end-user customisation blocks. Both media and associated technologies will possess a compelling nature, with high degrees of realism and

thrill. One of the fundamental aims of the project is to recapture the excitement once associated to Cinema in its pioneering days, and to extend it over diverse forms of entertainment, including home cinema and immersive interactive media products.

Key factors required to achieve this degree of innovation are:

- Technologies and formats for 3D-sound and 3D-image capture and coding, including novel high-resolution cameras.
- Technologies and methods for 3D sound and image postproduction.
- Technologies for the secure distribution and display of the new media.
- Tools for the new spatial media technologies and their creative application.

Impact

We expect to produce a significant scientific, technical and socio-economic impact that can be summarised through the following achievements:

- World leadership in a new generation of media technologies providing significantly higher performances in terms of built-in intelligence, scalability, flexibility, speed, capacity, ease of use and cost.
- Quick response to new and sustainable market opportunities based on converged business models between content, telecom, broadcast and consumer electronics industries.
- Widespread adoption of new digital media consumption and production patterns. Enhanced quality of life through new usage forms contributing to social, intellectual and leisure well-being. New opportunities for content production and exploitation.

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3DPHONE
All 3D Imaging Phone

The 3DPHONE project aims to develop technologies and core applications enabling a new level of mobile 3D experience, by developing an all-3D imaging mobile phone. The aim of the project is to realise all fundamental functions of the phone i.e. media display, user interface (UI), and personal information management (PIM) applications in 3D but usable without any stereo glasses.

The project will advance the state-of-the-art in mobile 3D technologies by:

- Implementing a mobile hardware and software platform with both 3D image capture and 3D display capability, featuring both 3D displays and multiple cameras. The project will evaluate different 3D display and capture solutions and will implement the most suitable solution for hardware-software integration.

- Developing user interfaces and applications that will capitalise on the 3D auto-stereoscopic illusion in the mobile handheld environment. The project will design and implement 3D and Zoom-able UI metaphors suitable for auto-stereoscopic displays.

- Investigating and implementing end-to-end 3D video algorithms and 3D data representation formats, targeted for 3D recording, 3D playback and real-time 3D video communication.

- Performing ergonomics and experience testing to measure any possible negative symptoms, such as eye strain, created by stereoscopic content.

The project will research ergonomic conditions specific to the mobile handheld usage, in particular, the small screen, one hand holding the device, absence of complete keyboard and limited input modalities.

Concept and project objectives

Today, mobile devices have reached a point where ubiquitous multimedia is becoming feasible. It is now possible to send/receive multimedia messages, watch TV broadcasts, and perform basic videoconferencing on current- generation mobile devices. Further to these developments, mobile multimedia processing hardware and software solutions will eventually require new levels of experiences in mobile multimedia.

The project will develop techniques for all-3D phone experience: mobile stereoscopic video, 3D UIs, 3D capture/content creation, compression, rendering, and 3D display.

3D will be a new paradigm for how users interact with mobile devices and their surrounding. This will have a disruptive effect on how media is created and how users interact with their mobile device and applications. 3D will create market disruptions through a new value chain. 3D interaction will move users from existing, mainstream 2D end-to-end systems because of its attractive effect and enhanced experience.

Developing an all-3D mobile phone requires a holistic solution greater than the sum of its parts. For example, 3D enabled phones already exist in the market, particularly in Asia, and various vendors have started to promote auto-stereoscopic displays on mobile devices. In Japan, DoCoMo has already sold more than 2.8 million 3D display enabled phones.

However, despite users' clear interest in 3D technologies; simply providing 3D display capabilities is not sufficient, as demonstrated by the poor usability and lack of innovative applications of these existing phones.

To make the best use of the technologies to support user experience, a new user interaction paradigm (all-3D phone experience) will be needed, capitalising on the latest advances on 3D graphics rendering on mobile handheld platforms in order to push user experience into full 3D immersion, by the means of auto stereoscopic displays and 3D interaction using adapted sensors and actuators.

Building an end-to-end system for mobile 3D experience

The primary goal of the 3DPHONE project is to build an end-to-end system for mobile 3D experience. This system will deliver a complete 3D experience that will enable user interaction modalities. Users will be able to capture memories in 3D and communicate with others in 3D virtual spaces; interact with their device and applications in 3D, manage their personal media content in 3D. The expected outcome will be simpler use and a more personalised look and feel.

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"The 3DPHONE project aims to play a significant role in future 3D mobile media applications, by enabling a new level of mobile 3D experience. Using a new category of 'All-3D' mobile device, users will be able to capture memories in 3D, communicate with others in mobile 3D virtual spaces, and manage their personal media in 3D".

Tolga Capin
(3D PHONE Coordinator)

Mobile3DTV

Mobile 3DTV Content Delivery Optimisation over DVB-H System

"Uusi kolmiulotteinen mobiili-TV perustuu kahteen olemassa olevaan tekniikkaan: eurooppalaiseen DVB-H-standardiin sekä autostereoskooppiseen näyttöteknologiaan. Sillä on mahdollisuus tulla laajalti kuluttajien käyttöön kolmiulotteisen televisiokuvan välittäjänä. Lisäksi sen odotetaan synnyttävän uusia markkinoita eurooppalaisille laite- ja ohjelmistotoimittajille sekä sisällöntuottajille".

Hanna Viljakainen
(Mobile3DTV Coordinator)

The MOBILE3DTV project aims at developing core elements of the next generation of mobile 3D television (3DTV). The project scenario assumes that stereoscopic video is captured and converted to a proper content format, then compressed, encapsulated, and broadcast to a large audience of mobile users, whose terminal devices receive, decode, and display the 3D content.

Building upon two established technologies, namely the European DVB-H standard and auto-stereoscopic displays, the consortium will develop optimal mobile 3DTV data format and the associated content creation methods. Novel stereo video codec, suitable for the robust delivery over the error-prone broadcasting channel, will be developed in the project.

Resilience to transmission errors and concealment of degradations due to packet-loss, compression or stereoscopic artefacts will be investigated and optimised in terms of the quality perceived by user. Perceptual quality metrics will be developed in order to support the objective assessment of user satisfaction of the visualised 3DTV content.

Advanced computational imagery algorithms for visual quality enhancement will be developed for both encoder and decoder side aiming to ensure the best possible visual experience for an acceptable computational effort. A prototype handheld device will be designed to receive, decode, and play stereoscopic video-streams. It will be used as the terminal device of a complete end-to-end mobile 3DTV system to be setup within the project in order to demonstrate the feasibility of delivering mobile 3DTV content over a real DVB-H channel.

The resulting mobile 3DTV technology will have the potential to become widely available to consumers for 3D-content delivery. This is expected to strengthen the leading role of Europe in introducing novel media technologies and to generate new and sustainable market opportunities for European hardware manufacturers, software developers and content producers.

The Challenge

The concept of providing television-like services to handheld devices is well known. The results from pilots on broadcast mobile TV services amongst consumers in Finland, the UK, Spain and France have revealed clear consumer demand for such services as well as important indications over future business models for commercial mobile TV services. Recognising this high market potential, the European Commission has called for a single European standard for mobile TV and identified DVB-H as the "strongest contender for future terrestrial Mobile TV deployment in Europe".

At the same time, chipmakers and developers have offered new mobile platforms enriched with multimedia capabilities. Display

producers have been continuously improving the quality of visual representation of scenes on portable devices. Greater realism appealing to the mobile user has been pursued by increasing the spatial resolution, utilising an ever more realistic gamut of light and colour and by adding a third dimension. Auto-stereoscopic displays have been introduced for laptops and handheld devices.

However, mobility comes at high costs due to the specific features of the handheld devices and the radio propagation medium, e.g. multi-antenna diversity unavailable, battery operated devices (reduced power consumption), etc.

Therefore, new video encoding technologies need to be developed in order to overcome the impairments imposed by these characteristics. This is especially true for the coding and transmission of 3D visual scenes, where the third dimension add to the amount of information to be efficiently compressed and properly maintained through the error prone channel.

MOBILE 3D addresses core elements of the future mobile 3DTV technology. It focuses on the channel as a whole: from capture, through coding, transmission and display. Specifically, the project considers the following scenario: stereoscopic video content is captured, properly encoded, encapsulated and then broadcast over mobile TV (DVB-H system) to be received, decoded and played by a DVB-H enabled portable device.

Questions and problems

There are important unsolved questions and problems that will be addressed and answered through this project. The project will determine the optimal data format for mobile 3DTV content taking specific conditions into account. Currently, there are two established representations, namely *two channel stereo video* and *single-view plus depth*. The two channel stereo-video is easy to render, but inefficient to compress. The single-view video plus depth format offers good compressibility, but requires additional techniques for depth estimation at the content creation side. Depth image based rendering at the receiving side might be too computationally intensive for the low-power handheld.

A new concept of mixed spatial resolution is expected to cope with the problems of fast rendering and efficient compression. All three above-mentioned data representations will be analysed, compared and optimised for mobile 3DTV utilisation within the scope of the MOBILE3DTV project.

Very much related to the data representation format is the subsequent coding, where optimal algorithms will be developed and explored for possible standardisation. These new coding algorithms will be optimised with respect to the associated content creation format, channel and terminal-device requirements, and user experience.

Contact the project

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"The novel Mobile 3DTV technology is based on two established components, namely the European DVB-H standard and auto-stereoscopic displays. As such, it has the potential to become widely available to consumers for 3D Media content delivery. It is also expected to generate new market opportunities for European hardware manufacturers, software developers and content producers".

Hanna Viljakainen
(Mobile3DTV Coordinator)

Multimedia Search

As one of the most popular 21st century internet technology inventions, a good internet "search engine" is an essential entry point to find out what's on in the World Wide Web.

Once upon a time, IP veterans would have had to invoke an exact item. Today surfing and fetching the Web with your vague keyword query is the easiest way, and even six-year-olds who spell poorly can do it.

Free search engines have become the on-line media knowledge broker. An essential and interactive technology to match questions with answers, search engines allow for entry or for expansion of commercial viability for any networked media service. Whereas sites that are blacklisted, or ranked low, become invisible and unreachable at the very bottom of an obscure abyss. New gigabytes of data flow into the web daily, increasingly due to audiovisual user-generated content. To reach out, find, or navigate the vast ocean of multimedia content in the vast and visible portion of the future internet will require using smarter, faster and more powerful search engines.

Media search of all our broadcast material, from our ordinary everyday mobile internet access devices, reaching end users across heterogeneous and distributed communication environments, will require search engines that understand better the user's query and search engines that are multimedia. Such search engines will handle not just text-based documents as commercially done today, but natural language, music recordings, photo archives, streaming video sequences, live theatre - possibly also multi-avatar performances.

Moreover, going beyond the visible internet search domain, the same multimedia search technology finds equally important usage within enterprise networks, or as embedded service within media rich applications. It is fundamental for the growth of European ICT to maintain and support an ecosystem of European-based research activities, fostering rapid application development and service enterprises built on search technologies. One day soon n-dimensional digital data objects of any kind will easily be modelled, captured, transferred and retrieved by multimedia platforms, not to mention multimodal and multilingual, simple search engines.

Future Internet Search

Research in this domain has been very active recently, with EU projects and many specific National Initiatives all focused on the discovery of the algorithms and methods to handle future internet search needs. Ten collaborative European projects specifically focus on developing innovative audiovisual search engines. Two are presented in more detail below: VICTORY, possibly Europe's first 3D search engine, and PETAMEDIA a peer-to-peer tagged media project (organised as a network of excellence) addressing tomorrow's media search, based on the Tribler software and social computing experiments.

Other EU collaborations mentioned later in this booklet include the flagship industry-led PHAROS project whose plug-in architecture for multimedia search will integrate a variety of specialized algorithms and technologies to provide better and more personalized search services especially for mobile needs. VITALAS is another integrated EU project that tackles the semantic gap between today's low-level features (easily coded) and high level features or desirable categorizations based on specific use cases, where today's search engines do not yet have solutions.

SAPIR builds a distributed and decentralized system of peer-to-peer

search engine that is highly robust and scalable. DIVAS is original in developing a future internet search engine able to perform "direct search" (without relying on old metadata, which even where it exists, is error prone, or unreliable for different types of search not expected at time of content creation). RUSHES looks at the "raw" footage to solve the growing indexing and automatic metadata extraction problems. Similarly, TRIPOD investigates meaningful image searches (based on automatic metadata generation) for professional photography searches.

SEMEDIA looks at the social network dimension of dealing with large and heterogeneous broadcast archives and live performances. CHORUS is a co-ordination to build up a common vision and strategy across the active projects and national initiatives in this domain, with an executive Think Tank that joins a chorus of both industry and academic voices.

As far as the big research challenge in progressing from today's commercial text and language-based search engines to multimedia search engines, how to achieve this technology progress is a fundamental and open question. Incremental addition of functionalities is for the scientific community a contention point. The simple view is to decompose MM streams into image segmentation, sound track, and corresponding text - the recipe: being able to recognize audio, add some tags, hey presto you can then use a text search engine!

But as we now seem to be finding out, it isn't all that simple. The multimedia material itself is very different and not translatable to text even if we have an automatic speech-to-text mechanism in place, and add heavy-duty machine learning algorithms. Furthermore the tags that users actually provide on video behave very differently from text in text analysis and retrieval. These ongoing project's results will tell us more over the next two years of research and development.

In the meantime, the novelty and the vast amount of user generated content and the social interaction it facilitates adds new communication requirements, which is part of the reason why the internet of the future will support different sort of networks from yesterday's. Users download, upload, remix and fill today's web, but can this ebb and flow fulfill user-search for information and knowledge about the world around us? Do more quality, more content, tags and faithful recommendations of friends as proxy for what's important, allow us to ascertain what's true and newsworthy or simply attention-grabbing? Maybe yes, if users are given ways of providing tags appropriately. For instance, in 3D gaming sessions, what should be tagged? Somewhere in the new system rules there must be a level of semantic interoperability or context awareness that researchers and future internet search providers can discover, then model, generalize, and make use of.

Future internet challenges include new media architecture, exploiting asymmetric, distributed and more bidirectional communication, with more motivation to contribute to collective collaborative creative works. To get there, do we want new IPR values or is DRM a sufficient answer to today's problem?

PHAROS
Platform for searcHing of Audiovisual Resources across Online Spaces

"PHAROS fornisce la risposta alle esigenze dei motori di ricerca sui contenuti audiovisivi del XXI secolo, annotandoli automaticamente e rendendoli espliciti qualunque sia la loro natura e struttura di partenza".
—
"PHAROS will move search engines right into the 21st century, providing automatic annotation and full multimedia searching on audiovisual content whatever its nature and structure".

Francesco Saverio Nucci
(PHAROS Coordinator)

PHAROS will provide the means to search and explore contextually-relevant multimedia content, which could be audiovisual, structured or unstructured in origin. PHAROS will add semantic meaning to audiovisual content in a way that prepares it for information retrieval and help overcome the heterogeneity of video, music, images, and TV stream collections, making highly diverse content fully searchable and accessible.

Challenges

Multimedia information retrieval is the challenge of the future. Content is increasingly coming from multiple sources in many different formats and with varying degrees of structure, and there is the need for a coherent approach to its representation format and to its retrieval. A growing variety of audiovisual formats, standards and tools exist, each of them solving only parts of the problem but none addressing it as a whole, with the result that enterprise and businesses remain without a unique and stable reference solution.

A major challenge is to find uniform representation formats that allow heterogeneous data to be merged and indexed and to provide query functionalities that let users retrieve appropriate content from these collections. Furthermore, despite the emergence of sophisticated content-based search methods, the use of the content itself to search for an image or an audio file has not been widely adopted. A further limitation is that web search engines only let users search for and browse entire documents and global metadata.

A further challenge concerns automatic annotation. Think of the possibilities if vast video archives could be searched for specific content with them having to be previously manually annotated! Automated annotation will be provided in PHAROS through a library of annotators applied to audiovisual archives. Querying search and browse capabilities will also be extended to portions of documents with the content itself being used as example for further searches without burdening the user with complex interfaces.

Differentiation

PHAROS distinguishes itself from other audiovisual search solutions because it integrates content refinement and content retrieval with user and context technologies for socially derived relevance, and context-awareness and personalization.

The project platform will export API and web services interfaces that allow mash-up applications embedding the sophisticated PHAROS search paradigm and supporting users to find information in one place, through adaptive, intuitive and truly multi-modal interactions. Innovative user interfaces will also be provided to facilitate the integration of context and user technologies.

The openness of the platform will support the integration of new services and annotators and its distributed nature will provide the much-needed flexibility that enables a variety of differentiated and innovative applications to be built on top of it. PHAROS services will be extremely relevant for instance to publishers, improving trustworthiness of multimedia search and increasing robustness of content against malicious manipulation and by detection of viral spam.

A reference format for content publishing, the PHAROS AVRSS protocol, will be sponsored for wide use in order to become the reference for publishing, supporting visibility and catalogue growth with user-generated content, opening opportunities in the audiovisual long tail in line with the trend of convergence of internet, telephony and television media.

Approach

PHAROS is an Integrated Project and will develop a scalable content refinement framework which brings together multilingual transcription, contextual metadata extraction and content-based audiovisual analysis which will add semantic meaning to audiovisual, structured and unstructured data so that it can be easily retrieved. Its open interfaces will allow self sustainability by enabling new players to build applications on top of the platform and additional services to enrich the platform.

The project PHAROS will improve the state-of-the-art of audiovisual search, focusing on research areas such as automated semantic annotation, retrieval techniques for audiovisual content, heterogeneous data fusion, and mixed-media queries. Its core technologies will provide the foundation necessary to build real world user-centric applications.

As part of its integrated approach, the project will extend its cooperative network through the involvement of a selected group of external entities, non-members of the project, who will provide their audiovisual content for automatic annotation or will provide their own annotators. These entities are grouped into the project Federation, a reference team tightly involved in activities that will provide a reality check with real users, allowing PHAROS to calibrate the mechanisms being researched. This "early adopter" group will be extended to application developers as the project progresses.

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VICTORY

Audio-Visual Content search and retrieval in a distributed P2P repository

"Σε ένα Μελλοντικό Διαδικτυακό Κόσμο, όπου όλη η πληροφορία θα βρίσκεται κατανεμημένη και θα αναπαρίσταται κυρίως σε 3-Διαστάσεις, είναι εξαιρετικά σημαντικό να μπορούμε να ανακτήσουμε επιτυχώς ό,τι ακριβώς αναζητούμε, χρησιμοποιώντας κάθε είδους τερματική συσκευή".
—
"In a Future Internet World, where all the information will be distributed and mainly represented in 3-Dimensions, is of great importance to be able to efficiently retrieve exactly what we are looking for, using any type of end-device".

Petros Daras
(VICTORY Coordinator)

In light of three dimensional object retrieval evolving from text annotation to content-based and from standalone applications to web-based search engines, the creation of a search engine for 3D and multimedia distributed content into P2P and mobile P2P networks, is proposed. Driven by the very successful concept of Wikipedia, the first goal of the proposed project is to create the first distributed Visual Object Repository in which any peer can contribute to.

The main differences between VICTORY and any known knowledge repository, is that, firstly, any visual information will be described as MultiPedia object (3D object along with its accompanied information - 2D views, text, audio, video), and secondly, the distributed nature of the repository.

Scientific and technological objectives

The goal of the VICTORY project is the development of an innovative, distributed search engine that will introduce MultiPedia search and retrieval capabilities to a standard (PC-based) and a mobile P2P network. In order to achieve these goal four main objectives should be fulfilled.

The first objective of VICTORY is to develop the MultiPedia repository and the mechanisms to support its wide access by the community. The centralised MultiPedia repository will consist of only the 3D models that contain the global truth of the objects stored in the repository. The accompanying MultiPedia information (2D images, text, annotations, etc.) will be available on a peer-to-peer basis. Tools will be supported by the repository administration mechanism for population, management and reorganisation of the centralised content.

The content will be adequately categorised in order to support special interest groups targeting mainly industrial applications (automotive, games, simulations, etc.). Also, the repository will act as the main access point for the P2P framework and thus it will support mechanisms for adding MultiPedia content from the peers connected each time to the VICTORY network.

The second objective of VICTORY is to develop novel 3D search and retrieval algorithms which will be based on content, which will be extracted taking into account low-level geometric characteristics and context, which will be high-level features (semantic concepts) mapped to low-level features. In the existing 3D search and retrieval methods no semantic information (high-level features) is attached to the (low-level) geometric features of the 3D content, which would significantly improve the retrieved results. Therefore, the second objective of the proposed system is to introduce a solution so as to bridge the gap between low and high-level information through automated knowledge discovery and extraction mechanisms.

The strength of the VICTORY approach is the ability to translate both explicit and tacit knowledge of the user into semantic information by analysing user's explicit operations like manual annotation, query by example, feedback and intuitive interactions with the system like browsing or objects manipulations. This acquired knowledge will be exploited to automatically propagate annotations through the existing object database of each peer and to adapt the retrieval process to the user's subjectivity.

The third objective of VICTORY is the development of novel search and retrieval framework that allows an easy integration of different search methodologies. It will result in an integrated platform which allows processing and accessing data and knowledge by using ontology based management and retrieval mechanisms. The challenge within VICTORY means to bridge the gap between

textual-/metadata oriented data respectively and to apply this really innovative technology to MultiPedia content, especially such as 3Dobjects.

The fourth objective of VICTORY is the development of a P2P scheme so as to utilise not only the distributed data storage, but also the computational power of each peer for the pre-processing, interpreting, indexing, searching, retrieving and representing of MultiPedia data.

Through the VICTORY framework, users will be able to handle, share and retrieve 3D and audio-visual data among peers around the world. Moreover, every peer will be responsible for extracting and indexing the features of the shared 3D data, thus the efficient manipulation of the 3D data will be accomplished.

The P2P-based middleware will provide the means intelligence, semantics, and communications protocols) allowing the negotiation and determination of peer resources sharing. The key driver will be the user QoE realised as the combination of a multitude of Quality of Services (communications quality, processing speed, 3D content rendering quality, power consumption, etc) impacting the user experience.

By fulfilling the aforementioned objectives the VICTORY framework guarantees efficient multimedia content delivery to the place and time needed. Applications, where the VICTORY framework could be used, include but are not limited to automotive industry, mobile games, 3D animations on special working conditions, 3D presentations of cultural data, mobile commerce, etc.

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Audio-Visual Content Search and Retrieval in a Distributed P2P Repository

PETAMEDIA

Peer-To-Peer Tagged Media

In the Netherlands, Switzerland, UK, and Germany, national networks exist of collaborating excellent research groups in the areas of multimedia content analysis (MCA) and social and peer-to-peer (SP2P) networks.

The Network of Excellence PetaMedia brings these four strong national networks together, at first to form a European network of national networks, and eventually to establish a sustainable European virtual centre of excellence to which research groups throughout Europe can connect.

The four core partners of the project represent and coordinate the respective national networks; they are responsible for linking up EU national partners to the NoE. The purpose of joining four national networks is to achieve larger momentum, to integrate available resources, and to further develop complementary expertise necessary for pushing new paradigms in enabling efficient and effective access to multimedia content in emerging network structures.

The collective research effort that thus comes available will be directed towards integration of existing MCA and SP2P technologies, and towards identification and exploration of potentials and limitations of MCA/SP2P combinations. A particular scientific challenge that binds the partners is the synergetic combination of user-based collaborative tagging, peer-to-peer networks and multimedia content analysis. Solutions and collaborative research field trials will be built on the coordinating partner's open source P2P software Tribler.

The NoE will foster the linking up of researchers in the area of MCA and SP2P, resulting in a closer and harmonised collaboration at both European and national level. It is the ambition of the NoE to become an internationally renowned research centre with impact on national and European research funds in the MCA/SP2P area. The centre also takes up the challenge to create international research proposals based on complementary expertise of partners in national research networks.

Scientific and Technological Objectives

From a scientific and technological perspective, the purpose of is to achieve larger momentum, to integrate available resources, and to further develop complementary expertise necessary for pushing new paradigms in enabling efficient and effective

access to multimedia content in social/peer-to-peer network infrastructures.

The collective research that will integrate the four national networks will be directed towards the synergetic combination of user-based collaborative tagging, peer-to-peer networks and multimedia content analysis, and towards identification and exploration of potentials and limitations of combined tagging, MCA and SP2P concepts.

Solutions and collaborative research field trials will be build on the coordinating partner's open source P2P software Tribler.

The field trials are large scale experiments involving real users, which aim to evaluate the following two aspects:

- New technological contributions to merging automated video content analysis and user-based tagging in a P2P network structure.
- Perception of users of this new form of collaboration in a social network structure build on top of a P2P network structure.

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3DPresence
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Project number: 213696

ADAMANTIUM - ADAptative Management of mediA
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NAPA-WINE - Network-Aware P2P-TV Application
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Project number: 214412

OPTIMIX - OPTImisation of Multimedia over wireless
Ip links via X-layer design
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Outlook

The Networked Media industry is evolving in an environment characterised by an explosion of massively distributed digital objects both user generated and professional content, compounded with new consumption modes and users' demands for new services. Among others this requires moving from a traditional broadcasting approach to personal and on-demand media access and putting an increased emphasis on the context.

Further to an extensive consultation carried out, the following areas of research are of particular interest for future collaborative actions.

Content aware networks and network aware applications

Architectures and technologies for converged and scalable networking and delivery of multimedia content and services dynamically optimised will take into account the content, the user contexts and social networks.

Integrity and quality of media across media life cycle will optimise quality of experience for collaborative media creation and delivery (sharing, storage, retrieval, and fusion capabilities).

3D Media Internet

Architectures and technologies for Future Media Internet and 3D processing will enable mass distribution, caching, filtering, aggregation and networking of 3D content with optimised user quality of experience, including real time rendering of complex scenes from personalised user perspectives.

Technologies for 3D content representation with configuration/adaptation capabilities in multiple virtual worlds, with user controlled management of ownership, identification, trading, rights will be associated to presence in (possibly multiple) 3D domains.

Networked search and retrieval

Networked technologies and architectures with repositories and cached content optimising networked search, adaptation and access to relevant multimedia information composed of several information sources, types and origins, including physical world event information. It covers interaction with content, media-to-network and to (mobile) device dynamic adaptation, search capabilities across distributed repositories and P2P networks, and adaptation to context.

Immersive media experiences beyond HDTV, and electronic cinema

End to end architectures for next generation multimedia and cinema experiences beyond HDTV and current electronic and digital cinema with higher than today quality of experience, based on technologies enabling higher frame rates, wider colour gamut, higher contrast range, higher screen resolution, advanced version of spatial sound, 3D capabilities, immersive environments and multi viewpoint coding.

The intended R&D is expected to lead to a reinforced EU industrial position in Networked Media technologies and systems (including emerging domains, such as Electronic and Digital Cinema and future multimedia experiences beyond HDTV) and open up novel opportunities for mass market applications with open technologies (e.g. games) leading to a wider uptake of a "3D economy" in which content related SME's are expected to play a key role.

Find More About

Our Directorate

DG – Information Society and Media
The Information Society and Media Directorate General supports the development and use of Information and Communication Technologies for the benefit of everyone.

For more information on INFSO activities visit:
http://ec.europa.eu/information_society

Directorate D "Converged Networks & Services"
Director: João da Silva
The directorate engages in research on converged networks and explores new possibility of development in Europe, considering economic and social impact.
http://cordis.europa.eu/ict/ch1/

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Unit D2 "Networked Media Systems"
Head of Unit: Luis Rodríguez-Roselló
The Unit "Networked Media Systems" manages projects which addresses broadband Audio-Visual (AV) services and systems (including digital TV) and home platforms research.
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Further Information

CORDIS – Community Research & Development Information Services
CORDIS is the portal of research and technological development of the European Commission.

To find out more on FP6 and FP7 visit:
http://cordis.europa.eu/

European Future Internet Portal
European Future Internet is the central discussion forum for European activities on the theme The Future of the Internet.

For more information visit:
http://www.future-internet.eu

ICT Event 2008
Lyon 25-27 November 2008

Find out about this and other events at:
http://ec.europa.eu/information_society/events/ict/2008/

Unit AGENDA
Saint-Malo, 13-15 October 2008
Networked Media Summit 2008
The NEM Summit aims to be a major conference and exhibition devoted to the field of networked and electronic media and ICT at large.

For more information visit:
http://www.nem-summit.eu/

New network and service infrastructures will gradually replace the current Internet and Web as we know it. The research effort in this field has to be refocused to ensure European leadership in developing the "Future Internet".

In addition to these transformations, the main mid-to-long term drivers (http://cordis.europa.eu/fp7/ict/programme/) for ICT research priorities, identified for the first phase of FP7 remain valid today. These drivers include the high expectations of "more for less", i.e. more *functionality* and *performance* at lower cost as well as the need for better *scalability, adaptability* and *learning* capabilities of ICT systems.

They also include stronger requirements for *reliability* and *security,* user control and the need to handle higher volumes and more complex digital content and services. More innovation is also rising from the use of ICT in ever more challenging applications, in particular for health and social care, for transport, for lifestyle, culture and learning, for energy and environment.

The role of Small and Medium Enterprises (SMEs) is undisputable. They have a large capacity to focus on their research effort and to take fast technical and business decisions. The European Community research programmes in ICT provide major opportunities for SMEs to finance high-risk, early-stage research and development, to build strategic partnerships and to operate outside their local markets with higher value innovative products and services.

The rules for participation in FP7 also encourage further SME participation. For SMEs in FP7 projects, the Community financial contribution may reach a maximum of 75% of the total costs.

A Pervasive and trustworthy network and services infrastructure will gradually replace the current Internet, mobile, fixed and audiovisual networks. The "Future Internet" is a major federating research theme. In order to be among the leaders in ICT in the next ten years, European researchers and engineers have to address the major technological challenges.

Information and Communication Technologies influence the economy through the creation of new consumption and investment goods, new intra and inter-industries input-output relations and also through new processes and new business models.

The deployment of ICT in firms does require complementary investments in skills and knowledge in order to be fully exploited. However, ICTs' impact on growth, productivity as well as on knowledge capital is significant and generally strongly underestimated.

European Technology Platforms

European technology Platforms (ETPs) bring together the main industry and academic research stakeholders and aim to better coordinate their research and related activities and to achieve common goals.
An important outcome of each ETP is a Strategic Research Agenda agreed by its members, who are also committed to its implementation. These Strategic Research agendas (http://cordis.europa.eu/ist/about/techn-platform.htm) constitute an important input to the Work Programmes in FP7.

The industrial and academic research stakeholders related to the Future Internet have set up a number of European Technology Platforms: eMobility (http://www.emobility.eu.org), NEM (http://www.nem-initiative.org) and NESSI (http://www.nessi-europe.eu).

The Challenge: A Pervasive and Trustworthy Network and Service Infrastructures

The "Future Internet" emerges as a federating research theme globally. Structural limitations of the current Internet architectures are increasingly recognised world-wide, as a result of the constantly growing number of networked applications, business models, edge devices and networks that have to be supported by the Internet.

Challenges in terms of **scalability, mobility, flexibility, security, trust and robustness of networks and services** are thus emerging since the more than 30-year-old current Internet architecture was not designed to satisfy such a wide variety of application requirements and environments. The challenge is to comprehensively and consistently address the multiple facets of a Future Internet.

From a networking perspective, **scalability** entails a need to rethink architectures that can be supported by a wider variety of edge networks, for example wireless sensor networks. Constraints imposed on future networks by **new types of media applications** such as 3D virtual environments must also be supported.

Mobility and constantly higher end-to-end data rates also emerge as important design drivers, and so does security and trustworthiness. At network level, a clear challenge will be to provide the Internet with the flexible and ad-hoc management capabilities that have never been part of the "best effort" paradigm driving the original design.

These network infrastructures need to support an Internet of dynamically combined services with worldwide service delivery platforms and flexible infrastructure enabling the creation of opportunities for new market entrants.

"Third party generated service" emerges as a trend supporting the move towards user-centric services, as shown by the advances in Service-Oriented-Architectures (SOA) and in service front-ends as the interface to users and communities. Virtualisation of resources remains an important research driver enabling the delivery of networked services independently from the underlying platform, which is an important issue for service providers. Advances in these domains also require breakthroughs in software engineering methods and architectures addressing complexity in distributed, heterogeneous and dynamically composed environments.

Networks and service platforms need to be **trustworthy.** They become more vulnerable as current developments lead to increasingly complex large-scale heterogeneous networks with massive distributed data storage and management capacity. In this context trustworthy means: secure, reliable and resilient to attacks; guaranteeing desired levels of services; protecting user data; ensuring privacy and providing usable and trusted tools to support the user in his security management. It requires to be considered from the onset rather than being addressed as add-on features.

Societal and legal issues increasingly influence technological choices. ICT progress must ensure a society based on freedom, creativity and innovation, whilst providing security for its citizens and critical infrastructures.

As the Internet has revolutionised the access to multimedia content and enabled collaborative user-generated content, requirements in this field have a huge impact on a Future Internet. Advances in **3D processing** give rise to innovative applications particularly in gaming technologies and in virtual worlds.

These needs place new types of traffic demands and constraints on

network platforms, and create new requirements for information representation, filtering, aggregation and networking.

Moreover, they drive demand towards novel search tools and raise issues of identity management, ownership and trading of virtual digital objects as well as right of use. These environments coupled with their usage rules shove the research towards a "3D Media Internet" as a basis of tomorrows networked and collaborative platforms in the residential and professional domains.

The Internet is also revolutionising the Enterprise and business environments, with the introduction of **RFID technologies** enabling more automated processes. RFID opens the way towards an Internet of things, where multiplicity of tags, sensors, and actuators provide physical world information enabling new classes of applications combining virtual and physical world information.

Open architectures supporting such environments as well as understanding of their impact on the Internet hence emerge as research drivers. Integration with the mainstream business management platforms as well as integration of multiple businesses in collaborative and ad-hoc environments need to be taken into account.

Finally, there is an increasing demand from academia and industry to bridge the gap between **long-term research and large-scale experimentation** through experimentally-driven research. A fundamental need in this approach is the set-up of large-scale experimentation facilities.

This process goes beyond individual project testbeds in different ways: putting together different research communities in an interdisciplinary approach; anticipating possible migration paths for technological developments which may be potentially

disruptive; discovering new behaviours; and use patterns in an open innovation context, as well as assessing at an early stage the socio-economic implications of new technological solutions.

For their demonstration and experimentation, proposers under Challenge 1 are encouraged to use the dynamically evolving Future Internet Research and Experimentation (FIRE) facility and to federate their project testbeds within this facility.

The European Future Internet Assembly

A range of European research projects are involved in the creation of the European Future Internet Assembly, which aims to identify the long term societal and economic trends of future "on line societies"; how they may impact the underlying network and service technologies; and how they subsequently drive research requirements.

As a consequence, opportunities for action at European level will be explored with the intention of further facilitating and mobilising the relevant research constituencies, also taking into consideration initiatives already launched in other regions of the world.

The European Future Internet Assembly offers a vehicle for excellence and innovation that will create an opportunity for European actors to exchange and promote their views in the global "Future Internet" debate and develop initiatives emerging from the first call of the ICT programme, such as the "EIFFEL" initiative.

The European Future Internet Assembly aims to:

- Coordinate European efforts with a view to foster cross-disciplinary innovation and creativity
- Develop the European knowledge base underpinning the Future Internet
- Design and build the technologies and networking architecture for the Future Internet
- Encourage collaborative business models and social network applications
- Create the conditions for the development of innovation friendly service oriented architectures
- Ensure the robustness of the networks and create trust and security in the on-line world
- Develop the tools and approaches harnessing the potential of the Internet of Things
- Develop capabilities for the creation, sharing, search and delivery of new-media content
- Raise awareness of economic, policy and regulatory orientations identified by the UN Internet Governance Forum, the OECD and the European regulatory framework

Visit the website: http://www.future-internet.eu