European Commission
Information Society and Media

Future Networks

FP7 ICT Call 4 Projects Portfolio

Seventh EU Framework Programme for
Research and Technological Development.

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FOREWORD

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The fourth ICT Call[2] for proposals of the EU Seventh Framework Programme for Research and Development (FP7), published on 19th November 2008, invited proposals for Integrating projects (IPs) and Small and medium scale focused research projects (STREPs) in the Objective 1.1 "The Network of the Future" sub-objectives b) Spectrum-efficient radio access to Future Networks and c) Converged infrastructures in support of Future Networks.

A total of 24 proposals were retained for funding, representing more than 110 million € of EU investment. The new set of projects is ensuring a good integration potential and complementarities with current portfolio and clusters, as the Network of the Future projects are organised into three clusters: Converged and Optical Networks (CaON), Radio Access and Spectrum (RAS), and Future Internet Technologies (FI).

Specifically the following topic areas have emerged within the topics of the call:

- Spectrum-efficient radio access to future networks

A large number of high-quality proposals from this area have been retained.

Considering the standardisation roadmap for next-generation mobile and wireless access systems, ARTIST4G, LOLA and SAPHYRE are focusing on the further development of LTE-Advanced systems.

Concepts and enabling technologies for cognitive radio systems and flexible spectrum usage are covered by several complementary retained projetcs. Whereas QUASAR and COGEU are focusing on the secondary use of licensed spectrum, particularly TV White Spaces, QoSMOS, FARAMIR and SAPHYRE are taking a broader approach towards sharing of licensed spectrum and cognitive usage of unlicensed spectrum. SAMURAI and SACRA are focusing on the enabling technologies for cognitive radio systems, including the necessary signal processing functions and the related hardware platform. WHERE2 is adding localisation capabilities to future mobile communication systems.

The area of novel radio network architectures beyond cellular is well covered and includes femto-cell topologies (BeFEMTO, FREEDOM, FIVER), relaying (ARTIST4G), and next-generation backhaul systems (BuNGee).
Some projects are addressing the topic of energy efficiency of mobile and wireless systems from complementary angles. While EARTH takes the network/base station perspective, C2POWER is also considering device/terminal issues. Energy efficiency is also addressed by ECONET and SACRA.

- Next-generation optical networks

The most important aspects of optical networks are covered by the portfolio of retained projects. End-to-end aspects are addressed by STRONGEST that is aiming at a network control plane supporting flexible management capability of multi-domain and multi-operator contexts with end-to-end carrier grade performance. Optical transport and control paradigms are also addressed by MAINS, taking the best-suitable optical transport techniques and combined them with a transport-agnostic GMPLS control plane, as well as in GEYSERS.

[1] *From 1st September 2010 Rainer Zimmermann passed the responsibility for the Future Networks Unit to Luis RODRIGUEZ-ROSELLO")*
[2] *Call identifier FP7-ICT-2009-4*

OASE and ACCORDANCE are focusing on the access network towards extended reach optical access with GBit/s performance for a large number of users. This is complemented by FIVER that aims at a novel integrated access network architecture where the optical access FTTH, the in-home optical distribution network and the final radio link become part of the access.

- **C**onverged service capabilities

ETICS and GEYSERS are both addressing new paradigms for future service provisioning. ETICS is a project driven by Telecom operators and aims at an end-to-end QoS architecture and new paradigms for multi-operator connections. GEYSERS is complementary and takes the IT-perspective with the aim to specify and implement a novel optical network architecture able to support the provisioning of the combined set of optical transmission and any-IT resources. It is intended to support a new type of business model where the network infrastructure is rented out to multiple operators.
The aspect of service capabilities across heterogeneous networks is covered by MONET that addresses the optimisation of a combination of satellites and ad-hoc terrestrial radio links to provide networking to low population density areas.

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

The Future Networks projects collaborative research enhances the positioning of EU industry in the field of network technologies and reinforces the European leadership in developing technologies for integrated wired and wireless networks. The projects contribute to global standards and develop innovative Intellectual Property Rights (IPR) for European companies.

Future network technologies and architectures, radio access and spectrum management, optical and converged network technologies are fundamental building blocks, supporting vital services of our society such as health, environment, government, transport and education. Great research challenges are still ahead and this needs the strengthening of all efforts to connect all the necessary resources in enabling the future networked society. The need is also to ensure the right conditions to allow the progress of the EU economies in a sustainable and inclusive way.

The future networks projects are front runners of the European Research and will continue to foster progress for Europe and make strong inputs towards achieving the EU research and Digital Agenda strategic aims.

Rainer Zimmermann

FP7 ICT Work Programme 2009-2010

Objective ICT-2009.1.1: The Network of the Future

Target Outcomes

a) **Future Internet Architectures and Network Technologies** Overcoming structural limitations of the current Internet architecture arising from an increasingly larger set of applications, of devices and edge networks to be supported.

- Novel Internet architectures and technologies enabling dynamic, efficient and scalable support of a multiplicity of user requirements and of applications with various traffic patterns, variable end-to-end quality of service, point-to-point or point-to-multipoint distribution modes, and supporting legacy and future service architectures. The target architecture should support personalised rich media networking, machine-to-machine communication, wireless sensor networks, ad-hoc connectivity networks as well as personal and body area networks. It should also be wireless-friendly, natively support mobility, be spectrum- and energy-efficient, support future very-high-data-rate all-optical connections as well as heterogeneous wired/wireless access domains. Routing and location-independent addressing or naming, dynamic peering, signalling, resource virtualisation, and end-to-end content delivery techniques are related research issues.
- Flexible and cognitive network management and operation frameworks enabling dynamic, ad-hoc and optimised resource allocation, control and deployment, administration with accounting that ensures both a fair return-on-investment and expansion of usage, differentiated performance levels that can be accurately monitored, fault-tolerance and robustness associated with real-time trouble shooting capabilities. The management architecture should target self-organised and self healing operations, cooperative network composition, service support and seamless portability across multiple operator and business domains.

Migration paths and coexistence through overlay, federation, virtualisation and other techniques should be investigated to support several network and management architectures including legacy systems. Benchmarking capability of the proposed architecture(s) is to be considered from the onset. Clean slate or evolutionary approaches, or a mix of these, can be equally considered.

If third country partnership is felt relevant by proposers, priority should be for those third countries having established programmes in this field, notably Japan and the USA.

b) **Spectrum-efficient radio access to Future Networks**

- Next-generation mobile radio technologies that are cost-, spectrum- and energy-efficient and adapted for implementation in future high-capacity mobile radio systems. Key technology building blocks expected to be addressed are adaptive modulation and coding schemes, multiple antenna and user detection schemes, cross-layer design and low–latency transmission schemes. They are expected to be complemented by co-operative technologies at base station and/or terminal level, novel network topologies and related dynamic channel modelling and estimation. Integrated projects are expected to take a comprehensive approach to the key technology building blocks and develop system evolution paths by jointly designing radio transmission techniques and radio interface protocol stacks and considering spectrum co- existence and sharing.
- 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. These should support environment-aware, self- reasoning- and learning-capable mobile devices that can change any parameter or protocol based on interaction with the environment with or without network assistance.

- Novel radio network architectures enabling the innovative usage of licensed, unlicensed or unused radio spectrum with the aim of radical cost- and energy-reduction. Target environments range from short to medium distance including systems based on femto-cells, ad-hoc networks and vehicular networks, up to wide-area terrestrial and satellite-based radio access networks.

c) Converged infrastructures in support of Future Networks

- Ultra high capacity optical transport/access networks based on state-of-the-art photonics with transparent core-access integration, optical flow/packet transport, dynamic wavelength allocation and end-to-end service delivery capability, overcoming the limitations of segmentation between access, metro and core networks and domains, lower cost optical access and the need for energy efficiency. Integrated projects are expected to address also a network control plane supporting flexible management capability of multi-domain and multi- operator contexts with end-to-end carrier grade performance.
- Converged service capability across heterogeneous access: Breakthrough technologies and architectures for seamless ubiquitous broadband services, integrating wired and wireless, fixed and mobile technologies in hybrid access networks, including hybrid-satellite networks.

These enable generic support for service portability and continuity across composite networks through the service-network interface, with ubiquitous access from any network, from any technological or administrative domain, from any location and with a variety of access devices.

d) Coordination/ Support actions and Networks of Excellence

- Coordination of research efforts to explore synergies across on-going national initiatives and with third countries (priority is with the USA and Japan); support actions to channel efforts towards standardisation initiatives and a coherent approach towards take-up and testing of new concepts leading to a European-led Future Internet.
- Support to integrated satellite and terrestrial systems with a focus on supporting both public service and private communication requirements.
- Research roadmaps, organisation of scientific and/or policy events, strategy and policy formulation.
- Networks of Excellence in new and emerging topics, with a clear and limited focus, requiring interdisciplinary teams of researchers.

Expected impact

- Strengthened positioning of European industry in the field of Future Internet technologies and reinforced European leadership in mobile and wireless broadband systems optical networks cognitive network management technologies.
- Increased economic efficiency of access/transport infrastructures (cost/bit)
- Global standards, interoperability and European IPRs reflecting federated and coherent roadmaps.
- Wider market opportunities from new classes of applications taking advantage of convergence.
- Accelerated uptake of the next generation of network and service infrastructures.

Funding schemes

a), b), c): IP, STREP; d): NoE, CSA

Calls and indicative budget distribution:

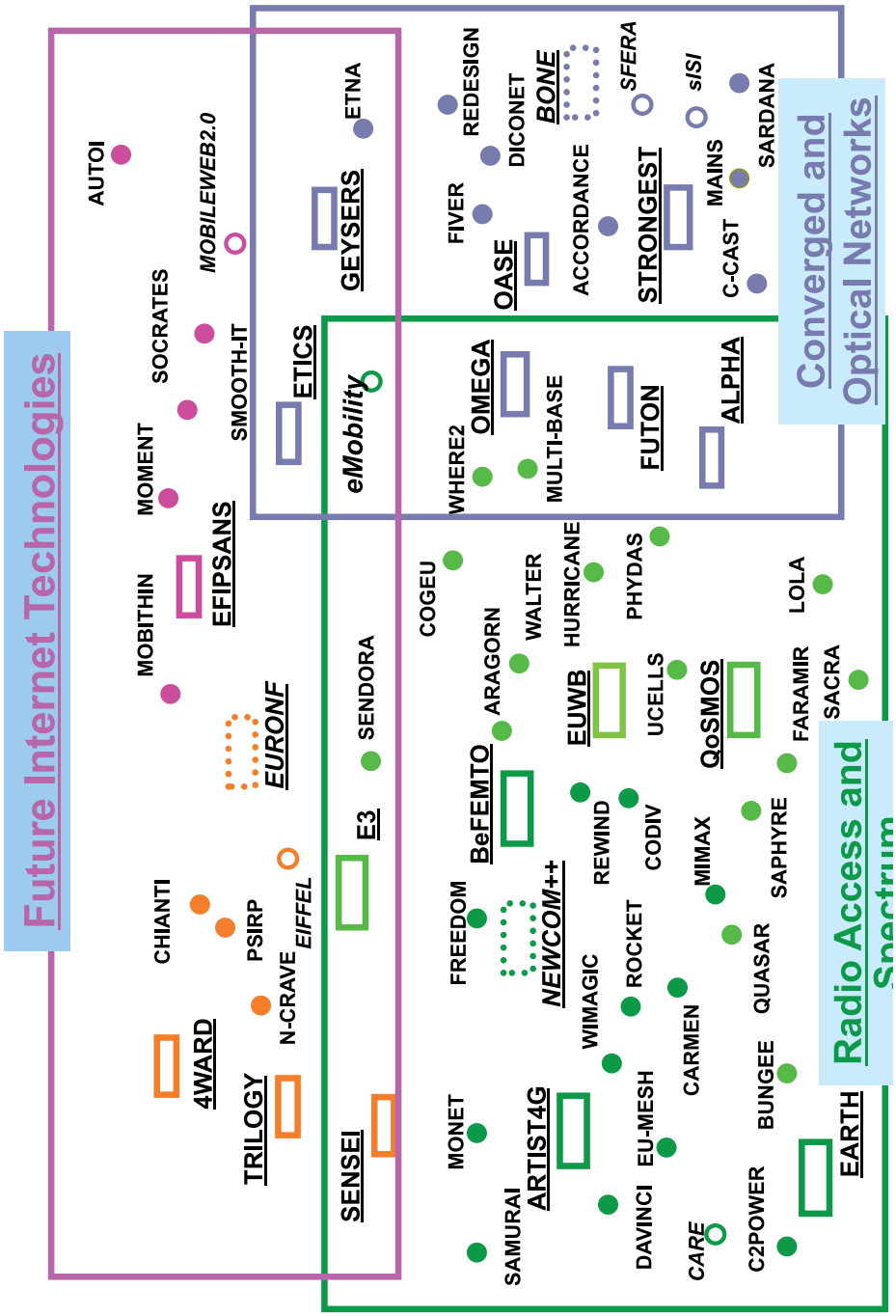
- ICT call 4 - target outcomes b) and c):
- IP/STREP: EUR 110 million of which a minimum of 50% to IPs and a minimum of 30% to STREPs
- ICT call 5 - target outcomes a) and d)
- IP/STREP: EUR 71 million; of which a minimum of 50% to IPs and a minimum of 30% to STREPs
- NoE: EUR 6 million; CSA: EUR 3 million

Project acronym	Instrument	Description[3]	Total cost	EC funding	Duration (months)
ACCORDANCE	STREP	A converged copper-optical-radio OFDMA-based access network with high capacity and flexibility	5.627.493 €	3.499.148 €	36
ARTIST4G	IP	Advanced Radio Interface Technologies for 4G Systems	14.395.224 €	8.676.703 €	30
BeFEMTO	IP	Broadband Evolved FEMTO Networks	10.175.149 €	6.851.221 €	30
BuNGee	STREP	Beyond Next Generation Mobile Broadband	4.669.537 €	2.975.953 €	30
C2POWER	STREP	Cognitive radio and Cooperative strategies for POWER saving in multi-standard wireless devices	5.159.714 €	3.450.888 €	36
CARE	CA	Coordinating the Antenna Research in Europe	568.101 €	497.740 €	28
COGEU	STREP	COgnitive radio systems for efficient sharing of TV white spaces in EUropean context	5.098.523 €	3.383.365 €	36
EARTH	IP	Energy Aware Radio and NeTwork TecHnologies	14.804.805 €	9.483.512 €	30
ETICS	IP	Economics and Technologies for Inter-Carrier Services	12.758.652 €	7.998.638 €	36
FARAMIR	STREP	Flexible and spectrum-Aware Radio Access through Measurements and modelling In cognitive Radio systems	5.529.324 €	3.457.377 €	30
FIVER	STREP	Fully-Converged Quintuple-Play Integrated Optical-Wireless Access Architectures	4.180.463 €	2.768.406 €	36
FREEDOM	STREP	Femtocell-based netwoRk Enhancement by intErference managEment and coorDination of infOrmation for seaMless connectivity	3.445.901 €	2.529.989 €	24
GEYSERS	IP	Generalised architEcture for dYnamic infraStructure sERvices	10.433.206 €	7.035.000 €	36
LOLA	STREP	Achieving Low-Latency in Wireless Communications	4.155.021 €	2.628.033 €	36
MAINS	STREP	Metro Architectures enablINg Sub-wavelengths	2.707.881 €	1.956.310 €	30
MONET	STREP	Mechanisms for Optimization of hybrid ad-hoc networks and satellite NETworks	3.596.013 €	2.434.607 €	30
OASE	IP	Optical Access Seamless Evolution	7.664.241 €	4.980.257 €	36
QOSMOS	IP	Quality of Service and MObility driven cognitive radio Systems	15.508.041 €	9.419.680 €	36
QUASAR	STREP	Quantitative Assessment of Secondary Spectrum Access	5.049.203 €	2.996.000 €	30
SACRA	STREP	Spectrum and energy efficiency through multi-band Cognitive Radio	5.950.524 €	3.770.412 €	36
SAMURAI	STREP	Spectrum Aggregation and Multi-User MIMO: Real-world Impact	4.596.081 €	3.094.389 €	30
SAPHYRE	STREP	Sharing Physical Resources – Mechanisms and Implementations for Wireless Networks	5.299.200 €	3.850.000 €	36
STRONGEST	IP	Scalable Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport	12.636.177 €	7.386.016 €	36
WHERE2	STREP	Wireless Hybrid Enhanced Mobile Radio Estimators - Phase 2	7.445.990 €	5.230.289 €	36
			171.454.464 €	110.353.933 €	

[3] IP – 'Integrated Project' or 'Large scale integrating collaborative project'
STREP – 'Specific Targeted Research Project'
CA – Coordination Action

FP7 – ICT Call 4 Future Networks Projects List

Future Networks Project Clustering – Call 1 & Call 4 Projects



Project Summaries (Alphabetical Order)

A Converged Copper-Optical-Radio OFDMA-based access Network with high Capacity and Flexibility

The ACCORDANCE STREP project composed by partners from Estonia, France, Germany, Greece, Spain and United Kingdom, investigates on a new paradigm for the access network: The introduction of OFDMA (Orthogonal Frequency Division Multiple Access) into a Passive Optical Network (PON) architecture offering at the same time optical backhauling for wireless and copper-based networks.

At A Glance: ACCORDANCE
A Converged Copper-Optical-Radio OFDMA-based Access Network with high capacity and flexibility

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Technical Leader
Ioannis Tomkos (AIT)

Partners:
Research and Education Laboratory in Information Technologies (GR), Alcatel-Lucent Deutschland AG (DE), Deutsche Telekom AG Laboratories (DE), Intracom Telecom (GR), Telefónica Investigación y Desarrollo (ES), University of Hertfordshire (UK), Karlsruhe Institute of Technology (DE), Universitat Politècnica de Catalunya (ES), Euprocom (EE)

Duration: 01/2010 – 12/2012

Total Cost: € 5.6 m

EC Contribution: € 3.5 m

Funding scheme: STREP

Contract Number: INFSO-ICT-248654

Main Objectives

The convergence with fixed networks is likely to deliver all desired benefits of data-centric, quality of services, mobile networks.

Although OFDM has been used in radio and copper-based communi-cation, it's only recently that it's making its way into optics and is expected to offer increased system capacity and flexibility by using highly integrated optoelectronic compo-nents.

ACCORDANCE introduces a novel high-capacity extended-reach optical access network architecture, based on OFDMA technology, implemented through the proper mix of state-of-the-art photonics and electronics. Such an architecture is not only intended to offer improved performance compared to evolving TDMA-PON (Time Division Multiple Access - Passive Optical Networks) solutions, but also inherently provides the opportunity for convergence between optical- radio- and copper-based access.

The main objectives of ACCORDANCE are:

- Define a novel Access Network Architecture achieving convergence among heterogeneous technologies (optical, wireless, copper)
- Propose low-cost, low-complexity concepts to achieve ultra-high data rates in the access network (even up to 100Gb/s)
- Introduce a flexible bandwidth allocation concept
- Provide smooth migration from and co-existence with legacy access solutions
- Provide multi-operator and multi-service support

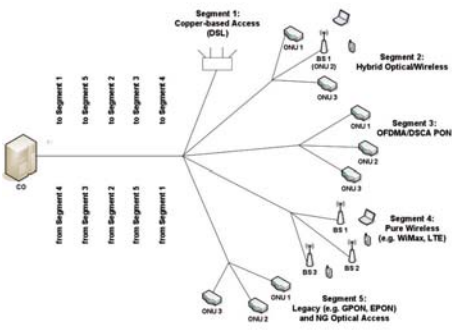
- Contribute to standardisation activities on NGOA
- Demonstrate and disseminate the results

Technical Approach

The work that needs to be performed during ACCORDANCE lifecycle has been organized between several work packages:

Technical work begins in WP2, where the ACCORDANCE architecture will be defined. After identifying initial requirements, the work of WP3 starts, which aims the implementation of the basic real-time processing capable functional node elements. Further work in WP2 and WP3 is tightly interconnected and runs in parallel, considering the investigation of the feasibility and cost of the targeted concepts in a real-world deployment.

Definition of the ACCORDANCE MAC layer requirements is fed by inputs from WP2 and WP3 and will be conducted in WP4 and WP5. WP4 is focusing on the OFDM/ODFMA PON MAC layer and the definition of a novel protocol along with flexible bandwidth allocation algorithms. WP5 will address the overall MAC and PHY aspects of the wireline / wireless network, taking into account the impact of existing solutions, possible migration and co-existence schemes.



Results obtained in WP2, WP3, WP4 and WP5 will be used by WP6 for the definition of a testbed and the preparation for experimental validation of the ACCORDANCE concepts.

In order to provide appropriate visibility of the achievements to the relevant forums and maximize chances for achieving the required impact level of the project, ACCORDANCE is supported by WP7 which includes 4 major EU industry partners who will contribute to EU leadership in the particular topics and support the adoption of ACCORDANCE concepts as global standards.

Key Issues

- Allocation of the spectrum in a significantly flexible manner and in multiple levels of granularity.
- Splitting the signal into several low-bitrate sub-carriers to provide the opportunity of using already available low-cost optical devices and electronics.
- Define a completely novel converged type of network architecture, incorporating essentially all kinds of access technologies, namely optical-, wireless- and copper-based.
- In-depth study of the migration paths to the new ACCORDANCE concept, both from a technical, as well as from a techno-economical point of view.
- Proof of concept and demonstration.

Expected Impact

- Boost the field of optical and wireless networking globally, and thus strengthen the position of Europe in those rapidly developing fields.
- Provide a natural environment for healthy competition among European network and service providers that will revitalize the European market and reinforce its competitiveness.

- Contribute to the emergence of a large number of SMEs manufacturing relevant components and equipment and thus stimulate the European telecommunication market.
- Introduce an extremely cost-efficient network infrastructure.
- Contribution to the development of competitive business environments that reduce cost/bit for the consumers.
- Contribution to related standardisation bodies.
- Increased data-centric traffic overall volume, effective management of dynamic traffic patterns and service differentiation
- Provide dynamic bandwidth allocation for wireless traffic over the optical network, and adaptation of a centralized wireless scheme to significantly enhance wireless connection quality.
- Answer future bandwidth requirements by achieving ultra-high data rates in the access network.

ACCORDANCE

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ARTIST4G - Advanced Radio Interface Technologies for 4G Systems

Offering ubiquitous user experience in cellular mobile systems through innovations on interference management and new relay concepts, and building consensus to foster the development of standards thanks to the participation of major actors from Finland, France, Germany, Italy, Netherlands, Poland, Spain, Sweden and UK.

At A Glance: ARTIST4G
Advanced Radio Interface Technologies for 4G Systems

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Docomo Communications Laboratories Europe (G)
Eurecom (FR)
France Telecom SA (FR)
Mitsubishi Electric R&D Centre Europe (NL)
Nomor Research (G)
Nokia Siemens Networks (G, PL, FI)
Qualcomm CDMA Technologies (G)
Sequans Communications (FR)
Telecom Italia (IT)
Telefónica Investigación y Desarrollo (SP)
Technische Universität Dresden (G)
Vodafone Group Services Limited (UK)

Duration: 01/2010 – 06/2012

Total Cost: €14.4 m

EC Contribution: €8.7 m

Funding scheme: IP

Contract Number: INFSO-ICT-247223

Main Objectives

Improving the ubiquitous user experience of cellular mobile radio communications systems

The first 3GPP Long Term Evolution standard version is complete and ready to be deployed. Although it increases peak data rate and spectral efficiency compared to legacy techniques, cell-edge and average user throughputs are still significantly lower than the peak rates. In the LTE-Advanced Study Item, ways to extend the standard are being explored.

However, most of the intelligence remains on the base station side with strategies consisting in avoiding interferences.

The main ARTIST4G objective is to improve the ubiquitous user experience of cellular mobile radio communications systems by satisfying the following requirements:

- High spectral efficiency and user data rate across the whole coverage area
- Fairness between users
- Low cost per information bit
- Low latency

A good key performance indicator for this objective is the ratio of the cell-average over the cell-edge spectrum efficiency. This ratio will be enhanced with respect to the following guideline:

- Improve significantly the cell-average spectrum efficiency over cell-edge spectrum efficiency ratio.
- Maintain or improve the cell-average spectrum efficiency.

ARTIST4G will also address the impact of these concepts on the network architecture.

Finally the project will not only use theoretical analysis and simulations to develop and validate innovative concepts, but also enable proof-of-concept via hardware prototypes and field trials in a representative test bed. It is expected that it will create a major impact on standardization and provide the partners with a technological head-start that will strengthen the European position in cellular communications.

Technical Approach

The non-uniformity of the quality of service within the network can be tackled following two different approaches. On the one hand, one can try to change the network topology in order to harmonize the transmit power distribution. However it would be naive to think that a perfect uniform throughput distribution can be achieved given the intrinsic nature of propagation rules. Thus on the other hand, one can try to minimize the main limiting factor: interferences.

Consequently, the major research topic of ARTIST4G is interference management, which is further divided in two sub-topics:

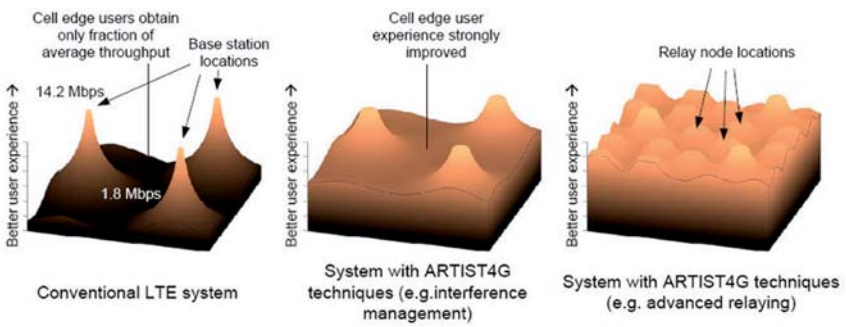
- The first approach is to avoid interference at the receiver. This can be interpreted as keeping a high level of orthogonality between multiple transmissions, while improving spectral efficiency.
- The second approach is to step back from the paradigm of fully avoiding interference by designing purely orthogonal transmission schemes and, instead, allow for soft-tuning between avoidance and allowance for interference. The goal here is to exploit interference.

This disruptive approach puts more focus on the receiver implementation (in uplink and/or downlink).

The spirit of these concepts is illustrated by the following: "orthogonality lures by its beauty but it blinds the reason".

The relative performances of different approaches will depend on the topology, environment, and terminal capabilities. Efficient usage of the proposed methods in various coexistence scenarios will also be investigated in ARTIST4G project.

The second topic studied to achieve balanced user experience is advanced relay techniques.



Several techniques that go beyond the scope of current standardization work will be addressed. Both interference management and relaying techniques will impact the network architecture. ARTIST4G project will propose new architecture solutions for supporting these techniques.

Finally, ARTIST4G will provide a proof-of-concept of the proposed methods.

Key Issue

The optimal combination of the three approaches, namely interference avoidance, exploitation and relays, is a key issue of the project. To help in this task, appropriate models will be needed at system levels that do not already exist. A corner stone of this model is the introduction of interference-cancelling receivers for which no link to system interface exists yet.

Expected Impact

- Rich and uniform quality of experience for mobile customers
- Strengthened European leadership in mobile broadband systems
- Increased economic efficiency of mobile access infrastructures (cost/bit)
- Consensus building among major 3GPP actors fostering standards development
- Accelerated uptake of the next generation of mobile networks

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Broadband Evolved FEMTO Networks

The aim of BeFEMTO is to develop evolved femtocell technologies based on LTE-A that enable a cost-efficient provisioning of ubiquitous broadband services and support novel usage scenarios like networked, relay and mobile femtocells.

At A Glance: BeFEMTO
Broadband Evolved FEMTO Networks

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Duration: 01/ 2010 – 06/2012

Total Cost: € 10.2m

EC Contribution: € 6.9m

Funding scheme: IP

Contract Number: INFSO-ICT-248523

BeFEMTO's Answer to the Broadband Gap

True broadband anytime, anywhere

Broadband services play an important role in stimulating and fuelling the European economy. It is becoming increasingly clear that the expansion of the broadband base to a larger population is a necessary condition for enabling these services.

BeFEMTO develops evolved Femtocell technologies enabling the cost-effective provisioning of ubiquitous broadband services with the aim of accelerating the uptake of next generation mobile broadband in support of the desirable roll-out of broadband access across Europe.

The project targets both near-term and long-term solutions. With its strong industry consortium, the BeFEMTO project aims to have a real impact on the standardisation of the next generation Femtocell technologies based on LTE-A in the near term. In the long-term, the project focuses on novel concepts and usage scenarios such as self-organizing and self-optimizing Femtocell Networks, Outdoor Relay Femtocells as well as Mobile Femtocells.

Benefits to European Economy and Society

The beneficiaries of the project results will be primarily end-users, but also the operators. End-users will benefit from the technological advances in terms of enhanced mobile coverage, high-speed access to broadband services, despite

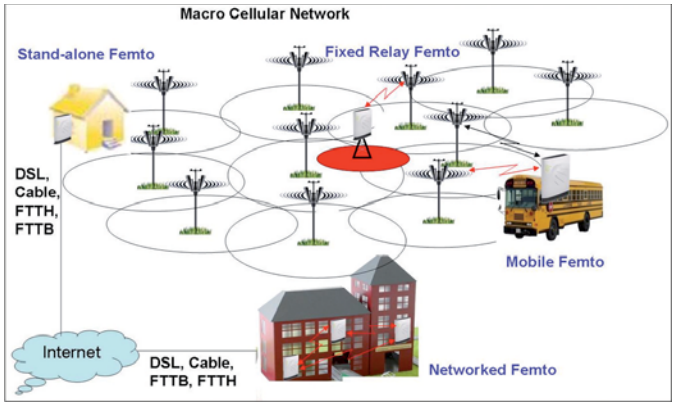
lower transmit powers leading to substantial reduction in radiation exposure. Operators will benefit from the developed technology due to the capital cost savings through smooth convergence of fixed and mobile broadband services and the operational cost savings through advanced self-management and -optimisation techniques.

The BeFEMTO consortium includes key European operators and vendors and is supported by an Advisory Board with representatives of related standardization (ETSI), industry forum (Femto Forum) and European regulation bodies (Ofcom, UKE, ANFR, ECO). The project will use this unique position to actively promote the harmonization of European regulation and to impact international standards in order to strengthen the position of the European economy.

Technical Approach

BeFEMTO's vision of broadband evolved femtocells comprises four major themes. It envisages a smooth convergence between broadband fixed and wireless services by focusing on LTE-A based stand-alone femtocell through development of innovative concepts and algorithms required to guarantee a successful deployment of femto solutions in the near future. In this context, advanced RF, interference and radio resource management procedures and co-existence with macrocells will be the key-enablers exhibiting great advances towards higher spectral efficiencies and reduced radiation exposure.

With networked femtocells BeFEMTO will investigate on advanced cooperation between femtocells installed in buildings such as hospitals, offices or shopping malls. This approach offers new service provisioning for home, office and enterprise environments, and, consequently, new market and business opportunities for service providers. This requires novel concepts and algorithms with special focus on resource and interference management, network synchronization, and architectural design facilitating a tight integration into macro and other infrastructure networks. Fixed outdoor relay femtocell with self-organising capabilities will relax signalling delay and loading on wireless links between relay and macrocell base station. Mobile or moving femto nodes, outdoor femtocells, are also novel and they are to be installed in passenger vehicles such as buses and trains providing broadband communications to people on the move such as public transports. Consequently, we have to cope with a wireless backhaul link as opposed to the wireline link used for fixed or indoor stand-alone femto nodes.



Key Objectives

BeFEMTO is targeting measureable technical objectives that strongly indicate the ambitious research motivation.

- Ensuring minimum capacity to each user irrespective of its location, network loading, mobility, targeting at least 8 b/s/Hz/cell of system spectral efficiency.
- A maximum averaged transmit power of less than 10 mW for indoor femto nodes.
- Defining and developing new applications and use cases particularly related to the themes adopted in the proposal thereby enabling seamless convergence between fixed broadband and mobile cellular systems.

Expected Impact

The expected impacts of BeFEMTO will be diverse and immense:

- It will develop advanced radio access technology that will lead to a highly efficient and unprecedented use of the radio spectrum.
- Combining this with the capital cost savings through smooth convergence of fixed and mobile broadband services and the operational cost savings through advanced self-management and -optimisation techniques, BeFEMTO will significantly increase the cost efficiency of the access infrastructure (cost/bit).
- Providing support for new deployment scenarios like networked femtocells for shopping malls and mobile femtos for public transport, BeFEMTO will expand the market opportunities for femto technologies and facilitate the entrance of new type of services.
- BeFEMTO technology will accelerate the uptake of next generation mobile broadband for expected 60% of all cellular systems traffic and support the desirable roll-out of broadband access across Europe.
- It will actively contribute to global standards, create European IPR and promote the harmonization of European regulation related to femtocell markets, reinforcing European leadership in mobile and wireless broadband systems.

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BuNGee: Beyond Next Generation Mobile Broadband

BuNGee's goal is to increase the overall mobile network infrastructure capacity density to well beyond what current next-generation technologies (e.g., LTE and WiMAX) are promising, utilizing a new deployment strategy.

At A Glance: BuNGee
Beyond Next Generation Mobile Broadband

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Duration: 01/2010 – 06/2012

Total Cost: € 4.6 m

EC Contribution: € 2.9 m

Funding scheme: STREP

Contract Number: INFSO-ICT-248267

BuNGee Main Objectives

BuNGee's capacity density of 1Gbps/ km2 will be the catalyst for accelerated uptake of next generation mobile broadband networks.

In dense urban areas where the market demand for wireless broadband access is the highest, the current next-generation technologies LTE and WiMAX support a mere 100mbps/km2. This is insufficient, and seriously jeopardises the wide scale uptake of IMT-Advanced technologies.

BuNGee's goal is to dramatically improve the overall infrastructure capacity density of the mobile network by an order of magnitude (10x) to an ambitious goal of 1Gbps/Km2 anywhere in the cell – thereby removing the barrier to beyond next-generation networks deployment.

To achieve this objective, the project will target the following breakthroughs:

- unprecedented joint design of access and backhaul over licensed and license exempt spectrum;
- unconventional below-rooftop backbone solutions exploiting natural radio isolations;
- beyond next-generation networked and distributed MIMO & interference techniques;
- protocol suite facilitating autonomous ultra-high capacity deployment.

To evaluate the effectiveness of these approaches, a high capacity radio cell prototype will be built targeting over 1Gbps/Km2. It shall serve as proof-of-concept in real life scenarios and demonstrate the superiority of BuNGee's architecture for mobile networks.

The developed technologies will be proposed as new standards for high capacity radio access networks, mainly to ETSI BRAN and IEEE 802.16 and/or LTE-Advanced, to maximise the exploitation benefits in Europe and globally.

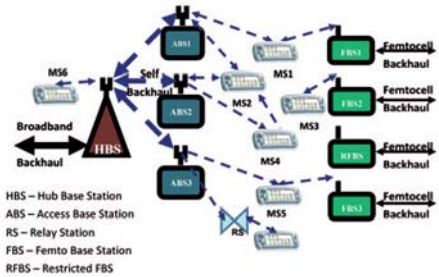
Technical Approach

The unprecedented approach we are proposing in BuNGee is:

- to have a much denser base station grid below the rooftops (e.g., on utility poles) and thereby bringing the backhaul network below rooftop;
- to exercise aggressive reuse combined with high spectrum efficiency, by using novel antenna, RF, base-band and network techniques;
- to undertake a joint design of backhaul and access networks, using heterogeneous radio elements, licensed and licensed-exempt spectrum, a cognitive radio approach, among others, aimed at achieving a maximum system capacity and QoS;
- to design a data and control plane protocol suite that facilitates autonomous operation by means of a complete self-organising networking paradigm.

The work is divided in 6 Work Packages, with four of them being technical:

WP1 focuses on compiling user requirements and translating them into technical specifications, used to define BuNGee initial system architecture.



WP2 focus on Channel modelling, antenna research, and collaborative networked and multi-beam MIMO.

WP3 addresses the resource assignment and higher layers protocols within the system and for the joint access-backhaul.

WP4: BuNGee's proof-of-concept, including simulations.

WP5 and WP6 focus respectively on Dissemination & Exploitation and Management.

Key Issues

The project will focus on the following inter-related research areas:

1. High-Capacity 4G Mobile Network that is Cost-, Spectrum- and Energy-Efficient
The novel BuNGee heterogeneous architecture allows a significant increase of available capacity to all the users in any point of the deployment.

2. Novel mobile Radio Network Architecture
BuNGee defines a novel radio system architecture, integrating the Hub Base Station, the Access Base Stations, the Relay stations and the Femto cells

3. Multi-beam antenna assisted MIMO
BuNGee will develop novel extremely high capacity MIMO techniques specifically adapted to the BuNGee architecture.

4. Co-Operative Technologies at Base Station
BuNGee will use co-operative technologies for MIMO operation and also for radio resource assignment.

5. Dynamic Channel Modelling and Estimation
The channel modelling of the HBS-ABS link models will include as many dimensions as possible, i.e. space, polarization, frequency and time, but will also minimise complexity for implementation in the system-level simulator.

6. Cognitive Radio and Network Technologies for Reduced Management Complexity

Cognitive radio principles are extensively used in maximizing the system capacity. BuNGee will also develop technologies for interference cancellation, especially for license-exempt usage.

7. Innovative Usage of Licensed, Unlicensed and Unused Radio Spectrum

In BuNGee, the spectrum is seen as an integrated resource. The traffic is split between licensed and un-licensed spectrum based on traffic requirements (QoS, data rates). The un-licensed spectrum is used according to its propagation characteristics, bandwidth and interference levels.

8. System Live Test

To prove the concepts of BuNGee, a Live Test in a real life mobile environment will be conducted.

Expected Impact

BuNGee will offer a new deployment strategy based on below rooftop deployment of access base stations utilizing existing structures as utility poles in conjuncture with self backhauling of these access base stations by wireless links. This approach offers much lower CAPEX and OPEX relative to traditional cellular deployment approach, thereby significantly lowering the cost/bit of the access network

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Cognitive radio and cooperative strategies for power saving in multi-standard wireless devices

C2POWER main objective is to research, develop and demonstrate energy saving technologies for multi-standard wireless mobile devices, exploiting the combination of cognitive radio and cooperative strategies while still enabling the required performance in terms of data rate and QoS to support active applications.

At A Glance: C2POWER
Cognitive radio and cooperative strategies for power saving in multi-standard wireless devices

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Duration: 01/2010 – 12/2012

Total Cost: € 5.1 m

EC Contribution: € 3.4m

Funding scheme: STREP

Contract Number: INFSO-ICT-248577

Main Objectives

Avoiding the "energy trap" of the Network of the Future

Energy is a critical resource in the design of wireless networks since wireless devices are usually powered by batteries. Without any new approaches for energy saving, 4G mobile users will relentlessly be searching for power outlets rather than network access, and becoming once again bound to a single location. To avoid the so called 4G "energy trap" and to help wireless devices become more environment friendly, there is a clear need for disruptive strategies to address all aspects of power efficiency from the user devices through to the core infrastructure of the network and how these devices and equipment interact with each other. The C2POWER project is the vehicle to address these issues through cognitive and cooperation techniques. The key objectives are to research, develop and demonstrate energy saving technologies for multi-standard wireless mobile devices, exploiting the combination of cognitive radio and cooperative strategies, while still enabling the required performance in terms of QoS to support active applications.

C2POWER requires a wider European approach in order to fulfil the ambitious objectives laid out and to secure a high technology impact factor through standardisation. In the first instance, the consortium structure is highly complementary and driven by academia; bringing large manufacturers, leading edge research organisations together with highly innovative SMEs and more immediate market oriented industry players. Concerning the technology impact, the partners involved are active members

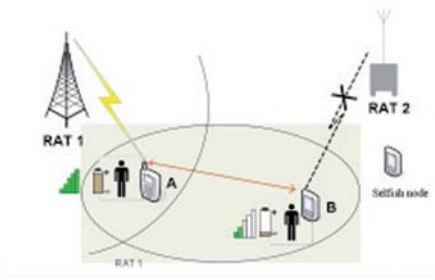
of various standardisation organisations (that include IEEE 1900.6, Bluetooth Special Interest Group (SIG), Femto forum, and the ETSI EMTEL Working group) and are capable and committed to place the key project outcomes in these relevant standards.

C2POWER tangible outputs includes demonstrators for energy efficient short-range cooperation, and vertical handovers; where the aim is to reduce the power consumption at the mobile device by up to 50%.

Technical Approach

The implementation of the C2POWER scenarios will progress along collaborative parallel activities that include:

- Context awareness and signalling for power saving strategies: investigation and implementation of energy efficient network and node discovery modules;
- Energy-efficient reconfigurable radio transceivers: to investigate and implement a transceiver platform that is multi-standard in nature, flexible and energy efficient:
- Cooperative short range communications for power saving: to investigate and implement energy efficient algorithms/ protocols for short-range communications that include: cooperation protocols based on Utility functions; routing, and cooperative relaying;



- Energy-efficient cognitive handovers procedures and policies: to investigate and implement energy efficient cognitive handover algorithms (including femto-cells) and the validation framework;

The aforementioned HW module/components will be integrated in the proof-of-concept phase to validate two major technology showcases on cooperative short range for power saving using UWB (Ultra Wideband), and energy-efficient cognitive vertical handovers.

Key Issues

The key components of the project includes one, the dominant, specifically dealing with technical aspects and the second one addressing business /management models related to the topic cooperation. At the technical level the key issues are:

- Investigate how context information can be used by cooperative strategies to achieve power efficiency at the wireless interface of mobile devices and save battery lifetime.
- Investigate and demonstrate the potential of cooperative techniques based on advanced short range communications for the goal of power/battery lifetime saving of mobile wireless devices.
- Investigate and demonstrate minimum energy consumption handover procedures and policies between heterogeneous technologies and associated tradeoffs in realistic scenarios.
- Investigate, design and demonstrate energy efficient reconfigurable multi-standard transceivers (BB and RF) able to switch from one standard to another according to a power saving strategy.

At the management/ business level, the key issue addresses methods and incentives to encourage cooperation among users/handsets and develop attractive business models for the

network/service providers to stimulate and motivate cooperative networking among users and between heterogeneous networks.

Expected Impact

C2POWER project targets to impact European Industry and Society on various levels.
The combination of cognitive radio and cooperative networks is still in its infancy and Europe can be considered to be currently level with its major competitors in the USA and Far East. However, this situation is only short-term unless European industry undertakes a concerted research effort on these new disruptive technology paradigms.

The energy saving approaches investigated and developed in C2POWER will assist to make future European communication products and systems more competitive, strengthening their market position. Furthermore, the reduction in energy consumption together with the lowering of the "radio pollution" through energy-aware and more effective radio resource usage will help facilitate more sustainable ICTs in Europe. This is particularly relevant in the context of the Lisbon Agenda and the aim to make the EU "the most dynamic and competitive knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment by 2010".

C2POWER will contribute to decrease the growing gap between the energy of emerging radio systems and what can be achieved by battery technology evolution accelerating the uptake of of the next generation of network and service infrastructures.

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Coordinating the Antenna Research in Europe

" CARE is aimed at reinforcing the existing cooperation among the European antenna research teams established by the FP6 ACE NoE and at providing the framework for a better collaboration with the research in NMS dealing with antennas and wireless technologies in Health, Transport, Security and Space applications."

At A Glance: CARE
Coordinating the Antenna Research in Europe

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Duration: 01/2010 – 04/2012

Total Cost: € 568.095

EC Contribution: € 497.740,00

Funding scheme: CA

Contract Number: INFSO-ICT-248272

Main Objectives

The networking of the antenna research and a better exploitation of antennas R&D synergies in an enlarged Europe is the key aim of the CARE project

Starting from the results achieved by the FP6 ACE Network of Excellence, CARE will continue and reinforce the collaboration among the European Institutions involved in antenna research, in particular towards the EU New Member States.

This can only be obtained through an inter-European effort aimed at improving the European excellence by supporting the cooperation and synergies among Institutions located in different countries.

In particular, CARE will reinforce the collaboration among the European Institutions by:

1. researchers secondments
2. international workshops
3. training courses
4. dissemination, by conferences and Internet.

The CARE funding will support the exploitation of the antennas research excellence within the enlarged Europe, in close cooperation with the European Association on Antennas and Propagation (EurAAP), see *www.EurAAP.org*.

With a two-year duration, CARE will make available to the EU NMS the existing benefits for the antenna researchers:

- the Antenna Expert Groups (AEG)

- the European School of Antennas (ESoA), see *www.ESoA-web.org*
- the European Conferences on Antennas and Propagation (EuCAP), see *www.EuCAP2010.org*
- the Virtual Centre of Excellence (VCE), see *www.AntennasVCE.org*
- the European Association on Antennas and Propagation (EurAAP) joined by over 300 European institutions and 1500 researchers and will pave the way towards a long-term excellence of the European antenna research.

Technical Approach

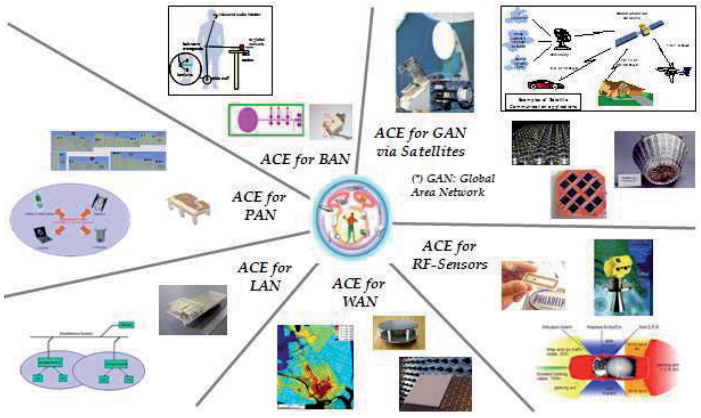
The CARE coordination activities are focused on the antennas subsystems, see figure below. The CARE Coordination Action concentrates on the antenna function of radio systems. This includes the electromagnetic interface from guided waves to free space radiated waves, the beam-forming functions, whether they are analogue or digital, adaptive systems to change the beam pattern, and other antenna-related signal processing. The radiative coupling to the close surroundings and to a scattering environment, together with system aspects such as MIMO antennas and the related optimisation algorithms are also included.

Key Issues

The key issues of the CARE Coordination action are addressed by the project WPs 1 to 5. The WP1 coordinates the European excellence provided by the Antenna Experts Groups in:

AEG 1: MM & Sub-MM Wave Antennas
AEG 2: Small Antenna & Sensors Antennas
AEG 3: Wideband Antennas
AEG 4: Array Antennas
AEG 5: Smart Antennas and is focused on the transfer of knowledge towards researchers in Academia and Industry, by offering researchers secondments and visits.

In WP2, the Antennas Best Practices Groups will provide the software tools to easily assemble complex antenna simulation and will distribute the state-of-the-art antennas measurement procedures able to guarantee the highest level of quality in indoor and outdoor Test Field.
In WP3, three CARE workshop will be organised (in 2010, 2011 and 2012) to present the latest R&D results achieved by the CARE secondment. These workshops will be joined with the major conference in Europe on antennas: the European Conference on Antenna&Propagation (EuCAP), see *www.EuCAP2010.org.*



EuCAP'2010: The 4th European Conference on Antennas and Propagation 12-16 April 2010, in Barcelona, Spain

The WP4 is aimed at further improving the content of the AntennasVCE portal, by publishing the latest information about technical breakthrough, planned events, books and papers databases, jobs, other projects links , etc. The long term goal is to make it the point of reference of the antenna research in Europe. In WP5, the ESoA initiative (see below) will be prolonged in 2010 and 2011, by the contributions of IMST, KIT, IDS, CTU, TNO, UNISI, UPM and EPFL.

4) Environment applications by sensor networks, including RFID and Smart Tags. Moreover, CARE will reinforce the networking and the exploitation of antenna R&D synergies by:

- Building long-term sustainable research cooperations and bringing together a wide range of skills, expertise and viewpoints, by researchers mobility
- Improve exploitation of research results by a direct connection with the Industry at national and European level.

A strong synergy is also expected with other FP7 projects, where CARE representatives will present the project results and will exploit the latest antenna technologies.

Expected Impact

The CARE coordination will have an impact on

1) Communications, i.e. in BAN, PAN, LAN, WAN and GAN, meaning body, personal, local, wide and global area networks
2) Intelligent Transport System able to provide mobile context aware services, including V2V and V2I communications
3) Health applications for diagnosis techniques and remote health control

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COGnitive radio systems for efficient sharing of TV white spaces in EUropean context

The main objective of the COGEU project is to design, implement and demonstrate cognitive radio technologies to allow an efficient use of locally unused TV channels for mobile communications through the introduction of secondary spectrum trading and new spectrum commons regime.

COGEU

At A Glance: COGEU
COGnitive radio systems for efficient sharing of TV white spaces in EUropean context

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Duration: : 01/2010 – 12/2012

Total Cost: € 5.1 m

EC Contribution: € 3.3 m

Funding scheme: STREP

Contract Number: INFSO-IC-248560

Main Objectives

COGEU will exploit a "once in a lifetime opportunity" for the Network of the Future implementing a cognitive access to TV White Spaces

The complete transition from analogue to the digital TV is planned in Europe for 2012. After analogue switch off the spectrum 790 MHz to 862 MHz (TV channels 61 to 69), the so called digital dividend, will be/was entirely cleared from broadcast. Within the remaining spectrum (470 MHz to 790 MHz) not all channels are occupied at each location. These locally unused channels are called TV White Spaces (TVWS).

In fact, the TVWS provides a "once in a lifetime" opportunity for the development of innovative services and the introduction of new cognitive radio technologies into the UHF bands.

However, despite the grand words about opening up a new band to support low cost, ubiquitous access and innovative new providers, there are many obstacles to TVWS systems. The creation of workable systems that clearly demonstrates and prove that no harmful interference is caused to broadcasters or other licensed systems is one of those challenges, as is the completion of standards.

The COGEU project aims to take advantage of the transition to digital TV by developing cognitive radio systems that leverage the favourable propagation characteristics of the TVWS through the introduction of real-time secondary spectrum trading, and the creation of new spectrum commons. COGEU will also define new methodologies for TV white

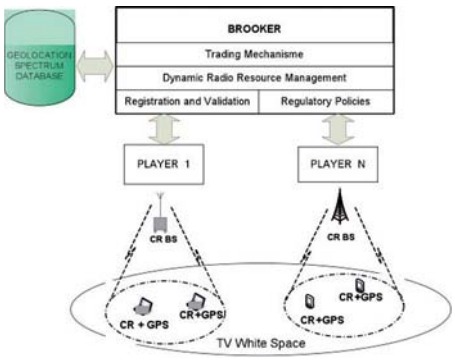
spaces equipment certification and compliance addressing coexistence with incumbent systems.

COGEU looks beyond the immediate opportunities of the often quoted rural broadband over TVWS and aims to show the way for new opportunities for hotspot, cellular, broadcast and public safety communications providers to extend their business options and services.

Technical Approach

The COGEU Project is structured in eight complementary workpackages (WP). WP1 and WP8 are dedicated to project management and project dissemination respectively.

- WP2: the purpose of this WP is to identify suitable applications for COGEU devices and to define the regulatory frameworks that will support them in TVWS. This workpackage will also identify suitable market mechanisms that support the trade of spectrum rights in TVWS, a simulation tool will be developed to validate such mechanisms. The workpackage will make recommendations with regard to the digital TV switchover that promote the efficient use of TVWS spectrum across Europe.
- WP3: this WP will define the system requirements, as well as the COGEU reference architecture and interfaces for the spectrum commons and the secondary spectrum market models.
- WP4: the main objective of this WP is to provide signal processing algorithms and sensing policies in order to make the secondary system capable of identifying TVWS. COGEU combines geolocation databases and sensing techniques for incumbent detection and determining usable channels in TVWS. This WP also set up an experimental testbed for coexistence analysis between commercial DVB receivers and TVWS devices in realistic scenarios.
- WP5: this WP will create a Software Defined Radio transceiver that is highly flexible and that can facilitate the use of TVWS while causing no harm to existing DVB and wireless microphone users. The TVWS transceiver with sensing and spectrum shaping mechanisms will be integrated in the COGEU demonstrator.
- WP6: this WP will investigate dynamic Radio Resource Management algorithms that use context information determining the TVWS bands and power at which a secondary user should be allowed to operate to minimize interference, optimize QoS and guarantee fairness in TVWS cognitive access.
- WP7: the purpose of this WP is to prove the feasibility of the COGEU concepts and ideas through real demonstrations of key aspects of the project. In the COGEU demonstrator players (spectrum seekers and spectrum holders) negotiate trough a third entity, a spectrum broker, which manages TVWS subject to regulation. The spectrum broker aggregates spectrum from TVWS, using real-time spectrum data information and auctions or lease them through open market mechanisms.



COGEU application scenarios

Three main application scenarios with good market potential will be investigated:

- Cellular, WiFi and WiMax network extension over TVWS;
- Mobile TV over TVWS;
- Public safety applications over TVWS.

Expected Impact

The application of COGEU technology and business models will be a major enabler for increasing the capacity of the wireless infrastructure, through spectrally efficient usage and correspondingly will remove barriers to entry through reducing cost/bit.

COGEU plans to contribute to the IEEE P1900 groups, the DVB standardization project and several regulatory bodies such as CEPT and ITU as well as, on a more political level, to RSPG.

As a consequence the COGEU project should greatly aid the European decision makers to move the TV spectrum management paradigm towards a more liberal and efficient method, by providing sufficient evidence on the technology and economics viability and its deployment.

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EARTH: Driving the Energy Efficiency of Wireless Infrastructure to its Limits

EARTH is a highly ambitious and unique project applying an integrated approach to investigate the energy efficiency of mobile communication systems. It is committed to the development of a new generation of energy efficient equipment, components, deployment strategies and energy aware network management solutions.

At A Glance: EARTH
Driving the Energy Efficiency of Wireless Infrastructure to its Limits

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15 Partners from 10 European countries: Alcatel-Lucent (DE), Ericsson (SE), NXP (FR), DOCOMO (DE), Telecom Italia (IT), Ericsson (HU), CEA-LETI (FR), University of Surrey (UK), Technische Universität Dresden (DE), IMEC (BE), Instituto Superio Tecnico (PT), University of Oulu (FI), BME (HU), TTI Norte (ES), ETSI (FR)

Duration: 01/ 2010 – 06/2012

Total Cost: € 14.8 m

EC Contribution: € 9.5 m

Funding scheme: IP

Contract Number: INFSO-ICT-247733

Main Objectives

The EARTH project will cut the energy consumption of 4G networks by 50%.

Telecommunication networks and in particular mobile networks are increasingly contributing to global energy consumption. The EARTH project tackles the important issue of energy saving by enhancing the energy efficiency of mobile broadband systems thereby reducing CO^2 emissions and cost of operation. It is a highly ambitious and unique project, applying an integrated approach to investigate the energy efficiency of mobile systems.

EARTH has mobilized a European consortium with serious efforts committed to the development of a new generation of energy efficient equipment, components, deployment strategies and energy-aware network management solutions.

The project is industry driven with strong contribution by academia. The partners representing industries, operators, research institutions and universities bring in the full diversity of knowledge and complement each other in a way only a European large scale integrating project can.

EARTH will investigate the energy efficiency limit that is theoretically and practically achievable whilst providing high capacity and uncompromised QoS. The target of EARTH is to enhance the energy consumption of mobile systems by a factor of at least 50%. The project is primarily focused on mobile cellular systems of LTE, its evolution LTE-A

and systems beyond, where potential impact on standardization is envisaged, but it will also consider 3G (UMTS/HSPA) technology for immediate impact.

The substantial reduction of network energy consumption will yield large cost savings for mobile operators. Thereby the economical barrier to offer mobile broadband coverage will be substantially reduced.

Hence, EARTH will facilitate high speed mobile services to all European citizens including countryside areas which are not reached yet by mobile broadband services. This strengthens European industry and fulfils the growing demands of end-users.

Technical Approach

Instead of improving single components, the EARTH project addresses the whole system in a holistic approach, from component level to network deployment and management.

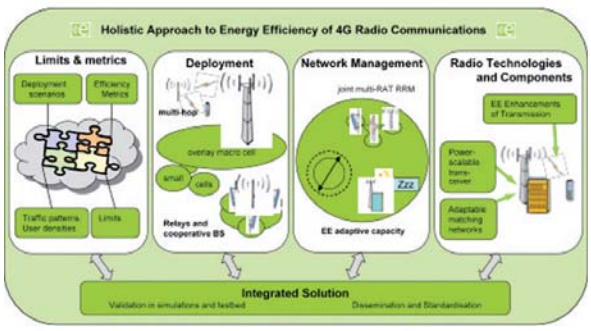
EARTH is organized in 6 work-packages. The results of the technical work packages (WP2-4) are validated in WP5 and WP6 in the operator testbed of a project partner and in system level simulations. They will be combined into an integrated solution and the achieved energy saving will be quantified and demonstrated.

Key Issues

The figure shows the key issues of the technical approach:

EARTH provides the means to analyse the energy efficiency of current solutions and the improvements yielded by deploying the envisaged solutions in real networks. Fundamental limits and trade offs are studied. Meaningful metrics will be defined to evaluate network energy efficiency with reference to key performance figures.

EARTH targets for improvements beyond current development trends. Those improvements will by yielded by energy efficient deployment strategies including heterogeneous networks, relays and cooperative base stations, by energy aware network re-configuration and resource management and by transceivers or base station equipment with high adaptivity to the traffic situation. Further improvements will be realized by employing advanced radio transmission techniques for energy efficiency instead of purely for spectral efficiency improvements. EARTH will develop energy efficiency enabling enhancements of radio interfaces and the related standards. The potential of joint optimisation both on node and network level realised by new interfaces will foster energy aware operation.



Expected Impact

- EARTH will provide increased economic efficiency of access infrastructures (cost/bit). The largest energy efficiency gains from EARTH solutions are expected to occur for the low-loaded parts of the networks.
- The scientific results of the innovative energy efficiency solutions developed by EARTH will be widely disseminated. Large parts will require amendments to standards or new standards in order to ensure multi-vendor interoperability and wide applicability.
- EARTH will reinforce the European leadership in wireless broadband systems. Systematic exploitation of the results in patents will ensure that the research investment is turned into economic potential. This will place the European telecommunications industry in the position to roll-out competitive new products and tools for cost efficient networks on the highly competitive and fast changing global market for mobile telecommunication.

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ETICS: Economics and Technologies for Inter-Carrier Services

ETICS reshapes the current Internet ecosystem and designs new technological solutions for inter-carrier Quality of Service assurances to meet future application usages, while taking into account new business models to foster investments of all actors of the end-to-end service value-chain.

At A Glance: ETICS
Economics and Technologies
for Inter-Carrier Services

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Israel Institute of Technology Technion (IL),
Primetel (CY)

Duration: 01/ 2010 – 12/ 2012
Total Cost: € 12.8 m
EC Contribution: € 8 m
Funding scheme: IP
Contract Number: INFSO-ICT-248567

Main Objectives

ETICS proposes a technical and economic framework supporting the whole life-cycle of a QoS-ensured service across multiple networks

The evolution of Internet usage demands more Quality of Service (QoS) guarantees in order to support stringent services (e.g. security for Cloud Computing, end-to-end delay for real-time applications, etc.). To ensure an excellent quality of experience for these services, networks must continue to evolve to meet the ever increasing capacity and reliability needs. In addition, there is the need to insure certain QoS parameters on a global end-to-end basis, which is further complicated by independent and heterogeneous control and management systems of the different operators.

Hence, a major challenge for future deployments lies in having an effective collaboration between often competitive providers allowing dynamic and scalable solutions, while preserving confidentiality on providers' assets.

Another key challenge arises at business level, since existing agreements do not cover QoS-capable services. Before investing in these future infrastructures, providers must be guaranteed incentive compensations.

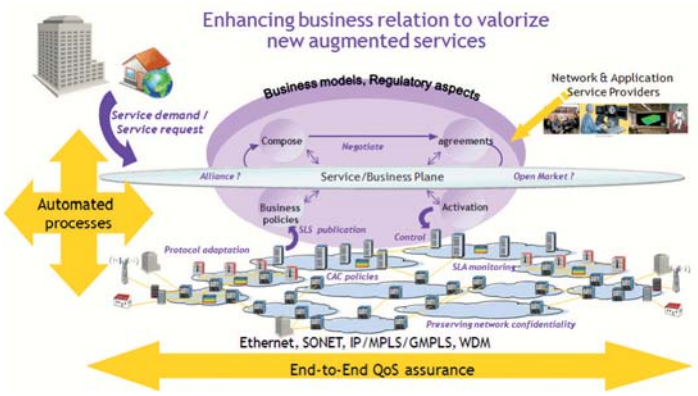
The ETICS project proposes a global response to these issues through a technical and economic framework supporting the whole life-cycle of a QoS-ensured service across multiple heterogeneous operator networks while providing adequate revenue sharing models for all value-chain actors (i.e. application/content and network providers).

ETICS's success will enable its partners to be in position to drive the roadmaps and standards for the future multi-service and multi-actors networks. Involvement of other operators and vendors, but also of regulators and Application Content Providers (ACPs), through open workshops and an external advisory panel, will ensure that all stakeholders contribute to the requirement definitions and to the validation of business and technical models, and may exploit the outcomes of ETICS. This approach will significantly lead to produce a common vision and path towards future inter-networking technologies.

Technical Approach

ETICS promotes a converged infrastructure where network operators provide end-to-end QoS guaranteed services to different users and applications, as they will receive fees relative to the actual usage of their resources. This usage will not be defined solely with respect to the bandwidth but also with respect to other performance or criticality factors such as delay, jitter, availability, flow isolation, etc. Business customers and every user will therefore see the benefits of new technologies through a greater experience, in particular through the use of interactive applications. ETICS roadmap is divided into 3 research axis:

- Paving the way towards a sustainable enhanced Internet ecosystem. New business models will be actively considered among a large panel from alliance/federation to trade market models, to ensure profitability, stability of arrangements and return of investment for all the involved players. ETICS will also investigate the impact of end-to-end QoS provisioning on carrier interactions and interconnection incentives, but also on interactions between carriers and ACPs.
- Designing a different network virtualization approach. ETICS will work on an ecosystem designing features of a Service/Business Plane, which manages network and content provider services. ETICS will define templates and processes allowing ACPs to have end-to-end connectivity requests with various levels of QoS assurances across multiple networks.
- Ensuring a coordinated network control & management. ETICS addresses the technical issues of ensuring expected QoS across heterogeneous networks contracted between different actors. It will propose evolutions in routing protocols, constrained-path computation, congestion control mechanisms and will leverage on existing standards (e.g. GMPLS, PCE, PCN) to design automated network management processes providing QoS interconnections..



Test-bed experiments and performance assessment analysis will be performed in order to demonstrate the technical feasibility and the benefits of the proposed business models, and to promote the inter-carrier architecture in socio-economic and technical domains.

Key issues

To support end-to-end QoS guarantees, ETICS fundamental mainstream is thus to build a sustainable ecosystem where the issues in interconnecting network architectures are both economically and technically addressed (cf. figure):

- Economically, to motivate carriers to invest in new technologies on their infrastructure which will ease the openness to third parties (other network service and application providers);
- Technically, to provision end-to-end QoS guarantees across multiple carrier networks having different control, management, operation and business systems.

Expected Impact

The ETICS project aspires to propose a new technological perspective with respect to the current availability of static inter-carrier services. The expected influence is on "classical" frameworks for remote working, learning and telemedicine, but also on "newer" emerging and highly demanding services such as enhanced converged services, integrated with shared virtual reality spaces, HD/3D TV, virtual private networking, real time stock market information…. Guaranteed QoS services will be one of the key factors driving innovation on the web in the future.

ETICS aims at accelerating the creation, management and deployment of new business models and network services interconnection for fixed and mobile technologies. It will enhance the interworking of service providers, improve the time to market of new services, reduce operational costs and complexity, and provide new revenue opportunities for carriers and ACPs. It will reduce the time required to return the investments when deploying new generation equipments from vendors, thus facilitating their adoption.

To reach these goals, ETICS will also actively participate in standardization efforts to develop/extend open and interoperable protocols (e.g. IETF CCAMP, PCE, PCN working groups) and business processes (e.g. TMF/IPsphere Forum). Finally, the ETICS testbed will help European network operators and equipment vendors in their exploitation strategies and leadership position in future standardization directions.

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FARAMIR: Enabling Spectrum-Aware Radio Access for Cognitive Radios

The main goal of FARAMIR is to research and develop techniques for increasing the radio environmental and spectral awareness of future wireless systems. Holistic approach is taken in order to cover technology development from spectrum sensing to spectrum use models and their application in network optimization.

At A Glance: FARAMIR
Flexible and spectrum-Aware Radio Access through Measurements and modelling In cognitive Radio systems

FARAMIR
A Cognitive Radio Project
Making Cognitive Radios Reality

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Duration: 01/2010 – 06/2012
Total Cost: € 5.37 m
EC Contribution: € 3.46 m
Funding scheme: STREP
Contract Number: INFSO-ICT-248351

Main Objectives

FARAMIR moves the state of the art in cognitive radios from concepts to factual engineering science and business

The next generation mobile radio technologies must be optimised better to exhibit cost, spectrum and energy efficiency. The previous decades long approach has been based on "generations game" (1G, 2G, 3G), where increasingly more complex standards with massive efforts have been developed.

Although this mainly air interface and standardization driven work has been successful so far it is starting to have problems due to diminishing return of investment. Recent measurements have also indicated that although spectral efficiency of many technologies is remarkably good, the spectrum itself is mostly under utilized. Moreover the reallocation of spectrum to different services or providers is a slow and cumbersome process because the interests of numerous stakeholders have to be considered and international coordination is required.

Recently cognitive radio (CR) and cognitive wireless network technologies have been proposed as a new paradigm to reduce management complexity, enabling heterogeneous networking, and as a technique to exploit spectrum more efficiently. This is achieved either through Dynamic Spectrum Access (DSA) or by employing other flexible and more optimal spectrum and resource allocation techniques.

FARAMIR-project is specifically designed to change this by moving the state of the art in CR and DSA from "concepts and order of magnitude estimates" to the "factual engineering science and business by providing facts, field trials and focused technology development". As a focused project FARAMIR has measurable and targeted technology goals, which have been chosen to provide a good science and exploitation basis both in the short- and long term. The overall goal of FARAMIR is to develop advanced and pragmatic sensing mechanisms, and enable their exploitation to increase the spectral efficiency of wireless systems.

Technical Approach

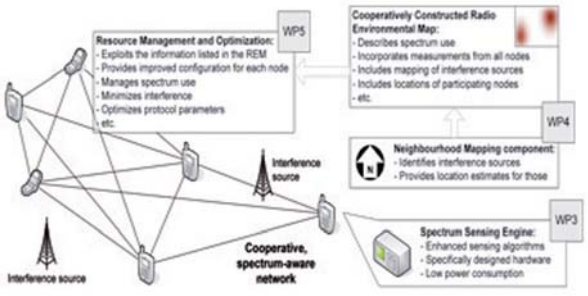
The work in FARAMIR is organized into following technical work packages.

WP2 develops the system architecture and reference, and studies in depth the possible use cases and scenarios for applications and prototyping. The main components include distributed spectrum sensing and spectrum management. The developed architecture will be extended to include hybrid networks that are able to support both cellular type of operations and ad-hoc type of operations. The system architecture will consider coordination between the different networks and elements that share the spectrum as well as the enabling elements and procedures. Moreover, it will take into account the required capabilities of the different types of radios and functional components such as sensing, databases, reconfigurability, decision-making, etc.

WP3 has two major thrust areas. One is the development of new spectrum sensing concepts and empirical models of spectrum use. The work package also coordinates and conducts several long-term measurement campaigns in different European countries. The work on spectrum sensing will consider algorithmic and implementation aspects. This integrated approach will guarantee practical relevance of the project. This work package will also develop new low-cost CMOS based spectrum sensing technologies that will be prototyped.

WP4 develops algorithms and protocols for cooperative spectrum sensing. In addition to coherent and energy detection approaches, feature detection techniques will be investigated. Moreover novel interference localization algorithms will be studied. We will also develop the required information models for the radio environment maps. We also make trade-off analysis, which takes in the account accuracy, costs of information exchange, data fusion algorithms and architectures complexity of cooperative sensing systems.

WP5 applies the project results to radio resource management (RRM) problems. Parameters necessary for the terminal to enable cognition and context-awareness for achieving near-optimal capacity and spectral efficiency will be analyzed and novel optimization techniques will be developed.



Finally, WP6 integrates the outcomes of the technical work of other work packages, and will develop prototype implementations that will be extensively tested and verified in field trials.

Key Issues

The core task of the project is the deve¬lopment of functional and realistic reference architecture for cognitive radio networks that utilize radio environment maps (REM). We apply the developed architecture and REMs to develop novel optimization technologies for future radio systems. FARAMIR will develop a comprehensive technology chain for this and will show how radio environmental information can be measured, collected, and represented efficiently.

Consortium

The consortium consists of ten partners from nine different countries. The participants have a proven track record on research and many of its partners have been the first movers in the domain of cognitive radios. The consortium is also striking a strong balance between academia, industry and regulators. The partners are well connected not only in the research community but also have strong contacts to standardization groups.

Expected Impact

Apart of building core-scientific competence for European academic and industrial partners we actively seek to apply methods and developed techniques to products and standardisation process. The project aims to enhancing the competitiveness of European industry in the area of wireless devices, networks and new applications, specifically by innovating better radio and spectrum optimisation methods, adding intelligence and machine-learning capabilities to RRM and REM modules. FARAMIR is also strengthening of the Information Society by providing technologies that ensure affordable, robust and resource-friendly wireless access methods towards information sources.

Developed tools and methodologies will be published. The project will also distribute most of the data that is generated by spectrum measurement campaigns. This open dissemination of the results and tools is expected to influence cognitive radio networks community and other project. The FARAMIR partners will also actively contribute to the appropriate standardisation.

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Fully-Converged Quintuple-Play Integrated Optical-Wireless Access Architectures

FIVER proposes and develops a novel integrated access network architecture based employing only OFDM signals for the provision of quintuple play services. FIVER architecture is completely integrated: FTTH, in-home optical distribution and the final radio link become part of the access network avoiding conversion stages providing cost, space and energy savings.

At A Glance: FIVER
"Fully-Converged Quintuple-Play Integrated Optical-Wireless Access Architectures"

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Duration: 01/ 2010 – 12/ 2012

Total Cost: € 4.1 m

EC Contribution: € 2.7 m

Funding scheme: STREP

Contract Number: INFSO-ICT-249142

Main Objectives

FIVER is a fully OFDM network. This permits a cost effective, fully centralised network architecture where the transmission impairments (both optical and radio) are compensated at the Central Office.)

FIVER develops a novel integrated access network architecture employing only OFDM signals for the provision of quintuple play services (Internet, phone/voice, HDTV, wireless -WiMAX, UWB and LTE femtocell- and home security/control). This architecture is completely integrated: The optical access FTTH, the in-home optical distribution network and the final radio link become part of the access.

FIVER is a fully OFDM based network. This permits a cost effective, centralised network architecture where the transmission impairments (both optical and radio) compensation and network management is done only at the Central Office. No further compensation, regeneration or format conversion is required along the network giving the streamlined network architecture capable of handling future services of interest.

FIVER services are fully converged: Both baseband (Gigabit-Ethernet provision) and standard wireless (WiMAX, UWB and LTE) signals are transmitted in radio-over-fibre through the FTTH, the in-building optical infrastructure and also the final user radio link. The use of full-standard wireless signals for optical and radio transmission gives two advantages: Fully standard receiver equipment can be used by the customer, and no ad hoc detection, re modulation

or frequency conversion is required. All the transmission compensation algorithms, electro optical subsystems and network management are developed by FIVER consortium.

FIVER is also future-proof. The project demonstrates HDTV service provision in the 60 GHz radio band at the last stage. Other wireless services operation in other bands can be included in the FIVER network architecture as long as they are OFDM-based. This is due to the powerful transmission impairment OFDM transmission compensation algorithms developed in the project.

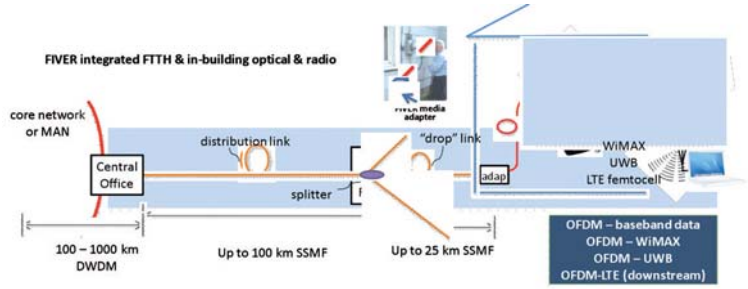
Technical Approach

FIVER develops and demonstrates 5-PLAY capabilities (in an integrated optical and radio network including centralised transmission impairment compensation of the optical path (GVD, PMD compensation) and of the radio path (multipath, interference). The Figure in this page shows the FIVER integrated approach. It can be seen a typical passive-optical network (PON) which consists of an optical line termination (OLT) located at Central Office (CO) which, multiplexes in wavelength (typically 1310/1490nm for audio and data, 1550 nm for video) the services provided by the FTTH network. After the drop fibre, the optical signal arrives to the optical network terminator (ONT) or optical network unit (ONU). ONTs are usually dedicated to an individual end user. ONU equipment is typically located in a basement or even on a curbside and shared by a group of users. Focusing in a home user configuration, the most costly scenario from the operator point of view, the signal after the ONT is photodetected and demodulated to provide the Internet, audio and video services. FIVER integrates the complete optical path (FTTH & in-building distribution network) and also the user radio path for a converged service provision.

FIVER converged approach distributes baseband (OFDM-GbE) and radio-over-fibre (UWB, WiMAX and LTE) signals. Each baseband or wireless signal is responsible of a given service: Internet data is provide by the baseband signal. HDTV is provided by the UWB wireless signals in radio-over-fibre. LAN connectivity is provided by WiMAX and cellular phone connectivity is provided by LTE in a femtocell configuration. This approach requires careful coexistence studies which are done in the project. Multipath distortion and narrowband interference from other licensed/ un-licensed services operating in the same frequency band must be considered. Collaboration between smart radios also represents an important new direction in network management that would be enabled by FIVER technology.

Expected Impact

FIVER architecture significantly reduces network deployment costs and associated costs at user premises. A European well-coordinated approach to design and test these novel FTTH architectures increases the opportunities for Europe to be at the cutting edge of optical access technology.



Improved energy efficiency: FIVER employs UWB for HDTV transmission, This technology exhibits the lowest radiation levels (-41.3 dBm/MHz power spectral density) in the market with very high spectral efficiency (UWB 0.9 bit/s/Hz). Also, the integrated provision of 5-PLAY services (no format conversion, re-modulation or frequency up/down conversion) implies that overall electrical consumption and real state requirements are reduced compared to conventional FTTH.

Electromagnetic pollution will be severely reduced as UWB, WiMAX LTE femtocell and UWB radio in FIVER are intended for short (UWB) and medium (WiMAX, LTE femtocell) range, being radiation more confined than conventional cellular networks based on GSM or UMTS.

FIVER provides more network functionalities i.e. “more for less”. This comes from the cross-over (convergence) of OFDM baseband, WiMAX, UWB, LTE wireless and 60 GHz radio. This convergence is done in FIVER with exceptional FLEXIBILITY: The overall network architecture is capable of perfect operation with any wireless standard as long as it is OFDM-based, which is commonplace.

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Femtocell-based Network Enhancement by Interference Management and Coordination

The project aims at improving the efficiency of networks with a massive femtocell deployment, by exploiting advanced interference-aware PHY-layer techniques as a function of the quality of the IP-backhaul link.

At A Glance: FREEDOM
Femtocell-based Network Enhancement by Interference Management and Coordination of Information for Seamless Connectivity

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Duration: 1/2010 – 12/2011

Total Cost: €3.4 m

EC Contribution: €2.5 m

Funding scheme: STREP

Contract Number: INFSO-ICT-248891

Main Objectives

Increasing demand for indoor wireless high bitrate services imply rethinking system architectures. Femtocell deployment is the FREEDOM target technology

The increasing demand for mobile traffic has motivated that the near-future 4G networks must enhance their efficiency in terms of spectrum, energy and cost. The solution addressed in this project is the use of femtocells, which it is also being considered by several major mobile operators and different standards such as IEEE 802.16m and LTE-Advanced.

Many technical studies and business models elucidate the outstanding potential of femtocells in terms of increasing the network capacity, saving energy and providing benefits from the social and economic side.

However, macrocells and femtocells (connected through an IP-based backhaul link) use the same spectrum, originating major challenges of great concern for industry and operators:

- Massive deployment will pose serious issues on the radio interference management between the macro and femto access points (FAP).
- No effective approach for insuring seamless handover.
- Lack of precise engineering solutions for scalability, redundancy and traffic partitioning.
- No current guarantee that the fixed broadband connection will prioritize the traffic originating from the FAPs for a service without call blocking or dropping.
- Current access control: solutions are "open" access paradigms, whereas the "restricted"

access is needed. The mechanisms proposed so far are not optimised and difficult to handle in overlapping coverage areas.

In order to keep a strong focus and efficiency, we limit the scope of our work to a single question which is key for future femto-based network design: How much the whole system efficiency can be improved by exploiting the available quality of the IP-based backhaul link?

The activities of the project will be timely aligned with the agendas of the working groups in the standards for maximum international impact. The FREEDOM consortium expects to generate techniques and results producing valuable intellectual property rights to boost world wide competitiveness of the partners, and of the major European operators members of the FREEDOM Advisory Board.

Technical Approach

All the market trends analyses indicate that the low FAPs density scenario is not supposed to hold true in the mid-term future (2011-2012) in urban environments, where more and more FAPs will be deployed and interference, handover and scalability problems are the main concerns. Additionally, there will be also a significant increase of the number of dynamic events leading to handover requests (that could not be properly managed) as well as an increase of the number of critical users (i.e. users located and crossing the edge of the FAP-BS or FAP-FAP coverage areas). In such a scenario, FREEDOM assumes a layered deployment, leaving room for load balancing strategies (requiring mobility management support to ensure femto/macro layer handover). Moreover, the exploitation of the IP-based backhaul link is a key enabling approach that FREEDOM will exploit to devise advanced interference-aware RRM techniques.

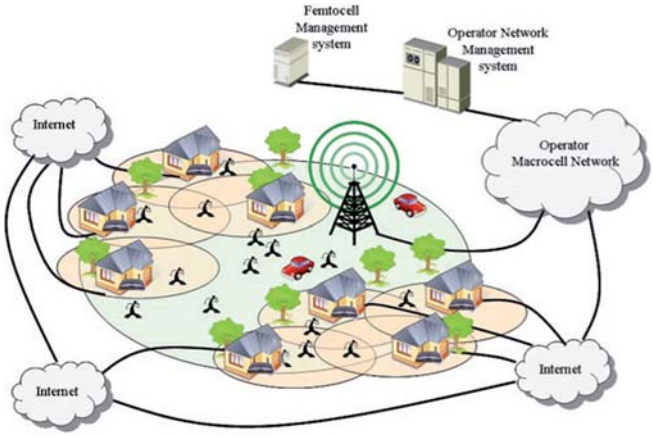
Key Issues

The core concepts investigated in FREEDOM in such a scenario are:

- Interference management and cooperation
- Dense femtocell-specific RRM and mobility support
- Scalability and effectiveness
- Femtocell-based network planning

Expected Impact

The combination of the new paradigms employed in the project constitutes a realistic and technologically viable set of solutions that enable the achievement of the targeted high



density in FAPs deployment. FREEDOM will thus benefit the at-home/office customers that will have access to higher bit rate services, dedicated advanced applications and possible cheaper tariffs policies. At the same time, the data flows routed through the ISP backbone by the FAPs will proportionally relieve outdoor macrocells of a substantial traffic load, lowering the congestion peaks and insuring better connectivity and QoS for the other subscribers. The benefits for the operators are even more significant, as the achievement of dense FAPs deployments will translate in a direct financial benefit proportional to the bandwidth routed on the ISP backhaul; in addition the possibility of offering new dedicated services for the home/office will enlarge the market segment, attracting new customers.

Beside the above, it has to be considered that serving indoor users from outdoor macrocells has a disproportionate drain on network capacity and power consumption. In this perspective, the advanced PHY techniques for interference avoidance as well as the advanced RRM employed by FREEDOM will further decrease the energy consumption and EM pollution of the whole system: topics highly impacting on the EC policies about the green issues.

The FREEDOM project targets to new concepts and techniques beyond the conventional cellular paradigm, and as such, it will benefit EU research community with respect to broader scientific knowledge to achieve higher wireless system throughput and higher spectrum efficiency. It represents an opportunity for researchers to cooperatively work on cutting-edge technologies beyond state-of-the-art.

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Generalised Architecture for Dynamic Infrastructure Services

GEYSERS - comprising partners from Italy, Germany, Switzerland, Spain, Poland, France, the Netherlands, United Kingdom, Belgium, Greece and India - equips optical infrastructure providers and network operators with a new architecture that enhances their traditional business operations.

GEYSERS
Generalised Architecture for Dynamic Infrastructure Services

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Duration: 01/2010 – 12/2012

Total Cost: €10.4 m

EC Contribution: €7.0 m

Funding scheme: IP

Contract Number: INFSO-ICT-248657

Main Objectives

GEYSERS defines and implements a novel photonic network architecture

The main objective is to enable optical network infrastructure providers to compose logical infrastructures which can be offered to network operators; network operators will then run cost-efficient, dynamic and mission-specific networks by means of integrated control and management techniques. This enables infrastructure providers, network operators and application providers to participate in new business scenarios for supporting services with complex attributes and strict bandwidth requirements. This "next generation telco service" extends the concept of cloud computing to integrate both network and IT resources; it represents a futuristic approach to the Infrastructure as a Service (IaaS) model. In GEYSERS, high-end IT resources at users' premises are fully integrated with the network services procedures, during both the infrastructure planning and connection provisioning phases.

According to this vision of the future of telecoms, GEYSERS specifies and implements a novel optical network architecture able to support 'Optical Network + Any-IT' resource provisioning seamlessly and efficiently. Energy consumption metrics for the end-to-end service routing are part of this efficiency. GEYSERS will specify and develop:

- mechanisms that allow infrastructure providers to partition their resources (optical network and/or IT), compose logical infrastructures dynamically, and offer them as a service to network operators.

This will be done overcoming the current limitations of (particularly) administrative domain segmentation.

- a Network Control Plane for the optical infrastructure, by extending standard solutions (ASON/GMPLS and PCE), able to couple optical network connectivity and IT services automatically and efficiently, and provide them in 1 step, dynamically and on-demand, including infrastructure re-planning mechanisms.

The GEYSERS outcomes will be validated in an EU-wide optical network test-bed.

Technical Approach

GEYSERS will define, develop and validate an end-to-end network architecture, based on extending standard ones, which is able to create a new planning, provisioning and (ultimately) business framework for network infrastructure providers and network operators (service providers). In this framework, the network infrastructure provider will be able to compose and offer part of its infrastructures (possibly combined with IT resources) as logical (virtual) infrastructures to network operators. Network operators will operate these logical infrastructures with Control Plane (ASON/GMPLS and PCE) technologies to offer coupled, optimized and dynamic Network+IT provisioning services (ie. interconnections between end-users and IT resources).

Key Issues

GEYSERS will introduce a new architecture that will re-qualify the interworking of legacy planes by means of a logical infrastructure representation layer for network and IT resources. This will enable a new business model where Infrastructure providers' resources are partitioned and offered dynamically, on demand, to network operators as a service.

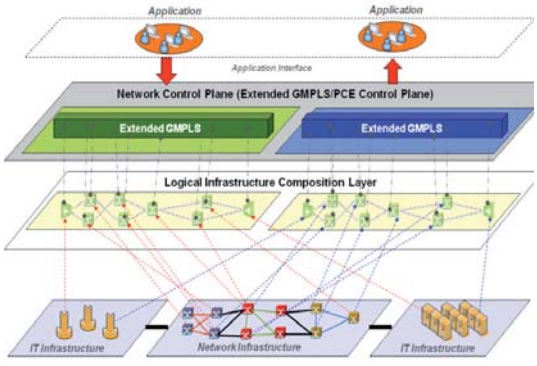
Expected Impact

Expected impact of the project with reference to the work-programme 2009-2010 are:

- to establish a breakthrough in the design and implementation of the Future Networks.
- to provide an enhanced Network Control Plane that will enable network operators to provide complex end-to-end services, by seamlessly controlling optical network and IT resources, with dynamic wavelength allocation functionalities and capabilities.
- to (re)plan infrastructure resources on demand. This will lead to an optimized cost-efficient use of infrastructures. These will be key differentiating factors in the business.

GEYSERS will:

- focus on ultra high capacity optical networks based on dynamic wavelength allocation with end-to-end service delivery capability. The



Logical Infrastructure Composition Layer (see figure) will overcome network and domain segmentation limitations. The Network Control Plane will support flexible management in a multi-infrastructure operator environment with end-to-end carrier grade performance.

- provide dedicated support for highly IT-reliant distributed mission-critical enterprise applications, by defining a Future Network architecture that enables infrastructure providers, network operators and application providers to contribute in a business model where complex services with complex attributes can be pooled.
- attract a global interest and generate considerable feedback amongst interdisciplinary stakeholders.
- contribute to global standards and European Intellectual Property. The GEYSERS consortium comprises outstanding European and International actors in the field of optical networking (both commercial and academic). They have the capability to influence standardization and generate Intellectual Property. This will reinforce the position of Europe's industry in both fields. The insights gained in GEYSERS will be used to actively collaborate and push forward the definition of new network standards. In addition, novel networking technologies will lead to patent applications to protect the Intellectual Property of the consortium members.

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Achieving Low-Latency in Wireless Communications

A key issue for which network operators are seeking solutions is that of determining applications and subsequently defining services which require very low latency and short channel acquisition times. LOLA will provide such scenarios and technologies for LTE-Advanced system architecture development and study.

At A Glance: LOLA
Achieving Low-Latency in Wireless Communications

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Duration: 01/2010 – 12/2012

Total Cost: € 4.1 m

EC Contribution: € 2.6 m

Funding scheme: STREP

Contract Number: INFSO-ICT-248993

Main Objectives

M2M is an application area of extremely high growth potential in the context of future LTE-Advanced networks.

The focus of LOLA is on access-layer technologies targeting low latency robust and spectrally-efficient transmission in a set of emerging application scenarios. We consider two basic types of wireless networks, namely long-range LTE-Advanced Cellular Networks and medium-range rapidly-deployable mesh networks. Research on low-latency transmission in cellular networks is focused firstly on transmission technologies in support of gaming services which will undoubtedly prove to be a strategic revenue area for operators in the years to come. Secondly, we also consider machine-to-machine (M2M) applications in mobile environments using sensors connected to public infrastructure (in trains, busses, train stations, utility metering, etc.). M2M is an application area of extremely high growth potential in the context of future LTE-Advanced networks. A primary focus of the M2M research is to provide recommendations regarding PHY/MAC procedures in support of M2M to the 3GPP standardization process. The rapidly deployable mesh topology component addresses M2M applications such as remote control and personnel/fleet tracking envisaged for future broadband civil protection networks. This work builds upon ongoing European research in this important area. Fundamental aspects of low-latency transmission are considered in addition to validation on real-time prototypes for a subset of the considered application scenarios. The cellular scenario validation is carried out using both live measurements from an HSPA test cell coupled with large-scale real-time emulation using the OpenAirInterface.org emulator for both high-

performance gaming and M2M applications. In addition, a validation testbed for low-layer (PHY/MAC) low-latency procedures will be developed. The rapidly-deployable wireless mesh scenario validation makes use of the real-time OpenAirInterface.org RF platform and the existing FP6 CHORIST demonstrator interconnected with commercial M2M equipment.

Technical Approach

The LOLA project aims to design and validate access-layer radio technologies on three integrated system testbeds covering the two network topologies and the two low-latency application scenarios. Studies will be carried out during the first phase (first nine months) to define the targets of the core workpackages and validation scenarios, their interfaces and their specifications. Subsequently, solutions that meet the determined requirements will be identified; making use of existing technological building blocks available to the LOLA partners. Finally, implementation and integration issues will be dealt with in order to convincingly validate the proposed technological innovations.

The project is built around six technical work-packages with a top-down approach from system overview to technological prototypes:

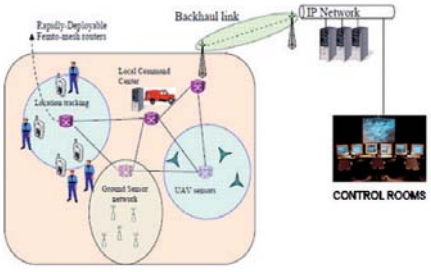
WP2 covers all system engineering aspects of the two network topologies under consideration (cellular and mesh). After defining precisely the target application scenarios to address in the project, WP2 provides system architecture and requirements for WP3 and WP4, as well as technical specifications for the three testbeds implemented in WP5. WP2 is therefore the starting point of the project allowing for a consistent approach toward common objectives, system requirements and working assumptions. It is the role of the industrial partners to lead this WP in order to guarantee a solid industrial vision regarding the application scenarios and requirements. WP3 covers the study of the traffic characteristics of M2M and gaming applications and derives models of the latter based on real-time measurements.

WP3 involves measurement and modelling of traffic patterns with regard to low-latency aspects. The outputs of WP3 are traffic models integrated into the traffic generation modules used for system performance evaluation on Testbed 1 in WP5.

WP4 covers the study PHY/MAC algorithms (AMC, traffic scheduling, HARQ) and mechanisms in accordance with WP2 requirements. In addition selected implementations will be carried out on existing real-time platforms used in WP5 for Testbeds 2 and 3 and PHY abstraction models will be developed for Testbed 1.

WP5 covers the integration of selected WP3 and WP4 technologies on three different testbeds satisfying WP2 requirements. A small-scale field trial (Testbed 3) of selected technologies will be carried out at the end of WP5.

WP6 deals with dissemination and standardization issues, which are critical in order to promote the innovations of the consortium.



Key Issues

LOLA will provide in-depth study of access-layer procedures (PHY/MAC) for next generation network infrastructures allowing for the deployment of new and highly-strategic services, namely online-gaming and M2M/ sensory communications

Traffic measurement and modelling for low-latency protocol development also plays a key role in the project for dimensioning the access network.

LOLA promotes the use of globally standardized LTE/LTE-A access networks for massive amounts of M2M sensory traffic rather than specially-deployed networks.

Focus will be on cost/bit optimizations for the huge number of potential M2M devices connected to the future internet via cellular networks.

Expected Impact

LOLA will provide input to standardization activities as well as LTE development activities by ensuring better understanding of M2M traffic and the impact of such traffic on LTE networks.

The considered technologies will allow for improved public safety services, for instance surveillance through remote controlled sensors in buildings or in vehicles operated by public transportation.

LOLA's prototyping activities will provide important contributions to the development of the open-source initiative OpenAirInterface.org

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MAINS (Metro Architectures enablINg Subwavelengths

MAINS is a STREP Project in the EU's 7th Framework Programme having as main objective to design and demonstrate a cost-effective metro network architecture based on optical subwavelength transport technologies with enhanced Control Plane capabilities allowing applications and network interworking.

At A Glance: MAINS
Metro Architectures enablINg Subwavelengths

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Duration: 01/2010 –06/2012

Total Cost: € 2.7 m

EC Contribution: € 1.9 m

Funding scheme: STREP

Contract Number: INFSO-ICT-247706

Main Objectives

MAINS proposes a cost-effective metro network architecture based on optical subwavelength transport technologies with enhanced Control Plane capabilities allowing applications and network interworking

MAINS aims to develop a pre-commercial metro-regional network architecture able to offer high scalability, survivability and cost efficiency for future services demands. The proposed architecture promises greater cost efficiency for future traffic volumes, lower resource consumption, improved reliability and lower latency, compared to current metro network architectures.

Current networks cannot efficiently support the huge growth in traffic expected in the near future. Network costs of current metro architectures strongly depend on traffic growth; the higher the traffic the higher the network costs. Therefore, new cost-effective network architectural solutions are needed in order to assure low cost broadband access and face with the huge expected traffic increase, in particular in the metro segment. The metro is impacted the most by the requirements of emerging applications (High Definition video distribution, videoconference, virtual PC, etc). The metro network architecture proposed in MAINS is based on two key technological pillars: the sub-wavelength optical switching technologies in the Data Plane (i.e. optical bursts and packets), and an enhanced GMPLS architecture in the Control Plane to extend network control to the sub-lambdas, and ease the interworking of network and IT resources. Furthermore, this architecture aims also to facilitate the introduction of new "network centric" services (e.g. Virtual PC) which combine both network resources (bandwidth) and

IT resources (content storage and computing) provided by the network operator.

MAINS is an industry-driven project which brings together the Spanish incumbent operator (Telefonica), an emerging operator from Cyprus (PrimeTel), an Irish manufacturer of subwavelength optical switching equipment (Intune), an Italian R&D SME specialized in control plane software development (Nextworks) and two major Universities (Univ. of Madrid and Univ. of Essex) with wide experience in subwavelength optical switching and service to network interworking.

Technical Approach

The MAINS technical activities are organised into the following Work Packages:

- WP1 "Network and service requirements, industrial application and standardization", which deals with the metro network requirements and techno-economic analysis to implement network-centric application awareness in optical networks and its standardization.
- WP2 "Metro architectures exploiting optical packet/flow switching", which is devoted to the control plane specification in support of sub-wavelength switching in metro ring and mesh architectures.
- WP3 "Control Plane and Service Development", which implements prototypes for the interface between the service and network layer and the extended GMPLS control plane.
- WP4 "Experimental validation of MANS concept", which validates the outcomes of the aforementioned WPs in laboratory testbeds and field trials.

Finally, all the activities related to the outreach dimension and management are handled in WP5 "Project Management".

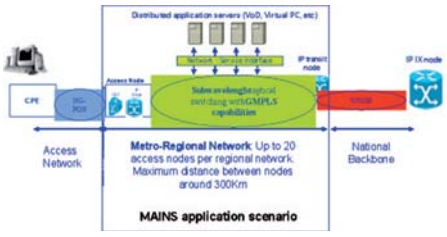
Key Issues

Key issues that MAINS is expected to tackle can be summarised as follows:

1. Cost-effectiveness: MAINS results will be based on techno-economic analysis to be reported in WP1 deliverables and dissemination papers.
2. Innovation: MAINS proposed architectures are based on the combination of innovative data and control plane solutions:
   - Data Plane: The key is the use of sub-wavelengths (bursty time-shared use of a single wavelength) by building an architecture based on dynamic time-shared use of ultra-fast tunable components and optical burst switching systems.
   - Control Plane: MAINS solutions are based on GMPLS extension for sub-wavelength granularity, together with the XML interface for flexible (cross-technology) transport resource configurations.

The MAINS architectural designs will be reported in WP2 deliverables and dissemination papers.

3. Standardization: MAINS contributions to standards will be reported in several WP1 deliverables. One of the project objectives is the control plane standardization (e.g. GMPLS extensions for sub-lambda granular networks). The main targeted SDOs are the Internet Engineering Task Force (IETF, in particular the Common



Control and Measurement Plane and Path Computation Element Working Groups) and the Open Grid Forum (OGF, in particular the Network Service Interface and Grid High-Performance Networking Working Groups).

4. Implementation of metro network prototypes comprising the innovative data and control plane solutions designed in the project. In particular, software (control plane, network-service interface…) and hardware implementations (OPST, OBST nodes) will be delivered by WP3 and WP4.
5. Validation and demonstrations of the proposed architecture: In particular, the MAINS experimental activities to be done in WP4 will be carried out over a lab as well as over a field trial in Cyprus which will demonstrate a virtual PC application over the MAINS architecture.

Expected Impact

- Strengthened European position in the development of the Future Internet. The MAINS solution will allow easy service deployment in the metro domain, and will enable network operators to take a large stake in the introduction of Future Internet services.
- Reinforced European leadership in developing highly flexible and scalable optical networks that enable a real synergy between network, service and content providers.
- Increased economic efficiency of access/transport infrastructures (cost/bit): MAINS aims to design cost-effective metro network solutions able to face with the expected traffic increase in a more scalable way than current IP-based architectures
- Control plane standards for sub-lambda granular networks;
- Wider market opportunities from new services: MAINS proposed architecture enables portable and high quality network centric services with a minimum of cost (e.g PC virtualization services).

Accelerated uptake of the next generation of network and service infrastructures. The industrial partners in MAINS can guarantee the exploitation of the project results and provide the motivation to develop and deploy the concept of MAINS.

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MONET – Mechanisms for Optimization of hybrid ad-hoc and satellite NETworks

MONET will investigate solutions to the end-to-end optimization of resource management in a hybrid MANET-Satellite network with the objective of optimizing link availability and reducing cost and energy. The team is composed of entities from Portugal, Italy, United Kingdom, Spain, France and Slovenia.

At A Glance: MONET
Mechanisms for Optimization of hybrid ad-hoc and satellite NETworks

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Duration: 01/2010 – 06/2012

Total Cost: € 3.6 m

EC Contribution: € 2.4 m

Funding scheme: STREP

Contract Number: INFSO-ICT-247176

Main Objectives

MONET will consider end-to-end as well as local optimization on each segment

The concept of a hybrid MANET-Satellite network is a natural evolution of considering the problem of providing local and remote connectivity in a highly mobile, dynamic and often remote environment.

This combination raises significant challenges in terms of optimising network resources, link availability, providing Quality of Service (QoS) and Quality of Experience (QoE) and minimizing costs and energy. Issues such as the re-organisation of MANET to connect to satellite access points, re-organisation of the satellite access points, selection of which satellite access points to use, the use of satellite as a relay between two MANET, the adjustment of routing in accordance with the current network situation and the exchange of cross layer information to improve resource management will be investigated in MONET.

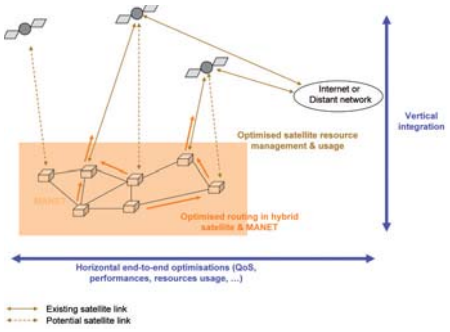
Expected achievements and innovations

- Optimised resource management and usage in the overall system. End-to-end optimised mechanisms are considered as well as local optimisation on each segment.
- Routing Decisions taking into account satellite links, as well as other parameters (e.g. energy consumption, link quality)
- Taking into account of the specificities of the satellite segment in the wireless network routing decision.
- Managing the satellite resources in coherence with the MANET network topology and traffic.
- Enabling end-to-end (from the user point of view) QoS or management resources mechanisms.

- Providing broadband services through an integrated hybrid satellite-MANET network, seamlessly for the end-users.

Technical Approach

The first step in understanding such hybrid networks and associated challenges, is the perception of the possible applications and uses for these types of networks. This will be achieved through the study of a set of scenarios and development of a concept of operations for the network (WP2). Next, in order to understand the complexity of these heterogeneous, dynamic and distributed environments, the MONET team will investigate protocol, functional and network architectures using complementary top-down and bottom-up approaches (WP3). The most promising investigated mechanisms and solutions (WP4) will be developed (WP5), implemented (WP6) and subsequently validated through a field exercise representing a real life application (WP7) in Spain.



Key Issues

The movement of nodes that form a mobile ad-hoc network makes it likely that some partitions may occur in the wireless network without connectivity among them. Both geostationary/non-geostationary satellites can be envisaged as a "range extension" network. The challenge of how to provide connectivity between nodes in the same ad-hoc cluster; between nodes belonging to different ad-hoc networks with the added possibility of nodes using different equipment or technologies is an important one. The MONET approach proposes to address this through the investigation of mechanisms for the re-organisation of the MANET to connect to the access points on one hand, or the re-organisation of the access points themselves.

In multiple satellite and fixed backbone links within a MANET, the issues of how to organise them, choose between them, provide a higher QoE, minimize communication costs, minimize energy consumption to ensure higher network life become important ones. All of the issues mentioned above are closely related to routing, or how to adjust it in accordance with the current network situation, the availability and characteristics of internet links, and the network usage requirements.

The lack of infrastructure often dictates the uses of distributed network management. However, the use of the satellite access links may require a centralized management entity that manages the access points and their organization and hand-overs between them. Therefore, the investigation of centralized versus distributed or mixed network management & re-organisation as well as determination of decision mechanisms (manual or automatic) constitutes another challenge to address. Other issues such as the connection/disconnection of satellite access points as well as the choice of satellite access points (horizontal handover) are counted among the key questions.

Expected Impact

The accomplishment of the proposed objectives will bring noteworthy added value to specific application scenarios (some of them well known as MANET applications):

- Providing remote access and broadband to rural or remote areas (helping to bridge the digital divide; collaborative work and e-business; everyday operations of large field teams; health services and telemedicine);

- Providing on demand connectivity to Airports and aircraft;
- Public Safety (providing emergency communications during/after disasters; forest fires, floods and earthquakes and coastal monitoring);

Additionally, the approach proposed by MONET will provide a wide set of economic benefits that can be summarized in four main points:

- Communications cost optimization;
- Network setup and restructuring acceleration;
- Cost efficient communications for remote or isolated areas;
- Increased performance, efficiency and resilience for hybrid networks.

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OASE Optical Access Seamless Evolution

The OASE Integrated Project will examine Fibre-to-the-Home (FTTH) within a multi-disciplinary study to provide a self-consistent and coherent set of technological solutions. The OASE project federates partners from all over Europe and is composed of major operators, industrial leaders in FTTH technologies, and European universities.

At A Glance: OASE
Optical Access Seamless Evolution

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Duration: 01/2010 – 12/2012

Funding scheme: IP

Total Cost: € 7.6

EC Contribution: € 4.9 m

Contract Number: INFSO-ICT-249025

Main Objectives

More access, more social interactions between people and enhanced communication-media diversity

The aim of the OASE project is the assessment and development of next-generation optical access (NG-OA) network architectures and systems concepts for the "2020" timeframe, focusing particularly on European requirements. The OASE project will examine FTTH solutions based on four multidisciplinary approaches: regulatory, technical and financial aspects, and business models. In combination with these aspects, NG-OA network architectures will be developed featuring the highest potential of enabling:

- ≥ 1 Gbit/s per customer
- ≥ 1000 customers per fibre feed
- ≥ 100 km transmission distance at economically competitive prices within a well-regulated and open market environment.

OASE will achieve the following objectives:

- Study current and future requirements for NG-OA networks from economic, business, operational and regulatory Europe-centric perspectives,
- Identify possible network architectures, and employ a set of energy-efficiency metrics and models to analyse their suitability, as well as assess the most appropriate migration strategies,
- Identify network technologies that may be employed by using relevant cost and technical factors,
- Examine the interactions between businesses in an "open network" marketplace by studying how increased convergence may offer new value chains and business opportunities,

- Validate the findings of the comparative merits for the identified network architectures and technologies in a controlled environment via experimental testing.

Technical Approach

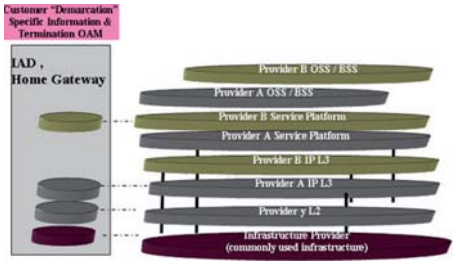
The aim of the project is to address in a coordinated way all aspects of NG-OA networks: architectures, technical aspects, feasibility, techno-economic issues, business modelling, and regulation. WP2 and WP3, which respectively examine requirements and architectures, are the core WPs around which the other WPs interact:

WP2 will identify technical, economic, operational and regulatory needs, and will also serve to establish a basis for broad acceptance in the operator and vendor communities.

WP3 will review existing optical access network architectures, propose novel solutions, and then evaluate them in terms of complexity, reliability, performance, resource allocation, and energy consumption etc.

WP4 will develop new system concepts based on existing and new technical solutions defined by WP3, taking into account migration scenarios.

WP5 and WP6 will closely interact together to perform the following: WP5 will provide the techno-economic modelling of CapEx/OpEx for the identified solutions and the assessment and analysis of the scenarios; WP6 will perform business modelling, and also consider regulatory impact on the final business models.



WP7 will take inputs from all WPs and perform experimental validation via extensive laboratory testing for the identified solutions.

The impact of the project including: standardisation, dissemination of the results within the industry through the creation of an industry board, industry events and workshops, and publications, will be ensured by WP8. The project includes major vendors and operators who will also ensure relevant standardisation and exploitation of the results.

Key Issues

The OASE project addresses 5 key issues:

- Open Access – open interfaces, enabling the simple and easy use of third party infrastructure, clear definitions of services and their quality, and operational responsibilities.
- Appropriate technologies for NG-OA, which will enable easy interconnection on the one hand, as well as reliable and fast "zero touch" re-connection between different network providers on the other hand.
- Network consolidation: reduction of locations due to the use of optical technologies has to be consistent with the open networks / open access model, and also has to provide the required high resiliency.
- Investigate optimal technical solutions that support increasing bandwidth demand (≥1 Gb/s per customer), a high customer number, and long distance transmission.
- Develop a European solution that allows easy migration from legacy FTTH/B solutions to NG-OA networks.

Expected Impact

The OASE project through its numerous realisations will:

- Provide a cost-effective optical fibre deployment solution, including OpEx, to enable benefits from the ICT world to be fully exploited,
- Reinforce European industry capability in next-generation NG-OA technologies,
- Increase European influence in next-generation optical access standardisation,
- Provide new business case solutions, enabling the resolution of remaining bottlenecks in access network deployment,
- Significantly reduce OpEx and CapEx for each stakeholder by encouraging co-operation amongst the different market players ,
- Enable a faster and more flexible roll-out of optical broadband access infrastructure,
- Ensure substantial industrial back-up and long-term recommendations,
- Enable the resolution of remaining bottlenecks to make Gb/s access bandwidths truly available and affordable to the citizens of Europe.

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Quality of Service and MObility driven cognitive radio Systems

QoSMOS is about opportunist spectrum access, with managed QoS and mobility. Value chain development, spectrum portfolio management, integration with core networks, flexible terminals and demonstration are the main ingredients. The use of TV White Spaces is an early opportunity to exploit the outcome of the project. The consortium for this 3-year IP includes service providers, manufacturers, systems integrators, a test equipment manufacturer and the best research institutions and universities. NEC Japan has joined the consortium without funding, the first time they have been engaged in an EC project.

At A Glance: QoSMOS
Quality of Service and Mobility driven cognitive radio systems

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Duration: 01/2010 – 12/2012

Total Cost: € 15.5 m

EC Contribution: € 9.4 m

Funding scheme: IP

Contract Number: INFSO-ICT-248454

Main Objectives

The top-level objective of the project is to provide a platform for efficient radio access to future networks. Under this objective are two scientific and technical (S & T) objectives and two non S & T objectives. The two S & T objectives are cognitive wireless access provision and network support provision. The two non S & T objectives are use case development and preparation of regulatory policies.

The drivers for the project are a general dissatisfaction of customer experience with mobile broadband, coupled with a shift in spectrum regulation. At present there are two ways that a user may obtain mobile broadband services, one is using a mobile network operator (MNO) who employs licensed spectrum and the other is to use a fixed network operator with unlicensed spectrum on a WiFi service. In the first case, the customer experience is determined by the QoS policies and cell planning of the MNO and is better outdoors. In the second case the customer experience is largely determined by the density of WiFi access points in the locality and the experience is better indoors. Initiatives by both types of operator have emerged to improve the coverage from different directions – the MNOs are introducing femtocells to improve indoor coverage and the fixed operators are increasing outdoor coverage through the use of hotspots and systems like FON.

The shift in spectrum regulation, by the national spectrum agencies, is to move away from the

binary choice of licensed or unlicensed, by including a third option which is secondary use of spectrum. This is where network operators can use, for free, spectrum that is licensed to users such as broadcasters, if it can be proven that such use does not cause interference to the licensed (or primary) users. QoSMOS plays into this space – by providing a framework to allow secondary use of spectrum to provide indoor and outdoor broadband mobile communications – and opening up an alternative to either schemes currently used by MNOs or fixed operators. An early opportunity is the use of TV White Spaces in the UHF bands.

QoSMOS is driven largely by industry, to provide a long term solution to ever-increasing data demand and the ever-decreasing willingness for users to pay for it. The framework will encourage new service providers to enter the marketplace, allow networks to grow as they are needed and will have the flexibility to allow custom application development. Coverage will be provided by a large number of small and flexible base-stations in the same way as MNOs are talking about for LTE. The beneficiaries of QoSMOS are several: the end user, who will have a better experience; the network operator who will have access to large amounts of radio spectrum for free; the entrepreneurial service provider and application developer who will have a flexible and efficient delivery platform and the vendors who will have new markets.

Doing this work on a European scale offers several advantages. First, the companies involved form a critical mass of effort and bring several use-cases to the project so that the benefits are felt widely. Second, the regulatory conditions in the various countries are different but with common traits – such as the requirement to avoid harmful interference – and the framework being developed by QoSMOS allows fine-tuning for the different regulatory regimes.

The achievements expected are a framework and development of key technologies as outlined above. Standards support is being set up from the beginning, with an ETSI RRS work item and early contributions planned to IEEE 802.21 and 802.22. This is being done to ensure standards acceptance and development from the beginning. Proof of concept of the key technologies and guidelines for deployment will be provided in the final year of the project, enabling products to reach the market roughly one year after the project end.

Technical Approach

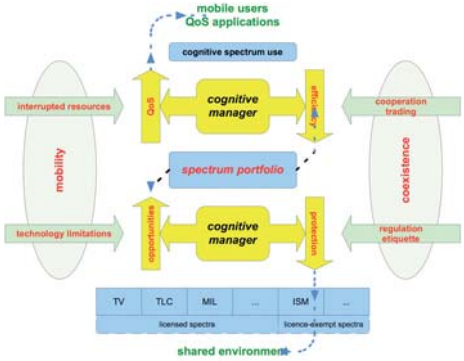
The approach starts with use-cases that are generated by the industrial members of the consortium. The initial use-cases are the connected home, rural broadband connection, coverage of the street, smart metering, cellular extension and public safety. Workpackage 1 is developing these use-cases and continues to work them through the value chain analysis as the project progresses. Workpackage 2 takes the use-cases and provides designs and specifications for the system architecture. Radio environment sensing and mapping, one of the key technical challenges, takes place in Workpackage 3. Workpackage 4 will perform research to arrive at best designs for terminals; software defined, highly flexible, low complexity, low power consumption and low cost. Workpackages 5 and 6 form a two-step cognitive process for managing the spectrum (see concept diagram). First, Workpackage 6 will develop a management method for spectrum portfolio management, probably done centrally. From this portfolio, techniques to be developed in Workpackage 5 will allocate radio resources to individual links, probably done in a distributed fashion. This two-step process is considered key to gaining high efficiency in spectrum management. Workpackage 7 is concerned with building test-beds and simulations to prove the key technologies. Workpackage 8 is about

exploiting and disseminating results and it is here that the standards work is performed, as well as the interactions with the EAB. Finally, Workpackage 9 is management of the project.

Key Issues

The key issues that the project will tackle are:

- sensing, database and other methods of avoiding interference from secondary users to primary or other secondary users,
- developing metrics for spectrum occupancy for decision making and micro-trading,
- development of QoS and mobility management in cognitive radio and integration with core networks
- researching best methods for cognitive radio terminal designs,
- spectrum portfolio management



QoSMOS concept

Expected Impact

The impact will be the availability of a viable alternative mobile broadband delivery platform which is low-cost, has QoS management and can support mobility. Downstreaming of the results will be via the External Advisory Board (EAB) that consists of European regulators, broadcasters and other bodies, via ETSI, and via any new bodies that will be set up, such as a European cognitive co-ordination body similar to CogNeA in the USA. Through the EAB, European regulators will be prepared for the commercialisation of opportunistic use of spectrum.

The project will provide the necessary framework and critical technical building blocks to enable actors in the value chain, from vendors to applications providers, to differentiate themselves and bring CR systems to market.

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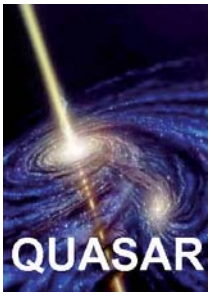
Quantitative Assessment of Secondary Spectrum Access



The overall objective of the QUASAR project is to remove the "hype" from Cognitive Radio and Dynamic Spectrum Access discussion and replace that with clearly justified facts and quantified spectrum opportunity models that can be used to make real business and deployment decisions.

At A Glance: QUASAR
Quantitative
Assessment of
Secondary
Spectrum Access

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Duration: 01/2010 – 06/2012

Total Cost: € 5.0 m

EC Contribution: €2.9 m

Funding scheme: STREP

Contract Number: INFSO-ICT-248303

Main Objectives

QUASAR assesses and quantifies the "real world" benefit of secondary

The need for the radio spectrum for the rapidly growing broadband access services is evident. Abundant and fast access to spectrum has three main advantages: it fosters rapid innovation in wireless systems and services lowering entry barrier on the market; it enables affordable mobile broadband access to all; and it makes new energy efficient wireless systems possible.

Secondary use of already licensed, but inefficiently used spectrum, (Cognitive Radio) has been proposed as a solution to make more efficient use of the spectrum. Low spectrum occupancy in a number of measurement campaigns worldwide has been the basis for claims of large gains in spectrum efficiency by cognitive radio. However, little research has been done to substantiate these claims. The QUASAR project aims at bridging this gap between the claims made in conventional cognitive radio research and practical implementation by assessing and quantifying the "real-world" benefits of secondary (opportunistic) access to primary (licensed) spectrum.

The specific objectives of QUASAR project are:

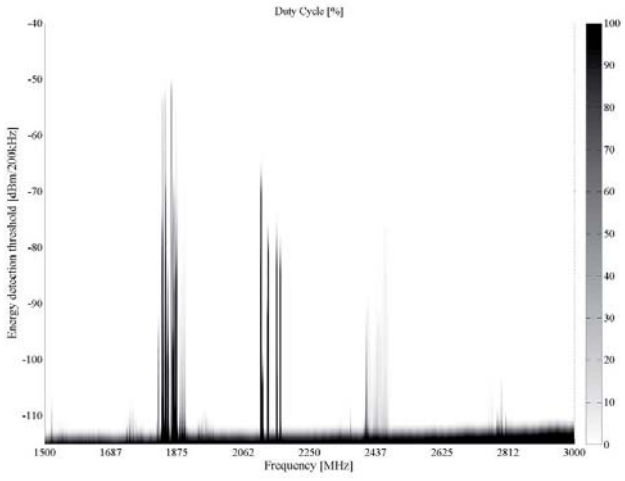
- investigating the impact of opportunistic spectrum access on primary system performance, especially as a function of primary system receiver requirements.
- moving the community from "detecting spectrum holes" to the regime of "discovering 'real' spectrum opportunities."
- developing detailed methods to assess the impact of multiple secondary users.

- multi-parameter and utility based assessment of value of spectrum (opportunities).
- providing detailed roadmaps and guidelines on how to apply and analyze new opportunistic spectrum access business models.
- providing specific and reasoned proposals to go beyond the current regulatory framework and to cover the whole value-chain inspiring interaction between all stakeholders and regulators.

Technical Approach

The QUASAR project is broken down into six work packages (WPs). WP1 has two stages – the first task is to define the models, scenarios, performance measures and to make initial proposals for a number of secondary spectrum access regimes that are to be studied in the project. A key line of investigation in the project is about establishing the technical, business and regulatory feasibility of the secondary access regimes. The assessment of the business impact of the proposed schemes, and the regulatory feasibility is done in the remainder of WP1.

Work packages WP2-4 study three key issues that will determine the technical feasibility and performance of the proposed schemes. WP2 introduces the concept of spectrum opportunity discovery and will estimate the performance of secondary access with respect to various methods to determine the possibility to fit the secondary link into the spectrum, space and time constraints given by the primary users.
WP3 studies the impact of the performance of the primary system, in particular the capabilities of the primary receivers to withstand secondary interference both inchannel as well as in adjacent channels. Both current primary systems (ignorant of potential secondary use) as well as future systems, designed to withstand various amounts of secondary interference.
Unlike most previous studies, which analyze the behaviour of a single secondary user accessing the primary's spectrum, WP4 studies schemes for and interference impact caused by secondary multi-access, i.e. when several secondary users access the spectrum in a cooperative or non-cooperative way. Besides analyzing the feasibility of the various proposed secondary access regimes, WP2-4 will have the common objective to provide models and tools for the performance evaluation.
These methodologies and tools provided by WP2-4 will be put together in WP5. They will be developed and integrated into a toolbox



for quantitative assessment of the spectrum availability and achievable performance of secondary access. This assessment will be done both with respect to traditional capacity measures as well as using user utility base performance measures. The tools are demonstrated by assessing the performance of the proposed schemes in the scenarios defined in WP1.
WP6 finally deals with the dissemination of results with focuses on two items – technical publications and input to regulatory bodies. The toolbox used for spectrum availability assessment (or parts of it) is also made publicly available on the project website.

Expected Impact

Together with other European Projects in the area QUASAR is re-positioning Europe to the forefront of cognitive radio research. As some of the competing economies, most notably the USA through FCC decisions, have started to work on dynamic spectrum access and cognitive radio technologies, it is imperative for European industry and community to build a cohesive policy framework and business model to ensure competitiveness. It should be noted that developing only technology advances or pure standardization alone will not necessarily ensure commercially viable exploitation and success, as has been learn from recent history. The European industry position is strengthened by moving it to the forefront of new spectrum use concepts.

QUASAR will provide a comprehensive analysis of the techno-economical environment and provide detailed roadmaps and guidelines on how to apply and analyze new opportunistic spectrum access business models. The project will finally provide specific and reasoned proposals to go beyond the current regulatory framework. A balanced project team will provide results of high scientific quality and strong impact on the regulatory process and wireless business.

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Spectrum and Energy efficiency through multi-band Cognitive Radio

SACRA addresses the implementation of a multi-band cognitive radio technology for spectral and energy-efficient broadband communications and targets, as major outcome, a proof-of-concept.

At A Glance: SACRA
Spectrum and Energy efficiency through multi-band Cognitive Radio

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Duration: 01/ 2010 – 12/ 2012

Total Cost: € 5.95 m

EC Contribution: € 3.77 m

Funding scheme: STREP

Contract Number: INFSO-ICT-249060

Main Objectives

The innovation brought by SACRA is in the combination of advanced hardware design with new cognitive radio algorithms to be integrated into a demonstrator platform.

Energy efficiency and flexibility in the use of radio spectrum are two major research challenges for the development of future wireless communications technologies. To address these challenges, SACRA project is designing and implementing a multi-band cognitive radio technology for future broadband communication devices.

SACRA develops a cognitive radio technology that is able to perform an optimal joint resource allocation on two separate frequency bands of the radio spectrum. The objective is to distribute the user data flows in an optimal way, based on measurements of radio spectrum occupancy and other inputs of interest. To support such cognitive operation, an advanced hardware platform is needed: SACRA addresses jointly these different aspects in one project to guarantee a coherent system approach towards a target scenario of interest defined at the beginning of the study. The innovation and impact brought by SACRA project are therefore in the combination of innovative approaches on radio frequency front-end and base band components design with new cognitive radio algorithms integrated into a single demonstrator platform.

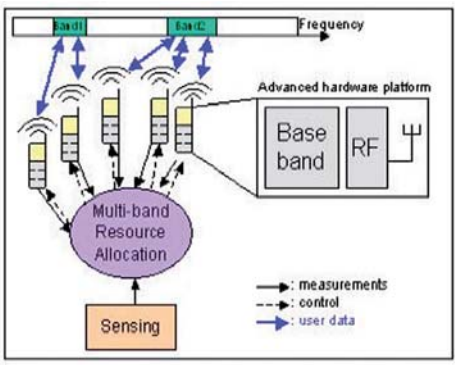
The main SACRA objective is to develop this demonstrator in order to validate the complementary enabling techniques designed for cognitive systems to increase the overall system gain (throughput/power compromise), especially for IMT-advanced target. The

demonstration is scheduled in 2012 and will be a major technical achievement as well as a valuable tool to promote the SACRA approach. Operators, manufacturers and regulators will be invited to workshops where SACRA partners intend to demonstrate a cognitive radio network based on the SACRA platform including wideband RF power efficient solutions for dual-band communications and spectrally efficient radio resource management compared to state-of-the-art technology. The resulting SACRA platform should be able to communicate in real-time, over the air, with a real IP application on top of the protocol stack. Finally, the SACRA platform will be proposed to address the next challenges in the wireless communications domain.

Technical Approach

In SACRA project, the technical approach consists first in the definition of a target scenario for the study, in the specification of global system requirements (architecture, target figures, characteristics) and in the definition of working assumptions, parameters and hypothesis (WP1).

Based on this common framework, the different enabling techniques are studied and beyond-state-of-the-art solutions are proposed. WP2 addresses the sensing and access techniques



and especially advanced space-time frequency polarization coding schemes. WP3 is dedicated to the radio resource management and provides interference management and allocation techniques for multi-band operation. WP4 addresses the design of antenna and radio frequency parts: integrated RF receiver front-end and versatile ADC, compact multi-band dual polarized multiple antennas, architecture for an integrated RF transmitter, DAC and power amplifier pre-distortion. WP5 will address the flexible base band design by providing a framework for embedded software design and validation. All these studies will allow to finally form a compound system integrated in a single platform, to be validated and tested in the scope of WP6. In WP1, the system specifications will be refined along the project, taking into account the results achieved in the enabling techniques related studies. WP1 will finally provide a recommended system definition, with associated techno-economical study.

Dissemination of the project results, especially through workshops and proposals to standardization is addressed in WP7.

Key Issues

Cognitive radio aims at improving the way the radio spectrum is used. Today's approach is based on dividing the spectrum into small pieces, each for a specific purpose. Since the applications use their spectrum to a limited extent, this leads to the unwanted situation of under-utilization of this scarce radio resource. As radio communications needs grow constantly, the current approach is reaching its limits. Consequently, cognitive radio and dynamic spectrum allocation are becoming key technologies and key research activities in the field of wireless communications.

SACRA addresses this key issue by proposing a system approach based on both innovative

algorithms and advanced hardware components to support flexible communications on several bands, allowing an optimized use of the radio frequency spectrum in the considered bands.

Expected Impact

The cognitive radio concept is expected to become the most important technique able to improve the efficiency of the radio spectrum use and a key enabler to support the Future Internet. It will represent a crucial technology on the way to future high-capacity wireless communications networks, and thus major impacts are expected. Jointly with other European projects on cognitive radio related topics, SACRA will help to support a European leadership in the area of wireless technologies.

SACRA will support energy efficiency and flexibility in the use of spectrum resources, which are major research challenges for future wireless communications, as highlighted by the European Commission Work Programme.

As SACRA is addressing both the study and the design of hardware components to support the cognitive radio approach, it will provide key technology close to a product for coming wireless devices. Considering the crucial need for wireless technology to cover the growing capacity demand, wide market opportunities can therefore be foreseen.

In order to make applicable the concept of cognitive radio, the findings of SACRA will provide inputs to standardization groups (3GPP Release 10+, IEEE SCC41, ETSI RRS and follow-up). The project will thus contribute to the development of global standards for future networks. SACRA outcomes, and especially the demonstrator, will also be of interest for regulation bodies, as they will help them to build new regulation policies according to what is technically feasible with future wireless technology based on cognitive radio concept.

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Spectrum Aggregation and Multi-User MIMO: Real-World Impact

SAMURAI is focused to tackle the challenge of next generation telecommunication systems using multi user MIMO and aggregated spectrum techniques. SAMURAI will push the state of the art by marrying MU-MIMO and SA to achieve a quadruple increase in system capacity.

At A Glance: Samurai
Spectrum Aggregation and Multi-User MIMO: Real-World Impact

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Duration: 01/2010 - 06/2012

Total Cost: € 4.0 m

EC Contribution: €3.1 m

Funding scheme: STREP

Contract Number: INFSO-ICT-248268

Main Objectives

MU-MIMO and Spectrum Aggregation are important challenges in the improvement of spectrum efficient radios for future telecom systems

The SAMURAI project will propose innovative techniques in the area of Multi User –Multiple Input Multiple Output (MU-MIMO) and Spectrum Aggregation (SA). The main novelty of the approach adopted in the SAMURAI project is to pay a particular attention to the practical implementation and deployment aspects. The consortium has a strong industrial focus. The constraints from real life system implementation will be taken into account, from the design of signalling needed to support these schemes to hardware/software implementation issues. Further, the SAMURAI project will demonstrate MU-MIMO and SA on real-time testbeds.

In particular, the following measurable technical objectives will be achieved:

Development of a system level simulation tool This tool will model the impact of MU-MIMO and SA on capacity, average user performance etc., taking into account imperfect Channel State Information (CSI) and limited feedback;

Development and assessment of innovative MU-MIMO schemes, investigating practical implementation trade-off, especially with respect to the implementation and signalling constraints on the terminal side;

Development and assessment of SA schemes, from the practical implementation perspective (hardware and software) and including practical system considerations, such as signalling to

cover the multiple bands, reduction of overhead by considering primary/secondary carrier mechanisms;

Development of proof-of-concept (PoC) prototypes, covering a selection of MU-MIMO and SA techniques. Hence, the SAMURAI project will demonstrate on prototypes the feasibility and the performance of those two key technological enablers of next generation broadband wireless systems, thus accelerating the transfer from research to market. Public demonstration based on these prototypes will be organised by the project.

Technical Approach

The project technical approach can been divided into 4 main step/phases:

- Start at system level with simulation tools with the development of algorithms for MU-MIMO and spectrum aggregation techniques in ideal conditions;
- Increase the constrains in the simulator to reflect more realistic environment;
- Implement the most promising algorithms on the SAMURAI testbed
- Obtain feedback from the test bed to upgrade the system simulator;

The system level simulations will first allow the to assess the gain of the MU-MIMO and SA techniques in ideal conditions. This will enable the identification of boundary conditions. A first selection of the algorithms for implementation will occur.

Once the ideal performance and boundaries have been identified, more constraints will be added to the system studies such as implementation cost and feasibility of the developed solution, CSI cost, scheduling aspects. This enhancement will lead to a quality improvement of the system level studies considering more realistic deployment scenarios and operating conditions of broadband systems.

The most promising algorithms developed will be implemented, validated and measured and ready for the integration into the SAMURAI testbed. Most of the testbed activities will be based on Eurecom's OpenAirInterface platform (www.openairinterface.org), an open-source hardware/software development platform for experimentally-driven research for fourth generation wireless systems.

Finally the SAMURAI integration takes place and the system simulator is upgraded so it can take into account the results obtained after the technology demonstrator has been realised. This will be achieved by the end of the project.

Key Issues

For MU-MIMO, the SAMURAI project we will push the state-of-the-art schemes that are robust to channel estimation errors, feedback delay and other system imperfections. In this way MU-MIMO systems will become more practical and more feasible to implement. Fundamental insights in the trade-off between feedback and receiver complexity as well as between feedback and link QoS (Quality of Service), allowing operators to better tune their networks will be obtained. Last but not least we expect that the project there will contribute to a better understanding of the practical effects of the wireless channel on the MU-MIMO transmission systems.

With respect to the SA, key issues addressed by SAMURAI will be related to the PHY and link layer and how to have a practical implementation of it.

Finally, the combination of SA and MU-MIMO will be addressed, offering the boost of performances for the entire future telecom systems.

Expected Impact

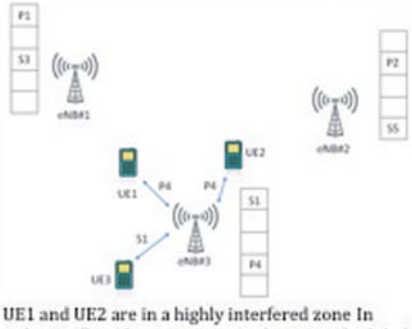
SA and MU-MIMO will be techniques that contribute directly to the cost, energy and spectrum efficiency objectives.

Spectrum efficiency is maximized through optimization of the spatial multiplexing at multi-user level. Moreover, the SA building block enables the simultaneous use of several single bands of spectrum thus maximizing efficiency.

Energy efficiency is also a major target for SAMURAI. By conducting a multi-antenna multi-user optimization with the help of CSI at the transmit side enables an optimal usage of the available transmission time/frequency and power resources.

Cost efficiency is achieved by the low-complexity constraint imposed for the algorithms design.

The impact of the project is also expected at multiple levels such as dissemination, IPR (Intellectual Property Rights) creation, standard supporting activities, participation to trade show and training activities.



UE1 and UE2 are in a highly interfered zone In order to allow them to transmit they are scheduled in the same frequency band through MU-MIMO, while UE3 is scheduled in the less interfered band S1, given its spatial position.

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SAPHYRE - Sharing Physical Resources Mechanisms and Implementations for Wireless Networks

This is our vision: (i) to show how voluntary sharing of physical and infrastructure resources enables a fundamental, order-of-magnitude gain in the efficiency of spectrum utilisation; (ii) to develop the enabling technology that facilitates such voluntary sharing; and (iii) to determine the key features of a regulatory framework that underpins and promotes such voluntary sharing.

At a glance: SAPHYRE
Sharing Physical Resources – Mechanisms and Implementations for Wireless Networks

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Linköpings universitet (SE),
Telecom Italia (IT),
TNO (NL),
Technische Universität Ilmenau (DE),
Wrocławskie Centrum Badań EIT+ (PL).

Duration: 01/2010–12/2012

Total costs: €5.3m

EC contribution: €3.8m

Funding scheme: STREP

Contract number: INFSO-ICT-248001

Main Objectives

SAPHYRE paving the way for paradigm change from exclusive resource allocation to voluntary physical resource sharing

In current wireless communications, radio spectrum and infrastructure are typically used such that interference is avoided by exclusive allocation of frequency bands and employment of base stations. SAPHYRE will demonstrate how equal-priority resource sharing in wireless networks improves spectral efficiency, enhances coverage, increases user satisfaction, leads to increased revenue for operators, and decreases capital and operating expenditures.

SAPHYRE aims at developing new approaches to make better use of the spectrum resources that are available for mobile communication services. Development will be focussed on new principles and enabling technology for resource sharing in wireless networks, specifically for sharing of spectrum and infrastructure.

The main topics emphasised in the SAPHYRE project are: Self-organising infrastructure sharing, new adaptive spectrum sharing models, efficient autonomous co-ordination, and high spectral efficiency.

SAPHYRE will develop modern and novel physical layer techniques, including network and interference aware modulation/coding, multi-antenna, spatial scheduling, multi-hop, and relay co-operative transmission, leading to a high spectral efficiency for wireless communications.

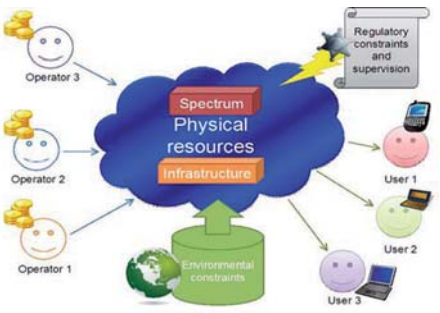
The common background is that different users can all gain from a collective approach, if they

voluntarily share the spectrum between them. But also operators will earn increased revenue by spectrum and infrastructure sharing due to a higher quality of the services they can offer. Furthermore, the SAPHYRE project will show how the different options for making more efficient use of spectrum resources will fit within the regulatory frameworks as they currently exist and recommendations will be made assisting ongoing regulation processes, which changes in the regulatory framework would be required or beneficial in order to provide optimal opportunities for the identified innovations.

Key Issues

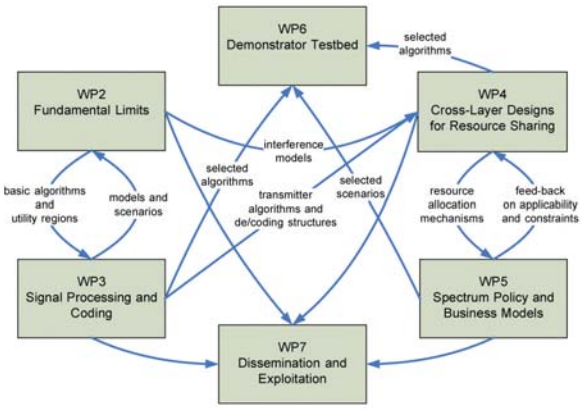
SAPHYRE's main objectives are listed in the following and they are conceptually illustrated in the figure below:

1. SAPHYRE will analyse and develop new adaptive spectrum sharing models by a generalised cross-layer and crossdisciplinary approach.
2. SAPHYRE will propose and analyse efficient co-ordination mechanisms which require as less regulation as possible (to counteract selfish, malicious users). In particular in sharing scenarios, incentive based design is applied in order to reduce regulatory complexity.
3. SAPHYRE will develop a framework for infrastructure sharing to support a quality of service (QoS) with sufficiently wide carrier bandwidths and competition between different operators.
4. SAPHYRE will develop modern and novel physical layer techniques, including MIMO, SDMA, multi-hop, relay co-operative transmission which lead to high spectral efficiency.



The physical resource sharing problems are interdisciplinary and require input from regulatory and political bodies, business and market experts, and communication and network engineers.

Technical Approach



The development of novel sharing mechanisms and implementations requires a cross-disciplinary approach. SAPHYRE will enable operators to guarantee cost-effective and energy-efficient high quality services and to earn increased revenue by spectrum and infrastructure sharing.

The technical work packages and their interrelationships are shown in the following figure.

- WP2 Fundamental Limits comprises basic limits for system design, game theoretic approaches, and interference and utility modelling,

- WP3 Signal Processing and Coding consists of applied signal processing, network and interference aware coding and decoding, and model design and evaluation,
- WP4 Cross Layer Design for Resource Sharing includes joint PHY/MAC and self organisation, network protocol design, and system level assessment,
- WP5 Spectrum Policy and Business Models develops reference scenarios, business models and pricing, regulation and spectrum policy,
- WP6 Demonstrator Testbed incorporates scenarios and test cases, platform development, and test case implementation.

Expected Impact

SAPHYRE will reinforce European research and industrial leadership and competitive position in spectrum and infrastructure sharing by enabling operators to adapt to the new business opportunities, enabling regulatory bodies to agree on easily maintainable sharing mechanisms, and enabling vendors to develop the new base stations and mobiles using the required radio technologies. The approach of SAPHYRE underlines the systematic collaboration of all sector actors within a consistent framework and a shared vision.

Much has changed since GSM was introduced including user requirements, markets, competition, regulations and policies, and the technology option. SAPHYRE recognises this need for a holistic approach to implement the idea of resource sharing in a timely, efficient, and successful way.

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STRONGEST - Scalable, Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport

STRONGEST is an Integrated Project in the EC's 7th Framework Programme having as the first goal the design and demonstration of an evolutionary ultra-high capacity multilayer transport network, based on optimized integration of Optical and Packet nodes, and equipped with a multi-domain, multi-technology control plane.

At a Glance: STRONGEST
Scalable, Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport

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Duration:01/2010 – 12/2012

Total Cost: € 12.6 m

EC Contribution: € 7.3 m

Funding scheme: IP

Contract Number: INFSO-ICT-247674

Main Objectives

STRONGEST's main goal is to design and demonstrate an evolutionary transport network, ensuring higher scalability, cost effectiveness and better end-to-end quality of service.

STRONGEST's main goal is to design and demonstrate an evolutionary ultra-high capacity multilayer transport network, based on optimized integration of Optical and Packet nodes, and equipped with a multi-domain, multi-technology control plane, overcoming the problems of current networks that still provide limited scalability, are not cost-effective and do not properly guarantee end-to-end quality of service.

STRONGEST is an industry led project; the consortium brings together major European industrial players, leading Telecom operators, Universities and Research Centres and as such, it enables the necessary synergies and creates an ideal environment for innovation and development.

The European scale of the project is made necessary by the development of a new reality in which countries and federations are immensely and inextricably linked. To have a common view at European level is essential to apply the project's outcomes.

A major impact from STRONGEST will be to strengthen the position of European industry in the field of Future Internet and to reinforce European leadership in optical networks technologies. The design of a more efficient transport network with reduced cost per bit and the particular attention to energy efficiency will turn into benefit to the entire Community.

Network Operators have a tough target to reduce CO^2 emissions, whilst at the same time supporting significantly higher information bandwidth. They will use the results of STRONGEST, which will provide the optimum transport network architecture to achieve these targets. STRONGEST results will be exploited by Vendors to develop traffic engineering solutions running in multi-technologies and multi-domain context, and the related control plane in both legacy nodes and new optical/packet nodes. Academic Partners' plan to use the STRONGEST results for further enhancement of knowledge transfer, training and skills creation in the field of telecommunication networks, more specifically in the field of optical networks.

Work breakdown

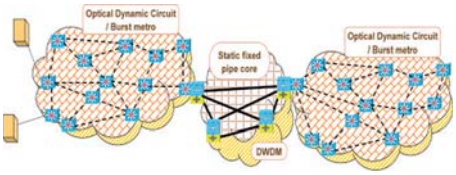
STRONGEST scientific and technical activities of the project are organised into 4 main Work Packages:

- WP2 "Network efficiency and optimization"; its main goal is to design efficient and optimized network architectures for new transport solutions.
- WP3 "End-to-end solutions for efficient networks"; its main goal is to provide efficient solutions to support end-to-end services delivery across domains that are heterogeneous in terms of technologies.
- WP4 "Network prototypes implementation and demonstration"; its main goal is the implementation, integration and experimental validation of the developed solutions.
- WP5 "Technical coordination, dissemination and standardization", for guaranteeing strong coordination of all the technical activities in the project, including dissemination and standardization

Finally, all the activities related to the management of the project are included in WP1 "Project Management"

Key Issues

- To analyse the feasibility of the proposed architectures by means of performance and techno-economic impact studies, aiming at network performance and cost optimization.
- To identify the best solutions to reduce the energy consumption of the telecommunication network. Efficient combinations of optical and electrical components will be investigated.
- To research, develop, analyze and experimentally validate the optimum combination of L1 (Optical) and L2 (Packet Transport, OBS,…) transport technologies.



- To pursue end-to-end services delivery crossing domains that are heterogeneous in terms of technologies (circuit transport networks and connection-oriented packet transport networks), control plane models (e.g. multi-layer/multi-region), OAM mechanisms, vendors and operators.
- To enable the virtualisation of resources, allowing the cooperation among heterogeneous data-plane technologies; this will permit quick and low-cost introduction of new services independent of the underlying transport platform.
- To experimentally validate the investigated network architectures, forwarding concepts and control mechanisms in an experimental implementation; therefore, quantitative technical laboratory investigations will be carried out.

- To contribute to the development of new European and global interoperable standards for multi-layer and multi-domain data and control plane, thus reinforcing the European position in standardization bodies and fora. The proposed new control and management mechanisms will be presented to the relevant working groups in IETF, IEEE802, OIF and ITU-T, ETSI standardization organizations.
- To foster the scientific exchange and collaboration between other scientific projects and organizations such as IST FEDERICA, BONE, AKARI (Japanease research Project) and GENI (American research Program).
- To educate European key staff including research managers and industrial executives.

Expected Impact

STRONGEST will contribute towards the transformation of communication network infrastructures and will support the knowledge based economy by setting the foundations of novel network architectures. In more detail:

- Strengthening the position of European industry in the field of Future Internet technologies and reinforce European leadership in optical networks technologies.
- Increasing the economic efficiency of access/transport infrastructures (cost/bit).
- Facilitating the creation of Global standards, interoperability and European IPRs reflecting federated and consistent roadmaps.
- Creating wider market opportunities from new classes of applications.
- Accelerating the uptake of the next generation of networks and service infrastructures.

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WHERE2: Wireless Hybrid Enhanced Mobile Radio Estimators – Phase 2

Positioning information is inherently linked to all mobile devices. WHERE2 exploits the synergies of positioning information in wireless communication systems to improve wireless communications and positioning capabilities.

At A Glance: WHERE2
Wireless Hybrid Enhanced Mobile Wireless Estimators – Phase 2

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Duration: 07/2010 - 06/2013

Total Cost: € 7.4 m

EC Contribution: € 5.2 m

Funding scheme: STREP

Contract Number: INFSO-ICT-248894

Main Objectives

Exploiting network cooperation by P2P links to estimate position and motion information of mobile terminals to optimize the network itself.

WHERE2 develops new cooperative positioning and communications technologies based on mobile radio networks.

Exploiting network cooperation and mobile terminal cooperation by P2P links, position and motion information of mobile terminals can be accurately estimated. This information can be used to optimize both a radio access network itself and procedures which support cooperation among these networks. The key top level objectives of the project are:

Positioning:

Enable indoor terminal location with an accuracy at least equivalent to that of outdoor GPS, by combining and extending distributed techniques into the highly dynamic heterogeneous and cooperative scenario.

Communications:

Quantify geo-location-based cooperation gain in wireless communications in terms of throughput, reliability, power consumption, complexity and security.

Realization:

Develop integrated hardware platform to confirm performance and feasibility of cooperative positioning and communications algorithms by trials.

Technical Approach

The research work in WHERE2 focuses on four work packages (WPs) to investigate the performance of potential future mobile radio systems in indoor areas. These WPs are

- WP1: Scenarios, relevant channel models and market feedback
- WP2: Heterogeneous context-aware cooperative positioning
- WP3: Geo-location aided cooperation for future wireless networks
- WP4: Heterogeneous Test Bed for Location and Communications

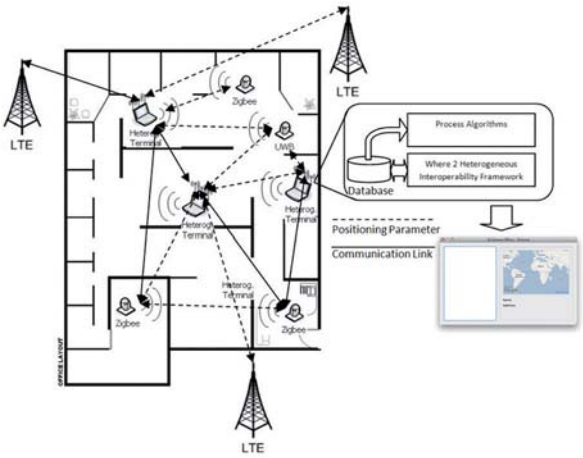
Future mobile radio systems, 4G in particular, are expected to operate in heterogeneous communication systems to fulfil the need of a ubiquitous access and they will include the ability to position the terminal to strengthen this in every environment.

WP1 is split into three tasks. In task 1-1 the system parameter and the framework of the scenarios are defined that are the base for all research activities. In task 1-2 the wireless channel is characterized to define a coherent multi-link heterogeneous channel model for communication and positioning investigations in WP2-WP4. In task 1-3 a continuous feedback from the industry partners about standardisation activities and information about operator strategies is exploited to incorporate an instantaneous feedback about changes in the real market.

In WP2 various aspects to position a mobile in a distributed cooperative heterogeneous communication system via mobile radio links and inertial sensors are investigated. A strong link to WP1 and a clear focus on realistic conditions in the hardware, e.g. complexity, latency, asynchronous air-interfaces, etc., allow to implement the best suited algorithms for the selected hardware platforms for integration in WP4.

In WP3 geo-aided communication is investigated for coordinated, cooperated and cognitive radio networks. Here the degree of reduced cooperation in the network defines the different foci of the tasks:

Starting with task 3-1 for coordinated radio networks, continuing with task 3-2 with cooperative mobile radios and finally in task 3-3 a cognitive network, where no cooperation between the licensed and the non-



licensed network exists. The investigations are performed on the PHY layer as well as on the protocol layer of the underlying communication systems. A combination of different radio platforms will be integrated in WP4 to show cooperative positioning and communications for an indoor scenario. This integration is fed by the implementation and validation of multiple algorithms. Finally, these algorithms will be realized in trials.

Expected Impact

Next-generation mobile radio technologies
WHERE2 investigates future mobile radio technologies under a combined approach, which considers both communications and positioning requirements. On the one hand this approach will allow identifying potential synergies between communications and positioning. On the other hand it provides solutions for optimising those. Investigations will indicate how already standardised systems like 3GPP LTE, WiMAX, etc. can be evolved using WHERE2 technology in terms of their positioning and cooperation capabilities in order to improve both communications and positioning QoS metrics.

Cognitive radio and network technologies
WHERE2 aims to provide knowledge about the communications infrastructure in the neighbourhood of mobile terminals. This supports cognitive approaches by a-priori knowledge of available RANs and consequently reducing spectrum sensing effort. Dynamic routing will enable decentralised (P2P) communication beyond the radio horizon of mobile devices. This enables RANs to dynamically adapt their cell sizes according to network traffic resulting in increased cell breathing capabilities.

Novel radio network architectures
WHERE2 will develop architectures for heterogeneous RANs in order to enable and improve cooperative positioning and P2P communications in dynamic RAN topologies. Through the consideration of position and movement information, network architectures, which deploy short range P2P communications and femtocells for increasing network throughput, are applicable even for highly mobile users.

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Find out more and find your way to the right funding scheme:

Practical Guide to EU funding opportunities for Research and Innovation
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EU funding for the advancement of ICT
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