# Project Information

**CELTIC**
Telecommunication Solutions

## Distributed Wireless Networking Experimental Infrastructure for Optimization and Convergence

The ICARUS platform addresses significant research challenges related to system coexistence, scale, interoperability, and evaluation tool design, in the scope of a beyond 3G scenario where a diverse wireless networking world of "network-of-wireless-networks" accommodating a variety of radio technologies and mobile service requirements coexist in a seamless manner.

ICARUS provides an efficient, accurate and scalable virtual distributed testbed (VDT) implementation to support cross-system and cross-layer optimization of heterogeneous systems in a unified manner.

### Main focus

The future leads towards a diverse wireless communications environment where the end user will be provided with "flexibility and choice", meaning the ability to attain any service, at any time on effectively any network, in order to enhance the quality of life of the individual.

The achievement of the vision, where applications exploit in an efficient way the available wireless system resources, raises the need for a heterogeneous system evaluation platform.

The developed virtual testbed, which covers the radio access network layers, considers all the aspects relevant for the analysis and dimensioning of a wireless network and is a very powerful tool for researchers to design and evaluate next generation wireless networks.

In the case of wireless technologies, one of the keys to achieve an optimum usage of the resources will rely on cross-layering, where a much richer set of information may be required to be exchanged between layers. Therefore the development of simulation tools that enable this rich transfer of information *between layers and systems* will be essential for the design and evaluation of new algorithms.

Due to the fact that future wireless systems will incorporate a significant variety of technologies, some of which are not specified yet, one of the core aspects in the simulator architecture is the definition of abstract classes that will allow the integration of new technologies.

Furthermore, ICARUS plans to develop the adequate interfaces so that the developed framework may interface real devices or test equipment, and use real data in the simulations.

The ICARUS project aims to address the above research challenges by:

- Implementing an efficient, accurate and scalable Virtual Distributed Testbed (VDT) to support cross-system and cross-layer optimization of heterogeneous systems in a unified manner.

- Through the use of the VDT, to investigate, design and evaluate cross-layer and cross-system interactions, between next generation radio protocols without neglecting important real-system details.
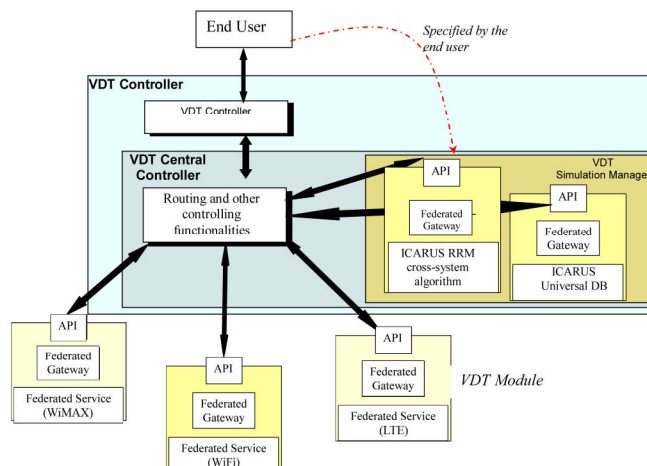


## ICARUS

Project ID: CP5-011

Start Date: 1 July 2008

Closure date: 1 July 2010

### Partners:

CBT, Communication & Multimedia, S.L, Spain

Centro Tecnológico de Telecomunicaciones de Catalunya, Spain

INESC INOVAÇÃO - Instituto National de Engenharia de Sistemas e Computadores, Portugal

Innovalia Association, Spain

Link Consulting, Portugal

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### Project Website

www.celtic-initiative.org/projects/icarus

## Approach

The development of ICARUS, a Pan-European Virtual Distributed Test-bed, will follow an approach geared towards the achievement of the following simulation framework objectives:

- Extendibility: Existent and future standards can be realized on the ICARUS platform;

- Modular design: An end-user transparent framework with 'plug and play' features to support algorithmic testing in a Beyond 3G heterogeneous environment;

- Open Interface: The open structure ensures that redeveloping and extensions can easily be achieved;

- Scalability: The scale of the air-interface technologies can be configured freely so that the cost of system devices can be minimized;

- Easy to update and maintain

- A Framework to allow design and evaluation of cross-system and cross-layer optimization algorithms.

In order to obtain the scientific advances in terms of an optimized radio access network solution in view of E2E (End-to-End) performance, ICARUS will consider a myriad of interoperability and optimization scenarios:

- Cooperative context-aware RAT selection between legacy systems (HSDPA, 802.16, 802.11e, 802.11g) and future emerging technologies (IEEE 802.11 VHT, IEEE 802.16m, 802.16j and 3GPP LTE);

- Non-cooperative RAT selection based on game theory;

- Efficient Inter-system handovers in Heterogeneous MBMS enabled wireless networks;

- Inter-system cross-layer optimization;

- Physical Layer optimization and interference reduction.

## Main results

- The **major results** foreseen in **ICARUS** include:

- A distributed **wireless networking experimental infrastructure** software prototype for testing cross-layer and cross-system protocols/algorithms.

- **Cooperative context-aware RAT selection algorithms** applied to legacy and future emerging technologies.

- Cooperative context-aware RAT selection algorithms extended to **point-to-point ad-hoc links.**

- **Non-cooperative RAT selection algorithms** based on game theory to provide service continuity within a heterogeneous operator and access technology environment.

- **Efficient Inter-system handovers protocols for Heterogeneous MBMS** enabled wireless networks.

- Transparent service continuity based on methods, procedures and algorithms across **MBMS enabled heterogeneous networks**.

- **Inter-system cross layer optimization algorithms** for legacy and future emerging technologies.

- **Multi-cell Dynamic resource allocation protocols**.

## Impact

Results obtained in ICARUS will benefit all players in the wireless community:

**Operators**: who will get vital experiences in cross-system and cross-layer optimization techniques for B3G. The results expected from ICARUS, and the availability of a powerful virtual testbed will aid the operators to face the important issues expected for future network deployments. The detailed studies to be carried out will provide criteria and specific algorithms for the defined case studies, while at the same time the flexibility of the testbed will allow to quickly specify modifications required to accommodate solutions coming from the market.

**Manufacturers**: who will have an additional and reliable benchmark for their own solutions, and the opportunity to tune them in realistic scenarios.

**Service providers**: the availability of a powerful testbed will allow quantifying the impact of the network conditions and system interworking on the services offered, and support tuning of system parameters.

**Academia**: the work will stipulate dissemination of this knowledge to undergraduate and postgraduate students. This will generate skilled engineers, which are well prepared to start their professional career in the wireless sector. Furthermore modules of the testbed can be used to improve the course contents.

**Users**: who will eventually be offered optimized services and drastically reduced costs, because of the ABCS procedures defined.

**Society**: in general terms, since efficient cross-layer and cross-system procedures will lead to an optimization of the network deployment and resource usage, namely minimizing the electromagnetic radiation.

## About Celtic

Celtic is a European research and development programme, designed to strengthen Europe's competitiveness in telecommunications through short and medium term collaborative R&D projects. Celtic is currently the only European R&D programme fully dedicated to end-to-end telecommunication solutions.

**Timeframe:** 8 years, from 2004 to 2011

**Clusterbudget:** in the range of 1 billion euro, shared between governments and private participants

**Participants:** small, medium and large companies from telecommunications industry, universities, research institutes, and local authorities from all 35 Eureka countries.

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