

# Project Achievements



## COgnitive network ManageMent under UNcErtainty

COMMUNE investigates the viability of applying cognitive learning techniques to solve problems in the management of modern networks in a wide range of networking scenarios.

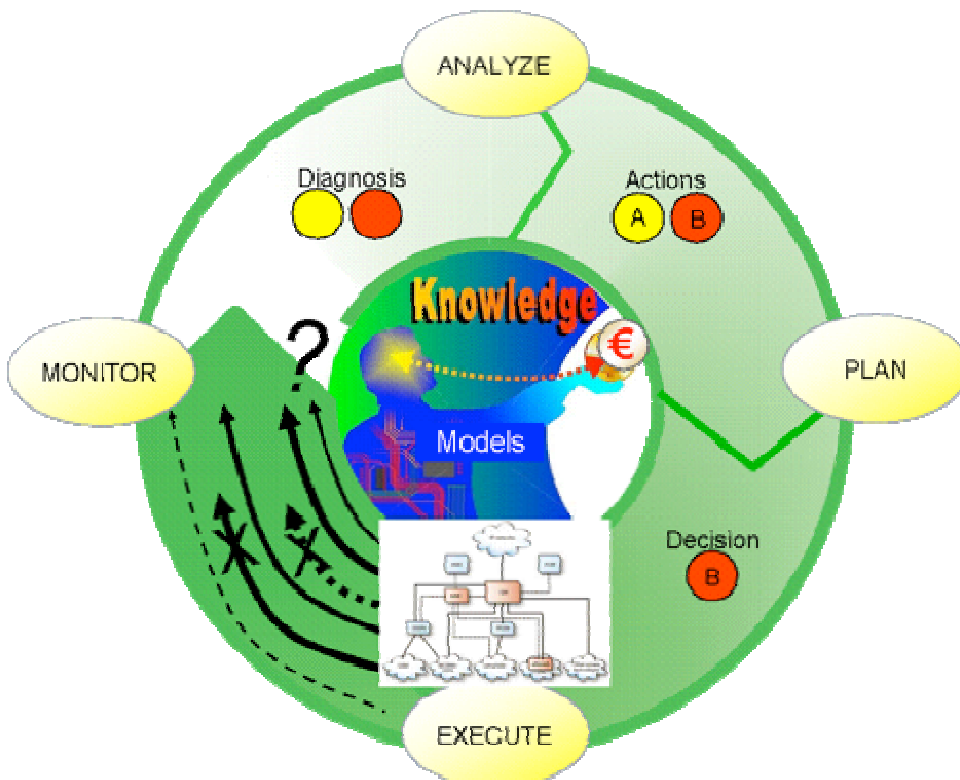
### Main focus

The main focus of COMMUNE was to investigate and evaluate the suitability of applying cognitive algorithms to resolve problems in management of networks. A broad set of scenarios was considered in order to derive the most general set of results. These included radio access (self-organized network - SON) management, Fibre to the Home (FTTH) management, Internet of Things (IoT) and multimedia QoE management for both over the top (P2P) and mobile networking cases. An-

other area of focus was experimentation with decentralized management architectures in order to both evaluate distributed management coordination and candidate implementation technologies.

Specific project objectives included:

- ◆ Analysis of the application cognitive algorithm to deal with uncertainty;
- ◆ Definition of a decentralized cognitive management framework to deploy the developed reasoning techniques;
- ◆ Validate the project approach and technology through simulations and experimentation;
- ◆ Dissemination of the project results through academic, industrial and related channels including standardization.



## COMMUNE

Project ID: CP8-001

Start Date: 2 November 2011

Closure date: 30 June 2014

### Partners:

Athlone Institute of Technology, Ireland

Daysha Consulting, Ireland

Elisa Corporation, Finland

Magister Solutions, Finland

Nokia Solutions and Networks, Finland

Orange Polska S.A., Poland

Oy L M Ericsson Ab, Finland

SistelNetworks, Spain

Telenium, Tecnologia y Servicios S.L., Spain

Telnet Redes Inteligentes SA, Spain

Temida, Slovenia

VTT Technical Research Centre of Finland, Finland

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### Project Website

[www.celticplus.eu/project-commune](http://www.celticplus.eu/project-commune)

<http://projects.celticplus.eu/commune/>

## Approach

COMMUNE adopted a two pronged approach to address the challenges described above. Firstly the project teams experimented with and evaluated the application of cognitive algorithms in a variety of networking scenarios. Candidate cognitive algorithms were selected after an analysis of the technical and usage requirements for each scenario. Technologies used here included Q-Learning, Fuzzy Logic, Neural Networks, Bayesian Networks and statistical techniques as well as policy based management for coordination purposes.

Secondly, the project developed and used the generic architecture for autonomic and cognitive network management (GARSON), from Orange, which allows for centralized or distributed implementation of management functions as a framework to evaluate the suitability of a number of different middleware frameworks for distributed cognitive management from both coordination/communication and service lifecycle management perspectives. Platforms used in this phase included Hazelcast, OSGi, VTT's Distributed Decision Engine (DDE) concept and the GoalBit P2P system.

## Achieved results

There are a number of important outcomes for the project under both the approaches outlined above. These include:

- ◆ Project results across a number of scenarios indicate that a hybrid management approach, i.e., a combination of centralised and decentralised management, is very often more appropriate than a unilateral approach.
- ◆ The benefits of cognitive algorithms to solve network management problems was demonstrated in a number of scenarios which are reported in the deliverables – available on the project web site -and published papers.
- ◆ The definition of the generic architecture for autonomic and cognitive network management (GARSON), is an important result of the project. It provided a comprehensive architecture for implementation of cognitive algorithms in a number of different network management scenarios.
- ◆ Another important outcome is demonstration of the suitability of different distributed implementation frameworks for network management including the Programmable Distributed Execution Environment (PDEE) framework which combines OSGi and FIPA technologies. These were used in a distributed SON man-

agement scenario involving a number of partners. This framework allows for on-the-fly executable code update and a high level of programmability of the management system. The DDE framework was also shown to effectively integrate algorithm prototypes distributed across mobile phones and a multi-access WLAN testbed. Hazelcast was shown to work effectively for IoT scenarios and a distributed multimedia algorithm was implemented on top of the GoalBit P2P platform.

- ◆ Substantial input was made to IETF standardisation in the IoT area.
- ◆ 16 peer reviewed publications papers have been published to date.

## Impact

From the short term, business oriented point of view the major area for application of cognitive techniques will be in the radio network management domain and in particular SON related product development – this is a core area of business for many project partners. We also expect to see the techniques developed in COMMUNE appear in other partner product lines such as IoT and FTTH in the medium term. The technologies and concepts developed within COMMUNE will also be used as a platform for future research, particularly for research related to SDN and 5G. In the case of the academic partners the results will be used to inform teaching and degree courses and projects.

## 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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