Project Achievements

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Monitoring and self-tuning of RRM parameters in a multi-system network

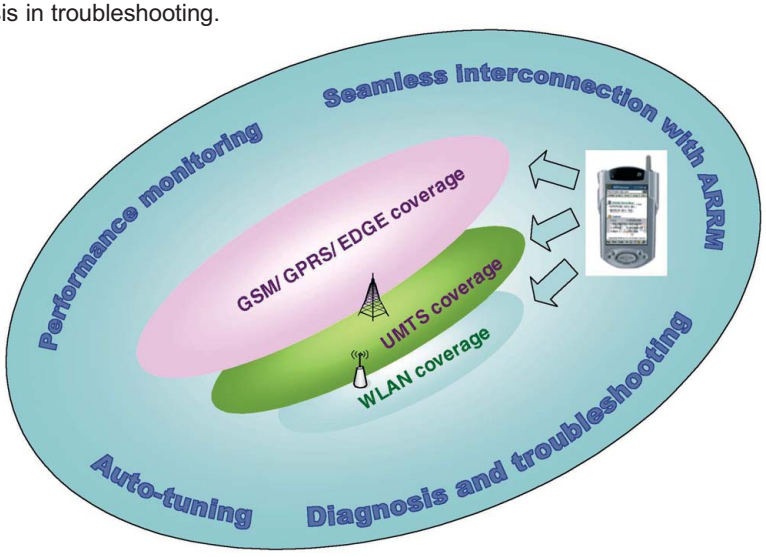
The Gandalf project focuses on automating radio resource management (RRM) tasks in heterogeneous radio access networks (GSM, GPRS, UMTS and WLAN), including advanced RRM, auto-tuning, and automated diagnosis in troubleshooting. These will allow to optimize usage of radio resources, and to enhance network performance and quality of service.

Main focus

The main challenge for the Gandalf project has been to develop and demonstrate methods and techniques for automating radio resource management tasks in heterogeneous network environment. Three tasks have been investigated in depth:

- Advanced and Joint RRM (ARRM and JRRM),
- auto-tuning techniques, and
- automated diagnosis in troubleshooting.

ARRM and JRRM algorithms have been developed for admission and load control and for mobility (i.e. vertical handover). A multi-system testbed with UMTS and WLAN subsystems has been developed to test new JRRM algorithms and their impact on network performance and quality of service. On-line and off-line auto-tuning algorithms for mobility and traffic balancing and for resource allocation have been developed and tested for UMTS, UMTS-WLAN and GSM-UMTS networks. A methodology for automated diagnosis has been developed for UMTS networks, aiming at automating and optimizing the fault-cause diagnosis process. The above approaches will contribute to improve network performance and the user-perceived quality of service, to optimize resource utilization of deployed networks and to reduce costs of maintenance tasks



Gandalf

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Partners

Ericsson Ireland, Ireland

France Télécom R&D, France

Moltsen Intelligent Software (now Wirtec), Denmark

Telefónica I+D, Spain

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Project web site

www.celtic-initiative.org/projects/gandalf

Approach

The approaches used in the Gandalf project for automation of management tasks were based on artificial intelligence and optimization methods: Bayesian Networks for automated troubleshooting; and fuzzy logic, Reinforcement Learning, Q-Learning and multi-agent optimization algorithms for the auto-tuning process.

The studies, tests and validations of the methods and techniques developed in the Gandalf project were carried out on two types of testing platforms: multi-system dynamic simulators including GSM, GPRS, UMTS and WLAN subsystems, and a multi-system testbed with WLAN and UMTS subsystems developed by the University of Limerick. Real network measurements were used in the study on automated troubleshooting.

Achieved results

Significant results have been achieved in the following three research domains:

Radio Resource Management with testbed implementation:

ARRM and JRRM algorithms for WLAN 802.11 and UMTS-WLAN networks respectively were developed. The UMTS-WLAN admission control strategy for interactive users based on statistical loads of current users was shown to be a successful solution, improving QoS and increasing capacity. Load based vertical handover has been introduced between UMTS and WLAN allowing to efficiently balance traffic between the two systems and to increase capacity. The testbed implementation has shown that WLAN can be successfully coupled to UMTS in a tight manner (tight coupling scenario) and provide additional resources.

Auto-tuning algorithms:

The auto-tuning process allows to adapt the network to traffic variations by dynamically adapting parameters of RRM algorithms. Fuzzy logic controllers have been designed to orchestrate the auto-tuning process. The Reinforcement Learning method has been implemented to optimize the process. Resource allocation auto-tuning algorithm has been studied for UMTS. Traffic balancing scenarios have been studied via mobility parameter auto-tuning in UMTS, GSM-UMTS and UMTS-WLAN networks. Capacity gain of 10 to 30 percent is typically achieved by the auto-tuning algorithms.

Automated network diagnosis: The Bayesian Network model has been adapted for automated fault cause diagnosis in UMTS network. The developed algorithms include automated model learning, segmentation and inference. The diagnosis model was first tested and validated using a dynamic network simulator, and in a second phase, the diagnosis model was adapted, tested and successfully validated in a real UMTS network using counters and KPIs (Key Performance Indicators) recovered from an OMC (Operation Management Centre).

About CELTIC

Celtic is a European research and development programme, established as Eureka cluster, 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. Launched in November 2003, Celtic (Cooperation for a sustained European Leadership in Telecommunications) was founded and has been supported by major European telecommunication players, both vendors and operators. Celtic fills the gap between public R&D programmes not specifically focused on telecoms and short-term R&D efforts by the telecoms industry

Timeframe: 8 years, from 2004 to 2011

Total budget: in the range of 1 billion euro, shared between governments and private participants

Participants: companies from the telecommunications industry (small, medium and large), universities, research institutes, and local authorities from all 35 Eureka countries may participate in Celtic projects.

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Impact

The project has been beneficial for business, industrial and technological activities. The methodology for automated diagnosis in troubleshooting is now being studied by project partners with the aim of benefiting the operator activities. The models have been integrated in an industrial tool that has reached maturity and is now in commercialization phase, (Wirtec partner). The RRM and auto-tuning activities have shown their importance in dynamic traffic balancing. Extension of the work is now being studied in 3GPP with the aim of integrating auto-tuning to the LTE (Long Term Evolution of UMTS) technology and improving its performance. Extensions of the Gandalf project are planned in different projects in both industry and academia.