Project Achievements

Green Terminals for Next Generation Wireless Systems

Green-T aimed at limiting energy consumption for multi-standard mobile terminals for wireless communication, to prolong the operational times and to avoid active cooling, using cognitive radio and cooperative strategies, while also focusing on preserving a proper level of security for the applications in an energy-efficient manner.

Main focus

The main focus of GREEN-T was to investigate the combination of cognitive radio and cooperative strategies to save energy of mobile terminals, while maintaining the required QoS of active applications. The following focus areas have been considered to achieve this goal:

Cognitive radios - the tools to collect context information about the environment surrounding the mobile terminal.

Cooperation - As the density of mobile devices increases, it becomes more possible to establish cooperative strategies.

Green Vertical Handover - GREEN-T studied different energy efficient vertical handovers. Mobile terminals equipped with multiple RAT interfaces capable of vertically handing over between different RATs. GREEN-T utilised context information about network and mobile environment to perform green cognitive vertical handover.

Green Reconfigurable Radio Transceivers - GREEN-T also investigated new hardware (RF, BB and Antennas) design for flexible multi-standard mobile devices with power consumption as a main metric for the device operation.

Security – GREEN-T has provided a solution to avoid malicious and selfish attacks, which are great threats in cooperative distributed systems. Misbehaving nodes will be detected and removed from the cooperative networks.

Approach

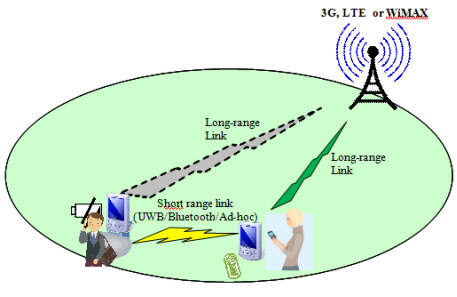
The project was divided into five technical work packages, all involving practical demonstrations, contributions to standardization bodies and scientific publications.

WP2 identifed technical scenarios that serve as guidelines for research throughout the project, to define GREEN-T system architecture, to define methodologies and metrics, and to evaluate the effectiveness of the proposed solutions.

WP3 investigated multi-standard flexible transceivers (RF and baseband) considering power consumption as a key metric, optimized RF front end/antenna matching for higher energy efficiency and studied antenna techniques to improve energy efficiency with limited complexity.

WP4 designed energy efficient cooperative Physical (PHY), Medium Access Control (MAC) and network layers, provided energy efficient security mechanisms for cooperative schemes and evaluated energy-efficiency of developed schemes and algorithms.

WP5 investigated, implemented and validated energy-efficient vertical handover



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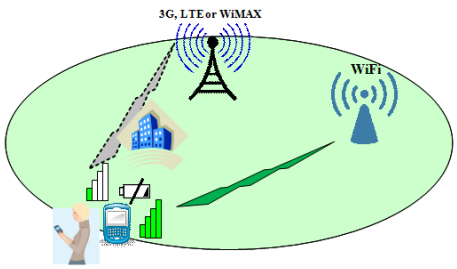

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GREEN-T

Project ID: CP8-002

Start Date: 1 July 2011

Closure date: 30 June 2014

Partners:

A2UICT, Korea

CTTC - Centro Tecnológico de Telecomunicaciones de Catalunya, Spain

Huawei Technologies Sweden AB, Sweden

Instituto de Telecomunicações, Portugal

Instituto Politecnico de Castelo Branco, Portugal

Iquadrat, Spain

Magister Solutions, Finland

Mecalbi, Portugal

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Project Websites

www.celticplus.eu/project-green-t

http://greent.av.it.pt/

procedures based on context information received from both user environment and the network.

WP6 provided proofs of concept of GREEN-T technologies:

Showcase 1: It shows how nodes belonging to a cluster can cooperate based on advanced short range technologies to optimize their connection to the RAT in order to save battery power of nodes.

Showcase 2: It evaluates vertical handover policies to select the RAT, which has the lowest energy demand, while providing the required QoS.

Achieved results

GREEN-T has provided innovative solutions for enabling power saving for multi-standard mobile terminals in heterogeneous wireless systems. GREEN-T has also provided proof-of-concept through simulations and demonstrations. The major visible results of GREEN-T are:

- Flexible RF and antenna technique designs, whose main goal is low power transceivers. The project proposed an improved Planar Inverted F-shaped Antenna (PIFA) on a very compact size (15*8*3 mm^3), covering a wide frequency range around 2.2GHz.
- Innovative network and node discovery mechanisms built on top of context aware architecture, to provide mobile terminals with all connectivity possibilities to select the most energy efficient connection, while reducing the energy consumed on blind search
- Cooperative strategies for PHY, MAC and Network layers to achieve energy efficiency and save battery power of mobile terminals, while maintaining the required QoS. The proposed solutions use network coding, and context aware to choose best relaying candidate node to maximize energy savings. The proposed algorithms achieve more than 50% energy savings compared to the most energy efficient algorithms in the state-of-the-art.
- Light weight security mechanisms for short-range cooperative strategies to avoid malicious and selfish security attacks. The project has managed to combine strong authentication (group membership) using asymmetric keys with strong privacy protection (not giving issuers insight in your whereabouts), to overcome the hurdles with user-key management for ubiquitous access to multiple radio networks.
- Green vertical handover algorithms which use context information to guarantee that mobile terminals are always connected to the most energy efficient RAT. The project have proposed multiple enhancements on handover between LTE and WiFi, as well as between LTE macro and femto cells, to enhance the energy efficiency of such handovers. The results show energy savings reaching up to 20%, while providing better Quality of Service (QoS).

Impact

Green-T impacts can be summarized in following points:

1) Significant improvements in overall energy efficiency and a decrease in the environmental burden, in compliance with objectives of the international community, industry, operators and consumers.

2) Improvements in energy efficient products and systems in the area of wireless communications in Europe and worldwide.

3) Decrease of both capital and operational expenditures for hybrid power systems. This enables the roll-out of mobile networks in emerging countries and a contribution to economic and social growth.

4) Introduction of advanced 'green' solutions into the standardization of wireless networks, and an increase in worldwide scientific knowledge on energy efficient communications.

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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