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Celtic Excellence Award in Gold

On March 29, 2011, at the Celtic-Plus Event 2011 in Heidelberg, Germany, the Wireless World Initiative New Radio+ (WINNER+) project was awarded the Celtic Excellence Award in "Gold." Celtic is a European research and development program with the objective of strengthening R&D activities in telecommunications. The WINNER+ project was set up as a Celtic project and was the final of a series of three European research projects: WINNER I, WINNER II and WINNER+. The research was focused on advanced radio resource management, heterogeneous networks, network coding and relaying, device-to-device communications, multiple-antenna systems and transmission coordinated between cells. Project participants included 28 industrial and academic partners from nine countries. The key industrial partners were Nokia Siemens Networks (project coordinator), Ericsson (technical coordinator), Alcatel Lucent, DOCOMO Euro-Labs, Deutsche Telekom, Telecom Italia, France Telecom, Qualcomm and Mitsubishi Electric. WINNER+ began on April 1, 2008 and was concluded on June 30, 2010.

The award was given to WINNER+ for its strong international influence in shaping the technology choices and standards for the Fourth Generation (4G) wireless communication technologies. The following is an overview of DOCOMO Euro-Labs' contributions to the project.

1) Femto Cell ICIC Scheme

An Inter-Cell Interference Coordination (ICIC) scheme for femto cells in LTE-Advanced networks was developed (**Figure 1**). The ICIC scheme proposes a novel signaling control procedure which enables User Equipments (UEs) connected to femto cells and UEs connected to macro cells to re-use the same resource blocks within a range in that residual interference can be tolerated. The solution can improve the femto cell deployment for NTT DOCOMO's LTE-Advanced network in the future.

2) Decentralized Radio Resource Allocation Scheme

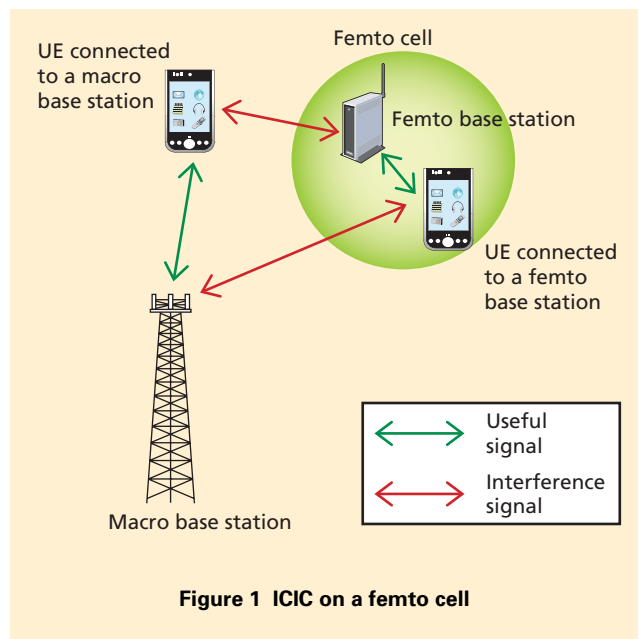A decentralized radio resource allocation scheme was

Figure 1 ICIC on a femto cell

designed based on a busy-burst[*1] technique (**Figure 2**). The proposed busy-burst signaling is used to avoid collisions due to simultaneous access of idle slots and to control the spatial reuse of reserved slots. This is accomplished by determining whether there is interference when receiving a busy-burst signal. The scheme exploits channel reciprocity and was developed for Time Division Duplex (TDD)[*2] systems. This radio resource management scheme is of interest for future activities towards standardization of decentralized and self-organized radio systems.

3) Cross-layer Optimization

A cross-layer optimization scheme between link layer and application layer was developed for allocating resources among multiple applications (**Figure 3**). Data rates provided to the application layer are adjusted, taking into account wireless link channel conditions, the number of users being
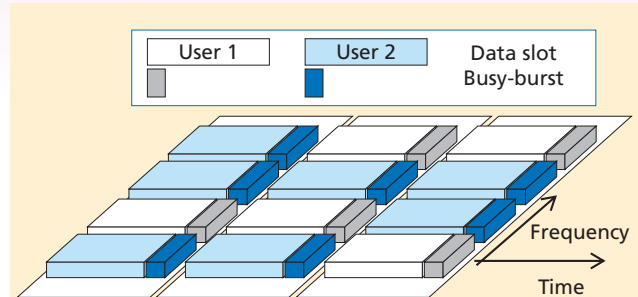

Figure 2 Resource allocation with busy-burst signaling

served, and other QoS constraints. The scheme has been proposed for LTE and LTE-Advanced networks and can improve the QoS offered by NTT DOCOMO's "Xi" (Crossy) network and future LTE-Advanced network.

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*1 **busy-burst**: An extremely short signal transmitted in a time-division mini-slot after a receiver has successfully received using a fixed resource.
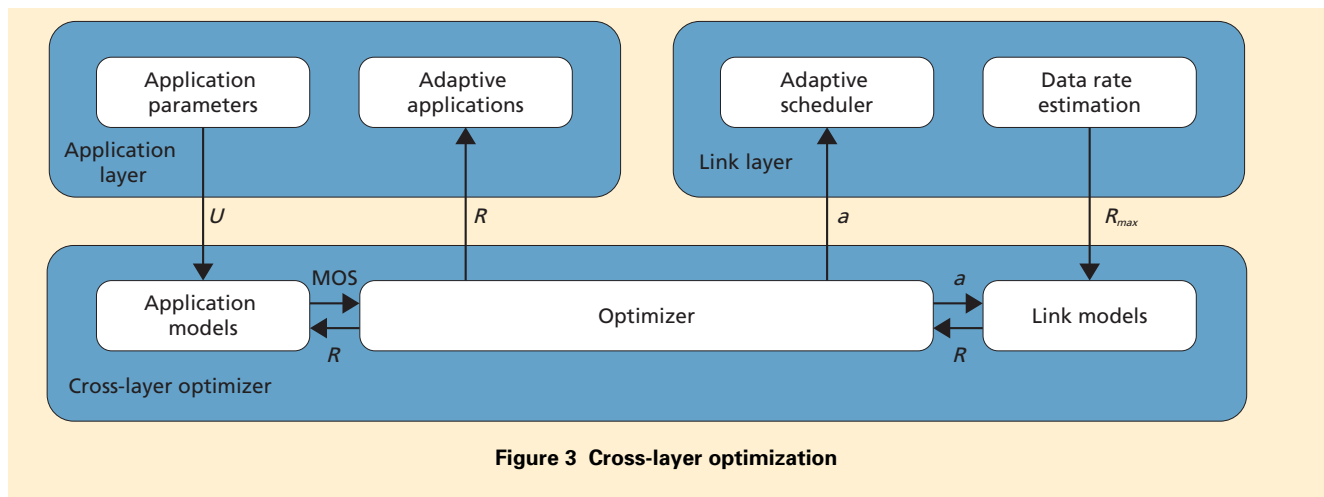*2 **TDD**: A format in which uplink and downlink use the same frequency and frequency band, but transmit signals on different time slots.

Figure 3 Cross-layer optimization