European Commission

Enhanced Multicarrier Techniques for Professional Ad-Hoc and Cell-Based Communications

At A Glance: EMPhAtiC

Enhanced Multicarrier Techniques for Professional Ad-Hoc and Cell-Based Communications

Project Coordinator

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SEVENTH FRAMEWORK PROGRAMME

EMPhAtiC aims at demonstrating the capability of enhanced multicarrier techniques to make better use of the existing radio frequency bands in providing broadband data services in coexistence with narrowband legacy services. The project addresses Professional Mobile Radio (PMR), and in particular the Public Protection & Disaster Relief (PPDR) service currently using legacy systems like TETRA.

Main Objectives

In the PMR/PPDR context, both cell-based and ad-hoc broadband data networking solutions are needed and will be addressed in EMPhAtiC. The coexistence issues and radio environment are similar in both cases. Ad-hoc methods studied for future releases of LTE are potential solutions, but they have to be adapted to the difficult radio environment of the PPDR cohabitation scenario. In addition to the mentioned PMR/PPDR case, the advanced waveforms and signal processing techniques to be developed and validated to find applications in various other scenarios of flexible spectrum usage and cognitive radio. At the waveform level, the main issue is the poor spectral containment of the cyclic prefix Orthogonal Frequency Division Mutiplexing (CP-OFDM) subcarriers leading to high side lobes of the modulated OFDM spectrum which creates interference to neighbouring frequencies and is thus problematic in the coexistence scenario to be addressed.

Propose an "innovative technological solution for smooth migration towards future broadband PMR/PPDR systems"

Additionally, high flexibility is needed to utilize effectively the variable spectral gaps between different narrowband users.

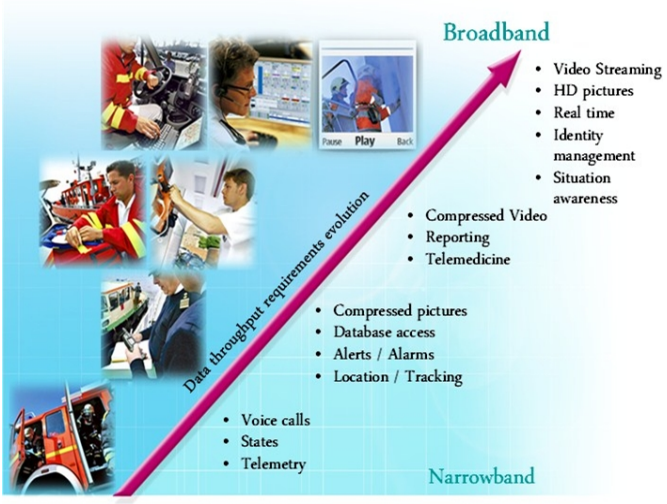
Technical Approach

The radio implementations have to support non-contiguous spectrum allocations, at least on the base-station side. Multicarrier modulation is a natural approach to address the latter issues, but increased flexibility is of significant interest, e.g., in the form of the different subcarrier spacing for different active users. New concepts on multimodal, multi-access flexible spectrum (DSA Dynamic Spectrum allocation) require new functionalities:

- Fast accurate spectrum analysis
- Reliable channel state information
- High flexibility/variability and scalability
- Coexistence with narrow bands and providing quality of service

A physical layer able to support these functionalities is needed. FB-MC (Filterbank Based multi-carrier)/ enhanced OFDM scheme can support DSA and cognitive radio (CR) better than OFDM.

The best and innovative techniques and algorithms available must be picked up, integrated and demonstrated. EMPhAtiC project will evaluate the applicability of the considered waveforms in heterogeneous networks, including cell-based, ad-hoc, cooperative and relaying networks, having in mind the coexistence with legacy waveforms in the PMR band.



Key Issues

At the technical level the key issues are:

To develop an efficient and highly flexible/variable filterbank processing structure. Such filterbanks could accommodate simultaneously different modulation formats with adjustable centre frequencies and bandwidths, possibly with non-equidistant subchannel spacings, and they could be used for the modulation, demodulation and frequency-domain equalization of different FB-MC and FB-SC waveforms, even simultaneously. Regarding the **coexistence between narrow-band and broadband** PMR systems, such a flexible filterbank could also provide in an efficient way the functionality of the transmitter and the receiver of legacy PMR signals. **The Feasibility and performance of FB-MC techniques in specific environments, e.g., relays, multi-hop and cooperative environments, with some loss of synchronization**: the objective will be to study the advantages of FB-MC when used in cooperative MIMO schemes and optimize the synchronization and channel estimation aspects of such a scheme. This performance can then be compared with CP-OFDM scheme, in fully and partially synchronized scenarios. Another objective is to improve schemes that do not employ FB-MC, such as coordinated multi–point, beam-forming, two-way relaying etc., and compare the performance with FB-MC based schemes. Develop the needed channel estimation, equalization and synchronization functions, which are compatible with the multimode wave-form processing solution.

The proof of concept will be achieved through software simulation while experimental performance will be evaluated using a hardware platform.

Expected Impact

The target the EMPhAtiC project is to improve the positioning of European industry in the PMR domain in terms of research, technology mastery and evolution for the future.

Increased economic and energy efficiency of access/transport infrastructures (cost/bit). This target is the keystone for reducing the cost of deployment of radio networks for PMR applications, and also more generally for Broadband Mobile Radio networks.

Several physical layer aspects are covered by the EMPhAtiC with advanced study of FB-MC technologies and its inclusion in current PMR systems. Being a step forward in these critical topics is an important way to develop the European leadership in the domain Future Broadband PMR systems.