Spectrum Aggregation and Multi-User MIMO: Real-World Impact

SAMURAI is focused to tackle the challenge of next generation telecommunication systems using multi user MIMO and aggregated spectrum techniques. SAMURAI will push the state of the art by marrying MU-MIMO and SA to achieve a quadruple increase in system capacity.

Main Objectives

The SAMURAI project will propose innovative techniques in the area of Multi User –Multiple Input Multiple Output (MU-MIMO) and Spectrum Aggregation (SA). The main novelty of the approach adopted in the SAMURAI project is to pay a particular attention to the practical implementation and deployment aspects. The consortium has a strong industrial focus. The constraints from real life system implementation will be taken into account, from the design of signalling needed to support these schemes to hardware/software implementation issues. Further, the SAMURAI project will demonstrate MU-MIMO and SA on real-time testbeds.

In particular, the following measurable technical objectives will be achieved:

1. Development of a system level simulation tool
   This tool will model the impact of MU-MIMO and SA on capacity, average user performance etc., taking into account imperfect Channel State Information (CSI) and limited feedback;

2. Development and assessment of innovative MU-MIMO schemes, investigating practical implementation trade-off, especially with respect to the implementation and signalling constraints on the terminal side;

3. Development and assessment of SA schemes, from the practical implementation perspective (hardware and software) and including practical system considerations, such as signalling to cover the multiple bands, reduction of overhead by considering primary/secondary carrier mechanisms;

4. Development of proof-of-concept (PoC) prototypes, covering a selection of MU-MIMO and SA techniques. Hence, the SAMURAI project will demonstrate on prototypes the feasibility and the performance of those two key technological enablers of next generation broadband wireless systems, thus accelerating the transfer from research to market. Public demonstration based on these prototypes will be organised by the project.
Technical Approach

The project technical approach can been divided into 4 main step/phases:

- Start at system level with simulation tools with the development of algorithms for MU-MIMO and spectrum aggregation techniques in ideal conditions;
- Increase the constraints in the simulator to reflect more realistic environment;
- Implement the most promising algorithms on the SAMURAI testbed;
- Obtain feedback from the test bed to upgrade the system simulator;

The system level simulations will first allow the to assess the gain of the MU-MIMO and SA techniques in ideal conditions. This will enable the identification of boundary conditions. A first selection of the algorithms for implementation will occur.

Once the ideal performance and boundaries have been identified, more constraints will be added to the system studies such as implementation cost and feasibility of the developed solution, CSI cost, scheduling aspects. This enhancement will lead to a quality improvement of the system level studies considering more realistic deployment scenarios and operating conditions of broadband systems.

The most promising algorithms developed will be implemented, validated and measured and ready for the integration into the SAMURAI testbed. Most of the testbed activities will be based on Eurecom’s OpenAirInterface platform (www.openairinterface.org), an open-source hardware/software development platform for experimentally-driven research for fourth generation wireless systems.

Finally the SAMURAI integration takes place and the system simulator is upgraded so it can take into account the results obtained after the technology demonstrator has been realised. This will be achieved by the end of the project.

Key Issues

For MU-MIMO, the SAMURAI project we will push the state-of-the-art schemes that are robust to channel estimation errors, feedback delay and other system imperfections. In this way MU-MIMO systems will become more practical and more feasible to implement. Fundamental insights in the trade-off between feedback and receiver complexity as well as between feedback and link QoS (Quality of Service), allowing operators to better tune their networks will be obtained. Last but not least we expect that the project there will contribute to a better understanding of the practical effects of the wireless channel on the MU-MIMO transmission systems.

With respect to the SA, key issues addressed by SAMURAI will be related to the PHY and link layer and how to have a practical implementation of it.

Finally, the combination of SA and MU-MIMO will be addressed, offering the boost of performances for the entire future telecom systems.

Expected Impact

SA and MU-MIMO will be techniques that contribute directly to the cost, energy and spectrum efficiency objectives.

Spectrum efficiency is maximized through optimization of the spatial multiplexing at multi-user level. Moreover, the SA building block enables the simultaneous use of several single bands of spectrum thus maximizing efficiency.

Energy efficiency is also a major target for SAMURAI. By conducting a multi-antenna multi-user optimization with the help of CSI at the transmit side enables an optimal usage of the available transmission time/frequency and power resources.

Cost efficiency is achieved by the low-complexity constraint imposed for the algorithms design.

The impact of the project is also expected at multiple levels such as dissemination, IPR (Intellectual Property Rights) creation, standard supporting activities, participation to trade show and training activities.

UE1 and UE2 are in a highly interfered zone. In order to allow them to transmit they are scheduled in the same frequency band through MU-MIMO, while UE3 is scheduled in the less interfered band S1, given its spatial position.