PROJECT RESULT

High speed communications systems

AIII: Multi-antenna transceivers for QoS, ubiquitous and improved wireless systems (MARQUIS)

Real-time demonstrator proves MIMO reality for Wi-Fi WLANs

Multiple aerials in digital wireless transmitters and receivers offer significant improvements in data rates and quality of service with lower radiated power. Multiple-input multiple-output (MIMO) communications systems will therefore form a crucial element in future mobile phone and data systems. The MEDEA+ MARQUIS project has developed the essential building blocks for multi-antenna terminals for use in wireless local area networks and demonstrated their integration in a real-time Wi-Fi demonstrator. Success in this project is ensuring Europe maintains leadership in this key communications area.

There is global interest in multi-antenna techniques for mobile phone and wireless local area networks (WLANs). These technologies can increase system capacity, augment the number of users served and improve quality of service (QoS). Such approaches add a practical and relatively inexpensive spatial dimension to existing time-, frequency- and code-multiplexing technologies.

The first multi-antenna products, based on simple transmit-diversity techniques, have already been marketed in the USA for mobile phone base stations, offering 20 to 30% increase in performance. But more sophisticated multiple aerials are necessary, combining transmit diversity with beam steering for example, to achieve higher data rates in base stations. This would also reduce the impact of high-speed data users on voice capacity in WLANs.

However, for the best performance, multiple aerials are necessary in the mobile unit as well; sending and receiving information over two or more aerials makes multiplexing possible by creating multiple signal paths to either boost data throughput or reduce bit error rates. Algorithms in the handset – and base station – receivers recombine the separate signals, compensating at the same time for interference and fading resulting from signals reflecting from various objects between transmitter and receiver.

Studying MIMO algorithms

Much theoretical study and implementation effort had been put into enabling successful applications of multi-antenna technology in mobile terminals. One key area was the implementation of efficient algorithms in the essential building blocks – antenna, front-end, baseband processing and media access control layer support – for multiple-input multiple-output (MIMO) terminals in WLANs. These are seen to represent a vast growth area.

MEDEA+ project A111 MARQUIS set out to approach the algorithmic, implementation and demonstration aspects of MIMO. Consortium partners included universities, research centres, system suppliers and service providers, offering complementary expertise.

The initial intention was to develop complete application-specific integrated circuit (ASIC) chipsets, but funding difficulties led to withdrawal of the chipmaking partners. The final demonstrators were therefore based on field programmable gate array (FPGA) devices and digital signal processing (DSP).

Work started with a state-of-the-art review of MIMO algorithms, focusing on orthogonal space-time block code (OSTBC), and the development of an end-to-end system model for performance evaluation. This simulator modelled the impact of MIMO technologies on Wi-Fi

WLAN standards and third generation (3G) mobile phone cell planning tools.

The results were used to define system architectures for practical applications. These blocks were integrated in a state-of-the-art 4-by-4 demonstrator to illustrate the increase of performance in MIMO systems and their interoperability. This demonstrator is one of the few 4-by-4 MIMO test beds available worldwide.

Doubling WLAN throughput

MARQUIS focused on adding MIMO capability to a typical IEEE 802.11a Wi-Fi wireless network interface. Such networks are currently specified for a maximum data rate of 54 Mb/s, though in practice throughput is only around 20 to 30 Mb/s. MIMO techniques developed in the project have made it possible to double the raw WLAN throughput to 108 Mb/s, using two aerials in a portable terminal. The project thus anticipated WLAN developments, being very close to the new IEEE 802.11n standard, which offers specified throughputs of at least 100 Mb/s.

Work on individual blocks was split over aerial design, radio-frequency (RF) front ends, base band and channel emulation as well as supporting software and firmware. Co-operation between partners was particularly good with much exchange of work and complementary experiences.

The real-time 4-by-4 transmitter and receiver demonstrator clearly showed the maturity of the project results. It also enabled realistic measurements, allowing comparison with the theoretical results obtained during the initial simulation activities. The demonstrator confirmed the validity of the MARQUIS MIMO algorithm implementation and pointed up real-life effects not visible in simulations.

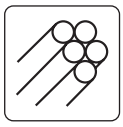
Major success for partners

Overall, the project was a major success, creating more results than expected. It has generated much European know how about MIMO technology and its implementation. And it has allowed several partners to catch up with the state of the art in this sector. It is also enabling Europe to contribute to the development of the IEEE 802.11n standard.

MIMO is now starting to take off worldwide. Members of the MARQUIS consortium are already in a position to market products developed as a result of the project, such as a new concept for a specific type of antenna by one of the SMEs. And the knowledge obtained throughout the project will be very valuable during the future development of MIMO products in Europe, significantly reducing time to market.

Seven patents are being or have already been filed as a result of work in MARQUIS. And, over the course of the project, there were more than 70 publications, helping to generate increased visibility for the project partners.

MARQUIS was only a first step however – providing a first proof of concept to meet future commercial possibilities in a timely manner. Further silicon implementation of MIMO techniques will be the next step. Hopefully this will be done with a larger European consortium in the second phase of MEDEA+, making it possible to look beyond Wi-Fi to areas such as Wimax and 3G.



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KEY PROJECT DATES:

Start: October 2003
End: December 2005

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