MEDEA+

PROJECT PROFILE

2T401: Hi-frequency microsystems on silicon (HI-MISSION)

ENABLING TECHNOLOGIES FOR HETEROGENEOUS SYSTEMS

Partners:

Acreo
Ericsson
Infineon Technologies
Signal Processing Devices Sweden
STMicroelectronics
United Monolithic Semiconductors

Project leader:

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Key project dates:

Start: October 2005
End: December 2008

Countries involved:

Austria
France
Sweden

The HI-MISSION project is developing innovative technology and a design platform for radio frequency system-on-chip and system-in-a-package microsystems applications for radar and microwave communications. These will enable flexible microwave designs, substantially decreasing development time for new products and making possible reuse of existing devices in new applications. High performance modules will be designed and demonstrated using multichip technology on a silicon substrate with enhanced functionality optimised for high frequency and high speed. Results will strengthen Europe's competitive position in automotive and communications applications, boosting market share, exports and jobs.

There is continuous demand in telecommunications and cars for electronic devices providing higher performance in smaller packages at lower cost. Problems arise in integrating functionalities not suitable for conventional silicon technologies. This can be overcome using multi-chip modules (MCMs), with specific functions on separate devices that are then interconnected. As long as this is cheaper than integrating all functions in a single chip, MCM solutions are preferred. But, if large volumes of devices are needed, fully integrated solutions may be considered.

Whatever the approach, it is necessary to decide between system-on-chip (SoC) and system-in-a-package (SiP) approaches for the right performance-cost balance in high frequency (HF) applications. SoCs do not seem cost effective for radio frequency (RF) and microwave applications where much on-chip integration of passive microwave components is required, especially when feature sizes in terms of gate length are below 100 nm.

For the near future, many microwave and mixed signal systems will consist of MCMs. Each subcircuit can use the optimal technology in terms of cost and performance. High performance and expensive chips for key functions can be integrated with cheaper passive component solutions and with components offering new functionalities or technologies not compatible with RF/microwave chip technologies.

The main goal of the MEDEA+ 2T401 HI-MISSION project is to develop a technology platform for RF SiP/SoC applications in radar and microwave communications systems. It offers a first step to increasing functions on a chip, and is also concerned with HF design, system co-design, manufacturability, reliability testing and cost of manufacture of each processing route developed.

HI-MISSION involves large and small European communications and radar companies as well as an industrial institute pooling forces to develop technology for low cost microwave modules. The main objective is to design and demonstrate high performance flexible modules optimised for low cost HF integrated circuit (IC) solutions.

Silicon substrate advantages

Various substrate materials are used for MCMs. Silicon is a strong candidate for the

future as new components including thin film bulk acoustic resonators (TFBARs), ferroelectric components – such as high density capacitors, delay lines, tunable filters and phase shifters – and micromachined components can be fabricated outside standard foundries.
An additional advantage of silicon is the similar thermal expansion coefficients between the dies and carrier substrate. Silicon is also a better thermal conductor than alternatives such as glass or alumina.
HI-MISSION is developing an MCM technique based on silicon substrates that can integrate not only standard silicon and gallium arsenide chips, but also components with high performances and new functionalities, such as high-Q passives, RF micro-electromechanical systems (MEMS), TFBARs, high density capacitors and tunable components based on ferroelectrics – components that cannot be directly integrated on ICs or that are not well suited for integration.
The ability to embed passive components as well as added functionality in the substrate is an attractive way to drive miniaturisation and cost reduction. The tunability of ferroelectric components enables development of devices with enhanced functionality and performance. The module can be tuned to different operating frequencies and performance optimised for a given frequency. Chips can be smaller, which improves yield, and individual chips can be more easily designed, resulting in shorter design cycles.
SiP module design requires strong interaction between packaging- and IC-oriented technologies and design methods, including co-design. To allow for an accurate first pass design, precise models should be available for the on-chip devices and passive components, as well as for off-chip embedded or mounted components. In addition, a suitable technique, with its own models, is required to realise electrical and mechanical interconnections between chips and carrier substrate.

Common technology platform

HI-MISSION technology will be used in microwave communications as well as automotive and security radar systems. A common technology platform will create the industrial infrastructure necessary for efficient low cost production methods and processes in Europe.
Emergence of silicon germanium (SiGe) processes with cut-off frequencies over 200 GHz from various suppliers opens up opportunities for lowering costs at frequencies over 100 GHz, and specifically for 77 GHz anti-collision radar in cars. HI-MISSION will compare the performance and cost of SiGe circuits for this – existing systems already make driving more comfortable and will evolve to provide even more features.
The continued scaling of CMOS, according to Moore's law, enables CMOS use in applications where SiGe technologies dominate today. While CMOS is not the best candidate from a performance view, the combination of simplicity, area, cost and availability from many suppliers makes it tempting to explore the limits of today's technology for demanding applications such as microwave communications and security radar. HI-MISSION will explore conventional 0.13 μm CMOS technology for 20 GHz communications. Variants of conventional CMOS transistors, built on sapphire instead of bulk silicon, offer additional HF performance, while preserving the attractiveness of CMOS. HI-MISSION will explore this for security radar applications.
A key development in mobile communications will be wireless access and transport networks with higher bandwidth and capacity. This will need higher operating frequencies – requiring low cost microwave technologies. The targeted development of HF modules will help ensure availability of communication services to citizens and result in less demand for land transport. Such highly integrated microwave modules will offer improved HF properties and lower costs than available today.
The components and subsystem level demonstrators proposed in HI-MISSION will contribute also to the key EU policy objective of universal integrated services by using them in mobile Internet – enabling citizens to access services wherever they are, whenever they want. An important supplement will be global positioning system (GPS) devices, integrated with the other communications systems.
Success in this MEDEA+ project will strengthen the competitive position of Europe in advanced telecommunications and radar devices for automotive and security applications, increasing market share and exports, and providing jobs and wealth. HI-MISSION will provide an advanced technology enabling an effective counter balance to collaborative research and development activities outside Europe.

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MEDEA+ Σ!2365 is the industry-driven pan-European programme for advanced co-operative R&D in microelectronics to ensure Europe's technological and industrial competitiveness in this sector on a worldwide basis.

MEDEA+ focuses on enabling technologies for the Information Society and aims to make Europe a leader in system innovation on silicon.