Project profile

Cluster for Application and Technology Research in Europe on NanoElectronics

CT209 | From RF to MMW and THz silicon SoC technologieS [RF2THZ SISOC]

PROJECT CONTRIBUTES TO

Communication	✔
Automotive and transport	✔
Health and aging society	✔
Safety and security	✔
Energy efficiency	
Digital lifestyle	
Design technology	✔
Sensors and actuators	
Process development	✔
Manufacturing science	
More than Moore	✔
More Moore	
Technology	55 nm

PROCESS DEVELOPMENT

Partners:
Advanced System Developments and User Services
Agilent Technologies
Alcatel Lucent
Astra SES
Robert Bosch
Bruco Integrated Circuits
CEA-LETI
ENSICAEN
ESIEE Paris
Fraunhofer Institute
Grenoble Institute of Technology
IEMN
IES
IHP
IMS
MASER Engineering
Micram Microelectronic
NEWTEC
NXP Semiconductors
Salland Engineering
Silicon Radar
STMicroelectronics
SynView
Telecom Bretagne
TU Berlin
TU Delft
TU Dresden
TU Eindhoven
Uni Saarland
XMOD Technologies

Project leader:
Jean-Louis Carbonero
STMicroelectronics

Key project dates:
Start: July 201
End: December 2014

Countries involved:
Belgium
France
Germany
Luxembourg
The Netherlands

To meet the needs of future radio frequency (RF) and high-speed equipment, the CATRENE RF2THz project aims to develop silicon technology platforms for emerging RF, millimetre-wave (MMW) and THz consumer applications such as 77/120 GHz automotive radars, MMW imaging and sensing, fast measurement equipment, 60 GHz wireless networking and fast downloading systems, 400 Gbit/s fibre optics data communications systems, 4G photonic mobile communications and high performance RF wireless communication systems as well as two-way satellite communications systems. It also targets MMW and THz applications in health science, materials science, genetic screening, security and industrial automation.

European communications equipment suppliers are only able to be competitive against their Far East rivals through higher performance enabled by innovative products based on the latest semiconductor technologies. They rely on early access to powerful microelectronics technology platforms to maintain their leading position worldwide. Successful research and development (R&D) on ultra-high-performance communications equipment must therefore be based on the close interaction of all players in the vertical technological supply chain.

Until now, relatively little effort has been made to close the THz frequency gap in the application spectrum of microelectronics communications technologies. The CATRENE CT209 RF2THZ SISOC project will focus on the technological and design-related prerequisites for the necessary THz-range applications.

As this discipline is still in its infancy, it is necessary to prepare the foundations. The close co-operation of experts from technology development, design methodology and application areas will accelerate the necessary process enormously. Consequently, European manufacturers may be able to gain a leading position and be the first to place applications on this important future market.

New BiCMOS technologies

RF2THZ SISOC will involve development of new bipolar plus CMOS (BiCMOS) technologies. For this purpose, one of the partners will integrate and optimise silicon-germanium (SiGe) heterojunction bipolar transistor (HBT) and back-end modules developed in previous projects in an advanced 55 nm CMOS technology. This will make possible a 0.5 THz 55 nm SiGe BiCMOS platform suitable for RF, MMW and THz system-on-chip (SoC) applications.

One partner will follow an integral approach to focus on improvements and breakthroughs in BiCMOS technology for the essential high-performance passive RF components. The necessary MMW packaging and the required RF testing solutions will also form part of this project. Another partner will develop silicon photonics devices for future silicon photonics foundry offerings.

After optimisation, characterisation of the THz, MMW and RF components will be carried out and models will be adapted and model parameters extracted. Design blocks will be developed both for full function integration and for design-for-test (DfT) or built-in self-test (BIST) introduction and full demonstrators will be assembled. Exploration of some promising advanced applications will also take place.

Three project partners have complementary technologies so they aim to collaborate to address directly different portions of the THz, MMW, RF and photonic markets. Furthermore, the development of high performance passive devices will be used as input for benchmarking back-end performance of 55 nm BiCMOS technology.

Two project partners will co-operate on photonics device development in the new BiCMOS technology to preserve the future integration of such components together with the high level digital integration required for SoC applications in a European foundry.

Challenging global competition

This CATRENE project builds on one of the strongest European fields of expertise in microelectronics and offers true European differentiating technologies with respect to US and Asian foundries. Consequently, it will strengthen European R&D and microelectronics businesses.

RF2THZ SISOC represents a European counterbalance to the US Defense Advanced Research Projects Agency SWIFT programme. It will strengthen the discipline of RF circuit and system design, which has been traditionally strong and vital in European countries such as Germany. This will help avoid future dependence on expertise from the Far East or other markets outside the EU. The combination of photonics and extremely fast high-performance microelectronics should represent serious competition to developments at the Massachusetts Institute of Technology and IBM in the USA.

The MMW market segment has historically been held by III-V semiconductor technologies. Due to the high manufacturing cost, high power consumption and limited integration scale of those technologies, this market has remained limited as a niche by comparison with the total semiconductor market.

However, the situation is changing rapidly, with silicon now being considered as the default semiconductor material for addressing more and more applications. This is due to a significant increase in the frequency performance of active silicon devices – cut-off frequencies ft/fmax, larger than 300 and 500 GHz respectively, are targeted by SiGeC bipolar transistor devices – an fmax of 425 GHz has already been reached at room temperature.

Higher degree of integration

With regard to radar transceiver applications at 77 GHz and above, all of the main critical circuit building blocks, such as low-noise amplifiers, mixers, voltage-controlled oscillators and power amplifiers, have now been demonstrated.

Thanks to the MEDEA+ SIAM project, a MMW SiGeC BiCMOS technology is now available in Europe for the full integration of complex systems operating at MMW frequencies. For the integration of future full systems operating at higher frequencies – at or above 100 GHz and approaching the THz domain – or for RF and MMW, very low and ultra-low-power systems together with a higher level of digital integration require a dedicated THz SiGeC BiCMOS technology, which is currently not available in Europe.

A higher scale of digital integration is mandatory not only for complex SoC realisation but also to allow more and more signal treatment; pre- and post-distortion; on-chip calibration; process, voltage and temperature compensation; and DfT and BIST, as well as the implementation of analogue, RF and MMW performance enhancement being developed in the ENIAC MIRANDELA project.

Previously, silicon technologies were mainly driven by the frequency performance of the bipolar or CMOS devices. Improvement of these active devices is required between technology generations. However, high performance passive devices and technology back ends are also mandatory to meet application requirements – such as low parasitic capacitance, low-loss transmission lines, high quality factor inductance and variable capacitance – and also have to be improved between generations.

This CATRENE project aims to provide answers to all of these complex issues and is expected to improve business and employment opportunities across the European microelectronics sector.

CATRENE Office
9 Avenue René Coty - F-75014 Paris - France
Tel.: +33 1 40 64 45 60 - Fax: +33 1 43 21 44 71
Email: catrene@catrene.org
http://www.catrene.org

CATRENE (Σ! 4140), the EUREKA **C**luster for **A**pplication and **T**echnology **R**esearch in **E**urope on **N**ano**E**lectronics, will bring about technological leadership for a competitive European information and communications technology industry.

CATRENE focuses on delivering nano-/microelectronic solutions that respond to the needs of society at large, improving the economic prosperity of Europe and reinforcing the ability of its industry to be at the forefront of the global competition.