

High-speed
Communication

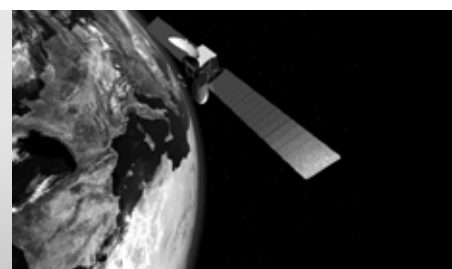
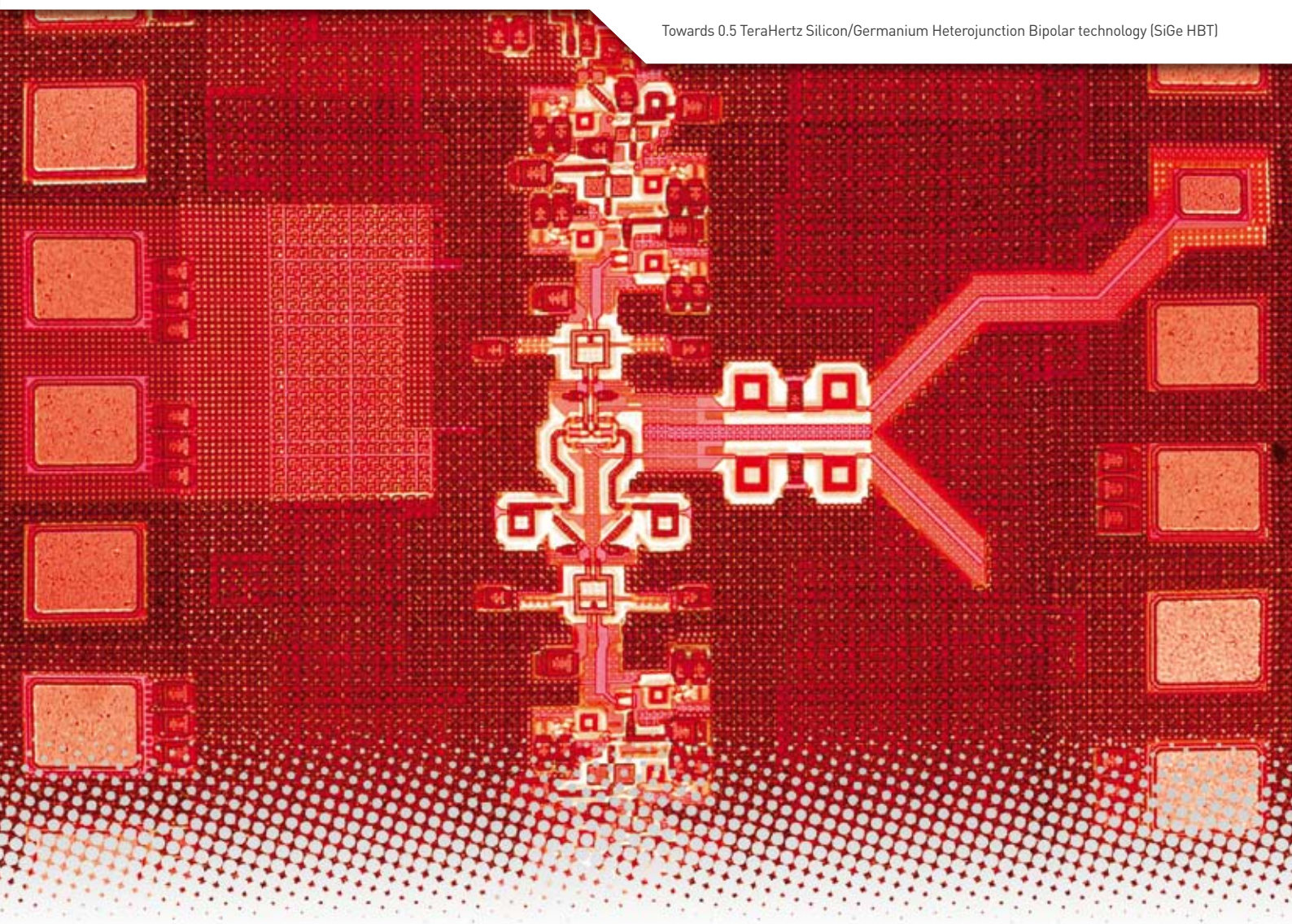
Radar
Applications

mmWave,
THz Imaging
and Sensing

• **5^{THz}** dot **five**



Towards 0.5 TeraHertz Silicon/Germanium Heterojunction Bipolar technology (SiGe HBT)



A European Integrated Project supported through the Seventh Framework Programme for Research and Technological Development.



Objective:

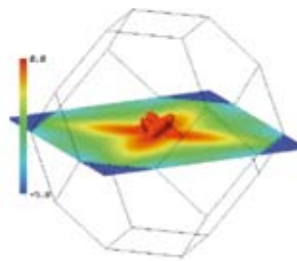
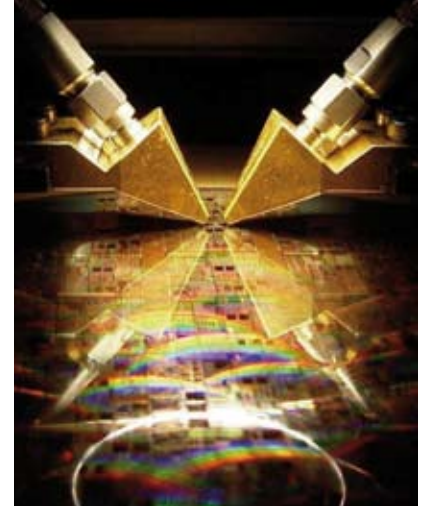
To develop transistors functioning at 500 GHz at room temperature, a performance which is currently only possible with very expensive technology, making it difficult to integrate functionalities for large volume consumer applications.

DOTFIVE is a three-years ambitious project focused on advanced RTD activities necessary to move the Silicon/Germanium Heterojunction Bipolar Transistor (HBT) into the operating frequency range of 0.5 TeraHertz (THz) (500 GigaHertz GHz).

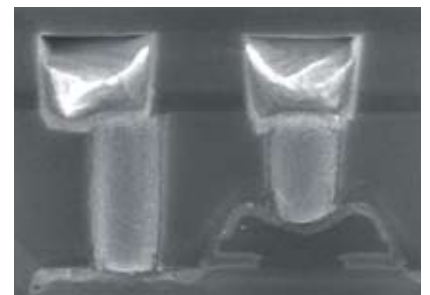
The project will enable the future development of communications, imaging or radar Integrated Circuits (IC) working at frequencies up to 160 GHz. For a given lithography node bipolar transistors and more recently HBTs have always led the frequency race compared to MOS devices, while offering higher power density and better analogue performances (transconductance, noise, transistor matching).

The main objective of this highly qualified consortium is to establish a leadership position for the European semiconductor industry in the area of millimeter wave (mmW) by research and development work on silicon based transistor devices and circuit design capabilities and know-how.

High-frequency
on wafer probing



Temperature distribution



Quasi-self-aligned SiGe HBT with
collector cavities

Brief history :

The invention of the transistor 60 years ago was the vehicle of a real technical, industrial and societal revolution, all stemming from a small piece of silicon. It was a decisive invention, without which electronics and computing as we know it today would not exist.

Since the invention of the integrated circuit 50 years ago enabling several transistors to be placed on a chip, the number of transistors per chip has doubled every 18-24 months (Moore's law). The resulting productivity gains have made the semiconductor industry a strategic industry in the global economy.

Integrated circuits, essentially based on CMOS (Complementary Metal Oxide Semiconductor) transistor

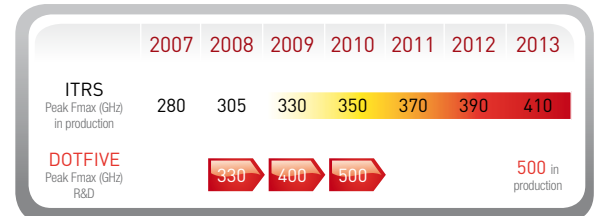
technology, have been the driving force of this revolution, evolving from just a few transistors per chip to 1 billion transistors on the same chip in 50 years.

In parallel to MOS transistors miniaturisation, the miniaturisation of the original bipolar transistors has led to the development of structures known as Silicon-Germanium Heterojunction Bipolar Transistors (SiGe HBTs) whose state of the art has reached (end 2007) a maximum oscillation frequency of roughly 300 GHz (0.3 THz) at room temperature.

The DOTFIVE project has set its goal at 500 GHz at room temperature.

Roadmap and ambitions:

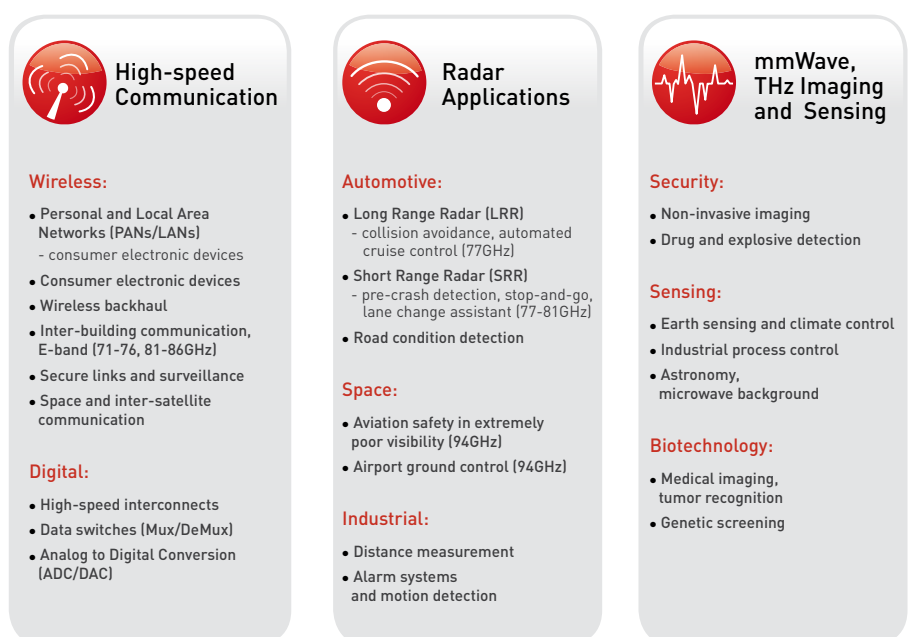
DOTFIVE will strengthen the European semiconductor industry in the area of SiGe heterojunction bipolar transistors technology, particularly for millimetre-wave applications, a field in which both STMicroelectronics and Infineon Technologies are key players. With this project, Europe will be getting ahead of the ITRS roadmap, strengthening its position in an area where the existing ecosystem is already strong.



Comparison between the ITRS¹ and DOTFIVE roadmaps

The new transistors developed by DOTFIVE will be used for designing circuits enabling new millimetre-wave applications such as automotive radars (77 GHz) or WLAN communications systems (60 GHz – Wireless Local Area Network). In addition to these already evolving markets, DOTFIVE technology sets out to be a key enabler for silicon-based millimetre wave circuits with applications in the security, medical and scientific areas.

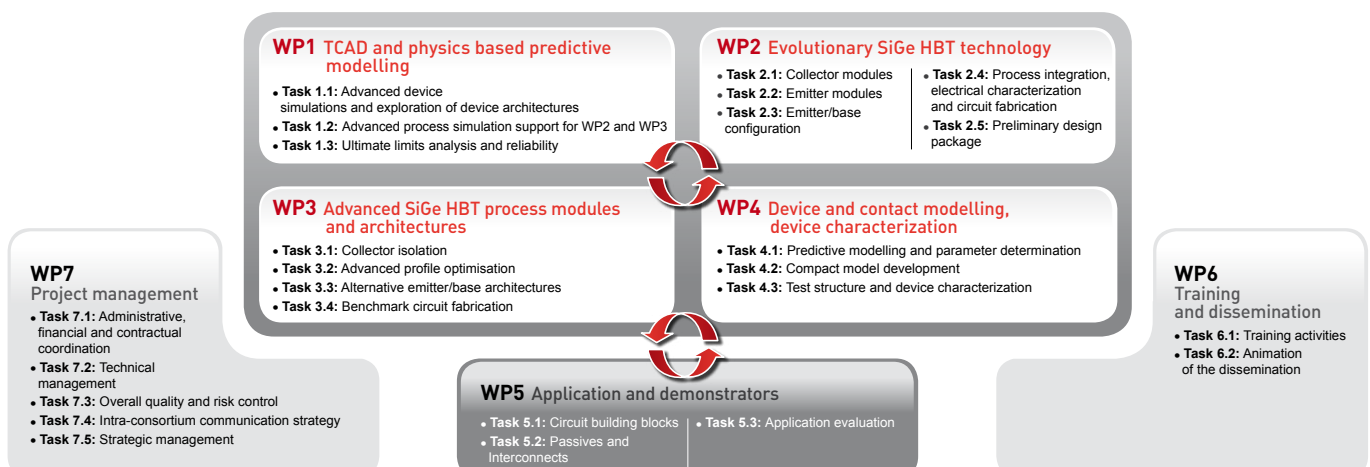
A higher operating speed can open up new application areas at very high frequencies, or can be traded in for lower power dissipation, or can help to reduce the impact of process, voltage and temperature variations at lower frequencies for better circuit reliability.



Potential to Transform Modern Information Society

¹ International Technology Roadmap for Semiconductors. The aim of the ITRS is to monitor the correct economic and technological development of integrated circuits and associated products.

Work organisation:





Consortium :

The consortium has a balanced partnership including:

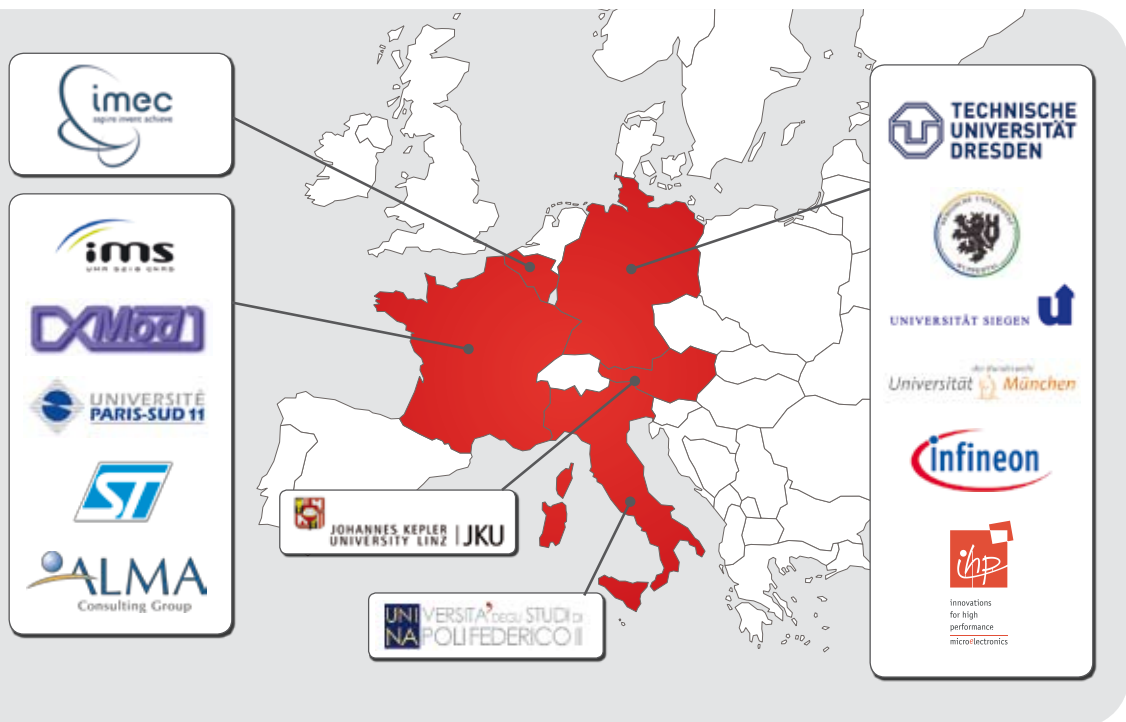
Industry: Infineon Technologies, STMicroelectronics SA & STMicroelectronics SAS, Alma Consulting Group

Small/medium enterprises (SME): XMOD Technologies

Research institutes: IMEC, Innovations for High Performance microelectronics (IHP)

Universities: Johannes Kepler University of Linz, Ecole Nationale Supérieure d'Electronique, Informatique et Radiocommunications de Bordeaux, Paris-Sud University, TU Dresden, Bundeswehr University in Munich, University of Siegen, University of Wuppertal, University of Naples

In order to reach these ambitious objectives the consortium consists of 15 partners from industry and academia in 5 European countries:



Acknowledgment:

Supported by the European Commission through the Seventh Framework Programme (FP7) for Research and Technology development with up to 9.7M€, out of a total budget of 14.75M€. The DOTFIVE project addresses the area "More than Moore" targeting heterogeneous Systems-on-Chip (SoC) solutions of the Information Society technologies priority.

The project runs from February 1st, 2008 to January 31st, 2011.

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