3.1 Publishable summary

The project FLEXWIN contributes to a significant advance towards smart RF microsystems by combining

- an RF-MEMS switch process monolithically integrated with a Si/SiGe BiCMOS process,
- highly reconfigurable mm-wave building blocks, able to be used over a broad frequency range and for different applications,
- a new RF-system design paradigm built around the concepts of reusability, multi-functionality and reconfigurability
- environmental sensing and control built into multifunctional RF ICs with digital control.

As first demonstrators of the highly innovative FLEXWIN technology platform, smart antenna architectures for mobile broadband satellite communication links in Ka-band will be realized. In fact, the multi-functional core FLEXWIN ICs will be used as intelligent pixels providing spatial power combining with full individual amplitude and phase settings of each pixel in transmit and receive mode controlled by a serial bus. Together with the monolithic integration of the environmental sensors on the very same IC, it dramatically reduces the antennas control system complexity providing significant advances in RF frontend adaptability.
The validity of the design paradigm will be further explored in two reconfigurable IC demonstrators using the RF MEMS SiGe BiCMOS technology and deliberately spaced in the radio spectrum: reconfigurable "commodity" building blocks up to 5 GHz, addressing mobile and wireless data applications, and for the 24-77 GHz range, addressing point-to-point, and emerging wireless LAN applications as well as radar sensors.

Figure 1 Primary FLEXWIN applications: Mobile SatCom and terrestrial wireless networks

Up to now, the consortium has progressed very well in several key development aspects towards the realisation of the demonstrators. The first step was the definition of the specifications for the three demonstrators

- Smart reflect-array with intelligent pixels for mobile Ka-band SatCom applications
- Smart direct-radiating-array with intelligent pixels for mobile Ka-band SatCom applications
- Reconfigurable micro- and millimetre-wave circuits from 3-5GHz and 24-77GHz

and the subsequent derivation of the parameters for each subsystem and circuits.

Based on these requirements, the architectures of the reconfigurable and multi-functional ICs were defined for the different demonstrators and in a first step, key analogue building blocks of the chips were successfully fabricated and measured. The next developments for the ICs included the design, fabrication and measurement of first partially multifunctional ICs (e.g. power amplifier, vector modulator and switch together on one chip) for the antenna demonstrators as well as the realization of a complete reconfigurable receiver chip for the third demonstrator. Furthermore, the development of the digital control circuitry for the multifunctional ICs, to be integrated on the very same chip, was performed and the designs were successfully tested. Finally, the complete multifunctional ICs for the antenna demonstrators were simulated, designed and are under fabrication. Besides the realization of the chip-sets, the two focal points for the successful development of the antenna demonstrators are the antenna elements as well as the multilayer manifold technologies. On the one hand, a variety of antenna elements was simulated and the most promising ones were chosen for fabrication to realize single-band and dual-band operation of the antennas in the Ka-band. Several passive antenna arrays were fabricated (reflect arrays and direct radiating arrays) and the subsequent measurements confirmed the simulated performance. On the other hand, the architectures and geometrical arrangements of the antenna manifolds, consisting of complex multi-layer structures, were defined and simulations on the thermal as well as on the electrical behaviour were performed. In a next step, the RF-layouts for the manifolds of both antenna demonstrators were designed, fabricated and successfully tested. The final step was the combination of both multilayer boards (antenna elements and manifolds) together with the cooling structure for the active antenna array demonstrators. All components for the two antenna demonstrators are currently under fabrication and will be assembled soon. In preparation for the final performance demonstrations of the antennas, developments were started for the software control and calibration of the antenna arrays. In terms of the underlying semiconductor technology, remarkable results were achieved for the monolithic integration of the RF-MEMS with the SiGe BiCMOS technology including successful demonstration of switches in Ka-Band, dicing and quasi-hermetic packaging of the chips. In addition, extensive reliability tests of the fabricated RF-MEMS devices showed very mature performance.

Overall, the FLEXWIN project demonstrates enhanced and smart capabilities of mm-wave systems due to built-in intelligence allowing convenient and flexible control of important parameters, and the use in harsh environments due to built-in sensing and autonomous parameter adjustment in each module. Further, it will establish reconfigurable multi-functional millimetre-wave ICs as an off-the-shelf commodity, which will ease mm-wave system implementation and shorten the time-to-market.

The official website for the project is:
http://www.flexwin.eu/

The partners in this project are:

EADS Deutschland GmbH	Germany	Coordinator
University of Calabria	Italy	Partner
University of Kent	United Kingdom	Partner
University of Ulm	Germany	Partner
IHP GmbH	Germany	Partner
MIPOT SpA	Italy	Partner
Ericsson AB	Sweden	Partner

The contact data of the Coordinator is:
Dr. Volker Ziegler
EADS Innovation Works
Dept: IW-SI
81663 Munich
Germany
eMail: volker.ziegler@eads.net