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

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 fabricated. 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 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 DC-, thermal and 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 and the multifunctional ICs for the active antenna array demonstrators. All components for the two antenna demonstrators were successfully fabricated and assembled. In addition, the software to address the chips in the antenna arrangement as well as to calibrate the antenna arrays was developed. Currently, the completely assembled antenna arrays are under testing. First promising results are obtained from the active reflect array demonstrator, which was characterized in an anechoic chamber and showed 2D electrical beamsteering at 30GHz. To the best of the consortiums' knowledge, this is the first demonstration of RF-MEMS into an active phased array system. The third demonstrator, the reconfigurable receiver based on the SiGe BiCMOS technology, was successfully tested by the end user Ericsson in a laboratory environment with real LTE signals. 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 demonstrated enhanced and smart capabilities of mm-wave systems due to built-in intelligence allowing convenient and flexible control of important parameters. Further, it has established reconfigurable multi-functional millimetre-wave ICs as an off-the-shelf commodity (e.g. by implementation of IHPs RF-MEMS device into the ADS Design Library), 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

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