IMEC GREEN RADIOS - OPENING NEW HORIZONS IN WIRELESS COMMUNICATIONS

IMEC SMART SYSTEMS

Building a flexible interactive world

imec

TOMORROW'S WIRELESS COMMUNICATION HIGHER THROUGHPUT, MORE FLEXIBILITY, LESS ENERGY

Data traffic in wireless communication systems has increased dramatically over the last decades, and we expect this evolution to continue for many years. At the same time, there is a growing need for more flexible devices with ever more intelligence. Along with these trends come an energy consumption and emitted electromagnetic radiation that are a cause for concern. Therefore, tomorrow's wireless communication systems should radically restrict the energy consumption and radiation, at the same time extending the throughput and flexibility.
The internet of the future will be based on wireless cognitive connectivity with small heterogeneous cells. This architecture allows terminals to set up wireless access via the shortest and best directed available link, leveraging where possible on mm-wave (60GHz) communication. This will boost the capacity while saving on scarce energy and spectrum resources.

Imec's green radio program pioneers design solutions for tomorrow's wireless communications. By exploiting the newest technologies, the power consumption and cost are drastically reduced.

Cutting-edge R&D

01

Cognitive reconfigurable radios

for tomorrow's intelligent, multi-standard terminals. Imec works on front-end, baseband and spectrum sensing solutions in deep-submicron digital CMOS technology.

02

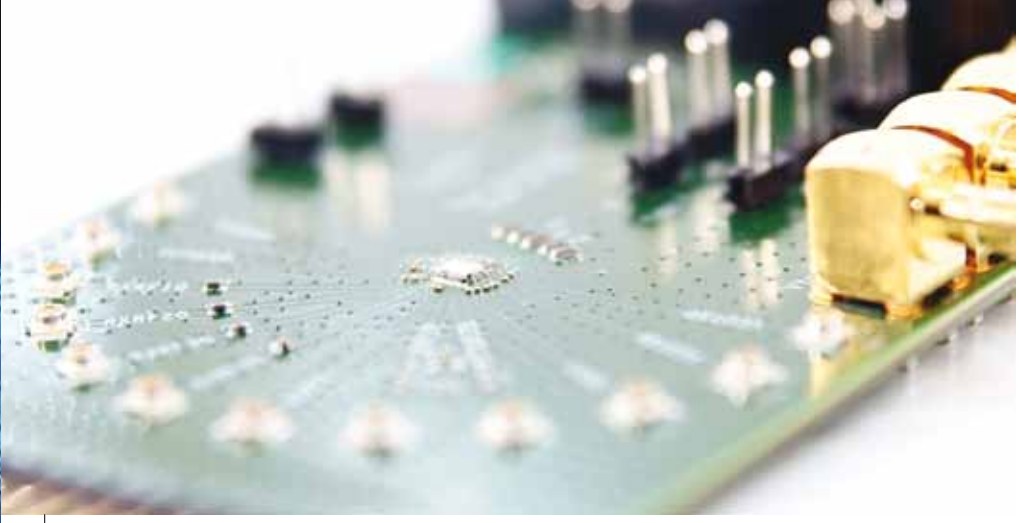
Mm-wave (60GHz) radios

open up new application areas by exploiting unused frequency bands for Gbit/s communication at short range, hereby also potentially reducing the electromagnetic radiation in various access scenarios. Imec focuses on CMOS transceivers and SiP (systems-in-package) technologies for multiple antenna solutions.

03

Ultralow-power radios

for use in tomorrow's ubiquitous wireless transducer systems, such as wireless sensors in intelligent buildings, machinery or body area networks.



01 | Flexible multistandard transceiver in 40nm CMOS technology

02 | Imec's first-generation SDR baseband platform

COGNITIVE RECONFIGURABLE RADIO

A revolution in flexibility, intelligence, and connectivity

01

Building on imec's expertise

Imec's research program on software-defined radios (SDR) has led to a world-recognized expertise and a first generation of SDR solutions:

- a flexible RF transceiver front-end
- a programmable high-throughput baseband platform
- scalable and low-power data converter circuits
- a system design environment
- software solutions for data processing on SDR platforms

The program's focus was on battery-powered terminals, resulting in low-power solutions.

02

Addressing the design challenges for the next generation

02A Seamless connectivity

Ubiquitous and seamless connectivity can be achieved in a heterogeneous network, if both the terminals and the network can be reconfigured to support horizontal roaming (between access points following one standard) and vertical roaming (between access points operating under different standards). This calls for technological answers that support seamless connectivity, at a low cost and with a high flexibility, using reconfigurable radios.

02B Reconfigurable radio platforms for 4G in ≤ 40nm CMOS

target more concurrent streams, higher rates and flexibility, at low cost and power.

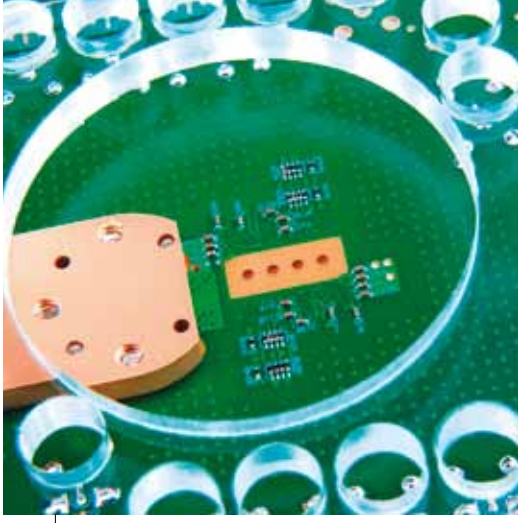
- Imec's reconfigurable radio front-end research focuses on scalable transceivers in cost-effective digital CMOS technology, targeting low power, low cost, high linearity and multimode operation. In addition, digital RF and surface acoustic wave (SAW)-less transceivers are being investigated.
- Imec's reconfigurable baseband research focuses on scalable, low-cost, low-power platforms that can be instantiated for multiple sets of standards and that include sensing solutions, multiprocessors for concurrent multi-stream baseband processing and flexible error coding.

02C Spectrum sensing for cognitive radios

Imec is developing a spectrum sensing engine that analyzes the frequency band occupation. Our solution includes novel signal processing algorithms that trade-off processing cost and sensing reliability, as function of the spectrum use scenario. In parallel, imec looks at radio architectures that allow sensing multiple channels in parallel while having flexibility in tuning the center frequency.

The goal of this exercise is to achieve real cognitive radios. Radios that sense and learn from the environment to autonomously adapt their transmission parameters, with a receiver able to scan a wide frequency range, searching for optimal transmit opportunities.

04 | Imec's 60GHz receive module



05 | Detail of imec's 45nm 60GHz RF front-end

06 | 60GHz wireless demo setup

MILLIMETER-WAVE WIRELESS COMMUNICATION

The quest for higher data rates and the spectrum scarcity makes designers of wireless systems explore higher frequency bands, such as the recently allocated 57-66GHz unlicensed band. This band is available throughout the world and allows multi-Gbit/s wireless communication. A disadvantage of such high-frequency communication, namely its high propagation attenuation, turns into an advantage for short-range applications (up to 10m): immunity to interference, high security characteristics and frequency reuse. A whole range of new applications comes into sight, from uncompressed video distribution in the home, fast downloads of Gbytes of data at video kiosks, to Gbit/s wireless connections between laptop and printers.

Traditionally, millimeter-wave radios rely on III-V technology and, more recently, on BiCMOS. Today, the advances in CMOS technology enable smaller transistors with a higher switching speed, making them suitable candidates for the analog circuits in millimeter-wave radios. This technology allows combining the analog radio with the digital radio baseband on one chip, resulting in a smaller, cheaper, single-chip radio. The demand for such low-cost, small-sized millimeter-wave modules also requires integrating the antenna with the CMOS chip. When high-performance solutions are targeted, this may involve a large number (16 or more) of very small (due to the high frequencies) antenna elements.

01

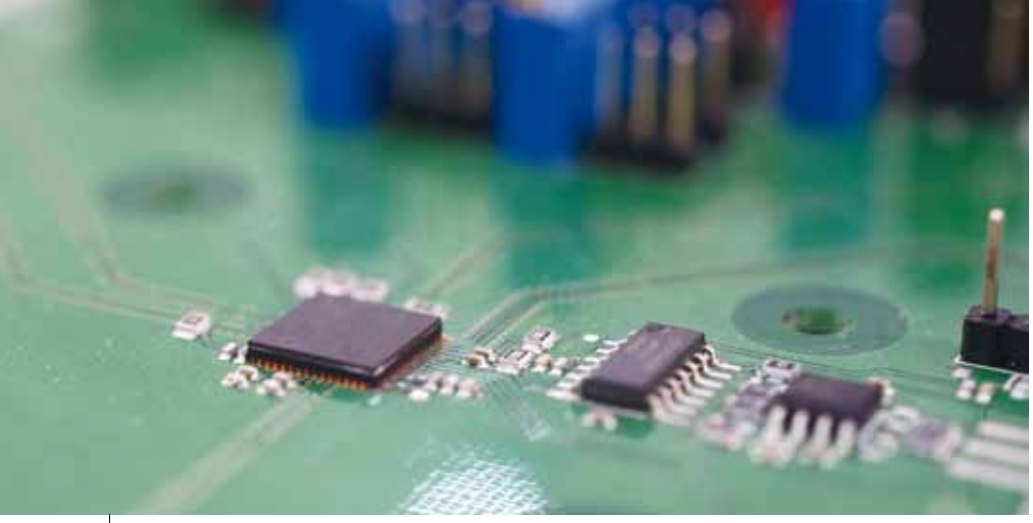
Building on imec's expertise

Imec has a longstanding expertise in broadband and MIMO systems, RF and millimeter-wave CMOS circuit design, and millimeter-wave integration (for antenna and antenna interface) SiP (systems-in-package) technologies.

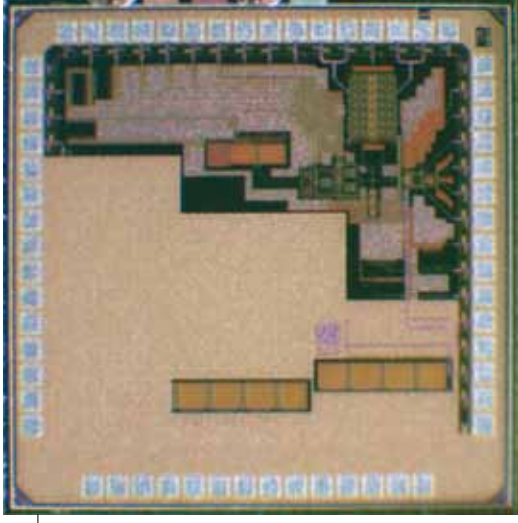
02

Addressing the design challenges for the next generation

The key design challenges for millimeter-wave communication are low area, low power, CMOS integration, system-level modeling, development of beamforming techniques, calibration and compensation, coping with variability in deep-submicron CMOS, integrated antenna arrays, and advanced packaging strategies.



07 | Test PCB with imec and Holst Centre's wake-up receiver



08 | Die of wake-up receiver

ULTRALOW-POWER WIRELESS COMMUNICATION

Today's wireless transducer systems typically use Bluetooth or ZigBee chipsets, or they use proprietary radios that operate most often in the ISM band. The autonomy of such systems is seriously limited by the power consumption of the radios, typically 80% of the sensor node's total power budget.

Imec and Holst Centre, an open innovation center set up by imec and TNO, are looking into techniques and devices that reduce this heavy power drain. The power consumption of these novel wireless communication chipsets is 10 to 100 times lower than the commercial equivalents.

These solutions are a key enabler for a new generation of wireless sensor networks, to be used in wireless body area networks (WBAN), machinery, or intelligent buildings. They allow a drastic autonomy, a much smaller form factor thanks to a reduced battery size, or the inclusion of more intelligence in the sensors.

Imec and Holst Centre develop and implement the analog front-ends and the required baseband algorithms, and integrate them in silicon. Also the essential features of the MAC are implemented. These functions are integrated in small form-factor prototypes, either SoC (systems-on-chip) or SiP (systems-in-package) that can be used for demonstration purposes.

Imec and Holst Centre are currently focusing on three types of radios, each optimized for a set of applications.

01

Impulse UWB radios

offering a unique combination of medium to high data rate (0.1 to 20Mbps) with record low power consumption (less than 5mW @ 1Mbps). Ideal for real-time streaming of a continuous flow of data. Our impulse UWB radios support the IEEE 802.15.4a and IEEE 802.15.6 standards.

02

Narrow-band radios

optimized for ultralow power WBAN, and operating in the worldwide available 2.4GHz ISM band. Our narrow-band radio is aligned with the emerging IEEE 802.15.6 standard for body-area networks.

03

Event-driven radios

operating in the 2.4GHz ISM band and consuming only 50µW when permanently scanning the reception channel. These can be used as low data-rate radios in, e.g. active RFID applications, or as a wake-up radio, i.e. a secondary radio that is used to wake up the main radio on request.

LET US COLLABORATE TO TAKE ON THE WIRELESS CHALLENGE TOGETHER

What we offer

- Imec offers a variety of business solutions and dynamic interaction models. These range from research collaboration at various levels of scope and depth to license agreements and transfer of IP and building blocks. Deliverables may include system-level models and exploration, design databases for IP components, and complete transceivers, processor and compiler solutions, design flows and approaches, case studies, and consultancy.
- In imec's collaborative research model, companies join the research programs based on a model where the cost, the risk, and the results are shared amongst the partners, giving them access to a large pool of IP at only a fraction of the cost. Typically, resident engineers from the partner companies join the research teams at imec to jointly develop new IP.

Potential partners

Imec teams up with companies across the value chain of the electronic devices market. Some use imec's know-how and prototypes to accelerate the development of their next-generation ICs. Others primarily want to get early access to system demonstrators to start the development of breakthrough end-user products before the commercial ICs for these products are available.

Target companies are:

- IDMs, fablite, and fabless companies
- EDA vendors
- Baseband platform and processor suppliers
- Dedicated modem vendors
- Error coding vendors
- Baseband software providers
- Hearing aid companies
- Biomedical BAN vendors
- Consumer BAN vendors
- Active RFID & RTLS providers

Why imec?

- Imec has pioneered low-cost, low-power, breakthrough wireless system solutions for over 15 years in the area of satellite communication, GPS, WLAN-OFDM, MIMO, turbo coding and software defined radio, and has transferred this technology to numerous companies for commercialization.
- For over 20 years, imec has developed innovative design technologies for wireless systems. These technologies have been adopted by several industrial players and have led to the creation of several spin-off companies.

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