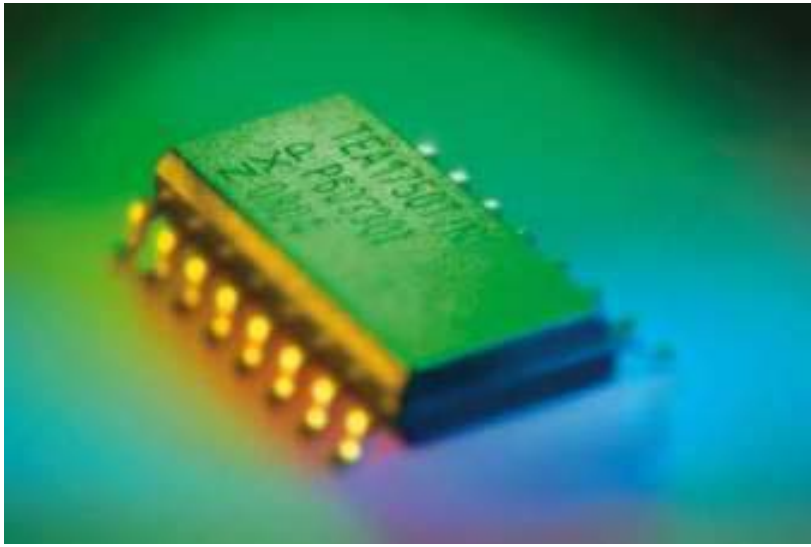
Better together in a new semiconductor era

Open innovation for new wireless systems and applications

CWTe 2010 fall Research Retreat
Dr. Hans Rijns
Vice President – Head of NXP Research

Outline

- Better together in a new semiconductor era
- Open innovation for new wireless systems and applications
- Summary



Semiconductor industry trends

From business driven …

… to customer driven ….

to society driven …

Health & wellness | Transport & mobility | Security & safety

Energy & environment | Communication | E-society

…or: from living faster to living better

a paradigm shift in the chips industry

Productivity era		Value add era
Making life faster	→	Making life better
Mainstream markets	→	Niche markets
Cost driven function integration in System on Chip	→	Function – technology optimization
Digital, Moore's Law	→	"More than Moore"

Today

Society trends drive innovation

Energy – sustainable, energy efficient

Health – affordable, personalized, self-diagnostics

Mobility – green, comfortable, efficient, safe

Security – low power, fit for purpose, secure & private

- growth driven by consumer demand and governmental regulations
- introducing new systems and application functionality
- strong interaction with analog physical domains of outside world: HPMS

... Driving growth for High Performance Mixed-Signal solutions

High Performance

Functional Performance

- Speed, bandwidth, bit-rate
- Accuracy, resolution
- Gain
- Linearity, dynamic range

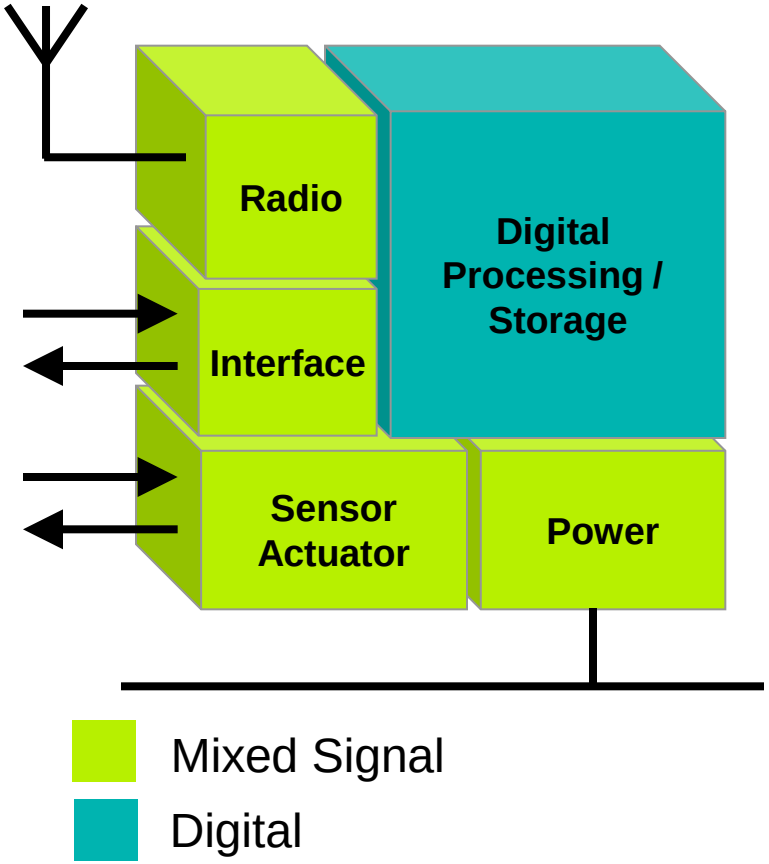
Efficiency

- Power
- Cost
- Autonomy

Robustness & versatility

- Reliability
- Withstand harsh environments
- Flexibility
- Adaptability

Mixed Signal is the optimized mix of analog and digital



What does it take to win ?

- Create broad competence access to new application-domain know-how
- Mastering system architecture optimization with concurrent design space exploration
  - global function optimization, local sub-function differentiations
  - diversity-of-thought for alternative design styles
- Accelerated technology explorations
  - active collaborative scouting; address new technology frontiers with sufficient critical mass
- Establishment of globally-recognized, regionally-cooperating industry-academia knowledge centers
  - Put our “flag on the mountain” and secure labor market

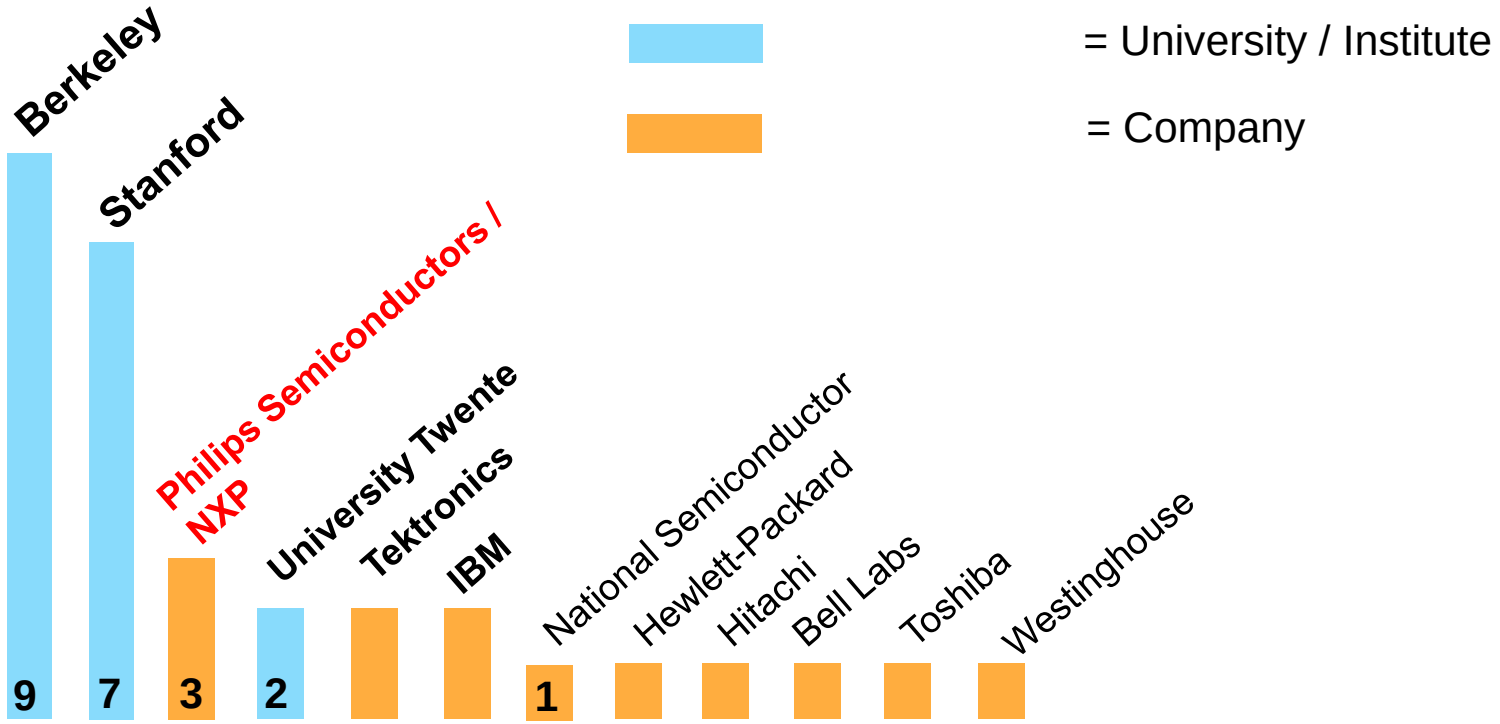
Where do we come from ?

Current situation in The Netherlands

- The Netherlands has been a top player in Mixed Signal Electronics
  - Three technical universities with solid papers on leading conferences
  - Institutes: TNO, Holst
  - Semiconductor companies: AxiomIC, Broadcom, Bruco, Catena, National Semiconductors, NXP, SiTEL
  - OEM companies: Philips, Thales, FEI, OCE, ASML
- But, the position is weakening
  - Number of students in Mixed Signal is rather low
  - Long term research in Mixed Signal is poorly funded
  - Companies mostly focus on short term business wins
  - Ample opportunity for improved alignment between above stakeholders

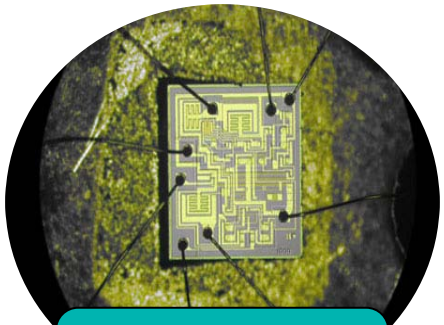
We are strong in HP Mixed Signal

Ranking on the list of Scientific articles cited 100 times or more in *IEEE Journal of Solid State Circuits*

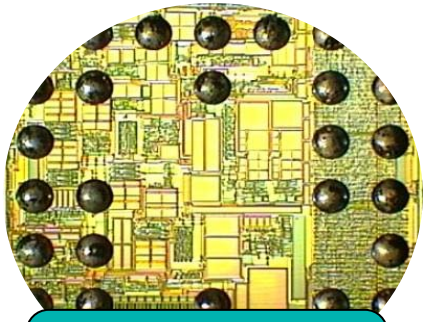


We are strong in HP Mixed Signal

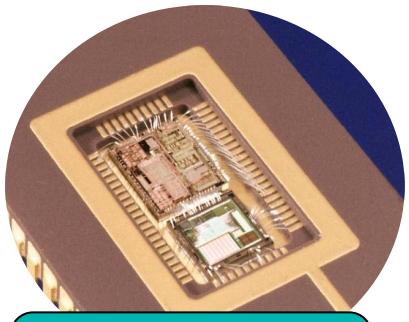
“Microchips that Shook the World” (IEEE Spectrum)



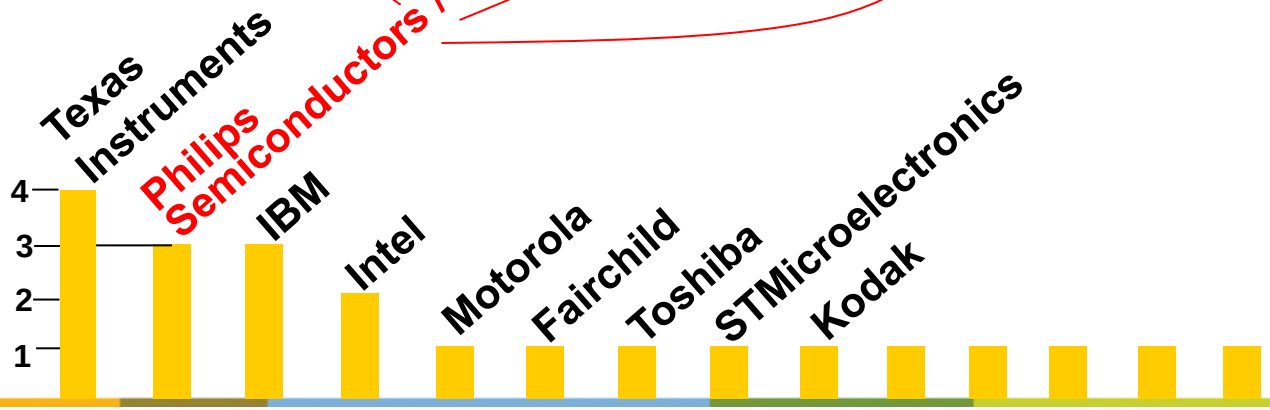
1971 NE555
Timer device



1983 TDA7000
FM receiver



1999 TDA93xx
One-chip TV



The Ambition

Be a top league player in High Performance Mixed Signal

- By defining and executing an ambitious research program at the universities
  - Well aligned between the three technical universities
  - With a healthy mixed of long, mid and short term research projects
  - That is attractive for top quality students
  - Inspired by industrial (long) term problems and grand challenges
- By further growing a healthy industry
  - With top talented people
  - Working on innovative product *solutions* addressing societal challenges
  - Collaborative learning with the academia
  - Collaborative creation with partners in the value chain
  - Collaborative pre-competition with competitors

The Approach

- How
  - Long and mid term program executed by academic staff, PhD students and Postdocs
  - Mid to Short term projects executed by academic staff together with industrial engineers, whenever appropriate
  - An advisory board of academic and industrial experts to drive the strategy and program content
- Funding model (initial target: 6 MEuro/year)
  - Long term program: NWO
  - Mid term program: STW
  - Short term program: Industry

The Actors

- The three technical universities
  - TUD: department of Electrical Engineering, Mathematics and Computer Science, DIMES
  - UT: department of Electrical Engineering, Mathematics and Computer Science
  - TU/e: department of Electrical Engineering
- Sponsors: NWO, STW, Industry
- Industrial Partners in High Performance Mixed Signal Semiconductor:
  - NXP, National, Broadcom, Bruco, Catena, Axiom IC
- OEM companies with need for mixed signal electronics experts
  - Philips, Thales, OCE, FEI, ASML

The benefits for universities

- A well balanced ambitious program running over the three technical universities and at various technical institutes like TNO and Holst
- A program that is attractive for students due to the application oriented focus
- State of the art shared infrastructure for advanced equipment with investments by technical universities, institutes and industry
- A program that has strong ties with the industry allowing advanced concepts to be validated in industrial applications
- A program that will lead to many publications and patent filings.

The benefits for industry

- Execution of an ambitious long and mid term research program at universities that is very well tuned towards industrial ambitions
- Training of top talented students
- Strong co-operation between industry and university partners, leverage of own resources
- Breeding ground of new ideas and business opportunities due to co-operation between scientific and industrial partners in the value chain

The benefits for The Netherlands

- Strong scientific and industrial R&D in the Netherlands leading to
  - Integral approach to validate scientific results
  - New business opportunities on the basis of further improving existing strengths at universities and industrial partners
  - Scientific reputation of the Dutch technical universities
  - Anker stone for local Labor market
- Industry addressing a number of societal problems like energy, health, environment, mobility.

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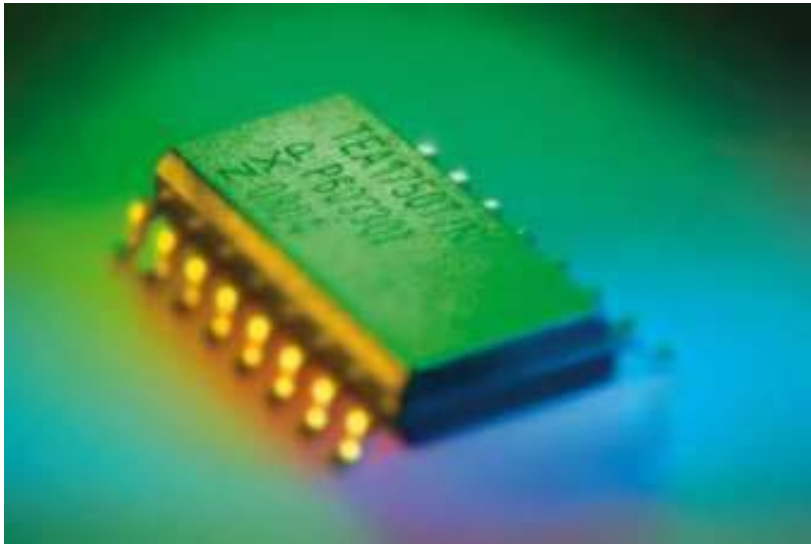
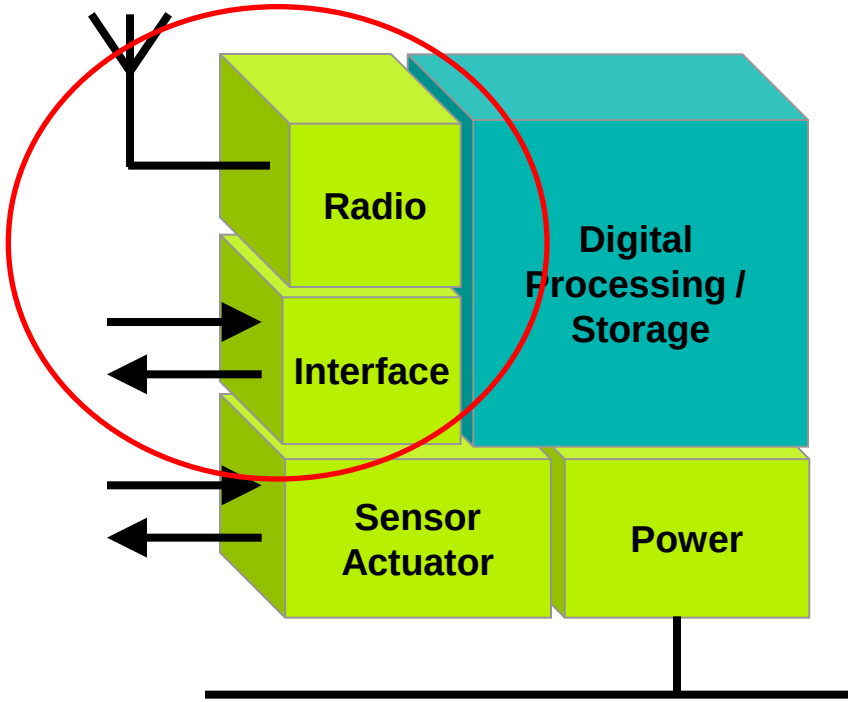


New Wireless Systems and Applications

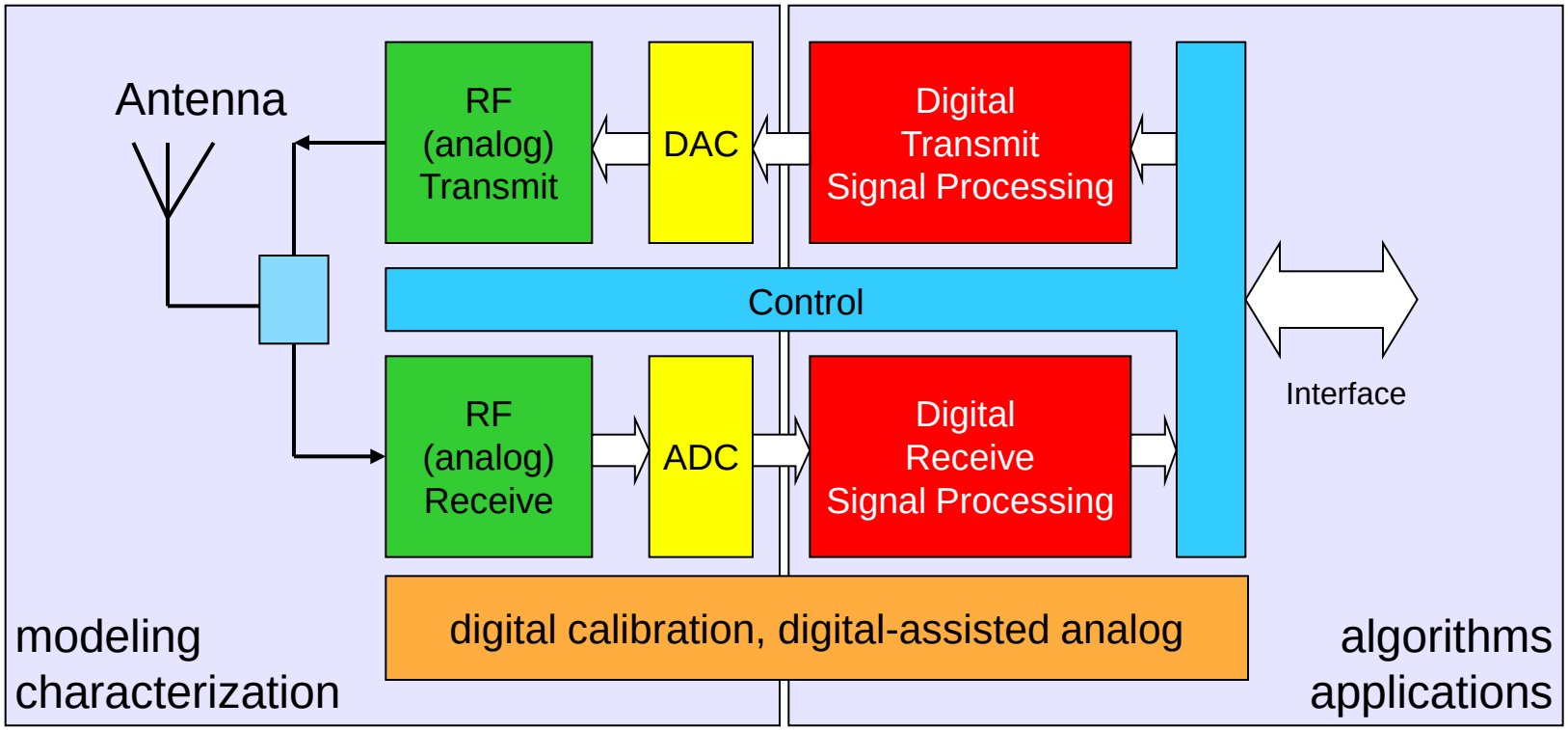
TRANSCEIVERS



Mixed Signal

Digital

Functional Transceiver architecture

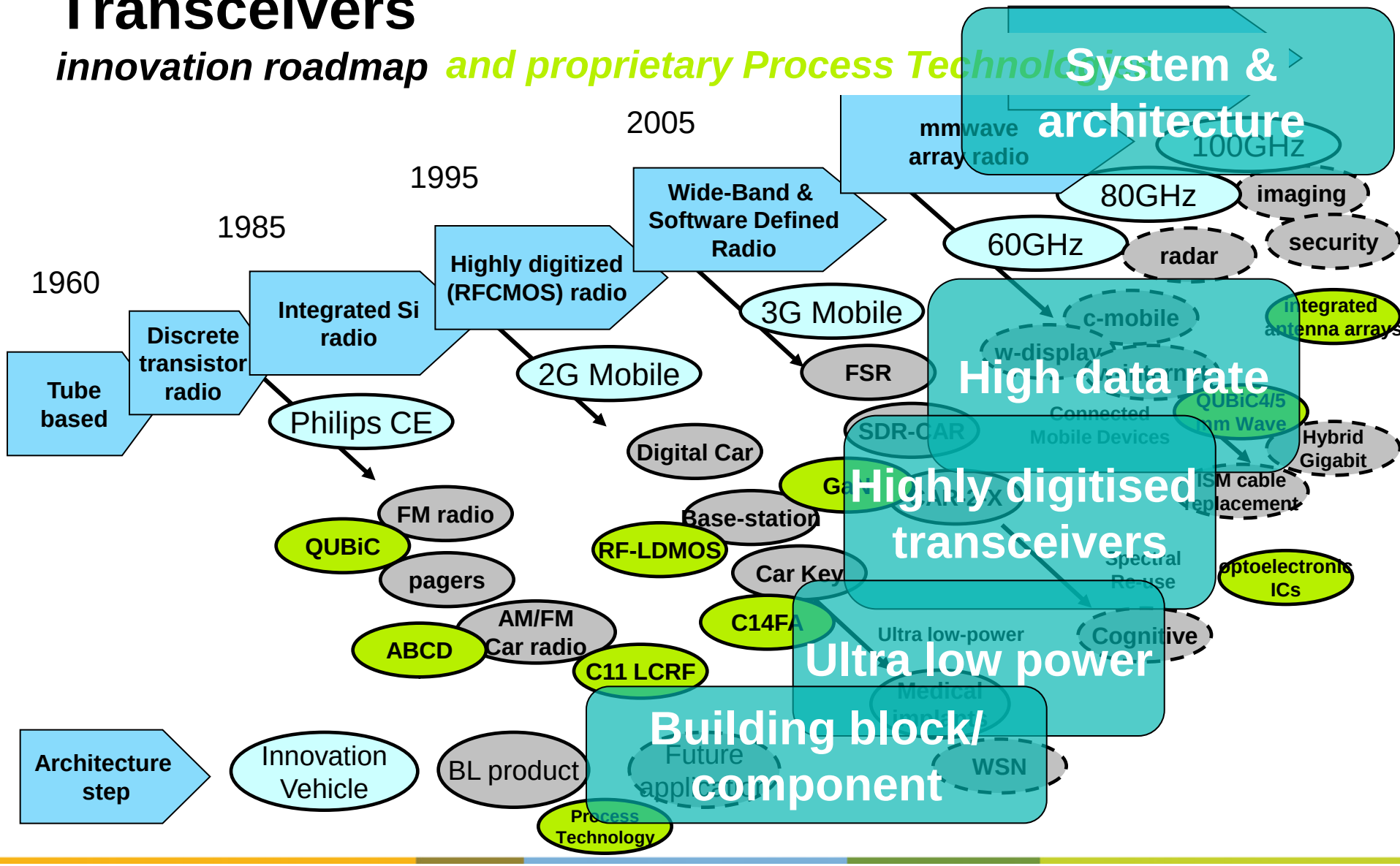


Three distinct innovation layers

- System / architecture -> new applications, QoS
- Circuit design -> wideband-ADC, DPLL, SDR, low-power
- Process Technology -> RFCMOS, QuBIC, GaAS, GaN, RFLDMOS

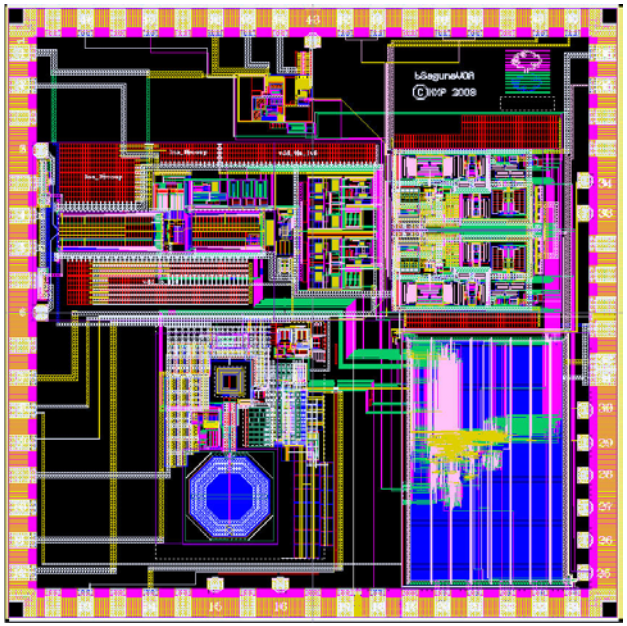
Transceivers

innovation roadmap ***and proprietary Process Technology***



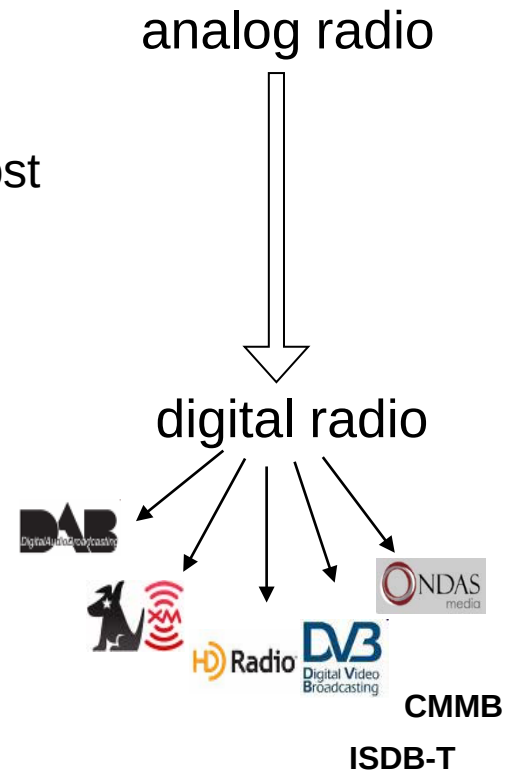
RFCMOS 2-way Car Key (Mantra-C)

- Objectives: long-range, 2-way RF transceiver in C14AMS. Support design methodology to enable fast derivatives.
- Research contributions:
  - Overall RFCMOS architecture
  - Front-end circuit design



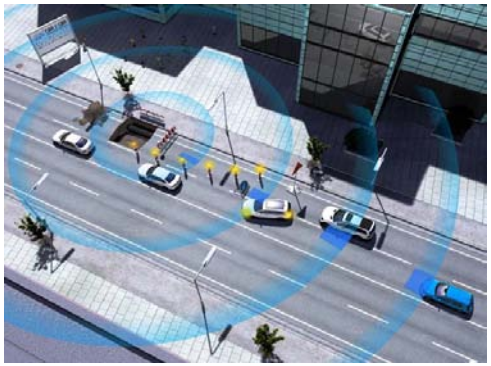
Multi-standard digital Car Radio

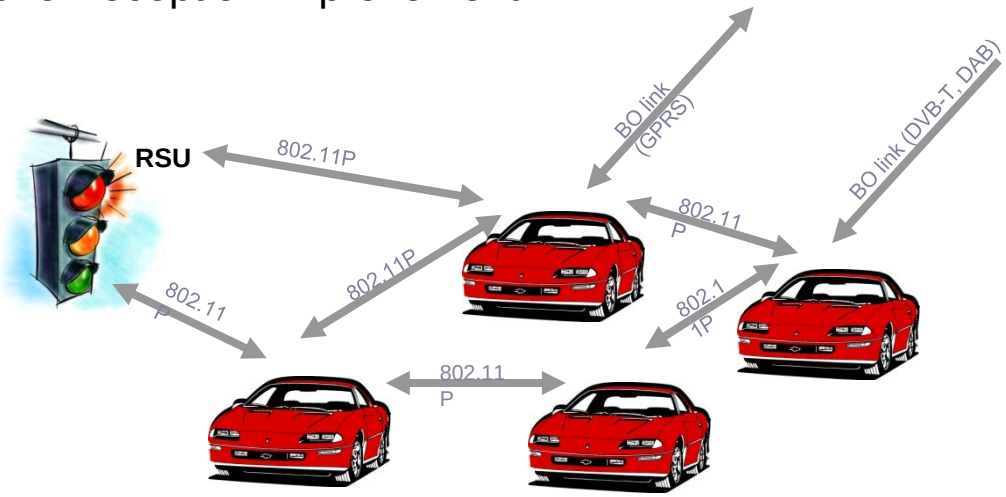
- Objectives: multi-standard, multi-stream SDR car radio, best in class reception performance and reduced system cost
- Research contributions
  - Best-in-class wide-band sigma-delta ADC
  - All-digital PLL for improved spur performance
  - RFCMOS DTV (VHF+UHF) tuner
  - RFCMOS SDARS (L+S band) multi-stream tuner
  - MARS SDR Baseband SW architecture
  - reception quality algorithms
  - porting support of BT, SXM, DAB, HD, ONDAS
  - Joint SDR Innovation program management BL/Research



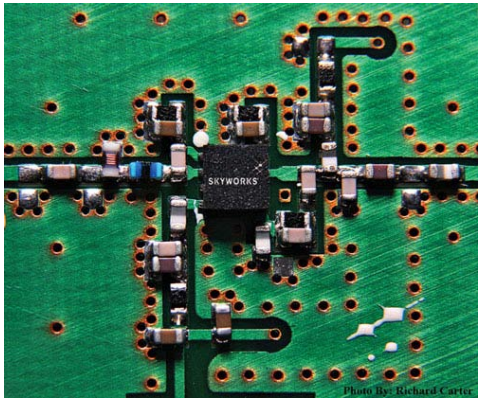
CAR2X communication (SPITS)

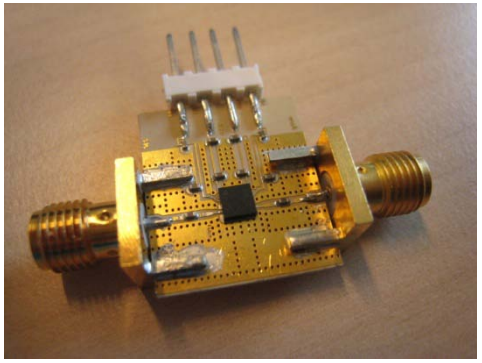
- Objectives: MARS based solution for CAR2X communication for Intelligent Transportation Systems. Differentiate through Best In Class Reception Quality
- Research contributions
  - System partitioning studies for CAR2X 802.11P and SW GPS (GPS, Galileo, Glonass).
  - 802.11P PHY and modem features for reception improvement





low cost QuBIC4x LNA





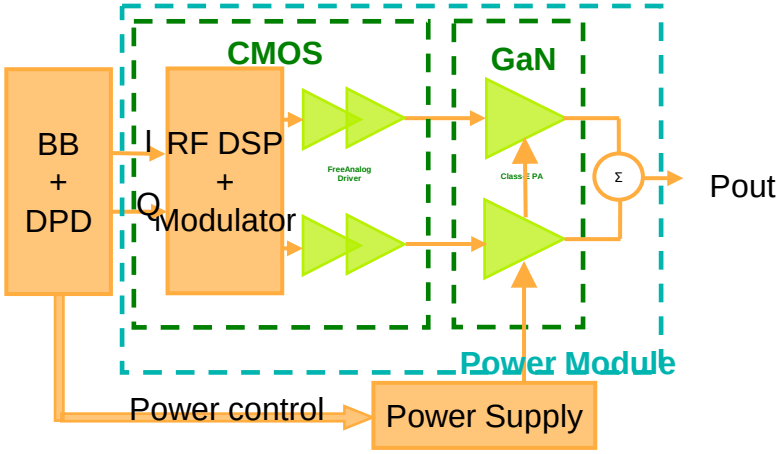
- Objectives: replace state-of-art GaAs base-station LNA with QuBIC4x with integrated ESD and on-chip impedance matching

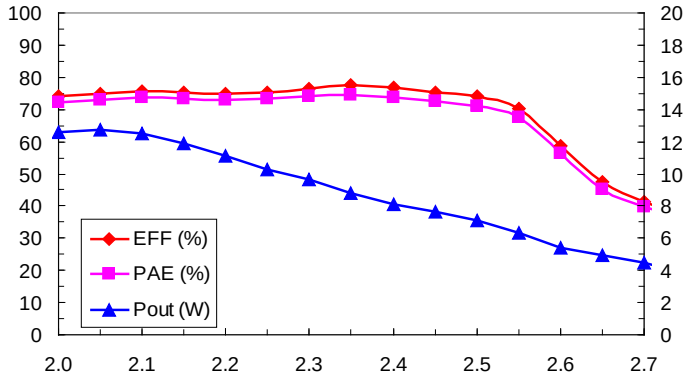
- Research contributions:
  - QuBiC4x process technology development
  - LNA design and device characteristics

Spec	Skyworks GaAs	NXP QuBIC4x
NF @ 1GHz [dB]	0.7	0.75
OIP3 [dBm]	+35	+30
OCP1dB [dBm]	+18	+14
Pdiss [mW]	425	200

Digital base-station transmit

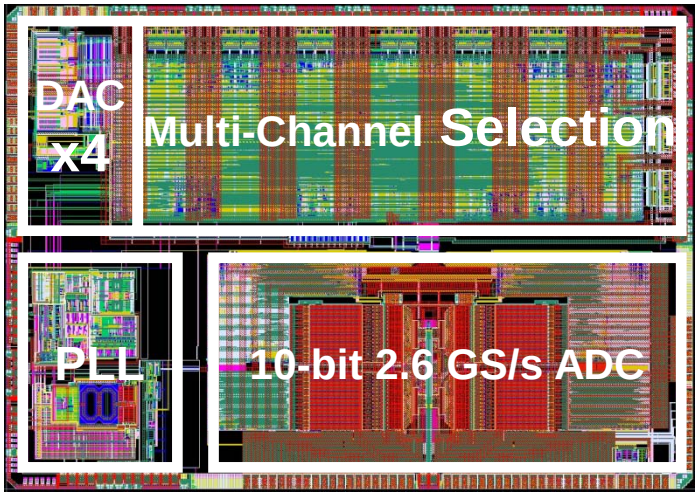
- Objectives: optimize PA efficiency and flexibility
- Research contributions:
  - digital switched-mode architecture and algorithms
  - Wideband power combiner
  - external GaN technology modeling & characterisation
  - FreeAnalog devices and CMOS driver design
  - World-record power efficiency

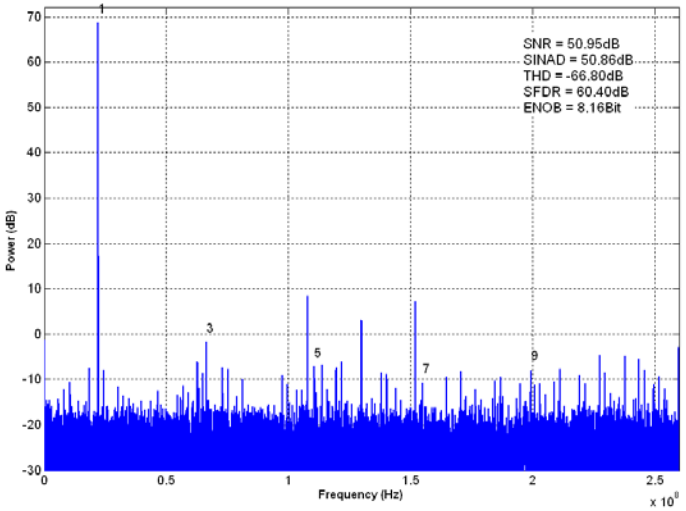




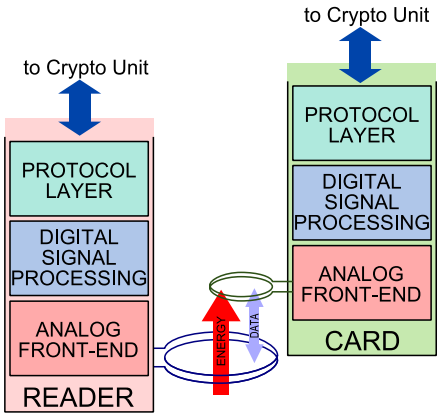
Multi-channel TV Receiver

- Objectives: cost-effective CMOS65 single-chip multi-channel cable TV receiver
- Research contributions
  - state-of-the-art ADC (2.6GB/s, 10b) in 65nm CMOS
  - High-speed Digital Multi-channel selection

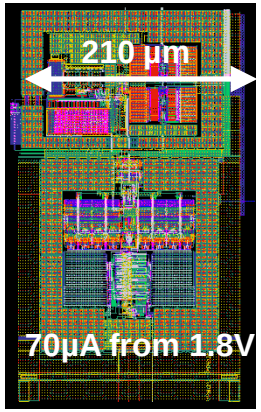


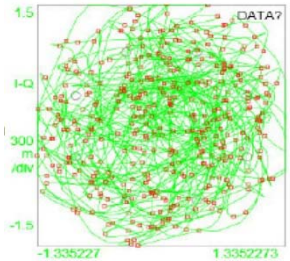


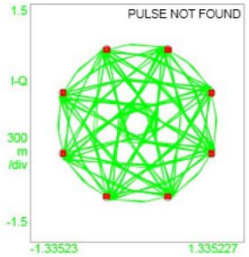
VHD-NFC: from 848kbit/ to 6.78Mbit/s



- Objectives: Increase data rate for contactless identification application (NFC, AFC, ePassport) within same power budget
- Research contributions:
  - introduction new complex phase modulation scheme
  - analog front-end implementation in CMOS14
  - digital non-linear adaptive equalizer
  - compliance to legacy protocol results in 80% of 8x net data-rate improvement
  - reader design by BL Gratkorn







Transceiver innovation directions

- System & Architectures
  - End-2-end , PHY-2-Network layers performance optimization
  - Spectrum-agile Cognitive radio's
  - Distributed / Collaborative radio's (QoS)
- High High-speed / Data-rate
  - mmwave circuit and antenna design
  - New application requirement studies
- Highly digitized radio's
  - Reception quality optimization
  - Extreme digital assistance
- Ultra low power
  - Field powered contactless, dynamic QoS
  - scavenging based, duty cycled wake-up radio's
- New building blocks and components
  - Design Space explorations, Device characterisation & modeling

Open Innovation by 3TU / Industry

- Establish a globally competitive integral Wireless Technologies research program
  - Create critical mass by combined knowledge, experience and resources
  - Based on joint research & innovation roadmaps
  - Manage complexity and efficiency / prevent duplication in activities and ensure optimum transfer of results;
  - Ensure structural alignment university curriculum and industry needs
- Accumulate know-how and ankor results
  - joint creation of system test-beds by multi-sourced design IP for proof-of-concepts
  - share controlled basic design IP repositories
- Shared access of infrastructure (tools, libraries, test facilities, ..) to minimize CAPEX

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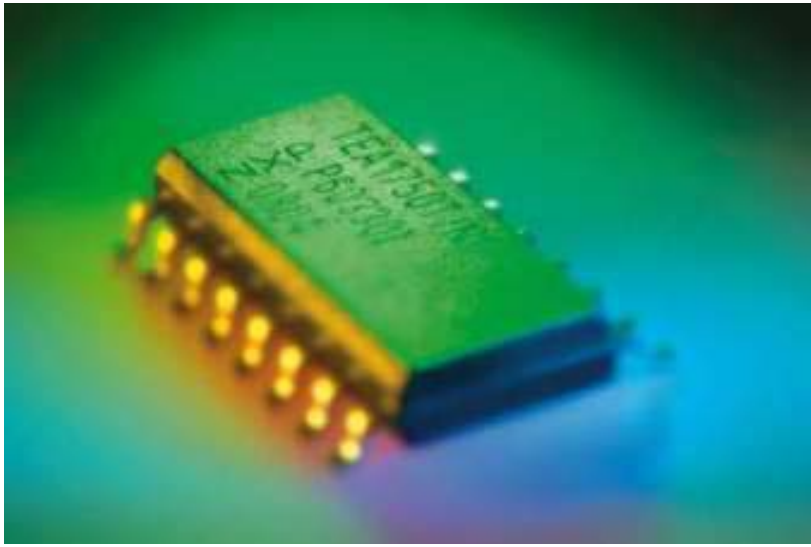
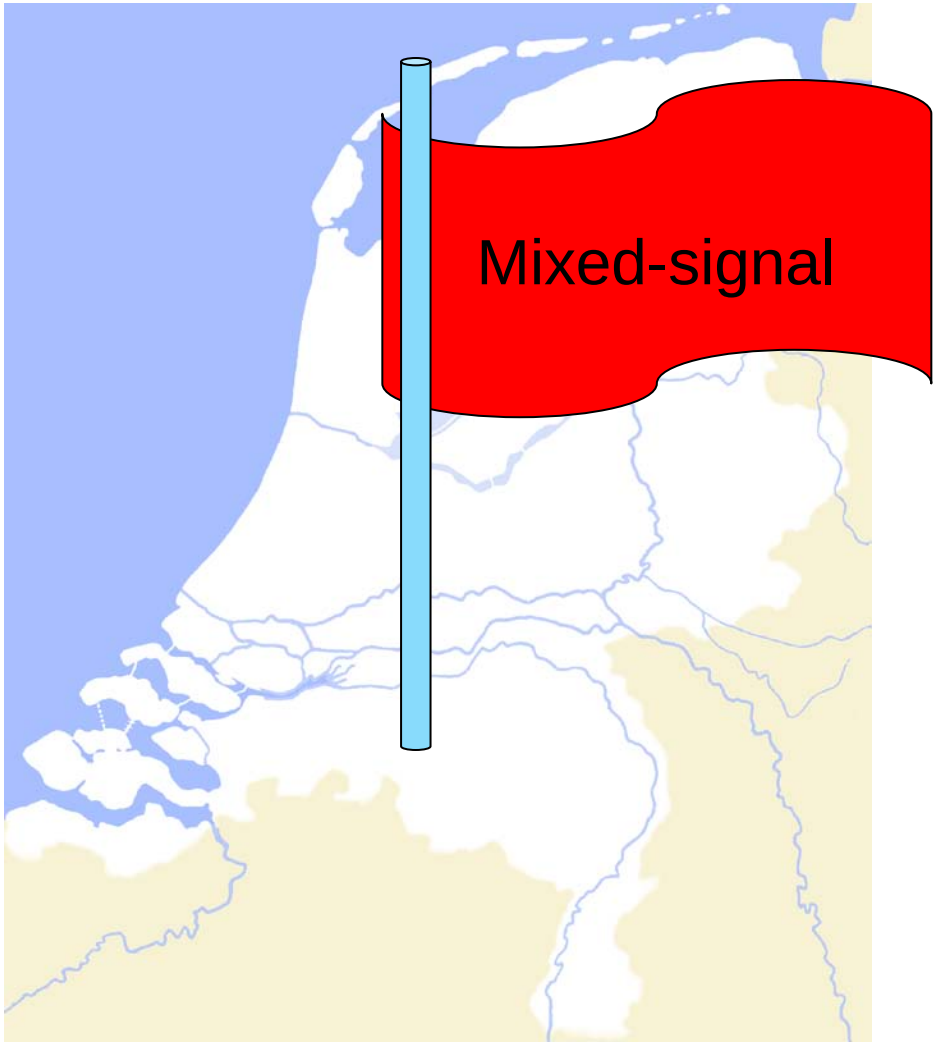


Summary

- Society trends clearly drive semiconductor innovation and business growth in Mixed-Signal area
- The Netherlands can be a TOP player in this field by combining efforts academia and industry
- The Wireless Technology program can be the lead vehicle
- Are we ready to act ?



THANK YOU