



5G Initiative – “5G Roadmap” Working Group

SSCS Contribution – Silicon CMOS/BiCMOS Integrated Circuits for 5G and Beyond

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On behalf of IEEE Solid-State Circuits Society

Silicon-CMOS/BiCMOS ICs for 5G+

■ Topic Field

- Device: “From bits to antenna” for infrastructure, mobile (UE), and autonomous (IoT) radios using solid-state technologies (HW)

■ Relation to SDO and other

- Silicon-CMOS/BiCMOS integrated circuits and systems (wireless Tx/Rx to digital), RFICs, SoCs, emerging IC technologies
- Enabling: mmW array-antenna radio access, backhaul and computing (MMIC/RFIC to digital). System-on-chip (SoC)/system-in-package (SiP) solutions provide inputs for standardization and system implementation feasibility

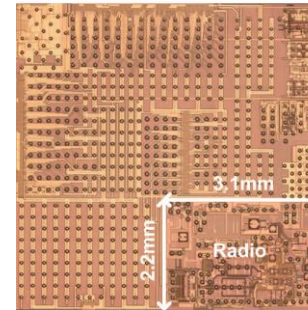
■ Impact Horizon (short, medium, long)

- Short: First generations of 5G/IoT from <6GHz into mm-wave bands
- Medium: Integration of massive MIMO toward physical limits
- Long: Evolving 5G (5G+) up to sub-mm-wave

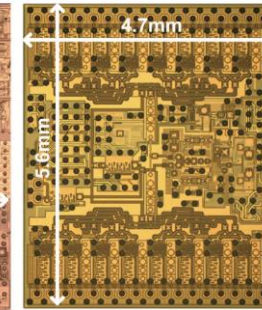
802.11ad 16-channel Tx/Rx

TX	
P_{sat} (PA)	8 dBm
Supply voltage	1 V
$P_{\text{D,PA}}$	45 mW
EIRP	24 dBm
EVM @EIRP	-23 dB
$P_{\text{D,TX}}$ (TX die power)	1190 mW
RX	
LNA, NF	5.5 dB
Supply voltage	1.2 V
$P_{\text{D,LNA}}$	35 mW
$P_{\text{D,RX}}$ (RX die power)	960 mW
Total	
Data rate (10/20m)	4.6/3.0 Gbps
EVM (TX&RX)	-22 dB

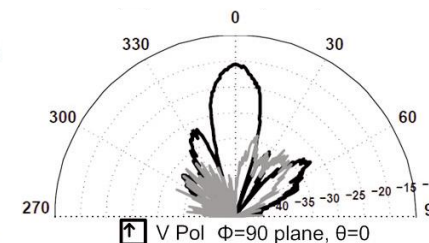
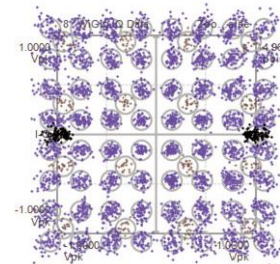
Baseband Chip



60GHz Front-end Chip

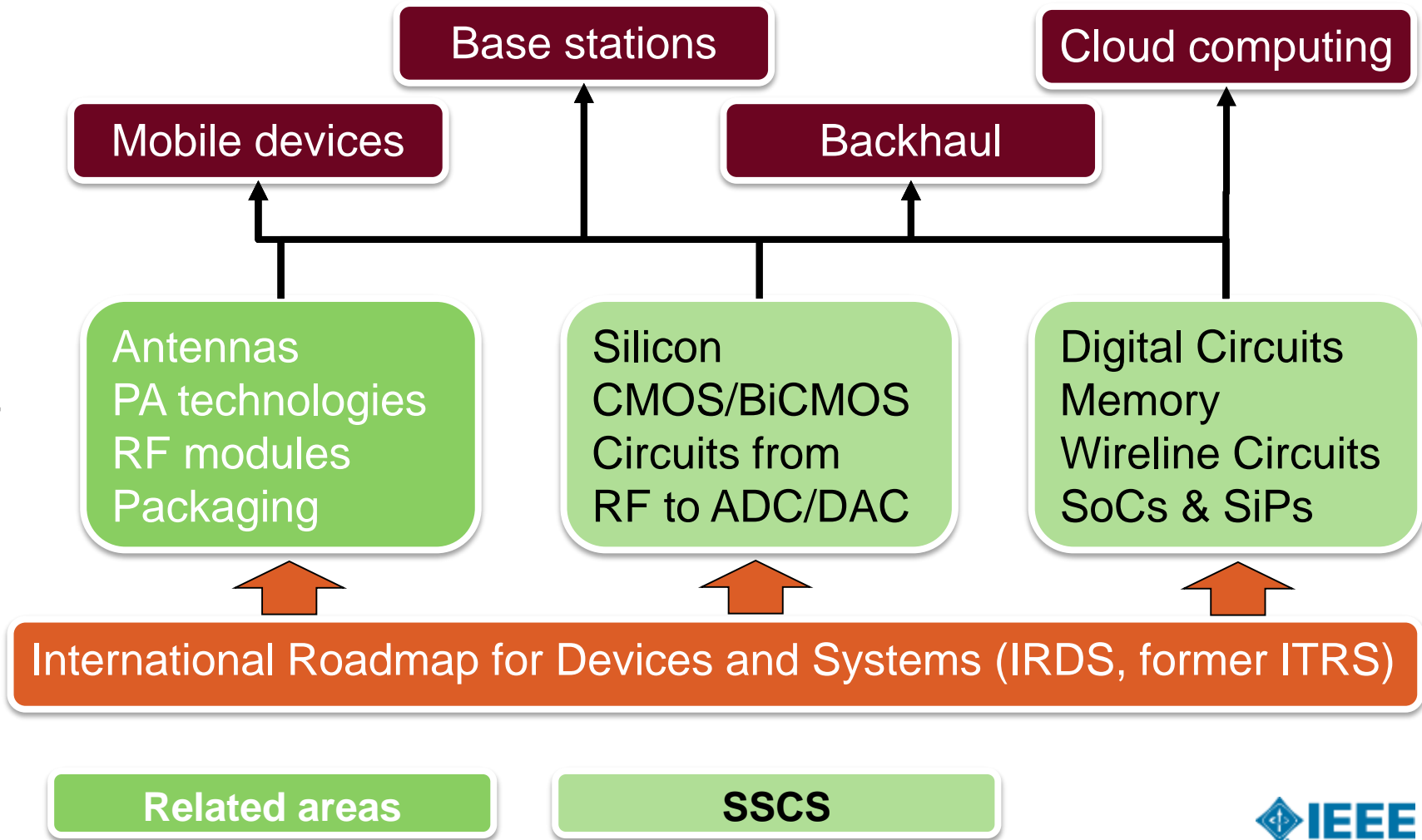


- Broadcom Inc, ISSCC 2014
- 40-nm CMOS
- 16-element array at 60 GHz
- 64-QAM support
- Phase shifters at RF
- Two-chip solution with microprocessor for calibration
- Total radio area 33.2 mm²

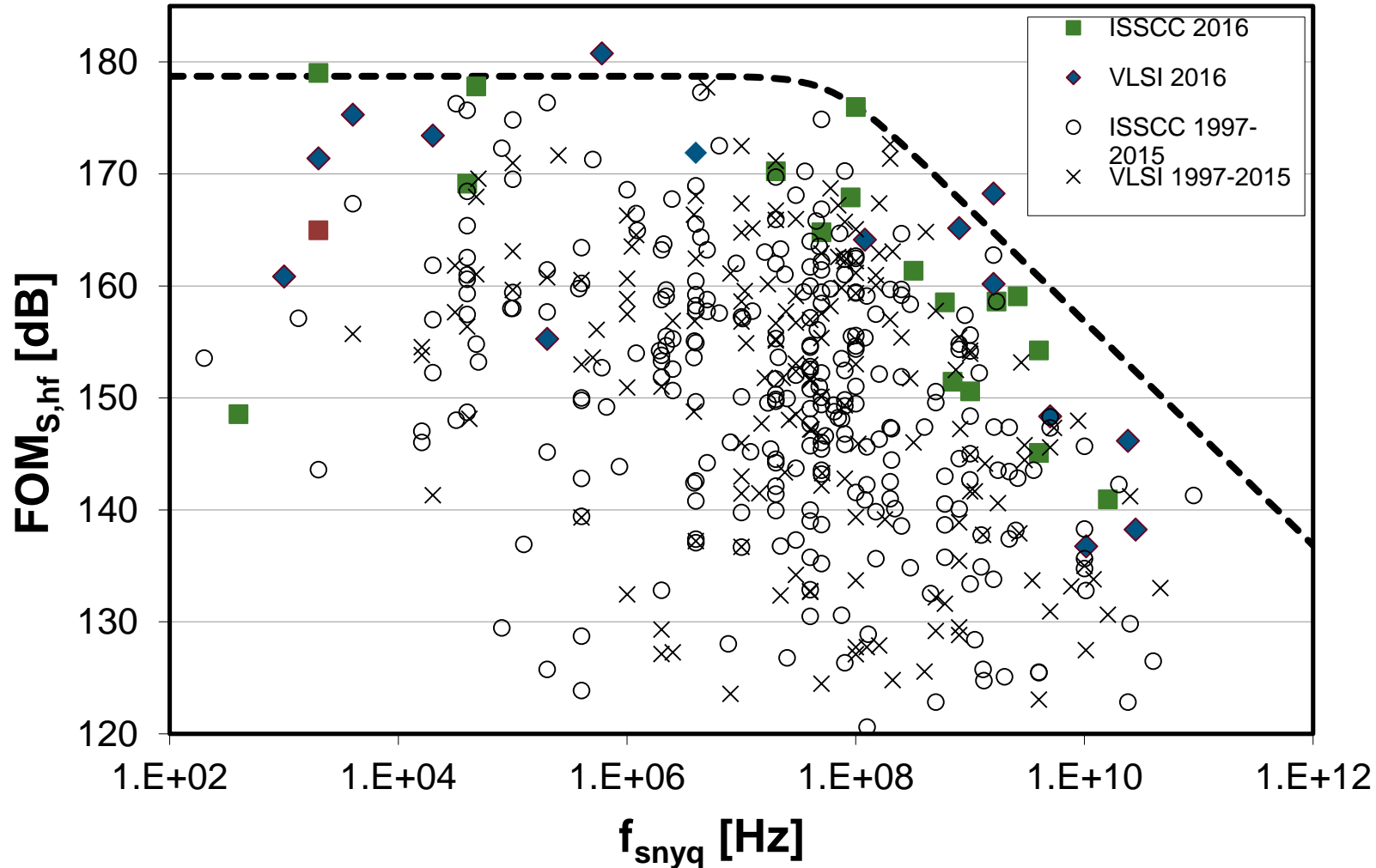


Solid-State Circuit Roadmaps

Roadmapping 5G and beyond
from components to solutions



Roadmapping Example: ADCs



B. Murmann, "ADC Performance Survey 1997-2016," [Online]. Available: <http://web.stanford.edu/~murmman/adcsurvey.html>

Recent SSCS Events on 5G

- ISSCC 2015 Special Evening Session: 'How to Achieve 1000 × More Wireless Data Capacity - 5G?'
- ISSCC 2016 Full-day Forum: 'Radio Architectures and Circuits Towards 5G'
- ISSCC 2016 Plenary: 'The Evolution of 5G Mobile Technology Toward 2020 and Beyond' by Seizo Onoe, Executive Vice President and CTO, NTT DOCOMO
- ESSCIRC 2015 Plenary: '5G Wireless Communication Beyond 2020' by Jonas Hansryd, Ericsson Research
- ESSCIRC 2016 Keynote: '5G and the future of IoT' by Professor Gerhard Fettweis, Technische Universität Dresden
- SSCS Distinguished Lecture: 'Overview of 5G Requirements and Future Wireless Network' by Prof. Sven Mattisson
- ISSCC 2017 Wireless IoT Forum: 'Wireless Low-Power Transceivers for Local and Wide-Area Networks'