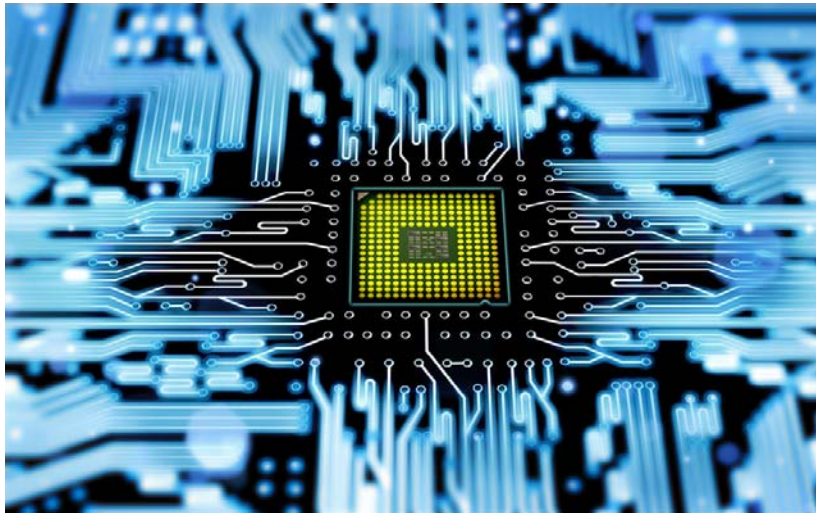




Wireless 100Gb/s Using A Power- and Hardware-Efficient Approach

(Project Real100G.com)

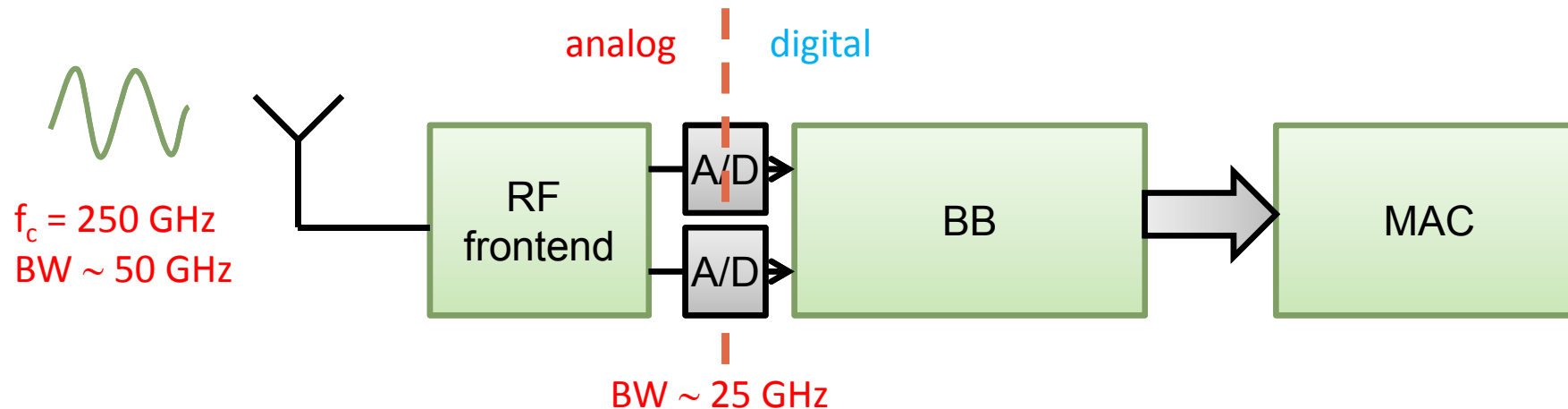
J. Christoph Scheytt



There Might be Three Major Options for 100 Gb/s Wireless

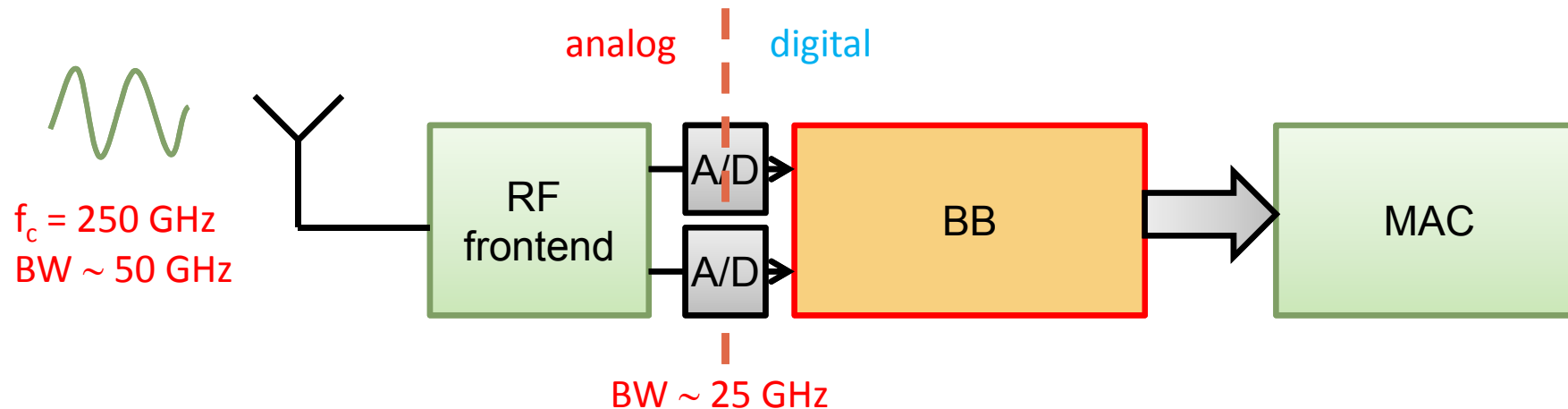
- **Extreme Spectral Efficiency (SE) x „moderate“ bandwidth (BW)**
>10 b/sHz x 10 GHz
→ RF bands at 60 GHz, E-band
- **Moderate SE x extreme BW**
4 b/sHz x >25 GHz
→ RF bands > 200 GHz
- **Free-space optics**
e.g. 40 Gbaud with 8-PAM (BW 30 GHz, 3 b/sHz)

Generic Receiver



- Generic receiver parameters:
 - $f_c > 200$ GHz, $RF BW \sim 50$ GHz
 - $SE 3$ b/sHz
 - $BB BW \sim 25$ GHz

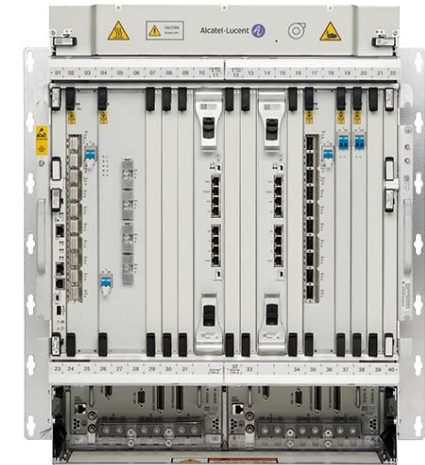
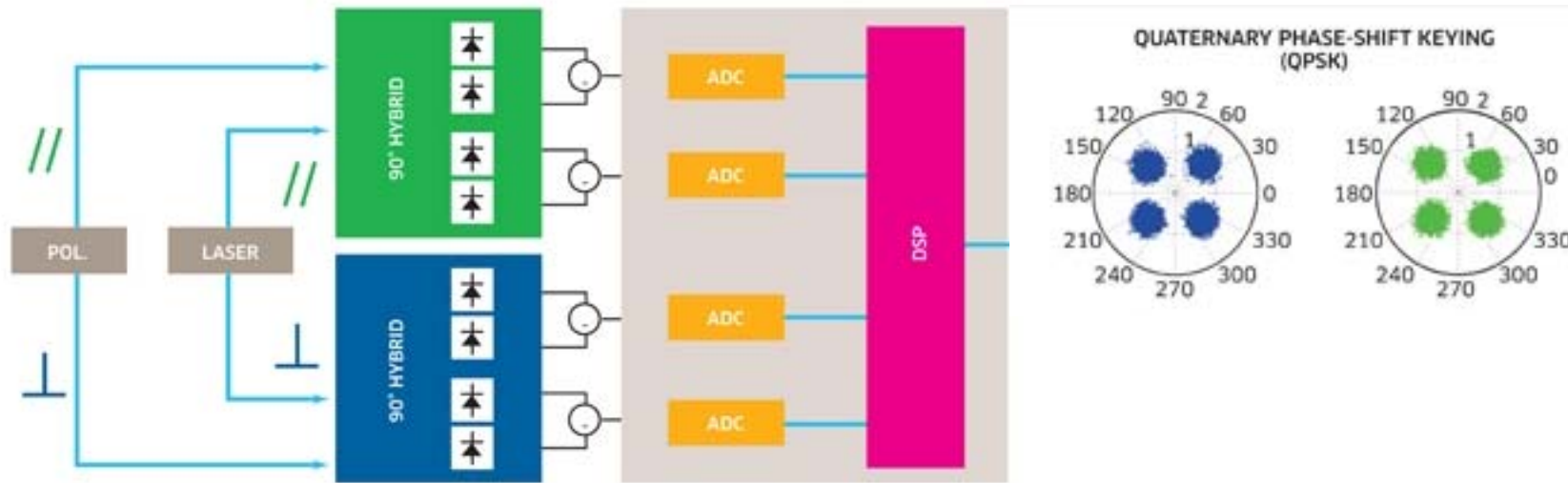
Generic Receiver



- Generic receiver parameters:
 - $f_c > 200$ GHz, $RF BW \sim 50$ GHz
 - $SE 3$ b/sHz
 - $BB BW \sim 25$ GHz

Is the BB feasible from HW perspective and how to implement it?

Similar 100 Gb/s Communication System



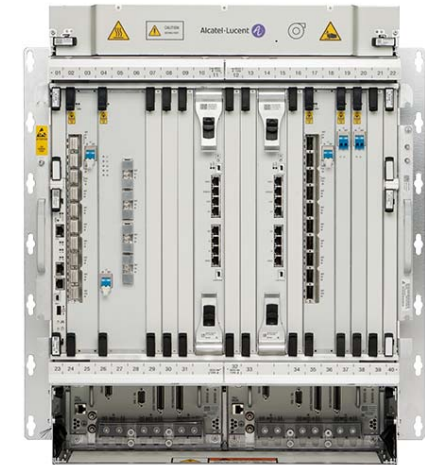
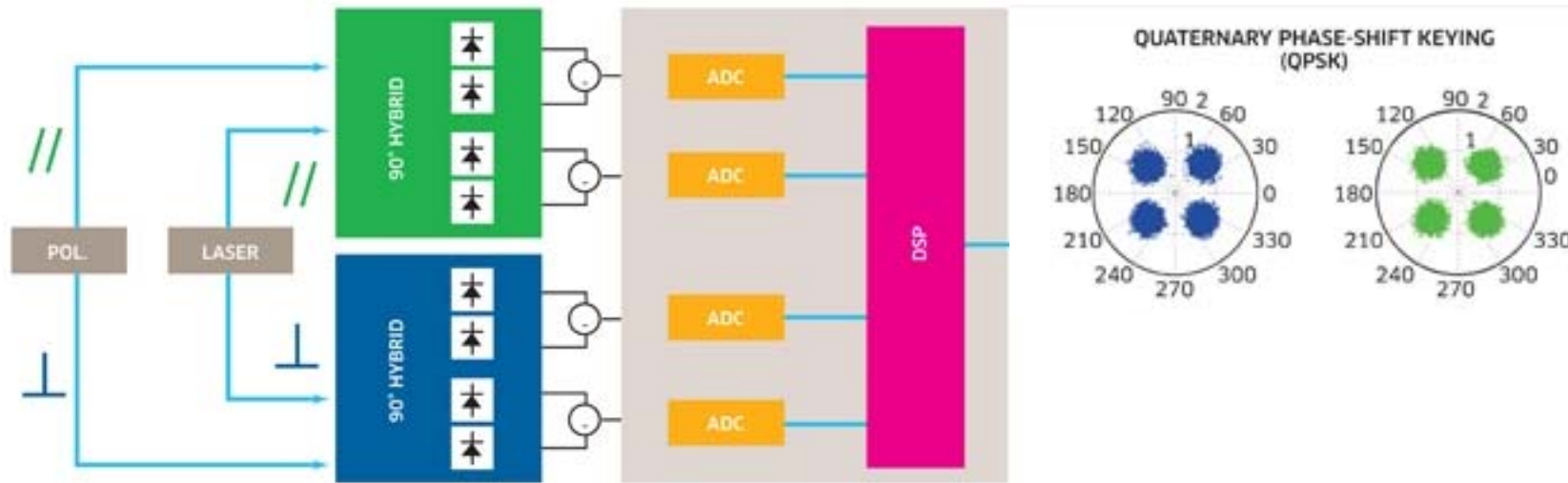
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... already there! → 100 GbE fiber-optic products are out since 2012

■ Use extensively wireless communication technology:

- Optical QPSK with 28 Gbaud using 2 polarizations at 0° and 90°
- IQ transceivers, DACs, ADCs, digital baseband

Similar 100 Gb/s Communication System



© Alcatel-Lucent

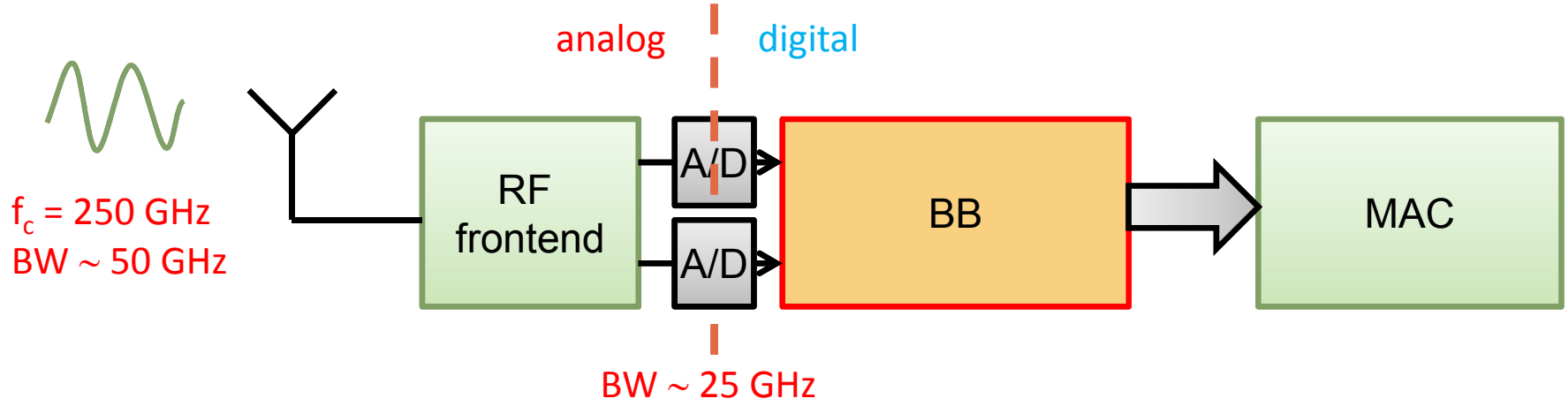
Can we learn from the optical guys for wireless 100 Gb/s?

- Ultra-fast ADCs (28 GSps, 8 bit) → power hungry, challenging design
- Many TFLOPs for signal processing → power hungry, complex hardware

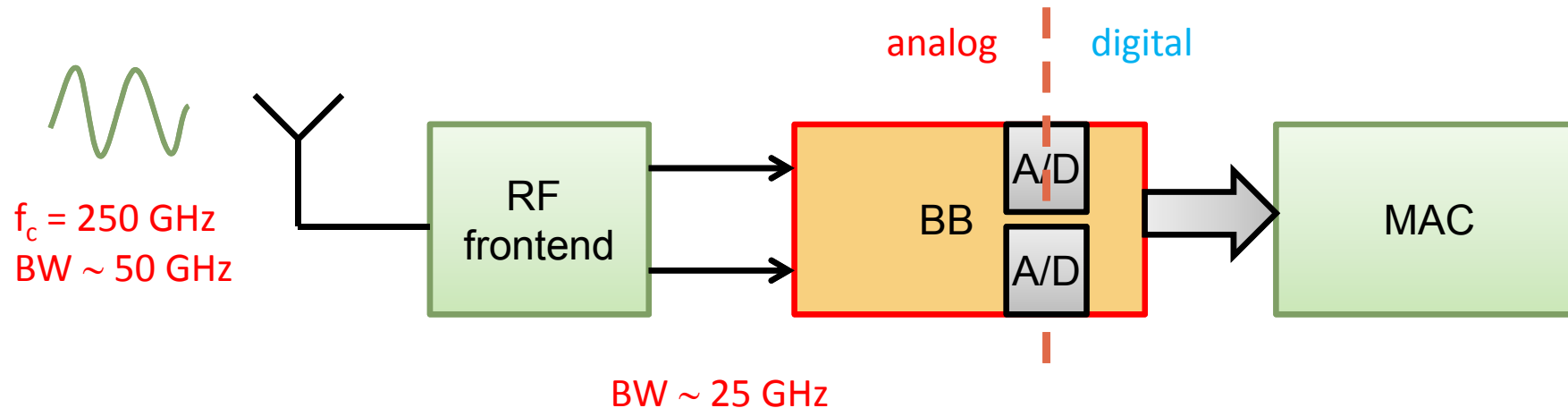
→ **100 Gbit/s coherent communication w/ digital BB is clearly feasible!**

... **but extremely power hungry (>50W)!**

Generic Receiver

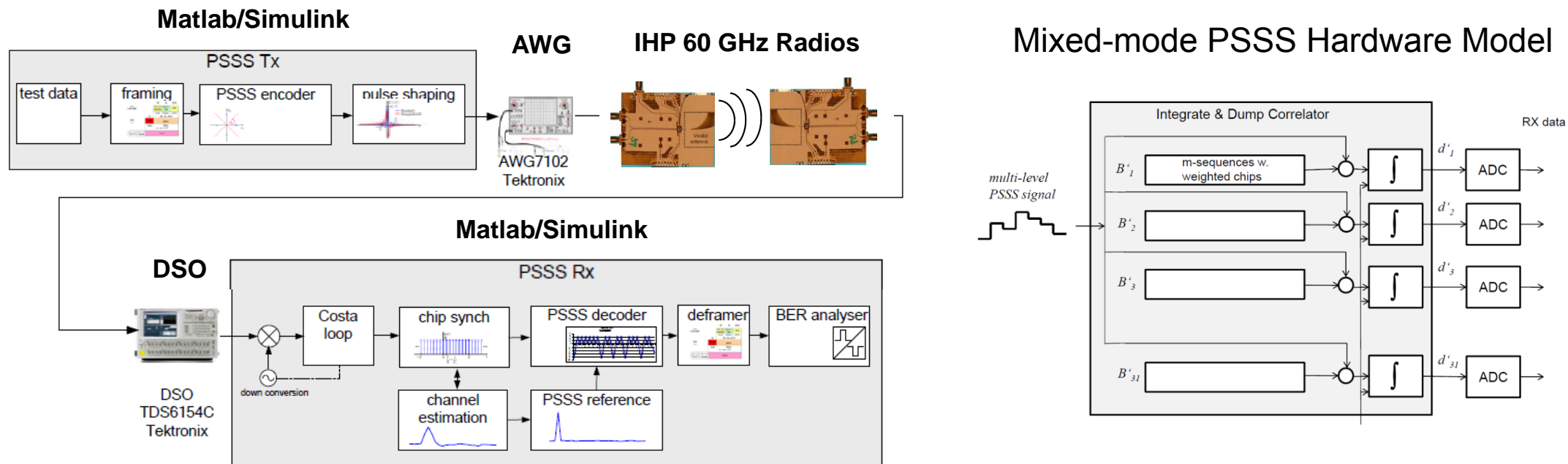


Mixed-Signal Receiver



- Analog processing is inherently power and hardware-efficient !
- Shift „analog boundary“
 - Mixed-mode BB w. dominant analog
- Choose „Analog-friendly“ modulation & coding
 - Parallel Spread-Spectrum Sequencing (PSSS) simplifies mixed-mode BB implementation
- Preprocessing in analog domain
 - reduced dynamic range for ADCs

PSSS Experiment Using 60 GHz Radios



- Matlab implementation of TX and RX used a mixed-signal hardware description
- 60 GHz radio modules from IHP
- Link experiments achieved 4 Gb/s @BER=1e⁻⁵ (3m)
- Compared well to OFDM link demo with same hardware



Summary

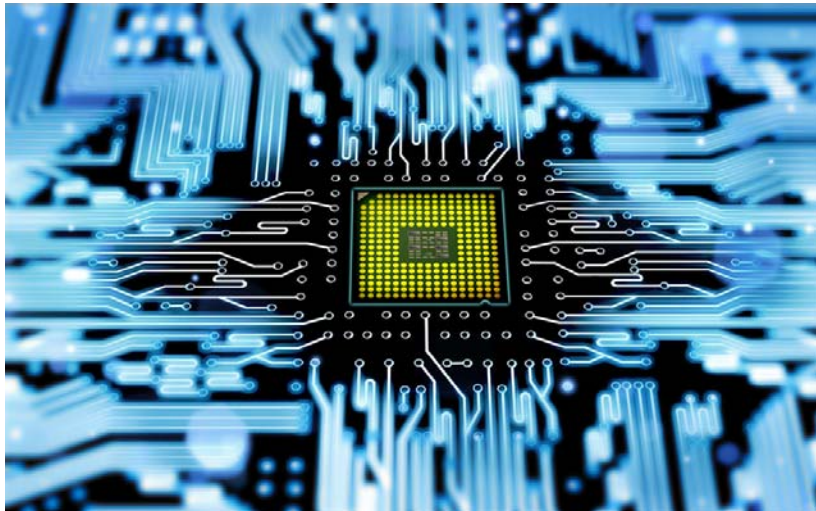
- **100 Gb/s Wireless Communications with moderate spectral efficiency requires extreme broadband BB hardware.**
- **This is even today feasible but power dissipation is prohibitive.**
- **Analog preprocessing in the BB will reduce hardware complexity and power dissipation.**
- **PSSS is an „analog-friendly“ modulation which greatly simplifies 100 Gb/s analog preprocessing (especially decoding & equalization).**
- **Partners from Real100G.com**



***Acknowledgements:
Rolf Kraemer
Ingmar Kallfass***



Thank you for your attention!



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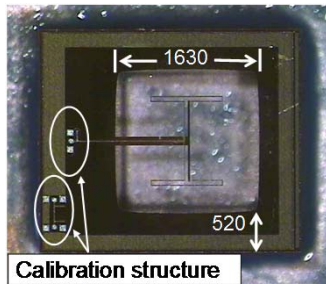
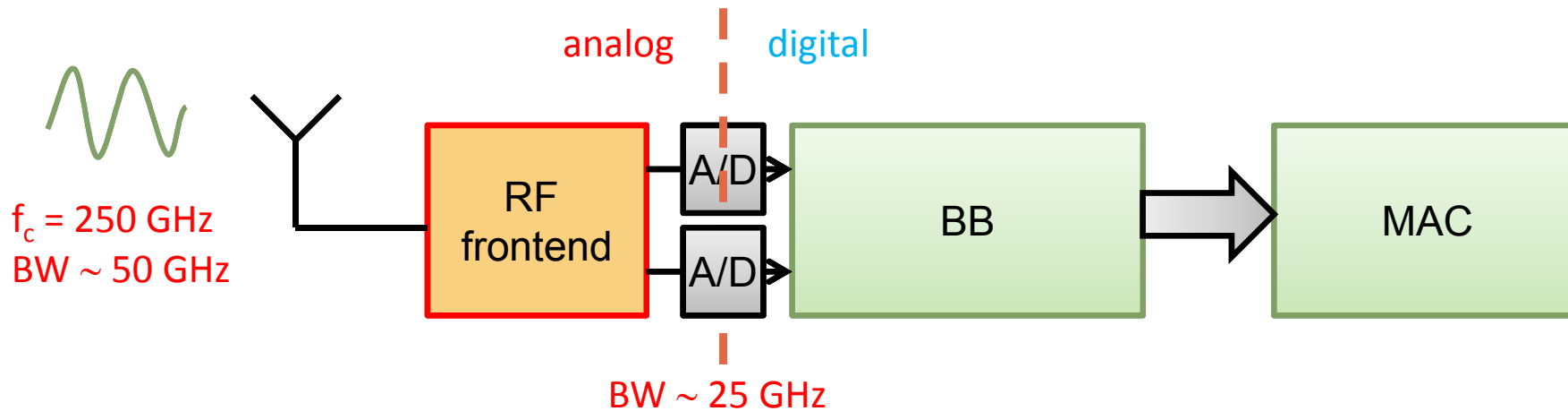
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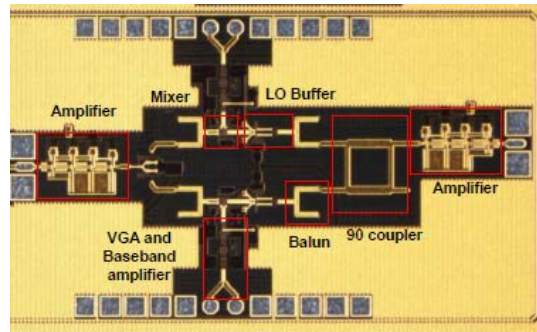
Challenges in 100 Gb/s Wireless Communications



Generic Receiver



120 / 240 GHz
On-chip antenna
IEEE IMS 2012
Wang et al.



240 GHz IQ receiver in 0.13µm
BiCMOS, RFIC 2013, Elkhouly
et al.

$P_{diss.} = 500 \text{ mW}$

RF Frontend
/ Demodulation
seems realistic ✓