IC research directions

Antenna-IC co-design

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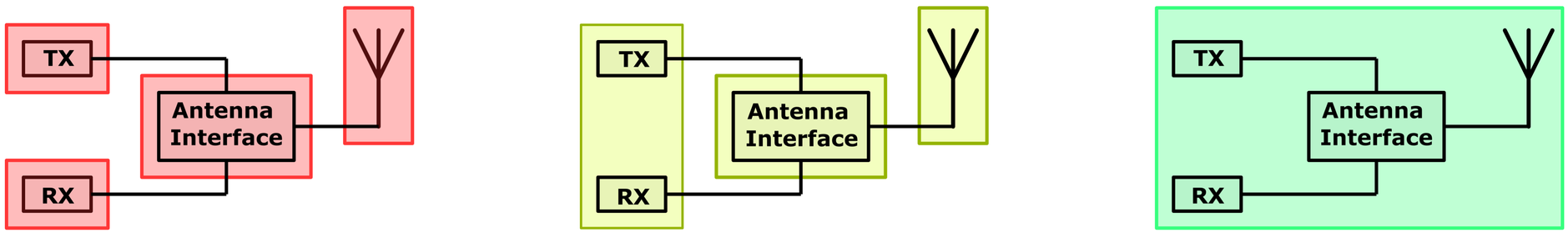
RF SAMPO

- Veturi program
- Business Finland

Motivation



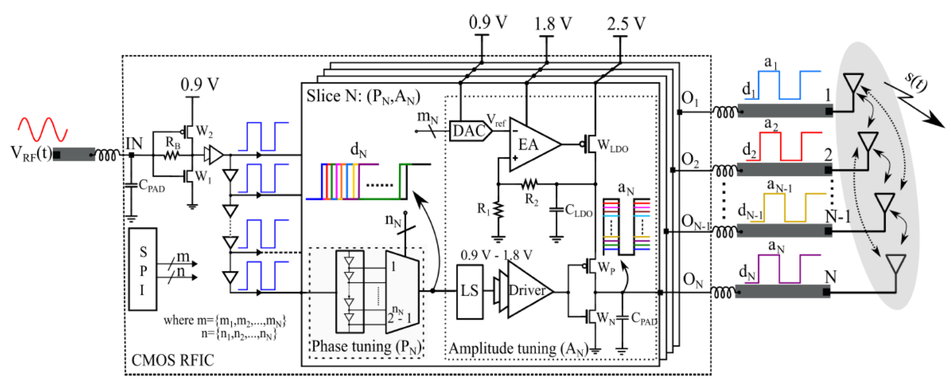
The Old Days **Present** **The Future**

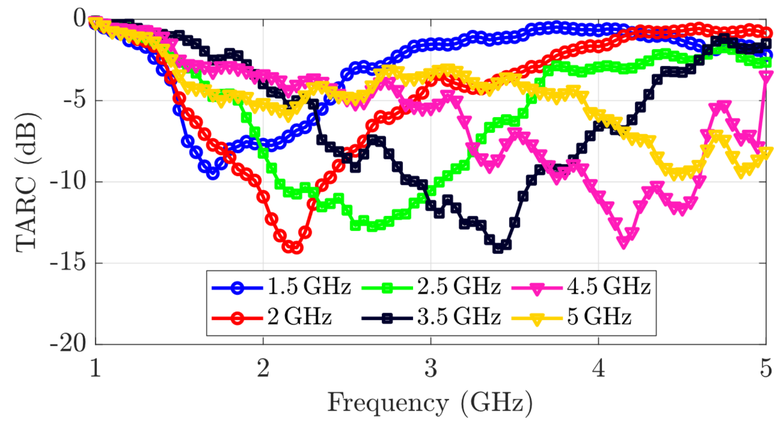
Design paradigm and methodologies evolve towards joint transceiver-antenna co-design

- Conventional segmentation of transceiver – matching & interconnection network – antenna limits the performance as well as offers little opportunities for innovations.
- Dense phased array implementations call for direct IC-antenna interconnection

Example 1: **Antenna frequency tuning with signal weights**

- Antenna is divided into four mutually coupled sub-elements
- Signals for each sub-element have a weight factor (amplitude & phase)
- Antenna frequency response can be tuned by altering the weights

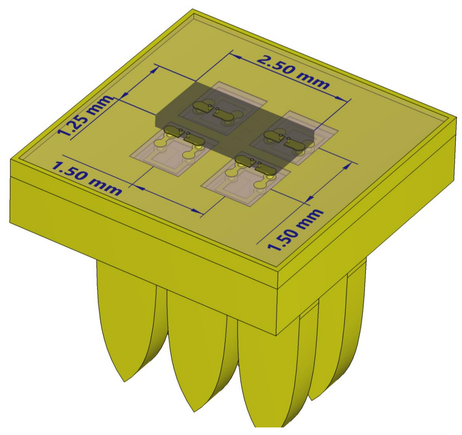




Example 2: **3D-antenna and IC interconnection at 100 GHz**

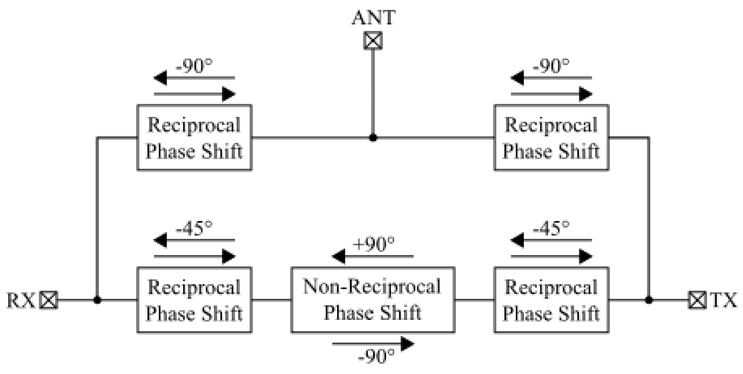
- Antenna size becomes on the same range as the transceiver IC at tens of GHz

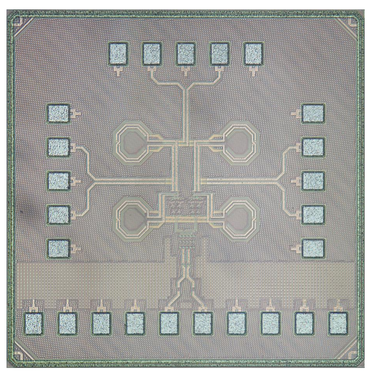
  → There is little or no room for matching circuits: direct IC-antenna interconnection is required

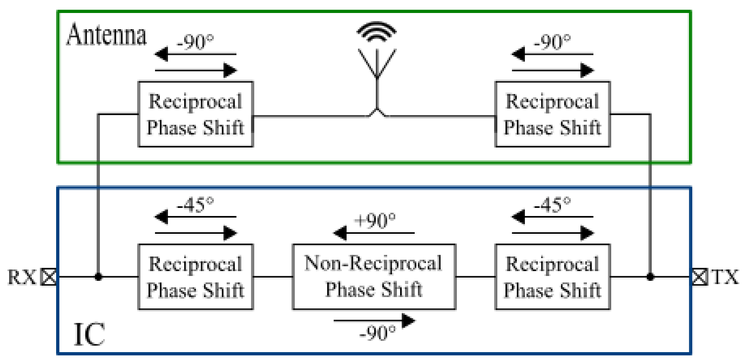


Example 3: **Radiating circulator**

- On-chip circulators include 90-degree phase shifters that are implemented as LC-lattice circuits.
- These LC-circuits occupy large die area → phase shifting is incorporated into antenna



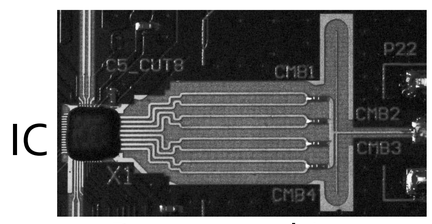




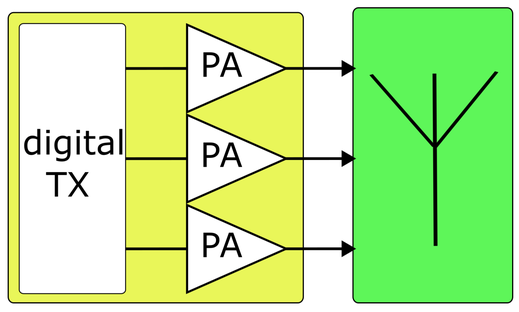
Example 4: **Power combining at antenna**

- Some power amplifiers, such as outphasing and Doherty, require a power combiner at the output
- Power combiners, either on PCB or on IC, are bulky and lossy

  → power combining can be performed at the antenna



Power combiner



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