0 – 6GHz **CMOS** Software-Defined Receiver

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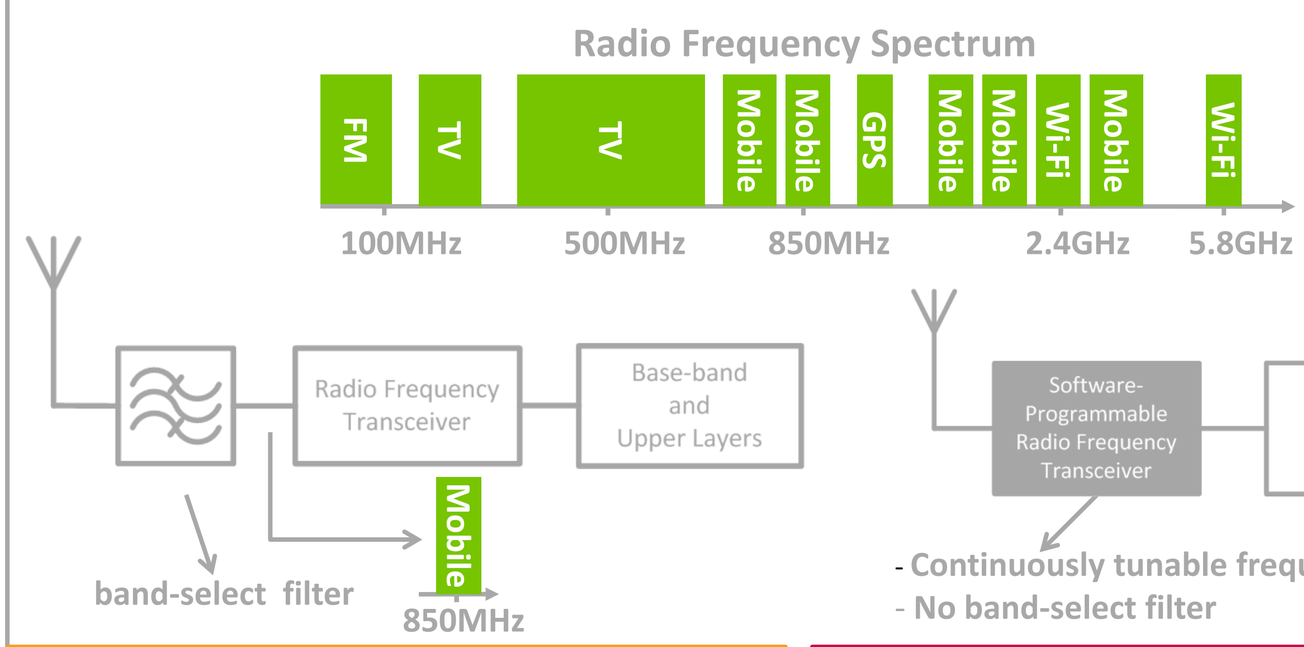
Motivation & Concept



Conventional 1-frequency band

Software-programmable wide-band

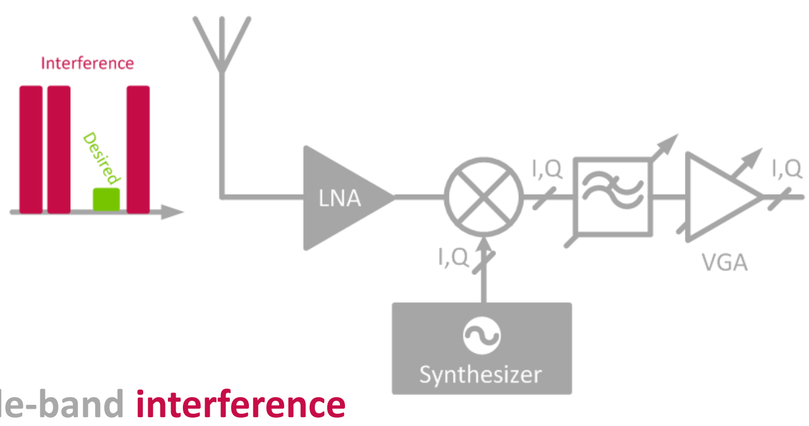
Communication; **anywhere** in the frequency spectrum with **any** modulation

- Cognitive radio
- TV white-spaces
- Multi-band cellular
- RF spectrum sensing
- Counter IED electronic warfare
- **Dynamic spectrum access**

Applications

Key Challenges

Conventional direct down-conversion architecture



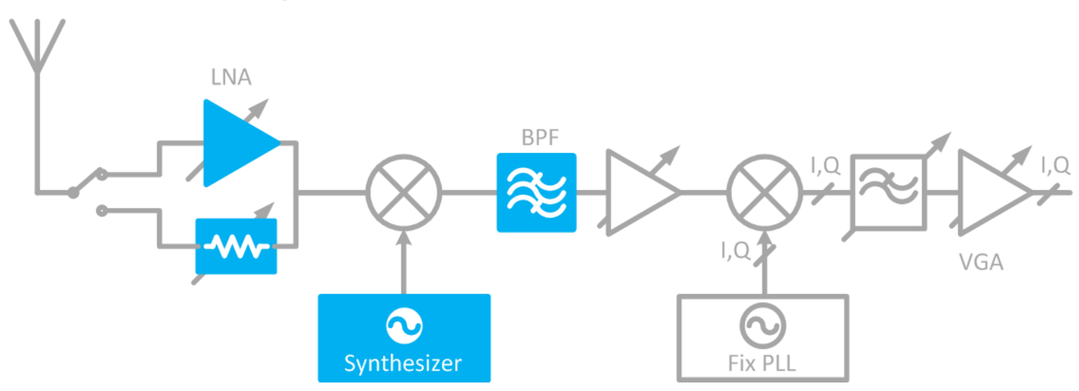
-Large, wide-band **interference**

-Local oscillator (LO) **harmonics**

- **Multi-decade** frequency synthesizer

Proposed SDR Solution

Up-down conversion architecture



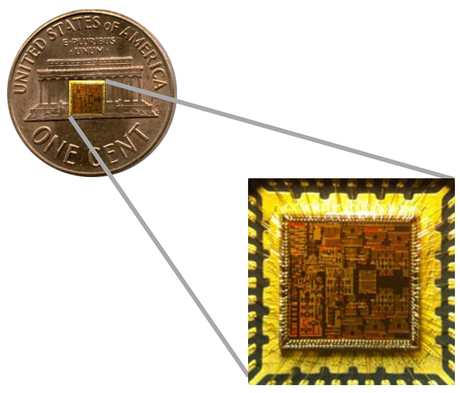
-LO **harmonic insensitive**

-**Low-noise** frequency synthesizer

- Fix **on-chip** bandpass filter

- **High-dynamic range** front-end

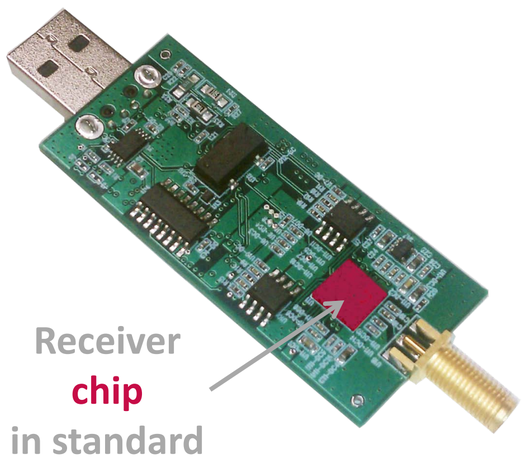
Implementation & Measurement



- **DC-6GHz** receiver
- 0.13µm **CMOS**
- 3.7mm x 3.9mm die size

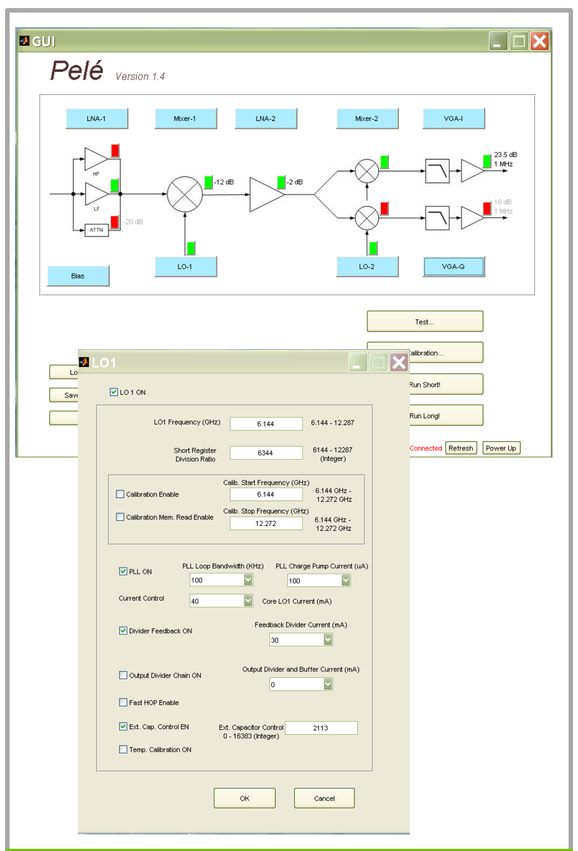
Silicon chip

USB 2.0 interface

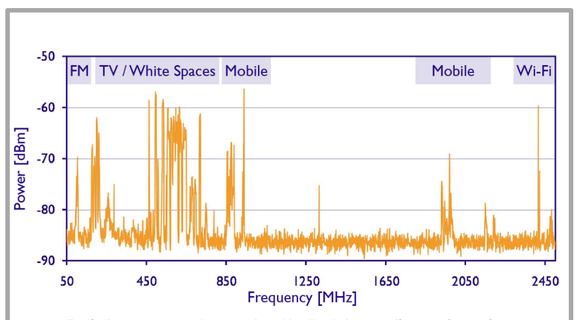


Receiver **chip** in standard 44-pin QFN

USB evaluation hardware



Programming software



Radio frequency spectrum captured by the 1st generation receiver using an external 0.05-2.5GHz antenna. Receiver channel bandwidth is set to 1MHz.

Current measured and next generation expected performance of the Transceiver

	1st Gen RX	Next Gen RX/TX
Frequency Range	DC-6GHz	
Channel Bandwidth	1-22MHz	1-40MHz
RX Sensitivity (1 MHz)	-85dBm	-108dBm
RX SFDR (Co-channel)	43dB	70dB
TX Output Power	N/A	10dBm
Phase Noise (1MHz Offset)	-120dBc/Hz	
Chip Power Consumption	RX: 650mW	RX: 250mW TX: 400mW
Technology	130nm Standard CMOS	

Measurement

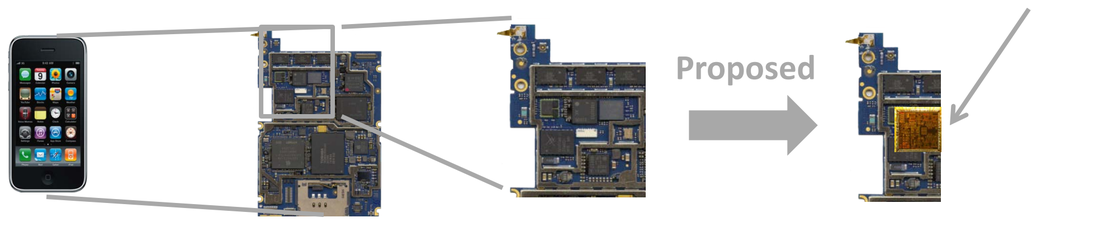
Future Work & Commercialization

Research work in progress

- MIMO software-defined transceiver
- Programmable power amplifier

Cellular communication

iPhone's cellular radio transceiver
Supports 2G & 3G



If the proposed transceiver chip is used:

- Supports **all existing & emerging** global frequency bands
- Significant **cost** and **foot-print** reduction
- USPTO patent application 12/727,194 and multiple disclosures

Other applications

- Dismounted RF spectrum sensing for electronic warfare
- Miniaturized instrumentation
- Software-defined tactical radios for defense and public safety

Recognitions

- **Best student paper** award candidate, IEEE RFIC 2011
  - **A. Goel, B. Analui, H. Hashemi,** "A 130nm CMOS 100Hz–6GHz Reconfigurable Vector Signal Analyzer and Software-Defined Receiver," IEEE RFIC Symposium, June 2011.
- **Inaugural winner:** USC Maseeh Entrepreneurship Prize Competition

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