

# Full-Duplex Radio Connectivity for Internet of Things

Timo Huusari<sup>(1),2</sup>, Dani Korpi<sup>1</sup>, Yang-Seok Choi<sup>2</sup>, Shilpa Talwar<sup>2</sup>, and Mikko Valkama<sup>1</sup>

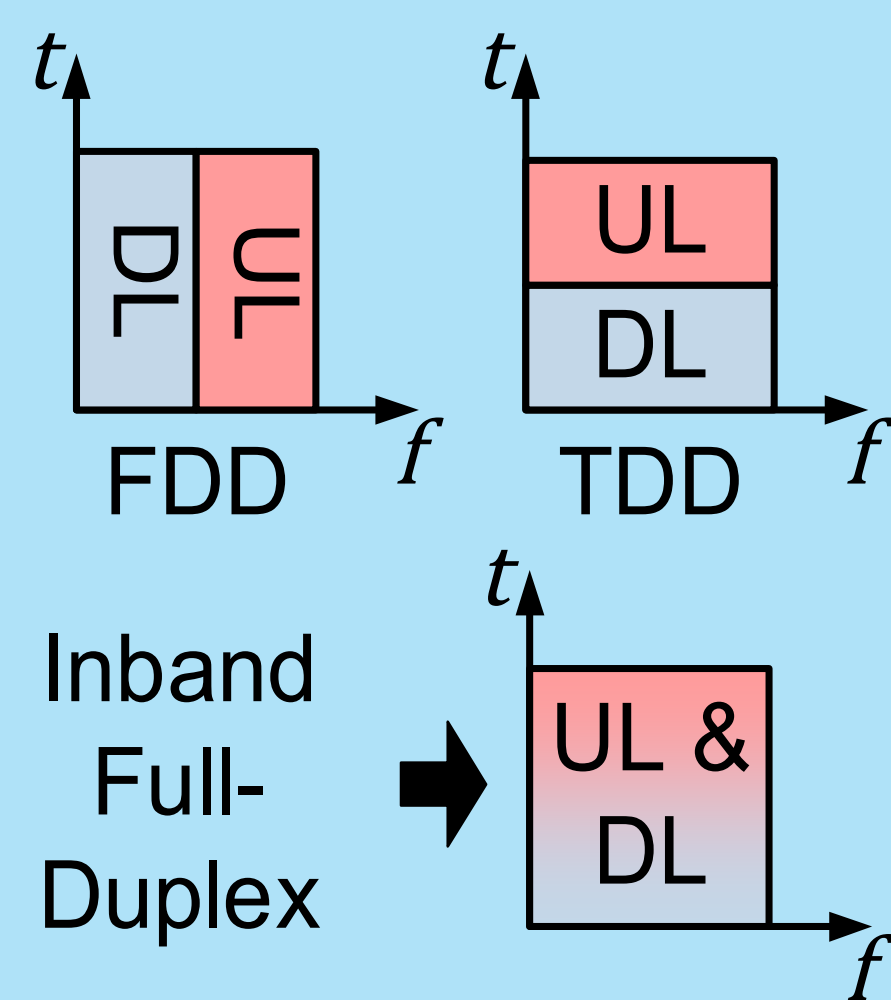
<sup>1</sup>Department of Electronics and Communications Engineering, Tampere University of Technology

<sup>2</sup>Intel Corporation

For more information: [timo.s.huusari@intel.com](mailto:timo.s.huusari@intel.com), [dani.korpi@tut.fi](mailto:dani.korpi@tut.fi), <http://www.tut.fi/full-duplex/>

## Full-Duplex Principle

Simultaneous transmission and reception on the same frequency band can double the spectral efficiency

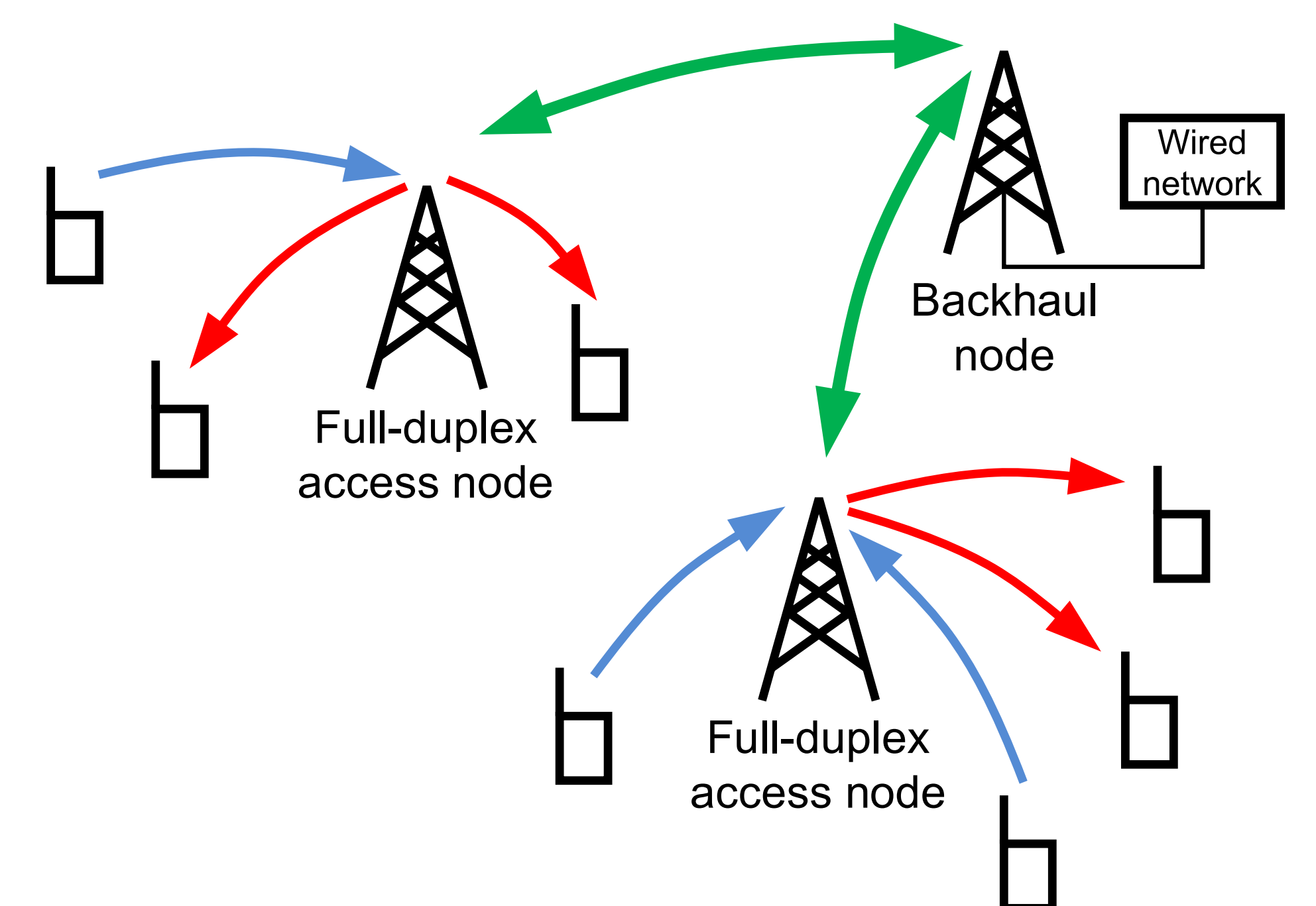


## Benefits of Inband Full-Duplex Transceivers

- Higher capacity
- Lower end-to-end delay in multi-hop systems
- Possibility to transmit and sense simultaneously
- Having only full-duplex capable access nodes already provides most of these benefits

## Full-Duplex for IoT

- To ensure low costs for the actual nodes, only the access nodes could be implemented with full-duplex capability
- This allows for legacy hardware in the nodes, while providing increased capacity and lower latency
- Technically, such full-duplex access nodes are already within the realm of possibility
- The developed full-duplex technologies can also be applied to mobile cellular networks



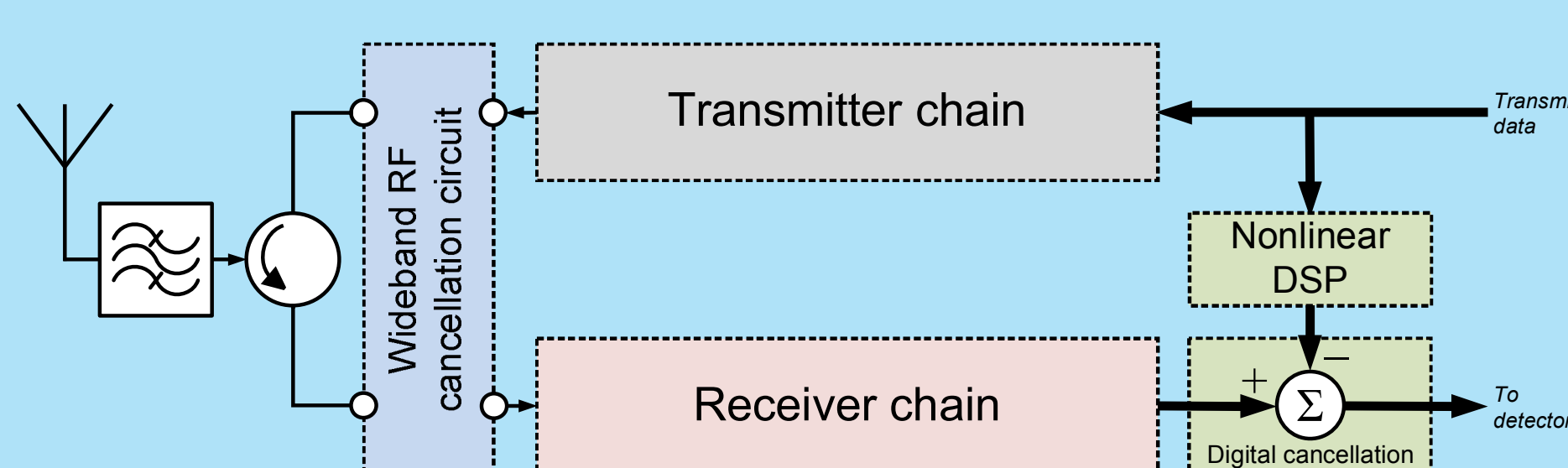
## Intel & TUT Collaboration on Full-Duplex

- Concept, design, and implementation of an analog RF canceller
- Digital cancellation development and evaluation
- RF and digital cancellation demonstration at
  - Mobile World Congress 2015
  - Intel Developer Forum 2015
- Various scientific publications



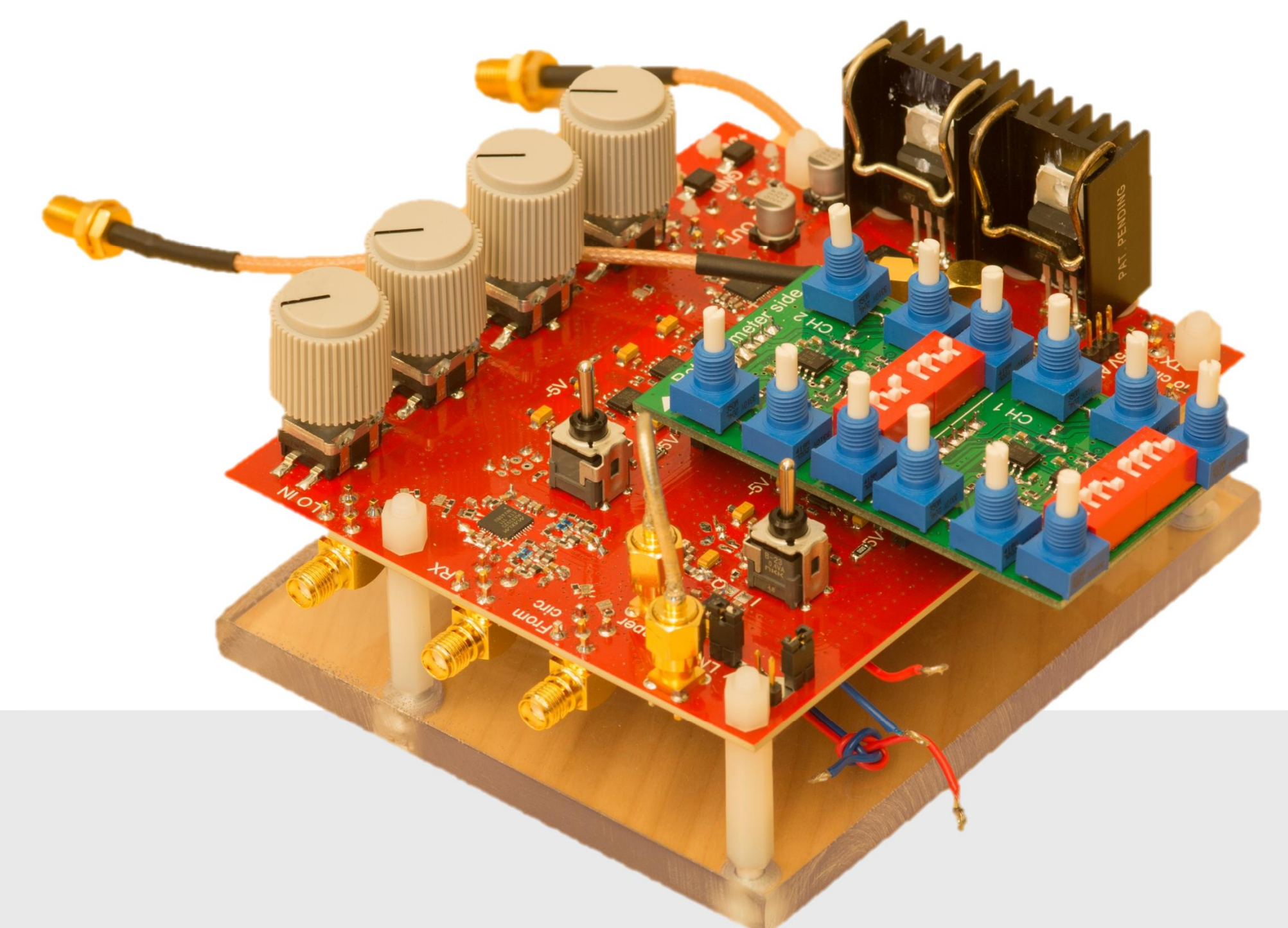
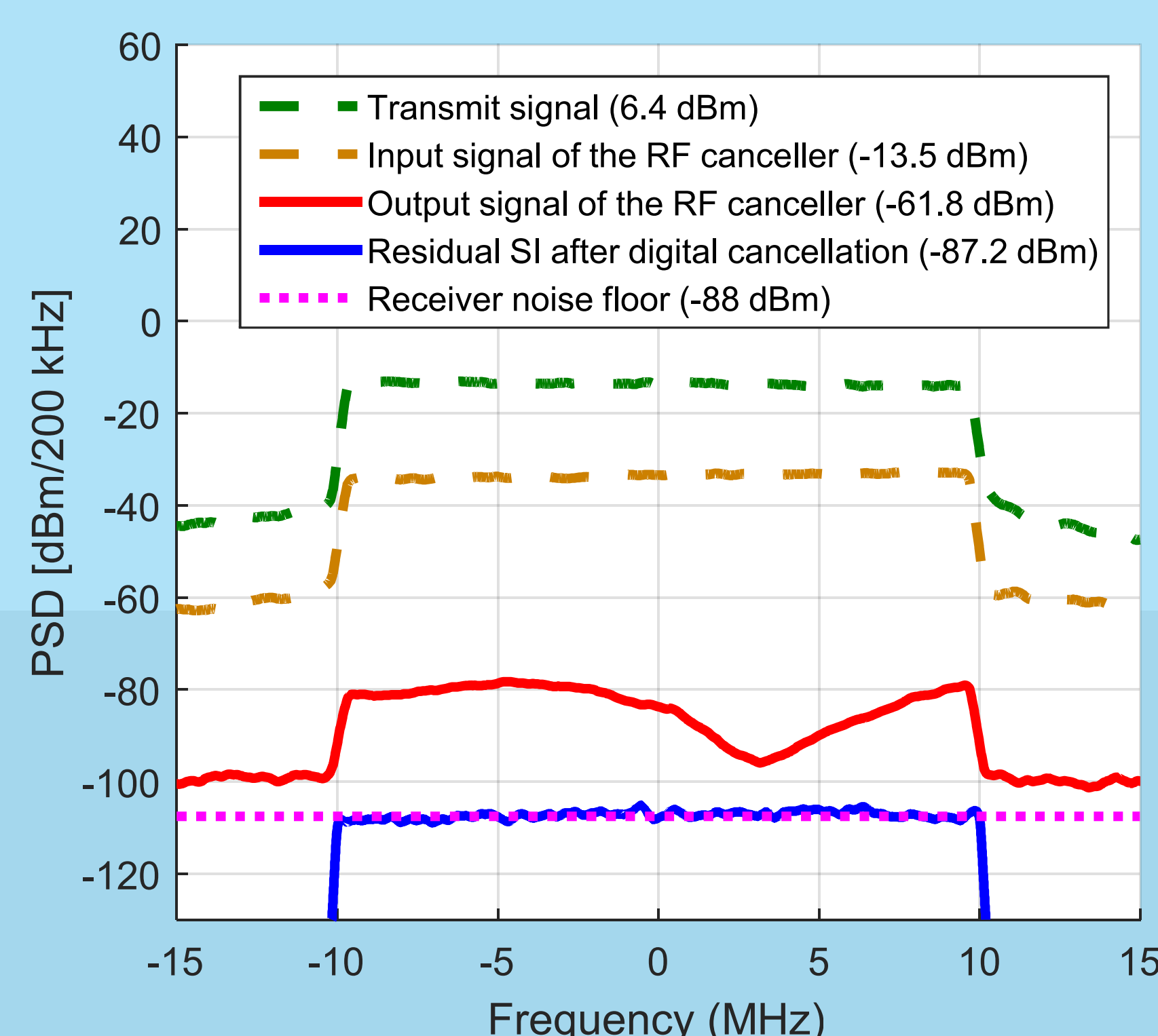
Demonstrating RF and digital cancellation at MWC 2015.

## Inband Full-Duplex Transceiver Prototype



The implemented prototype includes

- Shared TX/RX antenna
- Self-adaptive wideband RF canceller
- Self-adaptive nonlinear digital canceller



The implemented self-adaptive RF canceller

## Selected publications

- M. Heino, D. Korpi, T. Huusari, E. Antonio-Rodríguez, S. Venkatasubramanian, T. Riihonen, L. Anttila, C. Icheln, K. Haneda, R. Wichman, and M. Valkama, "Recent advances in antenna design and interference cancellation algorithms for in-band full-duplex relays," IEEE Communications Magazine, vol. 53, no. 5, pp. 91-101, May 2015
- D. Korpi, L. Anttila, V. Syrjälä, and M. Valkama, "Widely linear digital self-interference cancellation in direct-conversion full-duplex transceiver," IEEE Journal on Selected Areas in Communications, vol. 32, no. 9, pp. 1674-1687, Sep. 2014