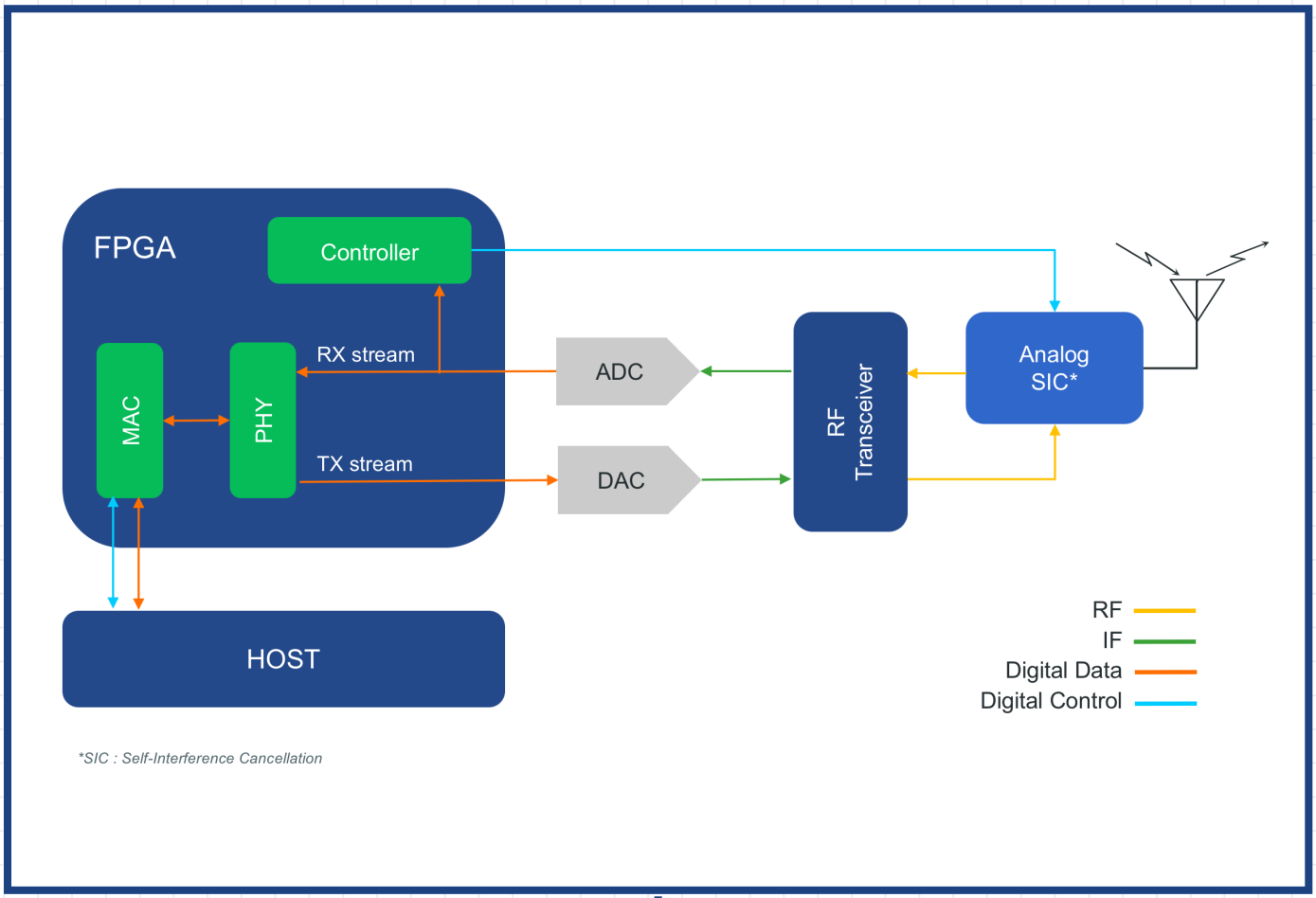
Orca

Orchestration and Reconfiguration Control Architecture

SDR DATA PLANE FUNCTIONALITY

PHY improvements: Full duplex link at sub 6 GHz



- Cancelling the imposed interference by the transmitter to its own receiver allowing they work at the same time and the same channel.
- Collision and interference detection while transmitting.
- 50 – 70 dB self-interference cancellation.
- FPGA-based IEEE 802.15.4 PHY and MAC.
- Energy efficient, low latency novel MAC protocol.

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CONTEXT

In-band full duplex (IBFD) has been proposed almost 10 years ago as a promising technology to improve the physical layer throughput and enable novel low latency MAC or relaying protocols. Various approaches have been proposed to implement in-band full duplex and boost the PHY rate [1]. When we are talking about networked experiments with in-band full duplex, then we see that this was not possible in the state of the art. The main reason is that a node capable of in-band full duplex relies on analog solutions for self-interference cancelation, baseband algorithms to deal with interference and finally novel MAC protocols that should be tightly integrated with the novel PHY.
While most research on in-band full duplex focuses on the PHY layer improvements offered by the technology, i.e., the PHY layer throughput is doubled, it is also interesting to explore the benefits of IBFD for other 5G related performance metrics: latency, reliability, energy consumption. In [2] we have shown that it is possible to design low energy and low latency MAC protocols relying on IBFD.

UNIQUE SELLING POINT

ORCA offers advanced in-band full duplex SDR functionality, in the form of 6 URSP RIO's that have been extended with a method for analog self-interference cancellation (electrical balance duplexer (EBD)) that gives self-interference cancellation between 50 and 70dB depending on the mode of operation. The EBD is tunable exploiting a real-time mechanism, making it feasible for real-world applications where the environment is varying over the time.
In addition, ORCA offers a full PHY implementation of the IEEE 802.15.4 PHY and CSMA protocol. This protocol was extended with sense while transmit functionality, able to detect collisions and interference while transmitting. The combination of these analog, PHY and MAC blocks result in a first solution towards networked IBFD nodes.

OPPORTUNITIES

There are several experiments that could be done with the current setup:

- Comparison of IBFD with traditional nodes using the same USRP hardware and PHY implementation;
- Creating a network of 6 nodes with IBFD coexisting with regular IEEE 802.15.4 nodes and evaluate throughput, latency, reliability for various network topologies;
- Modifying the PHY layer implementation to add novel algorithms for sense while transmit;
- Modifying the PHY layer to also include receive while transmit, which is the more traditional use of IBFD;
- Modifying the current IBDF sense while transmit MAC protocol.

REFERENCES

- ORCA in-band full duplex hardware [3,4]
- ORCA in-band full duplex sense while transmit algorithm [5]
- Sense and abort video protocol description [6]

1 D. Bharadia, E. McMilin, and S. Katti, "Full duplex radios," in ACM SIGCOMM omputer Communication Review, vol. 43. ACM, 2013, pp.375–386.

2 T. Vermeulen, S. Pollin . 2014. Energy-Delay Analysis of Full Duplex Wireless Communication for Sensor Networks. In Global Communications Conference (GLOBECOM), 2014 IEEE. Global Communications Conference (GLOBECOM), Austin, Texas, 08-12 December 2014. , pp. 455-46

3 B. van Liempd et al., "2.2 A +70dBm IIP3 single-ended electrical-balance duplexer in 0.18um SOI CMOS," 2015 IEEE International Solid-State Circuits Conference - (ISSCC) Digest of Technical Papers, San Francisco, CA, 2015, pp. 1-3.

4 T. Vermeulen, M. Laghate, G. Hattab, B. van Liempd, D. Cabric and S. Pollin, "Nearly instantaneous collision and interference detection using in-band full duplex," 2017 IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN), Piscataway, NJ, 2017, pp. 1-2.

5 T. Vermeulen, M. Laghate, G. Hattab, D. Cabric, and S. Pollin, "Towards instantaneous collision and interference detection using in-band full duplex," in IEEE Infocom, 2017.

6 T. Vermeulen, B. Van den Bergh, and S. Pollin, "Demo: A software defined radio platform for rapid cross-layer prototyping," in Proceedings of the 2015 Workshop on Software Radio Implementation Forum, ser. SRIF '15. New York, NY, USA: ACM, 2015, pp. 1–4. [Online]. Available: http://dl.acm.org/citation.cfm?doid=2801676.2801683