Exploiting Channel Reciprocity in Massive MIMO
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5G Wireless Networks

![Graph showing massive growth in traffic volume and connected devices](image)

- **Key challenges for future radio access**
  - Massive growth in traffic volume;
  - Massive growth in connected devices;
  - Wide range of requirements and characteristics for different services.

- **Emerging technologies for 5G**
  - MASSIVE MIMO: the focus of our work;
  - Heterogeneous network (HetNet);
  - Machine to Machine Communications (M2M);
  - Software Defined Network (SDN), etc.

**Massive MIMO Prototyping**

- **OpenAirInterface (OAI)**
  - Open-source hardware/software development platform and open-forum for innovation in the area of digital radio communications created by EURECOM [2].

- **ExpressMIMO2**
  - OAI’s hardware platform interfacing with the OpenAir4G modem

- **Massive MIMO prototype**
  - 64 Antenna array supported by 16 ExpressMIMO2 cards
  - Centralized high end computing engine

**Channel Reciprocity Exploitation**

- **Massive MIMO key challenges**
  - Acquisition of channel information at transmitter (CSIT);
  - Pilot contamination;
  - Fast and distributed coherent signal processing;
  - Hardware impairment, etc.

- **Time Division Duplexing (TDD)**
  - Use TDD channel reciprocity for massive MIMO to ease the acquisition of CSIT: no feedback needed;
  - However, hardware non-symmetry destroys the TDD reciprocity.

- **Relative Calibration**
  - Compensate the impairment by a multiplicative matrix;
  - Cost efficient: no additional hardware needed.

**Experimental Results**

- **Measurement on ExpressMIMO2**
  - 2x1 and 4x1 MISO case using 2 ExpressMIMO2 cards synchronized by cables;
  - Measured results:

- **Beamforming Gain**
  - Different CSIT acquisition methods: feedback mode, calibration matrix full estimation, diagonal estimation (assume the off-diagonal elements to be zero) and no calibration used.
  - Relative calibration fully achieves the channel reciprocity.

- **Future work**
  - Scale up the experiment to Massive MIMO case.

**References**

**Note**
Luc Deneire is a professor in Université de Nice Sophia Antipolis, Laboratoire I3S