

MASCOT MU-MIMO Testbed

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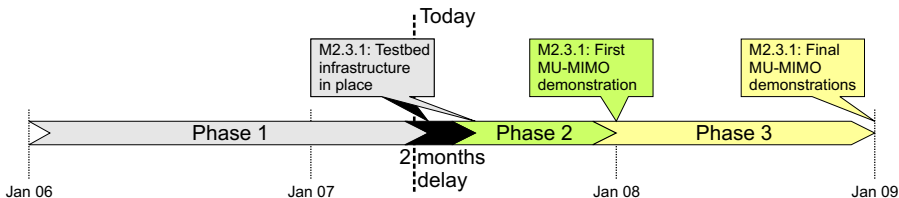
Outline

- 1 Schedule Task 2.3
- 2 MU-MIMO Testbed Status Update (M2.3.1)
- 3 Next Steps (M2.3.2 and beyond)
- 4 Discussion

Project Schedule Task 2.3: MU-MIMO Testbed

Task 2.3 is comprised of three phases:

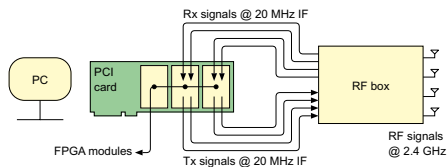
- 1 Setup of the testbed infrastructure: Multi-user extension of the ETHZ MIMO-OFDM PHY-layer testbed (M2.3.1)
- 2 Initial implementation of a basic MU-MIMO system and demonstration (M2.3.2)
- 3 Implementation and measurements of MU-MIMO algorithms



Real-Time Testbed

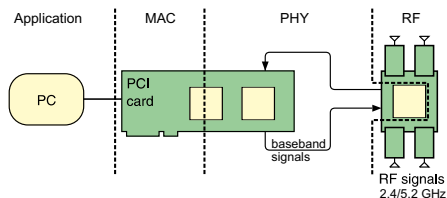
ETHZ MIMO-OFDM testbed

- No provisions for MAC (PHY controlled from MATLAB)
- Unidirectional point-to-point communication
- Only 2 terminals available



MASCOT MU-MIMO testbed

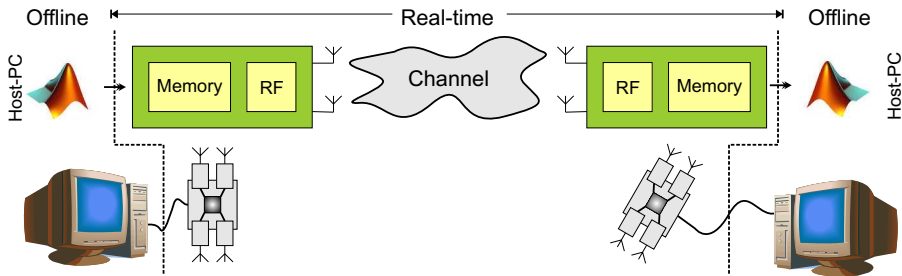
- New hardware platform and integrated MIMO-RF
- Embedded processor for MAC
- Supports bi-directional communication



Offline Testbed

Complementary to real-time testbed for fast verification of algorithms and transmission schemes

- Real-time over-the-air transmission
- Digital signal processing is non real-time in MATLAB
- FPGA used for AGC, synchronization, and filtering



Infrastructure Hardware

- Two XC2VP50 FPGAs for MAC and PHY
- PowerPC for MAC
- PCI, Gigabit Ethernet
- 128 MB SDRAM, 4MB SRAM

- Four independent SISO chains
- Bandwidth up to 40 MHz
- 2.4 and 5.2 GHz operation
- FPGA board with XC4VSX55
- Used for real-time **and** non real-time testbed



Initial Demonstration of MASCOT Testbed (M2.3.1, 31.07.2007)

M2.3.1 demonstration goal

Show the functionality of the MASCOT testbed infrastructure with multiple terminals

- Three terminals
- Real-time and non real-time testbed
- Basic MAC layer with point-coordination
- Channel access: TDMA (no collisions)
- Can serve as reference case for MU-MIMO demonstrations



Next Steps (M2.3.2 and beyond)

- 1 Definition of MU-MIMO algorithms to be demonstrated
- 2 Definition of the MU-MIMO system (MAC)
- 3 M2.3.2: Extension of the MU-MIMO testbed to 5 terminals
- 4 M2.3.2: Implement the first MU-MIMO demonstrations
- 5 Implement and test further MU-MIMO algorithms

Selection Criteria for MU-MIMO Algorithms for Demonstration on the Testbed

- Modifications to the PHY-layer of the real-time demonstrator require considerable effort: need to select algorithms carefully
- Experiments using the offline-testbed can provide quick feedback
- Offline testbed can be used efficiently by untrained personnel
- MAC-layer algorithms can be partially implemented in software
- Need to carefully consider the provisions at the system-level required for implementing a new transmission scheme

Potential algorithms for MU-MIMO demonstrations within MASCOT

- Demonstration of different multi-user STBCs on the non real-time platform: Alamouti codes, Golden code, MU-STBCs
- MU-MIMO rate adaptation and MU-MIMO scheduling
- MU-MIMO detector with close-to ML performance (exploit structure of MU-STBCs for complexity reduction)
- MU-MIMO system with variable amounts of collision
- Precoding for MU-MIMO systems

MU-MIMO rate adaptation and MU-MIMO scheduling

Non-technical issues:

- Limited novelty: Rate adaptation and scheduling are well explored
- Demonstrations of algorithms for MU-MIMO may still be of interest
- Real-time testbed allows demonstration of throughput, QoS, and fairness

Technical consideration:

- Moderate implementation effort (can be done in SW and requires limited knowledge about the testbed hardware)
- Initial testbed MAC-layer architecture (point-coordination) eases incorporation of link-adaptation and scheduling in up-link and down-link
- M2.3.2 should provide the basis for this type of demonstrations

MU-MIMO system with variable amounts of collision

- Collision increases capacity, but also complexity
- Gain from allowing collisions depends on user separation and SNR

Frequency offset, phase noise, synchronization:

- In single-user MIMO systems frequency offset and phase noise are modeled as a scalar constant (equal for all antennas)
- In a MU-MIMO MAC, frequency offset and phase noise are independent for all users
- Synchronization of users to the timing of the AP's time reference
- Handling of sample-rate offsets

User coordination (MAC-layer):

- Provide mechanisms for user-synchronization
- Coordination of users and radio resource allocation (space & time)

Precoding for MU-MIMO systems

- MU-precoding has been demonstrated previously
- MU-MIMO precoding may still be of interest but requires new of algorithms
- Only linear ZF precoding does not involve major changes to the PHY layer
- Potentially interesting to demonstrate LR-aided precoding from Task 2.2

Transmit CSI:

- Requires either feedback or reciprocity
- Feedback requires provisions at the MAC layer and causes transmission overhead
- Reciprocity and stability of the testbed RF is unknown (risk!)

Topics for Discussion with MASCOT Partners

- Which algorithms should be implemented/demonstrated
- Which algorithms should be demonstrated on the real-time platform
- Prioritization of the different algorithms (M2.3.2: Dec. 2007)
- Define system-level and MAC-layer requirements for planned MU-MIMO demonstrations
- Definition of a reference cases for performance comparison