ICT-215282: Reconfigurable OFDMA-based Cooperative NetworKs Enabled by Agile SpecTrum Use (ROCKET)

Technology Implementation Plan (TIP)

WP2
Enlarged System Bandwidth

2A1: Increased Usable Spectrum by Assignment
- Investigate Frequency Resource Allocation trade-offs by system-level simulations under various fairness constraints
- Derive key MAC Functionalities required for Efficient support of Scattered Multi-band operation
- Investigate Activity Mechanisms for Available Bands Allocation according to link conditions
- Investigate how Scattered Multi-band Operation affects Cooperative Relaying performance
- Identify parameters of the Spectrum Bands

MAC Performance comparison of different subchannel mappings in OFDMA systems (RWTH)

Game Theoretic analysis of Spectrum Aggregation (UniS)

2A2: Dynamically Increased Usable Spectrum by Opportunistic Spectrum Usage and Coexistence
- Study Existing Agile or Cognitive Radios (CR) Spectrum Usage Techniques
- Identify required key MAC Functionality for Efficient support of Dynamic Access to Radio Spectrum and certain Signalling procedures or Re-configurability Capabilities
- Study Distributed Coordination Mechanisms based on Game Theory Techniques for conflict resolution in case of Competing Secondary Systems
- Performance Evaluation of Activity Concepts

Coexistence by Spectrum Reuse (RWTH)

Coexistence by Spectrum Sharing (RWTH)

Spectrum deployment opportunities and frequency planning for multi-cell relay scenarios (TCF)

Distributed Spectrum Access using Game Theory (UniS)

WP3
Advanced Cooperative Transmission Techniques

3A1: Single-user Cooperative Techniques
- Investigate exploitation of Perfect and Statistical CSI to Increase Capacity in Cooperative MIMO Relaying
- Study Joint Design of Source and Relay(s) Signals and associated Joint Receiver Processing
- Investigate new Cooperative Protocols Two-way Relay Channel (TWRC) and Two-path Relay Channel (TPRC)

Precoder and resource allocation with full CSI for the OWRC (MOT)

Cooperative incremental redundancy for turbo-coded systems (MOT)

Cooperative DF protocol I with superposition coding (MOT)

OWRC with multiple Decode-and-Forward Relays (UPC)

Resource allocation for the Two-Way Relay Channel (UPC)

ARQ management for relay transmissions (UPC-UniS)

EGF/OQAM option at PHY for relayed transmission by tuning the EGF shaping filter of the OFDM symbols on the MSs mobility and channel delay spread (DUNE)

Hybrid ARQ combined with hybrid cooperative relaying (UniS)

Coding rate design for distributed turbo codes (CEA)

Distributed channel frequency multiplexer for distributed TC (CEA)

Enhanced receivers for cooperative DF schemes (UniS)

A novel multi-layer cooperative decode and forward scheme (UniS)

3A2: Multi-User Single-Cell Cooperative Techniques
- Extend Cooperative concepts into Cellular Multi-user Communication Scenario
- Study Simultaneous Transmission from Multiple Relays
- Investigate different Maximization criteria to Introduce Stream Differentiation
- Deduce Rules for Association between MS and BS-RS

Extension of the TWRC to the multi-user case, RRM and scheduling (UPC)

Multiuser uplink user pairing in inhomogeneous scenarios (DUNE, MOT)

Multi-user one-way, two-path relay channel with AF (TCF)

Comparison of Multi-BS Cooperative Transmission Techniques with orthogonal and limited cooperation schemes (UniS)

Uplink Multi-user Power Allocation for AF Cooperative MIMO Systems (UniS)

3A3: Multi-BS and RS Cooperative Transmission Techniques
- Extend Cooperation Schemes to case where more than one BS is involved in Servicing a given User for various possible schemes
- Investigate Insertion of Cell Borders RSs with good RS-BS links that Support MSs belonging to different BS Cells

Simplified Least Square Channel Prediction (ICOM)

Block Diagonalization MU precoding method robust against erroneous transmission, satisfying per antenna power constraints (ICOM)

Multi-BS and RS cooperative communication with analysis of AF relaying in linear and planar cellular system (UniS)

Outage Analysis for Distributed Antenna Systems (UniS)

WP4
Multi-cell Coordination for Advanced Interference Management

4A1: Multi-cell Advanced Antenna Techniques for Coordinated BSs and RSs
- Study Interference Avoidance Techniques across BS/RS Cells by means of Adaptive Antenna Techniques
- Propose Solutions exploiting Antenna Pattern adjustability and Multi Antenna Capability of Network Nodes to Efficiently Manage Interference among Co-band Cells

Coordinated precoding techniques for multiple BS-RS transmission (UPC)

Coordination of SDMA enhanced BSs (RWTH)

Region Coordination of SDMA enhanced BSs (RWTH)

Other cell aware precoding (UniS)

4A2: Multi-cell Radio Resource Management for Coordinated BSs and RSs
- Study Joint Decision on Dynamic Time-Frequency Allocation and Scheduling across Cells to address potential Interference between Cells when High Reuse is foreseen
- Study Feasibility of More-than-two-hops Transmissions
- Study Association of Infrastructure Node (either a BS or RS) to Multiple other Infrastructure Nodes exploiting Cooperative Transmissions
- Study Routing Protocols, that avoid Congestion and Node Depletion, and Improve High Throughput Connectivity
- Investigate Radio Resource Management through Cross-Layer Design (MAC/Routing)

Dynamic sharing of relay stations for load balancing (CTU)

Optimum multi-cell scheduling with and without relays (UPC)

Resource allocation techniques for interference mitigation, designed for half-duplex per chunks relays (CEA)

Adaptive resource allocation techniques for interference mitigation, designed for half-duplex per chunks relays (CEA)

Spectrum Load Smoothing in IEEE 802.16 Systems (RWTH)

Enhanced Fractional Frequency Reuse (RWTH)

Non real-time BS/BS. BS/RS coordination approach (ICOM)

Random Opportunistic Beamforming for non-ideal, inhomogeneous scenarios (DUNE)

Suboptimal beamforming for spatially clustered interference (DUNE)

Sequentially coordinated resource allocation between the interfering sectors of three adjacent cells (UniS)

WP5
Efficient and Reconfigurable MAC

5A1: Design of an Ultra-efficient MAC Protocol
- Design MAC Protocol with Efficiency Independent of Used PHY Transmission Scheme
- Develop New MAC Signalling Mechanisms
- Investigate appropriate Handover Strategies and necessary MAC Enhancements for High Mobile Users
- Performance Evaluation of Developed Ultra-Efficient MAC Protocol

Handover prediction based on channel characteristics (CTU)

Fast Predicted Handover (CTU)

Support of RS's mobility (CTU)

Position-based MS's movement prediction algorithm (CTU)

Reactive and proactive handovers mechanisms (CTU)

Persistent resource allocations for VoIP traffic to reduce MAC signalling overhead (RWTH)

Soft handover anticipation by use of geo localisation (TCF)

5A2: Design of a Reconfigurable Air Interface
- Identify MAC & PHY Key Parameters enabling Performance Gains through Reconfiguration and Analyze their Mutual Dependencies
- Derive Guidelines for Reconfiguration by means of Simulations Maximizing Overall System Performance for Different System Conditions
- Develop appropriate Signalling Mechanism for Entering Stations
- Define Reconfiguration Functionalities and Signalling Procedures of MAC/PHY Protocol that React on Changing Availability of Spectrum Resources
- Derive Guidelines for Reconfiguration of MAC/PHY Protocol

ARQ with reduced overhead (CTU)

Flow control in relay enhanced cells to increase cell capacity (RWTH)

WP6
Proof of Hardware Feasibility

6A1: Advanced Antennas Systems Design
- Design & Implement some Antenna Systems Tested in a Realistic Controlled Electromagnetic Environment
- Extract Realistic Antenna Parameters to be used for Tuning Simulation Models in order to Improve Simulation Channel Model Reliability
- Select Multiple Antennas Realistic from Antenna Implementation Perspective
- Design, Implement and Test some Antenna Prototypes
- Experiment with Different Canonical Diversities

Compact multi antenna system (CEA)

Over-The-Air test-bed (CEA)

6A2: RF/Baseband Co-design
- Study Compensation Techniques at Receiver
- Compare Additional Computational Complexity of Compensation Schemes
- Propose Proof-of-concept Platform of Compensation Techniques

Pre-distortion (CEA)

Rx compensation (CEA)

Hybrid Technique (CEA-ICOM)

6A3 High Performance Flexible MAC-PHY Implementation
- Investigate Implementation Tradeoffs raised by Advanced Baseband Techniques and Network Distributed Algorithms
- Identify most promising Techniques for Prototyping
- Implement and Integrated into Existing SW-defined Chain selected Techniques
- Obtain Performances of Implementation Platform
- Deduce Potential Performance of Targeted System

Channel prediction (CEA-ICOM)

Linear precoding (CEA-ICOM)

Parallel Complex Singular Value Decomposition (ICOM)

IEEE 802.16m | 3GGP LTE-A | IEEE 802.16m & 3GGP LTE-A | Possible Applicablity to WiMAX and/or LTE

Dissemination | **Diploma/Thesis** | ***Standard Contribution*** | *Patent Application* | ***Diploma/Thesis & Standard Contribution***

ROCKET