Cooperative Transmission Aspects

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Cooperative Transmission
Challenges

Key Objectives for Next Generation Wireless Networks

- Increase wireless channel capacity
- Increase spectral and power efficiency
- Increase network coverage
- Reduce outage probability

Limitations, Obstacles

- Limited bandwidth of wireless links
- Hardware size and increased cost of MIMO systems
- Broadcast nature of transmitted signals
Cooperative Transmission
State-of-the-Art

- Cooperative Transmission based on relaying nodes is a new transmit strategy for future wireless networks that takes advantage of the broadcast nature of wireless channels
- Relay Nodes provide diversity by creating multiple replicas of the signal of interest
- A virtual antenna array can be composed by properly coordinating different spatially distributed nodes in a wireless system
  - Emulation of a multi-antenna transceiver’s operation
- It can be considered an efficient solution for Improving the performance of wireless communications over fading channels without the need for physical co-located antenna arrays
Cooperative Transmission
State-of-the-Art
Cooperative Transmission
The Novelty

Multi-hop Transmission

Cooperative Transmission

Cooperative communications
Cooperative Transmission
The Advantages

- Higher spatial diversity
- Higher throughput
  - due to increased node throughput
- Lower delay
- Lower transmitted power
- Reduced interference
  - Due to lower transmitted power
- Adaptability to network conditions
  - Due to dynamic selection of neighbouring nodes to be the relays
Cooperative Transmission
The Issues - Open Problems

- **Node compromising (security)**
  - A wireless node may be compromised and therefore under the control of malicious parties.
  - Such a malicious node might serve as a Relay Node and damage the system performance through sending arbitrary information to the destination.

- **Greedy behavior of a Node (SLA, Policies)**
  - A wireless node not belonging to the same authority as the Send one may not work as a relay node for saving its own resources.
  - System performance degradation.
  - Reducing regular nodes' incentive for collaboration.

- **Noise and Channel estimation errors**
  - Relay node's misbehavior, such as forwarding wrong information or not forwarding at all.
Cooperative Transmission
The Issues – Open Problems

- **Interference levels**
  - Relay nodes may interfere one another; this implies optimisation of the relay network topology planning

- **Balance between cell coverage and cell throughput**
  - This has to do also with the accurate operation of the relay nodes and the corresponding cost

- **Channel estimation**
  - Existing schemes introduce signaling overhead
  - They are based on optimal combination of the direct transmission and the relay transmission over the fading channels
  - Thus, they require estimating channel information from the source to the relay and constantly sending the estimated channel information to the destination
Cooperative Transmission
The Issues - Constraints

❖ Most of the cooperative systems proposed so far are based on ideal assumptions
  ▪ Unfeasible synchronization constraints between the relay nodes
  ▪ The availability of perfect channel state information at the resource allocation unit

❖ There is a need for research on practical ways of realizing cooperative schemes based on realistic assumptions

❖ Relaying strategies and protocols
❖ Relay selection and resource allocation
❖ Cooperative communication in multi-hop cellular networks
❖ Synchronization effects in cooperative communications: effects and countermeasures
❖ How partners are assigned?
❖ Power control mechanism
❖ MAC protocol
Cooperative Transmission
The Standardisation

What are the opportunities and challenges in incorporating the cooperative techniques into the standards?

Cooperative techniques appear at several levels of the network

- Cooperative transmission among mobile stations (in centralized or non-centralized networks)
- Cooperation among networks (e.g. for traffic load balancing, handover, spectrum sharing)
- Cooperation among mobiles and networks in unlicensed operation
- Cooperation between licensed and unlicensed spectrum users

On going Stantardisation Activities

- The mesh mode MAC layer enhancement for IEEE 802.11
- The mesh techniques for 802.15 PAN networks
- The mesh operation and cooperative or multihop relay techniques for 802.16-2004 and 802.16e standards
- Spectrum sharing or cognitive radio techniques for 802.22 standard
Cooperative Transmission
The Impact

- Relaying protocols
- MAC Protocol
- Design of space-time codes
- Policies for nodes behaviour
Cooperative Transmission

The Context

Foreseen relation to the rest of the panels

- Self-Configuration and Management
  - Applicability of Self-* mechanisms for relay nodes configuration
  - Self-adaptation through dynamic relayings identification
- Advanced Multi-Carrier Communications
- Channel Coding
  - Space-time Codes
- Multi-user Communications
  - Cooperative conceptualisation into an integrated scheme of multi-input nodes, multi-users
- Opportunistic Access
  - Combined schemes for relayings selection and resource allocation