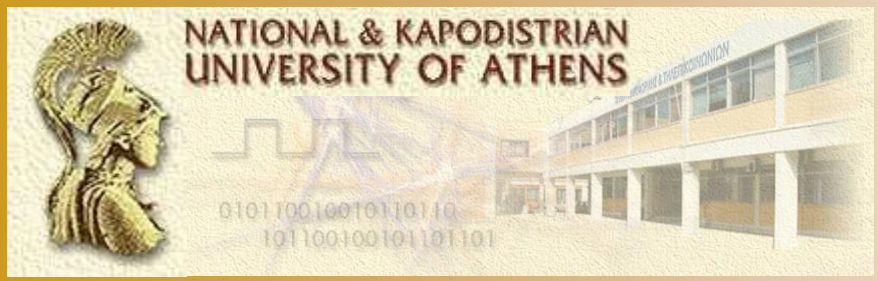
Cooperative Transmission Aspects



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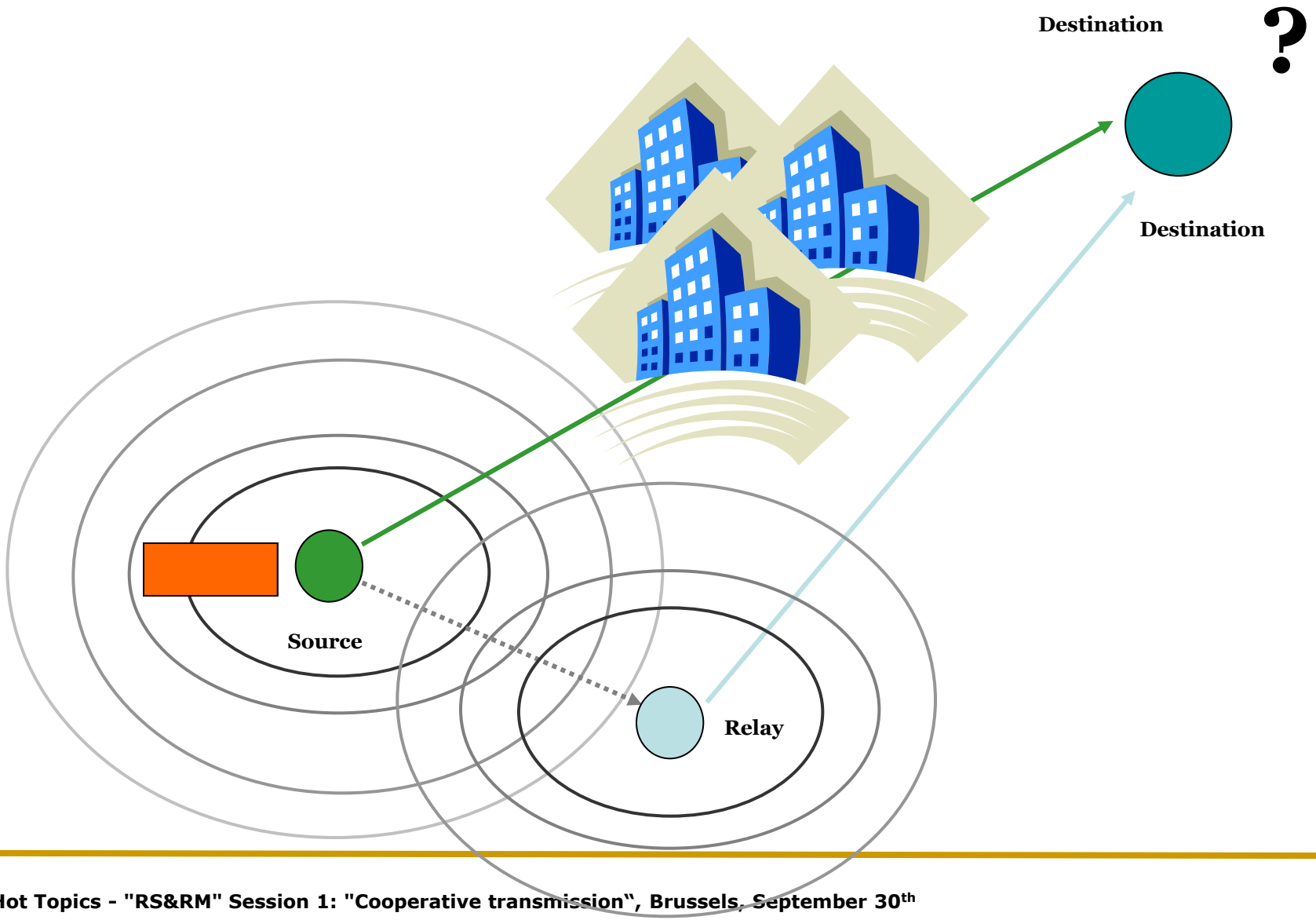
Cooperative Transmission
Challenges

- **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

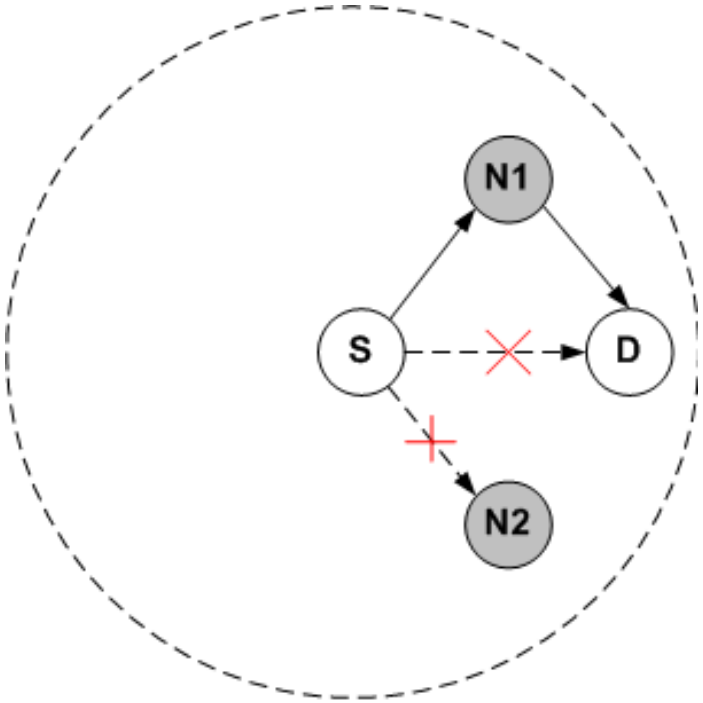
- **Cooperative Transmission based on relaying nodes is a new transmit strategy for future wireless networks that takes advantage of the broadcast nature of wireless channels**
- **Relay Nodes provide diversity by creating multiple replicas of the signal of interest**
- **A virtual antenna array can 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

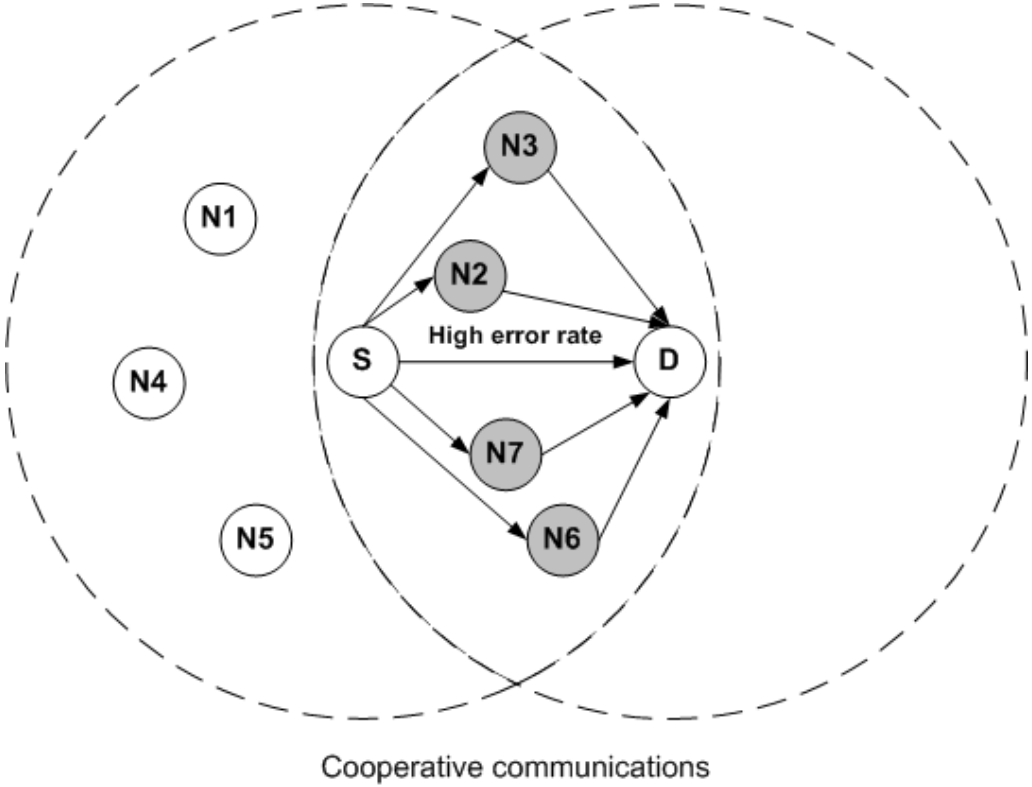


Cooperative Transmission
The Novelty

Multi-hop Transmission



Cooperative Transmission



Cooperative 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 to 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