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Purpose: Present the advantages of using coexistence protocols in Relay/Cellular operation and propose text for PAR

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Advantages of a Coexistence Protocol for Relay operation

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Phases relay operation

- **“Charge” phase**
  - BS -> RS (Relay station)
- **“Distribution phase”**
  - RS (Relay station) -> SS/MSS
- **“Collection” phase**
  - SS/MSS -> Relay station
- **“Discharge” phase**
  - RS -> BS
- **This presentation addresses mainly the collection/distribution phase**
Reducing the interference

• May significantly increase the spectral efficiency
  – 36% throughput improvement with relays implementing “beam forming” – see IEEE C80216mmr-05_008r3
    • May be too expensive

• This contribution will investigate how a “coexistence protocol” can produce similar results
Assumptions for the following study

• The antennae on BS and RS are omnidirectional
• Same basic topology as in C80216mmr-05_008r3
• The operator uses 3 frequency channels
  – The rejection of the adjacent channel is 30dB
• The reference case: the BS and associated relays use the same frequency channel
• The improvement: due to assignment of different channels to interfering cells
Reference case
Which transmitters might produce interference at SS receiver?

- Those having the signal strong enough, in the LOS conditions
  - We group those transmitters in a “Coexistence Neighborhood”
  - Assume that all the transmitters (BS and RS) use the same transmit power
  - Short lines in the next figure involve high interference
Coexistence “neighborhood”
C/I Distribution for the reference case

- C/I+N distribution [%]
  - Min to 0 dB: 3.214%
  - 0 dB to 3 dB: 10.756%
  - 3 dB to 6 dB: 10.284%
  - 6 dB to 9 dB: 10.151%
  - 9 dB to 12 dB: 14.636%
  - 12 dB to 15 dB: 14.057%
  - 15 dB to 18 dB: 10.458%
  - 18 dB to 21 dB: 7.377%
  - 21 dB to 24 dB: 5.372%
  - 24 dB to Max: 13.689%

- C/I+N distribution [dB]
  - C/I+N [dB] vs. C/I+N distribution [%]
  - Categories: >0, 0 to 3, 3 to 6, 6 to 9, 9 to 12, 12 to 15, 15 to 18, 18 to 21, 21 to 24, 24<
How to reduce the interference?

- Every RS uses a different sub-channel
  - limited throughput
- Every RS uses a full channel and BS schedules the transmitted powers for all the Relays such that the interference will be lower when sending the info for the target SS/MSS
  - Very complicated exercise, may not work for all the links
  - Limited throughput
  - Requires use of low MCRs
    - Long transmission times -> high power consumption from the MSS
Changing the frequency patterns

• Use another frequency pattern in the distribution phase

• Advantage
  – Drastically reduce the interference (see figures)

• Disadvantage
  – Needs frequency assignment
Different frequency pattern
Characteristics of the new frequency pattern

• Same number of interferes in the “Coexistence neighborhood”
• No adjacent interfering relays
  – All the interferers are more distant
• The cumulated interference is lower
  – Higher MCRs can be used
    • Lower MSS required transmission time and power consumption
Performance of the new frequency pattern
Comparison of C/(I+N) distributions
How to obtain the frequency assignment?

• Using 802.16h approach:
  – Data base:
    • GPS position of the Relays and BSs
    • IP Address
    • BSIDs
  – Sending the Radio Signature by RSs/BSs
    • Every SS/MSS/RS/BS can evaluate the interference
    • The information is centralized by the BS
    • Through **BS-BS distributed communication** the systems in Community may learn the interference and the interferers
  – Frequency channel selection procedures
Extending the concept

- Every frequency may be thought as a bunch of sub-channels
  - OFDMA/OFDM modes
- Negotiating the allocation of sub-channels per “bunch”
  - Depending on traffic amount
  - Flexibility on assignments
    - Token-based protocol, developed in 16h, may apply
Distributed power control

• Protocol based coexistence in 802.16h:
  – every NETWORK will have the possibility to use max. power at pre-defined time intervals
  – High spectral efficiency
    • Links not creating interference may work in parallel

• Protocol-based coexistence for cellular deployment:
  – Systems using a given FREQUENCY CHANNEL will have the possibility to use max. power at predefined time intervals
    • Allows distributed power management
      – No need for BS Controller
      – Base Stations will be able to control the Relay powers
    • Allows high spectral efficiency
Interference-free operation in cellular networks

• Could be created by coexistence protocols
  – The MSS is able to transmit/receive at higher $C/(N+I)$
  • Same data is handled in much shorter time

Reduces the MSS power consumption!
Relay PAR Scope

• Opt. 1:
  – To include:
    • “higher layer mechanisms, as Coexistence Protocols”

• Opt. 2:
  – To create a new PAR (after 802.16h is done)
    • “extension of the protocol-based coexistence for Relay operation”
      – Keeps the 802.16h expertise center
Drafting an 802.16 Coexistence Protocol

• Already started for 802.16h
  – First application: License Exempt use
  – Other applications:
    • Relays
    • Light-licensed bands

• Should be formatted as a stand-alone chapter, application independent

• Every application may enhance it and should have a sub-chapter to detail its usage