Downlink Control Channel Design Considerations for IEEE 802.16m

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Re:

TGm Call for comments on SDD, IEEE 802.16m-07/040

Abstract:

Discussed the functional of downlink control channel design and the relevant issues facing the working group

Purpose:

Discussion and adoption of functional area into SDD outline

DL Control Channel Design Considerations

- ## DL control channel functions
  - ➡ **Delivers important PHY and MAC control information including the following:**
    - ➡ **System time synchronization**
    - ➡ **Downlink and uplink resource allocations**
    - ➡ **Downlink paging**
    - ➡ **Uplink feedback channel allocations (e.g. ACKCH, CQICH, etc)**
    - ➡ **Uplink random access channel allocations**
  - ➡ **Requires more reliable transmission than data traffic, and should not rely on re-transmissions (HARQ)**

- ## DL control channel design should focus on
  - ➡ **Overhead**
  - ➡ **Performance**
  - ➡ **Complexity**
  - ➡ **Flexibility**
  - ➡ **Scalability**

DL Control Channel Design Options: Common vs Dedicated

➡ **Broadcast common control channel**
  - ➡ **Jointly coded**
  - ➡ **Broadcast control channel requires robust coding/modulation**
    - ➡ **Limited by worst user**
    - ➡ **Larger overhead**
  - ➡ **Current 802.16e DL control channels**
    - ➡ **DCD/UCD, DL/UL MAP, FCH, Preamble**
    - ➡ **DL cell radius is limited by the DL control channel**
  - ➡ **802.16m design should minimize control channel overhead**
    - ➡ **Super frame, frame, sub-frame structure**

➡ **Per user dedicated control channel**
  - ➡ **Separately coded**
  - ➡ **Control Channel elements distributed over the whole bandwidth**
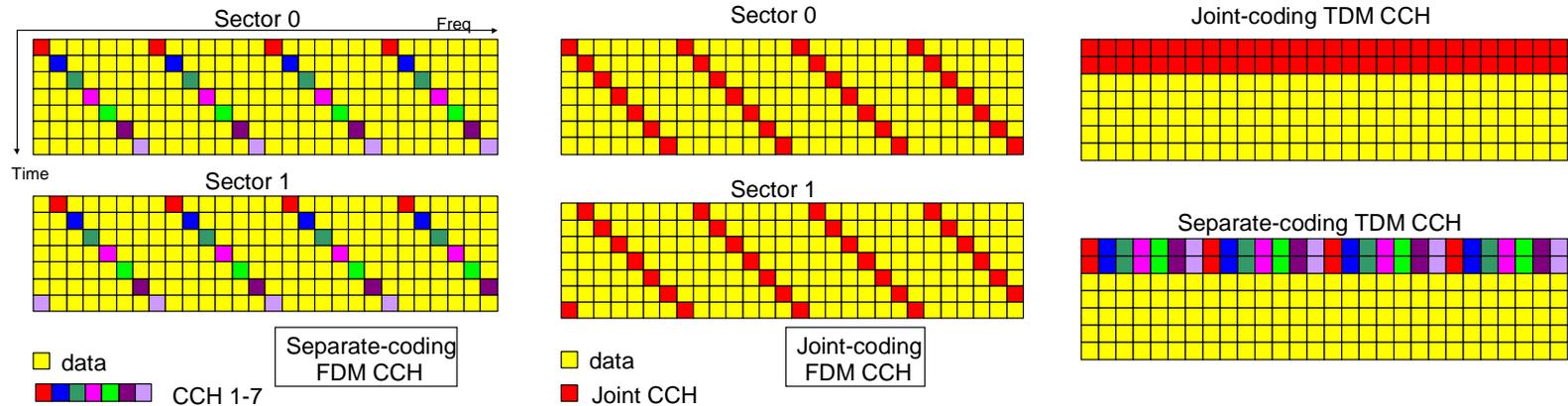 - ➡ **Per user power control is available**
  - ➡ **Per user control channel enables dedicated beamforming for control channel**
    - ➡ **Increase in overall coverage and capacity**
    - ➡ **Reduced control channel overhead**

DL Control Channel Options: FDM vs TDM

Sector 0

Freq →

Time ↓

Sector 1

■ data
■■■■■■■ CCH 1-7

Separate-coding FDM CCH

Sector 0

Sector 1

■ data
■ Joint CCH

Joint-coding FDM CCH

Joint-coding TDM CCH

Separate-coding TDM CCH

•TDM control and data regions

➡ Enable Microsleep

➡ **after reading UL/DL grant allocations on the DL, turning off RF functions until the next control channel cycle**

➡ Lower delay resulting in lower HARQ latency

➡ **Increased latency for FDM design will result in additional HARQ channels**

➡ **Reduced buffering requirements**

➡ Number of TDM symbols for CCH can be varied based on system load, MS location etc.

➡ **Lower overhead vs fixed CCH overhead**

➡ Easier to support variable sized DL sub-frame

DL Control Channel Design Details

- Control Channel should occupy the first 1 or 2 symbols in every 802.16m DL sub-frame
- Number of symbols occupied by CCH signaled by a 1 bit value
  - ➡ **Properly coded so that it reaches the worst case user**
- Control channel for each user is separately coded and has its own CRC
- Various coding rates supported for each user
- Coding rate detected blindly at the MS
- A control channel is composed of multiple control channel element (CCE)
- CCE's for each user is distributed over the whole bandwidth
- CCE's are composed of a fixed set of sub-carriers
- Multiple CCE's are concatenated to achieve different coding rates

■ **CE(i) Resource Element**   ■ **Control Resource Element**   □ **Data Resource Element**

frequency ⟶
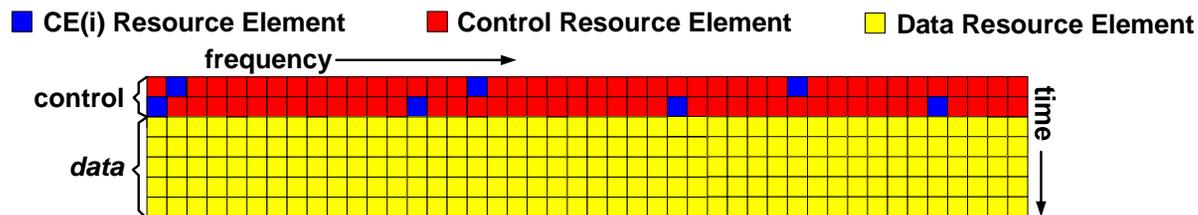
control
data
time

Summary

- **Several key issues must be agreed regarding downlink control channel design**

  - Broadcast common control channel
    - Carries common control information (e.g. 1 bit to indicate whether one or 2 symbols used for DL CCH)
    - Should be robust, and small overhead
  - Per-user dedicated control channel
    - TDM control region and data region
    - Enables micro-sleep, power control, beamforming etc.
    - Control channel element distributed over the whole bandwidth
  - Control channel could support proposed backward compatible frame structure of 802.16m
  - Control channel could support various DL MIMO/BF features proposed for 802.16m

- **A major functional area of the SDD effort and outline should focus on downlink control channel design**

Proposal to 802.16m SDD

- **Include the following components in the SDD ToC**

  ➡ Downlink control channel

  ➡ Broadcast common control channel

  [This channel should contain common control information, such as DCD/UCD and their equivalent for 802.16m]

  ➡ Dedicated per user control channel

  [This channel should contain per user control information, such as UL/DL resource allocation]