DL Control Channel Structure for 16m

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Purpose:
The purpose of this slide set is to introduce our contribution.

Background and introduction

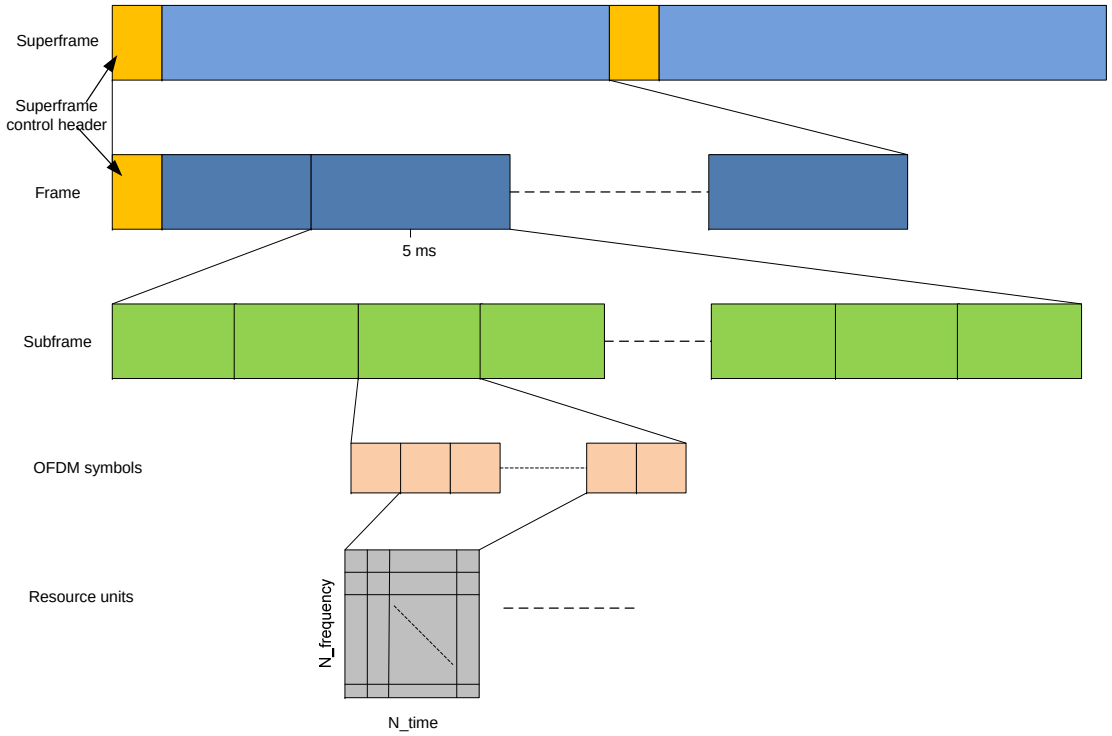
- Overhead reduction, latency reduction are among the list of system requirements in 802.16m SRD.
- Control information can be classified into static, semi-static and dynamic control information. If taking a look at the current 16e legacy system, control information are transmitted without carefully considering different characteristics of different control information.
- In general, DL control information can be classified into
  - system configuration information
  - system broadcast information
  - various management messages
  - DL/UL resource allocation
  - feedback information (e.g. ACK/NACK, CQI, power control)
  - etc.
- The design of the control channel should carefully consider different factors such as
  - overhead,
  - flexibility,
  - complexity,
  - Latency
  - Power efficiency
- Since dedicated MAC management messages will be transmitted as in-band signaling, this contribution mainly focuses on system information. Purpose of our contribution is to improve control information transmission efficiency.

DL control information classification

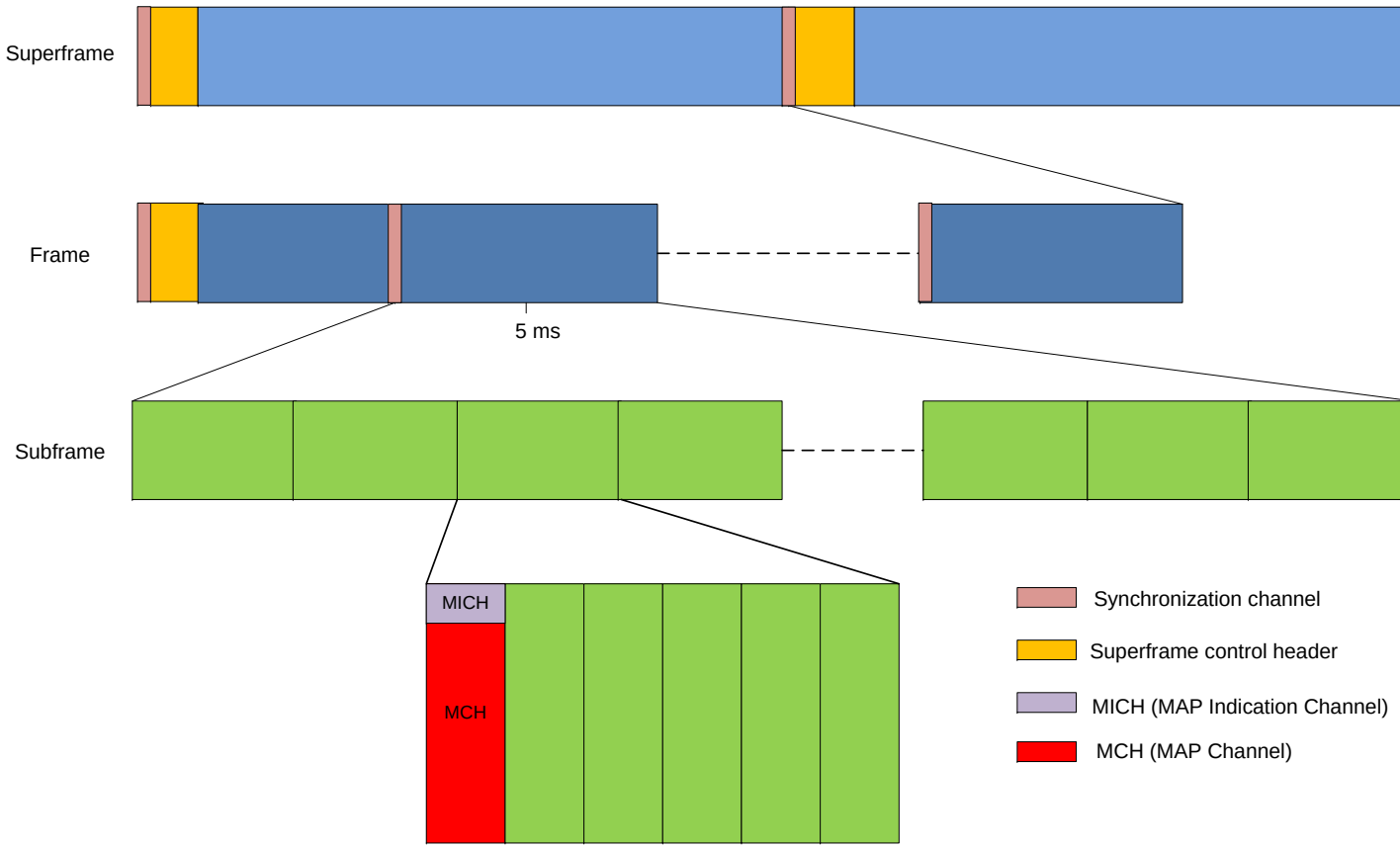
- DL control channel shall convey the information listed below:
  - System configuration information
    - Low fixed bit rate using predefined transport format
    - Required to be broadcast in the entire coverage area of the cell
    - Examples: FCH, DCD/UCD, etc. in 16e
  - Synchronization information
    - Required to be broadcast in the entire coverage area of the cell
    - Examples: preamble in 16e, synchronization channel, etc.
  - Resource allocation information
    - Dedicated and/or broadcast/multicast resource allocation information
    - Flexible transport format
    - Possible using advanced techniques e.g. MIMO
    - Examples: MAP, sub-MAP in 16e
  - Feedback (e.g. HARQ ACK/NACK, CQI, Power control) info
  - Other broadcast control messages
    - Examples: Neighbor BS advertisement message and paging information

Example frame structure

- Understanding frame structure is helpful in order to understand DL control channel design.
- As shown in the figure (based on the output of Frame Structure Rapporteur group C802.16m-08/118r1), each superframe is divided into multiple radio frames and furthermore each radio frame is divided into several subframes.



Proposed DL control channel mapping



Synchronization Channel (SCH)

- Synchronization channel (e.g. preamble) is required by MS to maintain coarse synchronization with the BS.
- The preamble shall be transmitted at the beginning of every radio frame.
- It provides the BS identity (e.g. ID-Cell and Segment Number)
- These ID-Cell and Segment number are used to locate the MAP indication channel (MICH) of the sector and defines the initial permutation used in the sector.
- BS transmits legacy preamble when legacy support is enabled otherwise BS will transmit new preamble.
  - If 16m preamble is used in the presence of legacy preamble, **additional overhead of 0.5% is introduced.**

MAP Indication Channel (MICH)

- In order to have scheduling flexibility and latency reduction, MICH is presented in every (concatenated) subframe.
- MICH is transmitted in the first OFDM symbol of every (concatenated) subframe and occupies fixed number of subcarriers.
- MICH is used to indicate the MAP related information, e.g. how many OFDM symbols are used for MCH (MAP message) and repetition of MAP messages.
- MICH is transmitted in different resource position in neighbor BSs in order to reduce the interference.

MAP channel (MCH)

- MCH contains jointly encoded resource allocation information.
- MCH is broadcast/multicast channel and transmitted with flexible repetition.
  - Blind detection is not required.
  - Users can efficiently grouped according to channel condition.
- MCH is transmitted in every (concatenated) sub-frame and has variable size.
- MCH is transmitted in TDM mode and may occupy one or several OFDM symbols.
  - There are two options to indicate the size of MCH:
    - In terms of number of Resource blocks
      - Requires more number of bits in MICH therefore increases MICH overhead but provides higher granularity
      - Size of MICH will be different for different frequency band because of number of Resource blocks is higher in larger band. Therefore require different formats for MICH.
    - In terms of number of OFDM symbols.
      - Requires less number of bits in MICH therefore MICH overhead is low but MCH may not fill the complete band and require unnecessary padding.
      - It is possible to support different permutation for MCH and Resource block within a sub-frame.
      - It also allows different frequency reuse for MCH and resource blocks. E.g. MCH can be transmitted using frequency reuse 3 while data can be transmitted using frequency reuse 1.
  - We propose that size of MCH should be indicated in terms of number of OFDM symbols.

Super-Frame Control Header (S-FCH)

- S-FCH should be of fixed size and transmitted using pre-defined MCS at pre-defined location.
- The content of superframe control header includes:
  - BSID
  - Super frame number
  - SCD count – (System Configuration Descriptor – DCD/UCD combined)
  - SCD MASK
    - In order to support hierarchical SCD
    - If BS changes any part of SCD, it will increase the SCD counter and indicate which part is changed using SCD MASK.
    - MS monitors SCD counter changing and analyzes the SCD MASK and decode relevant part of SCD.
    - BS can provide scheduling time of SCD fragments in one of the broadcast SCD fragment.
  - Frame configuration – concatenation of sub-frames.
  - Sub-frame/concatenated sub-frame zone configuration
  - Flag indicating whether broadcast information (e.g. SCD messages) is included in this superframe or not and possibly including a pointer in the superframe header to indicate the location of the broadcast information (e.g. sub-SCD messages).
  - If BS transmit paging messages message in any of the sub-frame of the superframe then S-FCH may contain a flag indicating the presence of paging in the superframe to enable better MS power usage during Idle Mode.
  - Flag indicating transmission of traffic indication message to enable better MS power usage during Sleep Mode.

SCD - System Configuration Descriptor (combined DCD/UCD)

- SCD is required to be transmitted with robust MCS resulting in a big portion of overhead especially when few field of the DCD/UCD changes. It requires BS to either re-broadcast DCD/UCD or delay the update so that it can be transmitted at its scheduled transmission. If BS re-broadcasts then it incurs lot of overhead but if BS delay the transmission than it may impact the system performance because those changed parameters may be critical for proper system operation.
  - We propose to combine all type of system information under SCD (system configuration descriptor) and divide the SCD into sub-SCD according to the type of contents.
  - Require only single counter (SCD change count) and SCDMASK (SCD change count and SCD MASK can be transmitted in S-FCH) to manage complete system broadcast information.
  - SCDMASK will indicate which sub-SCD is changed so MS only require decoding that particular sub-SCD.
- DCD/UCD contains different types of system information. Some information does not change very often while some information changes more often. Therefore it is difficult to make a decision on the periodicity of DCD/UCD transmission. If period is too small then overhead is very high and if period is too large then system access will be longer.
  - We propose to allow different periodicity for different types of system information.
- In 16e, MS does not know when and where DCD/UCD will be transmitted therefore it requires decoding DL-MAP in every frame until it gets the DCD/UCD information.
  - We propose to indicate either flag or pointer in the S-FCH to assist MS to find SCD in a more power efficient manner.

Summary

- It is suggested to discuss and include the proposed text in IEEE C80216m-08/165r1 or latest version into SDD.