Title: Proposal of a Coordinated Coexistence approach between 802.11 and 802.16

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Purpose:

Proposal of a Coordinated Coexistence approach between 802.11 and 802.16

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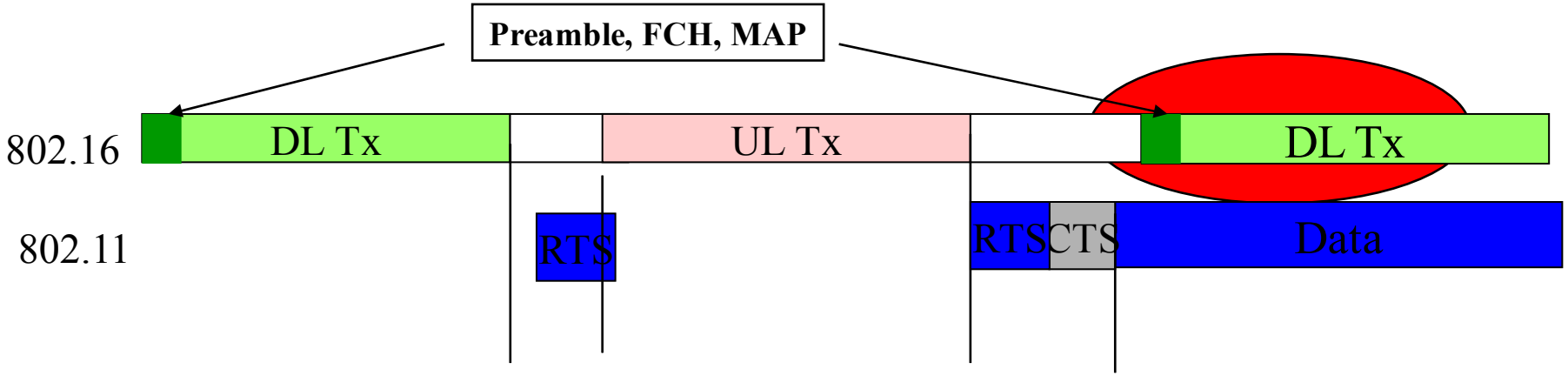
802.16 systems operation

- Scheduled mode
- 802.16h/D1
  - GPS synchronization
  - Scheduled with absolute time synchronization
  - Defined MAC Frame duration
  - Co-channel sharing based on time separation
  - CX Control Channel
    - Cognitive Radio approach

How 802.11 can affect 802.16 operation

- 802.16 silence intervals:
  - DL and UL transmissions will end before the Tx/Rx transition
    - The Tx/Rx sub-frame is not always fully used
    - BS RTG (Receive-Transmit Gap) < 60us
    - SSTTG < 50µs for OFDMA and <100µs for OFDM

- 802.11
    - CCA detect time for 20MHz channels **(< 4µs)**



Consequence of 802.11 operation - 1

- 802.16 DL Sub-frame
  - Preamble, FCH, DL MAP, UL MAP, Data transmission – affected by transmissions sync with Rx/Tx transition by 802.11
- 802.11 Transmission durations
  - Annex 1
    - 4ms limitation
      - May create interference to both UL and DL transmissions
        - Preferred MAC Frame duration is 5ms, including both UL and DL
  - The usage of the spectrum is not limited in time
    - Does 802.11y give “reasonable opportunities” for 802.16 operation?
    - Does 802.11y comply with the CBP requirements?

Consequence of 802.11 operation - 2

- Detection threshold value
  - Low levels consequences
    - Systems will not operate in parallel
      - Reduced spectral efficiency
    - Relatively higher cell sizes
  - High level consequences
    - Systems may operate in parallel
      - Reduced cell size
    - QoS problem

802.16h UCP (Uncoordinated CX Protocol) – EQP and Listen-before-talk

- Intra-frame gaps
  - Excellent opportunities for 802.11y transmissions
- Listen Before Talk
  - Excellent opportunities for 802.11y transmissions
  - Full 802.16 MAC Frames are made available
- EQP – Extended Quiet Periods
  - More full 802.16 MAC Frames are not used, min. quiet time is 50%
    - Additional guaranteed time for 802.11y only transmissions

802.16h UCP versus 802.11y

- 802.16 UCP is the result of feeling that 802.11y people does not wish to collaborate with 802.16h

- Lot of concerns in the 802.16h meetings his week
  - See Letter Ballot 24 database
    - IEEE 802.16-06/068
  - See Contribution IEEE 802.16h-06/108r3
    - Concerns about the real-time services
  - Ad-Hoc created to resolve the 20 related comments

- **802.16h UCP – summary of concerns**
  - High delays, no QoS, serious problem with Real Time Services
  - Low spectral efficiency

- **FCC problem**
  - Low 3.65GHz spectral efficiency = spectrum cannibalization!
  - 802.11 technology may be considered as privileged in the detriment of 802.16
    - FCC is NOT technology neutral
  - **May prefer the "exclusive licensing" approach**

Coordinated CX - proposal

- Fair 802.11 and 802.16 access to the media
- Mechanisms
  - GPS synchronization
  - Coexistence Control Channel
  - Master / Slave sub-frames
  - Listen-before-talk
  - Extended Quiet Periods

Interference avoidance in context of 802.16 MAC Frame

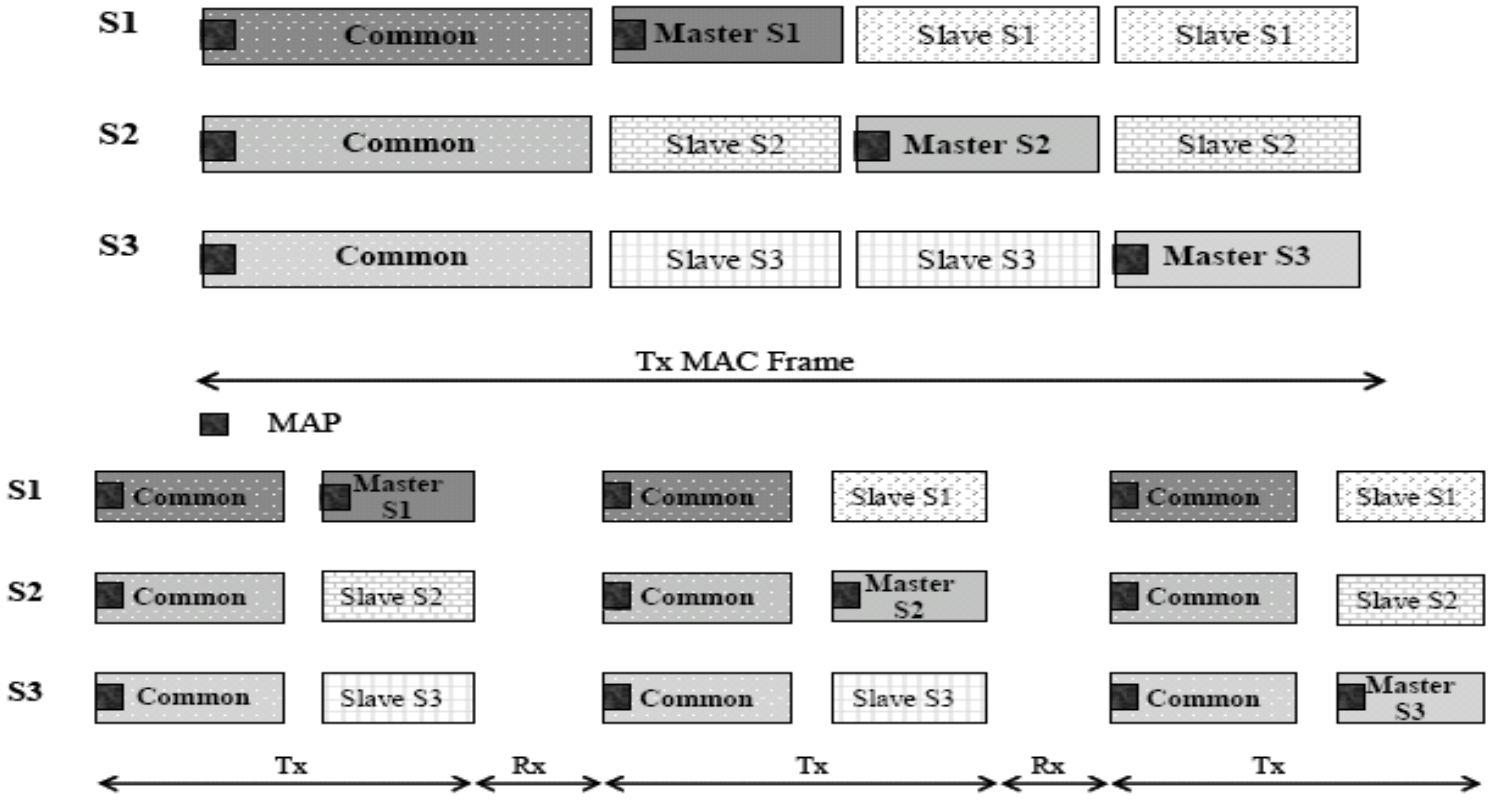


Figure h19—examples of WirelessMAN-CX Subframes

Candidate Master sub-frame determination using the CX Control Channel Slots

- A system will determine the less interfered Master sub-frame by
  - Listening to CX CC on all possible operating channels
  - Determine the less interfered one
- Up to 3 systems can share the channel at a given location

Needed changes to CX Control Channel definition in 802.16h

- Should be added the possibility to differentiate between Bursty systems and Scheduled systems
  - Add a slot, for every supported Master sub-frame, to indicate if a system is a 802.11 system

Coexistence between 802.11y and 802.16h in the Coordinated mode

- 802.11y system is Master
  - 802.16h operating as Slave
    - Apply “Listen before Send” for 1 symbol from the sub-frame start
    - If energy above threshold is detected, insert a “Extended Quiet Period” for the sub-frame duration
- 802.16h system is Master
  - 802.11y system operating as Slave
    - 802.11y can operate only if it is applying the CX Protocol and the transmission duration is limited to a specific sub-frame duration
- Common sub-frames
  - Reduced Tx power
  - 802.11y: CCA detection time is applied for 50 us from the start of the Common sub-frame and no energy is detected

Controlling interference during Master sub-frames with CX Protocol

- A BS can request slave systems to reduce their power/ stop operating during its Master sub-frames
  - Systems not able to use the Coexistence Protocol are not allowed to operate as Slaves
- Messages:
  - Reduce_Power_Request
  - Stop_Operating_Request

802.11y minimum needed changes

- BS synchronization using GPS and/or the 802.16h CX Control Channel sync slots
- Management beacons or messages to transmit the absolute time and the Master time repetition intervals and durations to STAs
- Rules for using the CX Control Channel and the Master/Slave sub-frames

The effects of applying the Coordinated Coexistence Mode

- The spectrum will be optimally and fair shared
  - Technology independent approach
  - High spectral Efficiency
  - High QOS
- Compliance of 802.11y with the CBP requirements

- Resulting situation
  - **802.11 – WIN**
  - **802.16 – WIN**
  - **FCC - WIN**

Conclusion

- **As long as the industry is not collaborating for a coexistence approach which is acceptable for all the players, it is a high chance that FCC will change the ruling for the 3.65GHz band**
  - **Exclusive licensing**
- **Existing requests to FCC**
  - **Some WiFi companies prefer the non- exclusive licensing**
  - **Some WiMAX companies prefer the exclusive licenses**
  - **WCA indicates non-exclusive licensing for Rural areas only**
- **It is already too late for the 802.11 – 802.16 collaboration on 3.65GHz?**