Comment to C80216j-06_057 Proposal for Requirement that RS Transmits Preamble

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None.

Purpose:

This contribution is to clarify M4 requirement (MS backward compatibility) of IEEE 802.16j-06_016 w.r.t. preamble & midamble, plus recommends modifications to TR. The analysis applies to the access link only (the preambles & maps seen by MS).

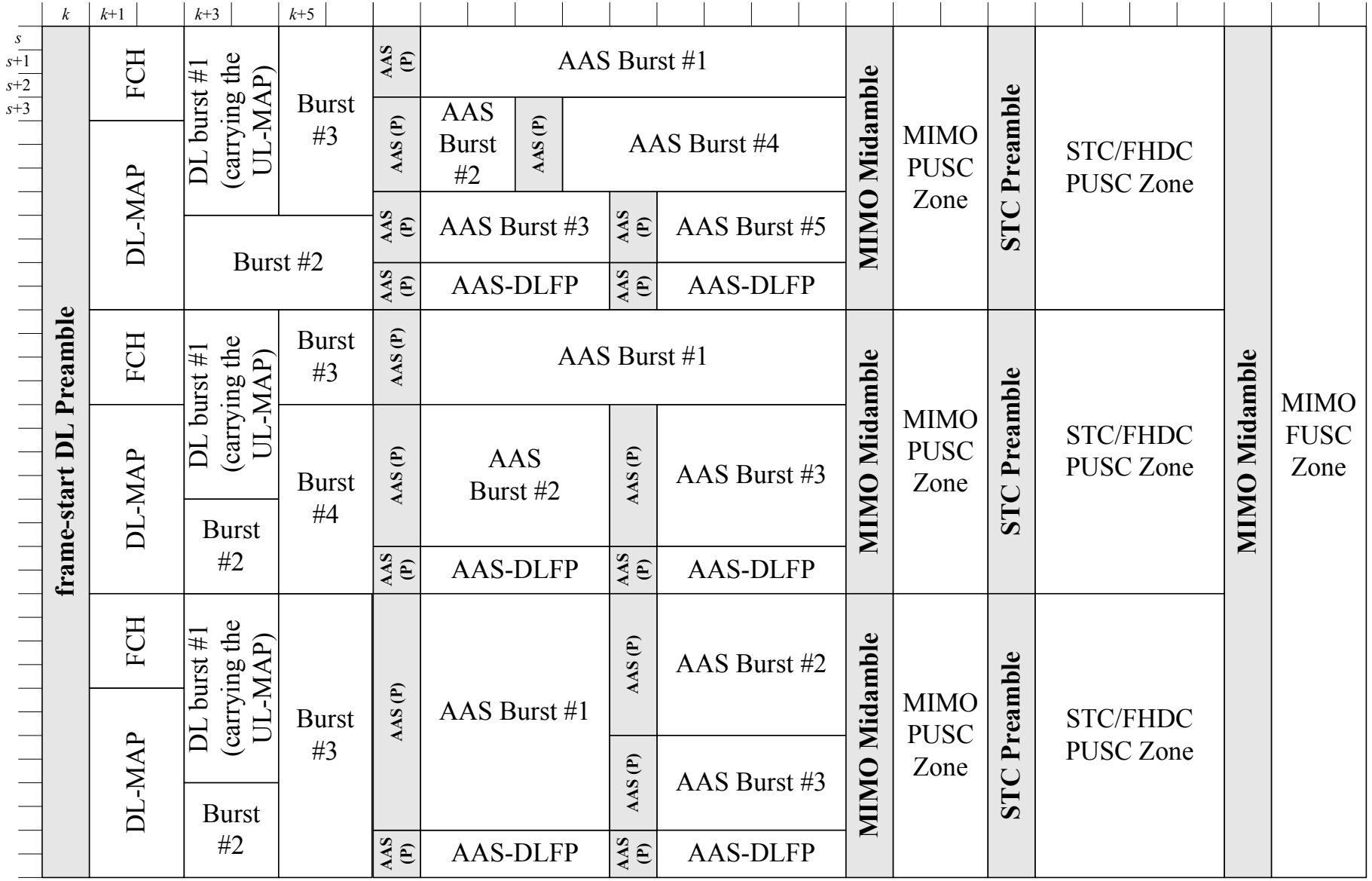
Outline

1. Preamble usage defined in 802.16 specifications
2. Frequency reuse scenarios
3. MS Operational Effectiveness in Presence of RS
4. Comparison analysis in different usage models
5. Recommended modifications to TR

Preamble Usage Defined in 802.16 Specifications

1. Frame-start DL Preamble
   (In 802.16-2004/16e-2005 page 552/513)
2. AAS Preamble
   (In 802.16e-2005 page 367)
3. STC/FHDC Preamble
   (In 802.16e-2005 page 571)
4. MIMO Midamble
   (In 802.16e-2005 page 599)

Preamble Definition



Frequency Reuse Scenarios

1. SFSS - BS and RS operate at "**same** *center carrier frequency*" and "**same** *segment*"
2. SFDS - BS and RS operate at "**same** *center carrier frequency*" but "**different** *segment*"
3. DF - BS and RS operate at "**different** *center carrier frequency*"

Scope Of Discussion - 1

1. In cases of SFDS or DF, transmitting preamble & midamble should be mandatory for the RS
   - RS is the only source for transmitting preamble & midamble
2. In the case of SFSS, transmitting preamble & midamble may be optional for the RS

Scope Of Discussion - 2

1. With regards to AAS Preamble, STC/FHDC Preamble and MIMO Midamble, transmitting preamble or midamble by RS should follow 802.16 specifications defined for BS in SFSS
   - RS is the only source for transmitting preamble or midamble due to spatial diversity
2. **With regards to Frame-start DL Preamble, transmitting preamble may be optional for the RS in SFSS**

The Purposes of Frame-start DL Preamble for MS

1. Cell search & frame boundary detection
2. Cell ID & segment identification
3. Frequency/timing offset compensation
4. Channel estimation
5. Channel quality measurement (CINR)

The Analysis of RS Transmitting Frame-start DL Preamble

Tx frame-start DL preamble	Tx FCH, DL-MAP, UL-MAP, DCD, UCD	Comment
N	N	
Y	Y	
Y	N	Not recommended*1
N	Y	Not recommended*1

***1: the preamble and "FCH, DL-MAP, UL-MAP, DCD, or UCD" could be in different channel conditions**

Relay Station Modes

- SFSS (Single Frequency Single Segment)
  - **Mode I** - RS doesn't Tx frame-start DL preamble, FCH, DL-MAP, UL-MAP, DCD, and UCD
  - **Mode II** - RS Tx the same frame-start DL preamble, FCH, DL-MAP, UL-MAP, DCD, and UCD as those sent by BS
- SFDS or DF (Single Frequency Different Segment or Different Frequency)
  - **Mode III** - RS Tx it's own frame-start DL preamble, FCH, DL-MAP, UL-MAP, DCD, and UCD that were received from BS
  - **Mode IV** - RS Tx it's own frame-start DL preamble, FCH, DL-MAP, UL-MAP, DCD, and UCD

MS Operational Effectiveness in Presence of RS

Effectiveness to BS \ RS Mode		Mode I	Mode II	Mode III	Mode IV
BS cell search & BS frame boundary detection @ MS		Same	Conditional*3	Same	Same
BS cell ID & BS segment identification @ MS		Same	Same	Same	Same
DL frequency/timing offset compensation @ MS		Same	Conditional*3	Same	Same
DL channel estimation @ MS	Only by pilots in its burst	Same	Same	Same	Same
	Also by preamble and/or pilots in other bursts	Possibly Negative*1	Possibly Negative*2	Same	Same
Channel quality measurement @MS (CINR accuracy of BS preamble)		Same	Possibly Negative*3	Same	Same

Same: No change w.r.t. MS operational effectiveness

Conditional: Could be positive, same or negative depending on the operating environment, e.g., whether it is in range extension model or throughput enhancement model, whether the RS signal received by the MS is much stronger than the BS signal, whether the RNG-RSP (ranging response) message can be used effectively, etc

***1: depend on sources of bursts included in the channel estimation algorithm**

***2: due to channel estimation algorithm**

***3: MS receives multi-path signals from BS & RS**

MS Operational Effectiveness in Presence of RS

Effectiveness to RS \ RS Mode		Mode I	Mode II	Mode III	Mode IV
RS cell search & RS frame boundary detection @ MS		N/A	Conditional*3	Same	Same
RS cell ID & RS segment identification @ MS		N/A	Same	Same	Same
DL frequency/timing offset compensation @ MS		Conditional*1	Conditional*3	Same	Same
DL channel estimation @ MS	Only by pilots in its burst	Same	Same	Same	Same
	Also by preamble and/or pilots in other bursts	Possibly Negative*2	Possibly Negative*2	Same	Same
Channel quality measurement @MS (CINR accuracy of RS preamble)		N/A	Possibly Negative*3	Same	Same

Same: No change w.r.t. MS operational effectiveness

Conditional: Could be positive, same or negative depending on the operating environment, e.g., whether it is in range extension model or throughput enhancement model, whether the RS signal received by the MS is much stronger than the BS signal, whether the RNG-RSP (ranging response) message can be used effectively, etc

***1: time synchronization problem between BS & RS, Doppler shift**

***2: due to channel estimation algorithm and sources of bursts included in the algorithm**

***3: MS receives multi-path signals from BS & RS**

Comparison Analysis in Different Usage Models

1. In pure ranging extension usage model
2. In pure throughput enhancement usage model
3. In mixed usage model

Pure Ranging Extension

- In a RS coverage, MS cannot detect frame-start DL preamble from BS; or MS can detect frame-start DL preamble from BS but cannot correctly decode FCH, DL-MAP, UL-MAP, DCD, and UCD from BS
- Mode I RS cannot work in this case

Pure Throughput Enhancement

- In a RS coverage, MS can correctly decode FCH, DL-MAP, UL-MAP, DCD, and UCD from BS
- Mode I, II, III or IV RS could be used in this case

Mixed Usage Model

- In a RS coverage, some MSs are operating in pure ranging extension while some MSs are operating in pure throughput enhancement
- Mode I RS may not work in this case

Recommended Modifications to TR

M4	PHY frame structure for backward compatibility with legacy 16 mobile station	The specification shall define a backward compatible frame structure that supports relay links while accommodating the legacy access links.	MMR-BS (M) RS (M)	

Add the following text

- RS shall be required to either transmit the frame-start DL preamble plus "FCH, DL-MAP, UL-MAP, DCD, and UCD", or transmit none
- Transmitting AAS Preamble, STC/FHDC Preamble and MIMO Midamble by RS should follow 802.16 specifications defined for BS

Open Issues for Further Discussion During Technical Proposal Phase

1. We recommend RS be required to transmit the frame-start DL preamble when it operates with BS at “same frequency, different segment” or “different frequency”
2. In pure range extension usage model, we recommend that the RS be required to transmit the frame-start DL preamble
3. In SFSS scenario, could RS operate in TYPE II mode while transmitting its own frame-start DL preamble?