Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**HARQ protocol operation in IEEE 802.16m**
Date Submitted	**2008-05-12**
Source(s)	Shashikant Maheshwari E-mail: shashi.maheshwari@nsn.com Xin Qi Yousuf Saifullah Xiaoyi Wang Adrian Boariu NSN
Re:	IEEE 802.16m-08/016r1: Call for Contributions on Project 802.16m System Description Document (SDD). Target topic: "HARQ".
Abstract	This contribution proposes a high level HARQ operation
Purpose	For discussion and approval by TGm
Notice	
Release	
Patent Policy	

Outline

This Contribution discusses

- HARQ transmission method
- HARQ timing and ACK/NAK feedback offsets
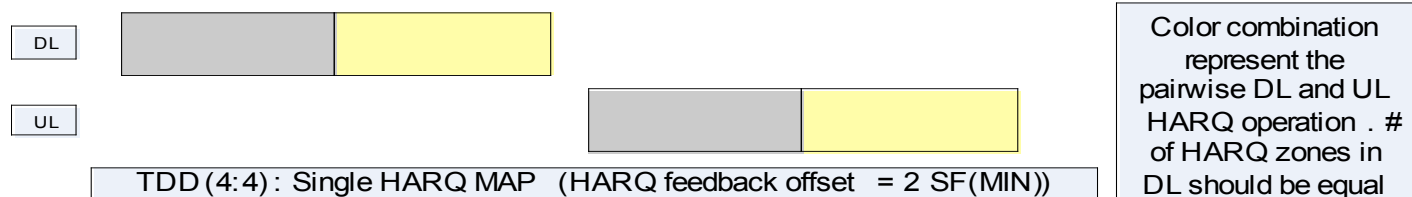- HARQ feedback method

HARQ transmission Method

- Synchronous HARQ
  - Advantages:
    - Low signaling overhead
  - Disadvantages:
    - Early termination creates fragmentation of resources because of no fixed slot structure (derivation of HARQ ACK/NAK location could be complex)
      - Require fixed HARQ slot size - granularity issue.
    - Resource wastage, if initial signaling is lost
    - Inflexibility in scheduling

- Asynchronous HARQ
  - Advantages:
    - Support adaptive coding with scheduling flexibility
      - Signaling overhead in case of adaptive synchronous HARQ is similar to asynchronous HARQ but looses scheduling flexibility.
    - No fragmentation
    - resilience to signaling loss.
  - Disadvantages:
    - Higher signaling overhead

- ## Propose to adopt Asynchronous HARQ transmission method.

HARQ Timing and feedback offset

- In 802.16e, HARQ feedback offset is fixed for all types of MSs. However, the decoding capabilities of different types of MS may be different.

- Latency requirements of different types of traffic is also different.

- In 802.16m, it is not necessary to have a resource allocation information in every sub-frame. Sub-frames may be concatenated.

- Therefore, IEEE 802.16m should provide support for variable HARQ feedback offset, when possible.

- Following slides represents the sub set of possibilities for HARQ timing in TDD/FDD mode with or without legacy support.

HARQ timing and feedback offset in 802.16m TDD with legacy support (UL – TDM)

| SF 0 | SF 1 | SF 2 | SF 3 | | SF 4 | SF 5 | SF 6 | SF 7 |

DL — Legacy Mode

UL Data, DL ACK/NAK

UL — DL/UL MAP , UL ACK/NAK(O), DL Data — Legacy Mode

TDD (4:4) : HARQ MAP in every 802.16m DL SF (HARQ feedback offset = 3 SF)

DL

UL

TDD (4:4) : Single HARQ MAP (HARQ feedback offset = 2 SF(MIN))
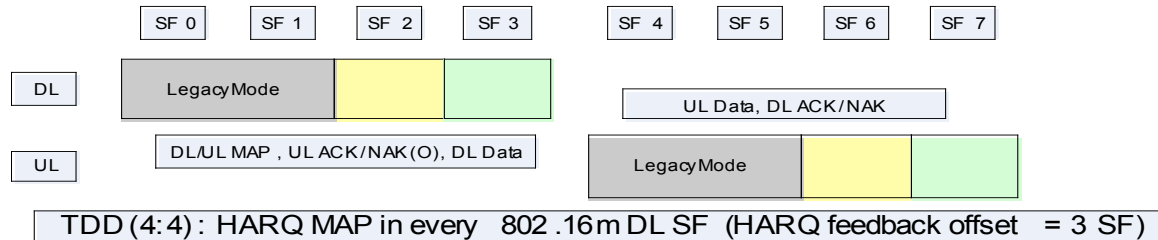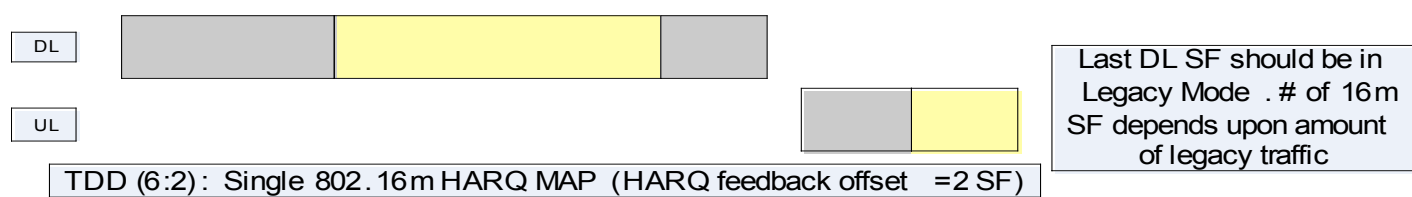
Color combination represent the pairwise DL and UL HARQ operation . # of HARQ zones in DL should be equal to # of HARQ feedback zone in the UL and vice versa .

DL

UL

TDD (5:3): Legacy traffic =HIGH, One 16m HARQ MAP (HARQ feedback offset = 2 SF)
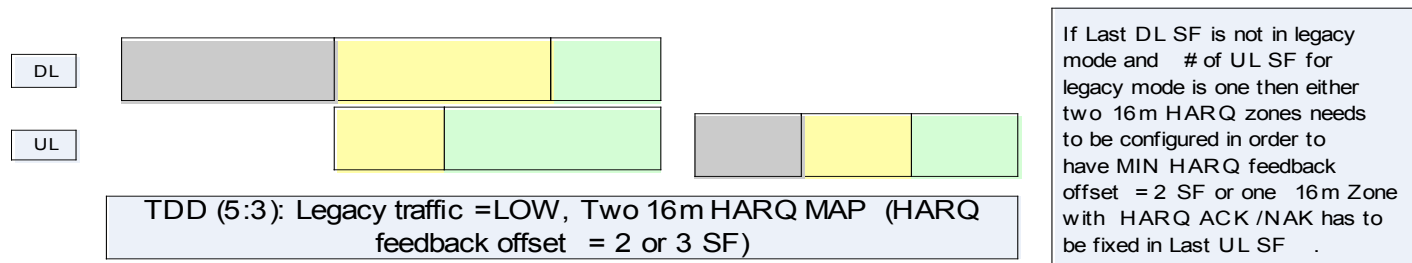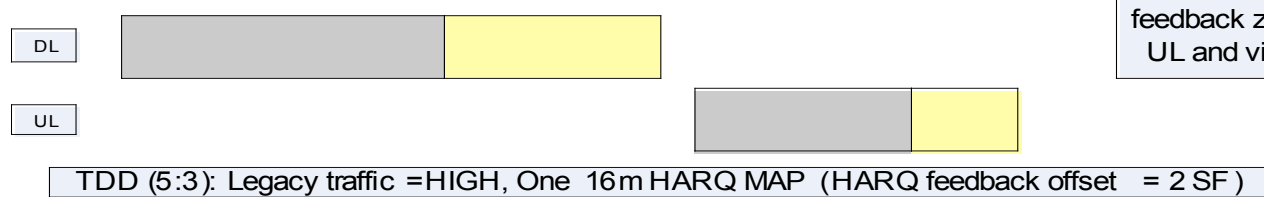
If Last DL SF is not in legacy mode and # of UL SF for legacy mode is one then either two 16m HARQ zones needs to be configured in order to have MIN HARQ feedback offset = 2 SF or one 16m Zone with HARQ ACK /NAK has to be fixed in Last UL SF .

DL

UL

TDD (5:3): Legacy traffic =LOW, Two 16m HARQ MAP (HARQ feedback offset = 2 or 3 SF)

DL

UL

TDD (6:2) : Single 802.16m HARQ MAP (HARQ feedback offset =2 SF)

Last DL SF should be in Legacy Mode . # of 16m SF depends upon amount of legacy traffic

5

HARQ timing and feedback offset in 802.16m TDD with legacy support (UL – FDM)
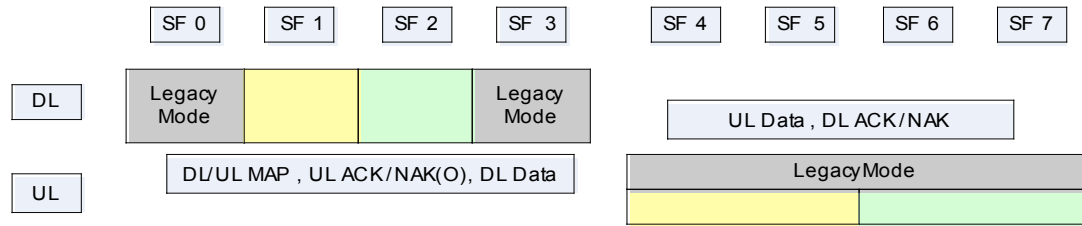
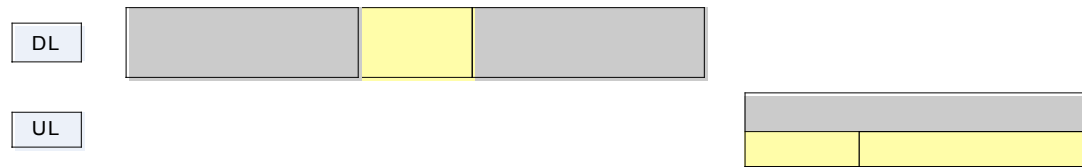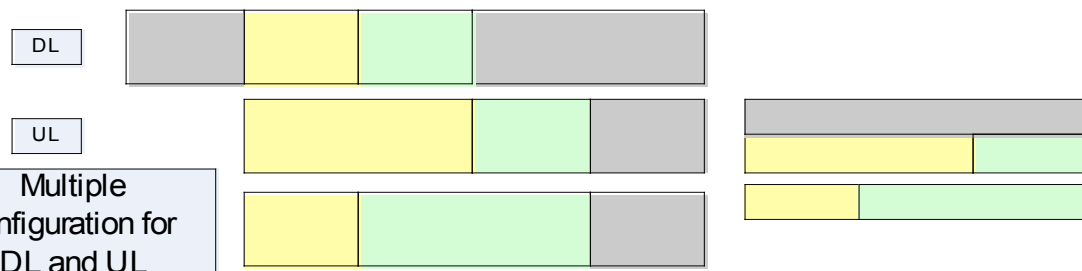In Order to have MIN HARQ feedback offset = 2, either insert Legacy DL SF at the end of DL frame or fix the HARQ ACK / NAK offset in the corresponding 2nd UL SF . # of 16m SF depends upon amount of legacy traffic .

| SF 0 | SF 1 | SF 2 | SF 3 | | SF 4 | SF 5 | SF 6 | SF 7 |

DL — Legacy Mode | | | Legacy Mode | UL Data , DL ACK / NAK

UL — DL/UL MAP , UL ACK/NAK(O), DL Data | LegacyMode

TDD (4:4) : HARQ MAP in every 802.16m DL SF (HARQ feedback offset = 2 SF)

If # of 16m DL HARQ zone is one , then last two DL SF should be in Legacy Mode . # of 16m SF depends upon amount of legacy traffic .

DL

UL

TDD (5:3): Legacy traffic =HIGH, One 16m HARQ MAP (HARQ feedback offset = 2 SF)

Having multiple 16m HARQ Zone provide variable HARQ feedback offset to support different capabilities of MS
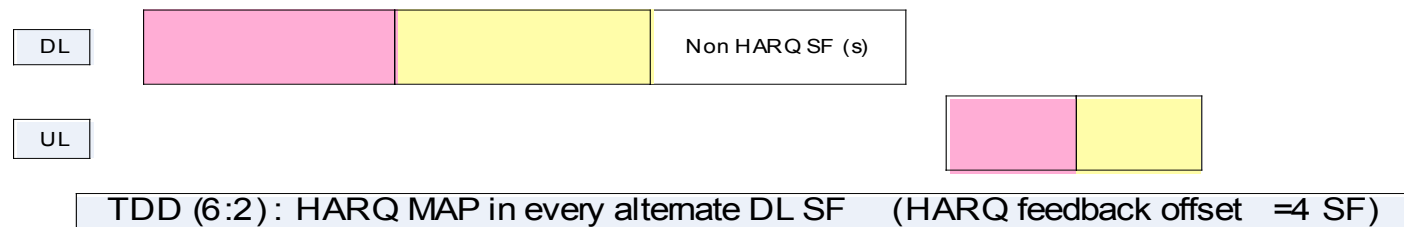
DL

UL
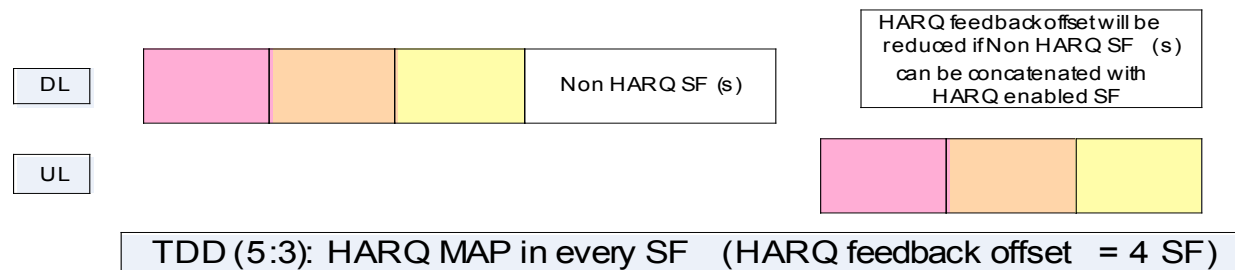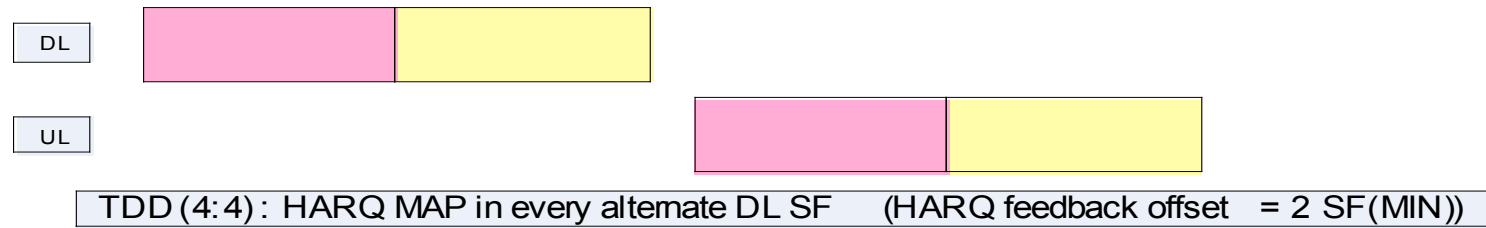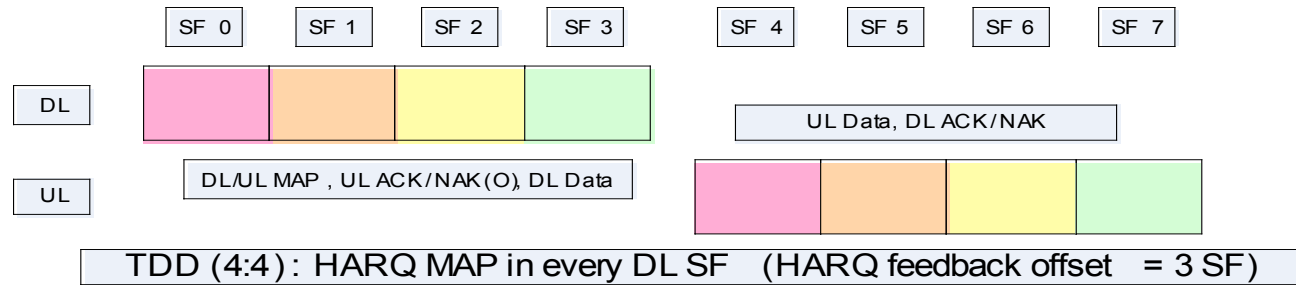
Multiple Configuration for DL and UL

TDD (5:3): Legacy traffic =HIGH, One 16m HARQ MAP (HARQ feedback offset =2 or 3 or 4 SF)

TDD (6:2) : Similar configuration options as 5:3 split

6

HARQ Timing and feedback offset in 802.16m TDD mode

| SF 0 | SF 1 | SF 2 | SF 3 | | SF 4 | SF 5 | SF 6 | SF 7 |

DL

UL Data, DL ACK/NAK

UL

DL/UL MAP , UL ACK/NAK (O), DL Data

TDD (4:4) : HARQ MAP in every DL SF   (HARQ feedback offset = 3 SF)

DL

UL

TDD (4:4) : HARQ MAP in every alternate DL SF   (HARQ feedback offset   = 2 SF(MIN))

DL

Non HARQ SF (s)

HARQ feedback offset will be reduced if Non HARQ SF (s) can be concatenated with HARQ enabled SF

UL

TDD (5:3): HARQ MAP in every SF   (HARQ feedback offset   = 4 SF)

DL

Non HARQ SF (s)

UL

TDD (6:2) : HARQ MAP in every alternate DL SF   (HARQ feedback offset   =4 SF)

7

HARQ timing and feedback offset in 802.16m FDD

| SF 0 | SF 1 | SF 2 | SF 3 | SF 4 | SF 5 | SF 6 | SF 7 |

DL — DL/UL MAP , UL ACK/ NAK(O) , DL Data

UL — UL Data , DL ACK/NAK

FDD : HARQ MAP in every DL SF   (HARQ feedback offset = 3 SF)

DL

UL

Combination of these two configuration support variable HARQ feedback offset to support different MS capabilities or type of traffic .

FDD : HARQ MAP in every alternate DL SF   (HARQ feedback offset = 2 SF)

H-FDD MS can be supported with above configuration

8

HARQ ACK Channel multiplexing Method

- HARQ ACK Channel can be TDM/FDM or CDM
- TDM/FDM
  - Scalable
    - # of HARQ ACK channels depends on # of HARQ burst
  - Resource allocation
    - Joint coding
      - MS follows the order in which HARQ allocations are transmitted.
    - Separate coding
      - MS can not find its own location based on ordering
      - Require specific ACK channel index position
      - Other solutions…
- CDM (Code Division Multiplexed)
  - All users transmits orthogonal codes in the same location.
  - Not scalable
    - HARQ ACK region granularity does not depends on # of HARQ burst. Resource wastage if # of transmitted HARQ burst are less.

Summery

- Propose to adopt asynchronous adaptive HARQ

- HARQ ACK/NAK feedback offset can be fixed or variable

- HARQ ACK/NAK feedback offset either can be indicated in the sub-frame where data is transmitted or in the sub-frame configuration information in the super-frame.

- Propose to adopt HARQ ACK channel as TDM/FDM.

Proposed Text to be included in SDD

11.X HARQ Protocol

HARQ transmission method shall be asynchronous adaptive HARQ.

11.x.1 HARQ protocol timing

[insert slides 4 to 7 here]

11.x.2 HARQ feedback offset

HARQ ACK/NAK feedback offset can be fixed or variable .Variable HARQ ACK/NAK feedback offset can support different MS capabilities and traffic types. HARQ ACK/NAK feedback offset is indicated in the sub-frame configuration information in the super-frame.

11.x.3 HARQ ACK Channel multiplexing method

HARQ ACK Channels are TDM/FDM.