

Implications of Backwards Compatibility on IEEE 802.16m Frame Structure

Document Number: IEEE C802.16m-07/265

Date Submitted: 7 November 2007

Source:

Mark Cudak, Kevin Baum, Anup Talukdar,
Amitava Ghosh, Fan Wang
Motorola

E-mail: Mark.Cudak@motorola.com

Re:

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

Abstract:

Discussed the functional implications of backwards compatibility with respect to the IEEE 802.16m frame structure

Purpose:

Discussion and adoption of functional area into SDD outline

Notice:

This document does not represent the agreed views of the IEEE 802.16 Working Group or any of its subgroups. It represents only the views of the participants listed in the "Source(s)" field above. It is offered as a basis for discussion. It is not binding on the contributor(s), who reserve(s) the right to add, amend or withdraw material contained herein.

Release:

The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

Patent Policy:

The contributor is familiar with the IEEE-SA Patent Policy and Procedures:

<<http://standards.ieee.org/guides/bylaws/sect6-7.html#6>> and <<http://standards.ieee.org/guides/opman/sect6.html#6.3>>.

Further information is located at <<http://standards.ieee.org/board/pat/pat-material.html>> and <<http://standards.ieee.org/board/pat>>.

Requirement: TDD Backward Compatibility

- An IEEE 802.16m MS shall be able to operate with a legacy BS, at a level of performance equivalent to that of a legacy MS.
- Systems based on IEEE 802.16m and the WirelessMAN-OFDMA Reference System shall be able to operate on the same RF carrier, with the same channel bandwidth; and should be able to operate on the same RF carrier with different channel bandwidths.
- An IEEE 802.16m BS shall support a mix of IEEE 802.16m and legacy MSs when both are operating on the same RF carrier. The system performance with such a mix should improve with the fraction of IEEE 802.16m MSs attached to the BS.
- An IEEE 802.16m BS shall support handover of a legacy MS to and from a legacy BS and to and from IEEE 802.16m BS, at a level of performance equivalent to handover between two legacy BSs.
- An IEEE 802.16m BS shall be able to support a legacy MS while also supporting IEEE 802.16m MSs on the same RF carrier, at a level of performance equivalent to that a legacy BS provides to a legacy MS.

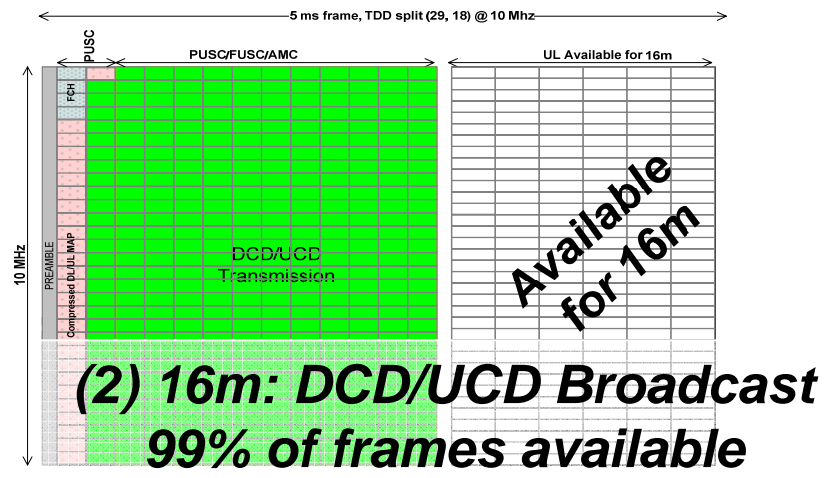
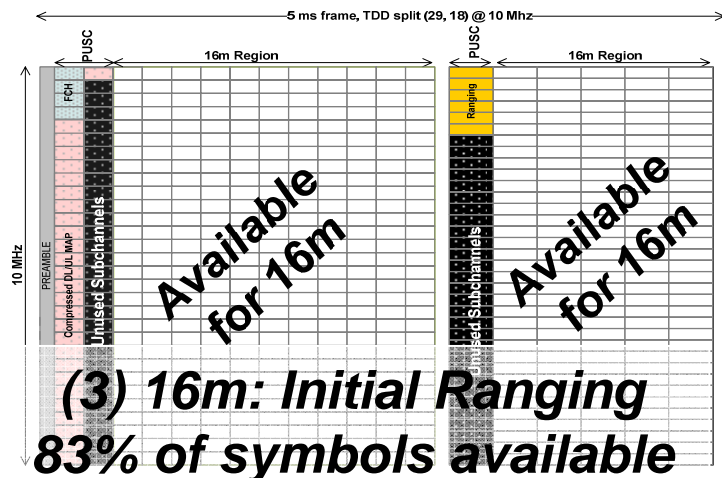
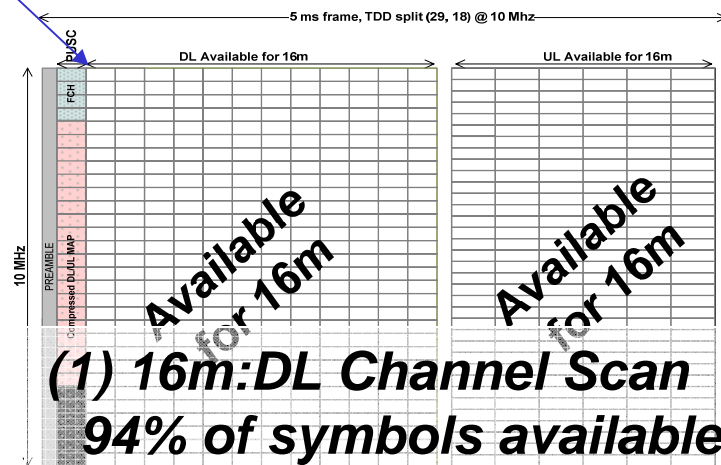
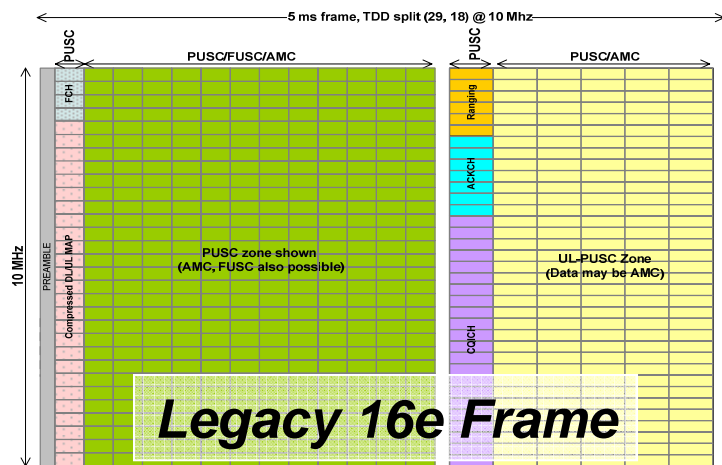
Necessary Conditions

- Fundamental 16e procedures must be supported
 - Initialization State
 - A 16e MS must be able to detect a 16m base station and enter the network.
 - The minimum 16e features necessary to support this activity must be incorporated in the 16m frame.
 - Idle State
 - A 16e MS must maintain synchronization with a 16m base station.
 - A 16e MS must be able to receive a page from a 16m base station.
 - A 16e MS must be able to perform cell re-selection.
 - Connected State
 - A 16m BS must emulate a 16e carrier for optimum performance
 - 16m MS must coexist with a 16e MS in the same 5 ms frame
- Coexistence of 16e and 16m in neighboring cells
 - A 16m BS serving all 16m MSs must not interfere with a neighboring 16e BS serving all 16e MSs

Initialization State

Less 10% overhead for 16e on average

Highly Reliable
Rep = 6



Initialization State: Implications

- A 16e pre-amble must be transmitted every 5 ms
- A 16e DL_MAP must be transmitted following every 16e pre-amble
- A 16e DCD/UCD must be maintained
- A 16e ranging region must be allocated periodically (e.g. every 4 frames)
- All other symbols may be re-allocated

Connected State: Considerations

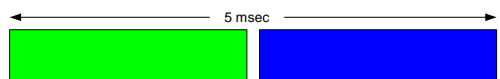
- Observations:
 - Multiple frame sizes should be supported
 - 5 ms is necessary for efficient backward compatibility support
 - Smaller sizes are desirable to improve the latency performance
 - TDD requires that Tx/Rx intervals be synchronized between 16e and 16m in neighboring cells
 - Implies a 16m frame must overlay the Tx/Rx silhouette of a 16e frame
 - Alternatively, a 16e frame may be punctured to accommodate a neighboring Tx/Rx pattern
- Assumptions:
 - 16e numerology is maintained (i.e. same sub-carrier spacing, cyclic prefix length and symbol duration)
 - Independent 16m control channels (e.g. MAPS, CQICH, ACKCH) are desirable to improve cell-edge coverage, range etc.
 - Grouping symbols into sub-frames can reduce signaling overhead

Connected State: Potential Solutions

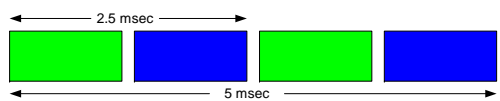
- Two possibilities exist for partitioning resources between 16m and 16e
 - **Symbol-Level:** Resource can be shared at the granularity of a symbol boundary
 - **Sub-block Level:** Resources can be reallocated in quantized groups of symbols
- Several options exist for multiplexing frame sizes (i.e. Tx/Rx intervals) between 16e and 16m
 - **Homogenous Frame Sizes:** A deployment using one frame size for all frames over time on a system wide basis. (e.g. always 5 ms with one Tx and one Rx interval, or always 2.5 ms with two Tx and RX intervals per 5 ms)
 - **Heterogeneous Frame Sizes:** A deployment may adopt the frame size over time to accommodate the mix of 16m and 16e traffic.
- Several possibilities exist for the sub-frame timing of multiple Tx/Rx intervals within a 5 ms frame
 - **Variable Timing:** As in 16e, the start time of the uplink interval can be adjusted based on frame configuration
 - **Absolute Timing:** The beginning of downlink and/or uplink intervals are fixed to simplify design and synchronization. Especially useful for Sub-block Level partitioning with multiple Tx/Rx intervals.
 - **Fixed-Symbol Timing:** The position of each 16m symbols is fixed with respect to the preamble

Connected State: Heterogeneous Frame Sizes

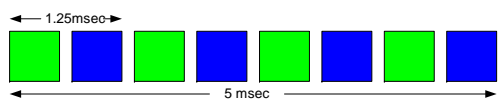
Multiple Tx/Rx Intervals



Full-frame 1:1



Sub-frame 1:2

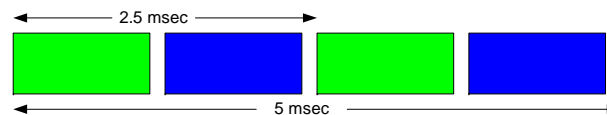


Sub-frame 1:4

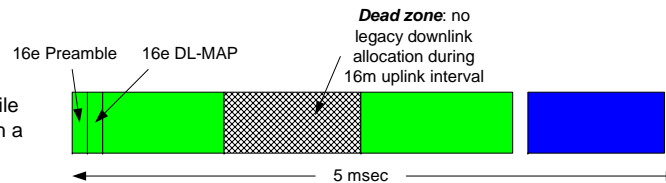
■ Downlink
 ■ Uplink

16e Compatibility (Adjacent Cells)

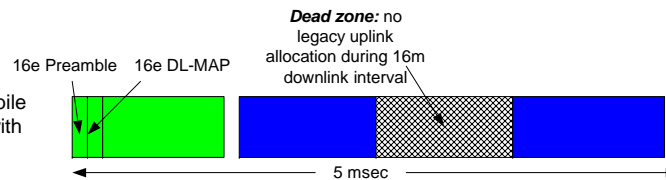
16e frame mapped to a 16m 1:2 sub-frame



Option 1: legacy mobile sees a 5ms frame with a 75% duty cycle

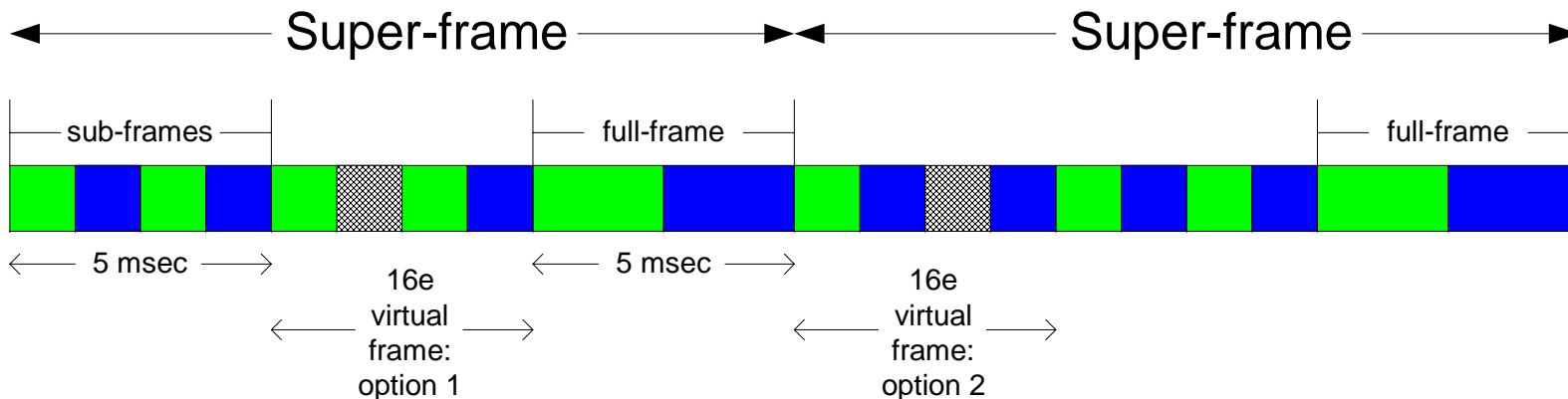


Option 2: legacy mobile sees a 5ms frame with 25% duty cycle

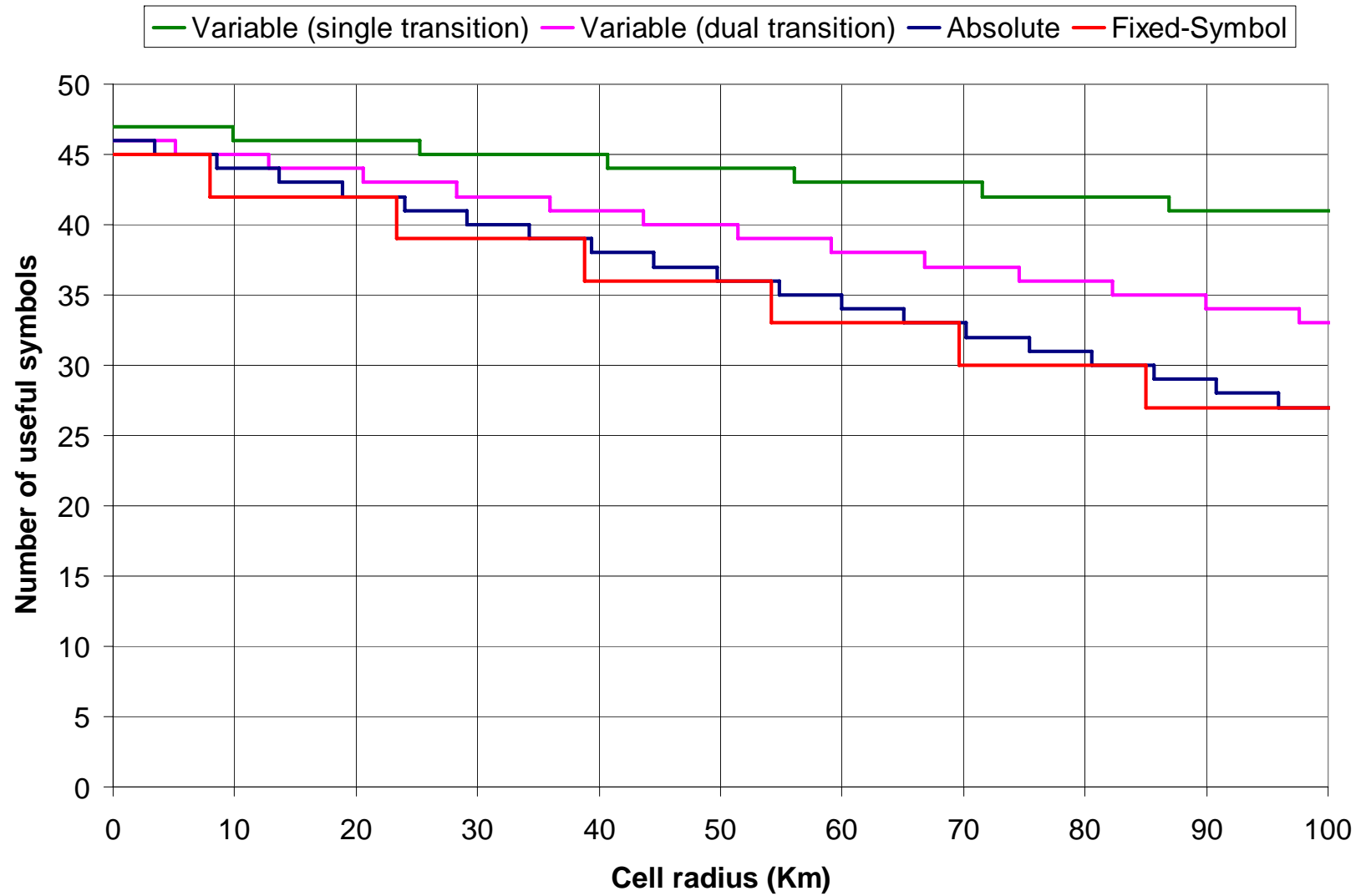


■ Downlink
 ■ Uplink

Heterogeneous Superframe



Connected State: Sub-frame Timing



Summary

- The SDD outline should dedicate a major sub-clause to frame structure
- The method of supporting legacy mobiles in the following states should be clearly identified:
 - Initialization State
 - Idle State
 - Connected State
- The method for coexisting with neighboring legacy base stations
 - TDD co-existence is of particular interest
- Develop consensus on some fundable assumptions
 - OFDM Numerology (sub-carrier spacing, cyclic prefix, etc)
 - Resource partitioning schemes and sub-frame timing (if any)
- The 16m frame structure should be an initial priority for the TGm PHY development