Implications of Backwards Compatibility on IEEE 802.16m Frame Structure

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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

Requirement: TDD Backward Compatibility

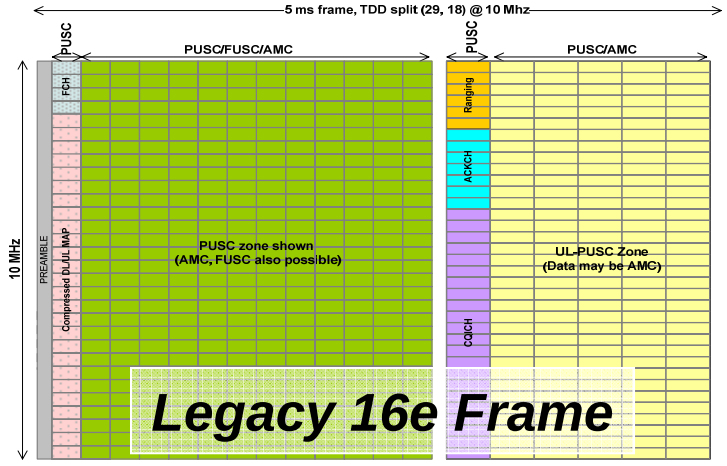
- An IEEE 802.16m MS shall be able to operate with a legacy BS, at a level of performance equivalent to that of a legacy MS.
- Systems based on IEEE 802.16m and the WirelessMAN-OFDMA Reference System shall be able to operate on the same RF carrier, with the same channel bandwidth; and should be able 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 be 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



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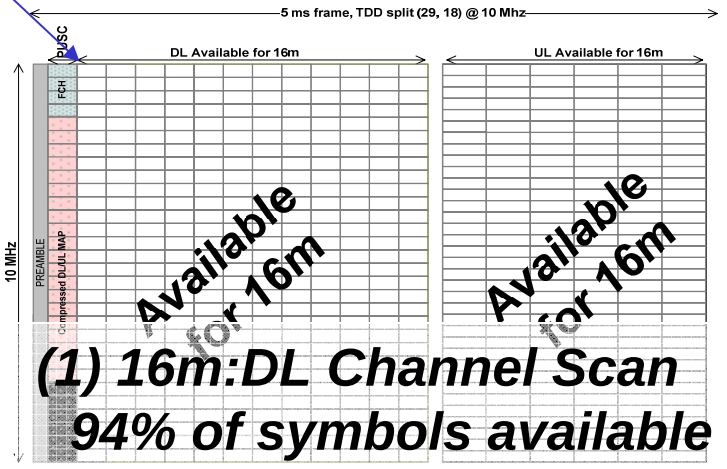
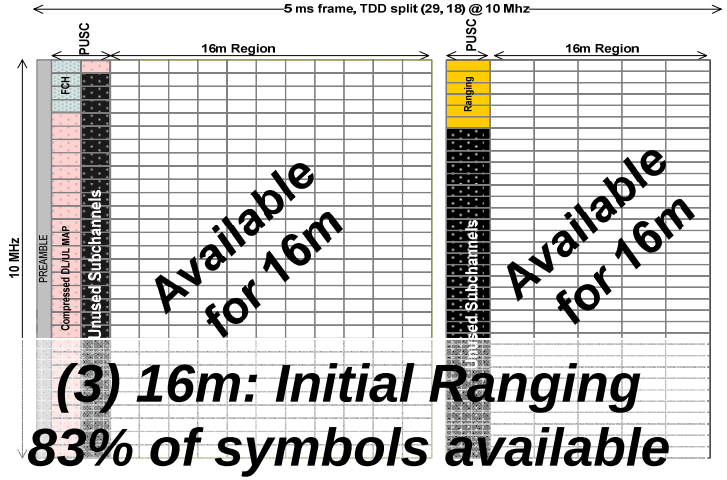
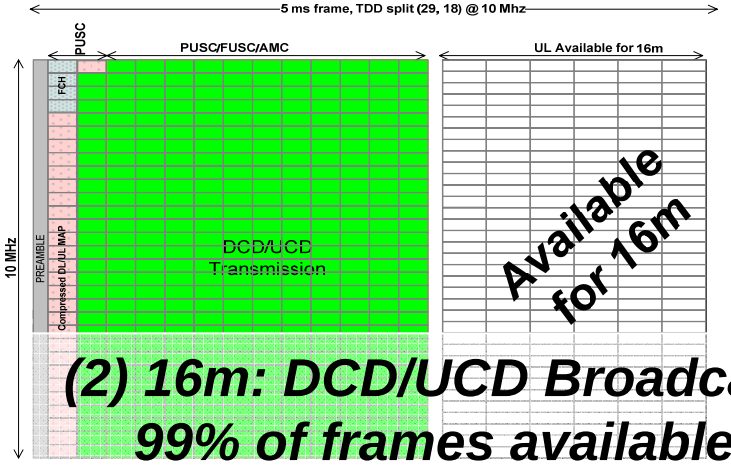






Initialization State: Implications

- 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

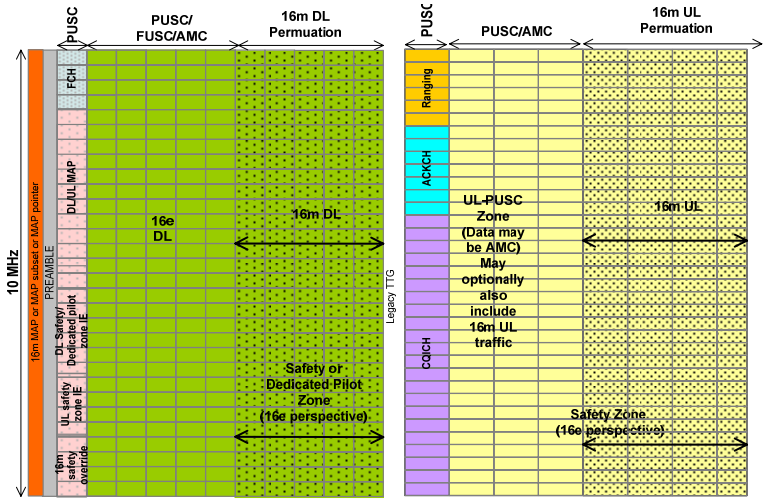
- Observations:
  - Multiple frame sizes should be supported
    - 5 ms is necessary for efficient backward compatibility support
    - Smaller sizes are desirable to improve the latency performance
  - TDD requires that Tx/Rx intervals be synchronized between 16e and 16m in neighboring cells
    - Implies 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

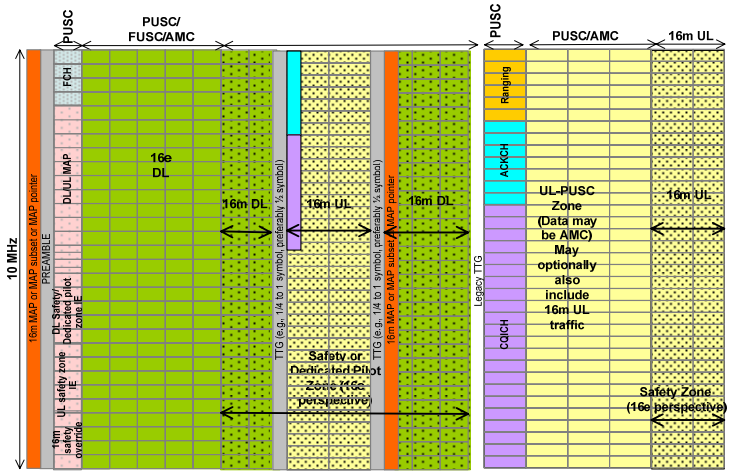
Connected State: Potential Solutions

- 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 internal 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

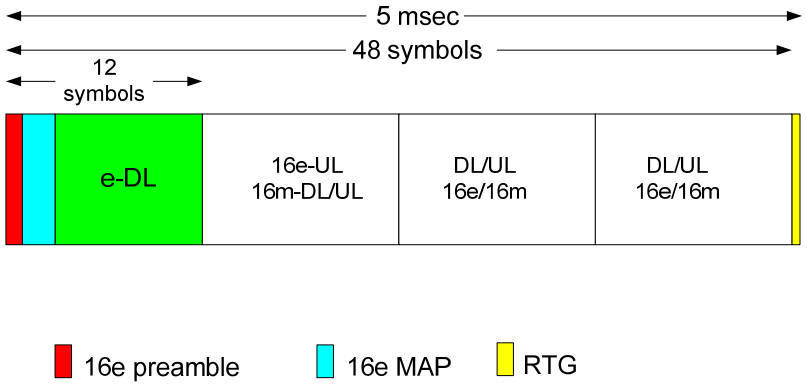
Connected State: Frame Partitioning

Symbol Level Partitioning



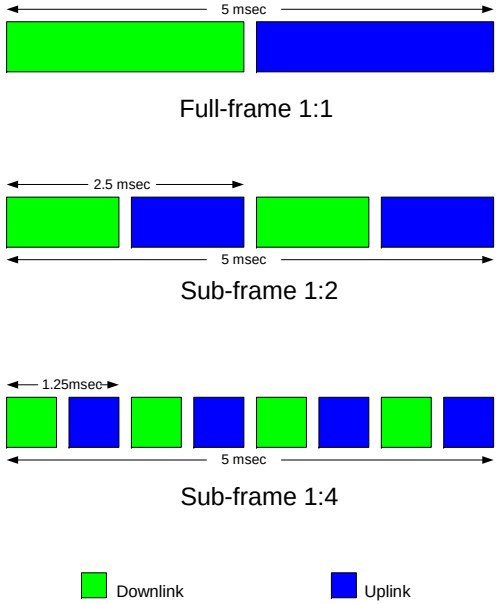


Sub-block Level Partitioning

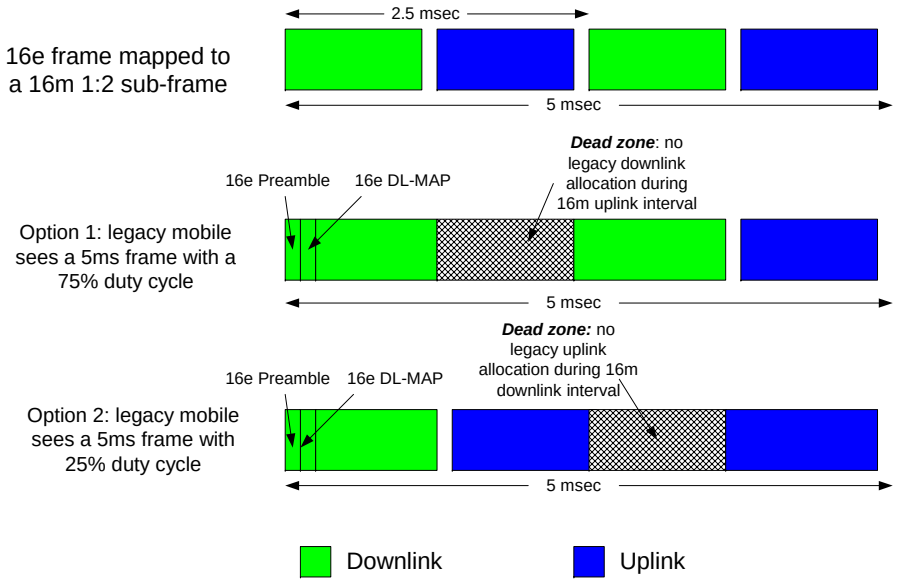


Connected State: Heterogeneous Frame Sizes

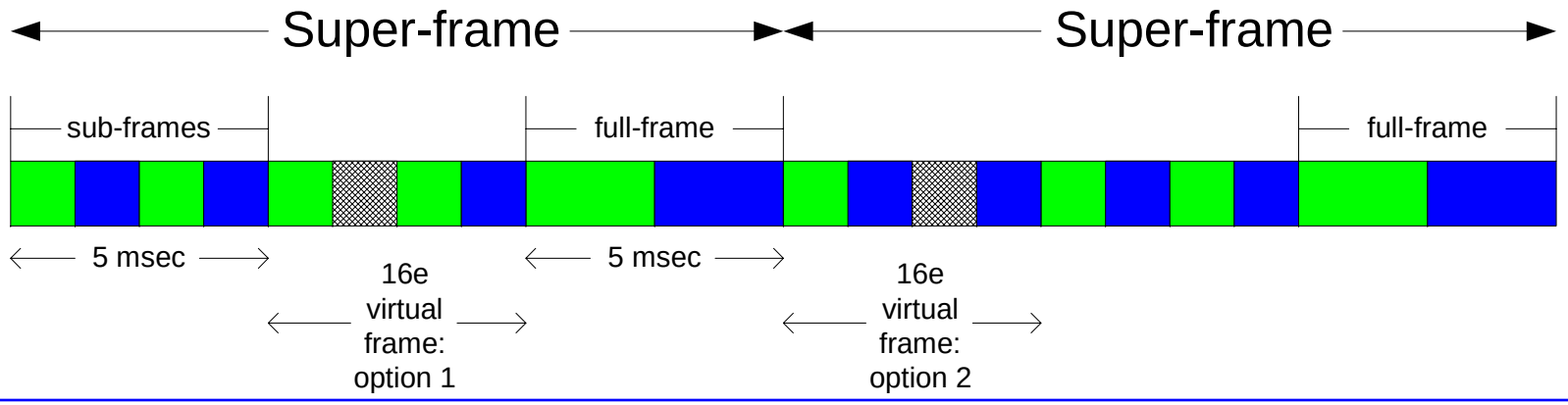
Multiple Tx/Rx Intervals



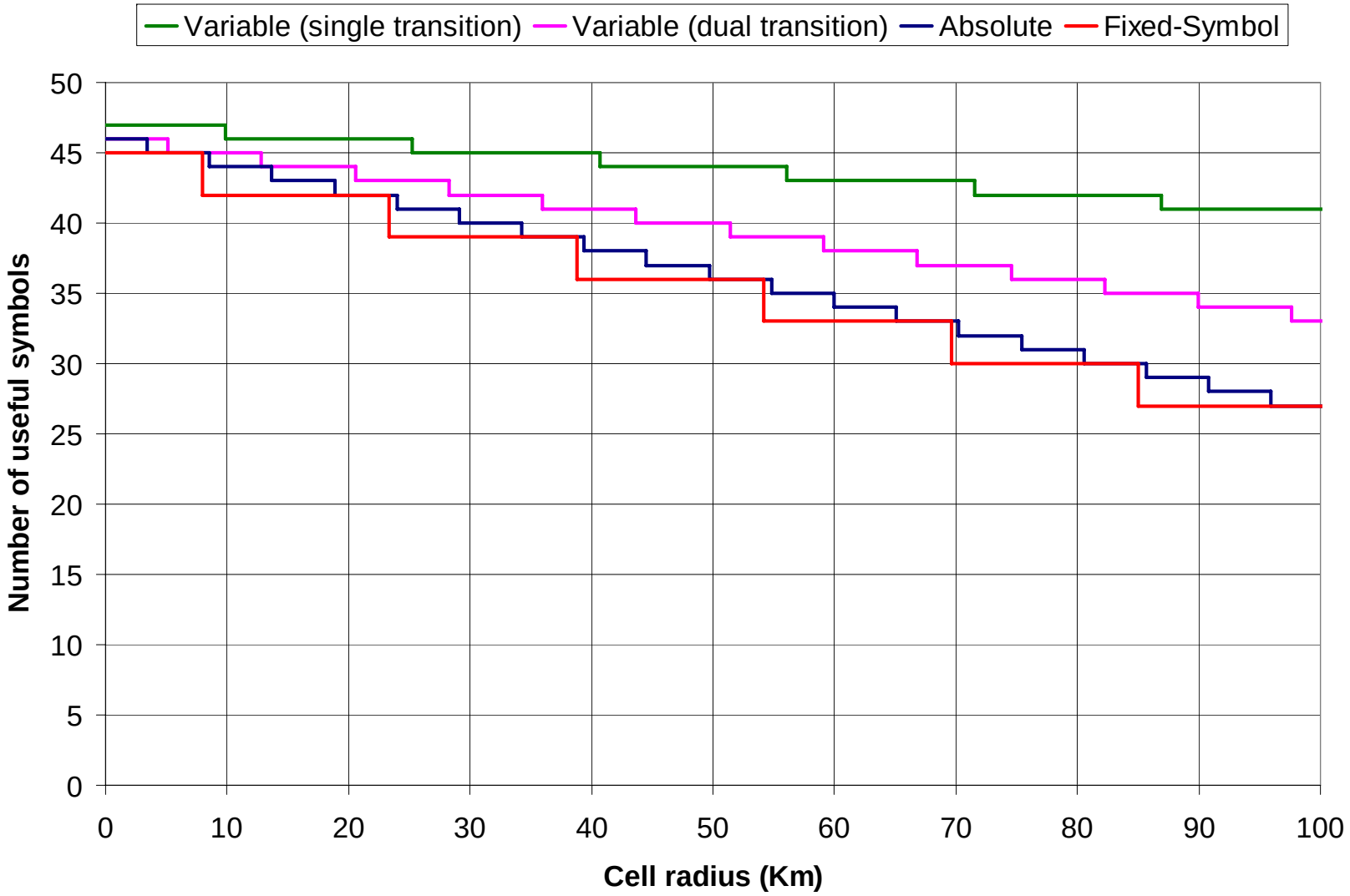
16e Compatibility (Adjacent Cells)



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-existance 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