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The IEEE Side of the Story: IEEE 802.16m for IMT-Advanced

ITG-524 Fachgruppentreffen on “IMT-Advanced – What to expect and when?”
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Outline

- IEEE 802.16m: Advanced Mobile WiMAX
  - Standardization bodies
  - When to expect: the roadmap
- A Short Primer on IEEE 802.16m
  - Core and advanced features
  - IMT-Advanced evaluation results
- Summary

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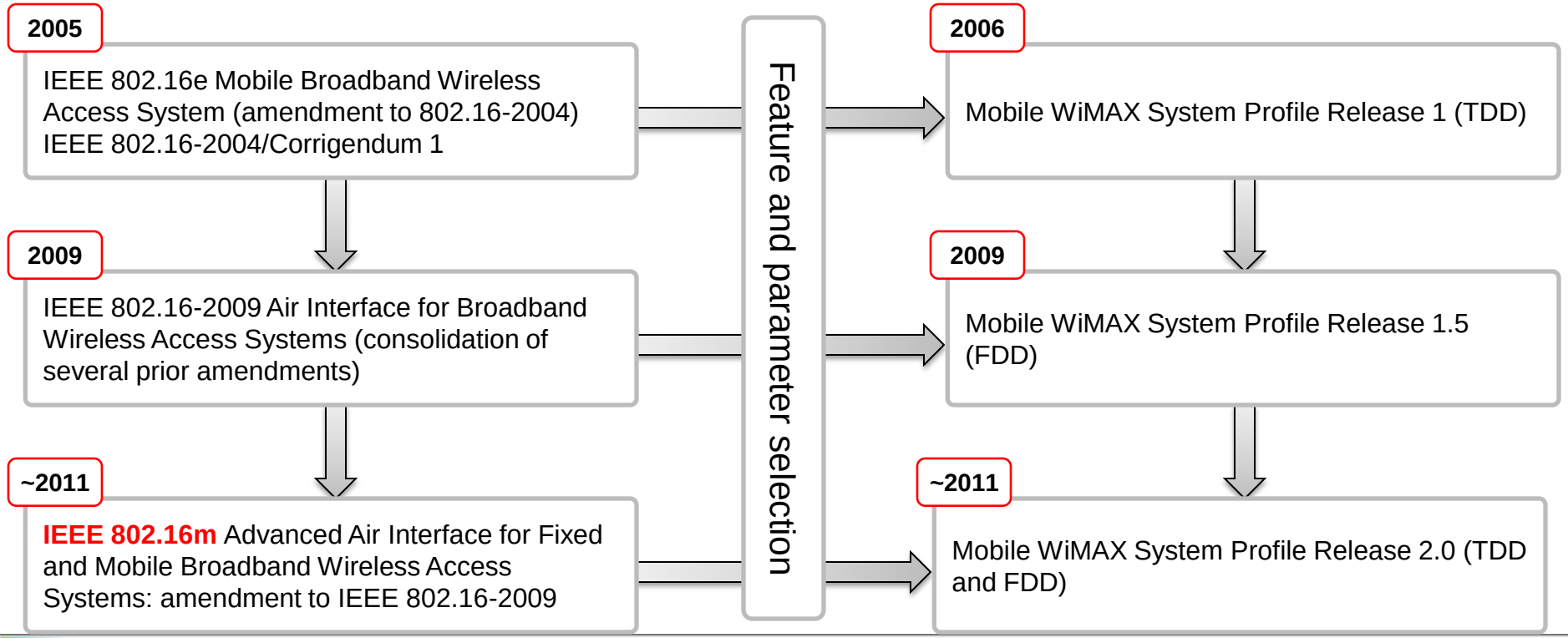
WiMAX Standardization Bodies

Specification of air interface, est. 1999

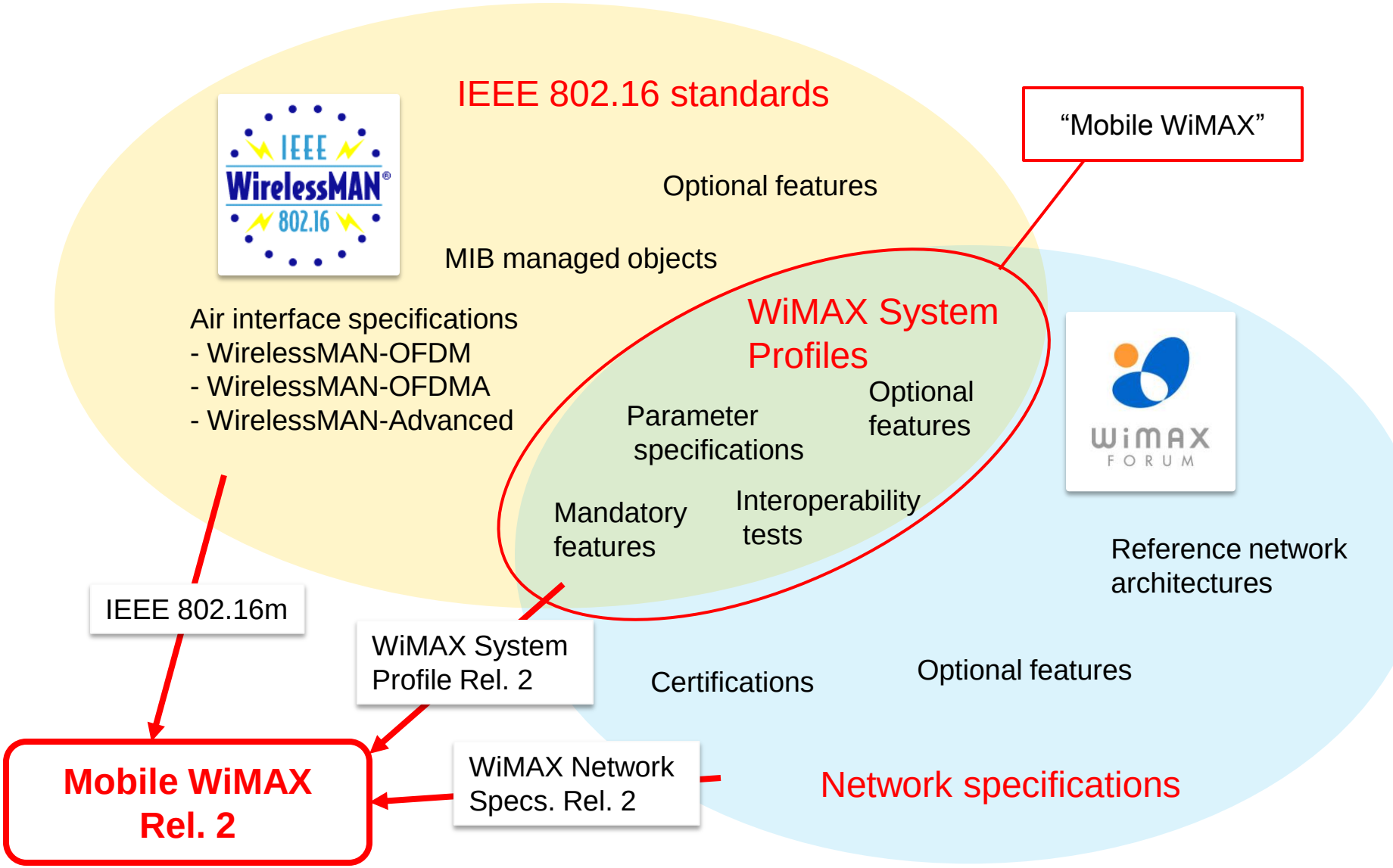
- Currently approx. 250 voting members
- Individual voting rights
- Task groups for liaison, maintenance, …
- Task Group “m” develops 802.16m

Certification and network specification, est. 2001

- Currently approx. 300 member companies
- Company voting rights
- technical, networking, certification WGs



What is Mobile WiMAX?



What is IEEE 802.16m?

From the Project Authorization Document (PAR), December 2006:

> ***The purpose of this standard is to provide performance improvements necessary to support future advanced services and applications, such as those described by the ITU* in *Report ITU-R M.2072.***

Amendment to IEEE 802.16-2009

- Specifies the WirelessMAN-Advanced Air Interface
- Development started in Q1 2007, ratification expected in Q1 2011.

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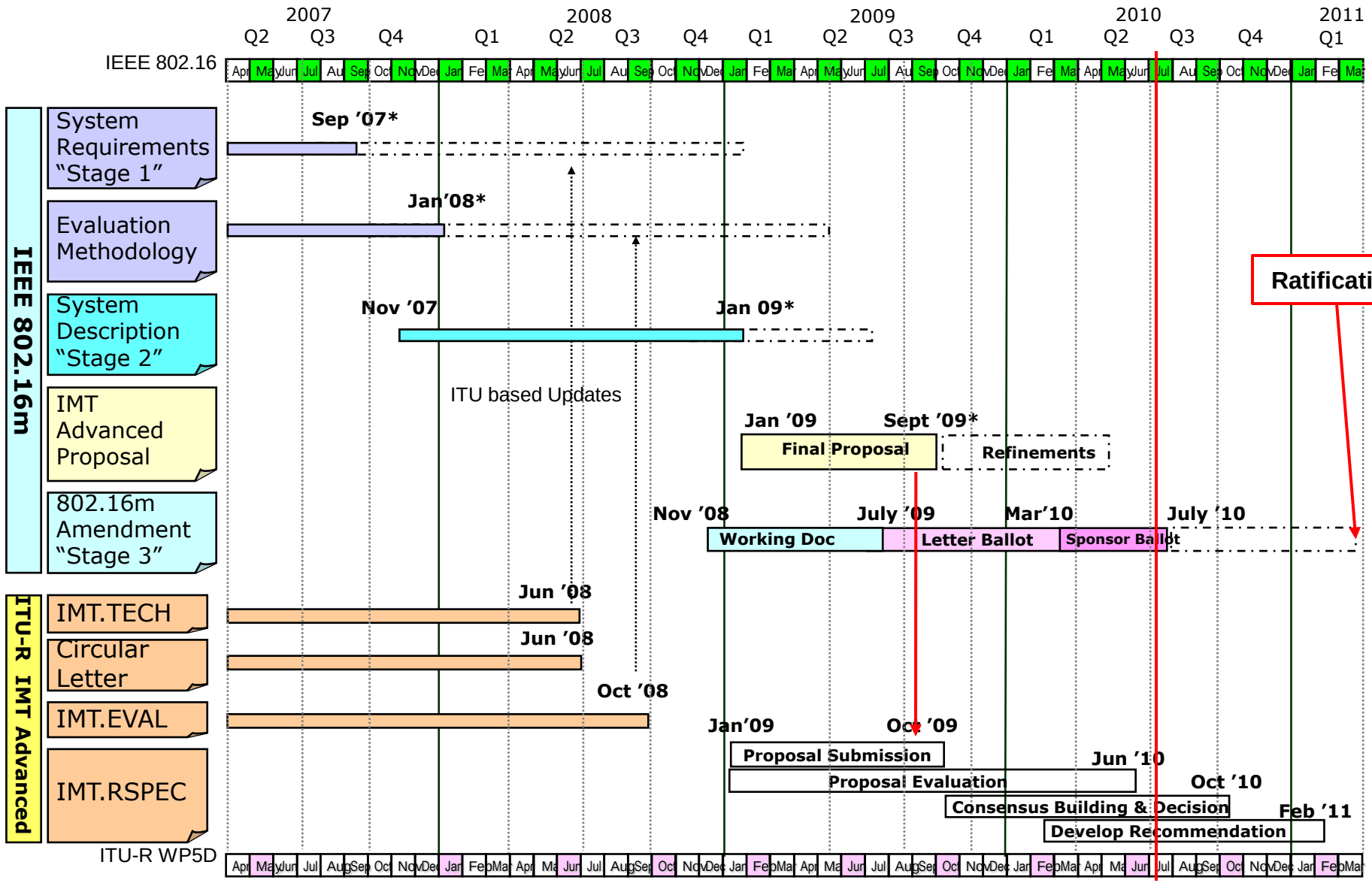
IEEE 802.16m Work Plan

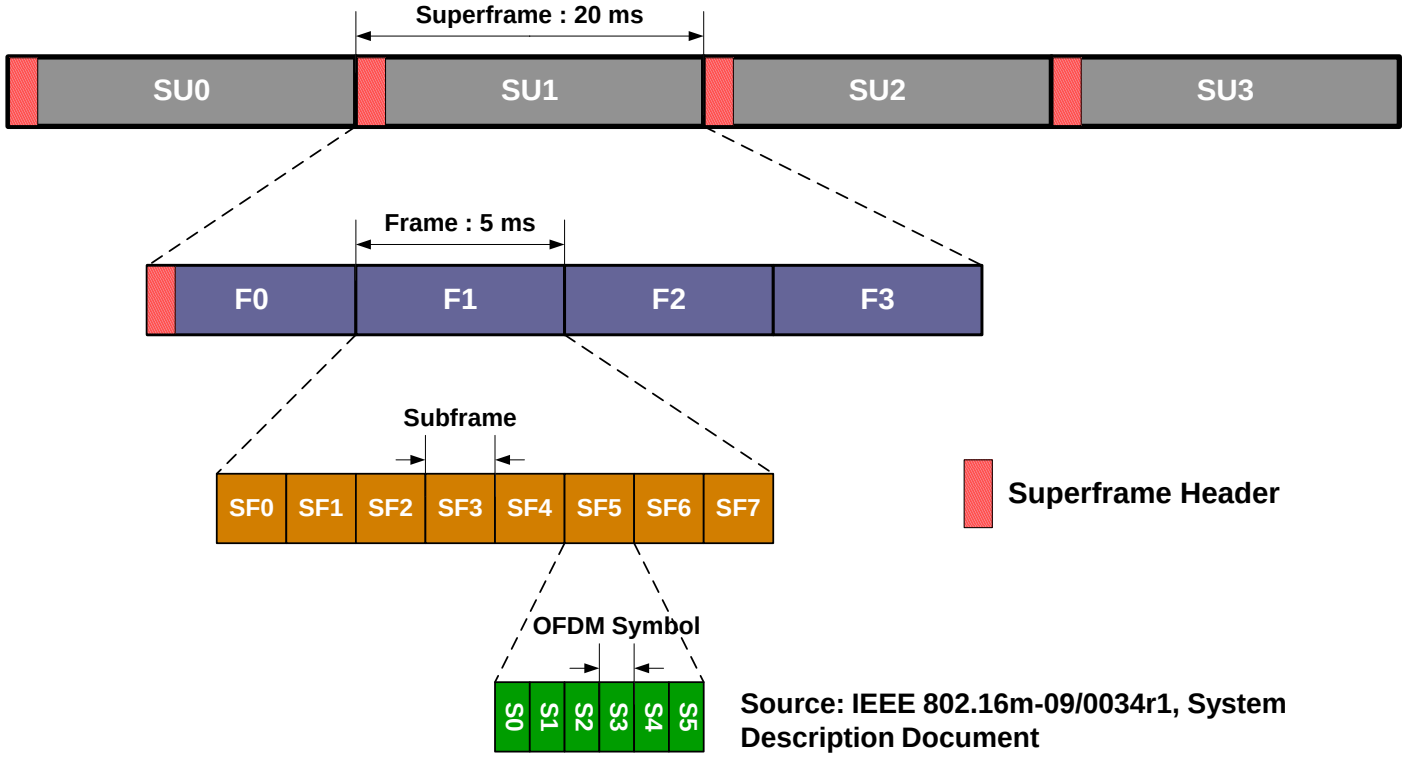


IEEE 802.16m Features

- Core features for enhancing baseline performance
  - MAC: Overhead reduction, multi-carrier aggregation, enhanced power saving, FFR
    - MAC PDU messages, formats and construction, security, persistent scheduling, group resource allocation, idle/sleep mode, (H)ARQ, FFR support, bandwidth request mechanism
  - PHY: Advanced MIMO, overhead reduction
    - Frame structure, frequency partitioning/permutation, resource allocation, control channels, DL/UL MIMO, channel coding, HARQ, channel quality measurements

- Advanced features
  - Support for femtocells
  - Multi-BS MIMO
  - Support for relay
  - Support for self-organization
  - Support for Location Based Services
  - Support for Enhanced Multicast Broadcast Service (EMBS)
  - Support for Advanced Air Interface in Lzone (legacy zone)

Basic Frame Structure for TDD and FDD



Source: IEEE 802.16m-09/0034r1, System Description Document

- Superframe contains 4 radio frames (5ms length each)
- Radio frame contains 5 to 8 DL/UL subframes, depending on radio configuration
- Subframe contains 6 to 9 OFDM symbols
- Both TDD and FDD configurations are supported
- Carrier bandwidth: 5-20 MHz, 512 to 2048 subcarriers
- Cyclic prefix ratios 1/16, 1/8, 1/4

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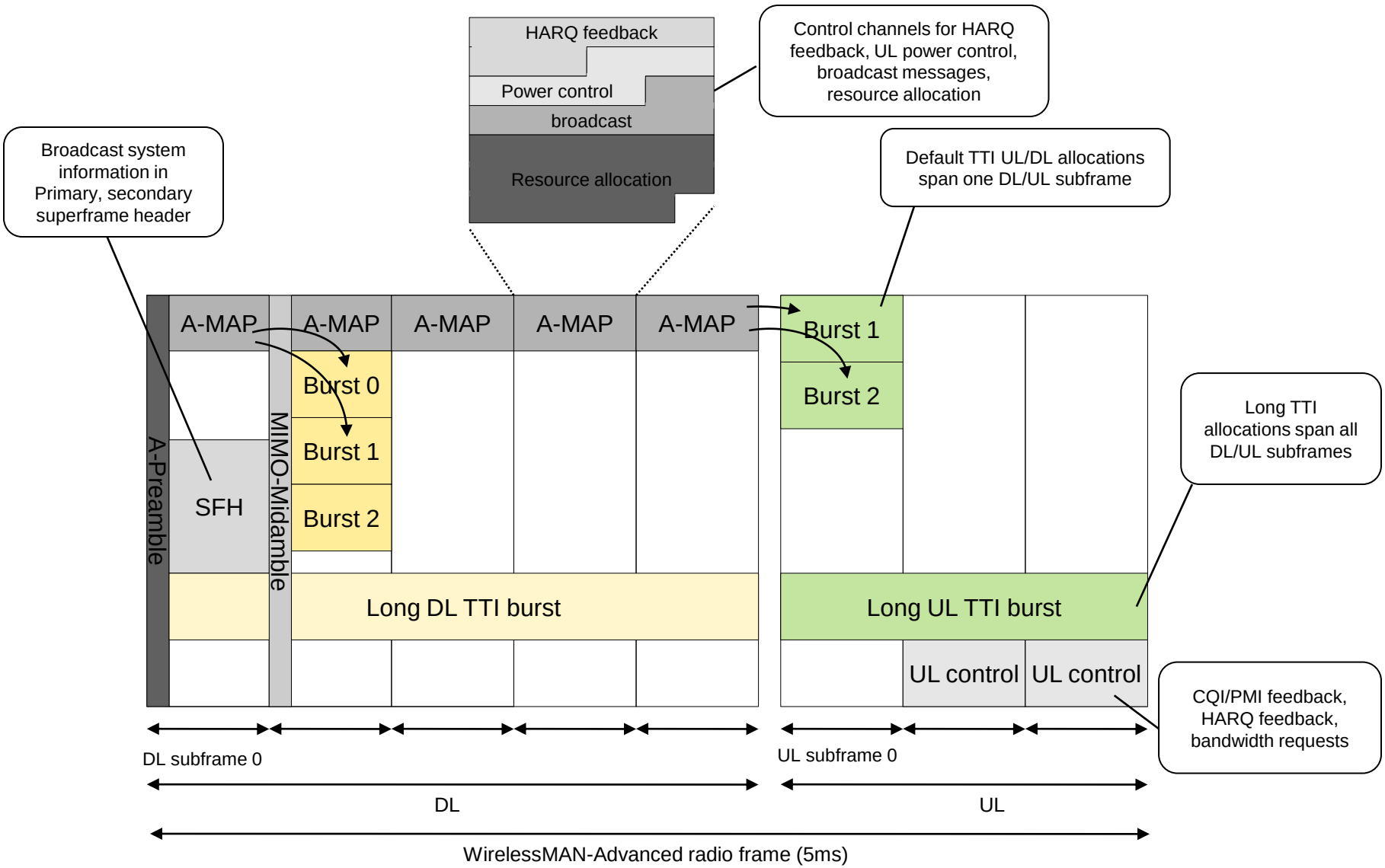
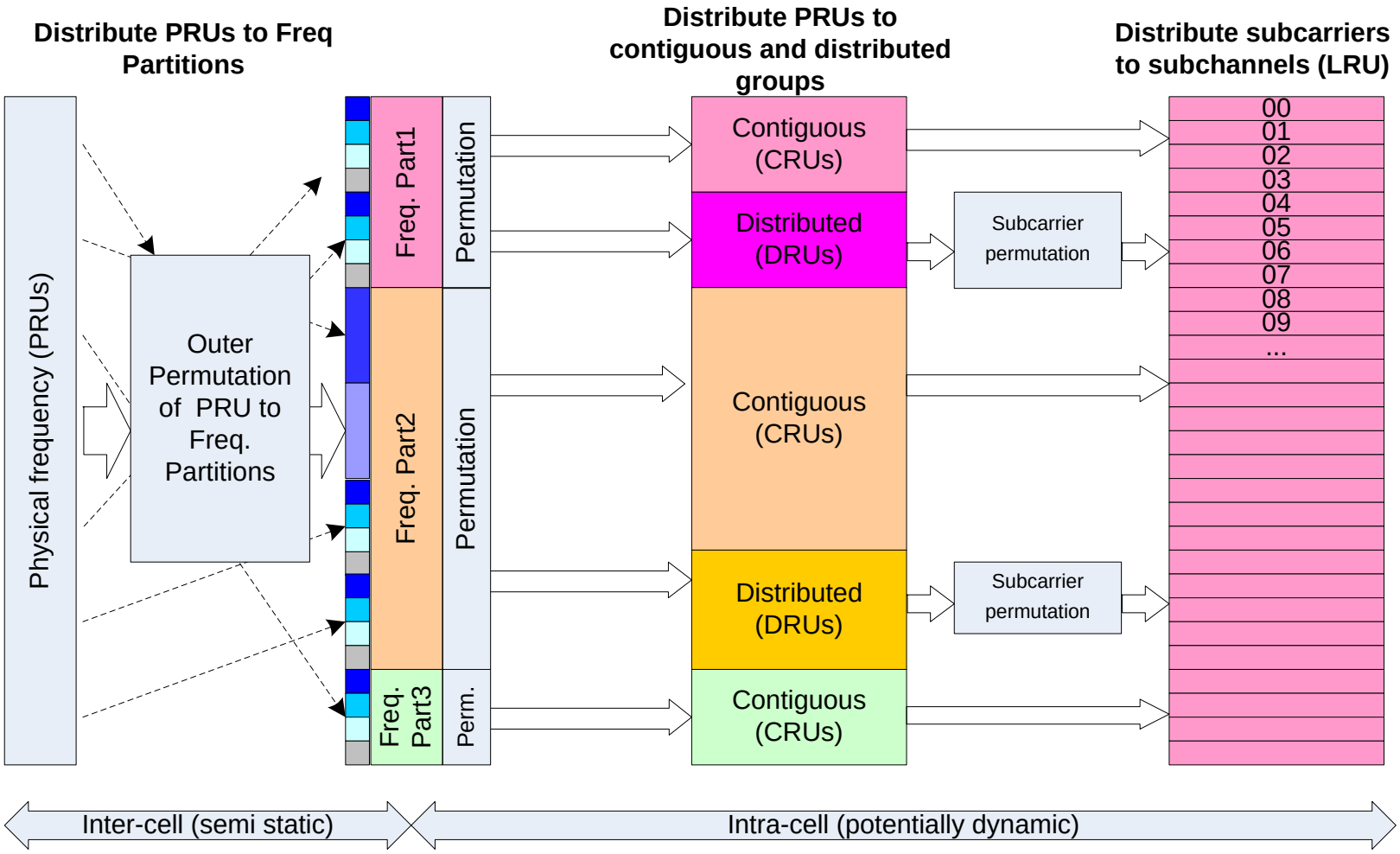
IEEE 802.16m Frame Structure (TDD)

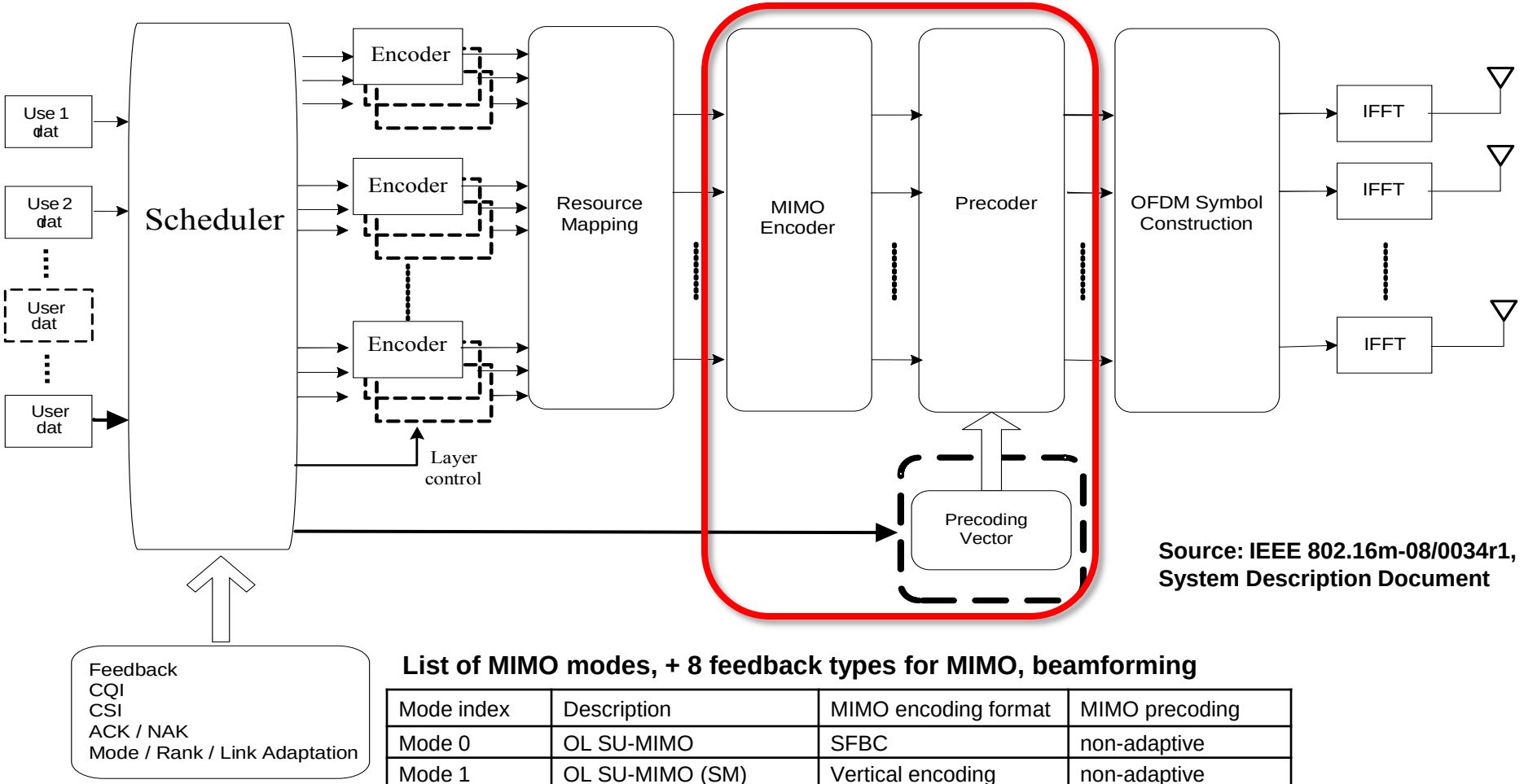


Frequency Partitioning and Permutation



Source: IEEE 802.16m-09/0034r1, System Description Document

MIMO Architecture



Source: IEEE 802.16m-08/0034r1, System Description Document

List of MIMO modes, + 8 feedback types for MIMO, beamforming

Mode index	Description	MIMO encoding format	MIMO precoding
Mode 0	OL SU-MIMO	SFBC	non-adaptive
Mode 1	OL SU-MIMO (SM)	Vertical encoding	non-adaptive
Mode 2	CL SU-MIMO (SM)	Vertical encoding	adaptive
Mode 3	OL MU-MIMO (SM)	Horizontal encoding	non-adaptive
Mode 4	CL MU-MIMO (SM)	Horizontal encoding	adaptive

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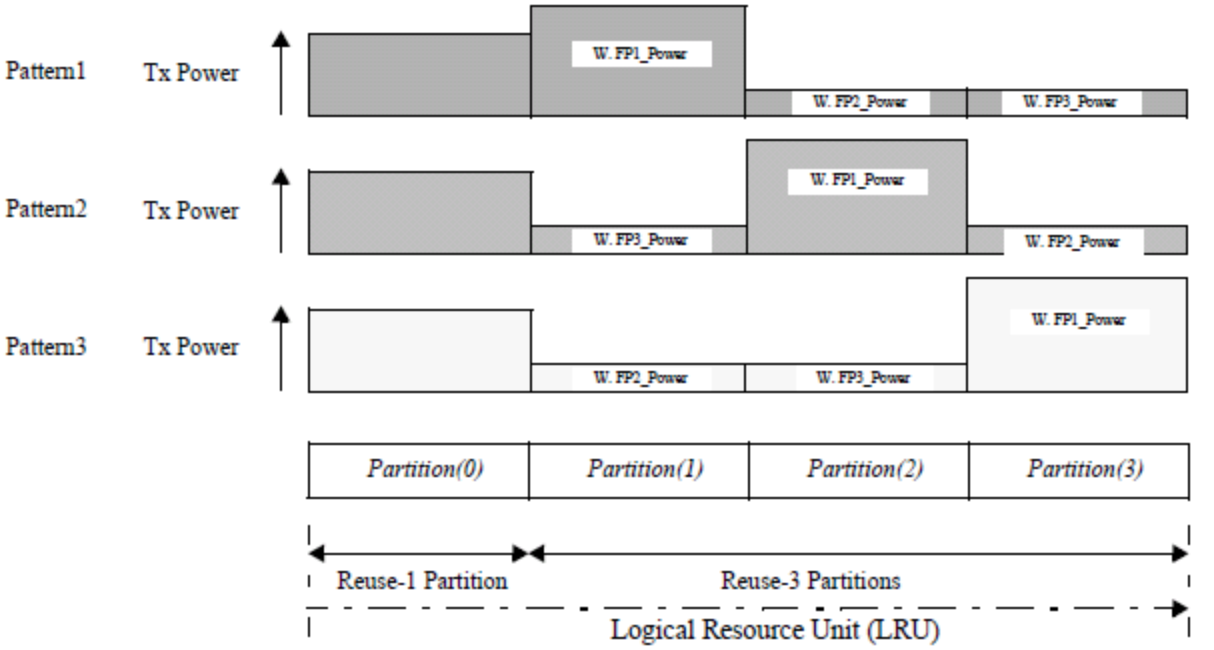
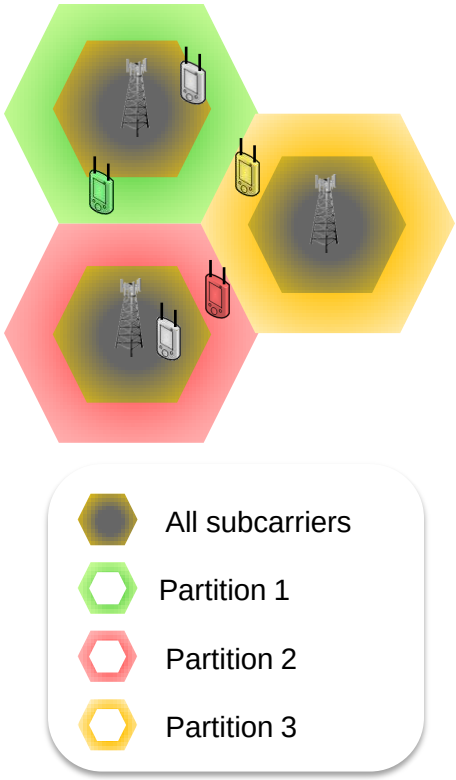
Fractional Frequency Reuse



Source: P802.16m/D6



- DL/UL Fractional frequency reuse based on frequency partitions
- BS indicates MS to measure frequency partitions
- MS indicates preferred partition index

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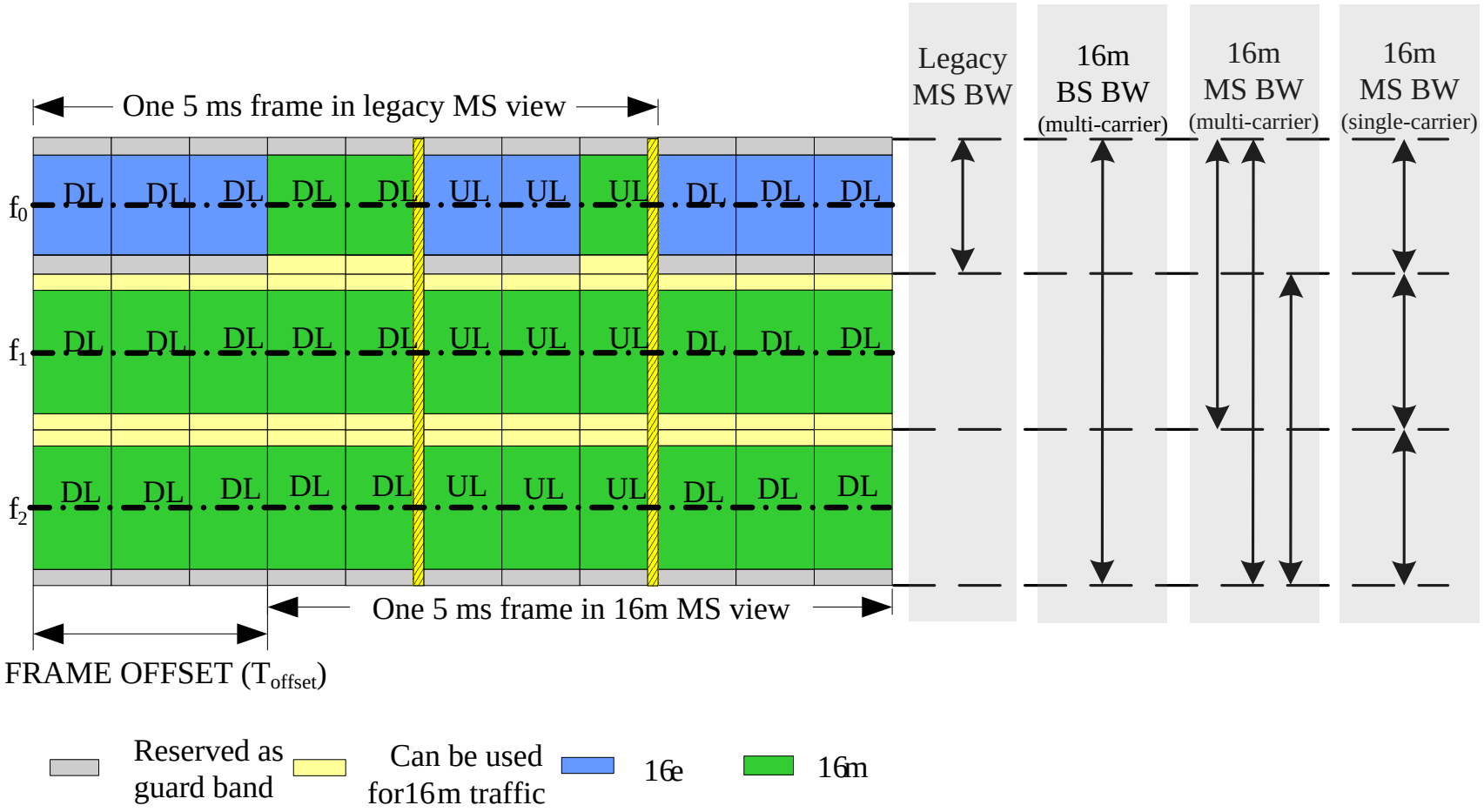
Multi Carrier Operation



Source: IEEE 802.16m-08/0034r1, System Description Document

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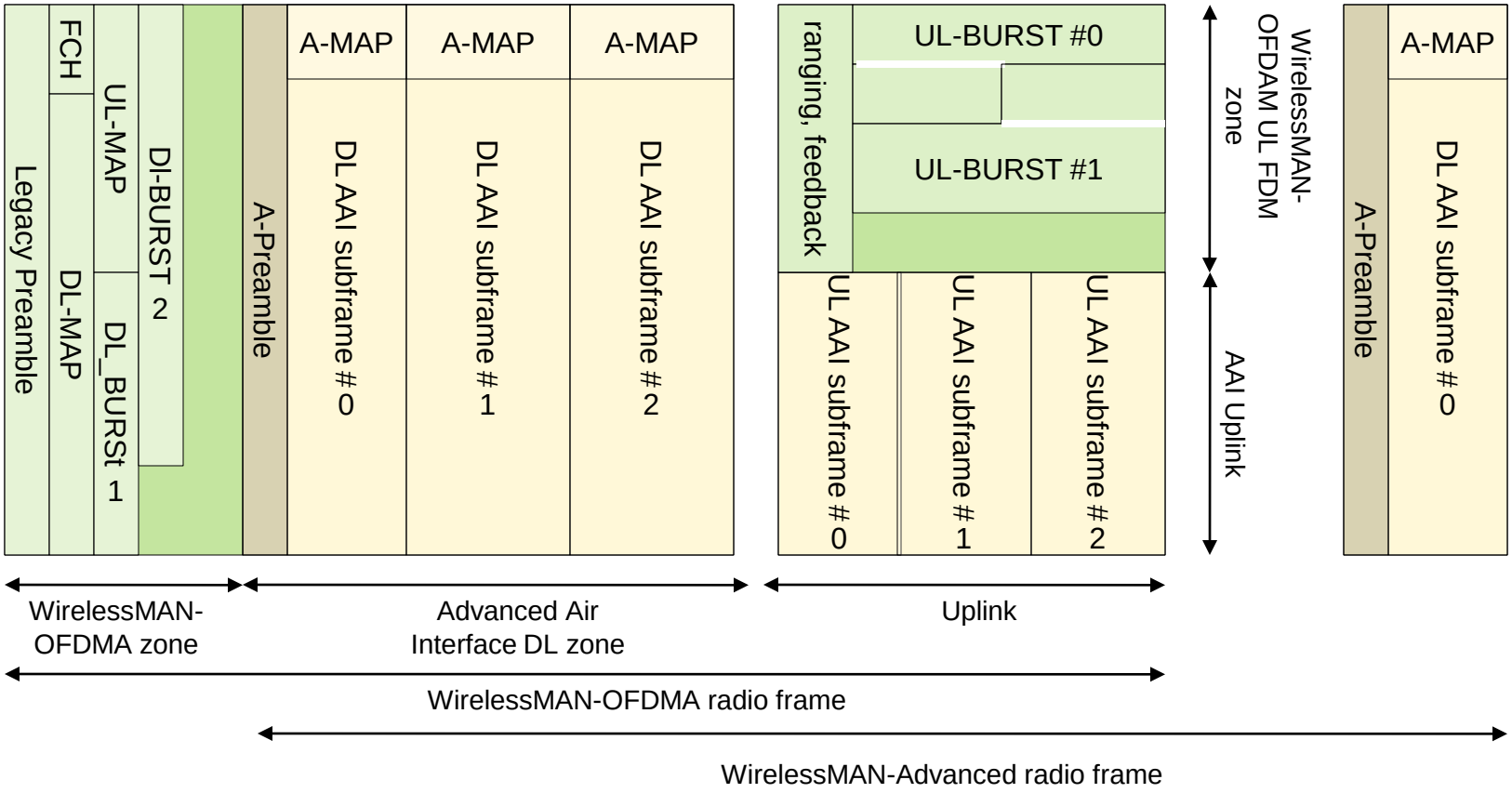
Legacy Support

- Co-existence of WirelessMAN-OFDMA and WirelessMAN-Advanced air interfaces
- WirelessMAN-OFDMA (Legacy) zones in frame structure
- FDM or TDM approach



IMT-Advanced Requirements and Results

- IEEE “self-evaluation” results in IMT-Advanced scenarios
- Results from other independent evaluation groups in IMT-Advanced evaluation process show similar results
- Scenarios are defined in ITU-R M.2134

TDD VoIP capacity

	ITU-Req	Self-evaluation
Indoor (InH)	50	**140**
Urban Micro (UMi)	40	**104**
Urban Macro (UMa)	40	**95**
Rural/high speed (RMa)	30	**103**

DL cell/cell edge user spectral efficiency in TDD downlink

	ITU Requirements		Self-evaluation results	
	Cell average	**Cell edge**	**Cell average**	**Cell edge**
Indoor (InH)	3.0	0.10	**6.93**	**0.260**
Urban Micro (UMi)	2.6	0.075	**3.22**	**0.092**
Urban Macro (UMa)	2.2	0.06	**2.41**	**0.069**
Rural/high speed (RMa)	1.1	0.04	**3.23**	**0.093**

Source: IEEE C802.16-09/0013, IEEE 802.16m evaluation results for PCT for IMT-Advanced

Summary

- IEEE 802.16m is an amendment to the consolidated IEEE 802.16-2009 standard
  - Specifies the WirelessMAN-Advanced Air Interface
  - Core features for baseline performance enhancement
  - Advanced features for support of femtocells, SON, EMBS, LBS
  - Submitted and evaluated as candidate technology for IMT-Advanced
  - Ratification by IEEE expected in Q1 2011
- IEEE 802.16m meets the IMT-Advanced performance requirements
- WiMAX Forum is developing WiMAX system profile release 2
  - Expected in Q1 2011
- Certified Mobile WiMAX Rel. 2 products after this date

References

- IEEE 802.16 WG, *802.16m System Description Document*, 802.16m-08/0034r2, Sept. 2009. http://wirelessman.org/tgm/docs/80216m-09_0034r2.zip
- IEEE 802.16 WG, *P802.16m/D6, Advanced Air Interface*, May 2010.
- IEEE 802.16 WG, *802.16m Evaluation Methodology Document*, 802.16m-08/004r5, Jan. 2009. http://wirelessman.org/tgm/docs/80216m-08_004r5.zip
- ITU-R, *RECOMMENDATION ITU-R M.1645*, June 2003.
- ITU-R, *REPORT M.2134 Requirements related to technical performance for IMT-Advanced radio interface(s)*, Nov. 2008

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