System Level Performance Evaluation on Multiplexing of USCCH in IEEE 802.16m

IEEE 802.16 Presentation Submission Template (Rev. 9)

Document Number:

IEEE C802.16m-08/671

Date Submitted:

2008-07-07

Source:

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Venue:

IEEE 802.16m-08/024, “Call for Comments and Contributions on Project 802.16m System Description Document (SDD)”.

Target topic: “DL Control Structure”.

Base Contribution:

None

Purpose:

To be discussed and adopted by TGm for the 802.16m SDD

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July, 2008

About This Contribution

- **Proposal on Text Modification**

802.16m -08/003r3	~~**The multiplexing scheme between control and data channels is FFS.**~~

FDM	Within a sub-frame, control and data channels are multiplexed using FDM. Both control and data channels are transmitted on logical resource units (LRU) that span all OFDM symbols in a sub-frame.

Based on System Level Performance Evaluation

This contribution gives the reason why we should adopt FDM

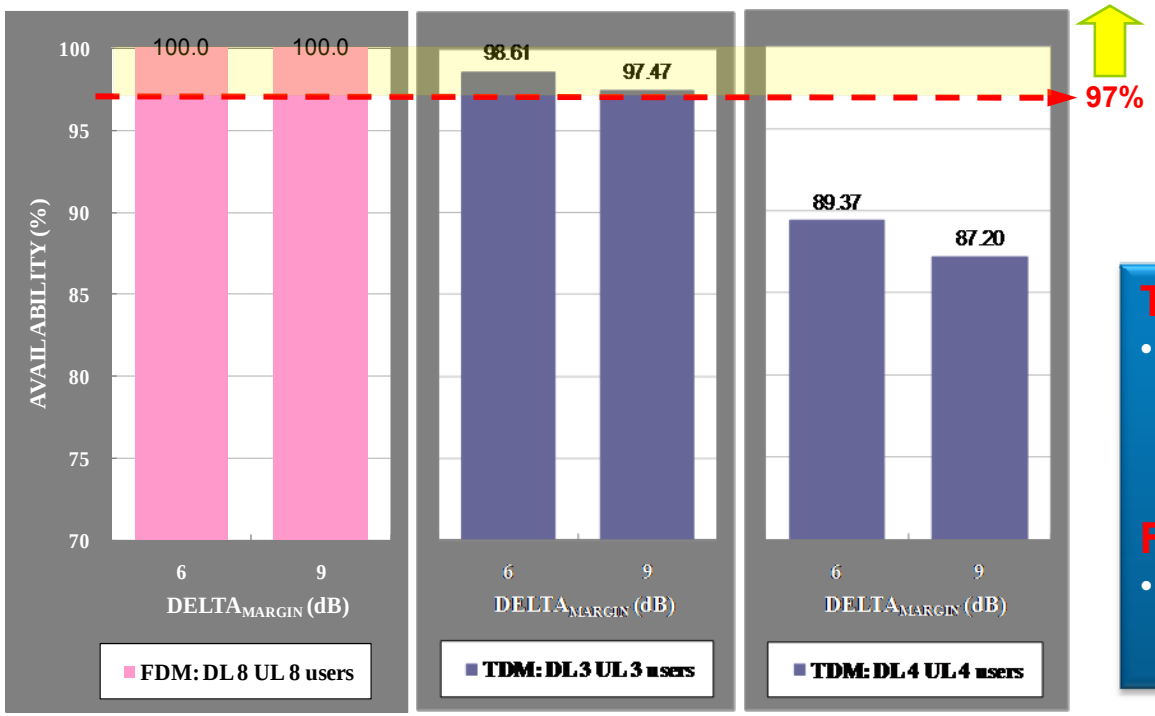
FDM vs. TDM

Performance Metrics	FDM	TDM
GRANULARITY of Ratio btw Control and Data (1-D MAP region)	▪ **HIGHER**	▪ Lower (especially for short-length sub-frame)
COVERAGE (Outage)	▪ **BETTER**	▪ Worse
SPECTRAL EFFICEINCY (Sector Throughput)	▪ **BETTER**	▪ Worse
CHANNEL ESTIMATION	▪ **BETTER**	▪ Worse
Processing Time (Latency)	▪ Longer	▪ Shorter ▪ **TRADE-OFF** between CH. est. performance and benefit of latency
Power Saving: Micro-sleep (in one Sub-frame)	▪ Not support	▪ Support ▪ **TRADE-OFF** between CH. est. performance and benefit of micro-sleep ▪ **NOT** significant gain within a sub-frame (<3%) [Annex]

Comparisons btw TDM and FDM

- **Performance Metric**
  - With fixed orthogonal resource overhead, **How many users can be supported** with satisfying MAP outage requirement (<3%)?
  - MAP outage is controlled by Δ_{MARGIN}

Availability (%) = 100 – MAP outage



MUX	Orthogonal Resource Overhead
FDM	16.7%
TDM	16.7% (1 OFDMA symbol)

*16.7%: Enable to support Maximum DL8 UL8 assignment blocks

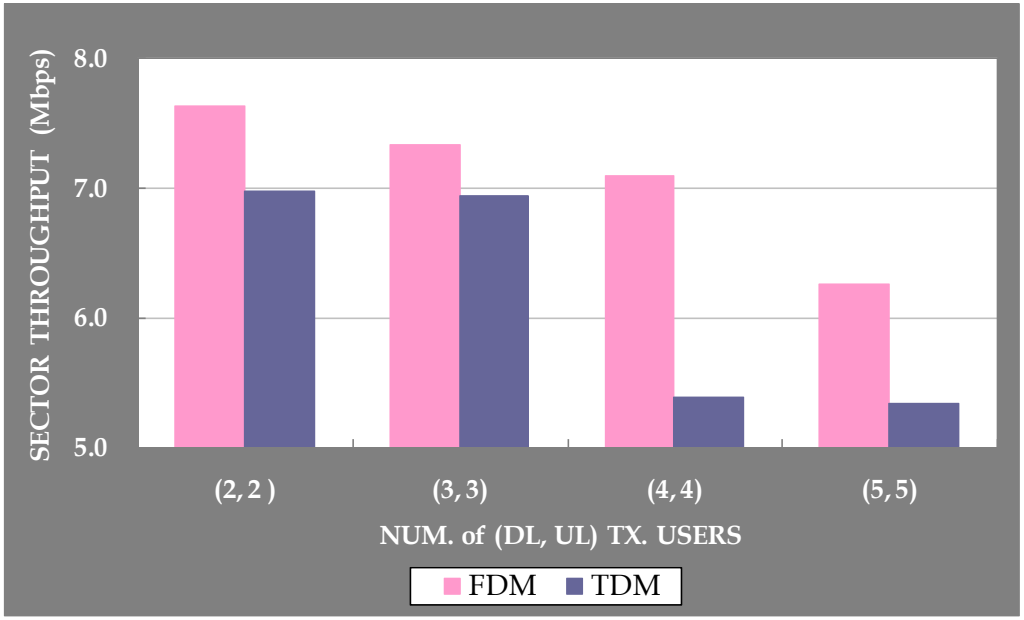
TDM
- Even if Δ_{MARGIN} is increased, TDM cannot support more than DL3, UL3 users

FDM
- Enable to support DL8, UL8 users without change of resource OH

Comparisons btw TDM and FDM

- **Performance Metric**
  - Maximum **SECTOR THROUGHPUT** with satisfying MAP outage requirement (<3%)
  - **GRANULALITY** of resource ratio between data and control
    - FDM: Resource + Power (SOFT Separation)
    - TDM: Resource (HARD Separation)

MUX	# of Users (DL, UL)	Orthogonal Resource Overhead	Δ_{MARGIN}
FDM	(2, 2)	8.3%	6dB
	(3, 3)	8.3%	5dB
	(4, 4)	8.3%	5dB
	(5, 5)	16.7%	5dB
TDM	(2, 2)	16.7%	4dB
	(3, 3)	16.7%	4dB
	(4, 4)	33.3 %	2dB
	(5, 5)	33.3 %	4dB



FDM yields BETTER throughput performance than TDM

Annex: System Level Simulation (1)

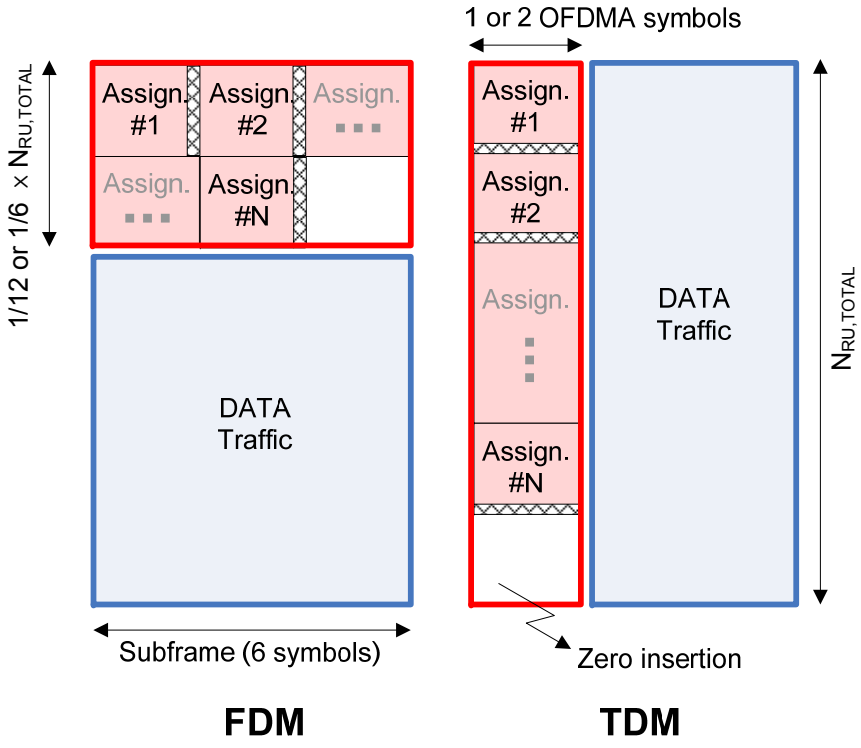
- **Performance Metrics**
  - **Sector Throughput** with satisfying MAP outage requirement
  - **MAP Outage** requirement: Distribution of user whose BLER is larger than 1% < 3% of total users

- **Per User Power Control**
  - $P_{MAPIE}[i] = SINR_{REQ} - SINR(CQI)[i] + \Delta_{MARGIN}$
    - $SINR_{REQ}$: SINR value required to satisfy 1% BLER
    - SINR(CQI)[i]: i-th user SINR set by CQI feedback value
    - Δ_{MARGIN}: Margin value to accomplish required MAP outage

Annex: System Level Simulation (2)

- **Major Assumptions**
  - Subframe structure
    - [IEEE C802.16m-08/062r1]
  - Only assignment block in MAP region
    - 48 bits (including CRC) per assignment block
  - Separate coding
  - 1-D MAP region indication
    - Period: Semi-static

MUX	Orthogonal Resource Overhead
FDM	8.3 or 16.7 %
TDM	16.7 or 33.3 %



* 8.3%: Maximum DL4 UL4 assignment blocks
  16.7%: Maximum DL8 UL8 assignment blocks
  33.3%: Maximum DL16 UL16 assignment blocks

Annex: System Level Simulation (3)

- **Simulation Environments/Assumptions**

Index	Value
Deployment Scenario	EMD baseline [IEEE 802.16m-07/037r2]
MCS for MAP	QPSK, 1/2
HARQ	Synchronous (No assignment message for retransmission)
Scheduler	Proportional fairness
# of Users per Sector	10
# of Scheduled Users	2, 3, 4, 5 per mini-frame (4, 6, 8, 10 for both DL and UL)
MAP Error Effects	Resource loss for MAX retransmission
Antenna Configuration	SIMO 1x2
Channel Model	Mixed (Ped B-3kmph-60%, Veh A-30kmph-30%, Veh A-120kmph-10%)
Channel Estimation	Real channel estimation (Equal impairment for both TDM and FDM)
Other Simulation Assumptions	EMD baseline

Annex: Power Saving (1)

- **Micro-Sleep (within a sub-frame)**
  - Symbol level power saving
- **Power Saving Gain**

$$PSG \le \sum_{i=0}^{2} \frac{3.5 - Max(p,q) - x_i}{6} \times z_i \times G_i \ \%$$

$$= 2.04\ \%$$

Power saving gain by Micro-sleep is NOT significant

	Required Time	
FFT	1 symbol	
MAP Region	p symbols	p=1
Pilot Region	q symbols	q=2
CH. Est. Delay	0.5 symbol	
MAP Decoding	Minimum 1 symbol	
Turn-off + Turn-on	x_0, x_1, x_2	

Parts	Portion of Power Consumption		Time for turn-off + turn-on		Power Saving Gain (%)	
Baseband Modem	z_0	0.1	x_0	1 symbols	G_1	50
RF Parts	z_1	0.65	x_1	1 symbols	G_2	30
Display Device	z_2	0.25	x_2	-	G_3	-

Annex: Power Saving (2)

- **Default Subframe Concept**
  - Sub-frame level power saving
  - Power saving gain can be much larger than Micro-sleep
  - One of sub-frame is pre-assigned to a MS as a default sub-frame, then the MS may go sleep mode during other sub-frame