

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

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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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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

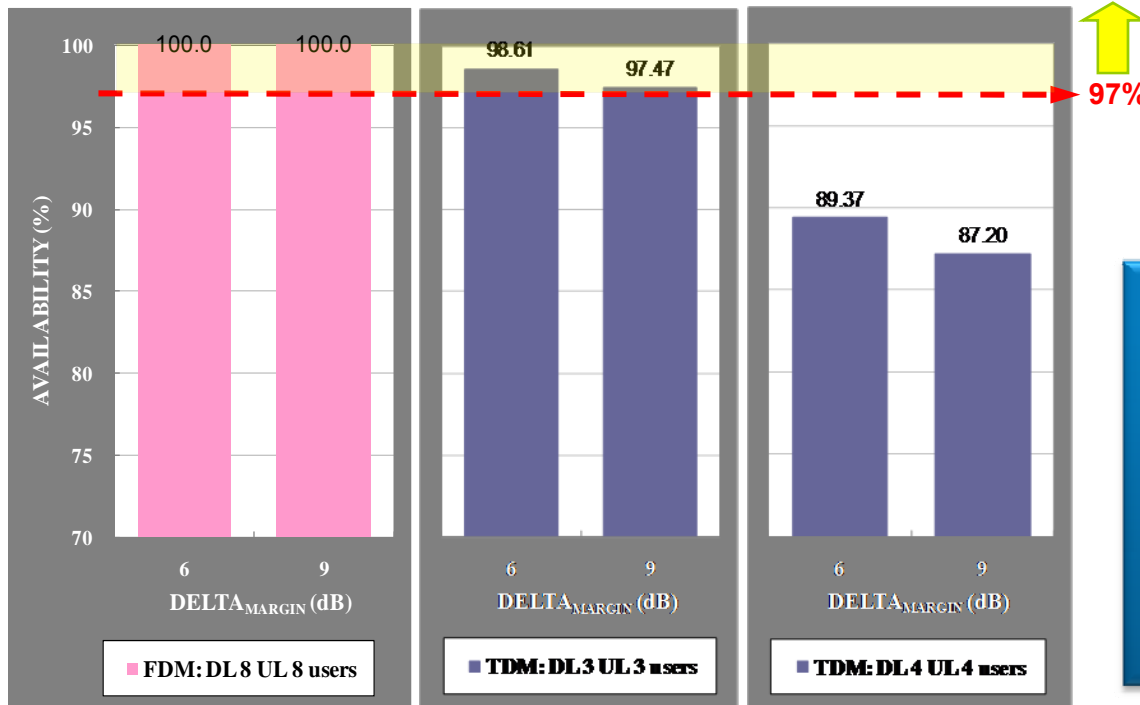
Performance Metrics	FDM	TDM
GRANULARITY of Ratio btw Control and Data (1-D MAP region)	▪ HIGHER	▪ Lower (especially for short-length sub-frame)
COVERAGE (Outage)	▪ BETTER	▪ Worse
SPECTRAL EFFICEINCY (Sector Throughput)	▪ BETTER	▪ Worse
CHANNEL ESTIMATION	▪ BETTER	▪ Worse
Processing Time (Latency)	▪ Longer	▪ 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

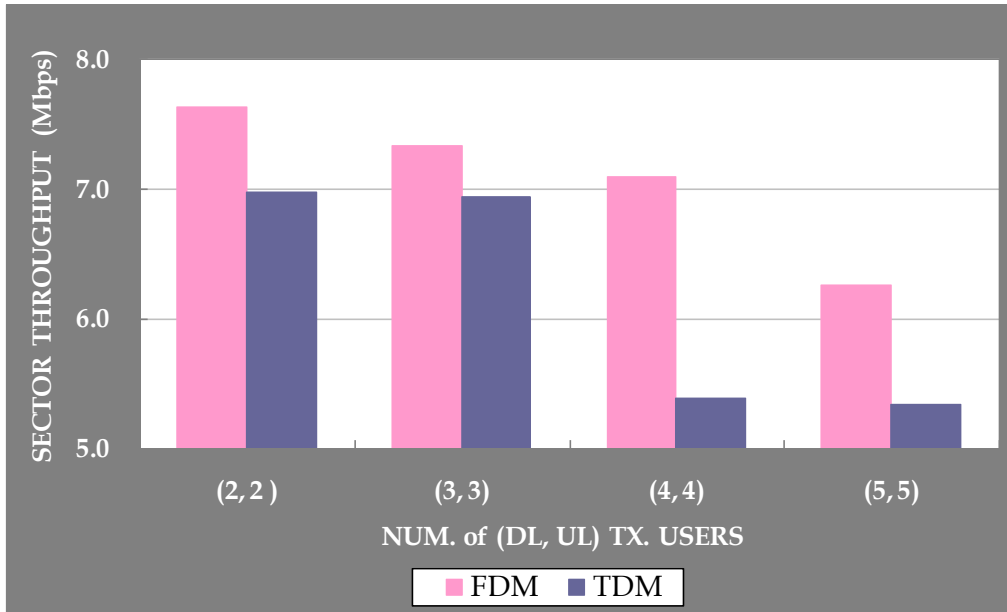
FDM

- 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%)
- **GRANULARITY** 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

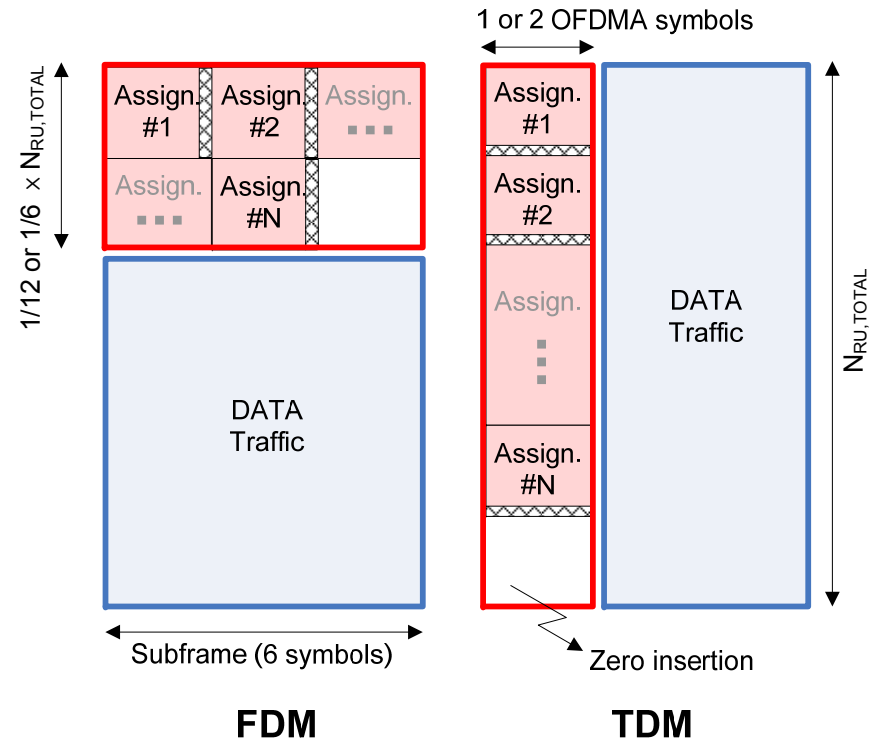
- $P_{\text{MAPIE}}[i] = \text{SINR}_{\text{REQ}} - \text{SINR}(\text{CQI})[i] + \Delta_{\text{MARGIN}}$
 - SINR_{REQ} : SINR value required to satisfy 1% BLER
 - $\text{SINR}(\text{CQI})[i]$: i-th user SINR set by CQI feedback value
 - Δ_{MARGIN} : Margin value to accomplish required MAP outage

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**

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

$$= 2.04 \%$$

▶ *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 (%)	
	z_0		x_0		G_1	
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

