Performance Comparison between 2- and 4-Switching Points in 5ms TDD Frame

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Jaeweon Cho, Chiwoo Lim, Hyunkyu Yu,
Hokyu Choi, Heewon Kang
Samsung Electronics Co., Ltd.
416 Maetan-3, Suwon, 443-770, Korea

Voice: +82-31-279-5796
E-mail: jaeweon.cho@samsung.com

Venue:

IEEE 802.16m-08/024, “Call for Comments and Contributions on Project 802.16m System Description Document (SDD)”.
Target topic: Call for Comment on the SDD draft (IEEE 802.16m-08/003r3).

Base Contribution:

None

Purpose:

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

Performance Comparison between 2- and 4-Switching Points in 5ms TDD Frame

Jaeweon Cho, Chiwoo Lim, Hyunkyu Yu, Hokyu Choi, Heewon Kang

Samsung Electronics Co., Ltd.

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About this Contribution

- Background
  - The current SDD draft includes the two configuration options for TDD
    - I.e. 2-switching points vs. 4-switching points in 5ms TDD frame
  - However, there has not been any technical discussion at TGm about a benefit of the 4-switching points option
  - If a gain of the 4-switching points option is not significant, we don't need to have both options for 16m TDD specification

- Goal and scope of this presentation
  - Evaluate a gain of the 4-switching option by comparing the performance with the 2-switching points option
  - Based on the analysis results, propose a text modification to the SDD

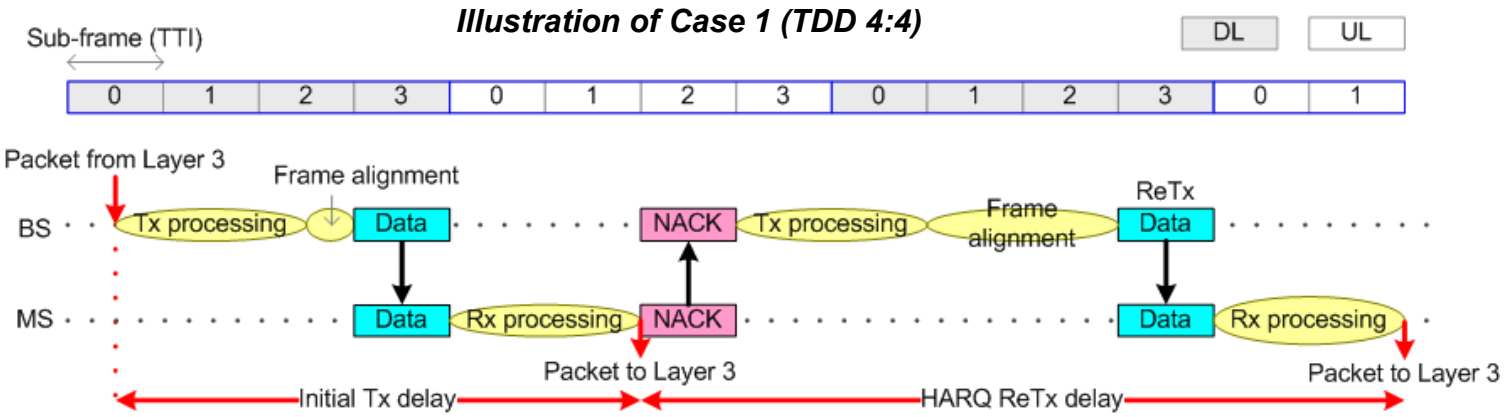
2-S/W Points vs. 4-S/W Points

- Two performance issue: Latency and Throughput

- Latency
  - Myth: The 4-S/W can reduce data latency due to a short S/W interval
  - Truth: May NOT reduce the latency because of a practical Rx/Tx processing time of data burst

- Throughput
  - Myth: The 4-S/W can increase data throughput due to a fast CQI reporting
  - Truth: 1) May NOT increase the throughput because of a practical delay for CQI report and another delay for applying it to scheduling
    2) On the contrary, shall not ignore a throughput reduction due to additional time gaps for TTG and RTG

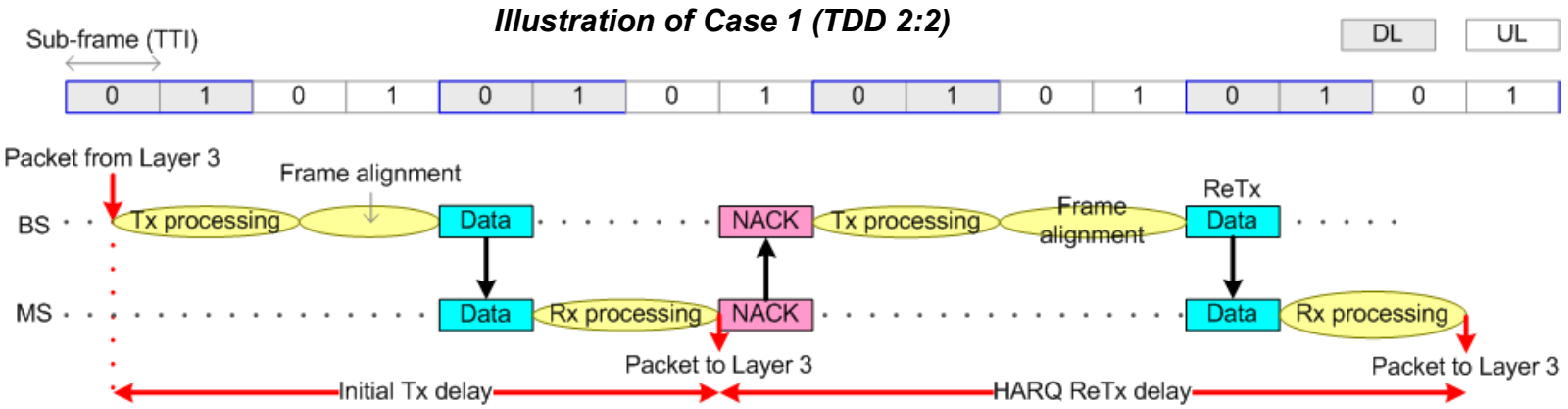
DL Data Latency in 2-S/W Points



Case	Timing when Packet arrives	Initial Tx delay	HARQ ReTx delay	Delay with ReTx Pr. = 30%	Averaged Delay for TTI = 0.617ms
1	DL sub-frame #0	5.5 TTI	8 TTI	7.9 TTI	5.65 ms
2	DL sub-frame #1	9.5 TTI	8 TTI	11.9 TTI	
3	DL sub-frame #2	8.5 TTI	8 TTI	10.9 TTI	
4	DL sub-frame #3	7.5 TTI	8 TTI	9.9 TTI	
5	UL sub-frame #0	6.5 TTI	8 TTI	8.9 TTI	
6	UL sub-frame #1	5.5 TTI	8 TTI	7.9 TTI	
7	UL sub-frame #2	5.5 TTI	8 TTI	7.9 TTI	
8	UL sub-frame #3	5.5 TTI	8 TTI	7.9 TTI	

Note: Rx/Tx processing time = 2 TTI. For details in the calculation above, see IEEE C802.16m-08/062r1

DL Data Latency in 4-S/W Points



Case	Timing when Packet arrives	Initial Tx delay	HARQ ReTx delay	Delay with ReTx Pr. = 30%	Averaged Delay for TTI = 0.617ms
1	DL sub-frame #0	6.5 TTI	8 TTI	8.9 TTI	5.34 ms
2	DL sub-frame #1	5.5 TTI	8 TTI	7.9 TTI	
3	UL sub-frame #0	5.5 TTI	8 TTI	7.9 TTI	
4	UL sub-frame #1	7.5 TTI	8 TTI	9.9 TTI	

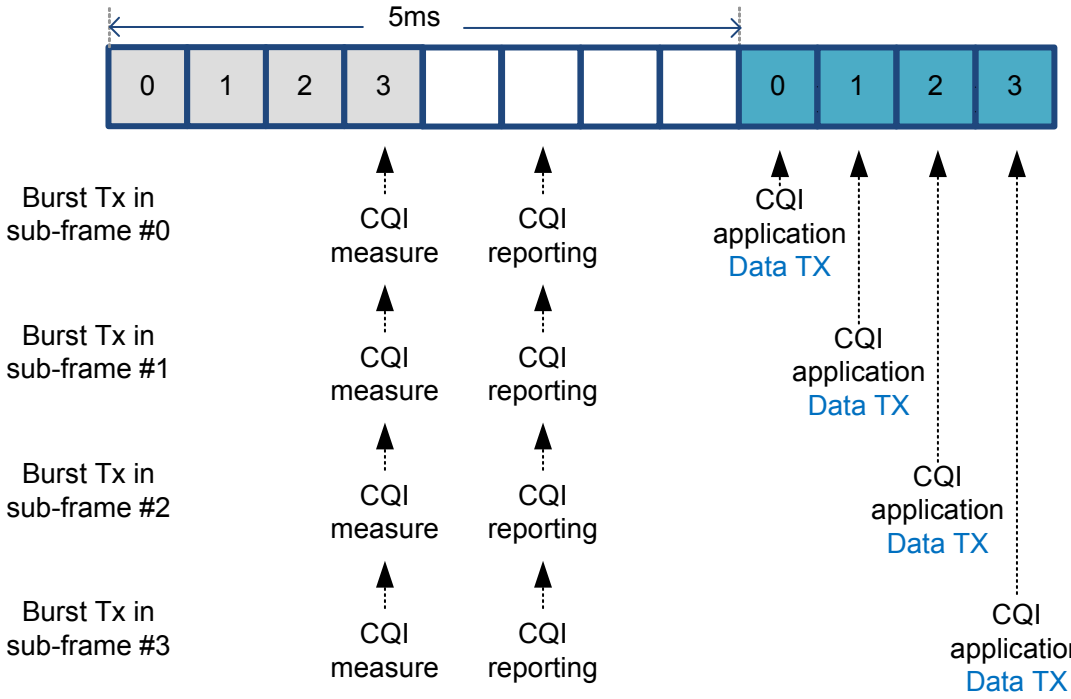
Note: Rx/Tx processing time = 2 TTI.

- Data latency results: **5.65 ms** (2-S/W points) vs. **5.34 ms** (4-S/W points)

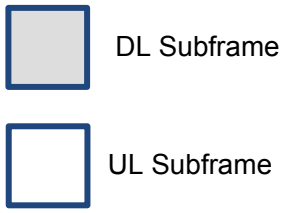
DL System Level Simulation

- Set-up SLS for the DL system throughput analysis
- Assumptions
  - DL:UL ratio = 4:4 (for 2 S/W), 2:2 (for 4 S/W)
  - Take into consideration …
    - TTG and RTG gaps
    - A delay between measuring and reporting of CQI, at MS
    - A delay between receiving and applying the CQI report, at BS
- Conditions
  - Simulation conditions are mainly based on 802.16m EMD. (IEEE 802.16m-08/004r2)
  - Channel : ITU-R Ped_B (3km/h), Veh_A (30km/h, 120km/h), Mixed
    - Mixed : Ped_B 3km/h(60%) + Veh_A 30km/h(30%) + Veh_A 120km/h(10%)

CQI Timing Diagram in 2 S/W

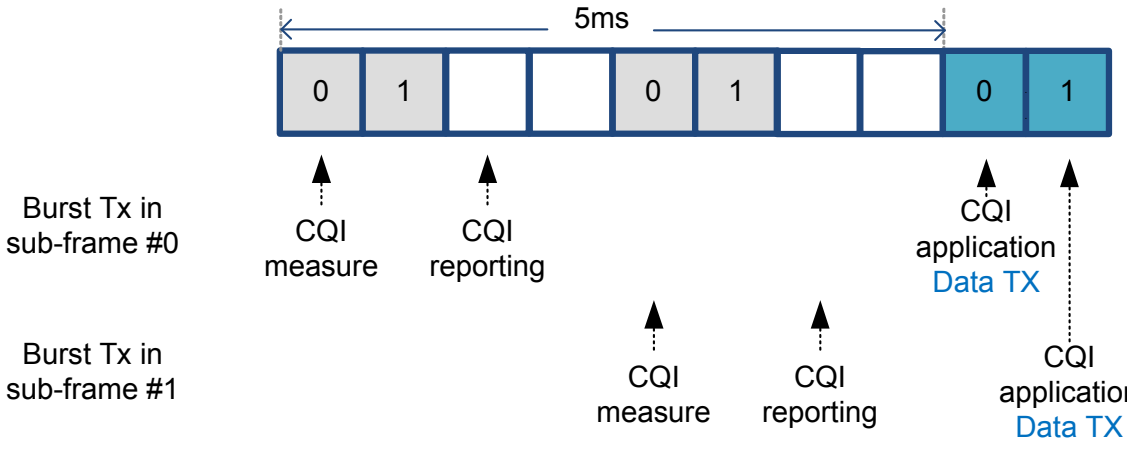


Data Tx	CQI delay
Sub-frame #0	5 sub-frames
Sub-frame #1	6 sub-frames
Sub-frame #2	7 sub-frames
Sub-frame #3	8 sub-frames

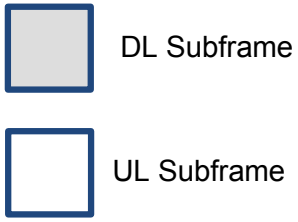


- Assumption
  - Processing delay from CQI measuring to CQI reporting = **1 sub-frame**
  - Processing delay from CQI reporting to CQI application = **2 sub-frame**
  - Time gaps: TTG (1 symbol = 102.8us) and RTG (idle time = 62.9us) / 5ms frame
  - Full band common pilot for CQI measuring reference in DL sub-frame #3

CQI Timing Diagram in 4 S/W

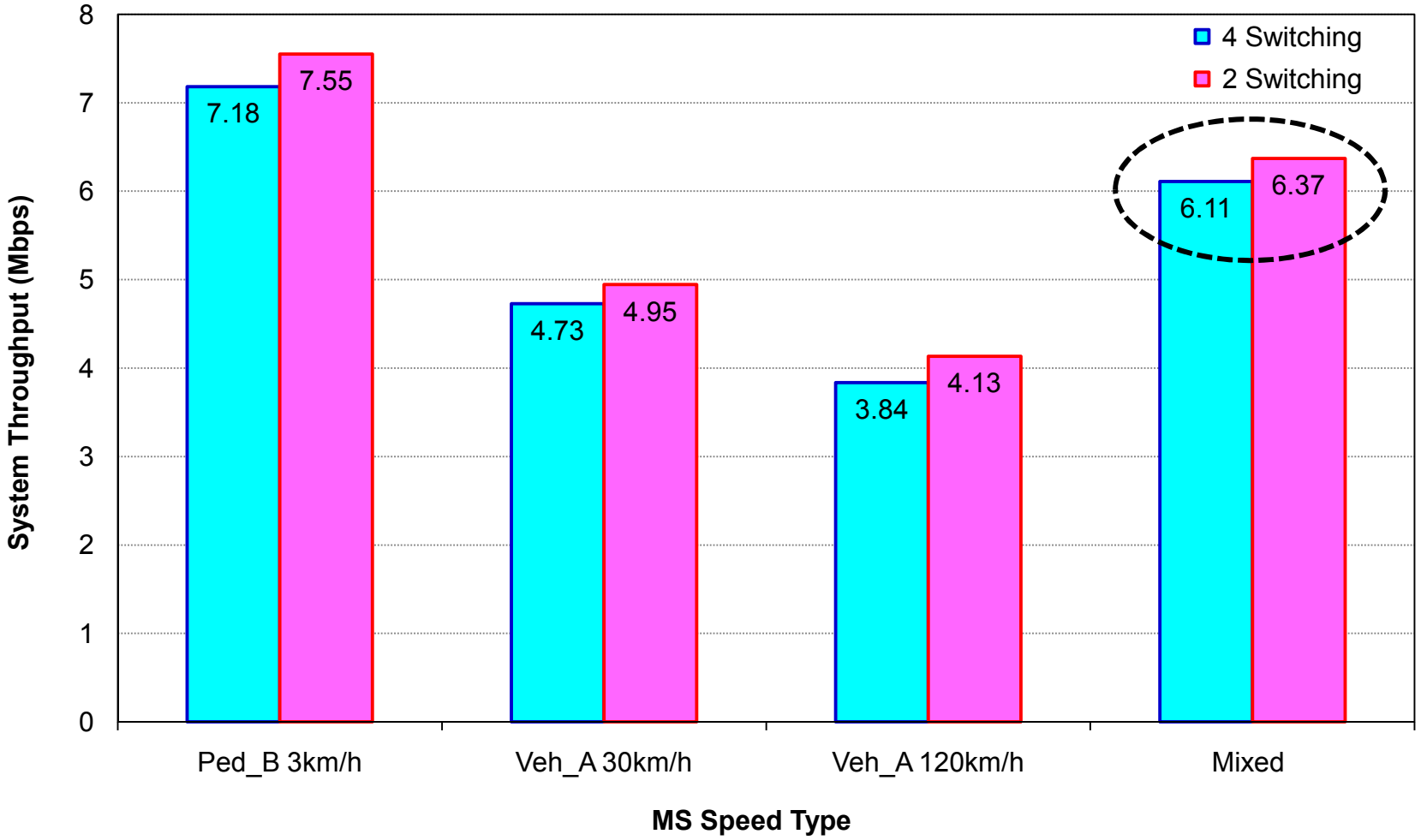


Data Tx	CQI delay
Sub-frame #0	8 sub-frames
Sub-frame #1	5 sub-frames



- Assumption
  - Processing delay from CQI measuring to CQI reporting = **1 sub-frame**
  - Processing delay from CQI reporting to CQI application = **2 sub-frame**
  - Time gaps: TTG (1 symbol = 102.8us) and RTG (a half idle time = 31.4us) / 2.5ms a half frame
  - Full band common pilot for CQI measuring reference in DL sub-frame #0

DL Throughput Results



- Throughput gain of the 4-SW over the 2-S/W = **– 4.2% (loss)** [Mixed]

Concluding Remarks

- Gain of the 4-switching points over the 2-switching points is NOT significant, but even a loss in system throughput is observed
  - Latency: 5.65 ms (2 S/W) vs. 5.34 ms (4 S/W)
  - Throughput: 6.37 Mbps (2 S/W) vs. 6.11 Mbps (4 S/W)

- Unlike the myth of the 4-swicthing superiority,

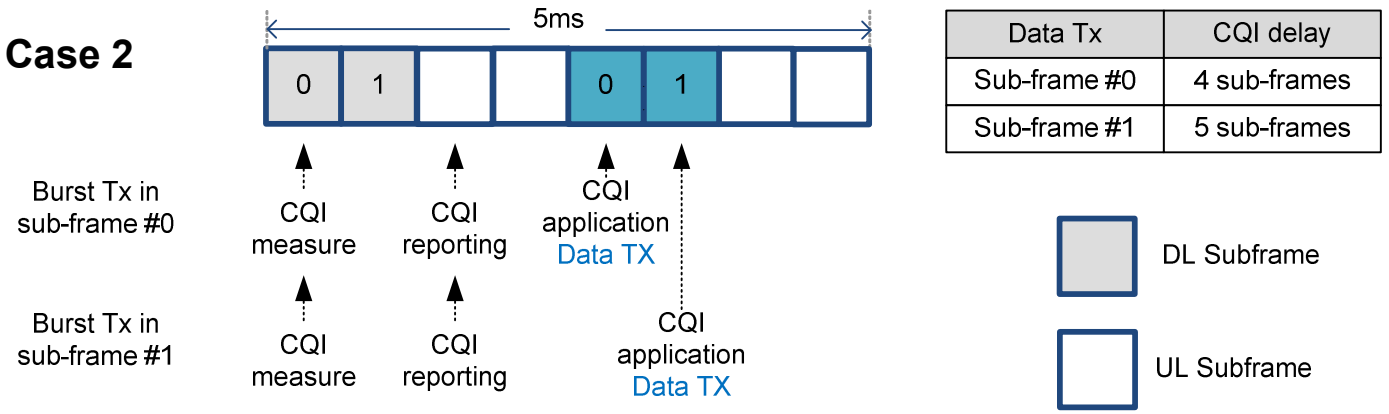
  Cannot see a noticeable difference in performance between the two options.

  Nevertheless, do we have to keep BOTH options?
  - *Remind: the 2 switching points option shall be kept for the legacy support*

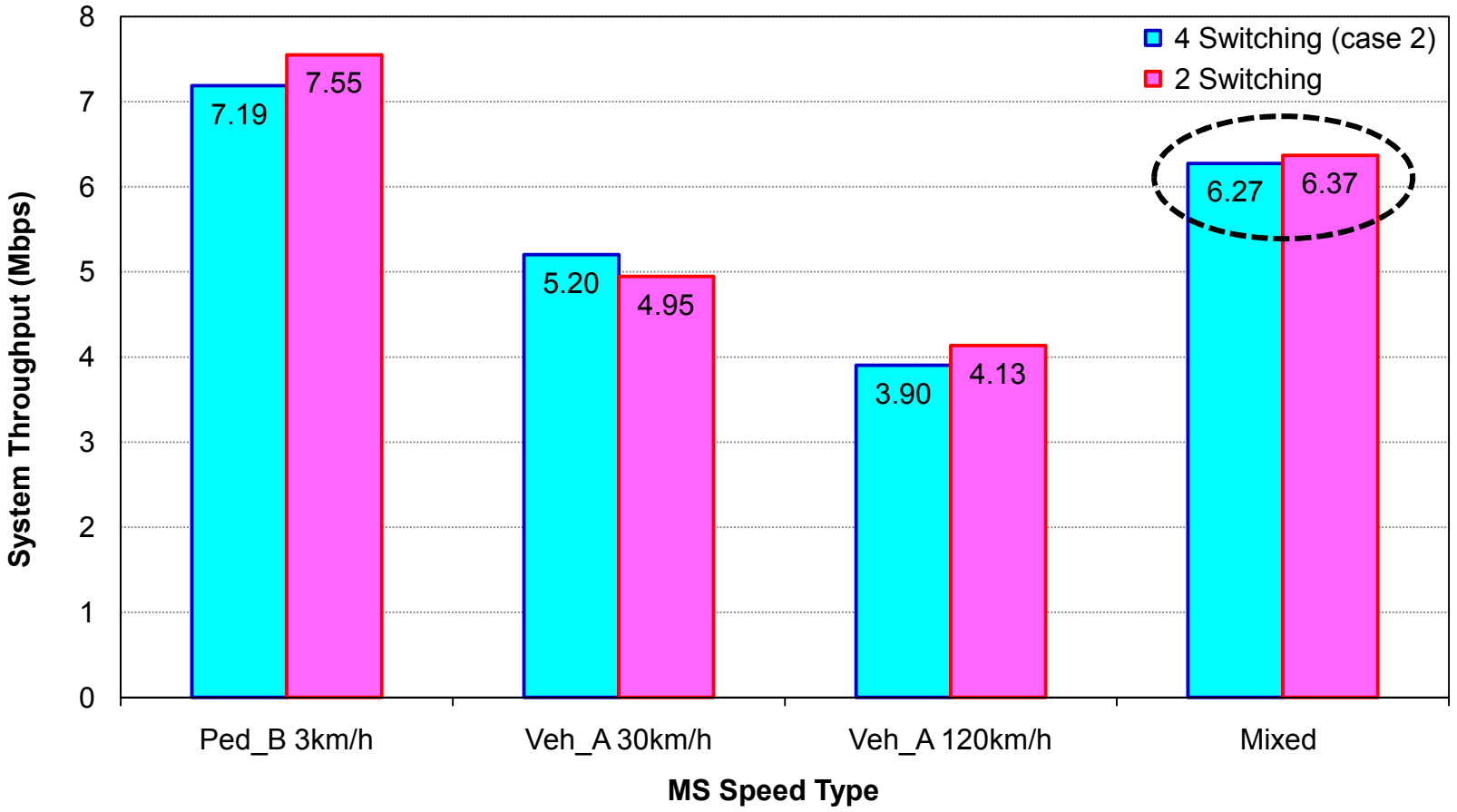
- Authors' Proposal: Remove the 4 switching points option in the 802.16m TDD configuration

Appendix: CQI Timing Diagram in 4 S/W (Case2)

- *Case1:*
  - Processing delay from CQI measuring to CQI reporting = 1 sub-frame
  - Processing delay from CQI reporting to CQI application = **2 sub-frame**
- *Case2: [very stringent constraint on processing time]*
  - Processing delay from CQI measuring to CQI reporting = 1 sub-frame
  - Processing delay from CQI reporting to CQI application = **1 sub-frame**
- *Both Cases:*
  - TTG (1 symbol = 102.8us), RTG (a half idle time = 31.4us) / 2.5ms a half frame
  - Full band common pilot for CQI measuring reference in DL sub-frame #0



Appendix: DL Throughput Results (case 2)



- Throughput gain of the 4-SW over the 2-S/W = **– 1.6% (loss)** [Mixed]

  ⇒ still Throughput Loss even with a very stringent constraint on processing time!