

# Proposed text of 8-Tx pilot pattern for the IEEE 802.16m amendment

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# Peak Spectral Efficiency (SE) Requirement

- Normalized peak data rate

Requirement Type	Link Direction	MIMO Configuration	Normalized Peak Rate (bps/Hz)
Baseline	Downlink	2 x 2	8.0
	Uplink	1 x 2	2.8
Target	Downlink	4 x 4	15.0
	Uplink	2 x 4	6.75
Target	Downlink	8 x 8	30.0 (TBD)
	Uplink	4 x 8	15.0 (TBD)

- 8 x 8 MIMO technology with rate up to 8 may be demanded or recommended
- DL peak spectral efficiency of 30 bps/Hz and UL peak spectral efficiency of 15 bps/Hz should be supported
  - Pilot overhead is an important design parameter

- Maximum throughput (peak SE) vs. pilot density

$$\eta = \frac{(N_{SC,RU} \times N_{OFDM,RU} - N_{P,RU}) \times N_{PRU,Subframe} \times R_c \times m \times M}{T_{Subframe} \times BW} \quad (\text{bps/Hz})$$

- Upper bound (8-stream): 2 pilots per stream
  - **EX1:** 16m frame structure w/ BW = 10 MHz, 8 x 8 MIMO w/ 8-stream transmission, 64QAM, rate-237/256 [1], 3 pilots per stream within an 18 x 6 RU

$$\eta = \frac{(108 - 24) \times 48 \times (237 / 256) \times 6 \times 8}{(5 \times 10^{-3} / 8) \times (10 \times 10^6)} = 28.67 (< 30) \quad (\text{bps/Hz})$$

- **EX2:** 16m frame structure w/ BW = 10 MHz, 8 x 8 MIMO w/ 8-stream transmission, 64QAM, rate-237/256 [1], 2 pilots per stream within an 18 x 6 RU

$$\eta = \frac{(108 - 16) \times 48 \times (237 / 256) \times 6 \times 8}{(5 \times 10^{-3} / 8) \times (10 \times 10^6)} = 31.04 (> 30) \quad (\text{bps/Hz})$$

# Application Scenarios

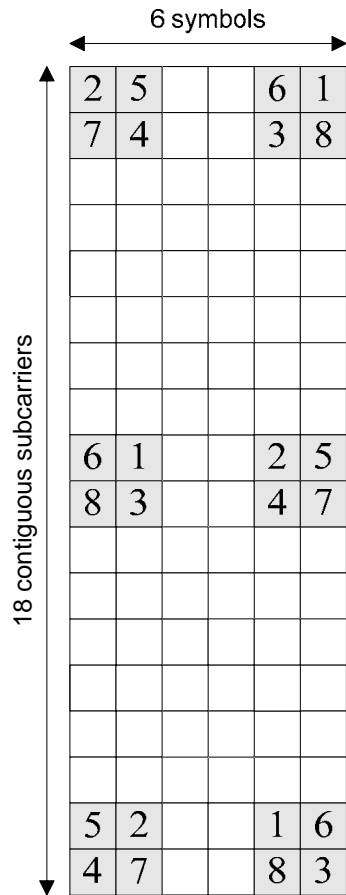
- It's not clear whether 8-Tx MIMO can work well
  - When MS moves far away from BS (due to low SNR)
  - When MS moves fast (due to low pilot density)
- High SNR is necessary to support 8-Tx MIMO
- Possible 8-Tx application scenarios – low mobility environments ( $\leq 3$  km/hr)
  - **Indoor office/hotspot environment:** Small delay spread
    - Single-PRU based channel estimation
  - **Outdoor pedestrian environment:** Large delay spread
    - Multiple-PRU based channel estimation
- Subband CRU should be supported for 8-Tx MIMO

# Pilot Patterns in 16m

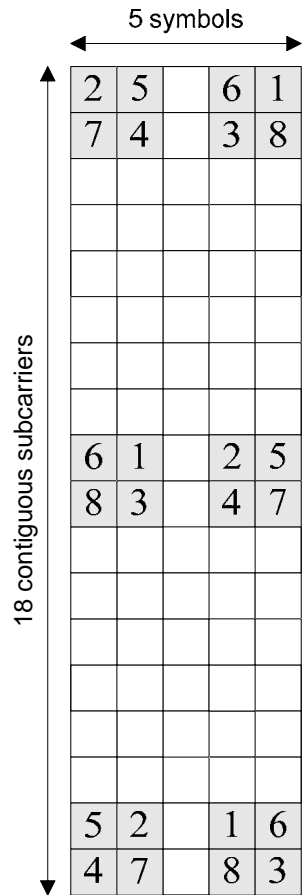
- Fujitsu's pattern [2]

P1	P7			P2	P8
P3	P5			P4	P6
		P1	P7		
		P3	P5		
		P2	P8		
		P4	P6		
P2	P8			P1	P7
P4	P6			P3	P5

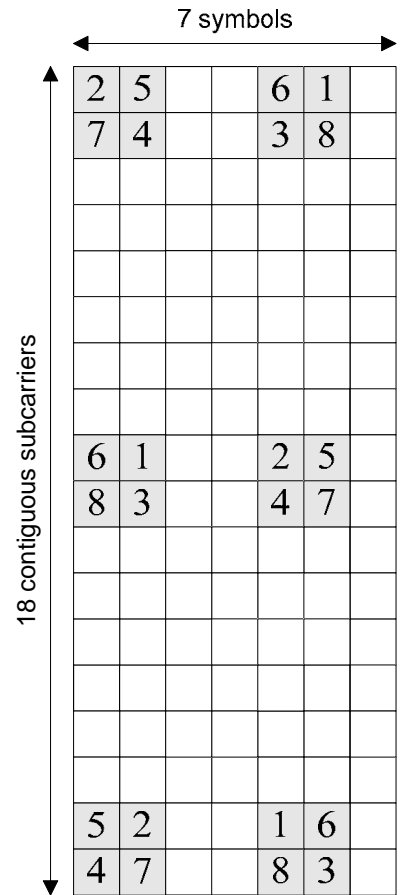
- **Samsung's pattern [3]**



(a)



(b)



(c)

- MediaTek's pattern [4]

2	5			6	1
7	4			3	8
6	1			2	5
3	8			7	4

(a)

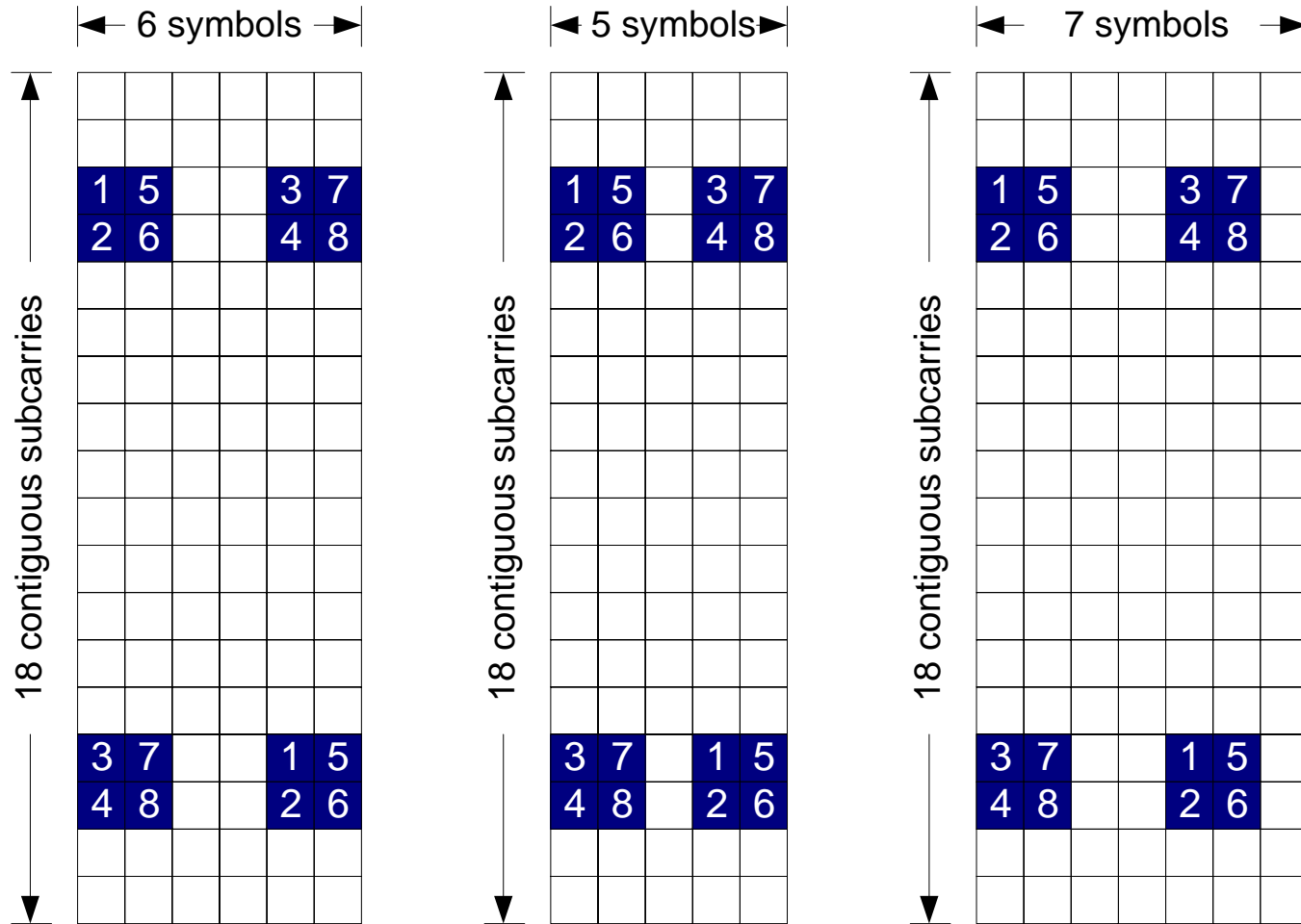
2	5			6	1
7	4			3	8
6	1			2	5
3	8			7	4

(b)

2	5			6	1
7	4			3	8
6	1			2	5
3	8			7	4

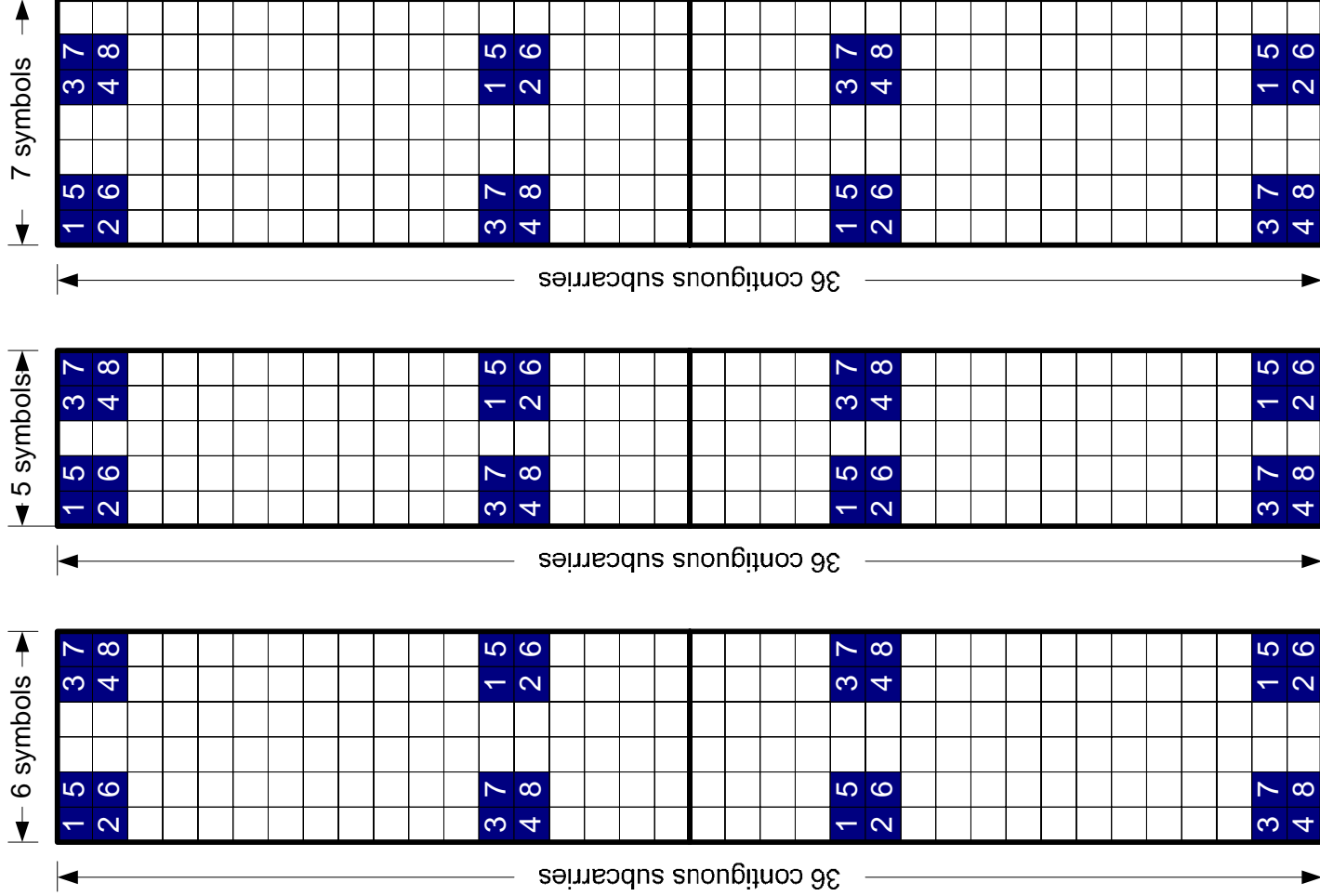
(c)

- ITRI's updated pattern (ITRI1)





- ITRI's updated pattern (ITRI2)



# Performance Results

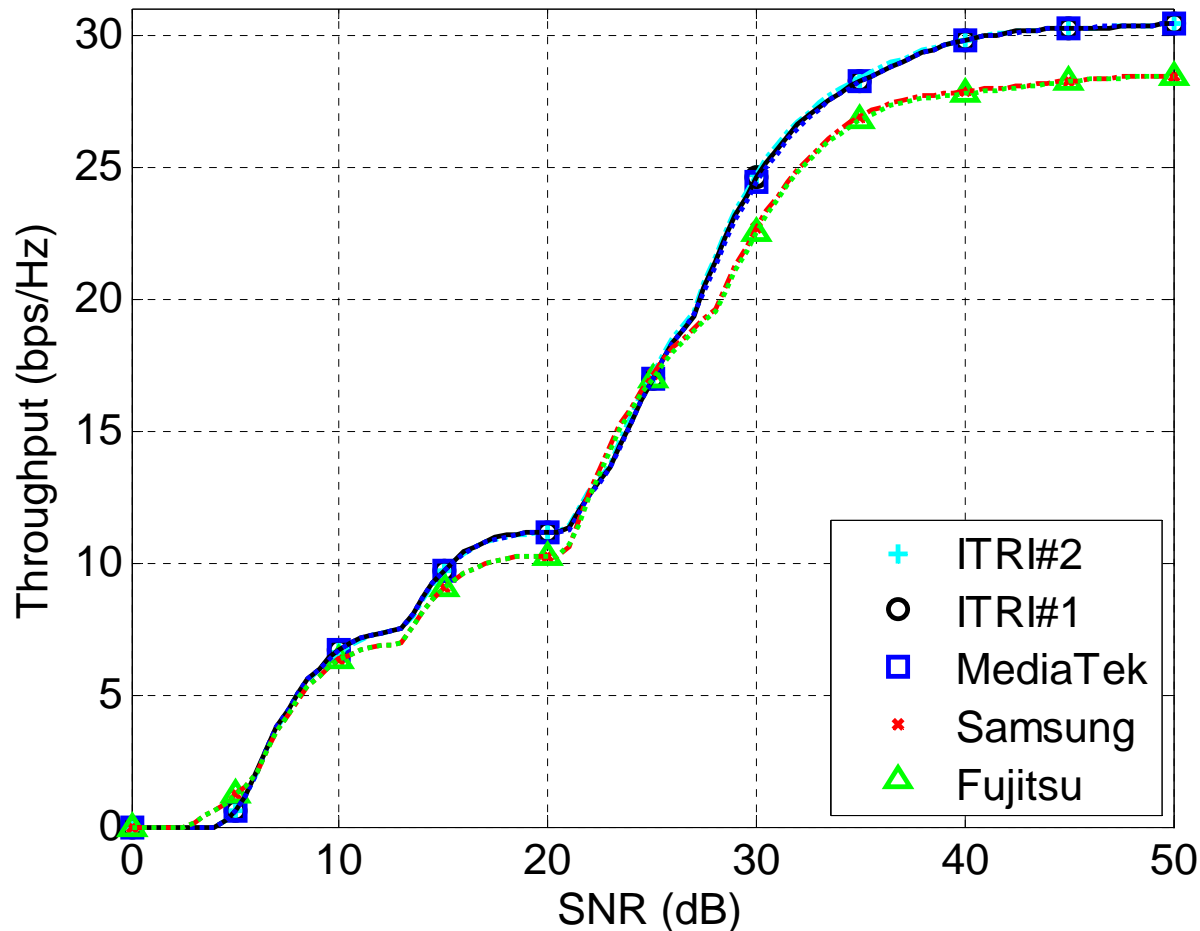
- Simulation parameters

Parameter	Value
Frame Structure	16m frame structure (10 MHz, 1024 subcarriers)
OFDM symbols/subframe	6
Permutation	None (CRU)
Channel model [16m EMD]	- Indoor hotspot (NLOS) with 3 km/h - Ped-B with 3 km/h - Veh-A with 30 km/h
Channel estimation (CE)	2D-MMSE (CE over single PRU or 2 CRUs), delay spread perfectly known but actual power delay profile unknown
Power boosting for pilots	5 dB
MIMO scheme	8 x 8 spatial multiplexing
Channel coding scheme	16e CTC
Detection scheme	Linear MMSE
MCS Set [1]	QPSK-101/256, QPSK-171/256, 16QAM-128/256, 64QAM-135/256, 64QAM-181/256, 64QAM-225/256 , 64QAM-237/256
Number of CRUs	2 CRUs with rate matching

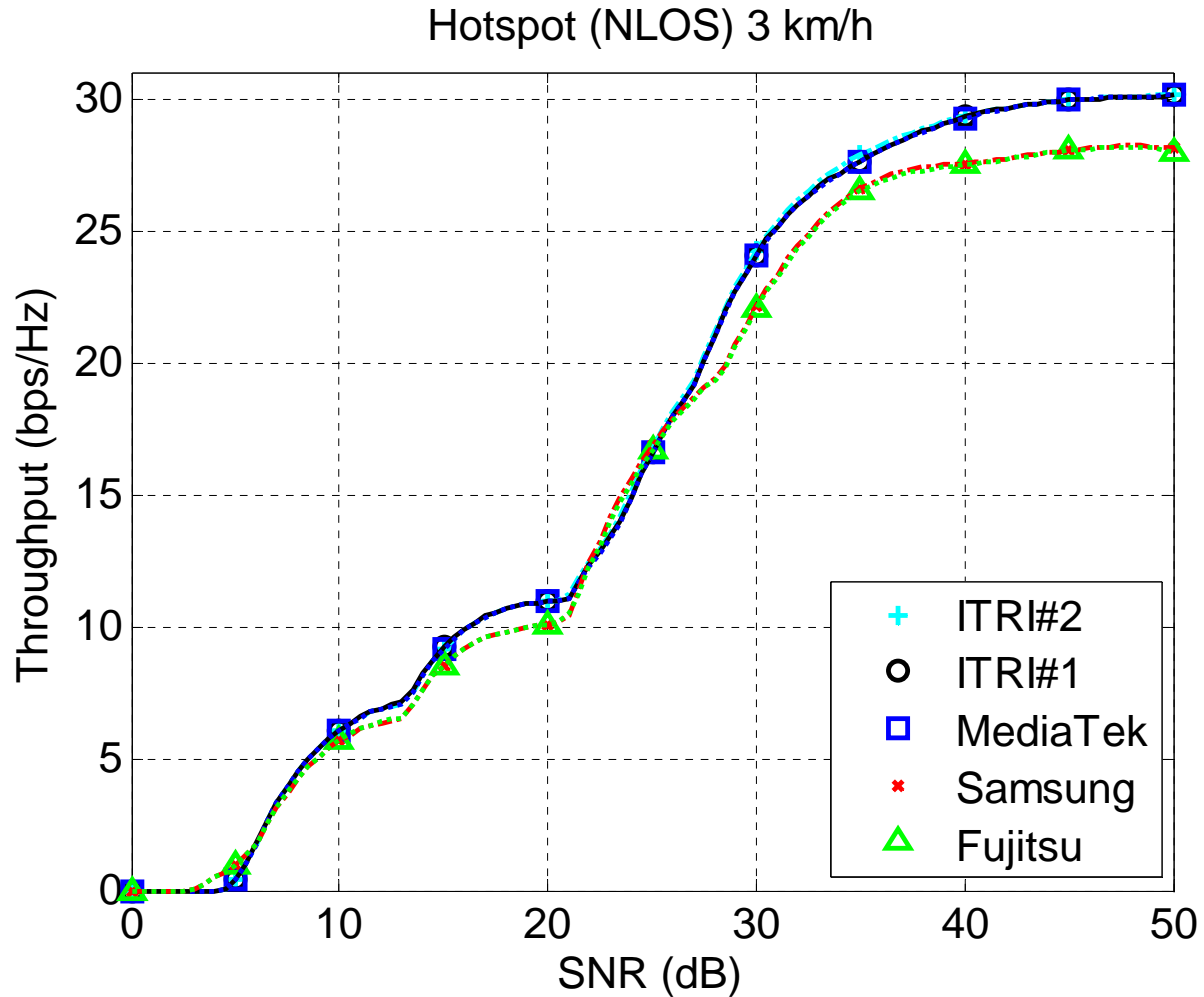
- Simulation results

- Indoor hotspot (NLOS) 3 km/h, CE over 2 CRUs

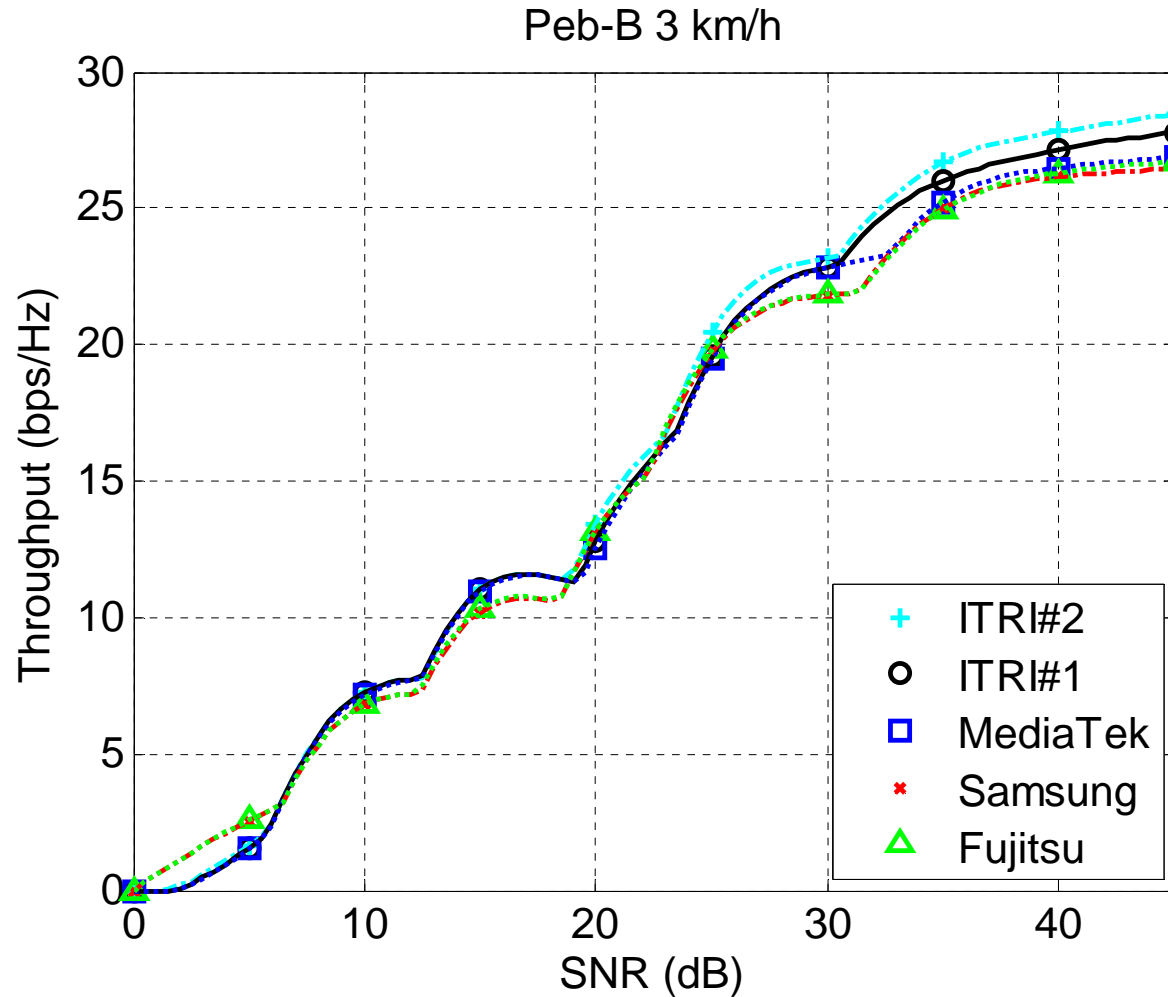
Hotspot (NLOS) 3 km/h



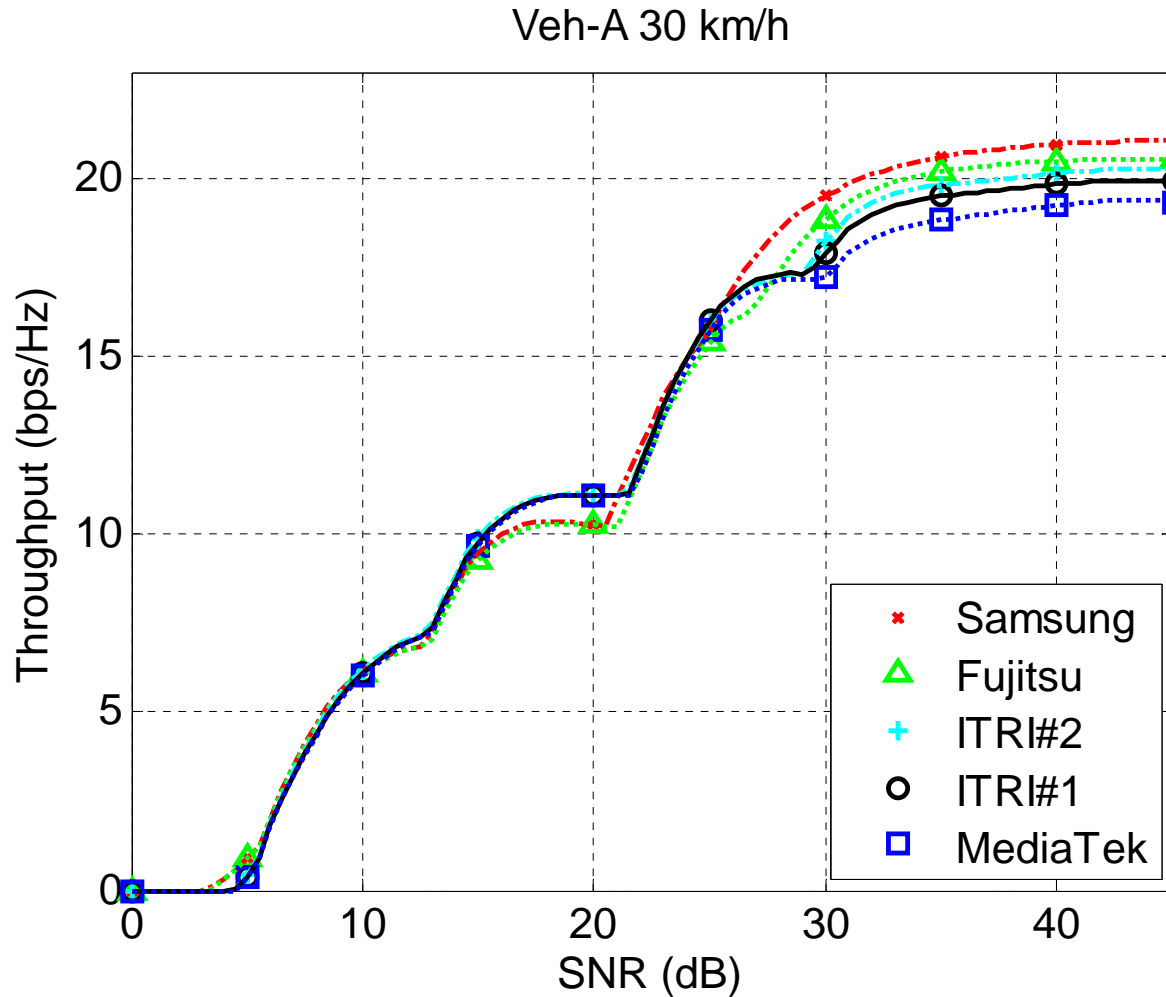
- Indoor hotspot (NLOS) 3 km/h, CE over single PRU



– Ped-B 3 km/h, CE over 2 CRUs



– Veh-A 30 km/h, CE over 2 CRUs



# References

- [1] IEEE C802.16m-09/510r2, “Proposed text of channel coding and HARQ for the IEEE 802.16m Amendment,” Samsung, Mar. 2009
- [2] IEEE C802.16m-08/1426r1, “Pilot design for 8 Tx antennas in 16m system,” Fujitsu, Nov. 2008
- [3] IEEE C802.16m-09/515, “Proposed Text of 8Tx Pilot Patterns for the IEEE 802.16m Amendment,” Samsung, Mar. 2009
- [4] IEEE C802.16m-09/570, “Proposed Amendment Text for 8-Stream Pilot Pattern,” MTK, Mar. 2009

# Proposed Text

## 15.3.5.4.1 Pilot patterns

The pilot patterns for eight pilot streams are shown in Figure xxx with the subcarrier index increasing from top to bottom and the OFDM symbol index increasing from left to right. Subfigure (a) in Figure xxx shows the pilot pattern for eight pilot streams in subframe with six OFDM symbols; Subfigure (b) in Figure xxx shows the pilot pattern for eight pilot streams in subframe with five OFDM symbols; Subfigure (c) in Figure xxx shows the pilot pattern for eight pilot streams in subframe with seven OFDM symbols.

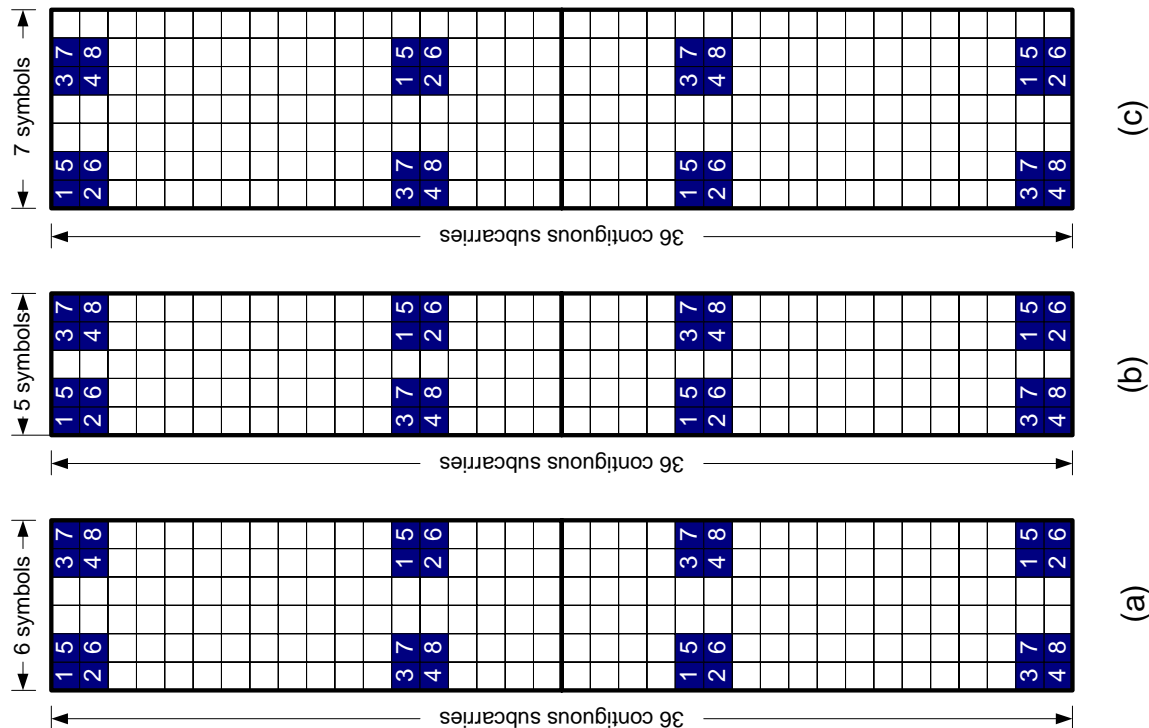


Figure xxx—Pilot patterns for 8 pilot streams