Proposal for Physical Structure of UL Feedback Channel

IEEE 802.16 Presentation Submission Template (Rev. 9)

Document Number:

IEEE C80216m-09/0190r1

Date Submitted:

2009-01-07

Source:

Hwasun Yoo, Sangheon Kim, Si-Hyun Park,
Jaehee Cho, Hokyu Choi, Heewon Kang
Samsung Electronics Co., Ltd

Voice: +82-31-279-4983
E-mail: hwasun.yoo@samsung.com

Venue:

Session #59, San Diego, USA

Re:

802.16m SDD

Base Contribution:

None

Purpose:

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

Proposal for Physical Structure of UL Feedback Channel

Jan, 2009

Hwasun Yoo, Sangheon Kim, Si-Hyun Park,

Jaehee Cho, Hokyu Choi, Heewon Kang

Samsung Electronics Co., Ltd

Objective

- **According to the SDD,**
  - A tile structure for FFBCH is (2X6)
  - Two types of FFBCHs : Primary and Secondary

- **Primary FFBCH (fast feedback channel)**
  - Semi-orthogonal sequence for fixed 6bit-payload
  - Performance improvement for high mobility users

- **UL ACKCH (HARQ feedback channel)**
  - Stable performance for high mobility users

Sequence for Primary FFBCH

- **64 Binary Semi-orthogonal Sequences**
  - Binary orthogonal subsequences with length 4
  - Reed-Solomon mapping for maximum correlation = 8
  - Binary phase vector

- **Relation btw (RS, Phase vector) and Sequence index**
  - After proper sorting of the semi-orthogonal sequences $S_l[k]$
  - Sequence index can be rewritten as

$$l = 4p + q, \qquad 0 \le l \le 63$$

  - $0 \le p \le 15$ is a Reed-Solomon mapping index,
  - $0 \le q \le 3$ is a phase vector index,

Primary FFBCH Sequence Mapping to FMTs

- **Cyclic Shifted Mapping**
  - Cyclic shifted sequences by 4 on different tiles
  - Maintain the same channel correlation within subsequences
  - Give more diversity to Phase vectors
  - Consistent structure with UL HARQ feedback channels

FMT #1

S1	S3	S5	S7	S9	S11
S2	S4	S6	S8	S10	S12

FMT #2

S9	S11	S1	S3	S5	S7
S10	S12	S2	S4	S6	S8

FMT #3

S5	S7	S9	S11	S1	S3
S6	S8	S10	S12	S2	S4

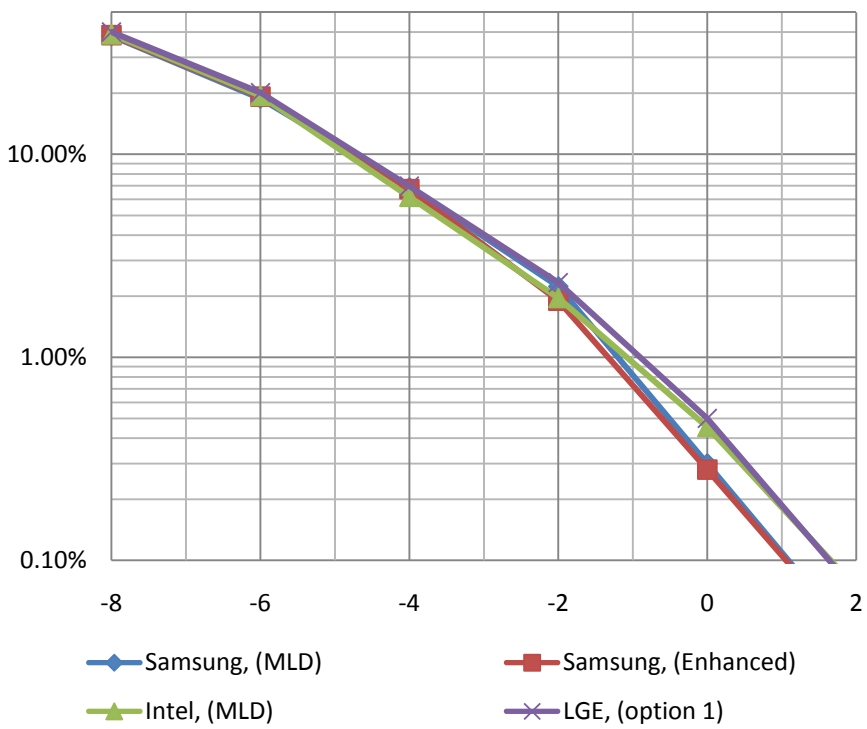
Advanced Receiver for High Mobility

- **Wiener Filter Receiver (LPF Receiver)**
  - Provides significant performance gain in high mobility,
  - Can be applied to all kinds of semi-orthogonal sequences
  - **Requires Prior-knowledge** about channel statistics such as Doppler frequency and SNR
  - Filtering before ML Correlators

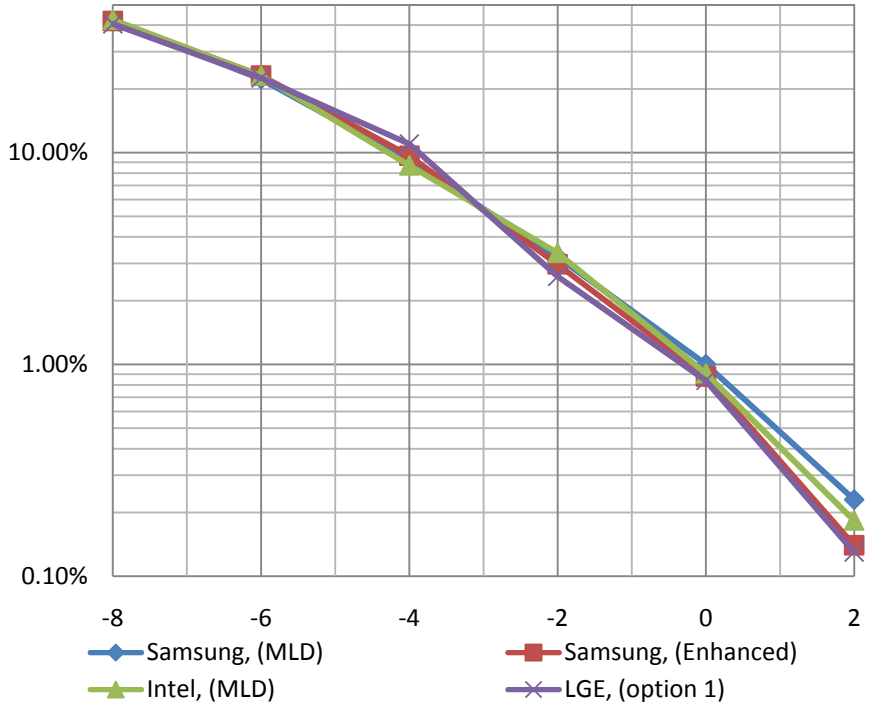
- **Enhanced Receiver for supporting High Mobility**
  - Can improve the detection performance in high mobility,
  - **Doesn't need any prior knowledge** on channel statistics
  - In high mobility case, most of misdetection occur between different phase vectors, not between RS mapping
  - Phase vector correction after ML Correlators
  - See Appendix#1 for details

Detection Performance of Primary FFBCH (i)

- **Ped. B 3km/h**



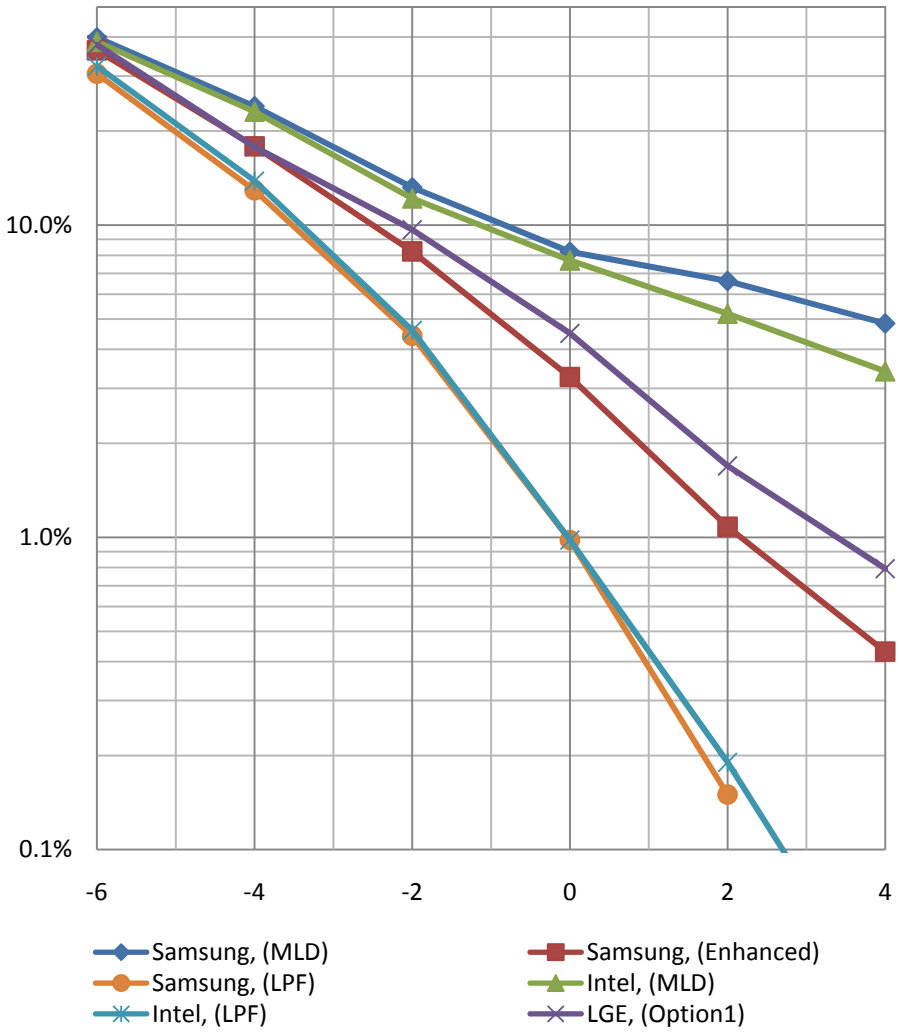
- **Veh. A 120km/h**



- **Remarks on Performance**
  - Samsung's sequence outperforms the others in Ped. B 3km/h
  - All sequences have almost the same performance in Veh A 120km/h.

Detection Performance of Primary FFBCH (ii)

- **Veh. A 350km/h**

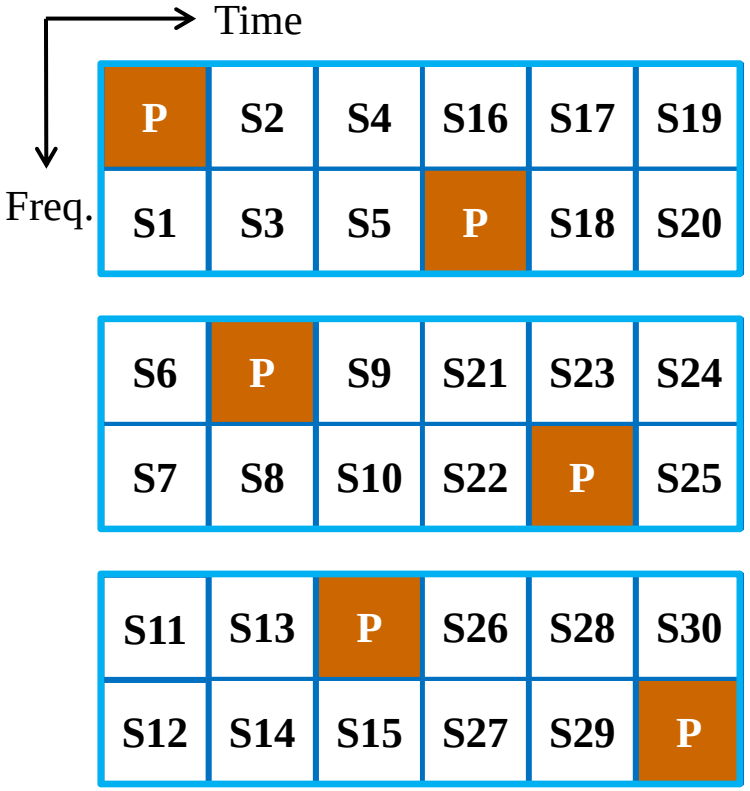


- **Remarks on Performance**
  - Regardless of sequence itself, a receiver with Wiener filter(LPF) improves detection performance
  - Wiener filter receiver requires channel statistics
  - Enhanced receiver improves the performance
  - 1%PER @ SNR 2.2dB

Secondary FFBCH Mapping to FMTs

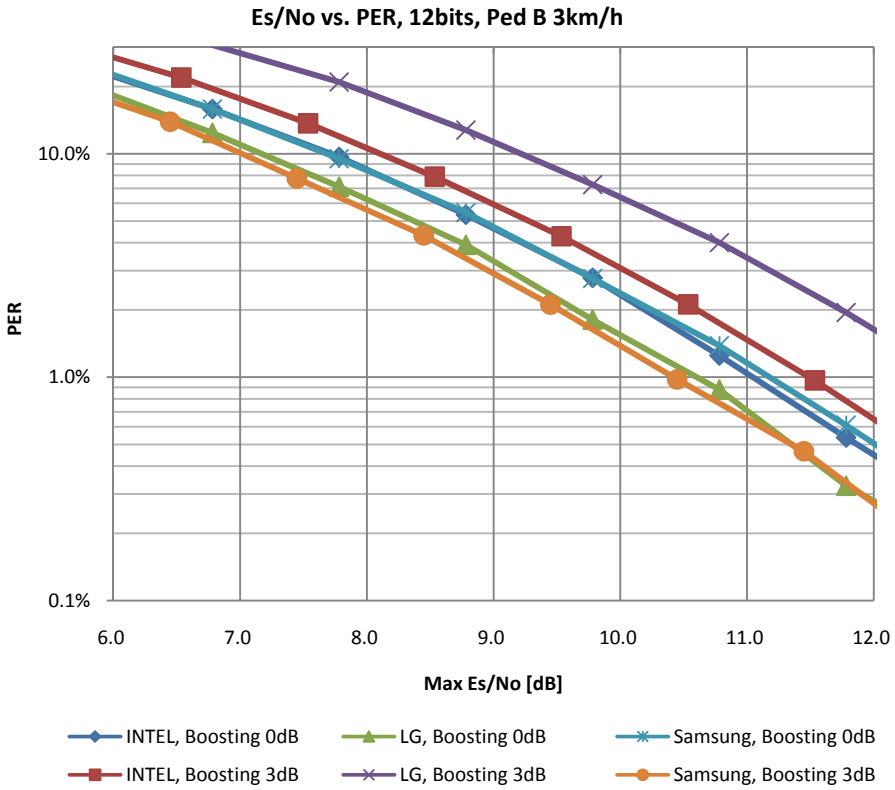
- **Physical Structure**
  - Two Pilots per FMT
  - **Shifted Pilot Position** on different FMT for **Pilot Boosting**

- **Modulation and Coding**
  - 30 QPSK symbols
  - 7~24 information bits
  - Block Code based on (60,12)
    - 7~12 bits: (60,12) block code
    - 13~24 bits: two (30,12) block code

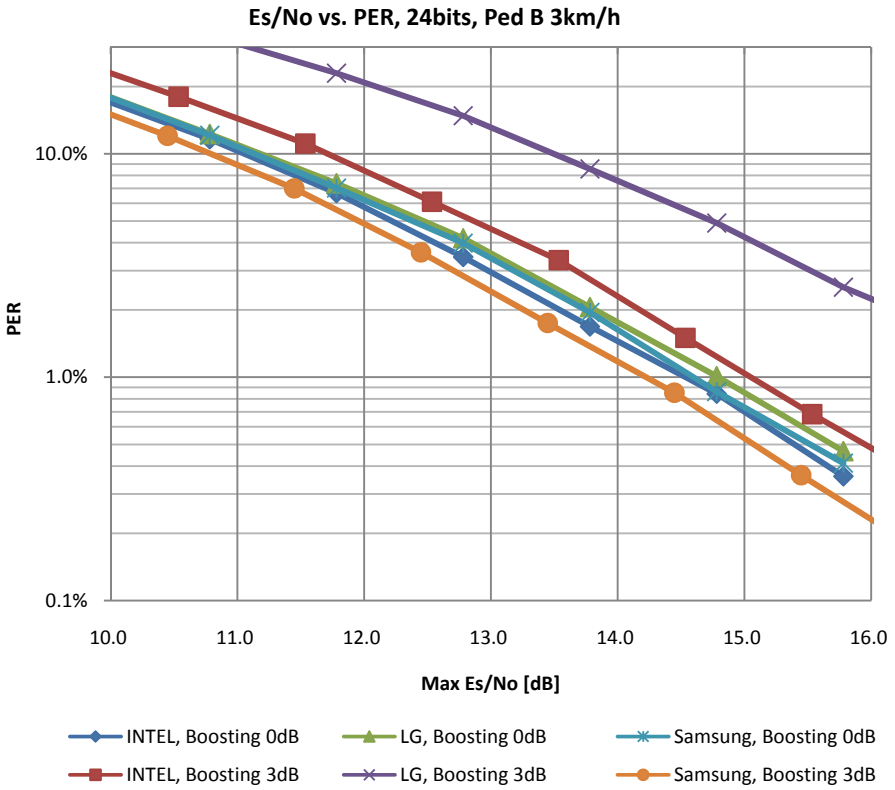


Detection Performance of Secondary FFBCH

- **12 information bits**



- **24 information bits**



- **Remarks on Performance**
  - In terms of max Es/No and pilot boosting, Samsung's structure shows the best performance.

UL ACKCH Mapping to FMTs

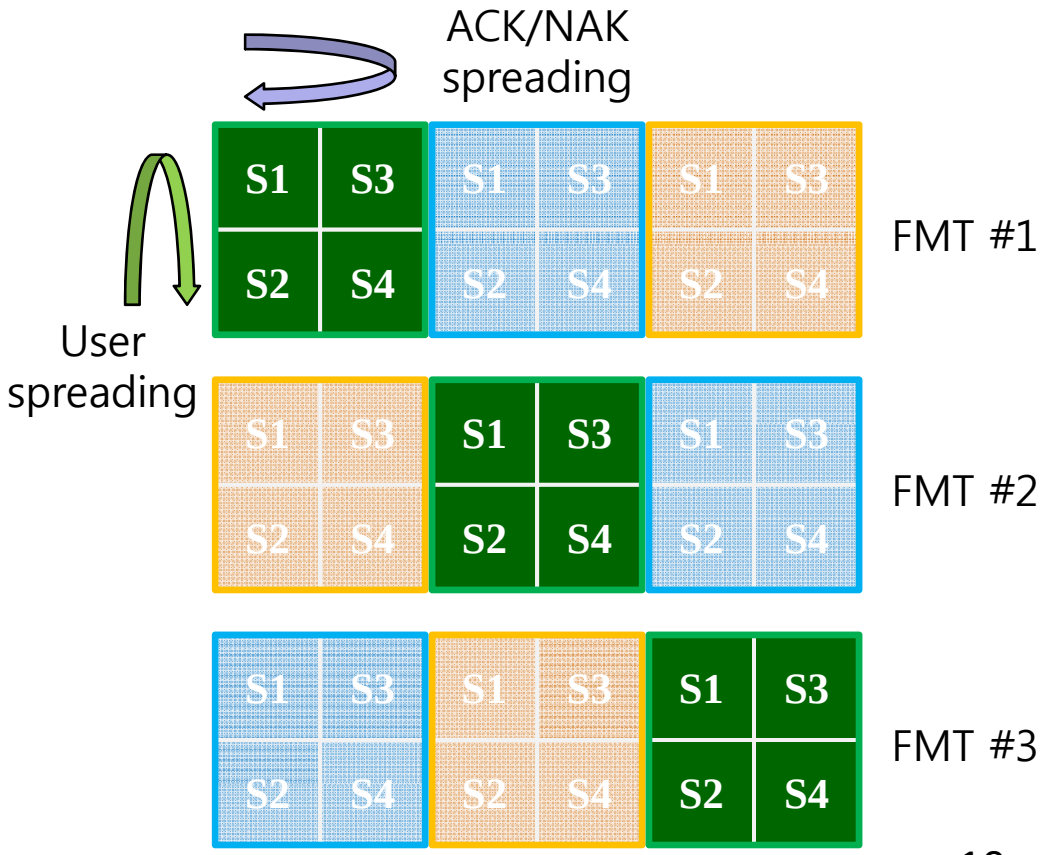
- **Multiplexing for Multiple users' ACKCHs**
  - 2 users are CDM'd within a (2X2) tile
  - 3 FMTs can carries 6 users' UL ACKCHs

User#1 ACK = [+1, +1, +1, +1]

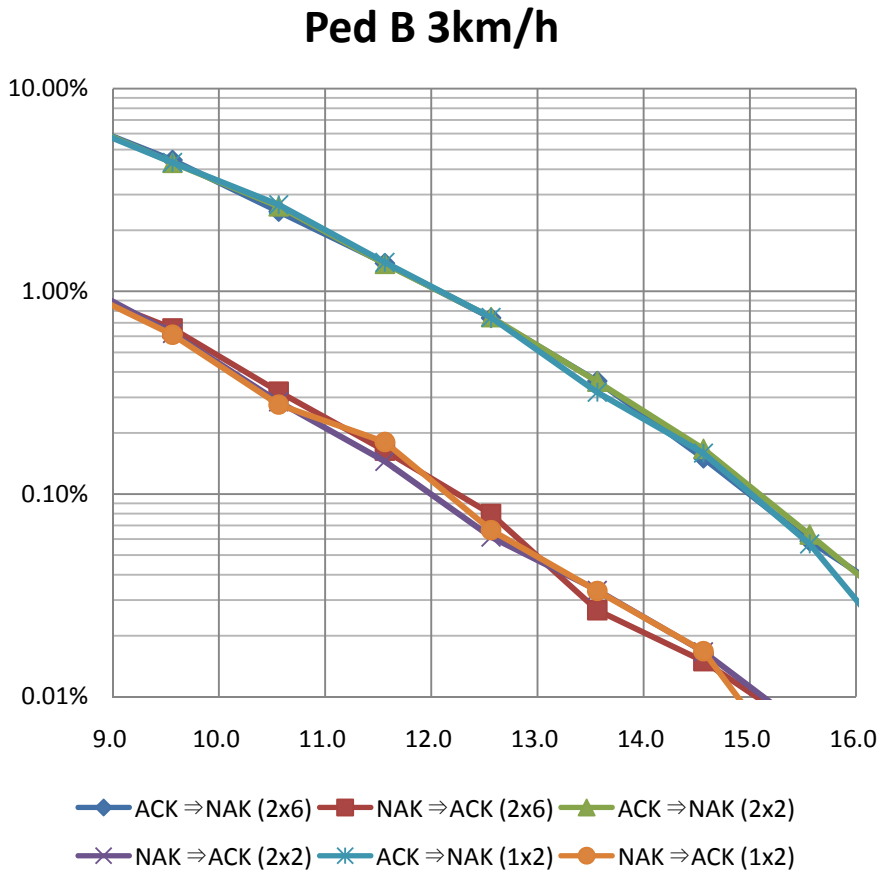
User#1 NAK = [+1, +1, -1, -1]

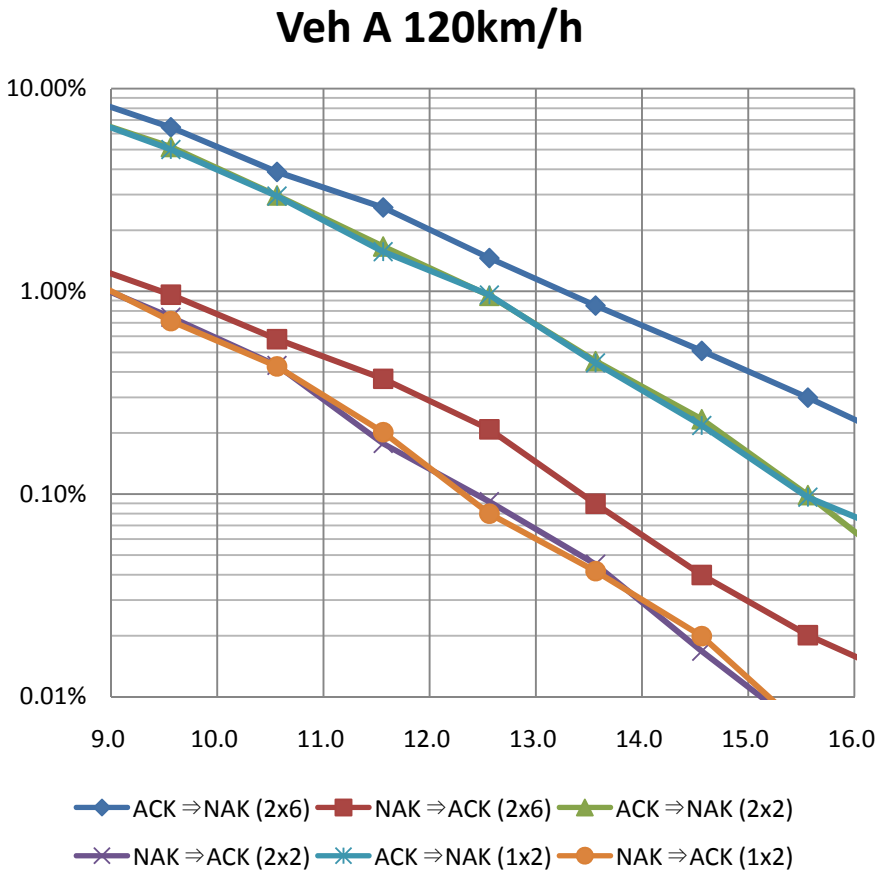
User#2 ACK = [+1, -1, +1, -1]

User#2 NAK = [+1, -1, -1, +1]



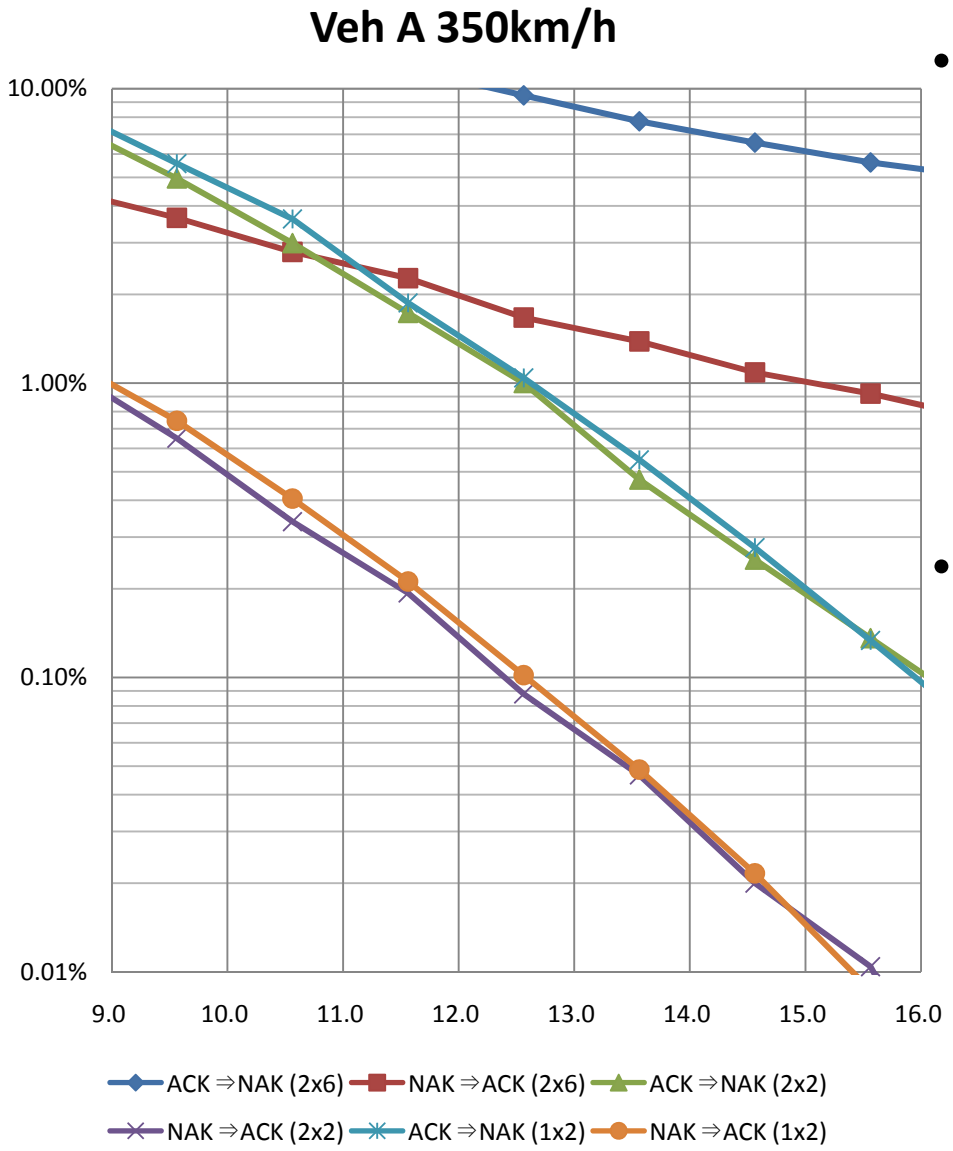
Detection Performance of UL ACKCH (i)





- **Remarks on Performance**
  - Erasure detection is interpreted as NAK
  - (2X6) is worst in Veh A 120km/h

Detection Performance of UL ACKCH (ii)



- **Remarks on Performance**
  - (2X6) tile suffers from error floor
  - (2X2) and (1X2) tiles provide stable performance
  - 1% ACK ⇒NAK and 0.1% NAK ⇒ACK error @ EbNo 12.5dB
- **Other consideration**
  - Too Small tile can introduce severer interference to the adjacent cells
  - Our preference is (2X2) tile for UL ACK

Text Proposal for UL FFBCH (i)

---------- Text Start ----------

11.9.2.1 UL Fast Feedback Channel

11.9.2.1.1 Multiplexing with other control channels and data channel

[Delete and add sentences as following in line 20, page 107]

The UL fast feedback channel carries one or more types of fast feedback information. ~~The use of TDM/FDM or CDM to multiplex fast feedback channels from one or more users is FFS.~~ The UL fast feedback channel is FDM with other control and data channels.

11.9.2.1.2 PHY structure

A UL feedback mini-tile (FMT) is defined as 2 contiguous subcarriers by 6 OFDM symbols. . ~~A UL FMT of 6 contiguous subcarriers by 2 OFDM symbols is FFS.~~

---------- Text End ----------

Text Proposal for UL FFBCH (ii)

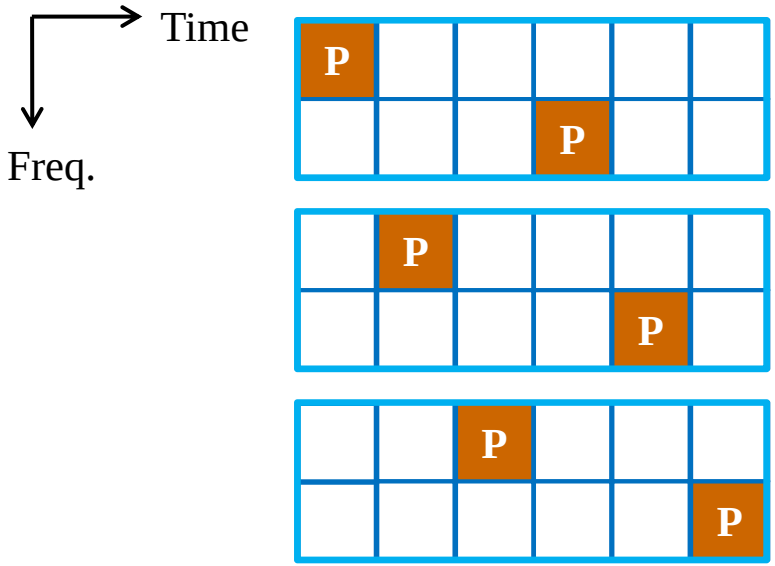
---------- Text Start ----------

11.9.2.1 UL Fast Feedback Channel

11.9.2.1.2 PHY structure

[insert the following in line 29, page 107]

A UL FMT used for Secondary FFBCH has 2 pilots per tile as shown in Fig. xxx.



---------- Text End ----------

Text Proposal for UL ACKCH

---------- Text Start ----------

11.9.2.2 UL HARQ Feedback Channel

11.9.2.2.1 Multiplexing with other control channels and data channels

[Modify the sentence in line 38, page 107 as follows]

~~Orthogonal signaling~~ TDM/FDM/CDM is used to multiplex multiple HARQ feedback channels.

---------- Text End ----------

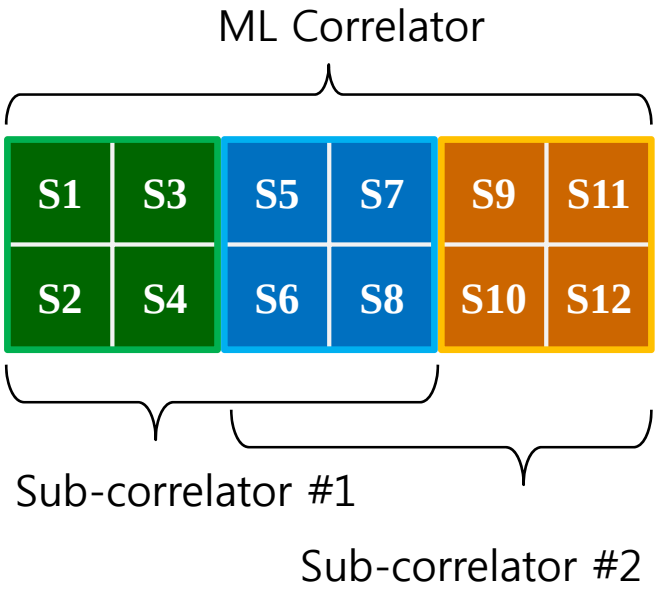
Appendix #1

Enhanced Receiver for High Mobility

- **General ML Detection**
  - Single Full length correlator

$$Z_{l,ML} = \sum_{t} \left| \sum_{k=1}^{12} s_l^*[k] \cdot y_t[k] \right|^2$$

$$\hat{l} = \arg\max_{l} Z_{l,ML}, \quad \hat{p} = \text{floor}(\hat{l}/4), \quad \hat{q} = \text{mod}(\hat{l}, 4)$$



- **Phase Vector Correction**
  - Two Short length correlators
  - p is already obtained from ML Detection
  - Affects only in fast fading conditions

$$Z_{q,PC} = \sum_{t} \left(\left| \sum_{k=0}^{7} s_{\hat{p},q}^*[k] \cdot y_t[k] \right|^2 + \left| \sum_{k=4}^{11} s_{\hat{p},q}^*[k] \cdot y_t[k] \right|^2 \right)$$

$$\hat{q}_{PC} = \arg\max_{q} \left(Z_{\hat{l},ML}, Z_{q,PC} \right)$$

Appendix #2

Channel Coding for Secondary FFBCH

- **Generating Matrix of Block Code (60,12)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	1	0
2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	1	1	1
3	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1	0	1	0	0	0	1
4	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	1	1	1	0	0
5	0	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	0	1	0
6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	1	1
7	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	1	0	1	1
8	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	1	0
9	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	1	0	0
10	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	1	1	1	1	0	0	1
11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	1	1	1	0
12	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0

	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
1	1	0	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	0	1	0	0	1
2	0	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	1	1	0
3	1	1	0	1	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0
4	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	1	1	0	0	0
5	1	1	0	1	0	1	0	1	1	0	1	0	1	0	0	1	0	1	1	0	0	1	1	0	0	1	0	0	0	0
6	1	0	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	1	1
7	0	0	0	0	1	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	1
8	1	1	1	1	1	1	1	0	1	1	0	0	0	1	0	1	1	0	1	0	0	0	1	0	0	0	0	1	1	1
9	0	1	1	1	0	0	1	0	1	1	0	0	1	0	1	0	1	0	1	0	1	1	0	1	0	0	0	0	1	0
10	0	0	1	0	0	0	1	1	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	1
11	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	1	1	0	0
12	0	0	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0	0	0	0	1	1