Pilots Design in Mobility Zones for Uplink MIMO in IEEE802.16m

Yang-Han Lee, Yih-Guang Jan, *Chao-Chung Huang, Jheng-Yao Lin, Hsien-Wei Tseng
Department of Electrical Engineering, Tamkang University
Taipei, Taiwan
huacc121@gmail.com

Abstract: In this paper, it considers uplink pilots design for various resource block types in IEEE 802.16m when a mobile travels in different mobility. When using pilots in the estimation of channel impulse response, the system performance, in terms of bit error rate (BER), is simulated and analyzed versus various pilot densities and pilot patterns. From these simulation results it will provide the system designer a design guide in the optimal selection of pilots when a mobile is moving in different mobility.

1 INTRODUCTION

Based on the Mobility-Zone (MB-Zone) structure as proposed in "propose for uplink pilots design in IEEE 802.16m" [1] and when pilots are used in the channel impulse response estimation, we propose a pilots design algorithm in the MB-Zone The system performance, in terms of bit error rate (BER), is simulated when pilot patterns as proposed in [1-7] are considered. In the proposed pilot design method the 'fundamental pilot structure' is maintained but only the pilot densities are varied when a mobile is moving with different mobility.

2 BASIC SIMULATION PARAMETERS

The basic simulation parameters considered in the paper are listed in Table I [8-12].

TABLE I SIMULATION PARAMETERS

Parameter	Baseline
Carrier Frequency	2.5GHz
System BW	10MHz
Channel Model	Vehicle A. with 3km/hr, 120km/hr, 350km/hr
Channel Coding	Not Use
Antenna Configuration	2 x 2 MIMO
Modulation and Coding	QPSK
Resource Allocation	1. 9 symbols * 4 subcarriers, 4*9 2. 9 symbols * 9 subcarriers, 9*9 3. 18 symbols * 6 subcarriers, 6*18 4. 18 symbols * 12 subcarriers,12*18 5. 18 symbols * 18 subcarriers,18*18
Pilot Tone Boost	2.5dB over data tone
Channel Estimation	MMSE

2.1 Frame Structure in Different Mobility Zone

The frame in different mobility zone, MB Zone, for 802.16m has the structure as shown in Fig.1 [1]. When pilots are used in the estimation of channel impulse response and then when the estimated channel impulse is used as the system channel impulse response the resulting system BER vs. SNR has the results as shown in Fig. 2. It reveals from these simulation results that in order to maintain the same system performance the high mobility users need to use a higher density pilots in the resource block while with lower density pilots for low mobility users. In the figure we also include the results when the pilot patterns proposed for high mobility users, e.g. for 350 km/hr, are also implemented for the 3 km/hr and 120 km/hr mobility users, their results are identified in the figure by a prefixing with HM, e.g. HM@3km/hr is for MS with 3 km/hr, it appears that it has around 1 dB gain in SNR comparing with the results when these low mobility mobiles are equipped with their respective low density pilots.

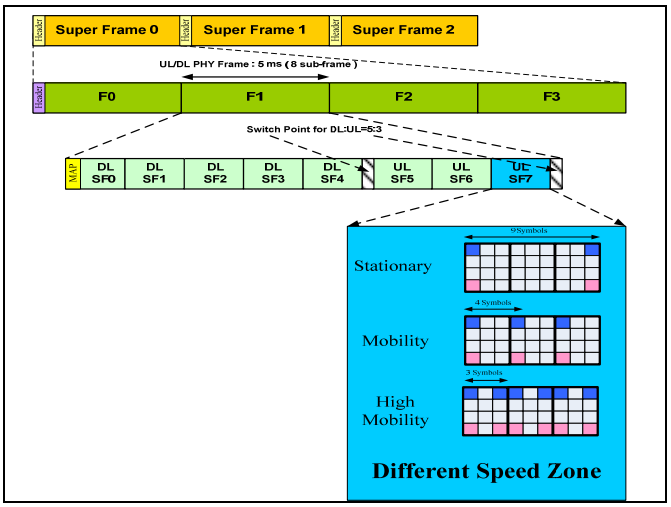

Figure 1 Frame Structure and Pilot Patterns in Various Mobility Zones.

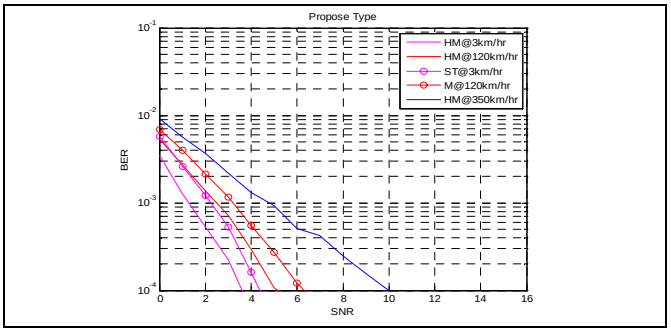

Figure 2 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Considered

3 SIMULATION OF VARIOUS PILOTS TYPES

3.1 Type A Resource Block

As shown in Fig. 3 is an illustration of Type A Resource Block (RB) with possible pilot locations as proposed in [1]; in

Fig. 4 it depicts the resulting pilot structures for this resource block type in various mobility zones. With the pilot patterns as proposed in Fig. 4 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 5 In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the structure proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

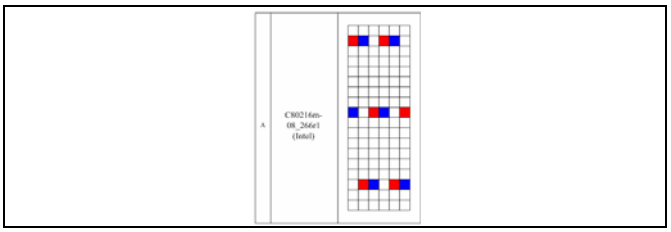

Figure 3 Type A RB

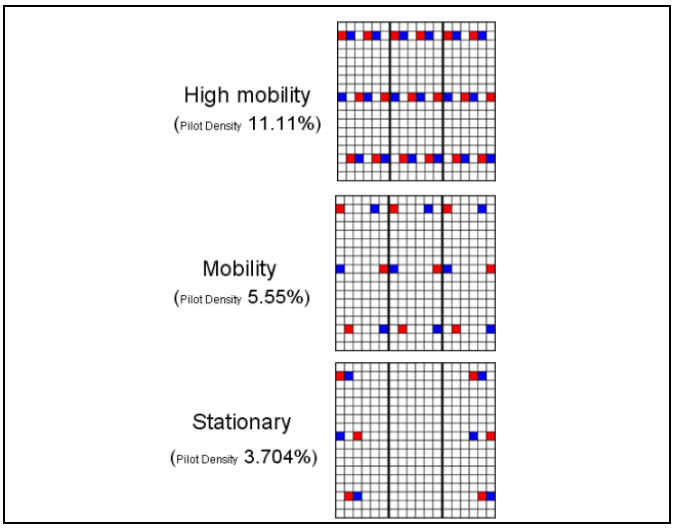

Figure 4 Pilot Patterns in Various Mobility Zones for Type A RB

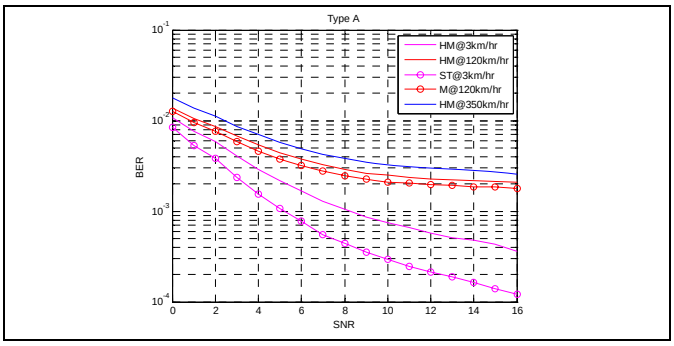

Figure 5 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Implemented for Type A RB

3.2 Type B Resource Block

As shown in Fig. 6 is an illustration of Type B Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 7 it depicts the resulting pilot structures for this pilot type in various mobility zones. With the pilot patterns as proposed in Fig. 7 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 8 In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

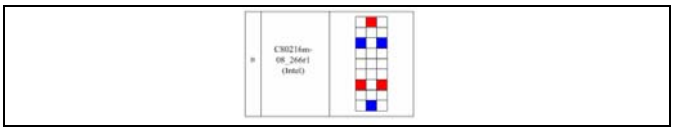

Figure 6 Type B RB

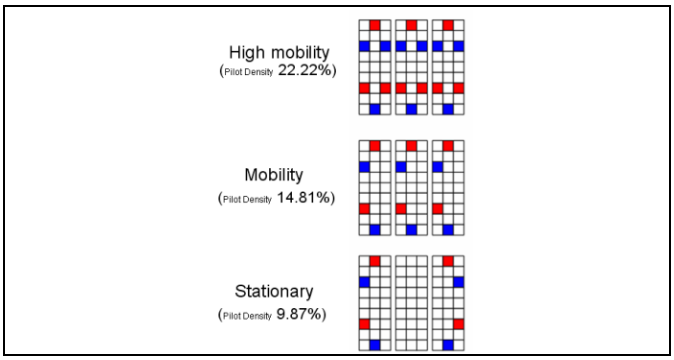

Figure 7 Pilot Patterns in Various Mobility Zones for Type B RB

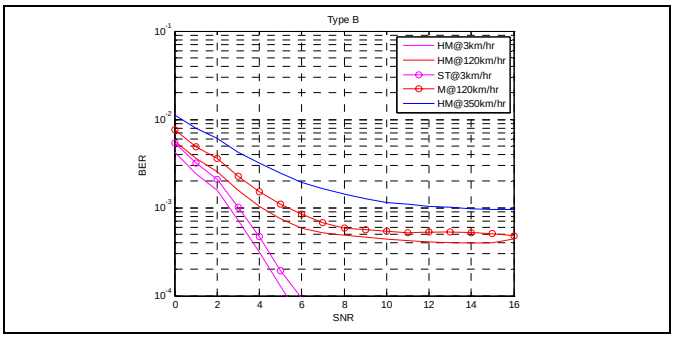

Figure 8 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Implemented for Type B RB

3.3 Type C Resource Block

As shown in Fig. 9 is an illustration of Type C Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 10 it depicts the resulting pilot structures of this resource type in various mobility zones. With the pilot patterns as proposed in Fig. 10 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 11 In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it

concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

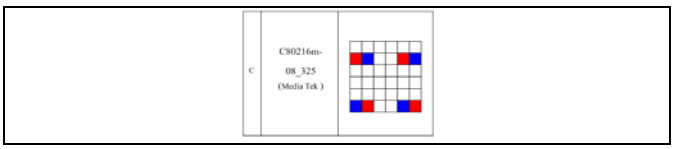

Figure 9 Type C RB

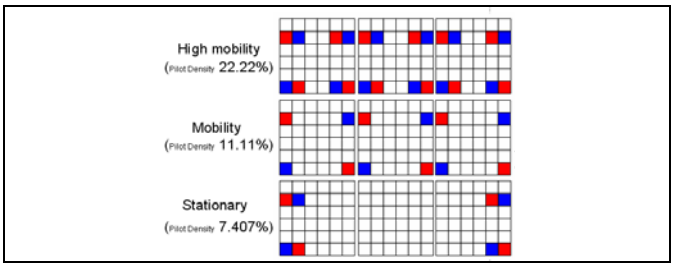

Figure 10 Pilot Patterns in Various Mobility Zones for Type C RB

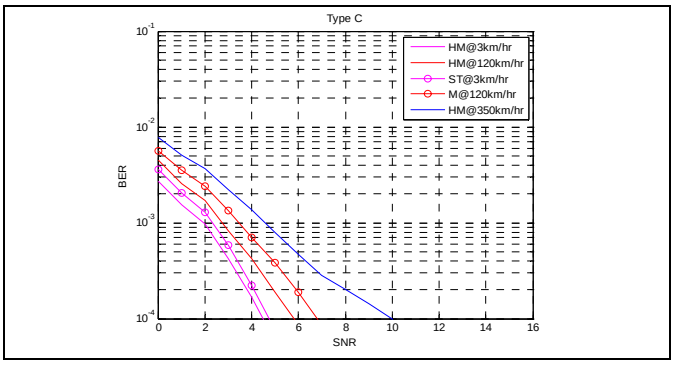

Figure 11 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Implemented Type C RB

3.4 Type D Resource Block

As shown in Fig. 12 is an illustration of Type D Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 13 it depicts the resulting pilot structures for this type of resource block in various mobility zones. With the pilot patterns as proposed in Fig. 13 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 14 In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

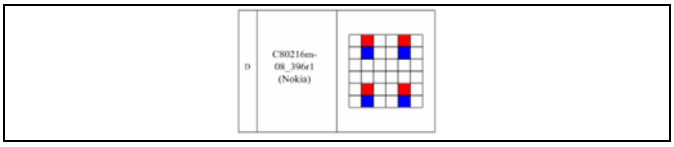

Figure 12 Type D RB

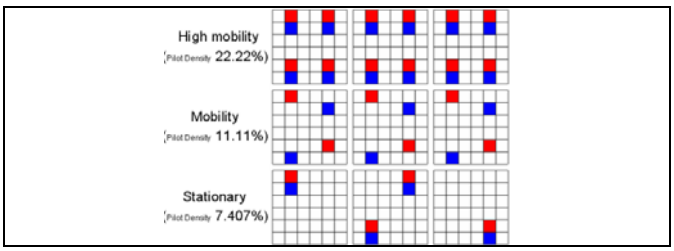

Figure 13 Pilot Patterns in Various Mobility Zones for Type D RB

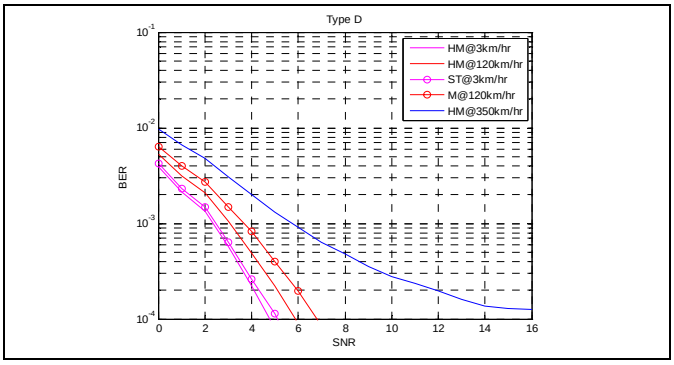

Figure 14 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Implemented for Type D RB

3.5 Type E Resource Block

As shown in Fig. 15 is an illustration of Type E Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig.16 it depicts the resulting pilot structures for this resource block type in various mobility zones. With the pilot patterns as proposed in Fig. 16 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 17. In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

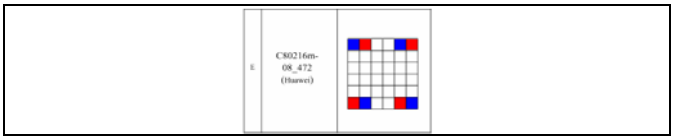

Figure 15 Type E RB

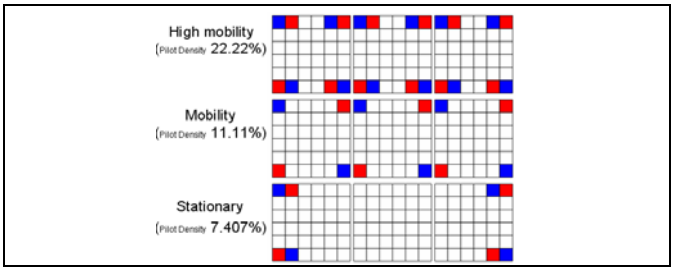

Figure 16 Pilot Patterns in Various Mobility Zones for Type E RB

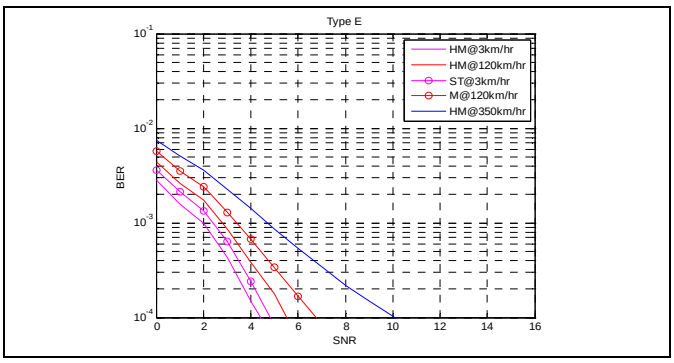

Figure 17 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Implemented for Type E RB

3.6 Type F Resource Block

As shown in Fig. 18 is an illustration of Type F Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 19 it depicts the resulting pilot structures for this type of resource block in various mobility zones. With the pilot patterns as proposed in Fig. 19 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 20. In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

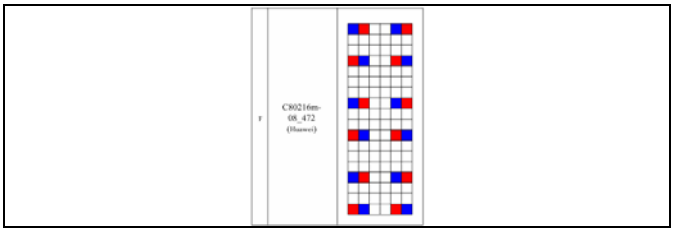

Figure 18 Type F RB

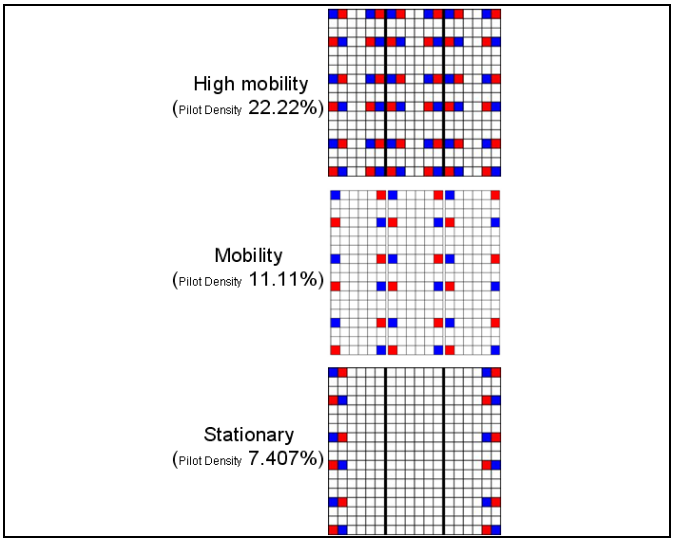

Figure 19 Pilot Patterns in Various Mobility Zones for Type F RB

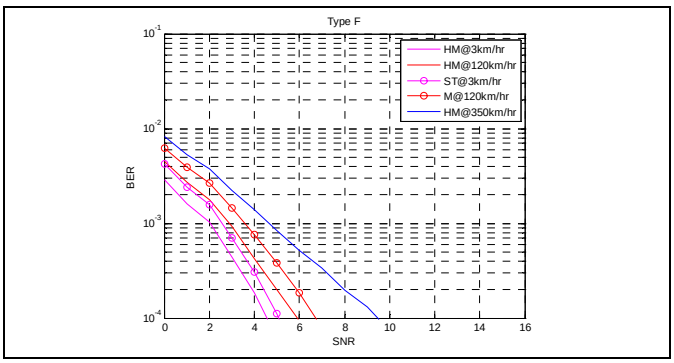

Figure 20 Simulation Rresult when Proposed Uplink Pilots in Various Mobility Zones are Implemented for Type F RB

3.7 Type G Resource Block

As shown in Fig. 21 is an illustration of Type F Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 22 it depicts the resulting pilot structures of this resource block type in various mobility zones. With the pilot patterns as proposed in Fig. 22 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 23. In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

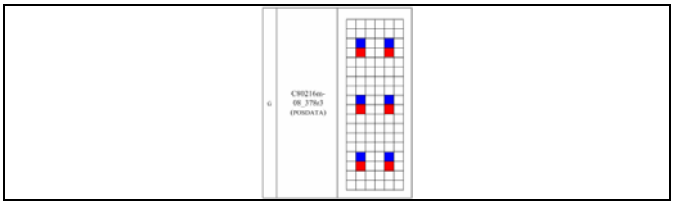

Figure 21 Type G RB

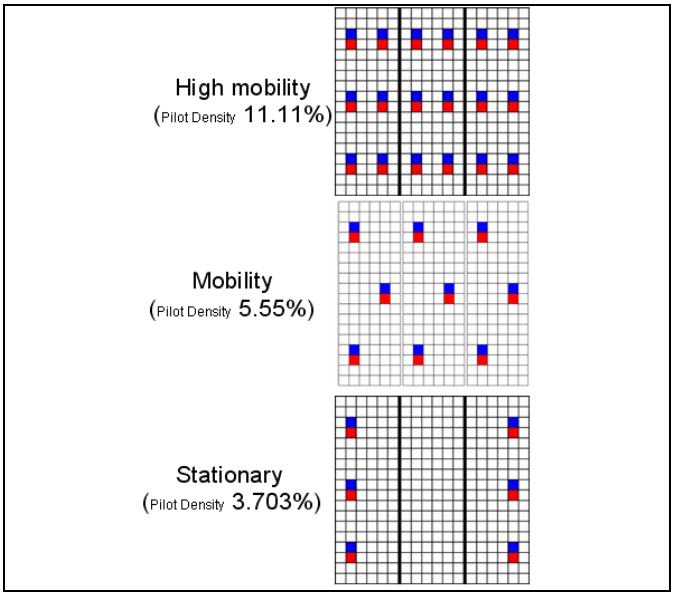

Figure 22 Pilot Patterns in Various Mobility Zones for Type G RB

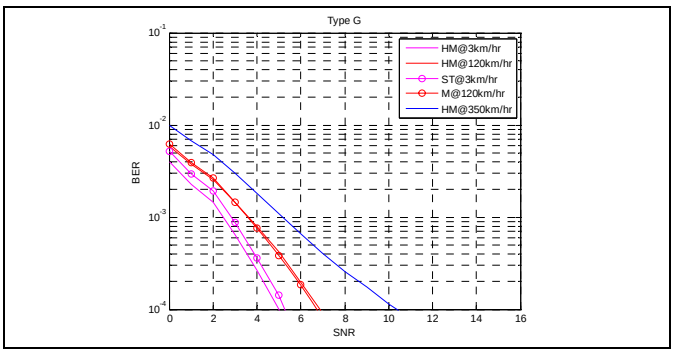

Figure 23 Simulation Result when Proposed Uplink Pilots in Various Mobilit Zoes are Implemented for Type G RB

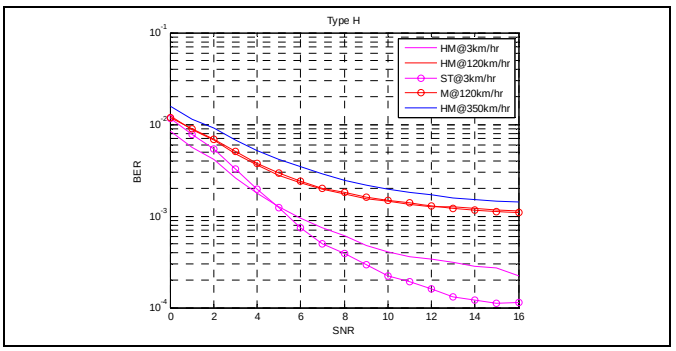

Figure 26 Simulation Result when Proposed Uplink Pilots in Various MobilityZzones are Implemented for Type H RB

3.8 Type H Resource Block

As shown in Fig. 24 is an illustration of Type H Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 25 it depicts the resulting pilot structures of this resource block type in various mobility zones. With the pilot patterns as proposed in Fig. 25 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 26. In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

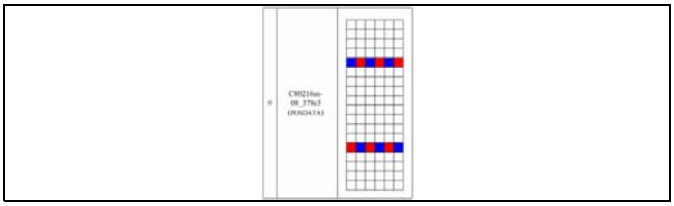

Figure 24 Type H RB

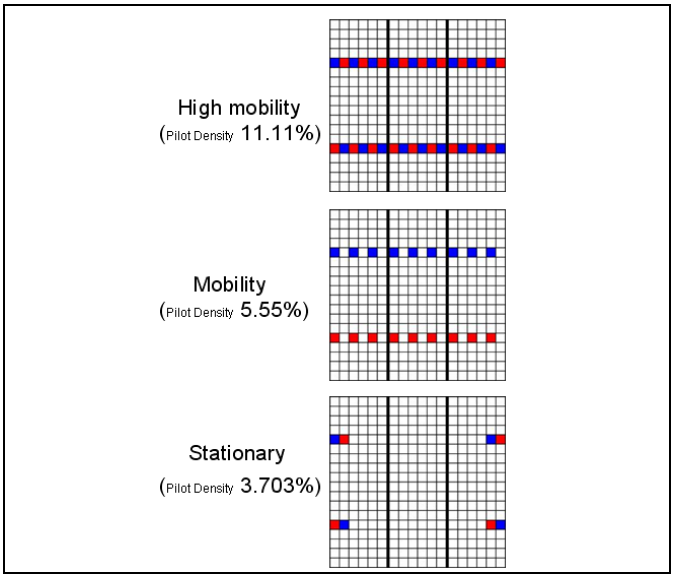

Figure 25 Pilot Patterns in Various Mobility Zones for Type H RB

3.9 Type I Resource Block

As shown in Fig. 27 is an illustration of Type I Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 28 it depicts the resulting pilot structures for this resource block type in various mobility zones. With the pilot patterns as proposed in Fig. 28 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 29. In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

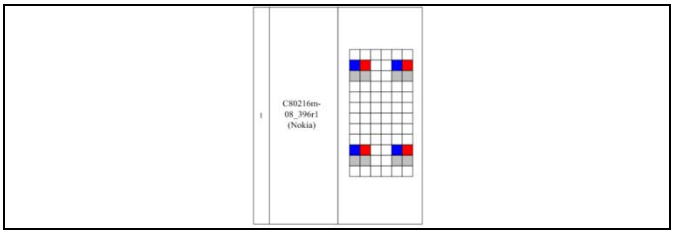

Figure 27 Type I RB

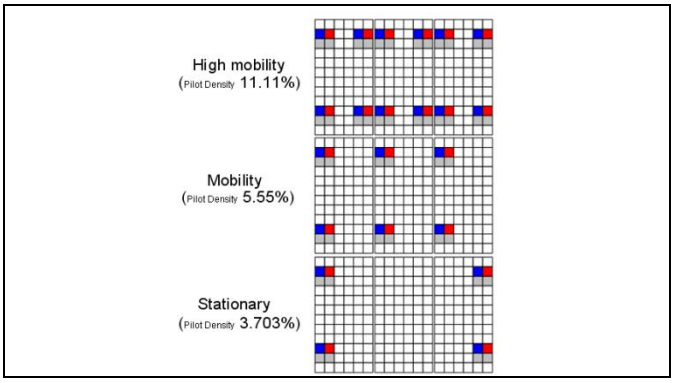

Figure 28 Pilot Patterns in Various Mobility Zones for Type I RB

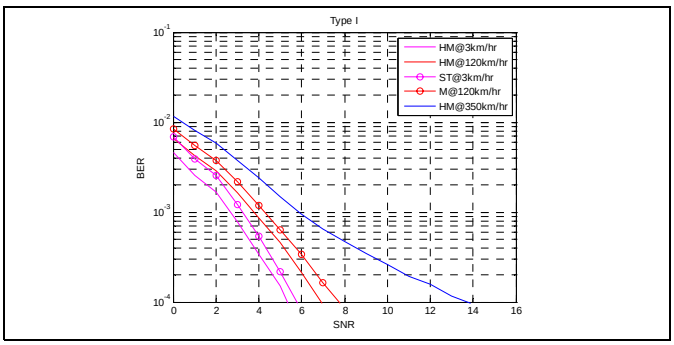

Figure 29 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Implemented for Type I RB

3.10 Type J Resource Block

As shown in Fig. 30 is an illustration of Type J Resource Block (RB) with possible pilot locations as proposed in [1]; in Fig. 31 it depicts the resulting pilot structures for this resource block type in various mobility zones. With the pilot patterns as proposed in Fig. 31 for mobiles at speed of 3 km/hr (low mobility), 120 km/hr (medium mobility) and 350 km/hr (high mobility) it has the simulation result as shown in Fig. 32. In the figure it also includes the simulation when the pilots proposed for high mobility is implemented for 3 km/hr and 120 km/hr mobility zones, their results are identified by a prefixing with HM, e.g. HM@3km/hr is for mobile at 3 km/hr and its pilot pattern uses the same structure as proposed for the 350 km/hr mobility zone. From the simulation results it concludes that in order to maintain the same system performance in all mobility zones it needs to include more pilots in high mobility zone than the number of pilots implemented in the low mobility zone.

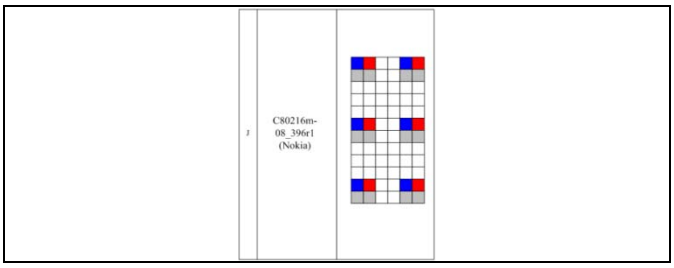

Figure 30 Type J RB

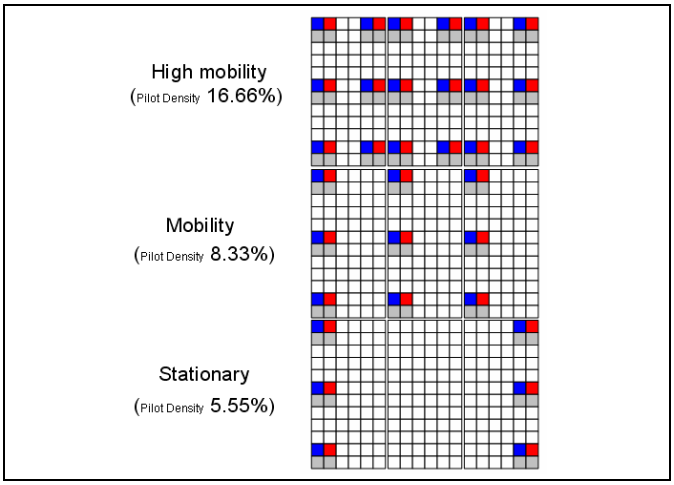

Figure 31 Pilot Patterns in Various Mobility Zones for Type J RB

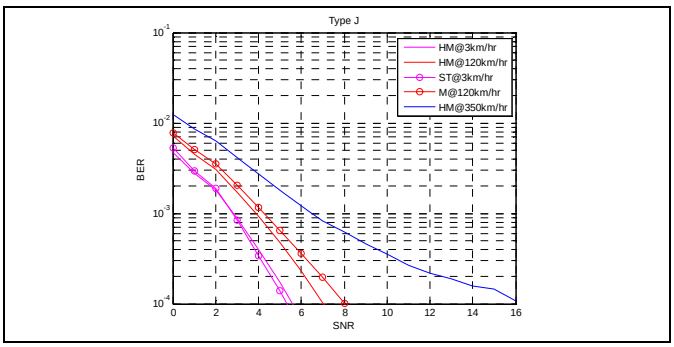

Figure 32 Simulation Result when Proposed Uplink Pilots in Various Mobility Zones are Implemented for Type J RB

4 CONCLUSION

In this paper several types of resource blocks that are to be implemented as the information blocks for IEEE802.16m are introduced. Pilots are inserted in particular locations of the resource block that are used for a mobile user in its network entry synchronization and in the channel response estimation. When pilots are used in the channel impulse response estimation and the resulted estimated channel impulse response is adopted as the true channel response the system performance, in terms of bit error rate (BER), is simulated and studied versus various pilot patterns proposed for the IEEE 802.16m. From these simulation results it will give the system designer a design algorithm in the selection of optimal pilots for mobile users when mobile are moving in various mobility zones.

ACKNOWLEDGMENT

This work was supported in part by National Science Council, Taiwan, Republic of China, under Grant No. NSC 97-2219-E-002-017, NSC97-2221-E-032-027-MY3, NSC 97-2221-E-032-002-MY2 and this study is conducted under the "A plan to actively participate in international standard organizations for wireless communications" of the Institute for Information Industry which is subsidized by the Ministry of Economy Affairs of the Republic of China.

REFERENCE

[1] IEEE C802.16m-08/444r2, Yih-Guang Jan, Yang-Han Lee, Ming-Hsueh Chuang, Hsien-Wei Tseng, Jheng-Yao Lin, Hsi-Chun Tseng, Po-Jung Lin, Ting-Chien Wang, "Propose for Uplink Pilot Design in IEEE 802.16m"

[2] IEEE C80216m-08_266r1, Yuval Lomnitz , Huaning Niu, Jong-kae (JK) Fwu, Sassan Ahmadi , Hujun Yin , Intel Corp., "UL symbol structure design for 802.16m -- symbol structure and pilot design"

[3] IEEE C80216m-08_325, Chih-Yuan Lin, Pei-Kai Liao, Ciou-Ping Wu, and Paul Cheng, "Design Considerations of Pilot Structures for Uplink MIMO Transmission"

[4] IEEE C80216m-08_396r1, Jianfeng Kang, Chao Wei, Xin Qi et. al., NSN & Nokia, "Uplink Physical Resource Allocation Unit (Resource blocks and Symbol Structures)"

[5] IEEE C80216m-08_472, Hongjie Si, Xin Chang, Qi Li, Zhigang Rong, Jianmin Lu, "Uplink Pilot Structures"

[6] IEEE C80216m-08_378r3, Dongjun Lee, Zhengzi Li, Jungnam Yun, Jaehyeong Kim, "Pilot Structures as relevant to Uplink MIMO".

[7] IEEE C80216m-08_396r1, Jianfeng Kang, Chao Wei, Xin Qi et. al., NSN & Nokia, “Uplink Physical Resource Allocation Unit (Resource blocks and Symbol Structures)”

[8] P. Komulainen and M. Latva-aho, **“**Multiuser MIMO transceiver strategy for TDD Uplink and downlink in time-varying channel,” Speech and Signal Processing, pp. 3141 - 3144, March 31 2008-April 4 2008

[9] Zhihua Shi, Haitong Sun, Chunming Zhao and Zhi Ding, “Linear precoder optimization for ARQ packet retransmissions in centralized multiuser MIMO uplinks,” Wireless Communications, pp. 736 - 745, February 2008

[10] S.P. Alex and L.M.A. Jalloul, “Performance Evaluation of MIMO in IEEE802.16e/WiMAX,” Selected Topics in Signal Processing, pp. 181 - 190, April 2008

[11] Deog-Su Han; Ji-Hoon Lee; Young-Min Seung and Sung-Joon Cho, “Performance Analysis of System Architecture using Wireless Relay Station and Virtual MIMO in WiBro Uplink,” Advanced Communication Technology, 2008. ICACT 2008, pp. 1935 - 1939, 17-20 Feb. 2008

[12] P. Komulainen, M. Latva-aho and M. Juntti, “Block diagonalization for multiuser MIMO TDD downlink and uplink in time-varying channel,” Smart Antennas, 2008, pp. 74 - 81, 26-27 Feb. 2008