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Title	**OFDMA PHY Enhancements for Ranging**
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Source(s)	John Liebetreu, Jeff Foerster, Jose Puthenkulam, Randall Schwartz, David Johnston, Hassan Yaghoobi, Intel Corporation Panyuh Joo, Seungjoo Maeng, Jaeho Jeon, Soonyoung Yoon, Jeong-Heon Kim, Jaehyok Lee, Myungkwang Byun, JeongTae Oh, Wonil Roh, Inseok Hwang, Jaehee Cho, Sanghoon Sung, Hun Huh, Jiho Jang, Ikbeom Lee, HeeSang Seo, Sijun Cho, Chiwoo Lim, Youngbin Chang, Jaeweon Cho, Jaeyoel Kim, Sung-Eun Park, Samsung Electronics Co. Ltd. Naftali Chayat, Tal Kaitz, Mohammed Shakouri, Vladimir Yanover, Marianna Goldhammer, Alvarion Ltd. Shawn Taylor, Gordon Antonello, Ron Murias, Lei Wang, Wi-LAN Inc. J. Pierre Lamoureux, Frank Draper, Jon Labs, Rainer Ullmann, Wavesat Wireless Inc Martin Lysejko, Ofer Kelman, David Castelow, Airspan Raja Banerjea, Don Leimer, Proxim Inc Phil Barber, Broadband Mobile Technologies Dale Branlund, Lalit Kotecha, Mike Webb, BeamReach Networks
Re:	Working Group Review of P802.16-REVd_D3
Abstract	
Purpose	To propose enhancements to the OFDMA PHY in 802.16REVd_D3 draft for better ranging performance in a broad set of channel widths.
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OFDMA PHY Ranging Enhancements

Introduction

In this contribution we propose enhancements to the WirelessMAN OFDMA PHY in the ranging operation. The purpose of up-link ranging is to synchronize each SS to the BS timing. For guaranteed ranging performance, it is required that more than a certain number of tones should be placed in continues tones. It is found that if the ranging tones are placed in contiguous block of frequency bands then as the size of the frequency block increases, the performance of ranging detection is improved. However, current 802.16d OFDMA ranging process requires up-link subchannels in the up-link frame. The subchannelization method is such that the blocks of frequency assignment for the ranging channel is not possible. Also, the ranging channels are transmitted in the same symbol time with other SS's data introducing severe interference from ranging signal, which are not time aligned, to other data channel. To mitigate this problem, specific ranging symbol period is introduced where only ranging signal and other heavily coded control signal such as CQI and ACK are transmitted. The subchannelization of this control symbol period is such that contiguous blocks of frequency assignment for the ranging channel possible (see control channel subchannelization in the newly proposed 802.16 standard).

With the proposed ranging scheme, the interference of ranging signals to to other data channel can be minimized since all of the ranging process is time limited to the first 3 non data bearing symbols of up-link frame.

OFDMA Ranging

In the OFDMA PHY, 4 ranging modes are defined-initial ranging, periodic ranging, bandwidth request (BR) ranging and hand off (HO) ranging. These 4 ranging modes are differentiated by code and time slot. Initial ranging and HO ranging time slot is allocated to the first two OFDMA symbol period in the up-link frame and periodic ranging and BR ranging time slot is the immediately following one OFDMA symbol period. Users are allowed to collide on these ranging channels by random ranging access with randomly selected code. Minimum number of tones for ranging is 32 and all of the above ranging channels use the same frequency band blocks defined in the CQI subchannelization. Except the frequency band, all the other ranging parameters (number of code, number of bits for each code) are system parameter determined at the initial system deployment. The frequency band is cell specific parameters determined in the CQI subchannelization. There shall be no difference in the number of bits for the code and number of tones used for each of 4 ranging modes.

Initial-ranging and HO ranging transmissions

The initial ranging transmission shall be used by any SS that wants to synchronize to the system channel for the first time and HO ranging transmission shall be used by any SS that wants to synchronize to other BS while in the HO process. An initial ranging and HO ranging transmission shall be performed during first two consecutive symbols in the up link frame using minimum of 32 tones The same ranging code is transmitted on the ranging channel during each symbol, with no phase discontinuity between the two symbols. A time-domain illustration of the initial ranging and HO ranging is shown in Figure 1.

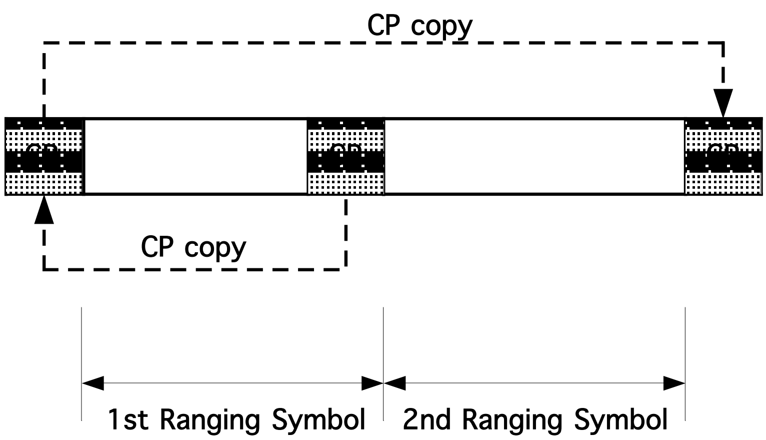

Figure 1 – Initial and HO ranging transmission for OFDMA

Periodic-ranging and bandwidth-request transmissions

Periodic ranging transmissions are sent periodically for system periodic ranging. Bandwidth requests transmissions are for requesting uplink allocations from the BS. These transmissions shall be sent only by SS that have already synchronized to the system.

To perform either a periodic ranging or bandwidth request transmission, the SS shall modulate randomly selected one ranging code on the minimum of 32 ranging tones for a period on one OFDMA symbol immediately following initial ranging symbols in the uplink frame. A time-domain illustration of the periodic ranging or bandwidth-request transmission is show in Figure 2.

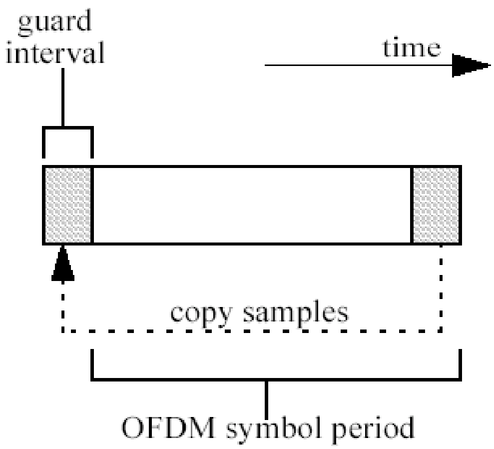

Figure 2 – Periodic ranging or bandwidth request transmission for OFDMA

Ranging codes

Several number of codes are assigned for each of ranging mode. Users are allowed to collide on these ranging channels by random ranging access with randomly selected code. Minimum number of tones for ranging is 32 and all of the above ranging channels use the same frequency band blocks defined in the control symbol subchannelization. Except the frequency band, all the other ranging parameters (number of code, number of bits for each code) are system parameter determined at the initial system deployment. The frequency band is cell specific parameters determined in the control symbol subchannelization. There shall be no difference in the number of bits for the code and number of tones used for each of 4 ranging modes.

The binary codes are the pseudonoise codes produced by the PRBS described in figure 15.. The codes for each ranging channel (initial, HO, BR and periodic) is generated by the polynomial $1+x^1+x^4+x^7+x^{15}$ and the PN mask for cell identification is generated by a M-sequence generator. The binary ranging codes are subsequences of the pseudonoise sequence appearing at its output. The length of each ranging code is minimum 32 bits to maximum 256 bits.

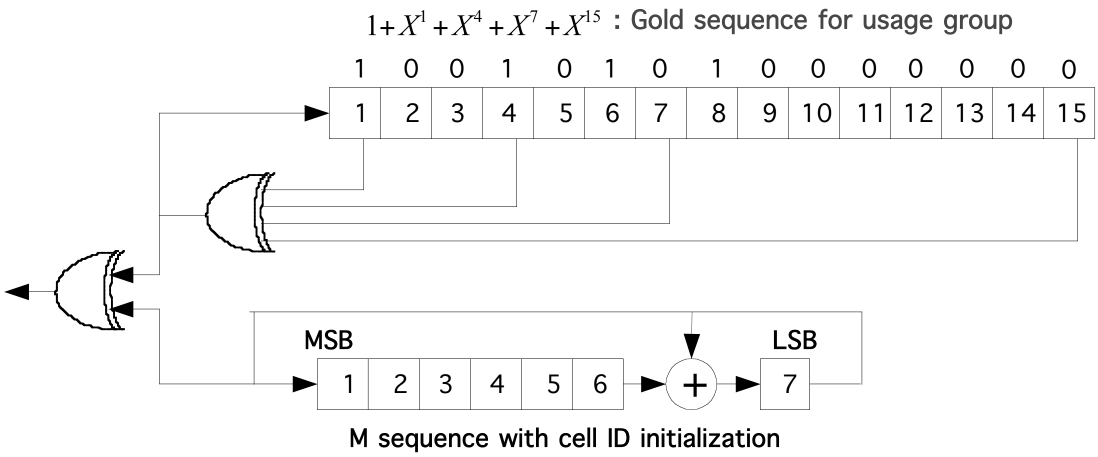

Figure 3 – PRBS for ranging code generation

The first K 256 bit code obtained by clocking the PN generator as specified is used for initial ranging. The next L ranging code produced by taking the output of the $(256xK+1)^{th}$ to $(256x(K+L)^{th}$ clock of the PRBS is used for HO ranging. Following the HO ranging code, the next M codes each of length 256 bits are used for periodic ranging and the next N codes are used for bandwidth requests. Each ranging code is masked by the cell specific code before transmission. This masking code is a M-sequence depicted in Figure 3. The M-sequence generator register is initialized by 7 bits cell identification number. The cell identification number is a system parameter which is indicated in the SICH.

Actual number of bits (minimum 32 bits to maximum 256 bits) used for the ranging is a system parameter fixed at the system deployment. The number of tones (hence the number of code bits) used for ranging as well as the number of code for the ranging is determined at the initial system deployment.

-The first K codes produced (length 256 bits) is for initial ranging

-The next L code produced is for HO ranging

-The next M codes produced are for periodic ranging

-The next N codes produced are for bandwidth request

The BS can separate colliding codes for periodic ranging and bandwidth request.

SS transmits the ranging code with the power adjustment by open loop power control. This will make the BS received signals' power from each SS approximately the same, hence improving the detection probability of the ranging code.

Ranging Performance

For the performance improvement, the tones for initial ranging should be contiguous blocks. A simple simulation result is shown to compare the initial ranging detection performance between proposed scheme and scattered tones. Here, total of 128 tones are used for initial ranging and the performance of proposed subchannelization band of 128 ranging tones is compared with the randomly scattered 128 tones over 1024 frequency bins. For the simulation was carried out with 3GPP2 vehicular B channel model with C/I assumed to be -3dB and the ranging detection condition to be within 10% of the CP length. As shown from the simulation result, the detection performance of initial ranging is better with the proposed tone placing. It is expected that a single contiguous block of 128 tone would perform better. However, the control symbol subchannelization is needed to mitigate inter cell interference by reducing hit ratio between subchannels. This subchannelization design approach resulted in the blocks of contiguous tones for ranging channel instead of one single frequency block. The proposed control channel subchannelization results in four 24 contiguous tone blocks and four 8 contiguous tone blocks.
The proposed ranging scheme has two advantage over current 802.16d ranging scheme. One is the ranging detection performance improvement and the other is the reduced interference to data signals transmitted by other SSs.

Table 1. Detection performance of proposed subchannelization

Veh B 60km/h				
CP 10%	Threshold	Pd(%)	Pf(%)	Pm(%)
	0.1	0.8983	0.0008	0.1009
	0.15	0.7	0	0.3
	0.2	0.4562	0	0.5438
	0.25	0.3013	0	0.6987

Table 2. Detection performance of scattered tone placement

Veh B 60km/h				
CP 10%	Threshold	Pd(%)	Pf(%)	Pm(%)
	0.1	0.5008	0.0035	0.4957
	0.15	0.2249	0.0001	0.775
	0.2	0.089	0	0.911
	0.25	0.0436	0	0.9564