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Title	**Short Initial-Ranging Transmission for IEEE 802.16e OFDMA**
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Re:	Task Group Review of IEEE 802.16e-03/07r3
Abstract	This contribution is to propose a modification in the length of the initial-ranging transmission for OFDMA.
Purpose	Task group approval of the modification.
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Short Initial-Ranging Transmission for IEEE 802.16e OFDMA

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Introduction

This document is to propose a modification to the initial-ranging transmission of IEEE 802.16e-03/07r3 and IEEE Std 802.16a™-2003 to improve the initial-ranging performance.

Problem Statement

Arrival timings of initial-ranging signals at a BS are not subject to be aligned with the OFDM symbol timing at the BS. The only information each SS under initial-ranging has is the received downlink OFDM symbol timing, which the initial-ranging signal is to be aligned with. Therefore, the initial-ranging signals from the SS's very close to the BS arrive at BS with little timing offset while the initial-ranging signals from the outermost SS's on the cell boundary arrive at BS with a timing offset equal to the round trip delay. The current draft specifies the initial-ranging transmission to last for two OFDM symbol times by repeating itself without phase discontinuity as shown in Figure 1 in order to guarantee a full continuous-phase signal over the intended OFDM symbol epoch[1] for successful detection and timing offset estimation of the initial-ranging transmission. Figure 2 shows a favorable example, where the initial-ranging transmissions from different SS's are either modulated with different ranging codes or separated by more than an OFDM symbol time. The RNG-A, RNG-B, and RNG-C respectively denotes the initial-ranging transmissions from SS's A, B, and C.

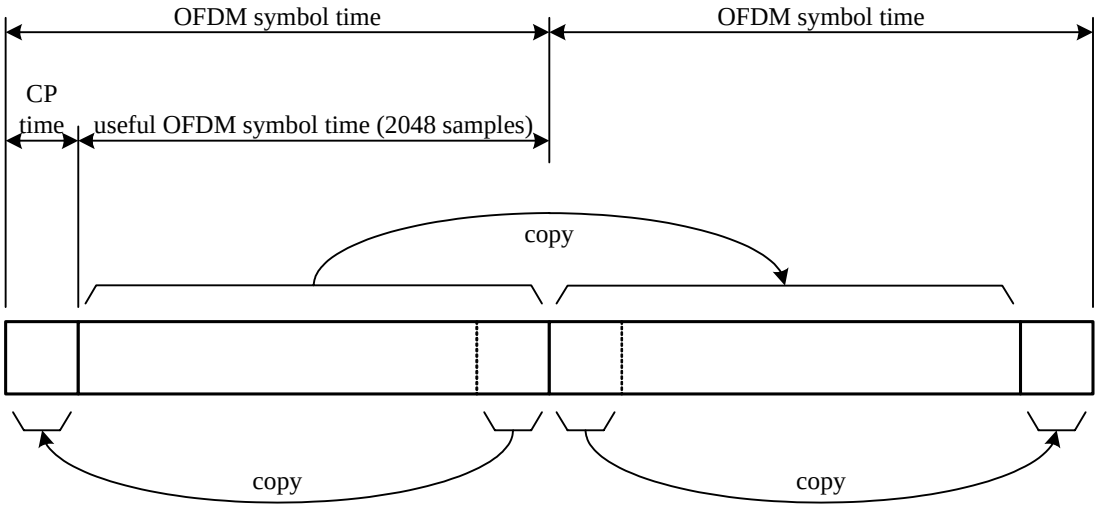

Figure 1. Initial-ranging transmission for OFDMA in the current draft.

[1] An SS randomly chooses success two OFDM symbol epochs within the data region allocated for initial-ranging. Denoting them as the *k*th and (*k*+1)st OFDM symbol epochs for an integer *k*, In this document, the "intended OFDM symbol epoch" denotes the *k*th OFDM symbol epoch at the BS. Note that an SS can only expect that the portion of the signal arriving at the BS during the *k*th OFDM symbol epoch is guaranteed to be successfully detected since the initial-ranging signal ends before the end of the (*k*+1)st OFDM symbol epoch due to the path delay between the BS and the SS, for which we denote the *k*th OFDM symbol epoch as "intended."

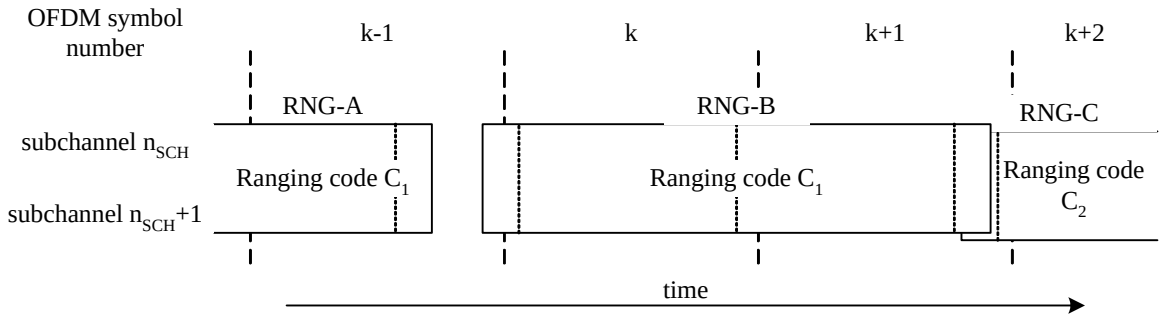

Figure 2. Favorable example of initial rangin transmissions.

On the other hand, if we denote the index of the intended OFDM symbol epoch by *k* as in Figure 2, the portions of a initial-ranging transmission in the (*k*–1)st and the (*k*+1)st OFDM symbol epochs incur interferences to other uplink transmissions, especially ranging transmissions. In the case when the round trip delay is less than a half of an OFDM symbol time, which would be typical in most practical cases, the long but incomplete portion in the (*k*+1)st OFDM symbol epoch can cause significant interference to other uplink transmissions.

Let us consider the example shown in Figure 3, where three different SS's initiate initial-ranging at three successive OFDM symbol epochs with an identical ranging code. Ideally, all three initial-ranging transmission should be successfully detected since the SS's have chosen three different epochs. However, with the current design of initial-ranging transmission, the incomplete portions of RNG-B and RNG-C in the (*k*+1)st and (*k*+2)nd OFDM symbol epochs degrade the detection of RNG-C and RNG-D, respectively.

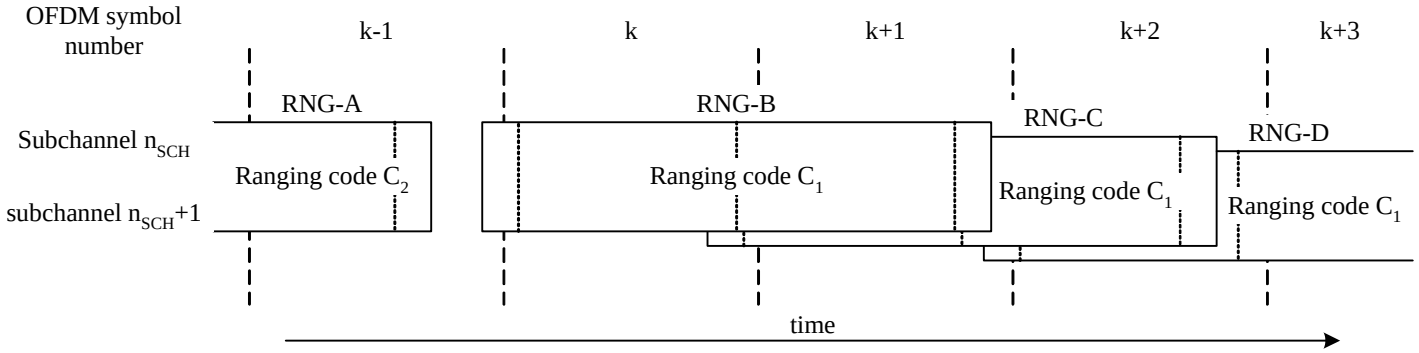

Figure 3. Example of successive initial-ranging transmissions adjacent in time.

Proposed Initial-Ranging Transmission for OFDMA

Unlike the preceding portion of the initial-ranging transmission in the (*k*–1)st OFDM symbol epoch, the portion in the (*k*+1)st OFDM symbol epoch can be shortened to reduce the interference to other uplink transmissions. Since the only purpose of the second repetition in initial-ranging transmission is to guarantee a complete continuous-phase signal during the intended OFDM symbol epoch at the BS, the length of the initial-ranging transmission have only to be T_s+2×MAX_DLY, where T_s denotes the OFDM symbol time and MAX_DLY denotes the maximum propagation delay between the BS and an SS within the cell. MAX_DLY shall be equal to the round trip delay between the BS and the outermost SS on the cell boundary or larger. The length of the initial-ranging transmission is limited to $2T_s$. Figure 4 shows the proposed initial-ranging transmission for improvement in initial-ranging performance.

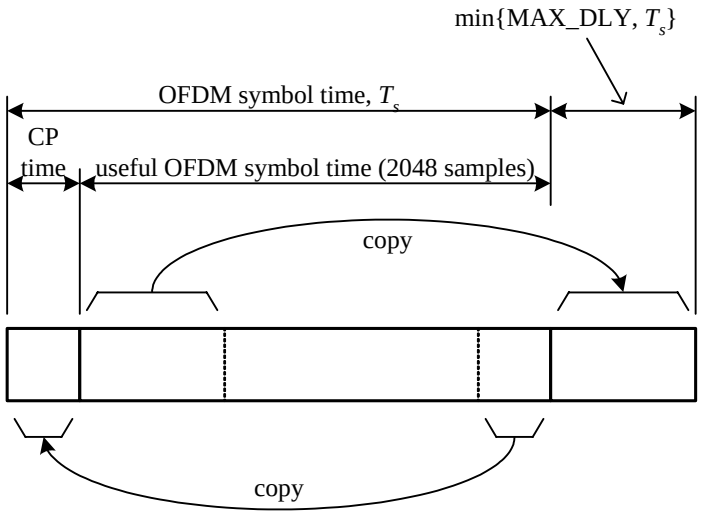

Figure 4. Proposed initial-ranging transmission for OFDMA

We also propose two means to let all the SS's in a cell have the value of MAX_DLY: First, we can define another TLV encoded DCD channel information on MAX_DLY; Second, MAX_DLY can be replaced with TTG since TTG is larger than the maximum round trip delay for the cell.

Proposed Text Changes

One of the following two proposals could be taken with the proposed short initial-ranging transmission:

Proposal #1:

Replace Figure 128bc with Figure 4, and delete the second and the third sentences in 8.5.7.1 so that 8.5.7.1 would read as follows:

"The initial-ranging transmission shall be used by any SS that wants to synchronize to the system channel for the first time. A time-domain illustration of the initial-ranging transmission is shown in Figure 128bc."

Also add the following row to Table 124:

Table 124–DCD channel encoding

Name	Type (1 byte)	Length	Value (variable length)	PHY scope
MAX_DLY	15	1	Maximum propagation delay between the BS and an SS within the cell	OFDMA

Proposal #2:

Replace Figure 128bc with the revised Figure 4, with "MAX_DLY" replaced with "TTG" and delete the second and the third sentences in 8.5.7.1 so that it would read as follows:

"The initial-ranging transmission shall be used by any SS that wants to synchronize to the system channel for the first time. A time-domain illustration of the initial-ranging transmission is shown in Figure 128bc."

Conclusions

The advantages of employing the proposed initial-ranging transmission are as follows:

(1) The ambiguities do not occur in timing offset estimation of initial-ranging signals;
(2) The success probability of initial-ranging is improved by reducing the interference to other initial-ranging signals;
(3) The BER performances of uplink data bursts is improved by reducing the interference to them.

References

[1] IEEE Std 802.16-2001, “Part 16: Air Interface for Fixed Broadband Wireless Access Systems.”

[2] IEEE Std 802.16a-2003, “Part 16: Air Interface for Fixed Broadband Wireless Access Systems – Amendment 2: Medium Access Control Modifications and Additional Physical Layer Specifications for 2–11 GHz.”

[3] IEEE 802.16e-03/07r3, “Part 16: Air Interface for Broadband Wireless Access Systems – Amendment 4: Mobility Enhancements.”