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Title	**Unique Randomizer Initialization for Interference Management in 802.16 OFDM PHY**
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Re:	IEEE 802.16-REVd/D3-2004
Abstract	Describes changes to initialization vector for randomizer in OFDM-256 PHY.
Purpose	These changes will provide for improved detection of error at the PHY level in low reuse networks.
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Unique Randomizer Initialization for Interference Management in 802.16d OFDM PHY

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1. Introduction

While not mandated by the 802.16 standard, it is anticipated that any large-scale network rollout will include synchronization of all base stations to a common timing signal. In particular, it is highly recommended that TDD networks have a common downlink and uplink frame timing to reduce and control intracell interference. In such a deployment, downlink bursts will be transmit by different basestations with the same start time and duration, as will uplink bursts by different user terminals. In this configuration, there is significant likelihood that strongly interfering signals may be demodulated and mistaken for 'desired' signals.

In the event that either a base station or subscriber station mistakenly decode an overlapping burst from an out-of-cell transmission, there should be good support in the standard to provide for detection at the PHY/MAC level of this type of error. In the downlink direction, although the downlink MAP announces the BSID each frame, there is nothing to explicitly tie the subsequent burst transmissions to that particular BSID. In the uplink direction, there is no way to differentiate bursts transmit by a desired user terminal and interfering user terminals, and when an interfering burst is received with sufficient SINR it will supplant the burst from the desired user terminal. Furthermore, an AAS basestation is capable of resolving multiple simultaneous uplink user signals based on spatial characteristics; once this is done, however, there needs to be a way to associate each of these signals with the correct user. To support this functionality unique training between users (as in [1]) has already been recommended, and we further recommend a connection-based error detection scheme, also at the PHY/MAC level.

The most common means of avoiding these problems is to arrange for an incorrectly identified burst to fail the CRC checksum test. This may be realized by making the randomization process of the 802.16d OFDM PHY [2] dependent on parameters unique to the base station and the specific connection to the subscriber station. In this case a mistaken reception of a burst from an unintended party (base station of subscriber station) will not be successfully unrandomized, and a detectable CRC error will result.

2. Conceptual Description of Standards Modification

The current randomization (scrambling) process for the 802.16 OFDM PHY is performed by a modulo-2 addition to each uplink or downlink data burst with a pseudo-random binary sequence output from a linear feedback shift register as described in 8.3.3.1 of [2].

The shift register is 15 bits long, with a seed value that is initialized at the beginning of each frame on the downlink, and again at the beginning of each downlink burst (not including burst #1). On uplink, the randomizer seed is initialized at the beginning of each burst. Preambles are not scrambled.

In order to create a randomization that is dependent on both base station and the connection, we introduce modifications to this seed value. For the preambles and broadcast portion of the downlink frame (FCH and burst #1) we recommend maintaining the fixed constant seed value as currently defined. For all other downlink bursts and all uplink bursts, we recommend that a combination of base station ID, DIUC/UIUC and frame number form the seed value for the shift register, rather than the current combination of DIUC/UIUC and symbol number.

The base station ID is a 48-bit value with the upper 24 bits being the operator ID, and the lower 24 bits used to identify the base station, while the frame number is 24 bits long. We recommend that the new randomizer seed values be formed from the lowest 4 bits of the base station ID, 4 bits of DIUC/UIUC and the lowest 4 bits of frame number.

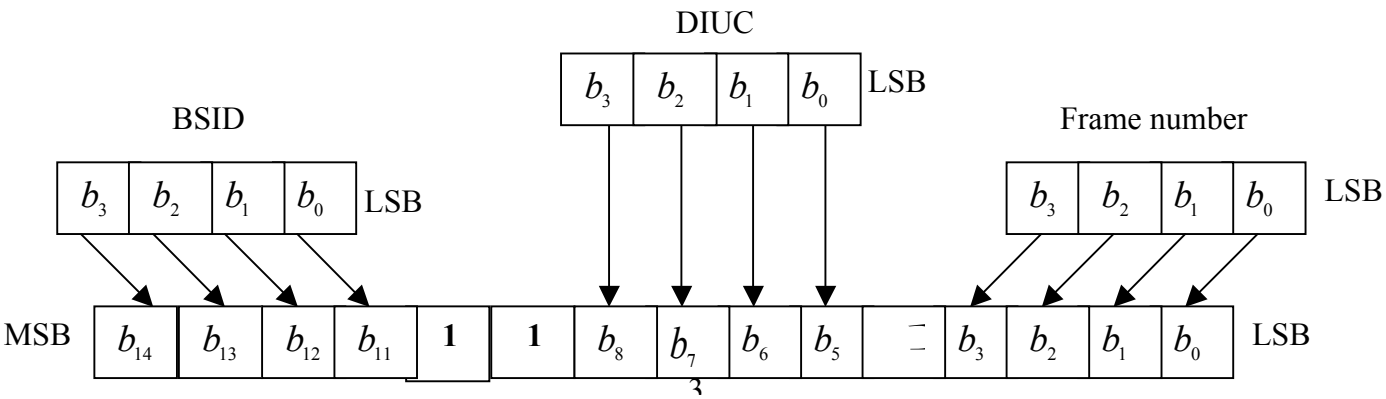
3. Proposed Text

The following changes to section 8.3.3.1 will incorporate these ideas:

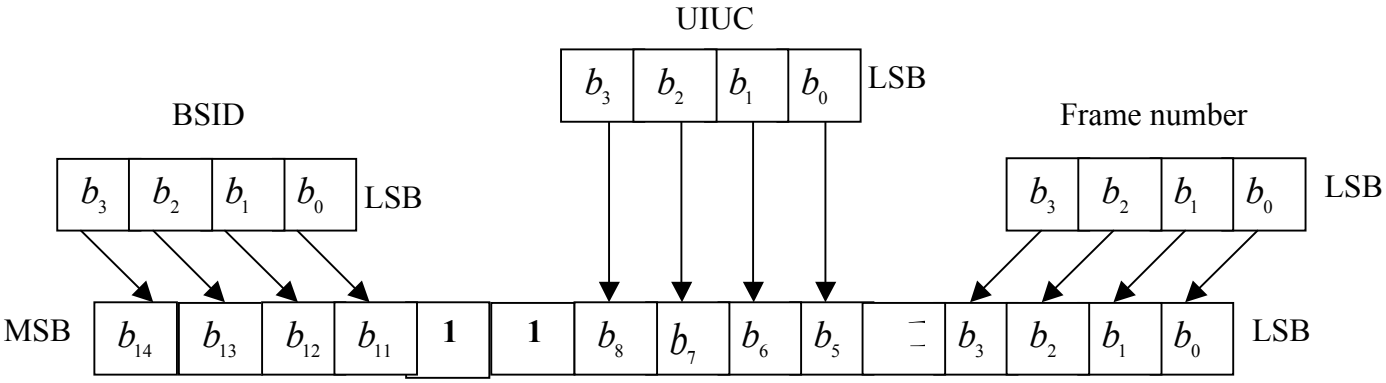
1) The paragraph immediately above Figure 192 is changed to read:
"On the downlink, the randomizer shall be re-initialized at the start of each frame with the vector: 1 0 0 1 0 1 0 1 0 0 0 0 0 0 0. The randomizer shall not be reset at the start of burst #1. At the start of subsequent bursts, the vector shown in Figure 192 shall be used to initialize the randomizer. ~~The OFDM symbol number (i.e. the number of the first OFDM symbol of the data burst) shall be counted from the start of the DL-subframe, the first symbol being counted as symbol #0~~. The frame number used for initialization refers to the frame in which the start of the downlink burst is transmitted."

2) The paragraph immediately above Figure 193 is changed to read:
"On the uplink, the randomizer is initialized with the vector shown in Figure 193. ~~The OFDM symbol number (i.e. the number of the first OFDM symbol of the allocation) shall be counted from the time instant pointed by Allocation Start Time field of the UL-MAP, the first symbol being counted as symbol #0~~. The frame number used for initialization refers to the frame in which the start of the uplink burst is transmitted."

3) Figure 192 is replaced with:



4) Figure 193 is replaced with:



OFDM Scrambler Initialization Vector

4. References

[1] IEEE C802.16d-03/62r1Training for AAS, Naftali Chayat, Tal Kaitz and John Liebetreu

[2] IEEE P802.16-REVd/D3-2004 Draft IEEE Standard for local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems