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Re:	"802.16m amendment working text": IEEE 802.16m-08/050, "Call for Contributions on Project 802.16m Draft Amendment Content". Target topic: "15.3.6 Uplink Physical Structure".	
Abstract	Proposes ranging schemes for 802.16 amendment	
Purpose	Review and adopt	
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Ranging Section for the IEEE 802.16m Amendment

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Introduction

The contribution proposes text for ranging section in the UL PHY control.

Proposed text

4. Abbreviations and acronyms

IS	infrastructure station
RCP	initial ranging cyclic prefix
RCode	initial ranging CDMA code

15.3.6.x Ranging

For proper system operation AMS transmits ranging signals for initial network entry and HO (initial ranging), and periodically in order to maintain synchronization on UL (periodic ranging) and to support bandwidth request.

The initial ranging is described in subclause 15.3.6.x.a, while periodic ranging is described in subclause 15.3.6.x.b.

15.3.6.x.a Initial ranging

The initial-ranging CDMA codes shall be used for initial network entry, and HO procedure against the desired target IS (infrastructure station).

If IEEE WirelessMAN-OFDMA system operates together with the AAIF system using the UL FDM in the PUSC mode, an initial ranging opportunity size has $N_{InitRangingLegacy}$ = 72 subcarriers (TBD) in frequency domain as defined in subclause A1 [Note: this subclause should point to UL phy for legacy support]. In all other cases, the initial ranging opportunity size has $N_{InitRanging}$ =72 subcarriers in frequency domain as defined in subclause A2 [Note: this subclause should point to UL phy]. The time domain duration of the initial ranging opportunity size is given in subclause 15.3.6.x.a.1.

A time-domain illustration of the initial ranging signal is shown in Figure x1.

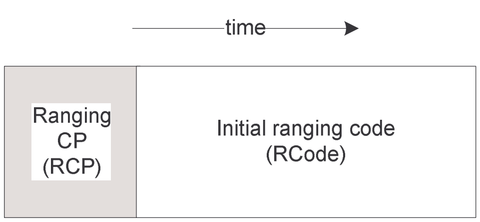

Figure x1 – Initial ranging signal transmission for AAIF.

15.3.6.x.a.1 Parameters for initial ranging signal

The ranging CP (RCP) duration and the initial-ranging CDMA code (RCode) durations are the main parameters for the initial ranging signal. Table x2 shows the values allowed for these parameters in conjunction with the initial ranging opportunity size duration. Informatively, the radius of the cell supported by the corresponding parameters is also provided.

Table x2 – Parameters for initial ranging signal and their initial ranging opportunity duration.

RCP (T_{rcp})	**RCode (T_{rcode})**	**Total initial ranging duration (T_{tot})**	**Initial ranging opportunity duration**	**Cell size coverage for CP = 1/8**
$T_g + 0.5\ T_s$	$T_u + T_s$	$2.5\ T_s$	3 OFDMA symbols (1/2 subframe)	7.7 km
$T_g + 1.5\ T_s$	$T_u + 2\ T_s$	$4.5\ T_s$	6 OFDMA symbols (1 subframe)	23 km
$T_g + 2\ T_s$	$T_u + 7\ T_s$	$10\ T_s$	12 OFDMA symbols (2 subframes)	30 km

15.3.6.x.a.2 Initial ranging transmission

The initial ranging signal is generated based on the ranging sequences provided in subclause 15.5.6.x.c. The initial ranging transmission shall be performed for T_{tot}, during which the same CDMA ranging sequence is transmitted on the ranging channel without any phase discontinuity. For this purpose the transmitted signal shall be generated according to 15.3.2.5, equation (173), except that T_{rcp} is used instead of T_g and $0 \leq t \leq T_{tot}$, where T_{rcp} and T_{tot} are given in Table x2.

If the initial ranging channel follows the idle OFDMA symbol that is used by the IS frame structure for TTG, the AMS shall transmit the initial ranging signal time-advanced by $0.5\ T_s$ relative to the corresponding ranging opportunity. Figure x3 shows such an example where initial ranging opportunity duration is 3 OFDMA symbols. The time-advancing transmission shall be applied irrespective of which initial ranging opportunity is selected in the ranging channel. This can be noticed in the figure as case b), where although the AMS chooses for transmission the second initial ranging opportunity, the transmission is still time-advanced by $0.5\ T_s$. By using time-advance transmission of the initial ranging code, the intercarrier interference is suppressed for the first UL OFDMA symbol at IS receiver.

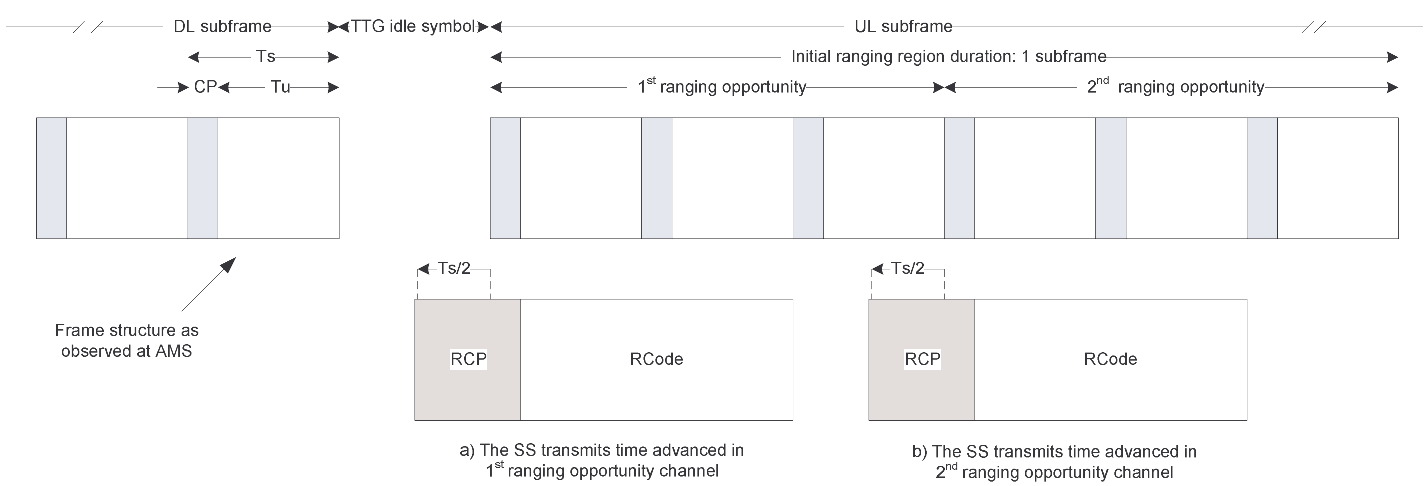

Figure x3 – Time-advancing transmission when the initial ranging region follows the TTG idle symbol.

15.3.6.x.b Periodic ranging and bandwidth request

If IEEE WirelessMAN-OFDMA system operates together with the AAIF system using the UL FDM in the PUSC mode, a periodic ranging opportunity size has $N_{PeriodicRangingLegacy}$ = 12 (TBD) subcarriers in frequency domain as defined in subclause A1 [Note: this subclause should point to UL phy for legacy support]. In all other cases, the periodic ranging opportunity size has $N_{PeriodicRanging}$ = 12 (TBD) subcarriers in frequency domain as defined in subclause A2 [Note: this subclause should point to UL phy]. The time domain duration of the periodic ranging opportunity size is given by $N_{PeriodicRangingDuration}$ = 3 and 6 (TBD) OFDMA symbols.

Periodic ranging signal is generated using the sequences defined in subclause 15.5.6.x.c. A CDMA ranging sequence covers $N_{PeriodicRangingLegacy}$ $N_{PeriodicRangingDuration}$ subcarriers. Mapping of CDMA ranging sequence to subcarriers is TBD.

If the bandwidth request region is the same as the periodic ranging region, *M* of CDMA ranging sequences are allocated for periodic ranging and *N* of CDMA ranging sequences are allocated for bandwidth request.

15.3.6.x.b.1 MIMO support transmission for periodic ranging and bandwidth request

The ABS can enable the MIMO support transmission for periodic ranging and bandwidth request when some of the AMSs it serves have MIMO capabilities transmission.

From the space of *M* available periodic CDMA ranging sequences for periodic ranging, a number M_1 of CDMA ranging sequences may be allocated for AMSs that do not have MIMO transmission capabilities, and a number of M_2 of CDMA ranging sequences may be allocated for AMSs that do have MIMO transmission capabilities.

From the space of *N* available periodic CDMA ranging sequences for bandwidth request, a number N_1 of CDMA ranging sequences may be allocated for AMSs that do not have MIMO transmission capabilities, and a number of N_2 of CDMA ranging sequences may be allocated for AMSs that do have MIMO transmission capabilities.

Using the MIMO capabilities transmission of an AMS is described in subclause 15.3.6.x.b.1.1.

15.3.6.x.b.1.1 AMS MIMO transmission for periodic ranging and bandwidth request for TDD

If the ABS enables the MIMO support transmission for periodic ranging and/or bandwidth request, an AMS that supports MIMO transmission shall consider that the number ranging opportunities that are available is twice as many.

Assume that ABS has N_t transmit antennas, while AMS has N_r receive antennas, that are also used for UL transmission. Due to TDD channel reciprocity, the uplink channel information $\mathbf{H}_{UL}$ can be regarded same as $\hat{\mathbf{H}}_{DL}^T$. Here, the downlink estimated channel information $\hat{\mathbf{H}}_{DL}$ has dimension $N_r \times N_t$. AMS randomly select both a ranging code r_i^p from M_2 periodic ranging (or N_2 bandwidth request) code set and an orthogonal vector $\mathbf{u} \in \{\mathbf{u}_1, \mathbf{u}_2\}$, where $[\mathbf{u}_1\ \mathbf{u}_2] = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$ for N_t = 2, $[\mathbf{u}_1\ \mathbf{u}_2] = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \end{bmatrix}^T$ for N_t = 4, $[\mathbf{u}_1\ \mathbf{u}_2] = \frac{1}{\sqrt{8}}\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 \end{bmatrix}^T$ for N_t = 8. AMS calculate the precoding matrix $\mathbf{v}$ by solving $\mathbf{u} = \mathbf{H}_{UL} \cdot \mathbf{v} = \hat{\mathbf{H}}_{DL}^T \cdot \mathbf{v}$. Then the ranging code after precoding, i.e. $\mathbf{v} \cdot r_i^p$, is transmitted.

15.5.6.x.c Ranging sequences

The length of ranging code for initial/HO ranging is 72, and for periodic/bandwidth request ranging is either 72 or 36. The ranging code is used to modulate the subcarriers in uplink tiles in the frequency domain. For the *p*-th group, $p \in \{0,1,2,..,N_p\}$ [N_p is TBD], there are 70 ranging codes for initial/HO ranging, and 70 and 36 ranging codes for periodic/bandwidth request ranging.

The ranging code in the frequency domain is defined as

$$r_i^p(k) = c^p(k) z_i(k), \quad p \in \{0,1,2,..,N_p\}, \quad i \in \{1,2,..,I\}, \quad k = 1,2,..,K \,. \qquad \text{(xxx a)}$$

Where,

- $c^p(k)$ [TBD] is *p*-th group specific code.
- *I*=70 and *K*=72 for generating length 72 codes.
- *I*=36 and *K*=36 for generating length 36 codes.

For *K*=72, the ranging code generator, $z_i^{72}(k)$, is given by (xxxb) and for *K*=36, $z_i^{36}(k)$, given by (xxxc).

$$z_i^{72}(k) = \begin{cases} \exp\left(\dfrac{-j2\pi ik(k+1)}{K-1}\right) & ,k = 1,2,..,K-1. \\ 0 & ,k = K. \end{cases} \qquad \text{(xxxb)}$$

$$z_i^{36}(k) = \exp\left(\frac{-j2\pi ik(k+1)}{K+1}\right), \quad k = 1,2,..,K. \qquad \text{(xxxc)}$$

The ABS can separate colliding codes and extract timing (ranging) information and power. The time (ranging) and power measurements allow the system to compensate for the near/far user problems and the propagation delay caused by large cells.