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Title	Training for AAS		
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Re:	IEEE 802.16REVd Sponsor Ballot		
Abstract	Training for reception of simultaneous transmissions requires that those can be discriminated, preferably at the training stage. This calls for the ability to modify the preambles so that channel from more than user can be studied. We propose cyclic time-shifting of the preamble as such modifier		
Purpose	Enhancing the AAS training mechanism		
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AAS training enhancement

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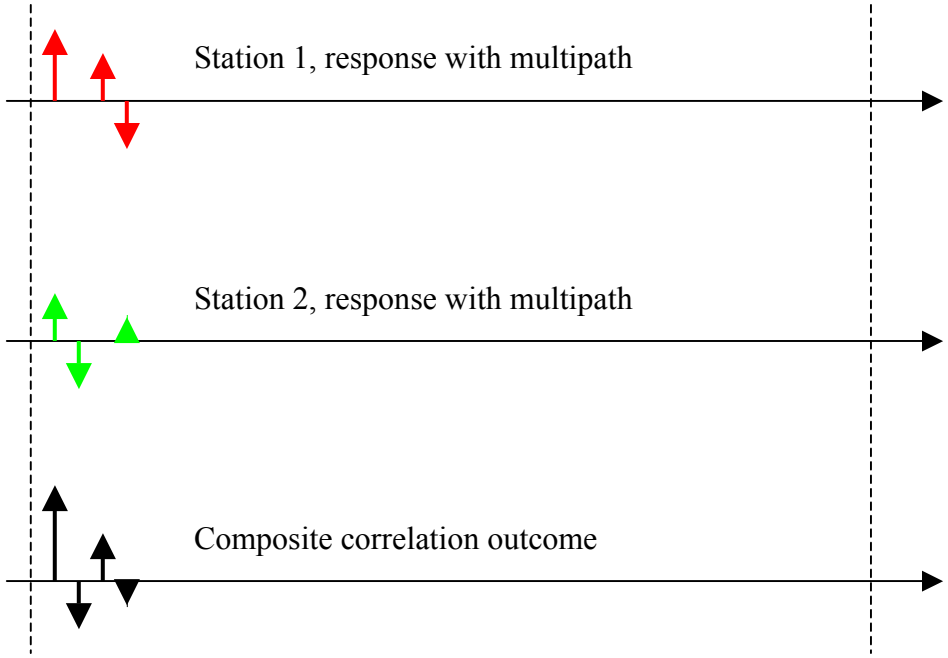
1. Introduction

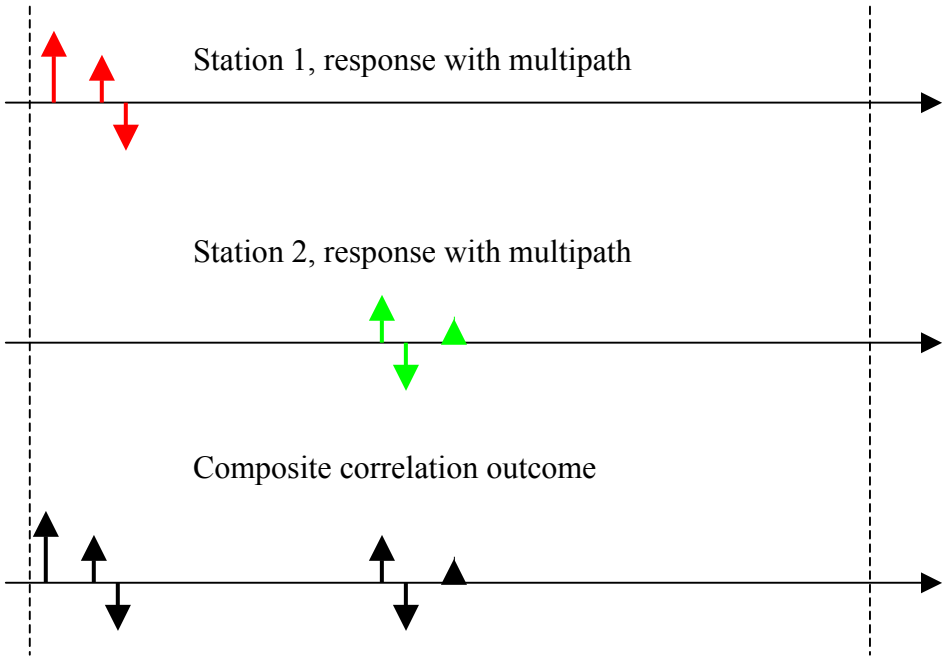
The AAS functionality calls for simultaneous reuse of the air resource by several transmissions. On the uplink this means that the BS has to estimate the channel response for each station and based on those estimates to separate the transmissions. One way to perform such estimation is to cause the stations to start their transmissions with different, preferably orthogonal preambles.

One way to introduce such property into the preambles is to time-shift them. As a simplistic example, let us look at the case that two stations transmit same training sequence simultaneously, without the time shift. The base station performs a cyclic correlation of the received waveform with the preamble. The result is illustrated in the drawing below.



As we see in the illustrative figure, the base station sees one composite response, in which it is not able to identify the contributions of the two stations separately.

In the case that the training sequences are transmitted with a cyclic time shift, the picture looks differently:



In this case the base station can identify the contribution of the two stations and perform a processing which will discriminate the transmissions of the stations.

From the implementation perspective, the changes to the processing on the CPE side are trivial. The stages of computing the preamble subcarrier loading and the FFT are same; the only thing to change is the starting point for the readout of the FFT result to the output.

One thing to note about the proposed mechanism of cyclic time shifting of the preamble is that all the good peak-to-average properties of the preambles that are currently part of the standard carry to the time shifted version as well. Moreover, for full bandwidth preambles the property that only even subcarriers are loaded is preserved.

From the standard's perspective, we propose to introduce the mechanism in the map, which will inform that for the elements from now on the preambles shall be transmitted with a cyclic shift. The base station can allocate then map elements with same start time but with different preamble time shifts in order to achieve the simultaneous transmission capability. This can be used both in full bandwidth and in subchannelization region. While the processing at the base station is beyond the scope of the standard, the generic mechanism allows enough flexibility for the base station to implement different strategies of selecting specific time shifts in order to achieve best separation properties.

The currently envisioned use for the mechanism is on the upstream, but we propose to allow such modifier also on the downstream, as hook for future use.

We propose that the capability to transmit the time-shifted preambles shall be mandatory – the implementation impact is miniscule, and it allows every CPE to participate in an AAS-enabled cell and to provide the advantage in the upstream. The capability to

receive time-shifted preambles is a more complicated capability and we recommend that only AAS-enabled stations shall be required to be able process such preambles.

The implementation of the proposal is within the scope of the extended XIUC codes. This can be done by either by adding a (optional) parameter to the AAS_map_IE or introducing a new one. Our preference is a standalone extended code, and this wording is brought below.

2. Proposed Text

[Add new clause 8.4.5.3.6 and shift the numbering of subsequent subclauses]

8.4.5.3.6 UL-MAP PHYMOD_IE

The Physical Modifier Information Element indicates that the subsequent allocations shall utilize a preamble (and midambles, for the case of subchannelization) which are cyclically delayed in time by *M* samples, meaning that the waveform transmitted during these training symbols shall be:

$$s(t) = \mathrm{Re}\left\{ e^{2j\pi f_c t} \sum_{\substack{k=-N_{\mathrm{used}}/2 \\ k\neq 0}}^{k=N_{\mathrm{used}}/2} \mathrm{c_k} \times e^{2j\pi k\Delta f\left(t-T_g-M/F_s\right)} \right\}. \text{ (eqnum)}$$

The PHYMOD_IE can appear anywhere in the UL map, and it shall remain in effect until another PHYMOD_IE is encountered, or until the end of the UL map.

Table XX: PHYMOD UL IE format

Syntax	Size	Notes
PHYMOD_Information_element() {		
extended UIUC code	4 bits	PHYMOD = 0x04
Length	4 bits	Length=0x1
Preamble Time Shift	8 bits	Preamble time shift
}		

Preamble Time Shift

The parameter indicating how many samples of cyclic shift are introduced into the training symbols of the following allocations (*M* in equation above).

[Add new clause 8.4.5.2.5 and shift the numbering of subsequent subclauses]

8.4.5.3.6 DL-MAP PHYMOD_IE

The Physical Modifier Information Element indicates that the subsequent allocations shall utilize a preamble which is cyclically delayed in time by *M* samples, meaning that the waveform transmitted during these training symbols shall be:

$$s(t) = \mathrm{Re}\left\{ e^{2j\pi f_c t} \sum_{\substack{k=-N_{\mathrm{used}}/2 \\ k\neq 0}}^{k=N_{\mathrm{used}}/2} \mathrm{c_k} \times e^{2j\pi k\Delta f\left(t-T_g-M/F_s\right)} \right\}. \quad \text{(eqnum)}$$

The PHYMOD_IE can appear anywhere in the DL map, and it shall remain in effect until another PHYMOD_IE is encountered, or until the end of the DL map. Only stations suppoting AAS functionality shall be assumed capable of receiving the consequently allocated bursts.

Table XX: PHYMOD DL IE format

Syntax	Size	Notes
PHYMOD_Information_element() {		
extended DIUC code	4 bits	PHYMOD = 0x04
Length	4 bits	Length=0x1
Preamble Time Shift	8 bits	Preamble time shift
}		

Preamble Time Shift

The parameter indicating how many samples of cyclic shift are introduced into the training symbols of the following allocations (*M* in equation above).