<table>
<thead>
<tr>
<th>Project</th>
<th>IEEE 802.16 Broadband Wireless Access Working Group <a href="http://ieee802.org/16">http://ieee802.org/16</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>On the definition of the transition gap for accommodating Relay operation</td>
</tr>
<tr>
<td>Date Submitted</td>
<td><strong>2007-01-08</strong></td>
</tr>
<tr>
<td>Source(s)</td>
<td>Youngbin Chang, Changyoon Oh, Hyoung Kyu Lim, Jaeweon Cho, Jungje Son, Panyuh Joo Samsung Electronics 416, Maetan-3dong, Youngtong-gu, Suwon-si, Gyeonggi-do, Korea</td>
</tr>
<tr>
<td>Voice:</td>
<td>+82-31-279-5519</td>
</tr>
<tr>
<td>Fax:</td>
<td>+82-31-279-5130</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:yb.chang@samsung.com">yb.chang@samsung.com</a></td>
</tr>
<tr>
<td>Rakesh Taori Samsung Advanced Institute of Technology</td>
<td></td>
</tr>
<tr>
<td>Re:</td>
<td>IEEE 802.16j Technical Contribution</td>
</tr>
<tr>
<td>Abstract</td>
<td>This contribution informs the definition of R-TTG/R-RTG.</td>
</tr>
<tr>
<td>Purpose</td>
<td>For more clear understanding of R-TTG/R-RTG</td>
</tr>
<tr>
<td>Notice</td>
<td>This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.</td>
</tr>
<tr>
<td>Release</td>
<td>The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE’s name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE’s sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.</td>
</tr>
<tr>
<td>Patent Policy and Procedures</td>
<td>The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <a href="http://ieee802.org/16/ipr/patents/policy.html">http://ieee802.org/16/ipr/patents/policy.html</a>, including the statement &quot;IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard.&quot; Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <a href="mailto:chair@wirelessman.org">mailto:chair@wirelessman.org</a> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <a href="http://ieee802.org/16/ipr/patents/notices">http://ieee802.org/16/ipr/patents/notices</a>.</td>
</tr>
</tbody>
</table>
1. Introduction

For TDD systems, frame structure for 2-hop and multi-hop relay is described in reference [1]. For proper RS operation in frame structure, there needs to define transition gaps within DL and UL subframe. In this contribution, we will define clearly transition gaps of RS.

2. TTG/RTG parameters in 802.16e system

In reference [2], TTG/RTG is defined as follows:

3.45 BS receive/transmit transition gap (RTG): A gap between the last sample of the uplink burst and the first sample of the subsequent downlink burst at the antenna port of the base station (BS) in a time division duplex (TDD) transceiver. This gap allows time for the base station (BS) to switch from receive to transmit mode and SSs to switch from transmit to receive mode. During this gap, the BS and SS are not transmitting modulated data but simply allowing the BS transmitter carrier to ramp up, and the transmit/receive (Tx/Rx) antenna switch to actuate, and the SS receiver sections to activate. Not applicable for frequency division duplex (FDD) systems.

3.63 BS transmit/receive transition gap (TTG): A gap between the last sample of the downlink burst and the first sample of the subsequent uplink burst at the antenna port of the base station (BS) in a time division duplex (TDD) transceiver. This gap allows time for the base station (BS) to switch from transmit to receive mode and SSs to switch from receive to transmit mode. During this gap, the BS and SS are is not transmitting modulated data but simply allowing the BS transmitter carrier to ramp down, the transmit/receive (Tx/Rx) antenna switch to actuate, and the BS receiver section to activate. Not applicable for frequency division duplex (FDD) systems.

In reference [3], SSTG/SSRTG is defined as follows:

“3.53 SS Rx/Tx gap (SSRTG): The SSRTG is the minimum receive to transmit turnaround gap. SSRTG is measured from the time of the last sample of the received burst to the first sample of the transmitted burst, at the antenna port of the SS.”

“3.54 SS Tx/Rx gap (SSTTGF): The SSTTGF is the minimum transmit to receive turnaround gap. SSTTGF is measured from the time of the last sample of the transmitted burst to the first sample of the received burst, at the antenna port of the SS.”

In OFDMA-TDD system as in reference [2], TTG/RTG is defined as follows:
“In TDD and H-FDD systems, subscriber station allowances must be made by a SSRTG and by a SSTTG. The BS shall not transmit downlink information to a station later than (SSRTG+RTD) before the beginning of its first scheduled uplink allocation in any UL-subframe, and shall not transmit downlink information to it earlier than (SSTTG-RTD) after the end of the last scheduled uplink allocation, where RTD denotes Round-Trip Delay. In addition the SS should be allowed to receive the downlink preamble for each frame that contains DL data for it, by assuring the period specified above does not overlap with the preamble. The parameters SSRTG and SSTTG are capabilities provided by the SS to BS upon request during network entry (see 11.8.3.1). TTG parameter is set to SSTTG + RTD and RTG parameter is set to SSRTG-RTD.”

3. Transition gaps in 802.16j frame structure

Figure 1 describes an example of 2-hop relay environment. MR-BS serves RS through the relay link and serves MS1 through the access link. RS1 communicates with MR-BS through the relay link and communicates with MS2 through the access link.

Figure 2 represents timing operation within 1 frame in 2-hop relay environment, referring to the frame structure defined in reference [1]. In the access region of the DL subframe, MR-BS and RS transmit preamble, MAP and data burst to its serving MS. During this time, Both MR-BS and RS operate as a Tx. mode.

In the relay region of the DL subframe, MR-BS continues its Tx mode, while RS needs to change its mode from Tx to Rx, for receiving data from MR-BS. Due to this mode transition, RS may need transition time gaps for proper mode change. To synchronize with MR-BS frame and RS frame, RS should finish its mode transition before arriving the DL relay zone data from MR-BS.

During TTG, MR-BS changes its mode transition from Tx mode to Rx mode, while RS continues its Rx mode during TTG. Only time gap needs to align the start symbol of the UL access region.

In the access region of the UL subframe, Both MR-BS and RS operate as an Rx mode to receive from their MSs. In the relay region of the UL subframe, RS needs mode transition from Rx mode to Tx before transmitting the UL relay zone data from RS.
Figure 2. MR-BS and RS frame structure in 2-hop environment.
4. Definition of R-TTG/R-RTG

Similar as current specification in [3], we can define mode change transition gap, which are called, RSTTG and RSRTG. RSTTG is mode change time from Tx. to Rx, RSRTG is mode change time from Rx. to Tx. Using this definition, we can define R-TTG, the time gap between DL access region and DL relay region within DL sub-frame, and R-RTG, the time gap between UL access region and UL relay region within UL sub-frame. In Figure 3, if R-TTG has one OFDM symbol length, the maximum RSTTG could be R-TTG + RTD/2. In other words, when RSTTG and RTD/2 is given value, R-TTG may be defined as simple equation as follows:

\[ R-TTG = \left[ OFDM\ symbol\ unit(RSTTG - RTD/2) \right]. \]

Within the DL sub-frame, R-TTG shall be defined by OFDM symbol unit because DL access zone and DL relay zone could be represented by OFDM symbol units. Similarly, R-RTG are described in Figure 4. R-RTG also could be defined as simple equation as follows:

\[ R-RTG = \left[ OFDM\ symbol\ unit(RSTTG + RTD/2) \right]. \]

![Diagram of R-TTG in RS DL sub-frame](image-url)
5. Reference