<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>Virtual Relay Grouping Concept to Support RSs Sharing the Same Preamble Relay Grouping and PUSC Segment Selection for FCH/MAP Transmission {Harmonized with IEEE802.16j-07_265}</td>
</tr>
<tr>
<td>Date Submitted</td>
<td>2007-03-1505</td>
</tr>
<tr>
<td>Source(s)</td>
<td>Hang Zhang, Derek Yu, Peiying Zhu, Wen Tong, David Steer, Gamini Senarath, Mark Naden, G.Q. Wang</td>
</tr>
<tr>
<td></td>
<td>Nortel</td>
</tr>
<tr>
<td></td>
<td>3500 Carling Avenue</td>
</tr>
<tr>
<td></td>
<td>Ottawa, Ontario K2H 8E9</td>
</tr>
<tr>
<td></td>
<td>Kanchei (Ken) Loa, Yung-Ting Lee, Yi-Hsueh Tsai, Chih-Chiang Hsieh, Heng-Iang Hsu, Shiann-Tsong Sheu</td>
</tr>
<tr>
<td></td>
<td>Institute for Information Industry</td>
</tr>
<tr>
<td></td>
<td>8F., No. 218, Sec. 2, Dunhua S. Rd., Taipei City, Taiwan.</td>
</tr>
<tr>
<td></td>
<td>D. J. Shyy</td>
</tr>
<tr>
<td></td>
<td>MITRE</td>
</tr>
<tr>
<td></td>
<td>McLean, VA, USA</td>
</tr>
<tr>
<td></td>
<td>Tzu-Ming Lin, I-Kang Fu, Fang-Ching Ren, Chie-Ming Chou and Wern-Ho Sheen</td>
</tr>
<tr>
<td></td>
<td>ITRI / NCTU</td>
</tr>
<tr>
<td></td>
<td>M100, ICL/ITRI, Bldg. 14, 195, Sec. 4, Chung Hsin Rd. Chutung, Hsinchu, Taiwan 310, R.O.C.</td>
</tr>
<tr>
<td></td>
<td>Dorin Viorel</td>
</tr>
<tr>
<td></td>
<td>Fujitsu Microelectronics Canada Inc, and Chenxi Zhu</td>
</tr>
<tr>
<td></td>
<td>Fujitsu Labs of America.</td>
</tr>
<tr>
<td></td>
<td>Young-jae Kim, Kyu Ha Lee, Jae Hyung Eom, Changkyoon Kim</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:wentong@nortel.com">wentong@nortel.com</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:pyzhu@nortel.com">pyzhu@nortel.com</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:loa@nmi.iii.org.tw">loa@nmi.iii.org.tw</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:wentong@nortel.com">wentong@nortel.com</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:yingtlin@nortel.com">yingtlin@nortel.com</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:pyzhu@nortel.com">pyzhu@nortel.com</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:loa@nmi.iii.org.tw">loa@nmi.iii.org.tw</a></td>
</tr>
<tr>
<td></td>
<td>Voice: +1 613 763-1315</td>
</tr>
<tr>
<td></td>
<td>Voice: +1 703 983-6515</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:dviorel@fmci.fujitsu.com">dviorel@fmci.fujitsu.com</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:chenxi.zhu@us.fujitsu.com">chenxi.zhu@us.fujitsu.com</a></td>
</tr>
<tr>
<td></td>
<td>Voice: +1-403-207-6311</td>
</tr>
<tr>
<td></td>
<td>Voice: +1-301-486-0671</td>
</tr>
<tr>
<td></td>
<td>Voice: +82-31-280-9975</td>
</tr>
<tr>
<td></td>
<td>Fax: +82-31-280-1562</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:youngjae2.kim@samsung.com">youngjae2.kim@samsung.com</a></td>
</tr>
</tbody>
</table>

In this contribution, we propose relay grouping to better serving the mobiles and to maintain good broadcast channel quality that allows frequency reuse amongst relay groups.

To incorporate the proposed text into the P802.16 Baseline Document (IEEE 802.16j-06/026r1)

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.

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.

The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "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." 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 <mailto:chair@wirelessman.org> 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 <http://ieee802.org/16/ipr/patents/notices>.
Virtual Relay Grouping Concept to Support RSs Sharing the Same Preamble Relay Grouping and PUSC Segment Selection for FCH/MAP Transmission [Harmonized with IEEE802.16j-07_265]

Hang Zhang, Derek Yu, Peiying Zhu, Wen Tong, David Steer, Gamini Senarath, Mark Naden, G.Q. Wang
Nortel

Kanchei (Ken) Loa, Yung-Ting Lee, Yi-Hsueh Tsai, Heng-Iang Hsu, Shiann-Tsong Sheu
Institute for Information Industry

D. J. Shyy
MITRE

Tzu-Ming Lin, I-Kang Fu, Fang-Ching Ren, Chie-Ming Chou and Wern-Ho Sheen
ITRI / NCTU

Dorin Viorel
Fujitsu Microelectronics Canada Inc
Chenxi Zhu
Fujitsu Labs of America.

Young-jae Kim, Kyu Ha Lee, 
Jae Hyung Eom, Changkyoon Kim
Samsung Thales

D.H. Ahn, Junhong Hui, Young-il Kim, C.I.Yeh, Byung-Jae Kwak, Su Chang Chae
ETRI

Aik Chindapol, Jimmy Chui
Siemens Corporate Research

Yousuf Saifullah
Nokia

1. Introduction

During the initial network entry, a _RS_ first selects a station (either a _MR-BS_ or another RS) as its serving station. Secondly, it can select or is configured by its serving station a segment for transmitting FCH and MAP. A _RS_ may either use the same segment as or a different segment from that of its serving station.
When a RS uses the same segment and preamble sequence as that of the serving station, it becomes a cooperative relay to the serving station and it does not have its own identity from a MS point of view. The system operation becomes simpler. When the serving station is the MR-BS, the frequency reuse gain is not optimized for this type of system operation. When a RS selects or is assigned a different preamble sequence, this RS has its identity and can transmit its own FCH and MAP. The benefit of the latter case is the potential gain from frequency reuse, compared to the first case. The issue of the latter case may result in higher co-channel interference on FCH/MAP transmission for certain scenarios as well as potential interference in the FUSC channels when two RSs are located close to each other or between MR-BS and RSs. The latter will also help to avoid handoffs which can occur when an MS moves across RS boundaries. With RSs covering small area it is expected the number of handoffs can increase several fold if each RS represents different PN sequences.

In the current definition of RSs there are two definitions. An non-transparent relay which transmits the preamble and the transparent relay which does not transmit a preamble. Since virtual group members transmit the preamble they come under the category of non-transparent relay under the current definition. However, the difference is that they transmit the same preamble and the whole group represents a single preamble therefore appearing to MS as a single non-transparent BS-like entity when an MR-BS is not involved in the group. When an MR-BS is included in the group it appears as a single BS entity to the MS.

In this contribution, we propose a method called RS grouping (refer to Figure 1):

- A group of RSs form a Virtual RS group as decided by the MR-BS based on criteria (e.g. potential interference that they cause to each other) which is implementation dependent. The virtual group may include the MR-BS.

- Each RS is assigned an individual unicast RSID and a multicast RSID as the RS group ID. The multicast RSID is the same for all members in the group. With these two separate IDs, the RS can be managed individually or as a group. These IDs are unique within the associated MR-BS.

- When the virtual RS group include an MR-BS, all the RSs in the virtual group shall either transmit the same preamble, FCH and MAP or they all do not transmit any preamble. When an MR-BS is not included in the virtual group, one of the RSs in the virtual group is a non-transparent RS and all the others shall either transmit the preamble, FCH and MAP of the said non-transparent RS or they all do not transmit preamble, FCH and MAP. The radio resources may be shared by these RSs for data burst transmission. The existence of the group is totally transparent to its MS(s).

- Different groups transmit different preambles.

- Removal of an RS from the group: During normal operation of the RS group, each RS continues to monitor the radio environment (e.g. the interference). One example is that for an RS that is located at the edge of the group coverage area, it could detect strong segment interference from other nearby RS(s) or RS groups. When this happens, it can request to be removed from the RS group and operate on its own using a different segment.

- Addition of an RS to an existing group or forming a new group: An RS, at network entry, can a) operate on its own, i.e., it selects or is assigned a dedicated preamble index (implying the segment), b) form a new group or c) join an existing group. The RS can perform measurements such as radio signals from the neighbors and then report to MR-BS regarding the preferred preamble index (implying the segment). The MR-BS replies by either confirming the preamble sequence index selected by the RS or...
assigning a different one, indicating whether it should transmit the preamble, and at the same time, providing the corresponding RS group ID.

- A group of RSs form a Virtual RS group as decided by the MR-BS based on different criteria (e.g., the potential interference that they cause to each other.) The criteria are implementation dependent. RS group may consist of one MMR-BS and one or more RS(s); or two or more RS(s) with at least one RS being a non-transparent RS.

- Each RS is assigned an individual unicast RSID and a multicast RSID as the RS group ID. The multicast RSID is the same for all members in the group. With these two separate IDs, the RS can be managed individually or as a group. These IDs are unique within the associated MMR-BS. For details on the definitions of RSID, please refer to contribution [1].

- All RS(s) in the same group shall transmit the identical preamble, FCH and MAP or do not transmit the frame start preamble. The existence of the group is totally transparent to its MS(s).

- Either the MR-BS or the upstream serving station of the group is responsible for managing the FCH and MAP of the group as well as other processes such as scheduling and handover of MSs within the group.

- Different groups transmit different preambles, the same or different FCH and MAP from that of the associated upstream serving station.

- Removal of an RS from the group: During normal operation of the RS group, each RS continues to monitor the radio environment (e.g., the interference). For a RS that is located at the edge of the group coverage area, it could detect strong segment interference from other nearby RS(s) or RS groups. When this happens, it can request to be removed from the RS group and operate on its own using a different segment.

Addition of an RS to the group: A RS, at network entry, can a) operate on its own, i.e., it selects or is...
assigned a dedicated preamble index (implying the segment), b) form a new group or c) join an existing
group. The RS can perform the measurement of radio environment and then report to MMR-BS regarding
the preferred preamble index (implying the segment). The MR-BS replies by either confirming the
preamble sequence index selected by the RS or assigning a different one, indicating whether it should
transmit the preamble, and at the same time, providing the corresponding RS group ID.

2. FCH/MAP Interference Evaluation

2.1 Parameters and assumptions

19 Umbrella macro cells (2 km cell to cell separation)
Tri-sector cell with cell site wrap around
Random drop relay locations
Number of relays per sector: 15 relays
Carrier frequency: 2.5 GHz
Beam Tx power is 20 watts. Relay Tx power is 600mW or 3W
Antenna gain: base = 15 dBi; relay = -1 dBi
Antenna pattern: base (3dB width) = 70 degrees (20 dB front to back ratio); relay = Omni
Noise figure: 9 dB for base, relay and MS
Thermal noise: -174 dBm/Hz
CIR Limit: 30 dB
Same pathloss model for base to relay, base to MS, relay to relay and relay to MS
Shadowing: 10 dB standard deviation; 0.5 correlation
Minimum distance: 35 m for base to relay & base to MS; No minimum between relay to relay & relay
to MS
Average CIR curves plotted are as observed by MS on the best segment reception.

2.2 Scenarios

Scenario 1 (No RS Grouping):

Each RS selects a PUSC segment which is different from the segment of its associated MMR-BS
Each RS measures the combined segment power of the remaining two segments from all cells/sectors
including its own sector
RS selects the segment with the lower combined power
Scenario 2 (Simple RS Grouping):

Each RS group assigns a PUSC segment which is different from the segment of its associated MMR-BS.

Each RS measures the combined segment power of the remaining two segments from external cells/sectors only.

RS report the segment with the lower combined power.

All RSs that report the same segment are assigned to the same RS group by MMR-BS.
2.3 Results

For individual relay case with no RS grouping, as shown in Figure 2, a degraded average FCH/MAP CIR statistics at MS are observed. However, with RS grouping, there is no degradation on average CIR statistics. In fact, it provides additional improvements in the low CIR region.

![FCH/MAP Interference Study (600mW Relay)](image)

Figure 2: FCH/MAP Interference Study (600mW Relay)

For higher power relay and with no RS grouping, the results from Figure 3 indicate a further degradation in the average CIR statistics. On the other hand, with RS grouping, an improvement in slightly shifting the curve to higher CIR is observed.
2.4 Evaluation Summary

In this study on RS grouping and PUSC segment selection:

There is no degradation in average FCH/MAP CIR received at MS. In fact, there is a slight improvement especially at the lower CIR region. Without RS grouping, the CIR degraded. Frequency reuse is possible amongst the RS groups as each group can transmit different FCH/MAP and potentially enable higher capacity in the relaying network.
3. Proposed text change

++++++++++++++ Start Text +++++++++++++++++++++++++++++++++++++++++

3.1 RS grouping procedure

[Add the following section]

6.3.9.16 Network entry and initialization

6.3.9.16.1 RS network entry and initialization

6.3.9.16.1.1 RS grouping

RS grouping method includes the following characteristics:

- A group of RSs form a Virtual RS group as decided by the MR-BS based on criteria (e.g. potential interference that they cause to each other) which is such as the potential interference that they cause to each other, and the criteria are implementation dependent. The virtual group may include the MR-BS. RS group may consist of one MR-BS and one or more RS(s), or two or more RS(s) with at least one RS being a non-transparent RS.

- Each RS is assigned an individual unicast RSID and a multicast RSID as the RS group ID. The multicast RSID is the same for all members in the group. With these two separate IDs, the RS can be managed individually or as a group. These IDs are unique within the associated MR-BS. For details on the definitions of RSID, please refer to contribution [1].

- When the virtual RS group include an MR-BS, all the RSs in the virtual group shall either transmit the same preamble as the MR-BS, FCH and MAP or they all do not transmit any preamble. When an MR-BS is not included in the virtual group, one of the RSs in the virtual group is a non-transparent RS and all the others shall either transmit the preamble, FCH and MAP of the said non-transparent RS or they all do not transmit preamble, FCH and MAP. All RS(s) in the same group shall transmit the identical preamble, FCH and MAP, or do not transmit the frame start preamble, FCH and MAP. The radio resources may be shared by these RSs for data burst transmission. The existence of the group is totally transparent to its MS(s).

- Either the MR-BS or the upstream serving station of the group is responsible for managing the FCH and MAP of the group as well as other processes such as scheduling and handover of MSs within the group.

- Different groups transmit different preambles, the same or different FCH and MAP from that of the associated upstream serving station.

- Removal of an RS from the group: During normal operation of the RS group, each RS continues to monitor the radio environment (e.g. the interference). One example is that for a RS at the edge of the group coverage area, it could detect strong segment interference from other nearby RS(s) or RS groups. When this happens, it can request to be removed from the RS group and operate on its own using a different segment.

- Addition of an RS to an existing group or forming a new group: At network entry, an RS at network entry, can a) operate on its own, i.e., it selects or is assigned a dedicated preamble index (implying the segment), b)
form a new group or c) join an existing group. The RS can perform the measurements such as of radio signals from the neighbors environment and then report to MMR-BSMR-BS regarding the preferred preamble index (implying the segment). The MMR-BSMR-BS replies by either confirming the preamble sequence index selected by the RS or assigning a different one, indicating whether it should transmit the preamble, and at the same time, providing the corresponding RS group ID.

3.2 MAC management message to enable the RS grouping configuration

{Insert the following section as a new section}

6.3.2.3.62 RS configuration request message

This message may be transmitted by a RS to request some physical layer operation parameters. A RS may use this message to report information to facilitate the determination of an MMR-BSMR-BS on configuration of RS operation parameters.

<table>
<thead>
<tr>
<th>Table XXX. RS_Config-REQ message format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
</tr>
<tr>
<td>RS_Config-REQ format</td>
</tr>
<tr>
<td>Configuration para_type</td>
</tr>
<tr>
<td>If (b0 of Configured_para_type == 1 )</td>
</tr>
<tr>
<td>Preamble_index</td>
</tr>
</tbody>
</table>

Configuration para_type
The first bit is used as preamble index indicator to indicate the preamble_index field is present in this message.
The second bit is used as indicator to indicate the intent to be removed from the current RS group.

Preamble_index
This field is used to indicate the preamble index.

6.3.2.3.63 MMR-BSMR-BS configuration response message

This message may be transmitted by an MMR-BSMR-BS for the purpose of RS configuration. An MMR-BSMR-BS may use this message to set operation parameters for a RS. MMR-BSMR-BS may transmit this message as a response to RS_Config-RSREQ or as an unsolicited message.
<table>
<thead>
<tr>
<th><strong>Management message type = 68</strong></th>
<th>8 bits</th>
<th><strong>Configured_para_type</strong></th>
<th>8 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b0 = 1: preamble configuration is included; b1 = 1: remove multicast RSID to disassociate from the RS group; b2 = 1: Unicast RSID is included; b3 = 1: Multicast RSID is included; b4 = 0: Do not transmit preamble; 1: transmit the assigned preamble. B5 – b7: reserved</td>
<td></td>
</tr>
<tr>
<td>If (b0 of Configured_para_type == 1) {</td>
<td></td>
<td>reserved</td>
<td>1 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shall be zero</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preamble_index</td>
<td>7 bits</td>
</tr>
<tr>
<td>If (b2 of Configured_para_type == 1) {</td>
<td></td>
<td>Unicast RSID</td>
<td>8 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multicast RSID</td>
<td>8 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multicast RSID as the RS Group ID</td>
<td></td>
</tr>
</tbody>
</table>

**Configuration_para_type**

The first bit is used as preamble index indicator to indicate the preamble_index field is present in this message.

The second bit is used as the indicator to instruct the RS to remove its multicast RSID so that it is disassociate from the current RS group.

The third bit is used as the Unicast RSID indicator to indicate the Unicast RSID field is present in this message.

The fourth bit is used as the Multicast RSID indicator to indicate the Multicast RSID field is present in this message.

**Preamble_index**

This field is used to indicate the preamble index.

**Unicast RSID**

This field is used to indicate the Unicast RSID.

**Multicast RSID**

This field is used to indicate the Multicast RSID for RS group operations.

---

4. References