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| Re: | A response to a Call for Technical Proposals http://wirelessman.org/relay/docs/80216j-07_007r2.pdf | |
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| Abstract | This contribution proposes connection management procedures for multicast and broadcast services (MBS) in multi-hop relay system | |
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| Purpose | This contribution is provided as input for the IEEE 802.16j Baseline Document | |
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Connection Management for Multicast and Broadcast Services (MBS)

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1. Introduction

Multicast and broadcast services (MBS) offer efficient utilization of network resources to deliver data from a source to multiple destinations. For multi-hop relay systems, it would be advantageous to have a method to establish and maintain a multicast distribution tree to distribute multicast traffic along each branch of the multicast distribution tree. In this way, the multicast data is transmitted only to the RSs associated with the MSs that have requested the MBS. Multicast data is transmitted only once by a MR-BS to an RS and then only once by that RS to a further RS or to the MSs that receive the MBS. Thus, the bandwidth utilization for multicast is improved.

The relay path configuration and connection management schemes for multi-hop relay systems have been proposed in the contribution C80216j-07/241r4. This contribution extends the relay path configuration schemes to the MBS.

2. Description of the proposal

This contribution proposes the procedures to build a multicast distribution tree to efficiently distribute multicast data from the source (MR-BS) to all the MSs that join the MBS in a multi-hop relay network.

The MR-BS may initiate a multicast distribution tree for the MBS. When a MS wants to initiate a MBS, it sends a DSA-REQ message to MR-BS to specify that it wants the MBS. The procedures for establishing multicast distribution tree are as follows.

When a MR-BS receives a MBS request from a MS, it checks whether the requested MBS has been created. If not, the MR-BS creates a multicast distribution tree for this MBS and allocates a multicast CID (MCID) to it. The MR-BS also determines the path(s) to carry this multicast service flow to the requesting MS. The MR-BS creates the

mapping between the determined path and the MCID. The MR-BS informs all the RSs on the path of the binding between the path ID and MCID by sending a DSD-REQ* message along path as specified in C80216j-07/241r4. Each RS along the path stores the path ID and MCID binding information for forwarding multicast data with the MCID. The MR-BS adds this path to the multicast distribution tree and records the number and identification information of the MSs using the path for multicast communications. A multicast distribution tree may consist of multiple paths.

If the multicast distribution tree has been created and an MCID has been allocated to this MBS, the MR-BS determines the path to carry this multicast service flow to the requesting MS. If the path is not in the multicast distribution tree, the MR-BS creates the binding between the determined path and the MCID. The MR-BS informs the path and MCID binding information to all the RSs along the path. Each RS stores the path-MCID binding information for forwarding multicast data with the MCID. The MR-BS adds this path to the multicast distribution tree and record the number and identification information of the MSs using the path for the multicast communications. If the path is already in the multicast distribution tree (due to the prior initiation of MR-BS or the request of another MS using the same path), the MR-BS simply updates the number and identification information of the MSs using the path for the MBS in the multicast tree.

As an example in Fig. 1, after RS1, RS2, RS3 and RS4 enter the network, MR-BS establishes the following paths:

$$P_0 = \{\text{MR-BS}\}, P_1 = \{P_0, \text{RS1}\}, P_2 = \{P_1, \text{RS2}\}, P_3 = \{P_1, \text{RS3}\}, P_4 = \{P_3, \text{RS4}\}.$$

When MS1 wants a MBS, MS1 sends a DSA-REQ to the MR-BS. This message is received by RS2 and forwarded to MR-BS along path P2. If this MBS does not exist in the multi-hop relay network, (i.e. MS1 is the first entity to initiate this MBS) upon receiving this message, the MR-BS creates a multicast connection and assigns a multicast MCID to this multicast connection. The MR-BS creates a multicast distribution tree for this MBS, $\text{tree-MCID} = \{\text{MCID}, 1, (P_2, 1)\}$. Here a multicast distribution tree is represented by the MCID, the number of (P, N) pairs in the multicast distribution tree, and a variable number of (P, N) pairs, $\{\text{MCID}, \# \text{ of } (P, N) \text{ pairs}, (P_1, N_1), (P_2, N_2), \dots\}$.

In the (P, N) pair, P represents a path between the MR-BS and a RS, and N represents the number of MSs that attached to the RS and receive this MBS. The MR-BS also maintains the identification information such as the basic and primary CIDs of the MSs that use the path for the MBS. The MR-BS determines P2 to be used to carry the MBS flow and adds P2 to the multicast distribution tree. The MR-BS informs all the RSs on path P2 of the binding between the path ID and MCID as specified in C80216j-07/241r4. Note that MS1 has no knowledge of the multicast distribution tree. However, if the MR-BS cannot establish multicast distribution tree for the requested MBS (e.g. the service flow parameters cannot be satisfied), the MR-BS sends a DSA-RSP to the MS node denying the MBS.

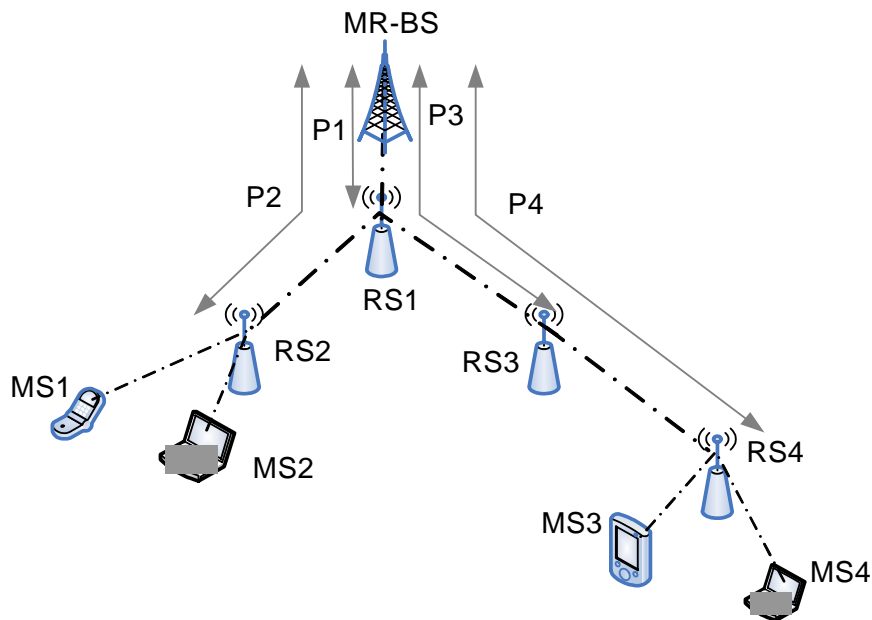


Fig. 1. An exemplary multi-hop relay system.

If MS2 also wants the same MBS, it sends a DSA-REQ request to the MR-BS. Upon receiving the DSA-REQ request for the MBS from MS2, the MR-BS determines that the multicast service flow for this MBS has been created and its MCID has been assigned. Furthermore, the MR-BS determines that path P2 is to be used to carry this multicast service flow to MS2 and path P2 has been added to the multicast distribution tree and bound to this MCID. Based on this determination, the MR-BS does not send a DSA-

REQ* to the RSs along path P2. MR-BS updates the multicast distribution tree information corresponding to tree-MCID to indicate that two MSs, MS1 and MS2, use path P2 for this MCID. The multicast distribution tree becomes {MCID, 1, (P2, 2)}. If MS3 also wants the same MBS, it sends a DSA-REQ request for the same MBS to the MR-BS. Upon receiving the DSA-REQ request for the MBS from MS3, the MR-BS knows that the multicast service flow for this MBS has been created and the MCID has been allocated to this MBS. Furthermore, the MR-BS determines that path P4 is to be used to carry this multicast service flow to MS3. However, path P4 has not been added to the multicast distribution tree and bound to this MCID. The MR-BS sends a DSA-REQ* message along path P4 to bind MCID and P4. The tree becomes tree-MCID={MCID, 2, (P2, 2), (P4, 1)}.

Note that for MR-BS and RS1, the MCID is bound to both paths P2 and P4. A multicast CID can be bound to multiple paths for a multicast service flow. This MCID and path ID binding information is used for the MR-BS and RSs to update the routing table and locate the next hop nodes for a multicast distribution tree. This information is used for scheduling when multicast data need to be forwarded along the multicast distribution tree. For example, when MR-BS needs to forward the multicast data with the MCID, the MR-BS determines that the MCID is bound to P2 and P4. Since both paths (P2 and P4) have the same initial hop RS1, the multicast data is forwarded to RS1 by the MR-BS. When RS1 receives multicast data, RS1 determines that the MCID is bound to both P2 and P4. Now, the next hops for P2 and P4 are RS2 and RS3, respectively. RS1 transmits the multicast data only once to RS2 and RS3 simultaneously according to a certain schedule. Both RS2 and RS3 receive the multicast data at the same time.

As shown in Fig. 2, a path is added to a multicast distribution tree. When a MS wants to have MBS, it sends a DSA-REQ message to the MR-BS to add the MBS. This is the same as requesting that a legacy service flow be created between the requesting MS and the MR-BS. The MR-BS receives this request and if this is the first MS that wants the MBS, then the MR-BS creates a multicast distribution tree and allocates a MCID if needed. If path P_x needs to be added to the multicast distribution tree, then the MR-BS sends a DSA-REQ* message to each RS along the path to bind the MCID and the path ID.

If the path Px between the requesting MS and the MR-BS already exists in the multicast tree-MCID, the MR-BS does not need to add path Px to the tree-MCID. The MS is informed using legacy service flow message DSA-RSP.

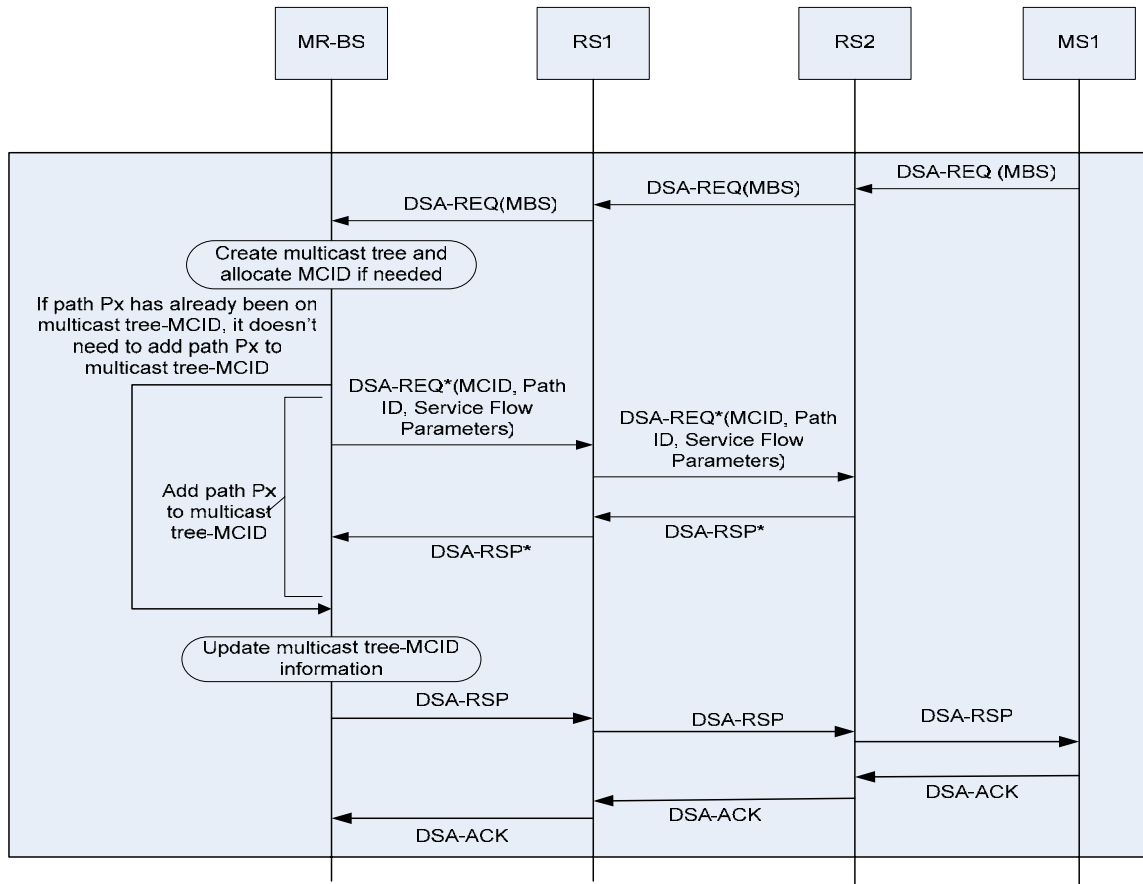


Fig. 2. Illustration of multicast connection management procedures

As shown in Fig. 3, a path is removed from a multicast distribution tree by the MR-BS. When a MS needs to leave the multicast service, the MS sends a DSD-REQ to the MR-BS to request removing it from the multicast service flow. The MR-BS first updates the number and identification information of the MSs that are receiving the MBS along the path to this requesting MS. The MR-BS determines if the path can be removed from the tree-MCID. If no other MSs uses this path for the MBS, the path may be removed from the multicast distribution tree. Otherwise, the path shall not be removed from the multicast distribution tree. If the path is removed from the tree-MCID then the MR-BS

removes the binding between the path and the MCID by sending a DSD-REQ* along path as specified in the contribution C80216j-07/241r4.

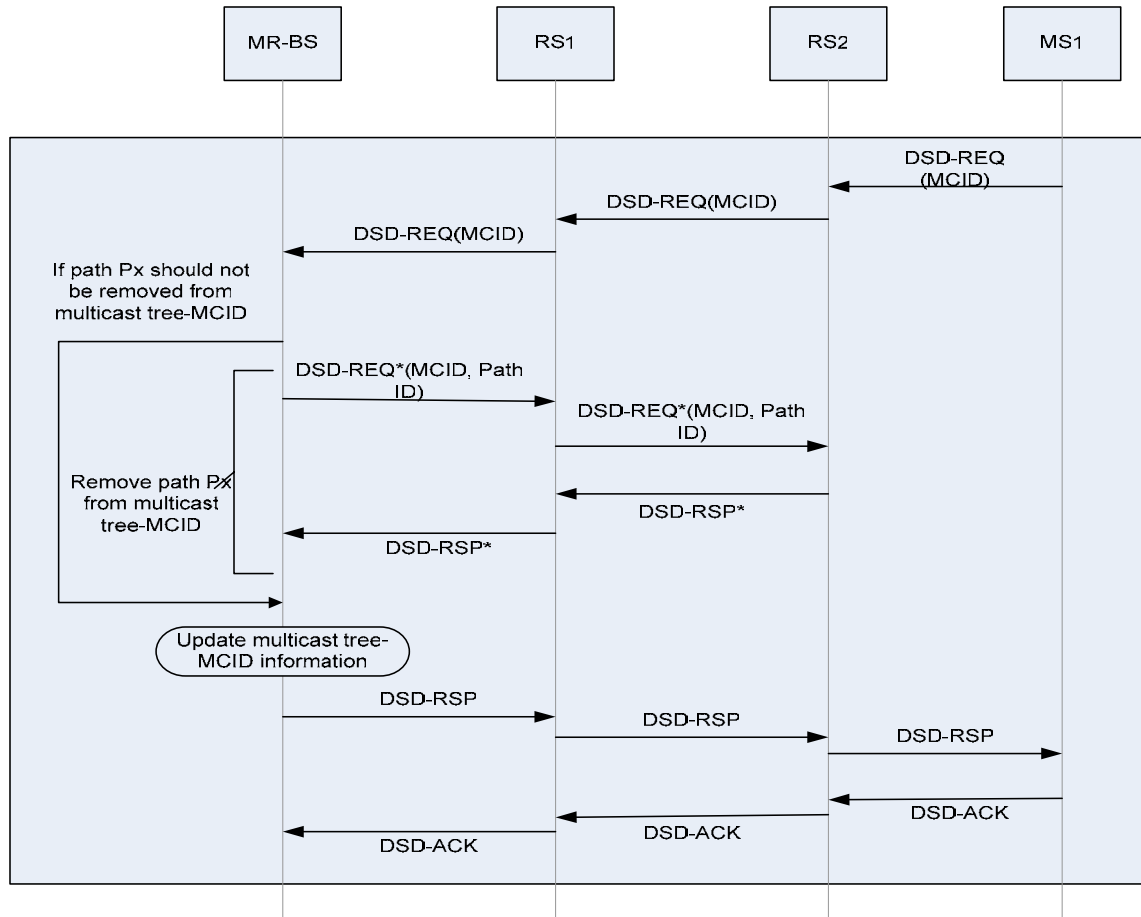


Fig. 3. Illustration of removing a path from a multicast distribution tree in MBS connection management

For example, for multicast distribution tree $\text{tree-MCID} = \{\text{MCID}, 2, (\text{P2}, 2), (\text{P4}, 1)\}$, when MS2 sends a DSD-REQ with MCID to MR-BS along path P2 to request removing it from the MBS flow, the MR-BS first updates the number and identification information of the MSs that are receiving the MBS along path P2. The updated multicast distribution tree information becomes $\text{tree-MCID} = \{\text{MCID}, 1, (\text{P2}, 1), (\text{P4}, 1)\}$. Because there is still a MS that receives MBS along path P2, the MR-BS simply sends a DSD-RSP to MS2 and MS2 acknowledges the DSD-RSP message with a DSA-ACK message. No further action is taken for RSs along path P2. If MS1 later sends a DSD-REQ to the MR-BS with MCID,

the MR-BS update the tree information to $\text{tree-MCID}=\{\text{MCID}, 2, (\text{P2},0), (\text{P4},1)\}$. The MR-BS determines that no MS is receiving the MBS of MCID along path P2, so the MR-BS sends a DSD-REQ* to each RS along path P2 to unbind the MCID and Path P2. The MR-BS deletes path P2 from the multicast distribution tree. The multicast distribution tree becomes $\text{tree-MCID}=\{\text{MCID}, 1, (\text{P4}, 1)\}$. The MR-BS then sends a DSD-RSP to MS1. MS1 then sends a DSD-ACK message to the MR-BS.

When the parameters for a multicast service flow change, a MR-BS or MS may also send a DSC-REQ message to update these changes. All the RSs in the multicast distribution tree of the MBS are informed of these changes. This is achieved by MR-BS sending a DSC-REQ* message to all of the RSs along all the paths in the multicast distribution tree as specified in the contribution C80216j-07/241r4.

3. Proposed text modification

[Add the following text to section 6.3.25]

6.3.25.3 Connection Management for Multicast and Broadcast Services

The MR-BS may initiate a multicast distribution tree for the MBS. When a MS wants to initiate a MBS, it sends a DSA-REQ message to MR-BS to specify that it wants the MBS. The procedures for establishing multicast distribution tree are as follows.

When a MR-BS initiates a MBS or receives a MBS request from a MS, it checks whether the requested MBS has been created. If not, the MR-BS creates a multicast distribution tree for this MBS and allocates a multicast CID (MCID) to it. The MR-BS also determines the path(s) to carry this multicast service flow. The MR-BS creates the mapping between the determined path and the MCID. The MR-BS informs all the RSs on the path of the binding between the path ID and MCID by sending a DSD-REQ* message along path as specified in Section 6.3.25.2. Each RS along the path stores the path ID and MCID binding information for forwarding multicast data with the MCID. The MR-BS adds this path to the multicast distribution tree and records the number and identification information of the MSs using the path for multicast communications. A multicast distribution tree may consist of multiple paths.

If the multicast distribution tree has been created and an MCID has been allocated to this MBS, the MR-BS determines the path to carry this multicast service flow. If the path is not in the multicast distribution tree, the MR-BS creates the binding between the determined path and the MCID. The MR-BS distributes the path and MCID binding information to all the RSs along the path. The MR-BS adds this path to the multicast distribution tree and record the number and identification information of the MSs using the path for the multicast communications. If the path is already in the multicast distribution tree (due to the prior establishment of MR-BS or the request of another MS using the same path), the MR-BS simply updates the number and identification information of the MSs using the path for the MBS in the multicast tree.

A path may be removed from a multicast distribution tree by the MR-BS. When a MS needs to leave the multicast service, the MS sends a DSD-REQ to the MR-BS to request removing it from the multicast service flow. The MR-BS first updates the number and identification information of the MSs that are receiving the MBS along the path to this requesting MS. The MR-BS determines whether the path can be removed from the tree-MCID. If no more MSs uses this path for the MBS, the path may be removed from the multicast distribution tree. Otherwise, the path shall not be removed from the multicast distribution tree. If the path is removed from the tree-MCID then the MR-BS removes the binding between the path and the MCID by sending a DSD-REQ* along path as specified in Section 6.3.25.2.

When the parameters for a multicast service flow change, a MR-BS or MS may also sends a DSC-REQ message to update these changes. All the RSs in the multicast distribution tree of the MBS are informed of these changes. This is achieved by MR-BS sending a DSC-REQ* message to all of the RSs along all the paths in the multicast distribution tree as specified in Section 6.3.25.2.