Topology Discovery and Path Management in IEEE 802.16j System

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IEEE C802.16j-06/195 http://dot16.org/CSUpload//upload/Relay_db/C80216j-06_195.pdf
IEEE C802.16j-06/164 http://dot16.org/CSUpload//upload/Relay_db/C80216j-06_164.pdf

Purpose:

The purpose of this slide set is to introduce contribution C802.16j-06_195 and C802.16j-06_164. This contribution is proposing topology discovery and path management schemes in multi-hop relay system. Changes in the standard are described in contribution C802.16j-06_195.pdf.

Outline

- Introduction
- Light-weight topology discovery procedure - Initial Topology Discovery
- Topology update
- Path calculation
- Path advertisement and cancellation
- Path selection
- Summary

Introduction

- Single-hop system
  - MS directly attaches to BS, and therefore BS knows the 1-hop path to the MS.
- Multi-hop relay system
  - There are one or more RS between MS and MMR-BS, but there is no existing mechanism for MMR-BS to determine the topology and path between an MS and itself.
  - Knowing topology and path to/from an MS by MMR-BS and RS is required to support various system features, such as scheduling, routing, signaling transfer, and path selection.
  - Maintaining path could produce significant system overhead.
  - We need a simple and light-weight topology discovery and path management mechanism.
- This contribution proposes a light-weight topology discovery and path management scheme.
  - Topology discovery is achieved by enhancing the existing ranging procedure, instead of adding a new procedure.
  - Path management is coordinated by MMR-BS and requires less complexity in RSs

Initial Topology Discovery

- Initial Ranging based topology discovery
    - When a new station (RS or MS) attempts initial entry to a network, it sends an initial RNG-REQ message to the MMR-BS (with the Initial ranging CID).
    - Upon receiving an initial RNG-REQ, a RS (RSi) encapsulates it into an Encapsulated-RNG-REQ together with its own RSID and sends it to the MMR-BS.
    - If a MMR-BS receives an initial RNG-REQ, it determines that the station sending the RNG-REQ directly attaches to it.
    - If a MMR-BS receives an Encapsulated-RNG-REQ, MMR-BS determines that the station sending the original RNG-REQ directly attaches to the RS (RSi) identified by the included RSID. It also generates the RNG-RSP for the RNG-REQ, encapsulates it into a Encapsulated-RNG-RSP and sends it to RSi.
    - Upon receiving an Encapsulated-RNG-RSP, RSi extracts the RNG-RSP from the MMR-BS and sends it to the attached station.
    - MMR-BS derives the topology based on the RNG-REQ and Encapsulated-RNG-REQ it receives.

Example Procedure of Initial Topology Discovery
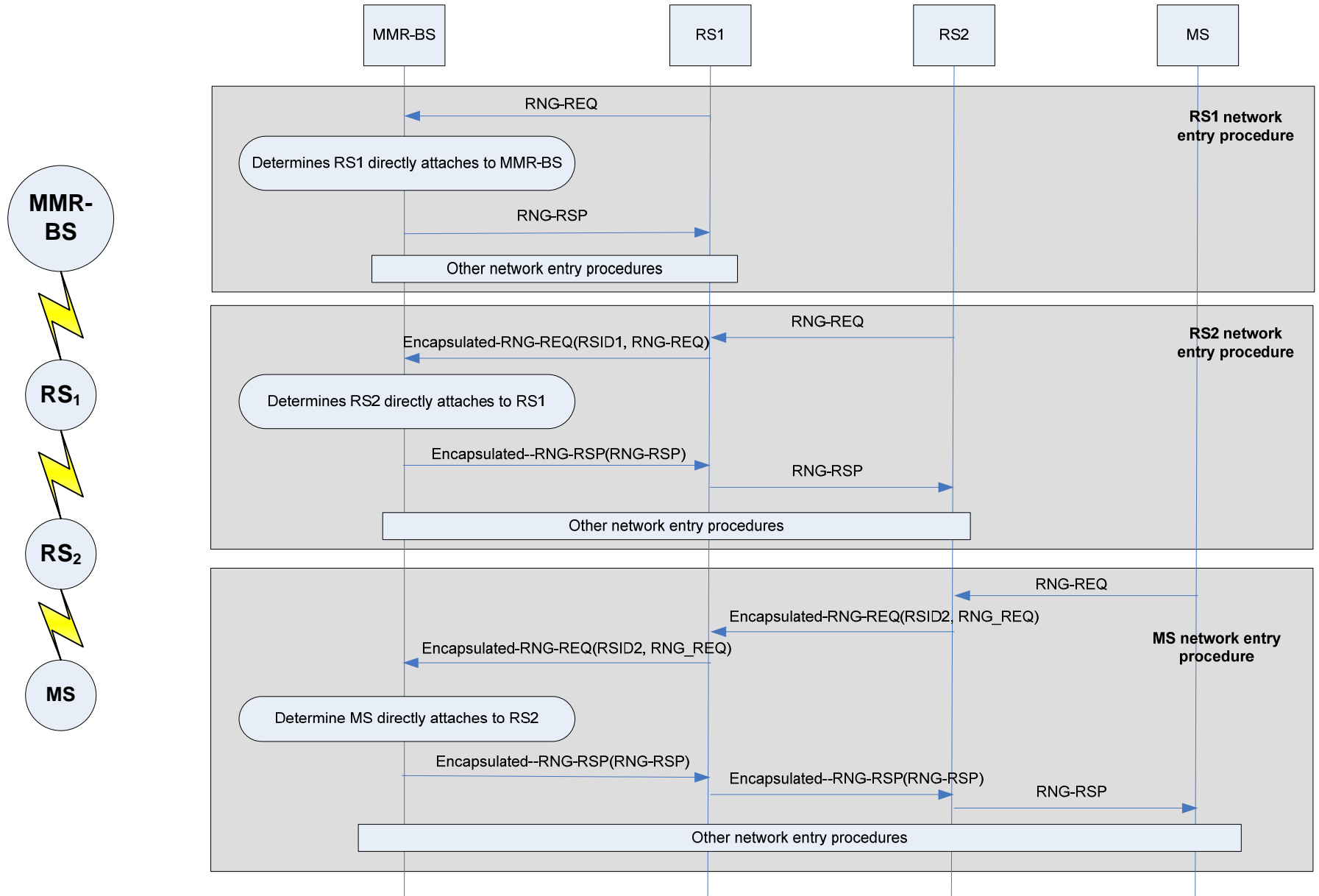
Topology Update

- The topology established during initial network entry of the MS or RS could be changed due to events such as mobility including handover, network re-entry or location update.

- It is assumed that these mobility related procedure should be able to provide update to the MMR-BS with the new topology information.

  - MMR-BS is aware of the RS mobility, it can detect topology update (MRS handover, active set update etc.) and may delete and establish new path and advertise them to all the affected RSs on the path.

- Separate procedure for topology update procedure is not required.

Path Calculation

- Based on the topology information obtained from the topology discovery process, MMR-BS makes centralized calculation for the path between MMR-BS and MS for both uplink and downlink direction.
- The two end points of a path associated to an MS are MMR-BS and the RS to which the MS directly attaches
  - Two MSs may share the same path between MMR-BS and the access RS
  - MS may communicate over multiple path between MMR-BS and the access RS
- The algorithm for determining the path based on the topology is out of the scope of this contribution.
- Whenever the topology is updated due to events such as mobility, the MMR-BS recalculates the paths and may generate new paths and/or delete invalid paths.

Path Advertisement and Cancellation

- When a new path is calculated after initial topology discovery or topology update, MMR-BS advertises the complete path information to all the RSs on that particular path.
    - MMR-BS sends a PATH-ADV-REQ message with the Action-Type field set to ESTABLISH with a uniquely assigned path id.
    - The complete path information and the path id are carried in the Path-Information TLV and Path-Id TLV.
    - Each RS receiving the PATH-ADV-REQ message records the path id and the complete path information, and then responds with a PATH-ADV-RSP.
- If the MMR-BS decides to cancel an existing path, it sends a PATH-ADV-REQ message with the Action-Type field set to CANCEL with the associated path id.
- The transmission schemes for PATH-ADV-REQ are specified in *Contribution C80216j-06_196.pdf "Transmission Scheme for MAC Management Message for a Group of RS"*.

Path Selection (1)

- MMR-BS maintains all the advertised paths.
- When a new connection is established for an MS, the MMR-BS selects one or more path to carry the traffic for the new connection.
- MMR-BS then informs all the RSs on the path of the traffic information by sending a PATH-SEL-REQ message with the Action-Type field set to ESTABLISH. Following information is included in PATH-SEL-REQ.
  - Path-id
  - CIDs of the connections that will be routed through the specified path
  - Optional SF Parameters for each of the associated service flow
- Upon receiving a PATH-SEL-REQ with Action-Type field set to ESTABLISH, it retrieves the complete path information based on the path Id, and records the mapping between the enclosed CIDs to the path information, which will be used to route the traffic carried over the specified CID.
  - If SF Parameters are also present for certain connection, RS also saves this information for scheduling traffic
  - Each RS replies with a PATH-SEL-RSP

Path Selection (2)

- If the MMR-BS decides to cancel an existing mapping between a path and one or more CID, it sends PATH-SEL-REQ message (with the Action-Type field set to CANCEL) to all the RSs on the path.
    - The Message includes the Path-Id and the affected CIDs.
    - The RSs receiving the message should remove the record of the mapping between the Path-ID and the associated CIDs, and won't use such information to route the subsequent packets carried over the specified CIDs.
- The transmission schemes for PATH-SEL-REQ are specified in *Contribution C80216j-06_196.pdf "Transmission Scheme for MAC Management Message for a Group of RS"*.

Example Procedure of Path Selection during SF Creation
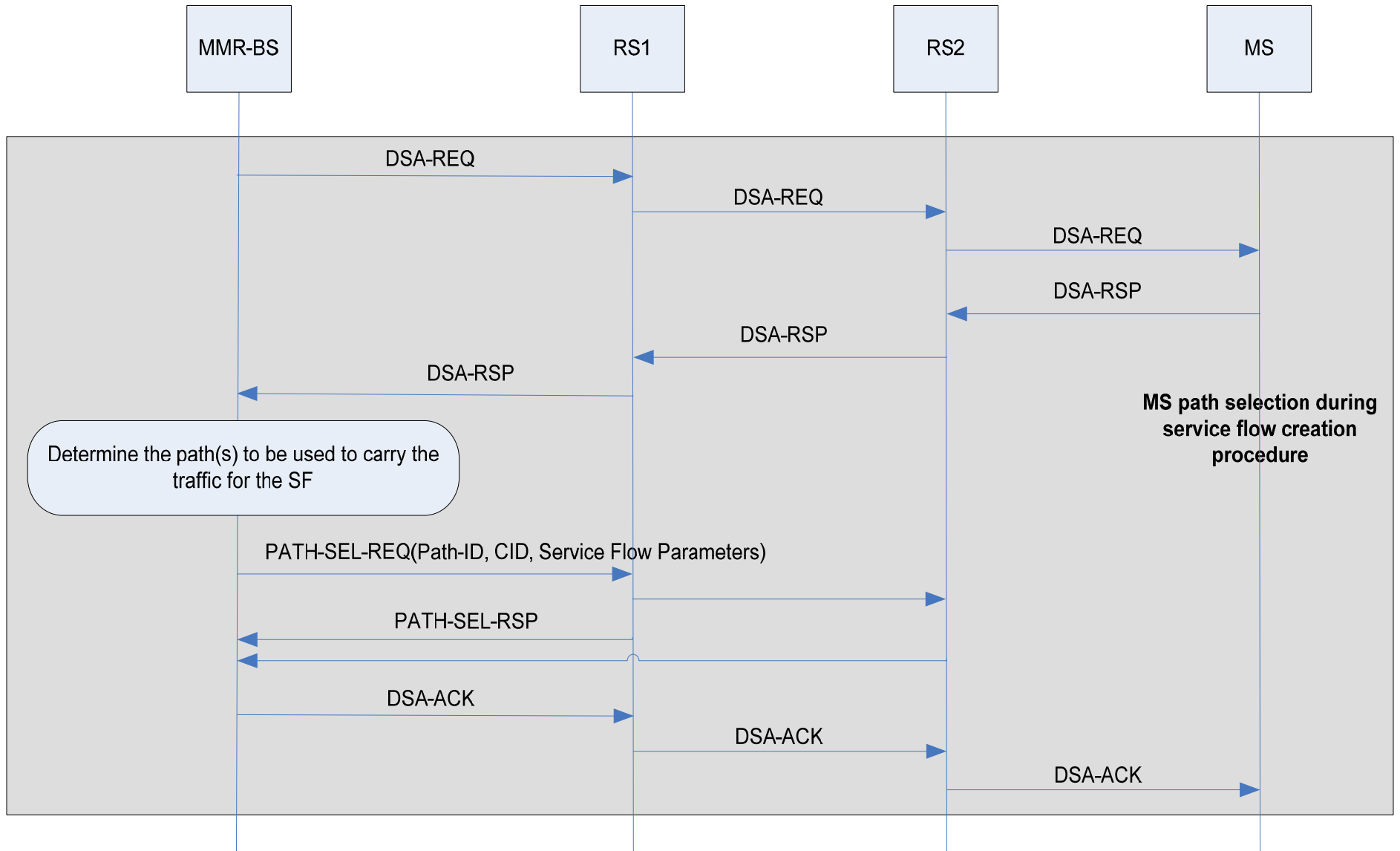
Summary

- There is clear need for topology discovery and path management scheme in multi-hop system.

- Proposed topology discovery and path management scheme is light weighted.

- MMR-BS controls and manages the topology within MMR-CELL. Require less complexity in the RS.

- Topology discovery is combined with ranging procedure therefore required minimum changes to the specs.

- Light-weight topology discovery and path management scheme can support and manage multi-path between MMR-BS and MS without requiring modification to MS.

- In case of distributed scheduling, it also provide mechanism to distribute SF Parameters to the RSs in the path to support the QoS requirements.

- Supports RS mobility and MS mobility (Handover, MDHO, active set update, etc.) efficiently and provide signaling for topology update and path management.

- Details of the proposed light-weight topology discovery and path management scheme and required changes in the specification are provided in contribution C802.16j-06_195.pdf.