Topology Discovery and Path Management in IEEE 802.16j System

IEEE 802.16 Presentation Submission Template (Rev. 8.3)

Source:

Haihong Zheng,	Voice:	+1 972-894-5000
	E-mail:	haihong.1.zheng@Nokia.com,
Yousuf Saifullah,		yousuf.saifullah@nokia.com
Shashikant Maheshwari		shashikant.maheshwari@nokia.com
Nokia Inc.		
6000 connection Drive		
Irving, TX 75063		

Venue:

IEEE 802.16 Session #46 Dallas, US

Base Document:

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

Purpose:

The purpose of this slide set is to introduce contribution C802.16j-06_195. This contribution is proposing topology discovery and path manageme 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
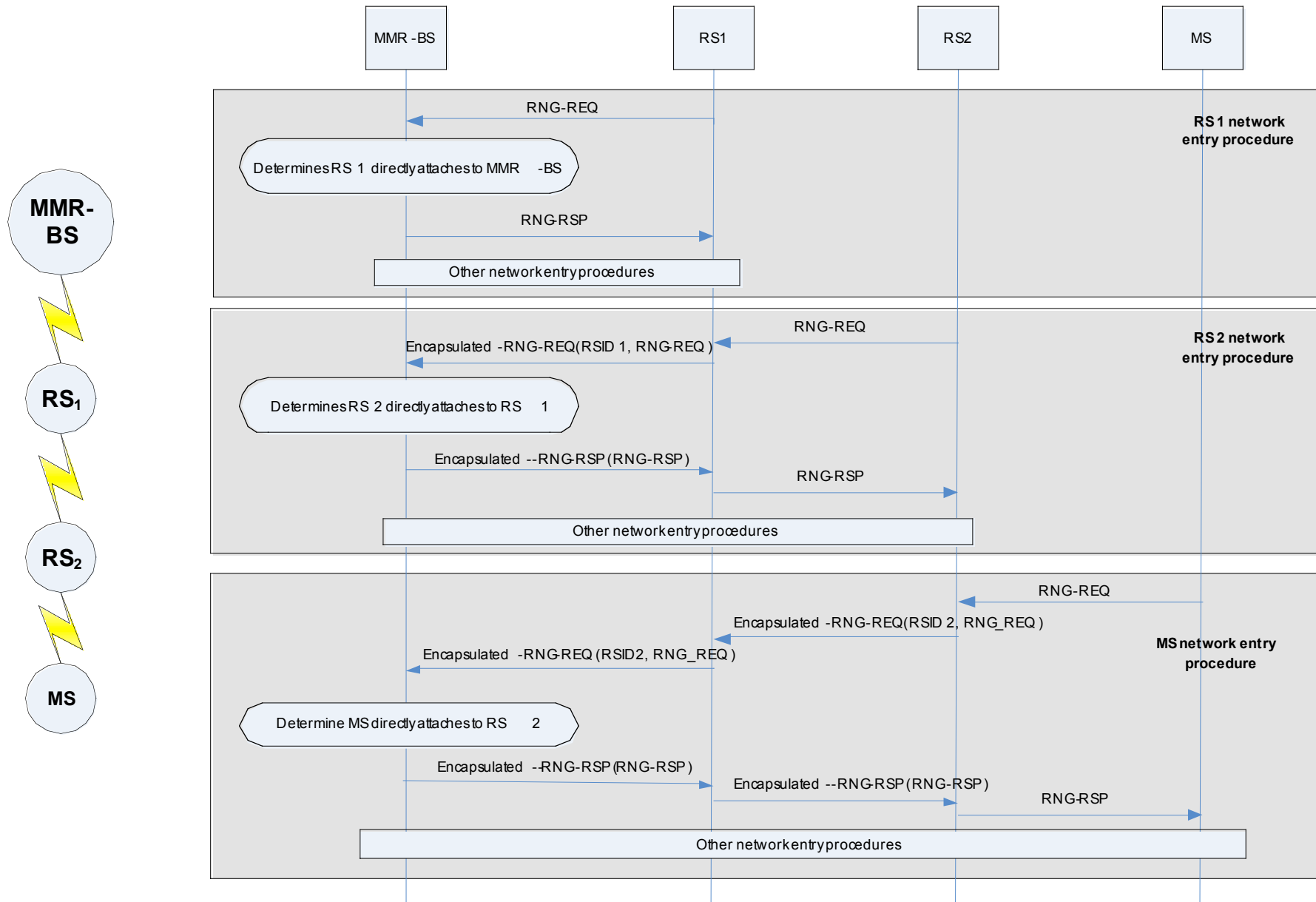
Topology Update

- 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 o 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 1 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 updat 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 T 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 fo 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 t enclosed CIDs to the path information, which will be used to route the traffic carried ove 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 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
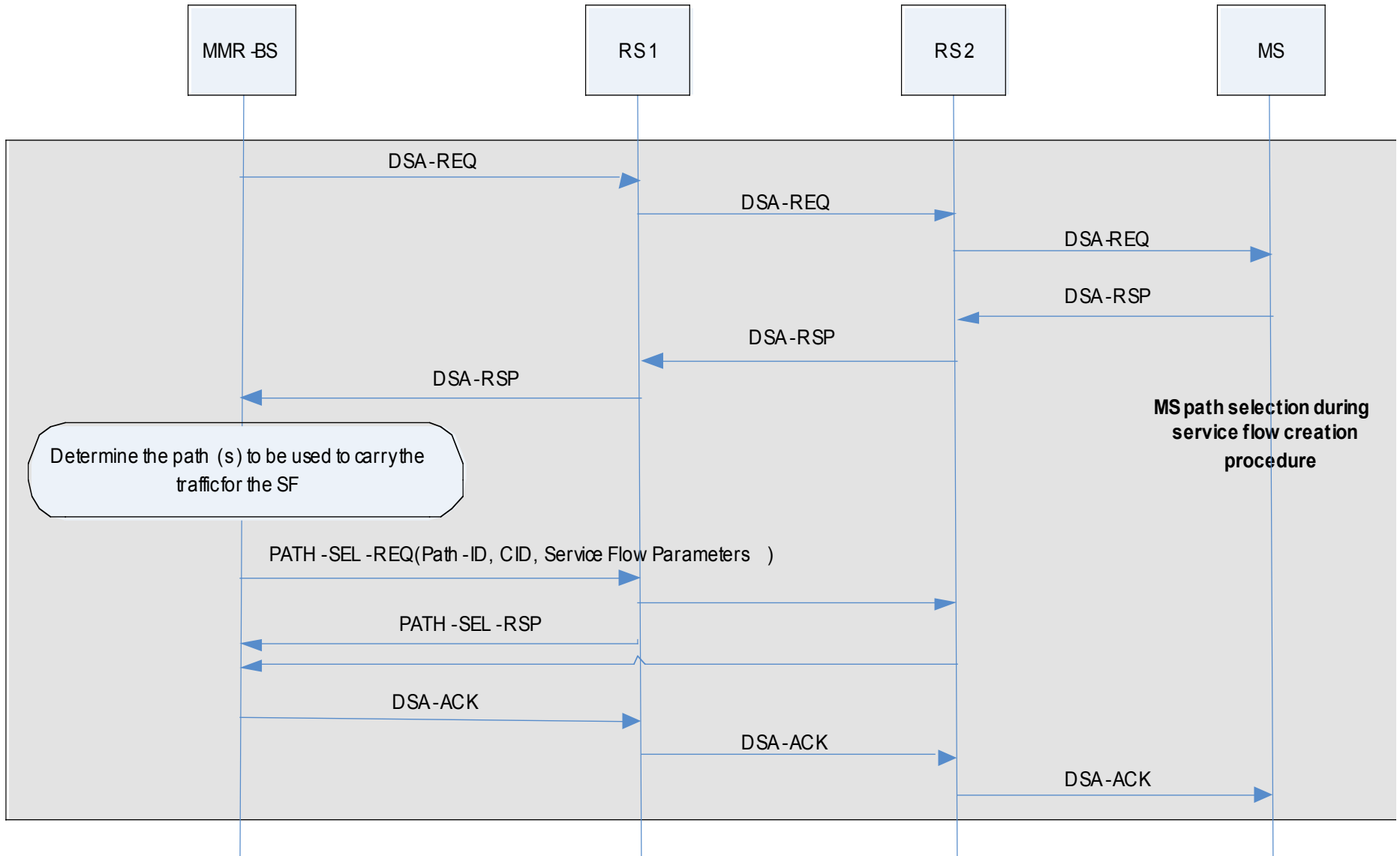
Summary

- 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 an 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, et 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.