SMART Relay Alliance proposal

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SMARTRelay

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- Objectives
- Network configuration
- Channel access
- Topology management
- Routing procedure
- Cross communication

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Objectives

- SMART Relay Alliance proposes RS specifications for 802.16j
- This group should take into account both
  - **Low-complexity Relay** stations for low cost solutions
  - **SMART Relay** stations for enhanced applications
- SMART Relay Alliance proposal is about this latter category

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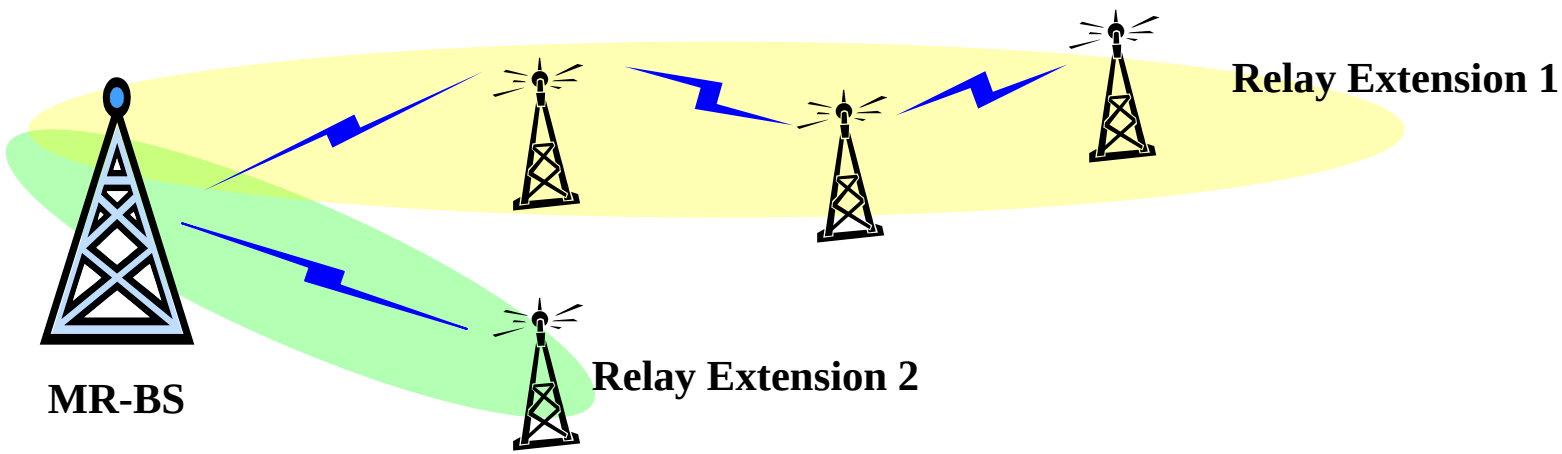
Introduction – Relay Framework

- MMR-BS–centric network
  - Commercial interest – Operators want control
  - Cost–efficiency – RS logic to be inexpensive
- Relay network managed as extended MMR-BS
  - RSs are collectively managed
  - Logical extensions to MMR-BS



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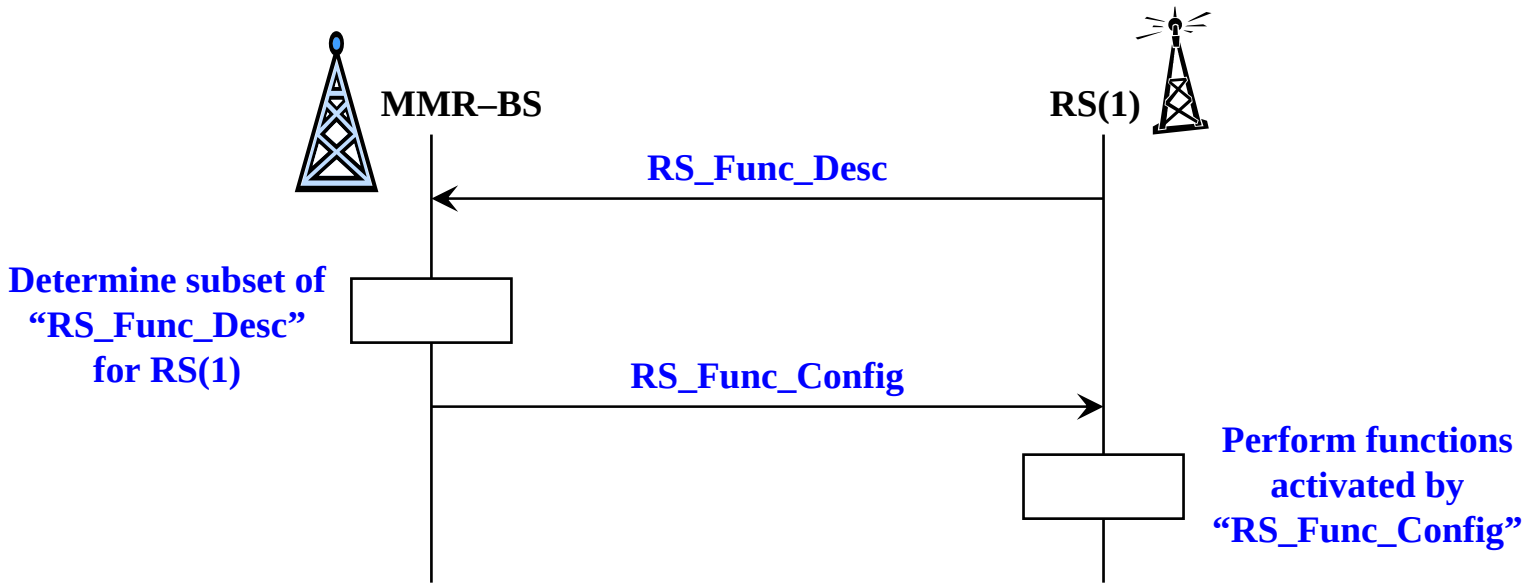
RS Configuration – Functionality

- RSs are configured to operate on behalf of MMR-BS
  - RSs may have varying functionality
  - MMR-BS responsible for selectively configuring different RSs
- Capability Negotiation
  - RS sends functionality information to MMR-BS
  - MMR-BS determines which functions to be activated
  - RS performs only activated functions



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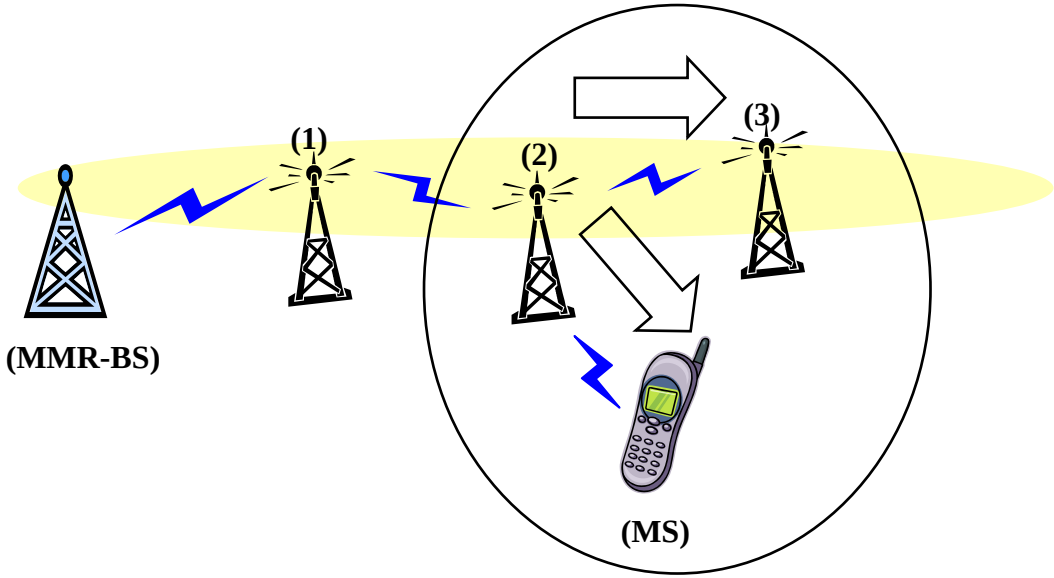
RS Configuration – Operation Modes (1/2)

- RSs operate in 2 modes – Downstream, Upstream
- Downstream
  - RS is an extension of the BS
    - To MS in its own cell
    - To other downstream RSs
  - RS performs “Infrastructure Functions” (IF) on behalf of MMR-BS
- Upstream
  - RS operates like MS
    - With MR–BS
    - With other upstream RSs
  - RS performs “Client Functions” (CF) – relays traffic
    - From own cell
    - From other downstream RS-cells
- RSs operate in both modes for relay network

RS Configuration – Operation Modes (2/2)

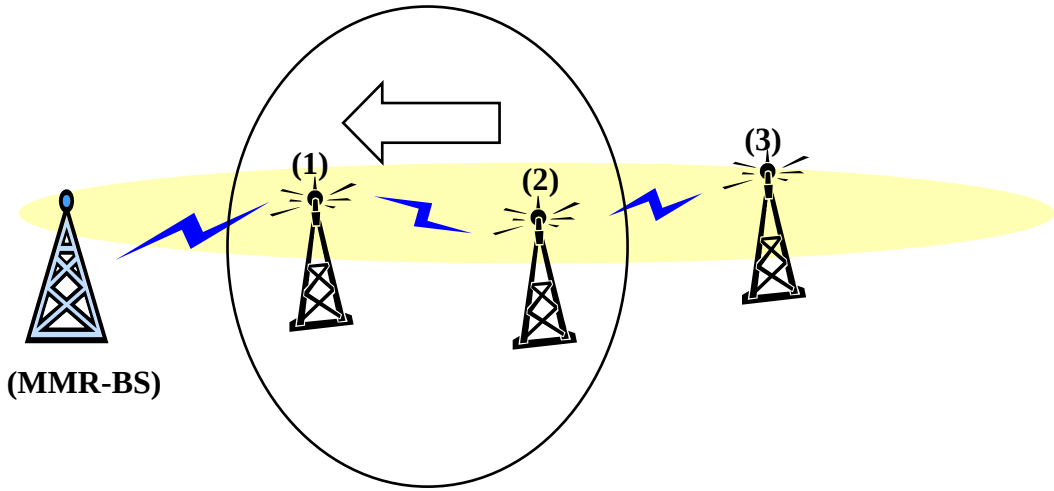


Downstream – IF-mode

- RS(2) provides Infrastructure Functions (IF)
  - To MS in its own cell
  - To downstream RS(3) & its MS

Upstream – CF-mode

- RS(2) performs Client Functions (CF) with upstream RS(1)
- RS(2) forwards data traffic
  - From its own cell
  - From downstream RS(3)



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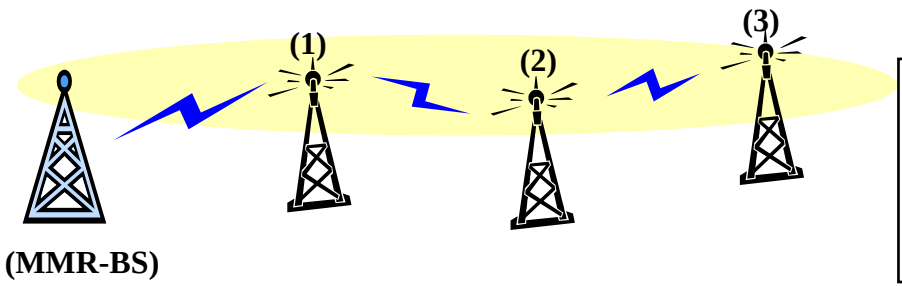
Channel Access (1/2)

- Channel access to MMR–BS sees 2 types of contention
  - Direct contention
    - RSs directly communicating with MMR–BS
  - Indirect contention
    - RSs that are 1 or more hops away from MMR–BS
- Bandwidth Request/Grant must address both Direct & Indirect contention for MMR–BS channel



• RS(1) makes Bandwidth Request for RS(1) and subsequent downstream RSs

• MMR-BS makes Bandwidth Grant for RS(1) and subsequent downstream RSs

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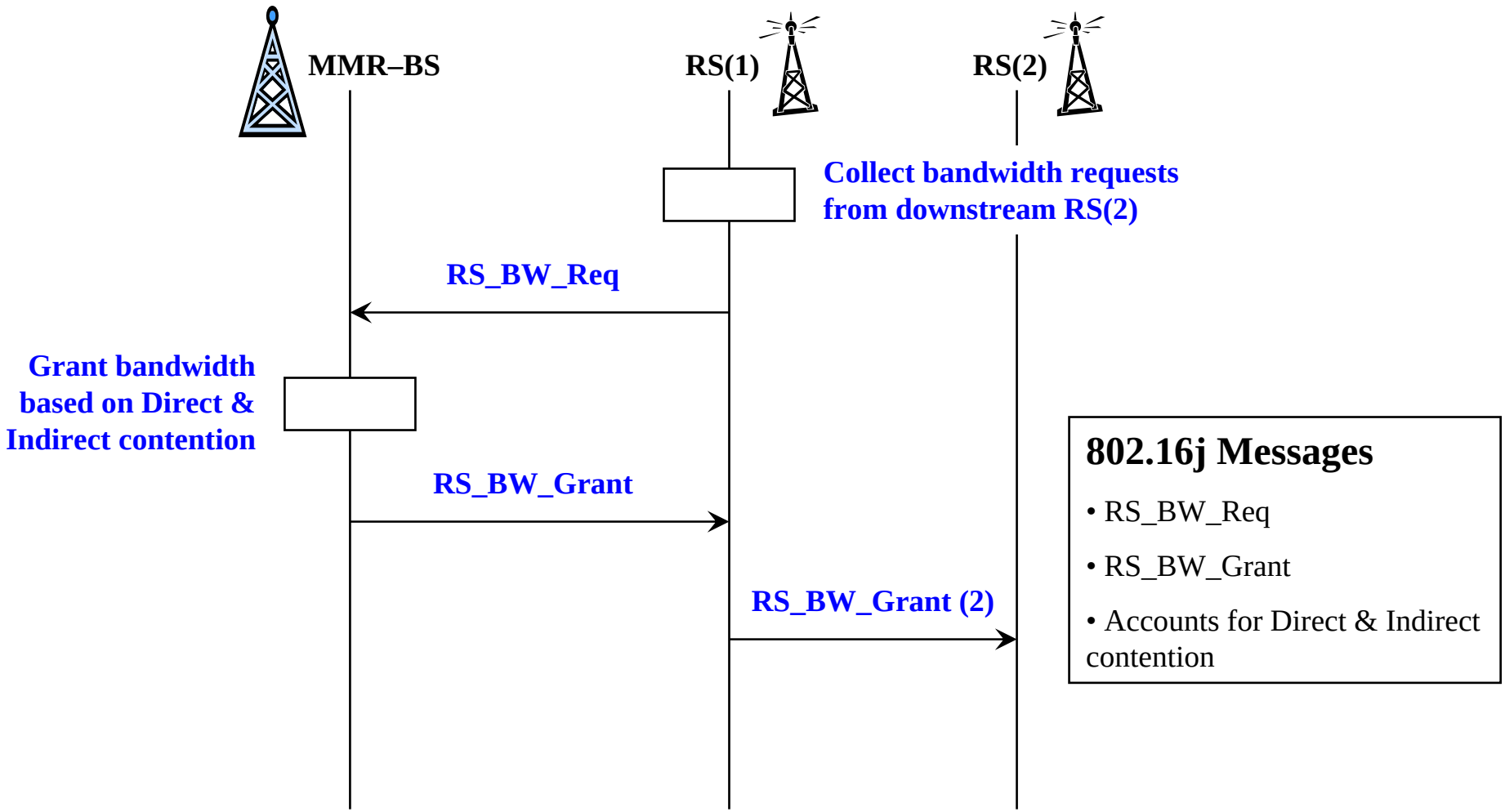
Channel Access (2/2)



802.16j Messages

- RS_BW_Req
- RS_BW_Grant
- Accounts for Direct & Indirect contention

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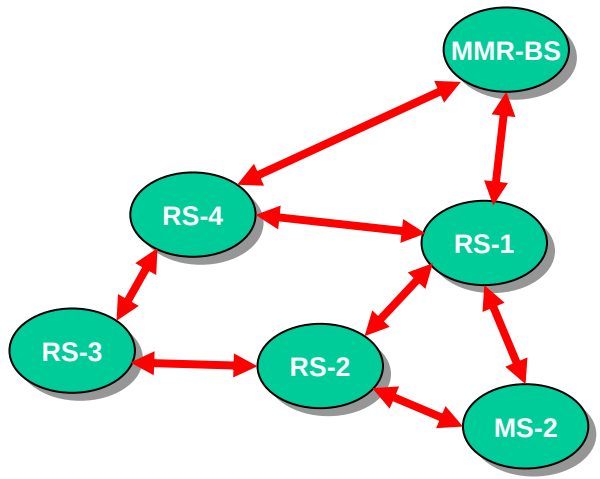
Topology management (1/3)

- **First step : Neighboring discovery**
  - Periodic exchange of link state messages (NCFG in 802.16-2004)
  - These messages transport the list of the 2-hops neighbors of the source
  - Construction of the local topology at the relay node
  - Each relay have the knowledge of its 3-hop neighborhood



NCFG messages

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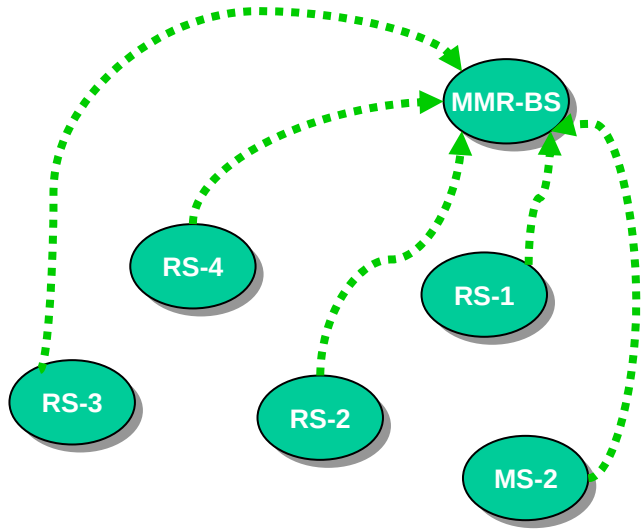
Topology management (2/3)

- **Network Topology establishment**
  - Transmission of the local topology to the BS using the link state messages (NCFG in 802.16-2004)
  - The MMR-BS construct a cartography of the network (global topology)
  - The MMR-BS is aware of its 3-hop neighborhood



Local Topology transmission

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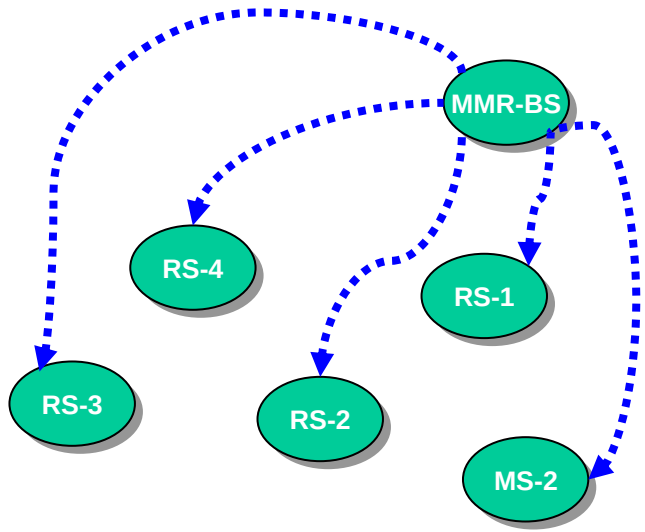
Topology management (3/3)

- **Tree topology construction at the BS**
  - Which algorithm?
    - Selection of the shortest path to the BS based on link states
  - Which metrics to weight vertices (dynamic/static)
    - At least Link states
  - Tree topology is transmitted to all nodes using CSCF messages



Tree topology transmission

- **All nodes perform these three steps periodically to handle network dynamicity**

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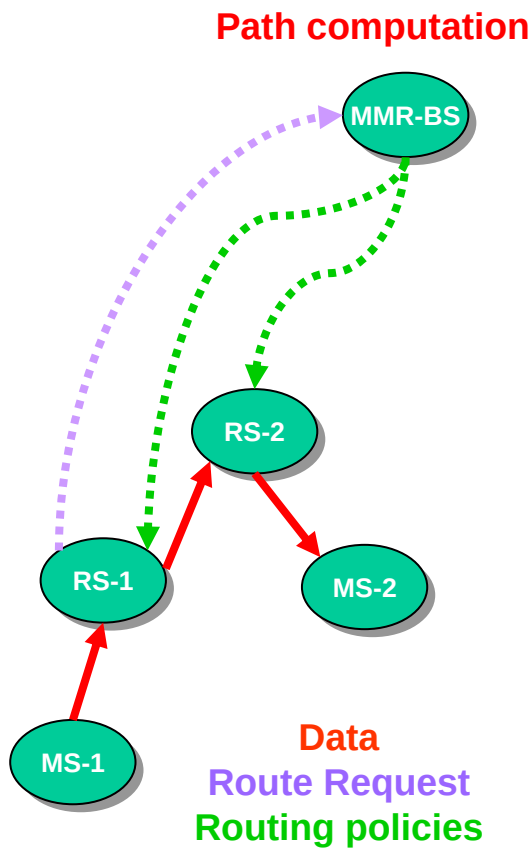
Routing (1/3)

- Technique 1: Reactive protocol
  - Takes into account all links available
  - RS-1 send a Route request toward MMR-BS to locate for the RS to which MS-2 is attached
  - The path between MS-1 and MS-2 is established and routing policies are sent to all relays which are in the path



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Routing (2/3)

- Technique 2: Pro-active protocol
  - This protocol takes advantage of the tree topology
  - A local routing table is built in all nodes based on the Tree topology information received in the CSCF messages
  - The update of these tables depends on the CSCF transmission rate
  - It doesn’t require any specific request, so **end-to-end delay is minimized**

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Routing (3/3)

- Technique 3: Hybrid protocol to take advantage of both Proactive and Reactive protocol
  - Proactive protocol to build a routing local table in all nodes
  - To set up dynamically new topology/routes based on the reactive one
- By default end-to-end delay is minimized (Proactive protocol)
- If other QoS Metrics are to consider, Reactive procedure is used
- The recommendation is to use Technique 3.

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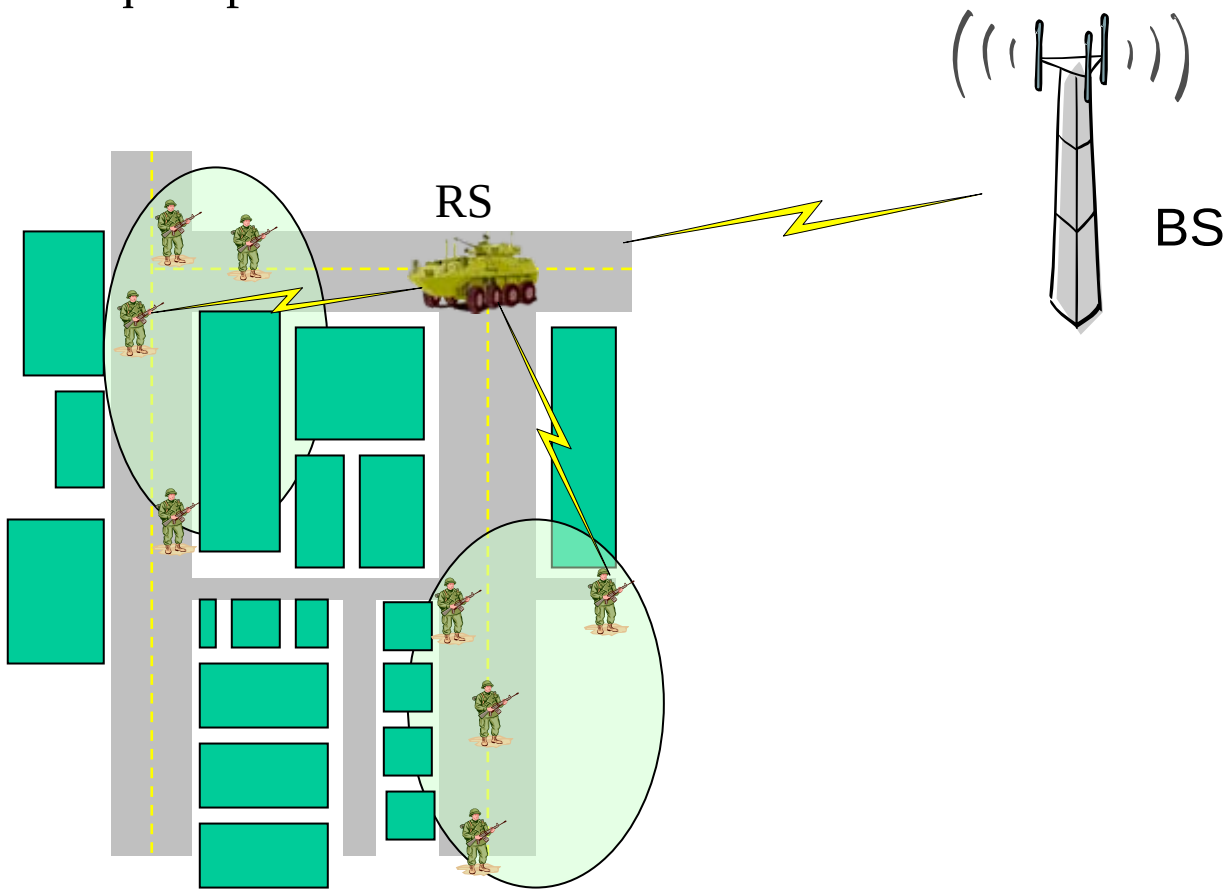
Cross Communications scenarios (1/4)

- **Example 1** : Military communication
  - Mobile user (e.g. soldier) communicates with another mobile user within the same squad/platoon



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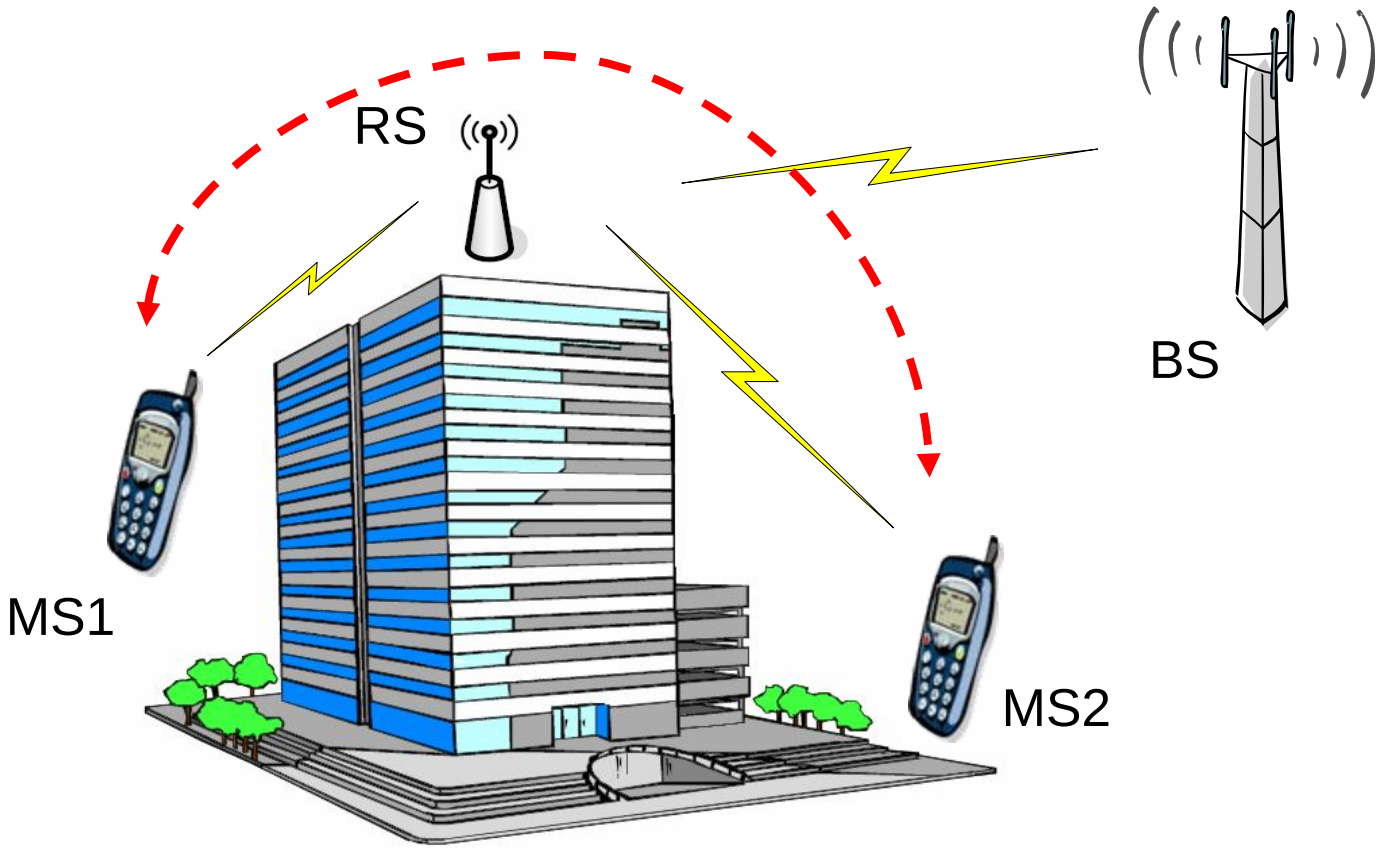
CC scenarios (2/4)

- **Example 2** : Communication in an office
  - Two MSs are located in the same building (same RS cell)
  - RF efficiency improved since data doesn't need to be transferred to the BS



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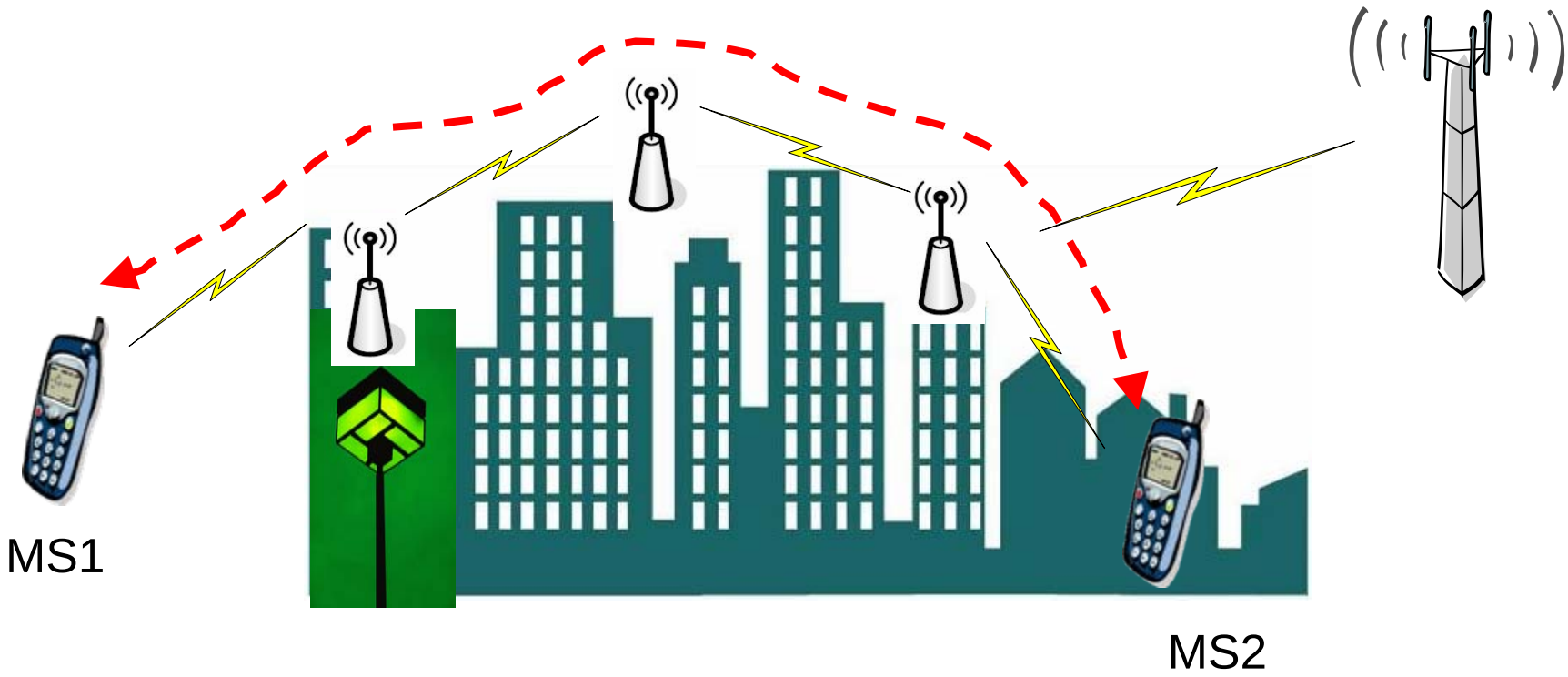
CC scenarios (3/4)

- **Example 3** : Communications among different RS cells
  - Two MSs are located in the same MMR cell but different RS cells



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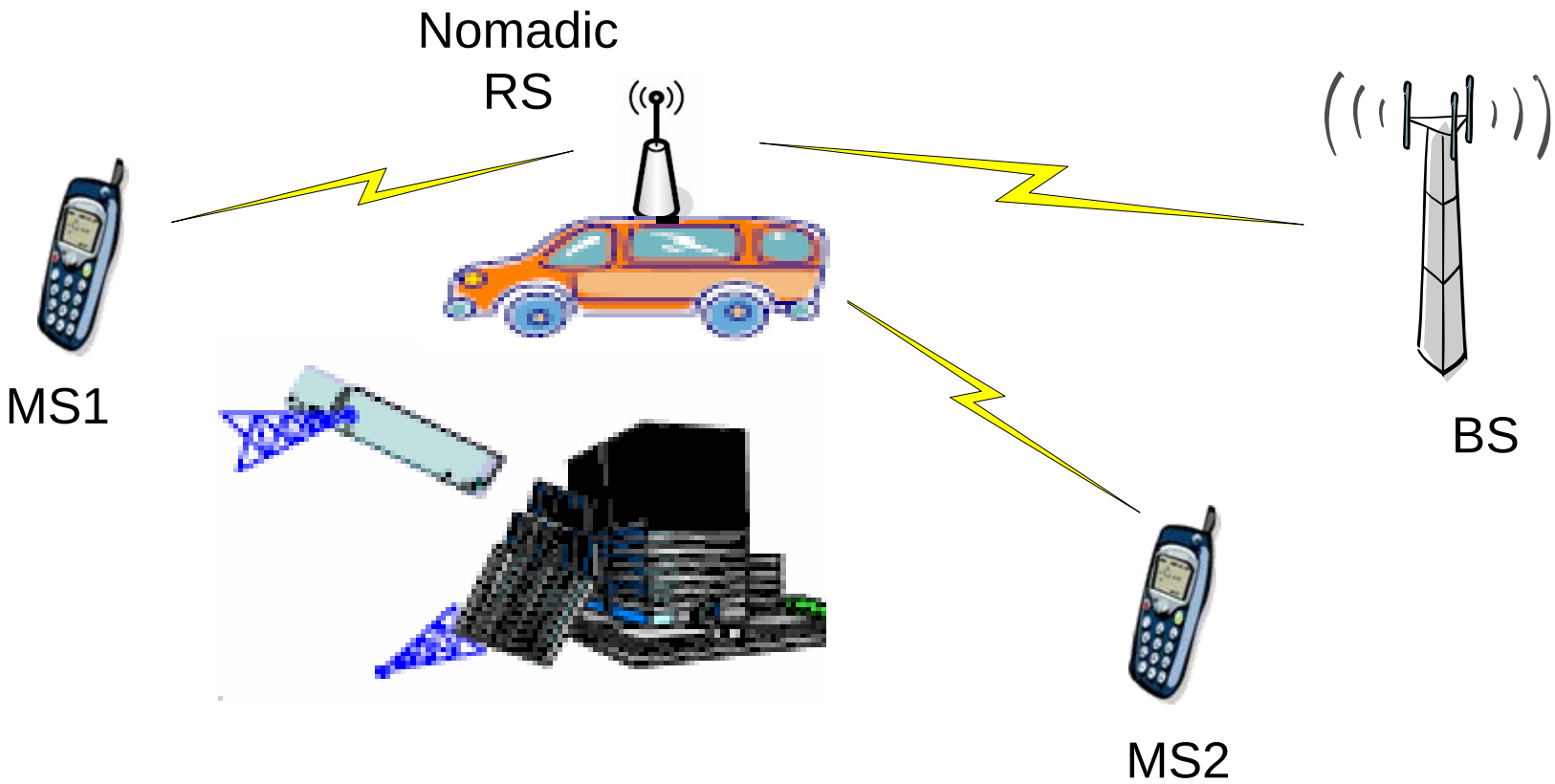
CC scenarios (4/4)

- **Example 4** : Emergency/Recovery situation



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CC advantages

- Bandwidth efficiency
  - Civilian applications
  - Military applications
- End-to-end delay minimization
  - Real-time applications (voice, video conference…)
  - Public safety applications
  - Military applications

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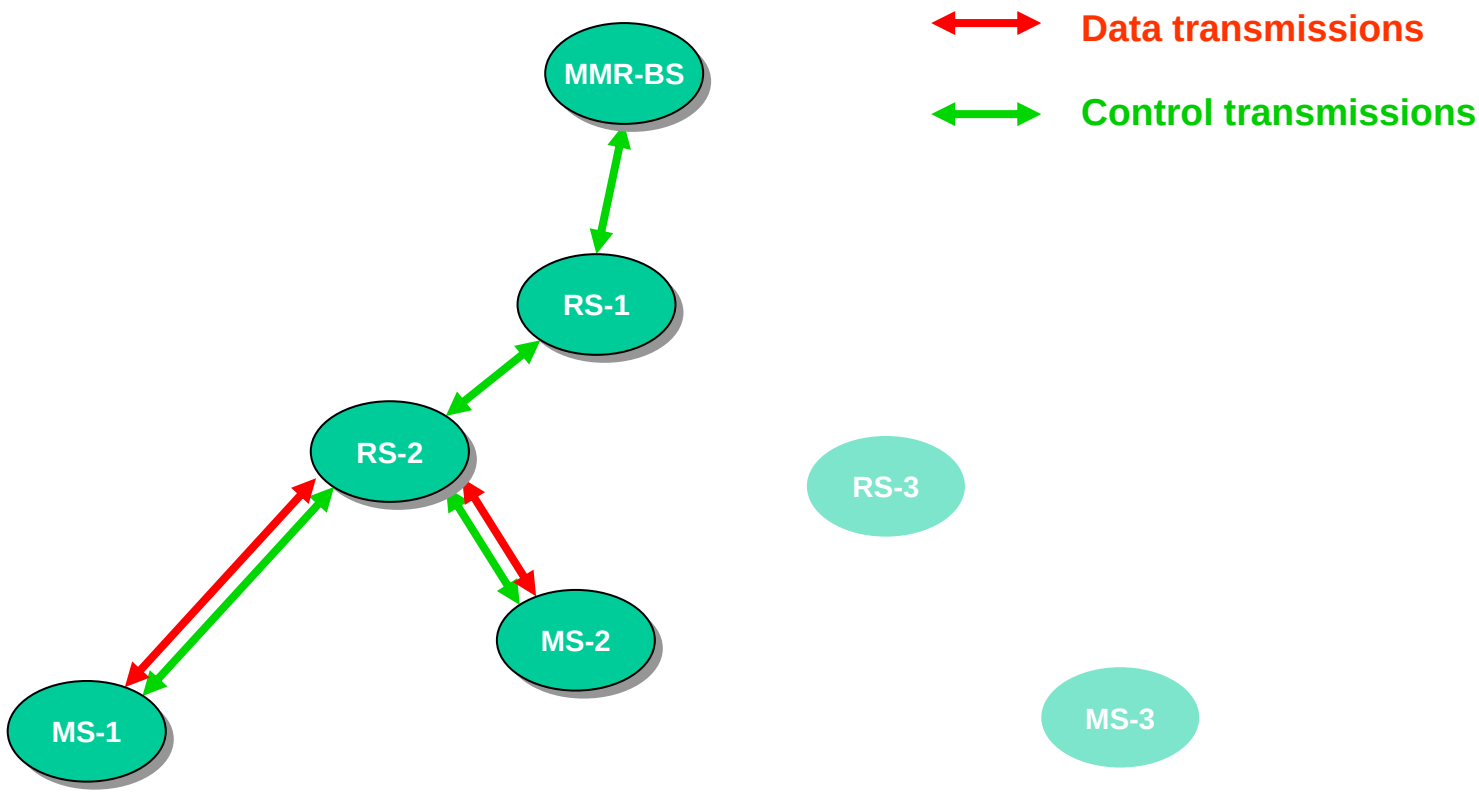
CC procedure (1/6)

- Cross-Communication procedure is controlled by the BS
- Data transfer only passes through 1 RS



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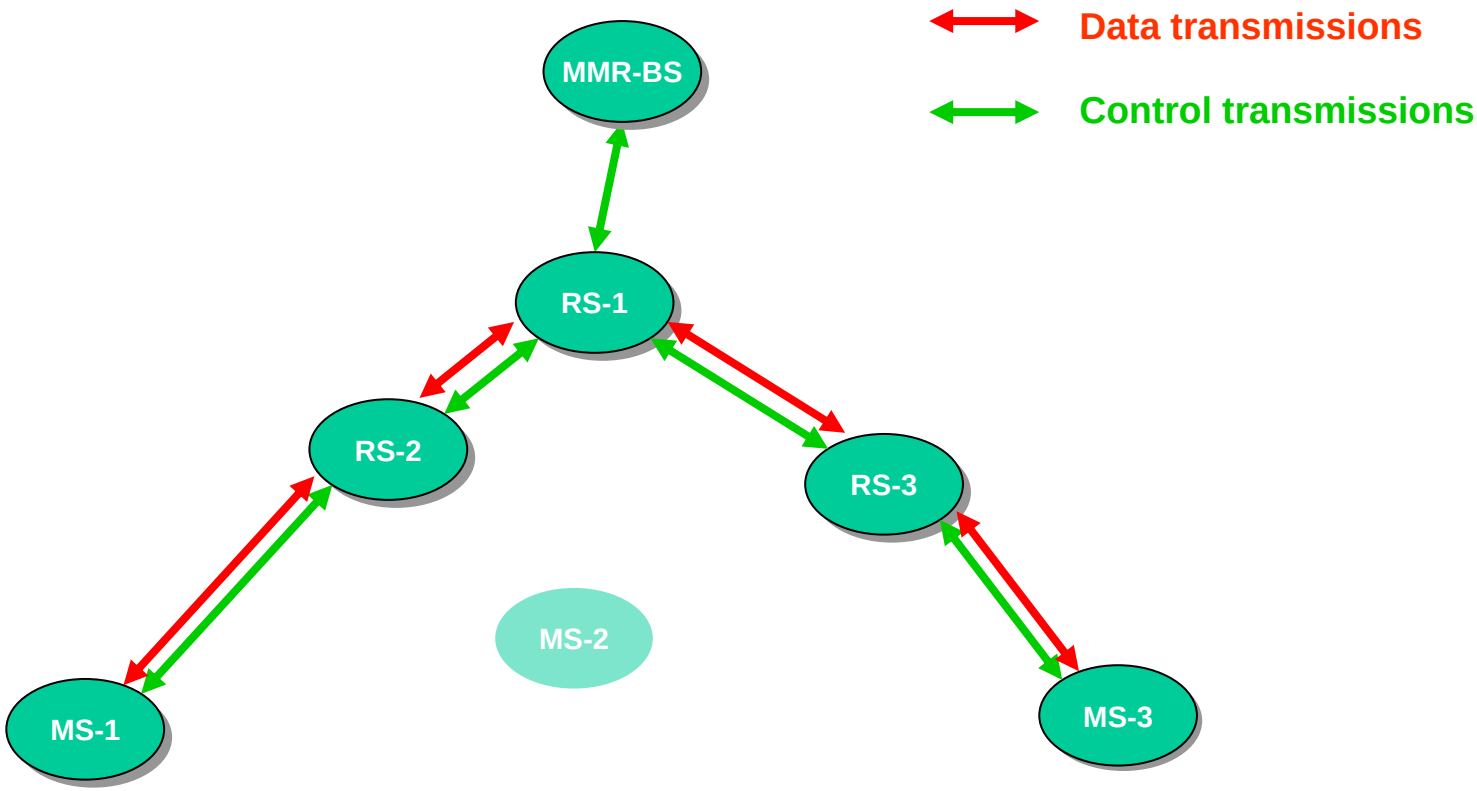
CC procedure (2/6)

- Data transfer can go through multiple RSs in MMR cell



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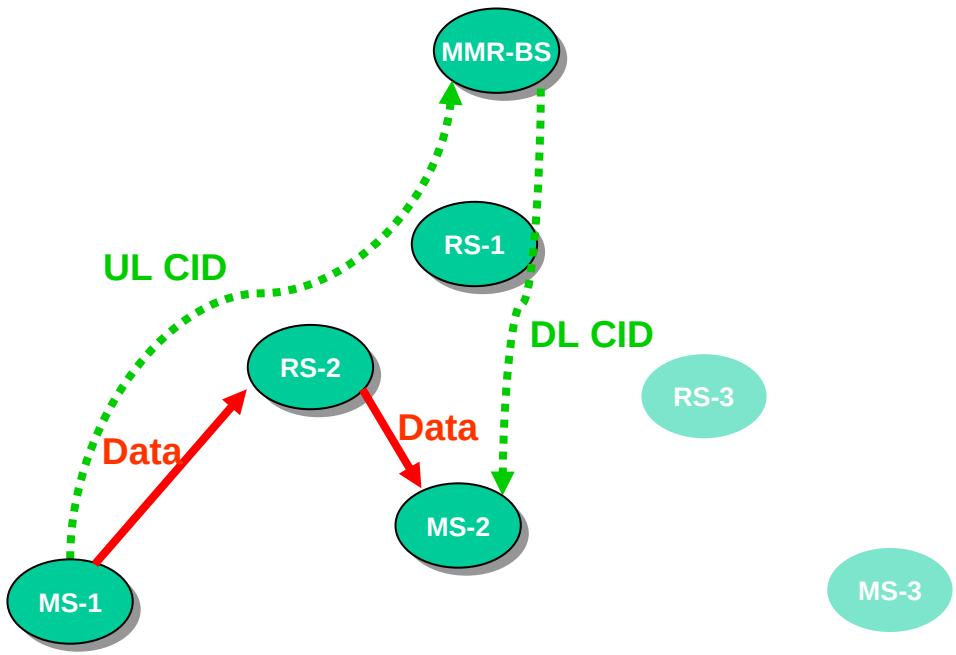
CC procedure (3/6)

- CC doesn't require any modification to the MS
  - It requires connections between MS and BS
  - 2 CID are used for 1 Cross-Communication

- The topology is still a **tree** (not a mesh)



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CC procedure (4/6)

- Simple procedure containing 2 parts :
  - **Cross Communication request** during connection setup
    - Request permission to the BS
    - Perform a bandwidth adjustment
  - **Redirection procedure** when a packet is received in the involved RS

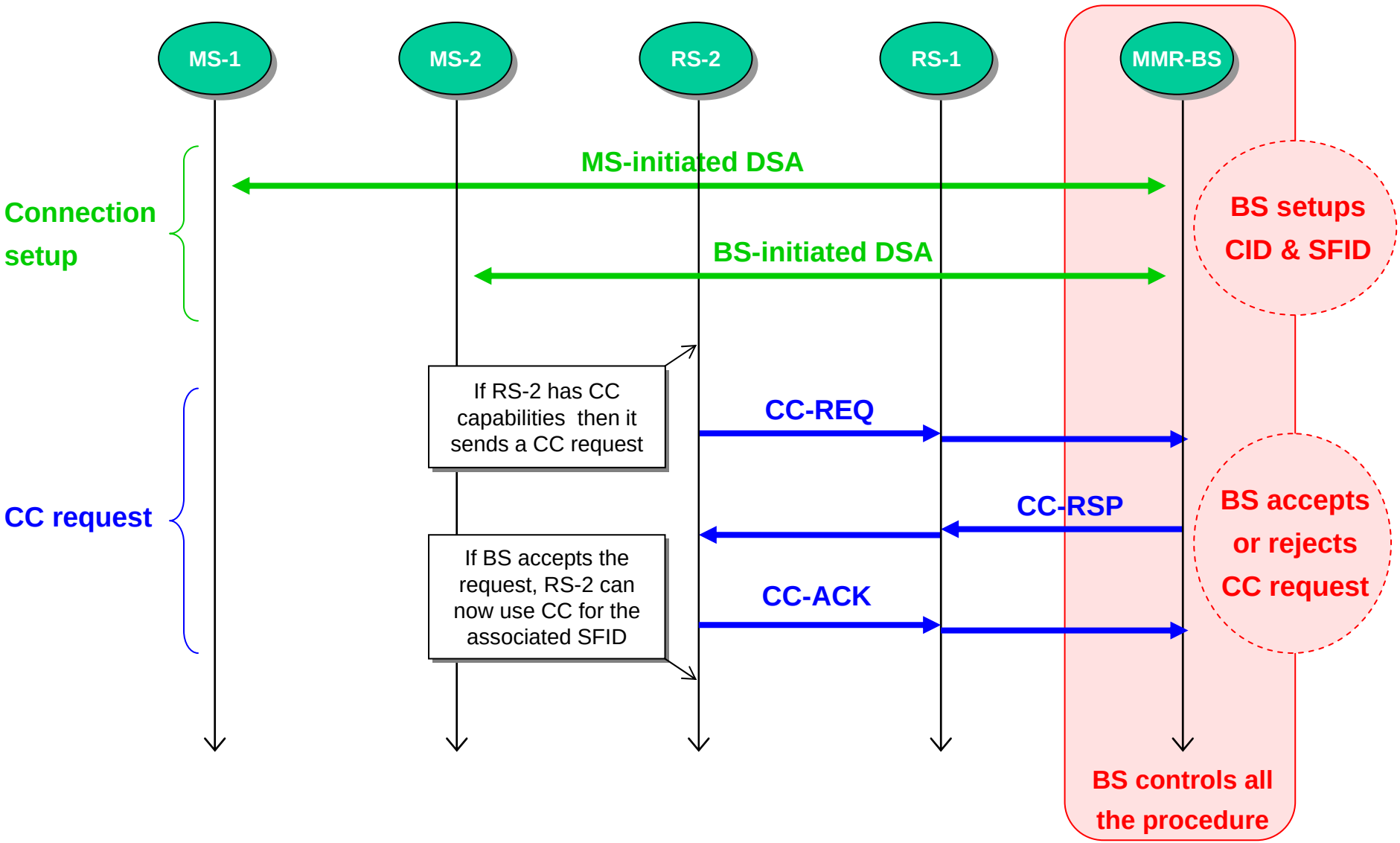
- CC authorization is based on the following conditions


Involved RS has CC capabilities (optional feature)


CCs are authorized by the infrastructure owner policy


BS authorizes CC for this MS, the selected QoS…

CC procedure: Request (5/6)



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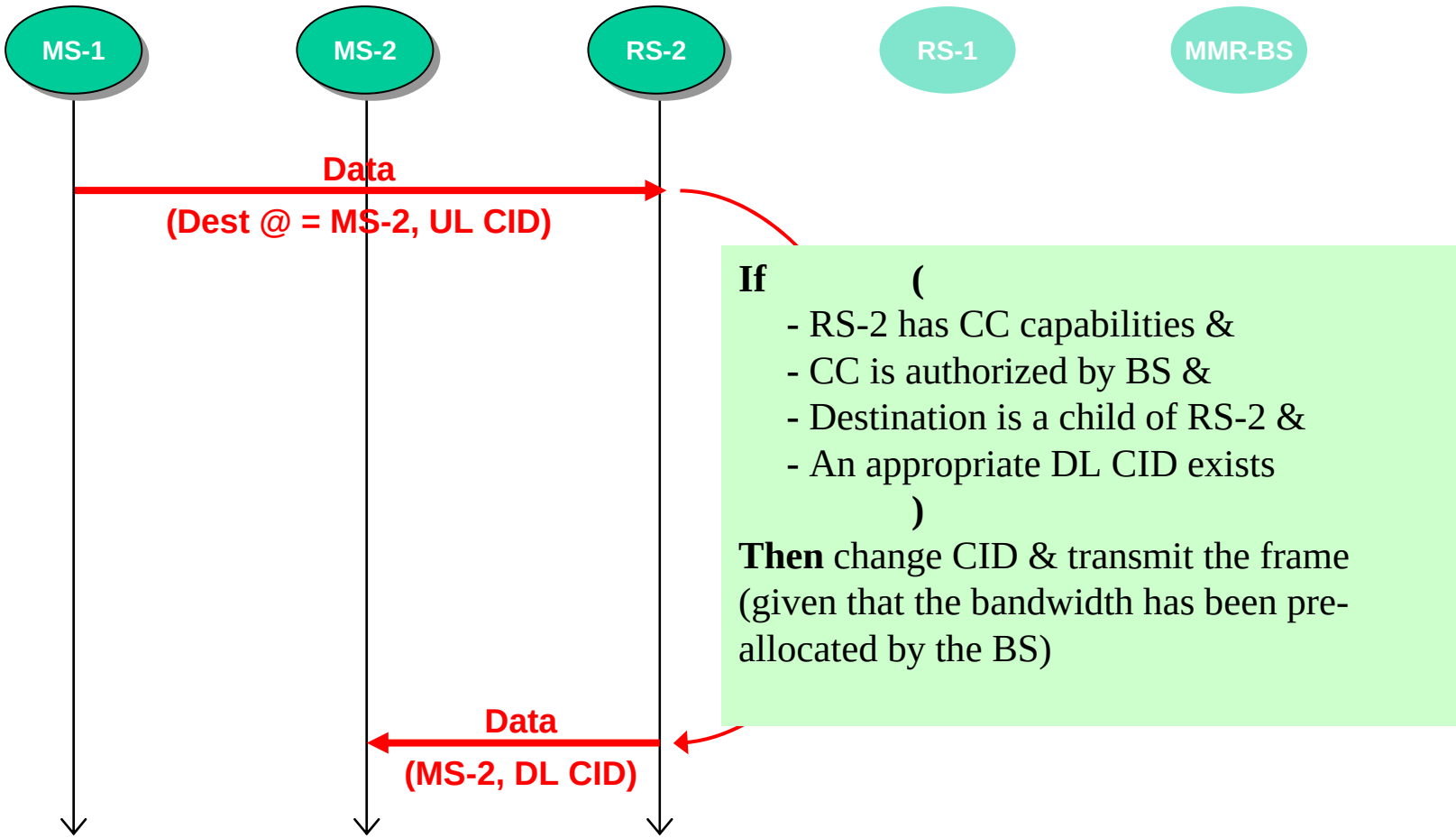
CC procedure: Redirection (6/6)



If **(**
- RS-2 has CC capabilities &
- CC is authorized by BS &
- Destination is a child of RS-2 &
- An appropriate DL CID exists

)

Then change CID & transmit the frame (given that the bandwidth has been pre-allocated by the BS)

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Security with CC

- Security in 802.16-2005 is based on a client/server architecture, where the BS is the server and the MS/RS are its clients.
- Just as connections, security associations are established between the MMR-BS and the MS/RS.
- The key management protocol provides the secure distribution of keying data from the MMR-BS to the MS/RS.
- In order to support CC, the RS is required to decrypt and encrypt MS-RS-MS data plane traffic when the MMR-BS is bypassed.
- The MMR-BS should provide the CC-enabled RS with the security parameters it needs to handle encryption of the data traffic it redirects.

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Summary

- RS specifications should be divided into 2 parts
  - **Low-complexity Relay** stations for low cost solutions
  - **SMART Relay** stations for enhanced applications
- **SMART Relay** stations should handle
  - Routing protocol
  - Topology management
  - Power Saving
  - Security
- **SMART Relay** stations can manage Cross Communications
  - If allowed by the infrastructure owner and the country regulation
  - It should be an optional communication mode