Relay Strategy of Broadcast Messages in Mobile Multihop Relay

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Purpose:

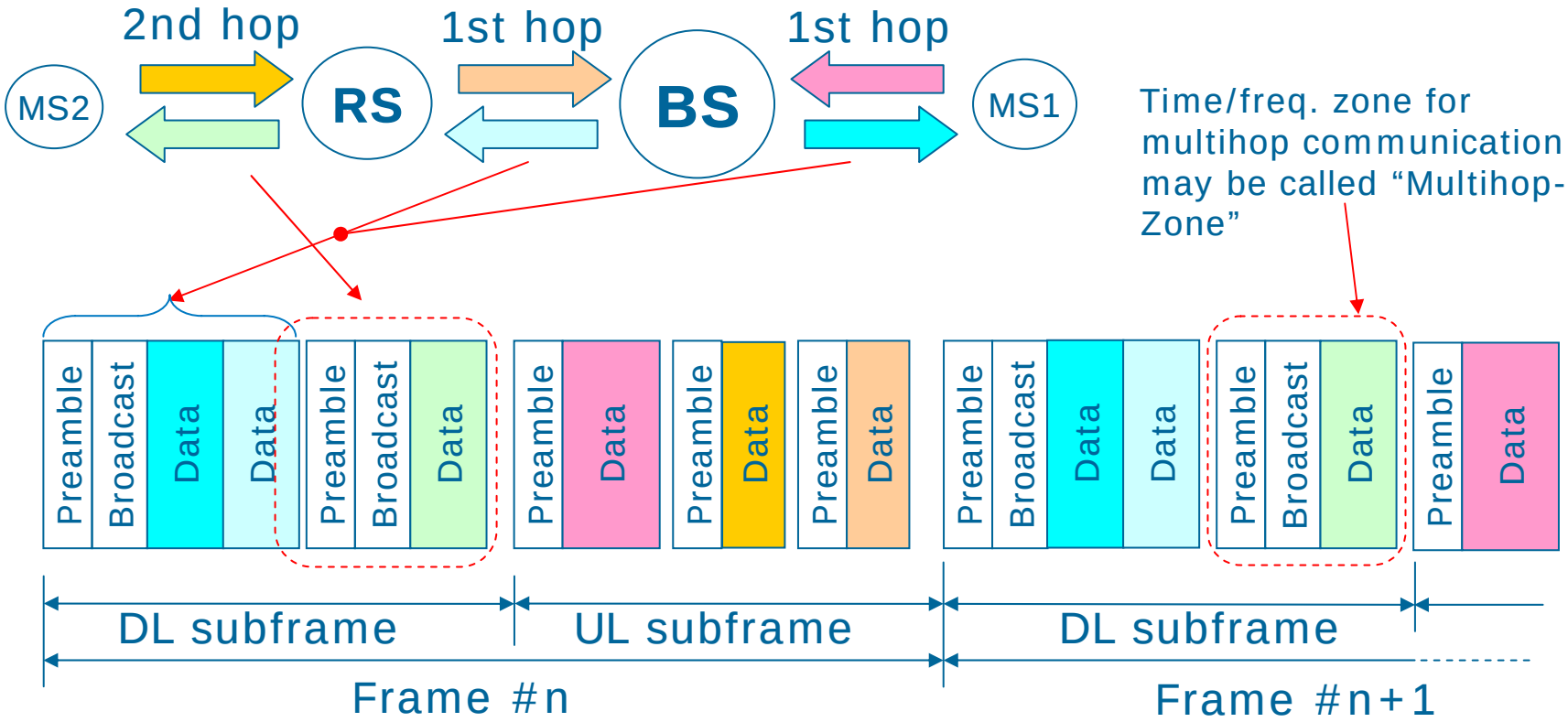
Contribution is intended to promote discussion of scope & objectives and aid the PAR definition for a 802.16 mesh task group

Introduction

- Two types of relay strategy were discussed at the past IEEE80216 MMR SG meetings
  - Only data is relayed
    - Preamble and broadcast message are reachable directly from Base Station (BS) to Mobile station (MS)
  - Broadcast message is relayed as well as data
    - MS is out of direct communication range from BS
- Relay of broadcast message may make multihop system complicated when backward compatibility is considered
  - Modification of frame structure is needed
  - SS or MS may be modified to communicate with relay stations
- But Relay of broadcast message expects coverage extension
  - Amount of control message is to be increased
- This presentation discusses feasibility of relay of broadcast message
  - Frame structure, broadcast strategy and RS processing are discussed

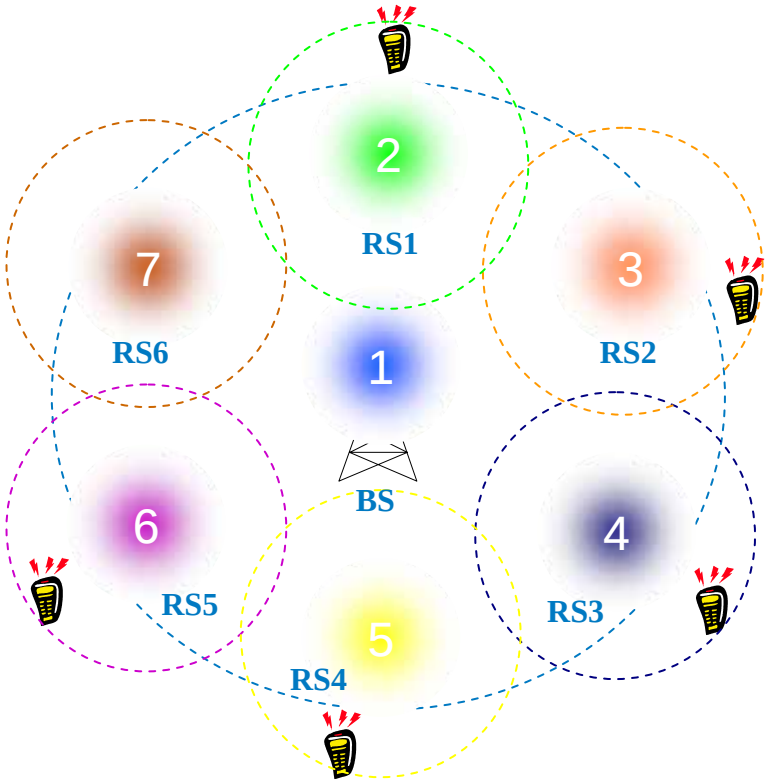
Frame Structure for Broadcast Message Relay

- To enable relay of broadcast messages, preambles and broadcast messages from RSs are inserted into a frame after preamble and broadcast message from BS
- If RS transmits preamble and broadcast message with same interval of BS, legacy MS will be able to communicate with the RS

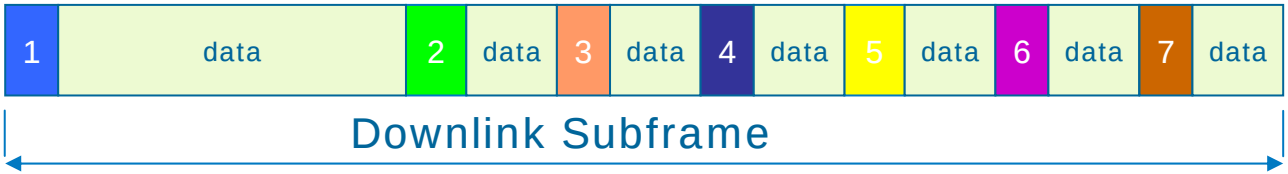


Simple Approach of Broadcast Message Relay

- Example: 6 Relay Stations (RSs)

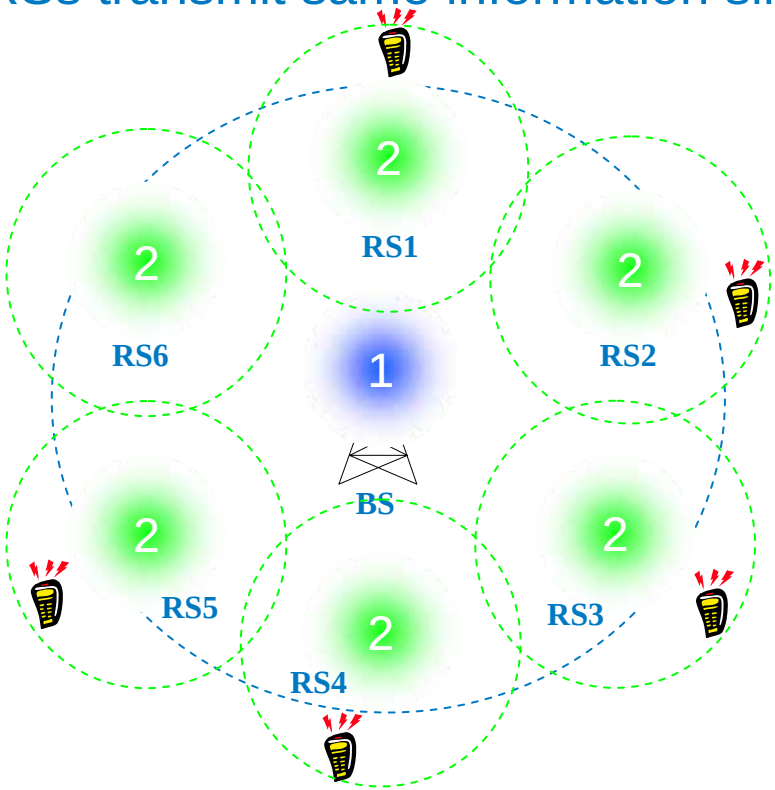


- All RSs may transmit preamble and broadcast messages in different time (by turns) to avoid interference
  - Simple approach
- Issue
  - Amount of preamble and broadcast message increases with increase in number of RS
  - Ratio of overhead (preamble and control) to data is large

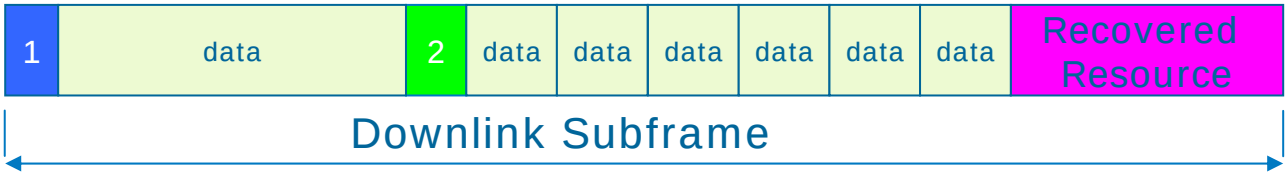


Simultaneous Transmission Approach

- Example: 6 Relay Stations (RSs)
- All RSs transmit same information simultaneously



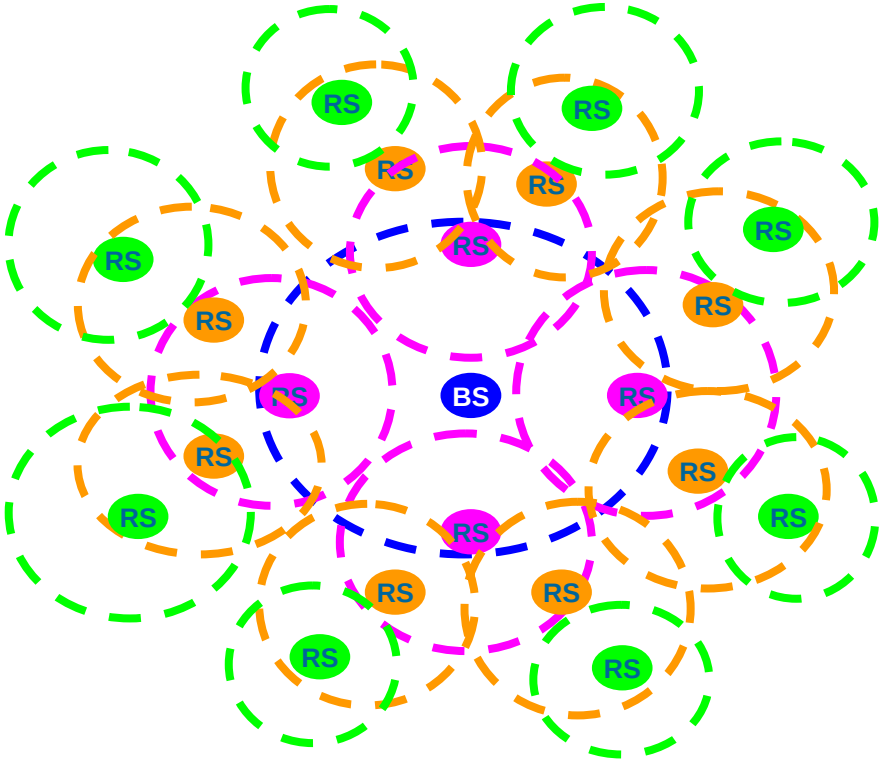
- If the time difference of the received signals from different RSs are within guard interval, MS can combine received signals without intersymbol interference
  - Cooperative approach is capable
- Intra-cell interference would be negligible but inter-cell interference may increase

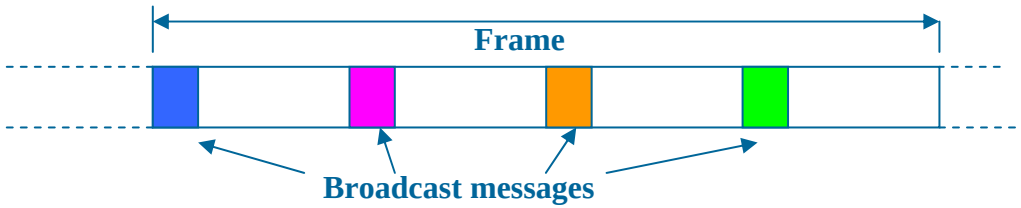


Overhead Calculation Example

- Assumption (based on IEEE802.16e system)
  - 5 ms Frame length (only downlink was considered)
  - 1 OFDM Symbol:112us (Tb: 89.6us, GI: ¼)
  - Number of OFDM Symbols in a frame: 44 (rough estimation)
  - 6 relay stations in a cell
    - 1 OFDM Symbols for Preamble
    - 2 OFDM Symbols for Broadcast Message (FCH, MAP)
  - Overhead
    - 3 OFDM Symbols x (1(BS) + 6 (RSs)) = 21 OFDM (by turns)
    - 3 OFDM Symbols x (1(BS) + 1 (RS)) = 6 OFDM (simultaneous)
- Overhead Reduction
  - from 21/44 (48%) to 6/44 (14%)

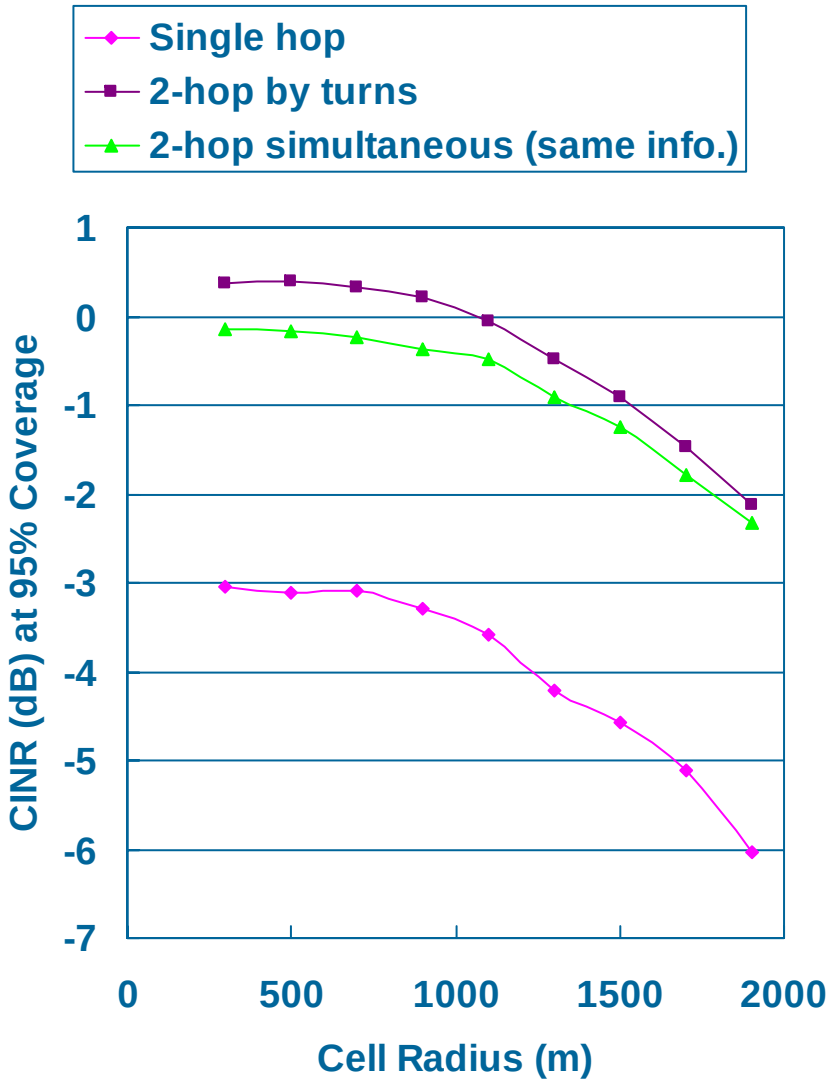
Extension to n-hop System





- Simultaneous transmission can be expanded to n-hop system
  - Coverage extension is expected

Coverage Reliability of Broadcast Information



- Coverage reliability (CINR value with 95% of reliability) was simulated for broadcast channel
  - Multi-cell environment with synchronized cells was assumed
- 2-hop system increases coverage reliability about 3 dB compared to single hop system
- Coverage reliability of 2-hop system with simultaneous transmission of broadcast message slightly degrades although inter-cell interference was anticipated
  - Saved resource by the simultaneous transmission of broadcast message is beneficial

Parameter Values for Simulation

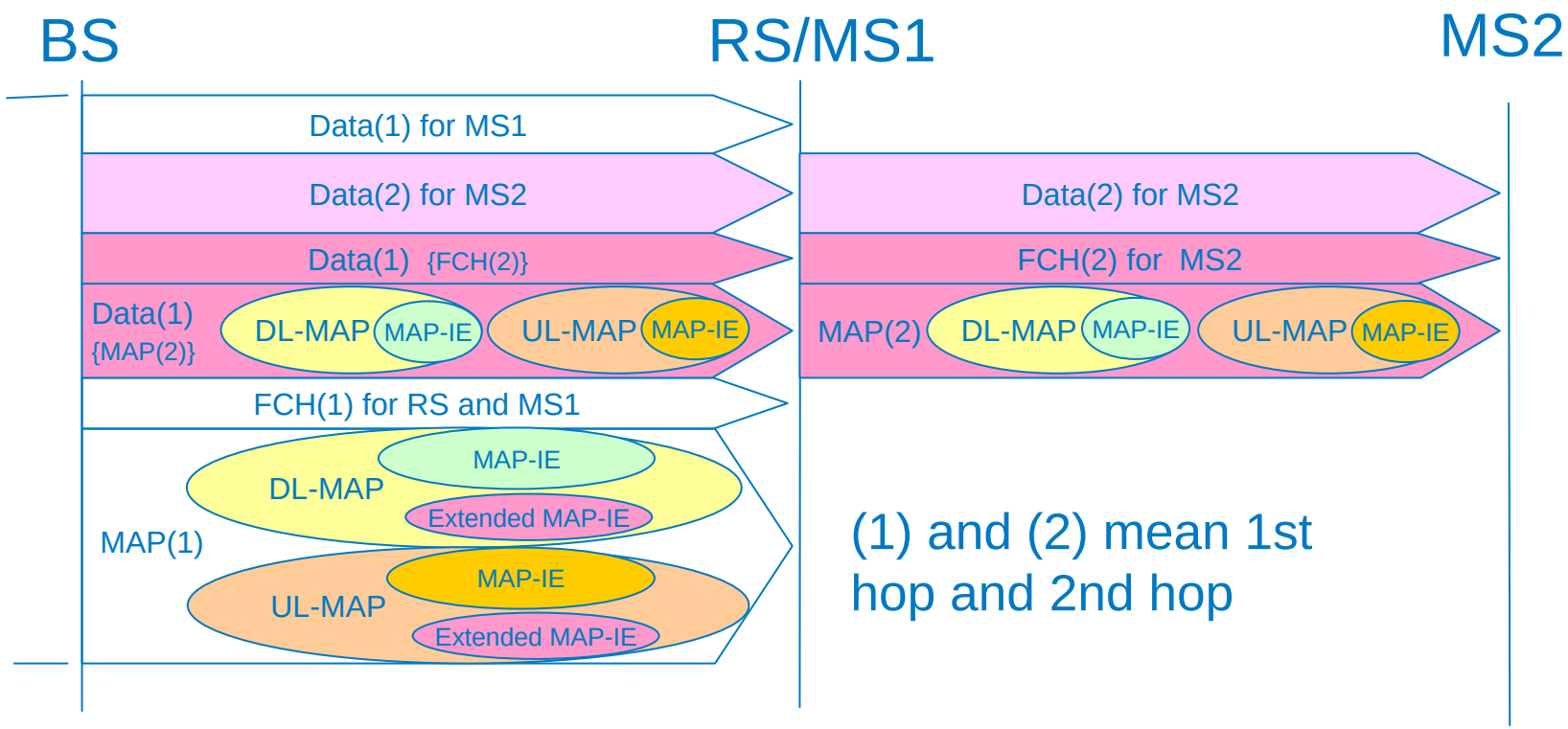
Cell radius	Variable	Carrier frequency	2.5 [GHz]
Max. number of hops	2	Bandwidth	10 [MHz]
Multiplexing	TDD	Maximum power (BS/RS/MS)	43/40/20 [dBm]
Multiple access	TDMA	Antenna gain (BS/RS/MS)	10/10/0 [dBi]
Number of time slots	20	Noise figure (BS/RS/MS)	5/9/7 [dB]
Number of cells	19	Pass loss model between	
Number of sectors	1	BS-RS, RS-RS	LOS
Cell synchronization	yes	BS-MS, RS-MS	Walfisch-Ikegami
Number of MS in a cell	10	Antenna height (BS/RS/SS)	50/30/1.5 [m]
Number of RS in a cell	6	Roof top height	25 [m]
BS-RS distance	0.6 x cell radius	Street width	20 [m]
RS mobility	Fixed	Separation bet. buildings	80 [m]
Number of RS antennas	1 (omni antenna)	Shadowing std. deviation	10 [dB]
		Shadowing corr. distance	50 [m]
		Shadowing corr. bet. cells	0.5

Processing of Broadcast Message at RS

- Three types of RS processing are defined based on RS intelligence
  - Case1: Forward
    - RS forwards FCH and MAP generated by BS to MS
    - Very simple processing
      - Just forward the messages according to instruction written in Extended-IE
    - Large overhead
  - Case2: Translate
    - RS generates FCH and MAP for MS according to Extended IE received from BS
      - A bit intelligent data processing is required
      - Small size of data base may be preferable at RS
    - Medium overhead
  - Case3: Create
    - RS generates FCH and MAP for MS according to information that RS collects independently
    - Intelligence is required
      - data processing and maintenance of data base
    - Small overhead

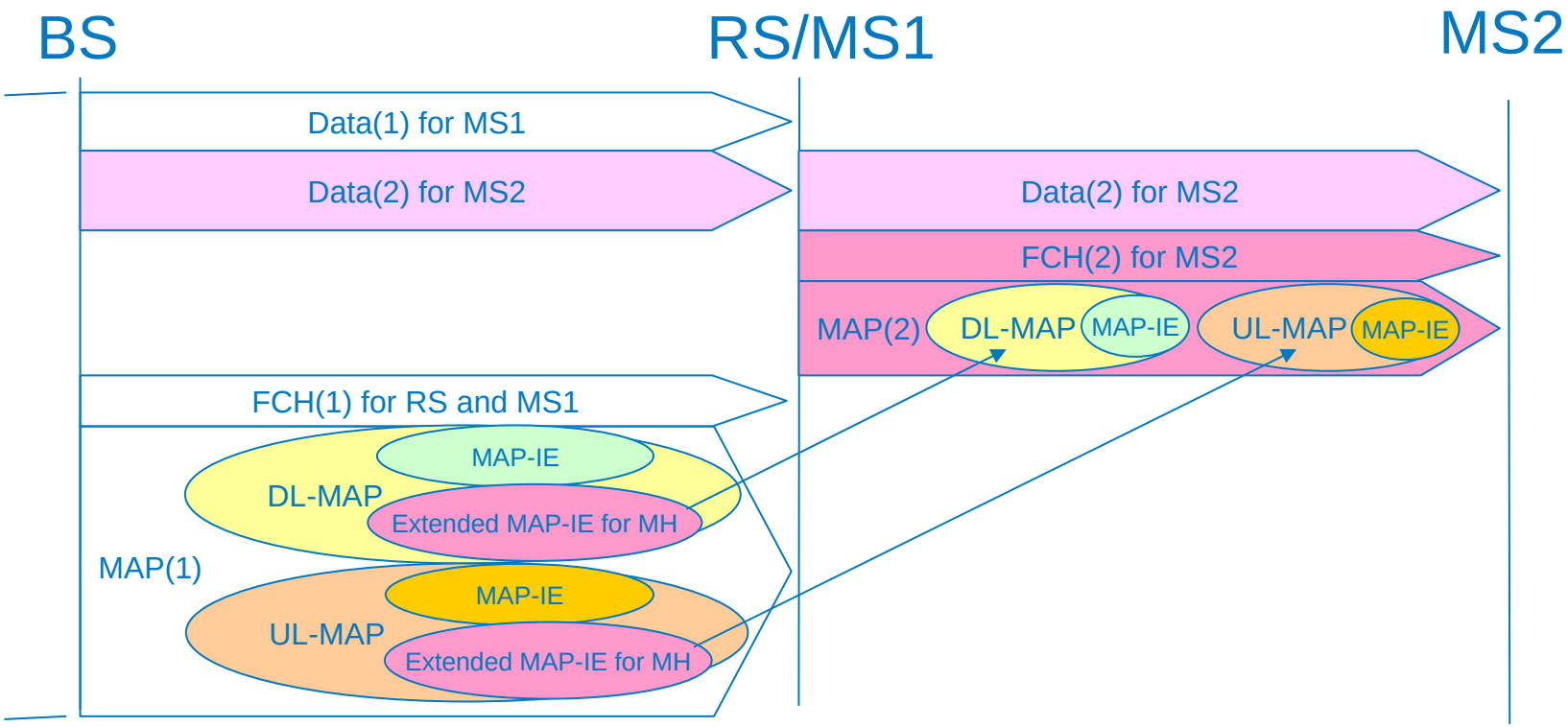
RS Processing: Forward

- FCH(2) and MAP(2) for MS2 are generated at BS and forwarded to RS as Data(1)



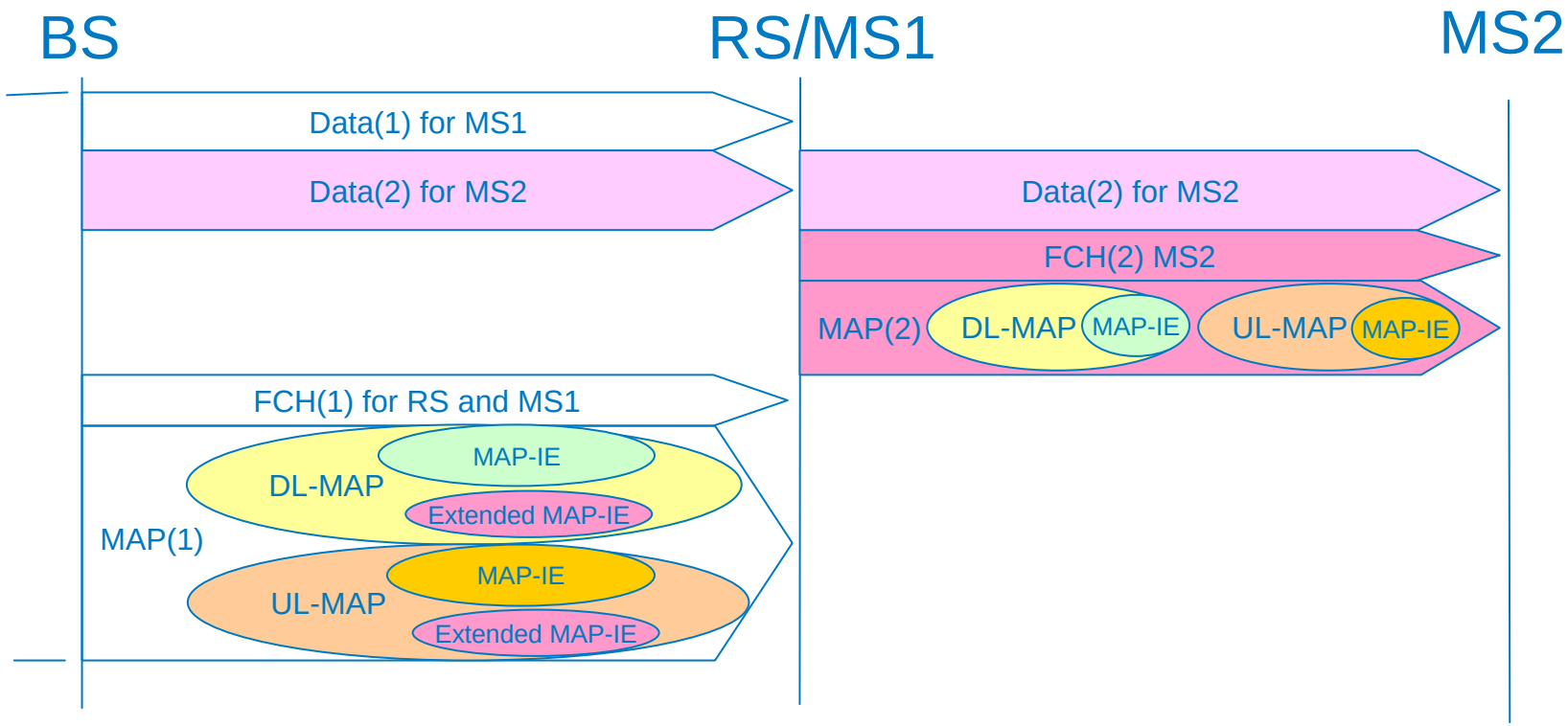
RS Processing: Translate

- FCH(2) and MAP(2) are not transmitted from BS to RS
- FCH(2) and MAP(2) are generated at RS based on Extend MAP-IE that is newly defined



RS Processing: Create

- RS Creates FCH(2) and MAP(2) based on the info that is collected by RS itself
- Minimum information is transmitted from BS to RS like allocation info of MH-Zone



Conclusion

- Feasibility of relay of broadcast message was discussed
  - Relay of broadcast message increases coverage reliability
  - Although amount of broadcast messages is expected to increase, various approaches will mitigate it
    - Cooperative relay approach
      - Simultaneous transmission of same information from relay stations saves radio resources
    - RS processing method of control message
      - Intelligent approach at RS reduces overhead part of communication
- Further discussion is desired at MMR Task Group this year