

# Cooperative Relaying in Downlink for IEEE 802.16j

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# Introduction

- General relay transmission using exclusive time-frequency resources
- How can we efficiently use resources?

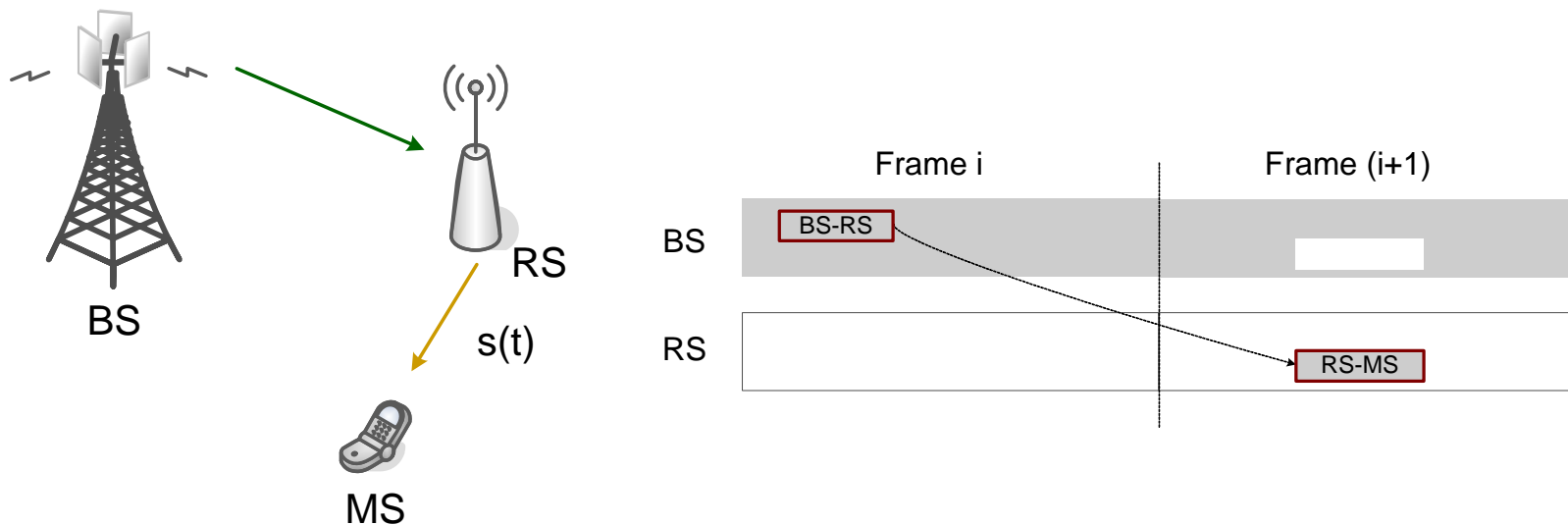


Fig. 1. Example of general relay transmission

# Introduction

- General relay transmission using exclusive time-frequency resources
- How can we efficiently use resources?

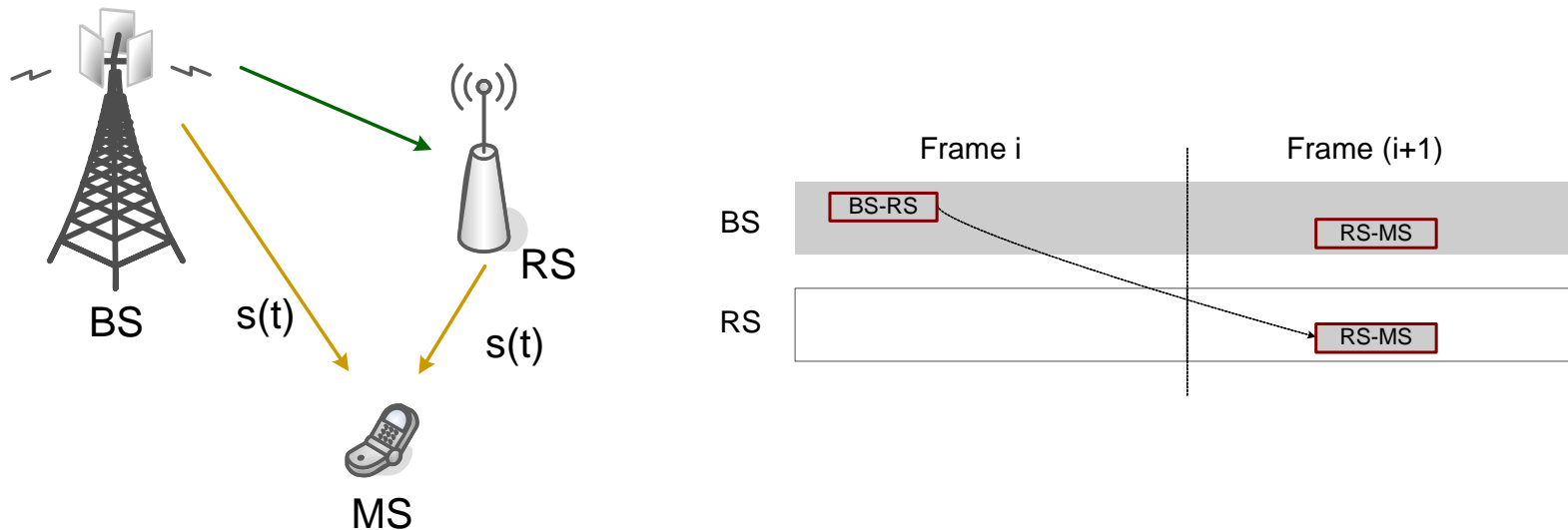


Fig. 1. Example of general relay transmission

# Cooperative Relaying in R-DL

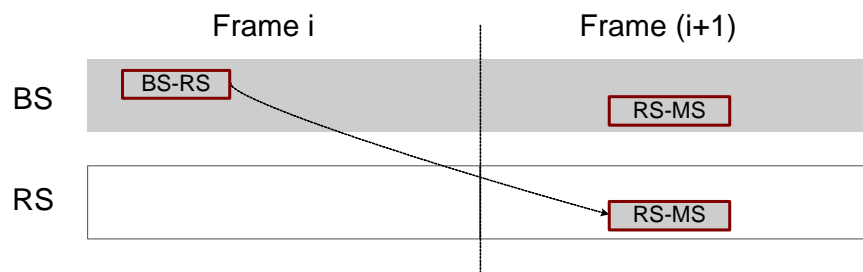
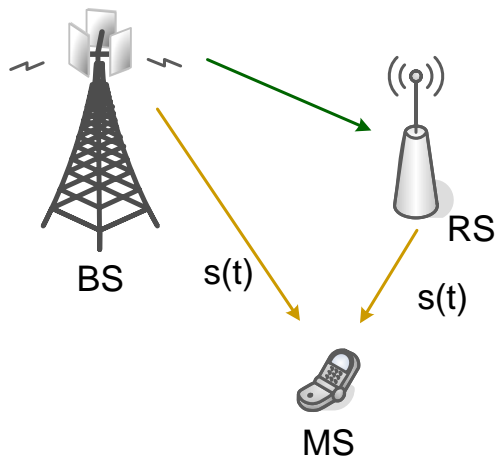
- Cooperative source diversity
  - Multiple sources with the same signals
- Cooperative transmit diversity
  - Multiple sources with STC-coded signals
- Cooperative hybrid diversity
  - Combination of source and transmit diversity

# Cooperative source diversity

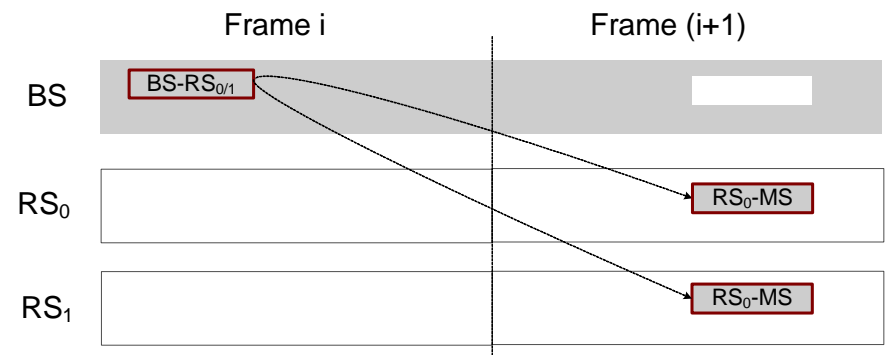
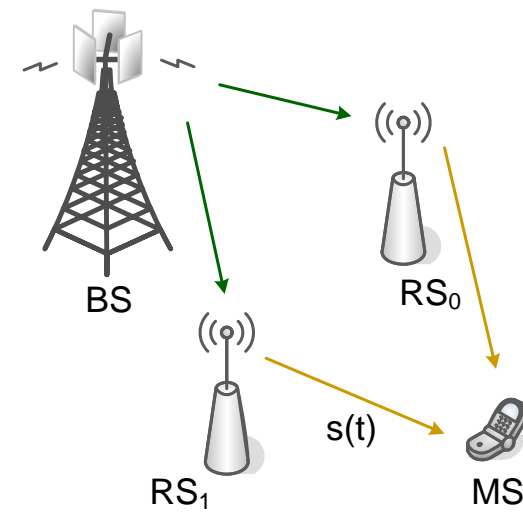
- Legacy SS/MS: no STBC support req'd
- Proposed method
  - Diversity gain using multiple signal sources
  - Simultaneous transmission in one or multiple RS & BS using the same media & data
  - Effective solution to the pilot collision problem
  - No additional functionality for MS
- Requirement :
  - Timing difference between sources  $<$  CP duration

# Cooperative source diversity (cont.)

- Example



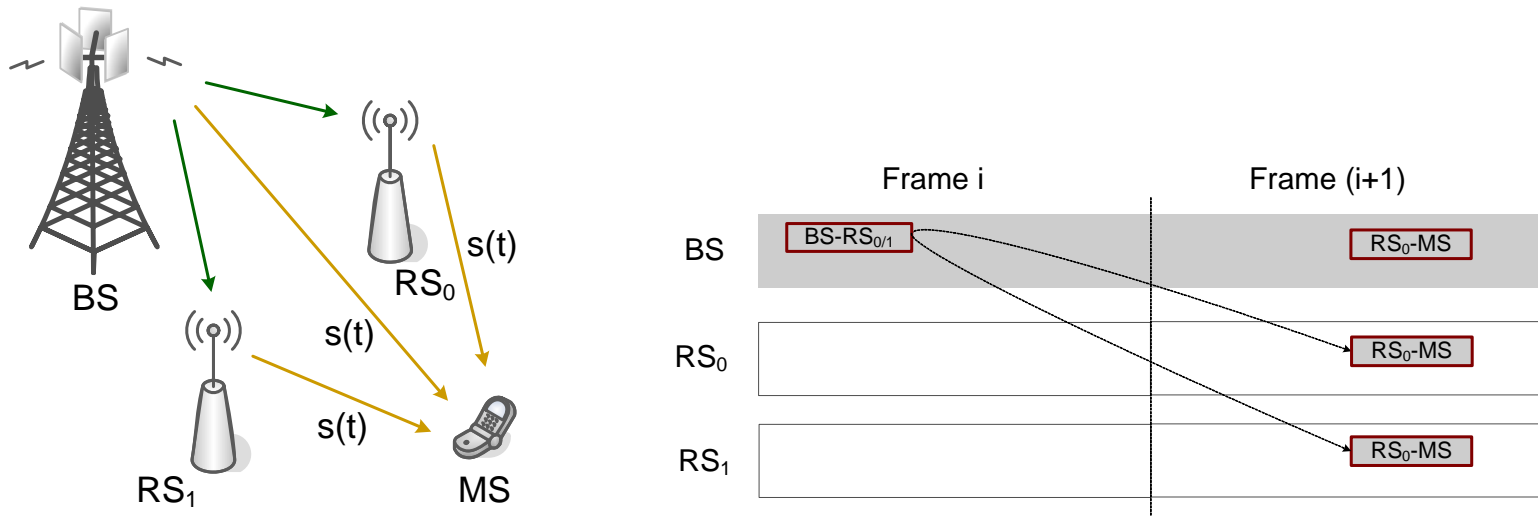
(a) Usage of BS & RS



(b) Usage of multiple RSs

# Cooperative source diversity (cont.)

- Example

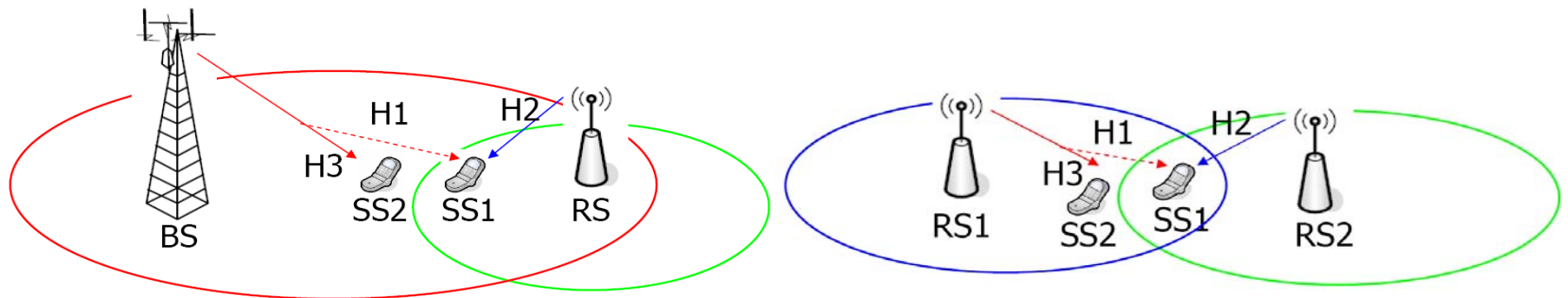


(c) Usage of BS & multiple RSs

Fig. 2. Examples of cooperative source diversity

# Cooperative source diversity (cont.)

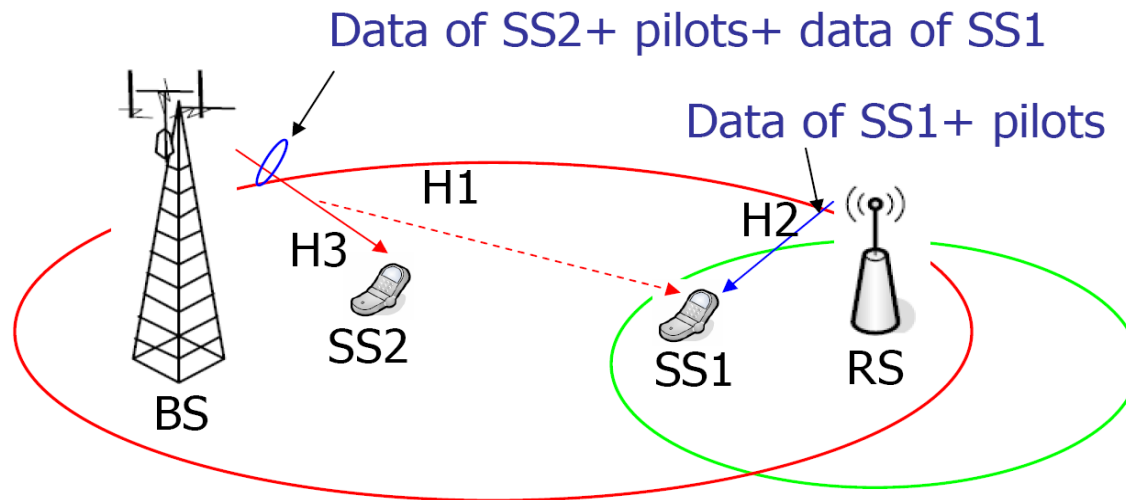
- To keep SS unchanged, RS shall use the same OFDMA subcarrier allocation algorithm for downlink transmissions, i.e. RS will insert pilot signals at the same locations as BS.
- During concurrent transmissions of BS and RSs, SS in the overlap area will hear superposed pilots, and thus estimate a sum of the channel rather than the true data channel response. The performance of the involved SSs will be greatly degraded by using wrong channel estimation for data detection.
- This problem, named as pilot collision, is a special problem after the introduction of RS.





# Cooperative source diversity (cont.)

- Cooperative source diversity is an effective solution to the pilot collision problem.
- Pilot collision will be solved because SS not only received the “collided pilot” but also the “collided data”.

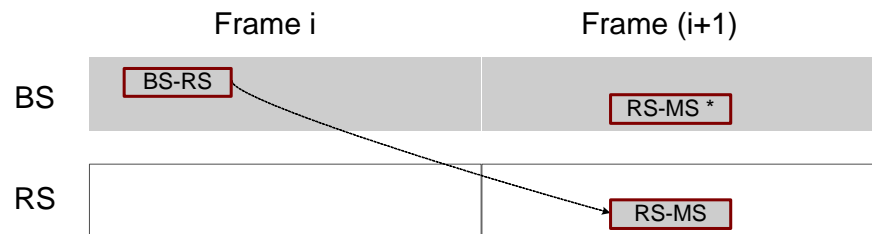
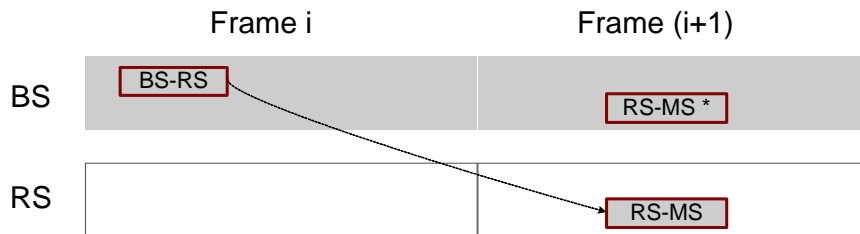
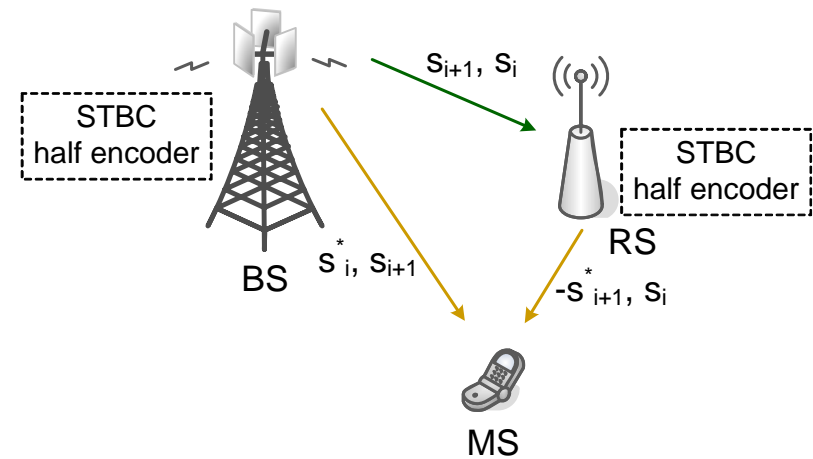
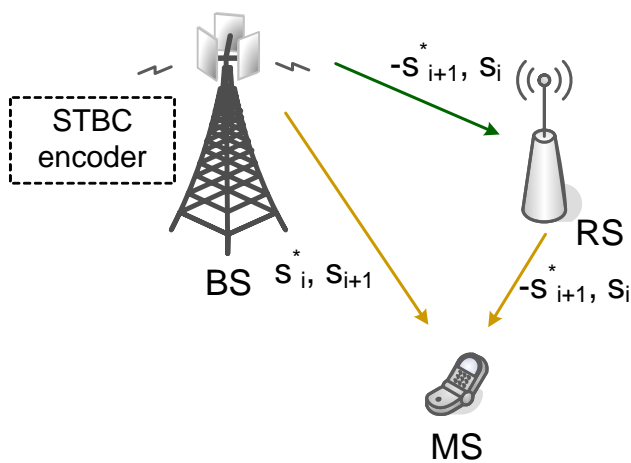


# Cooperative transmit diversity

- For SS/MS having STBC decoder
- Proposed method
  - Transmit diversity using multiple signal source
  - Usage of different STC encoding in each signal source
  - Two choices: No processing at RS or Low processing at RS
- Requirement :
  - Timing difference between sources  $<$  CP duration

# Cooperative transmit diversity (cont.)

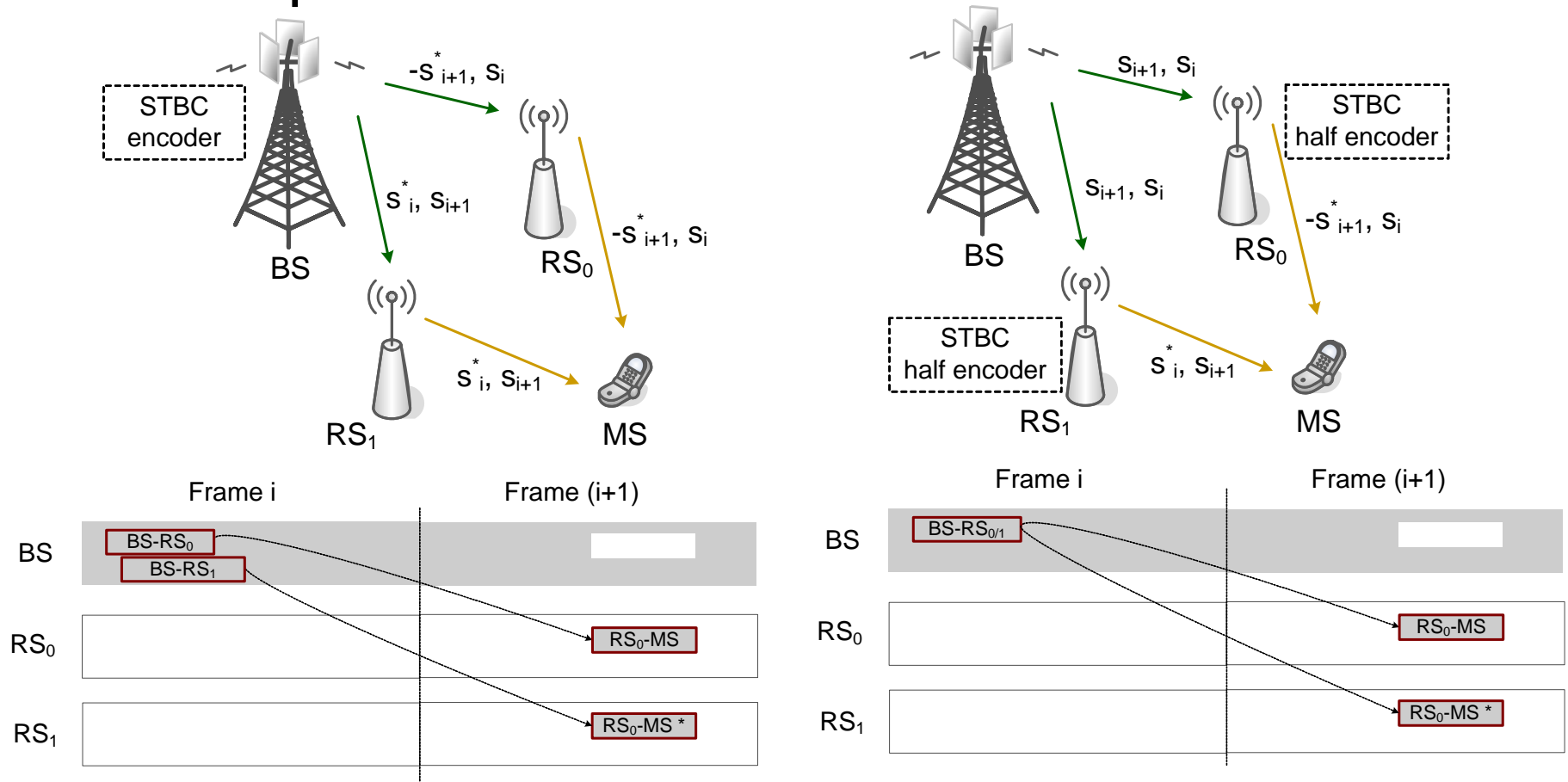
- Example



(a) Usage of the different STC encoded BS & RS

# Cooperative transmit diversity (cont.)

- Example



(b) Usage of the different STC encoded RSs

Fig. 3. Examples of cooperative source diversity

# Cooperative hybrid diversity

- Combination of source & transmit diversity
- Example

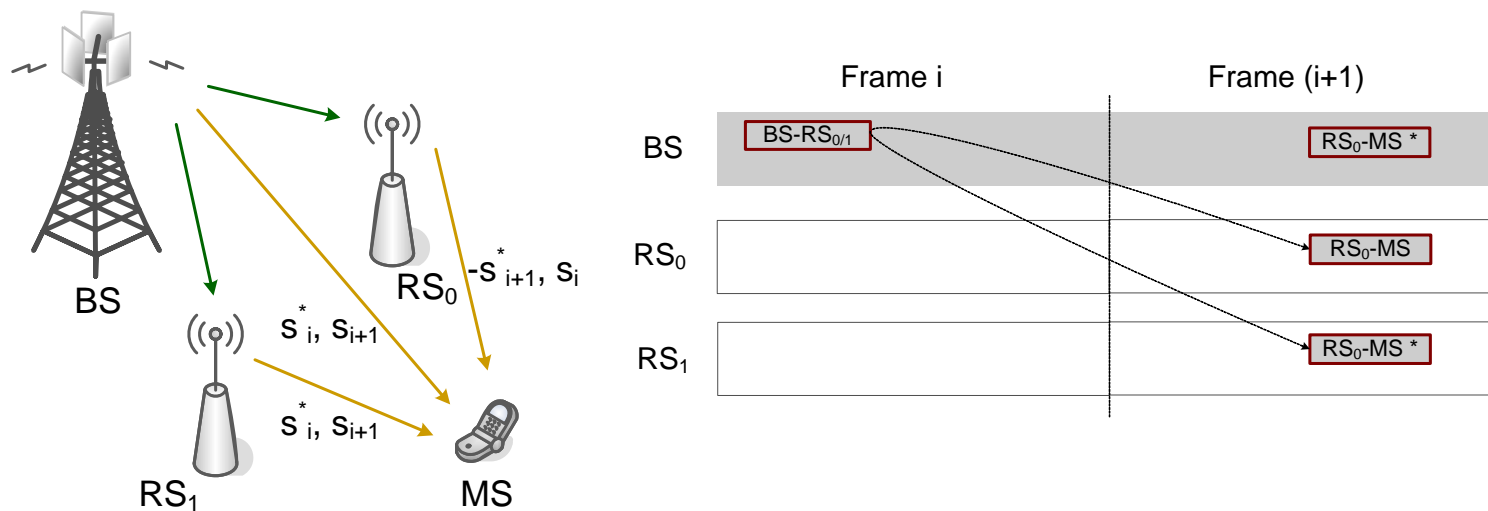
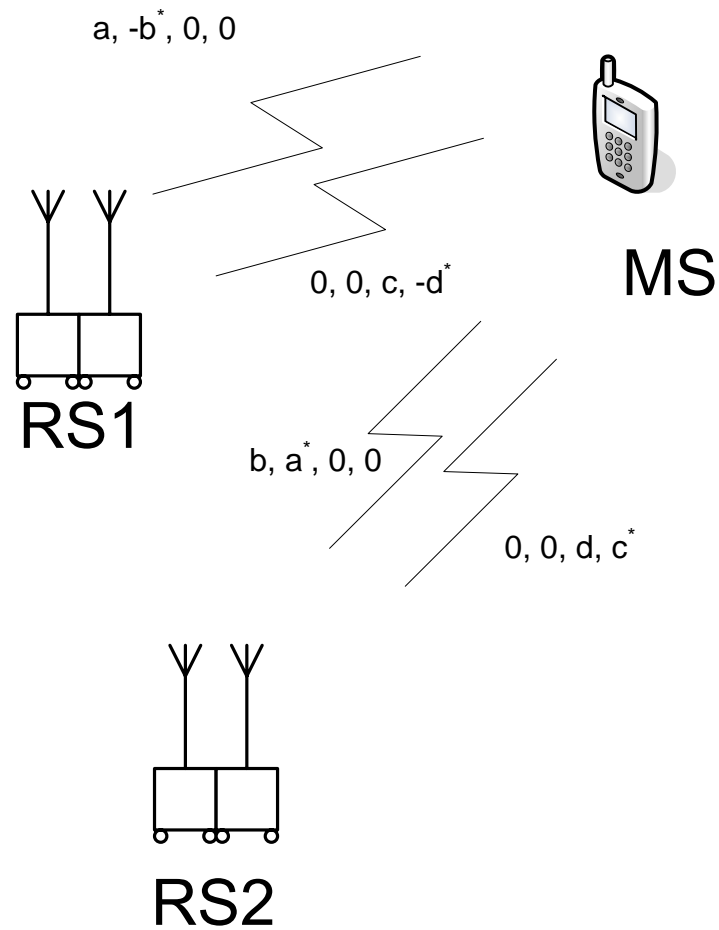


Fig. 4. Example of the same STC encoded sources of BS & a RS and another STC encoded source of RS

# Example with STBC for 4 Tx



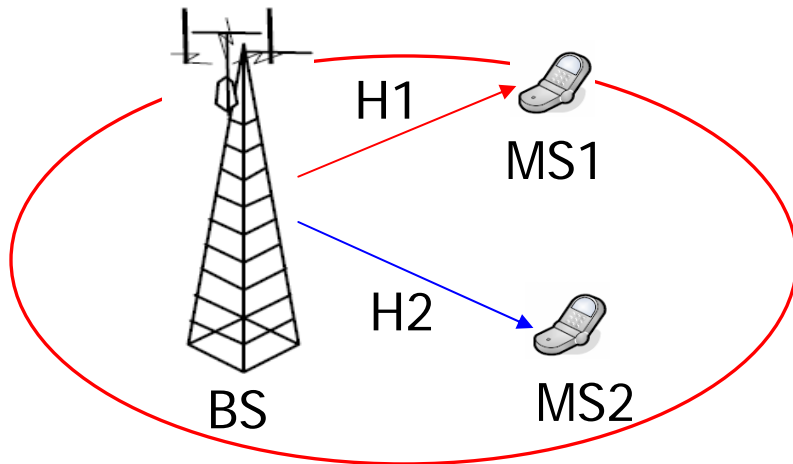
# Summary

- Cooperative transmission is a promising technique for mobile relay network
- Three cooperative relay schemes are proposed
  - Cooperative source diversity
  - Cooperative transmit diversity
  - Cooperative hybrid diversity
- Advantages
  - Large diversity gain
  - Effectively combat pilot collision

# Backup Slides



# Example of Pilot Collision



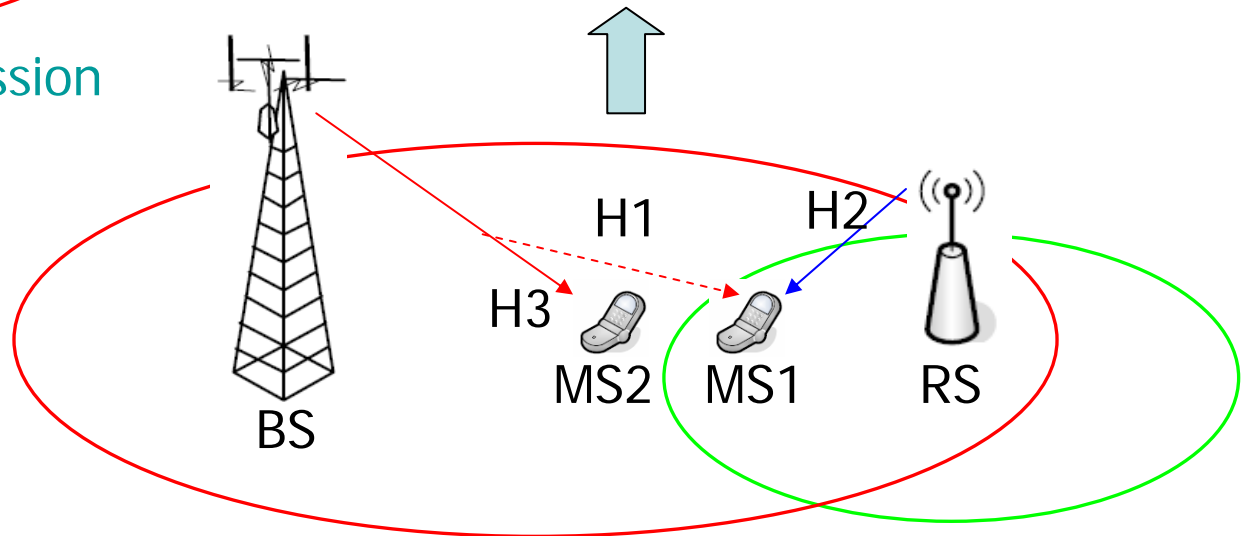
Traditional PMP transmission



- MS1 estimates H1 on subchannel 1 by pilots;
- MS2 estimates H2 on subchannel 2 by pilots;

## Pilot Collision

- MS1 overhears the pilots of BS and get a estimation of  $H1 + H2$  on subchannel 1;
- However, the true data subchannel response of MS1 is H2;



Transmission in 802.16j