Cooperative Diversity Schemes for Multi-Hop Relay System

Document Number:
IEEE C802.16j-06/073
Date Submitted:
2006.7.03
Source:

Chung G. Kang, Hyun S. Ryu
KOREA university
#5-1, Anam-dong, Sungbuk-Ku, Seoul, Korea
Voice: +82-2-3290-3236
E-mail: ccgkang@korea.ac.kr

Dong Seung Kwon, Heesoo Lee
ETRI
161, Gajung-dong, Yusung-gu, Daejon, Korea
Voice: +82-42-860-5936
E-mail: dskwon@etri.re.kr

Venue:
IEEE 802.16 Session #44 San Diego, United States

Base Document:
None
Purpose:
. Propose to support cooperative diversity schemes in IEEE82.16j specification.

Cooperative Diversity Schemes for Multi-hop Relay System

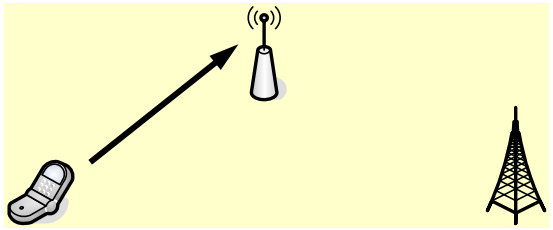
Chung G. Kang & Hyun S. Ryu
Korea University
Dong Seung Kwon, Heesoo Lee
ETRI

Types of Transmission Protocols: Example

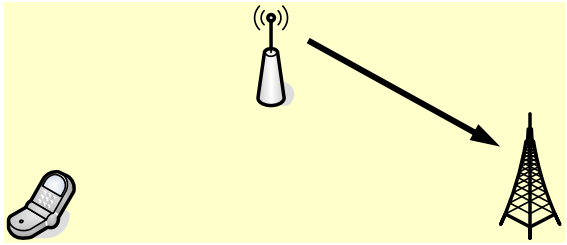
- **Simple Relay vs. Cooperative Diversity**

  - Simple Relay (SR)

    First Time Slot

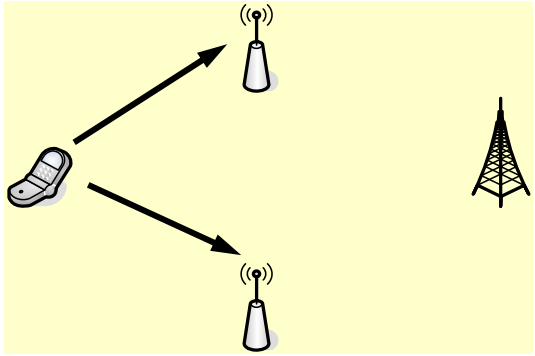


    Second Time Slot

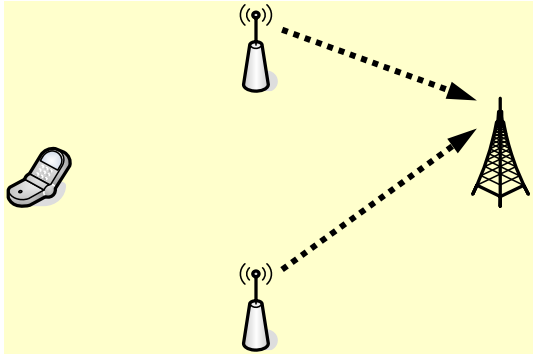


  - Simple Receive Diversity (SRD)

    First Time Slot



    Second Time Slot

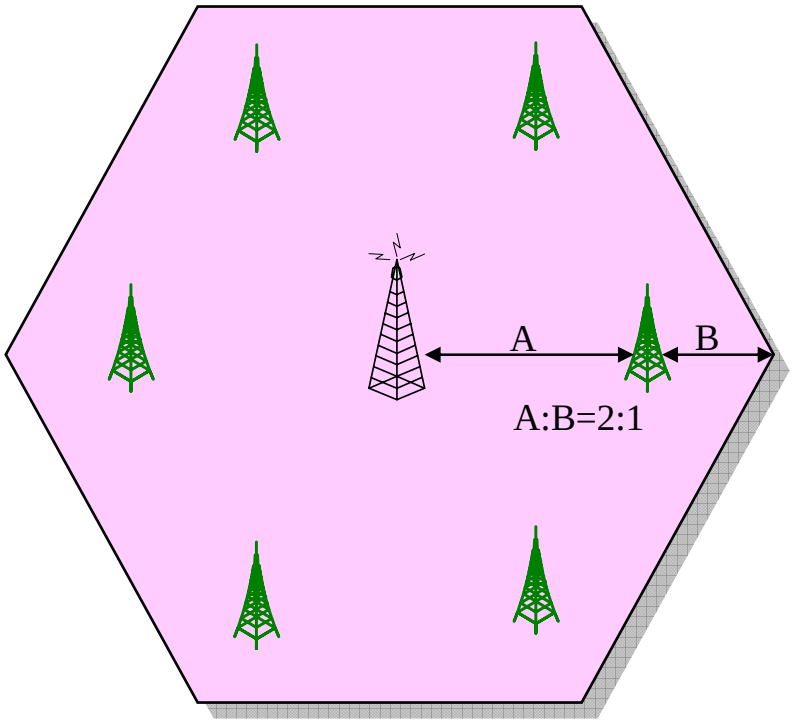


(Reference-IEEE: S802_16mmr-05_012r1)

System Level Simulation (1)

- **Simulation Scenario**

- Layout



- Simulation Set-up

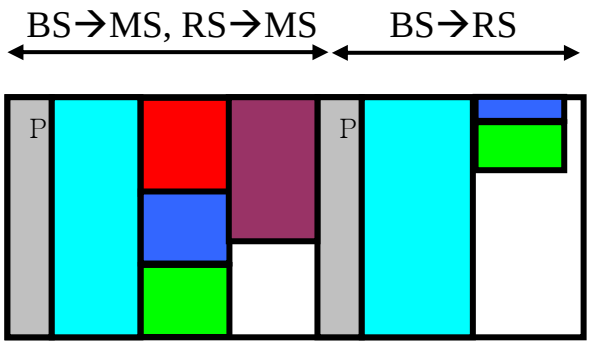
Cell layout	19cell, wraparound
RS configuration	6 FRS per cell, 2/3 position from BS
BS Power	20W
RS Power	10W
BS-RS Link	LOS pathloss model (shadow fading, 3.4dB)
BS-MS, RS-MS Link	NLOS pathloss model (shadow fading, 8dB)
Mobile speed	3km/h
Scheduling	Round robin
Traffic model	Ethernet (~100Kbps)

System Level Simulation (2)

• Frame Structure & Resource Allocation: Downlink

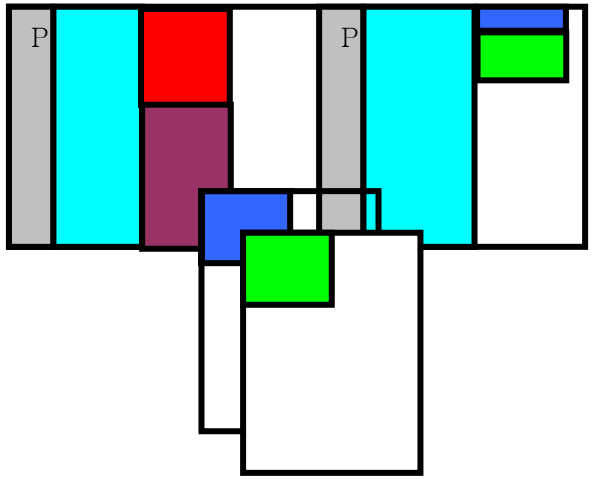
- Orthogonal allocation

1. BS link MS1
2. RS link MS2
3. RS link MS3
4. BS link MS4



- Overlap allocation

1. BS link MS1
2. RS link MS2
3. RS link MS3
4. BS link MS4



System Level Simulation (3)

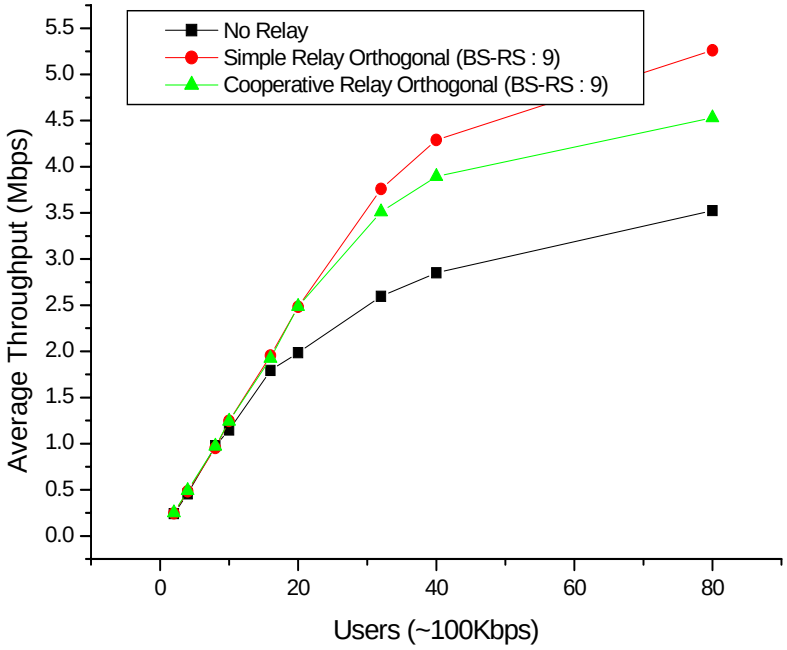
- **C/I Measurement**

	Allocation	Carrier Power	Interference Power
Simple Relay (SR)	Orthogonal Allocation	$C_{\text{Total}} = P_{\text{best}}$	$I_{\text{Total}} = \sum_{j=1}^{18}\left(\frac{1}{7}(BS^{j} + \sum_{r=1}^{6} RS^{r})\right)$
	Overlapped Allocation	$C_{\text{Total}} = P_{\text{best}}$	$I_{\text{Total}} = \sum_{j\neq i}^{19}\left(BS^{j} + \sum_{r=1}^{6} RS^{r}\right) + \sum_{j=i}^{19}\left(BS^{j} + \sum_{r=1}^{6} RS^{r}\right) - P_{\text{best}}$
Simple Receive Diversity (SRD)	Orthogonal Allocation	$C_{\text{Total}} = P_{\text{best}} + P_{\text{second best}}$	$I_{\text{Total}} = \sum_{j=1}^{18}\left(\frac{1}{7}(BS^{j} + 2\times\sum_{r=1}^{6} RS^{r})\right)$
	Overlapped Allocation	$C_{\text{Total}} = P_{\text{best}} + P_{\text{second best}}$	$I_{\text{Total}} = \sum_{j\neq i}^{19}\left(BS^{j} + \sum_{r=1}^{6} RS^{r}\right) + \sum_{j=i}^{19}\left(BS^{j} + \sum_{r=1}^{6} RS^{r}\right) - P_{\text{best}} - P_{\text{second best}}$

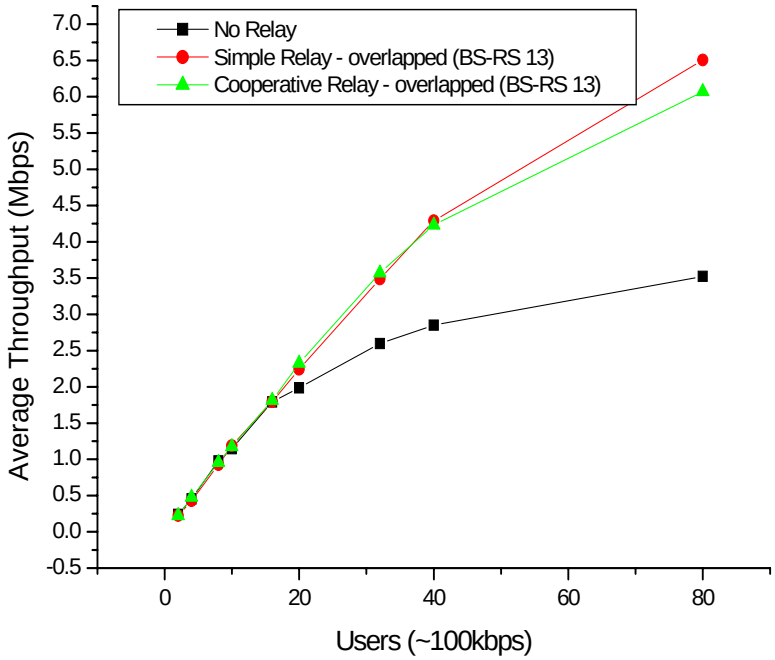
System Level Simulation (4)

- Performance Comparison: SR vs. SRD

- Orthogonal Allocation

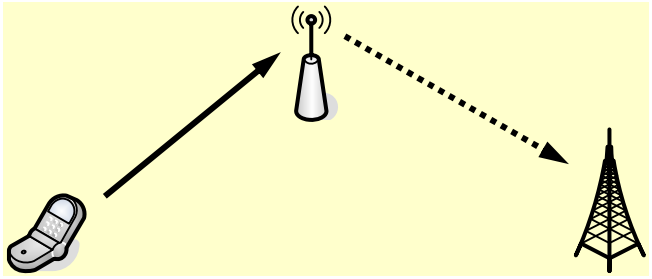


- Overlapped Allocation

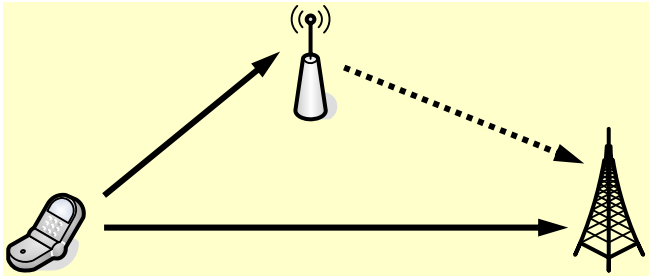


Types of Transmission Protocols: Diversity

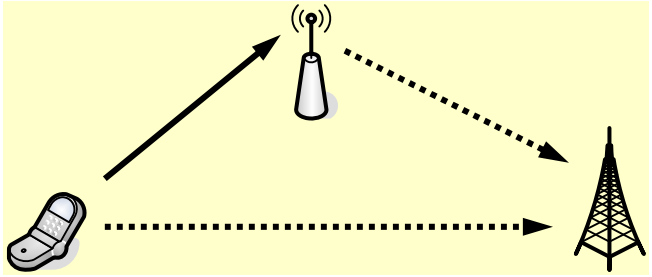
- **Simple Relay (SR)**



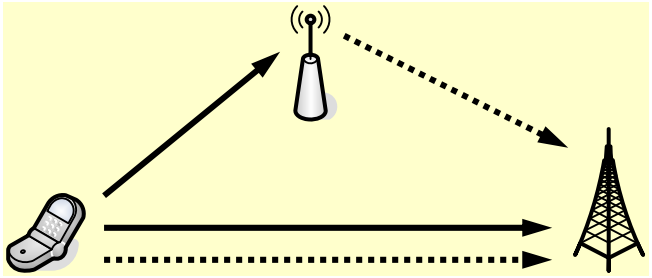
- **Receive Diversity (RD)**



- **Transmit Diversity (TD)**



- **Tx-Rx Joint Diversity (JD)**

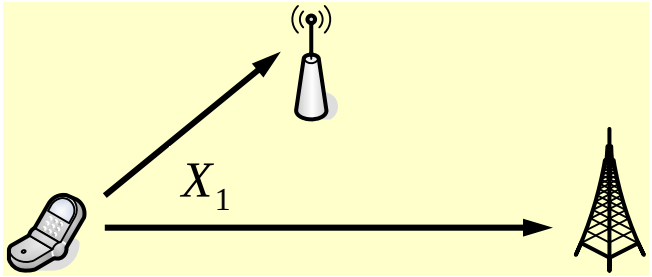


- Notes: ——► : first time slot, ·····► : second time slot

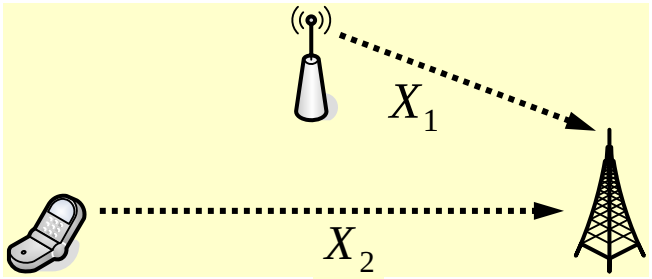
Types of Transmission Protocols: Multiplexing (1)

- **Spatial Multiplexing with Receive Diversity: Type A (SMRD-A)**

  - First time slot

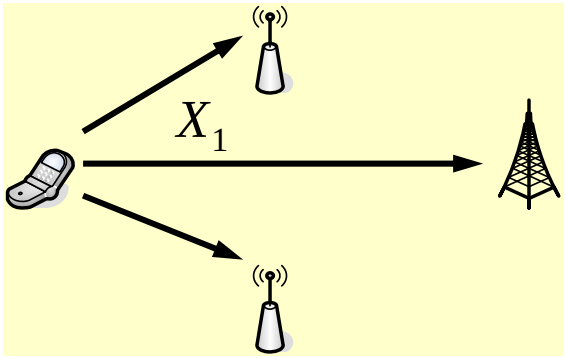


  - Second time slot

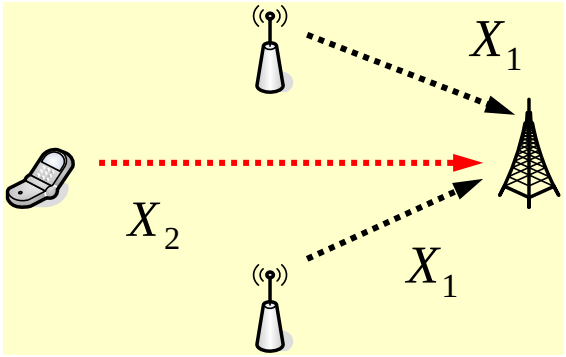


- **Extended SMRD-A**

  - First time slot



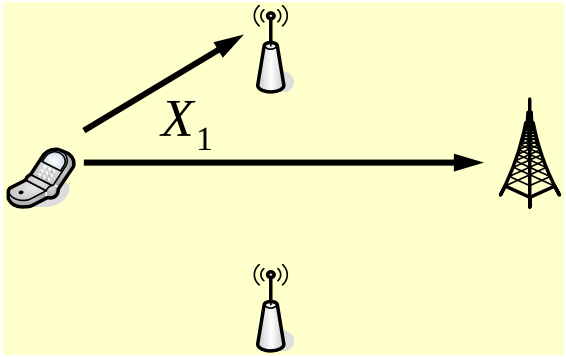
  - Second time slot



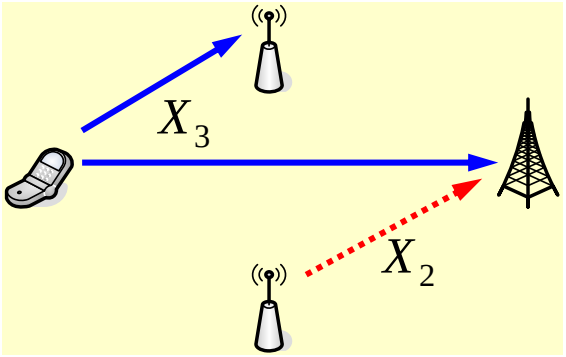
Types of Transmission Protocols: Multiplexing (2)

- **Spatial Multiplexing with Receiver Diversity Type-B (SMRD-B)**

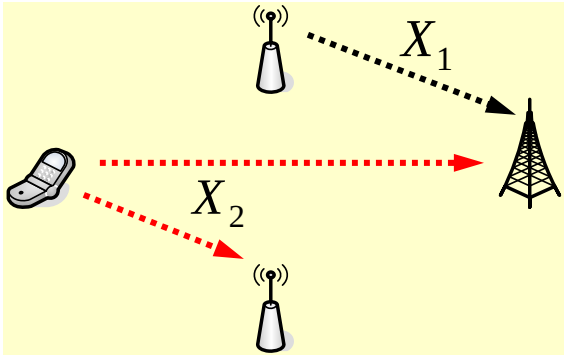
- First Time Slot



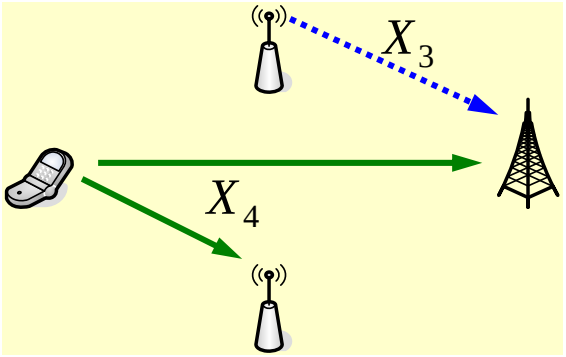
- Third Time Slot



- Second Time Slot

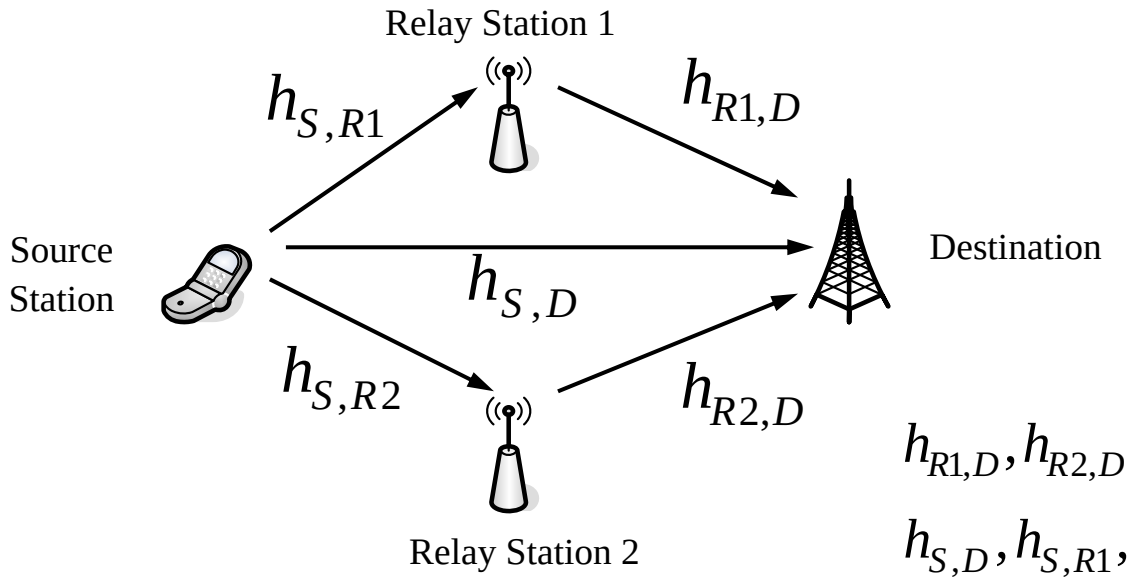


- Fourth Time Slot



Simulation Model: SMRD

- **Channel Model**



$h_{R1,D}, h_{R2,D}$: Rayleigh fading

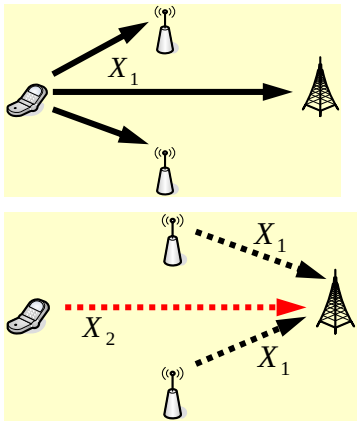
$h_{S,D}, h_{S,R1}, h_{S,R2}$: AWGN

- **Assumptions**
  - **A single antenna for all terminals and two antennas for destination**
  - **No interference among symbols over the different links**
  - **Binary DPSK modulation**

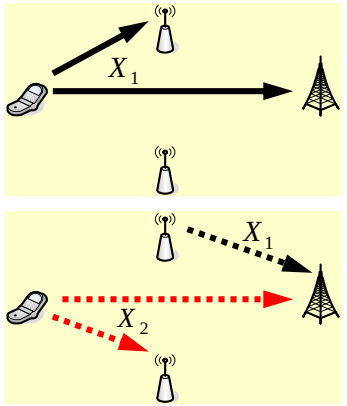
Simulation Result: SMRD

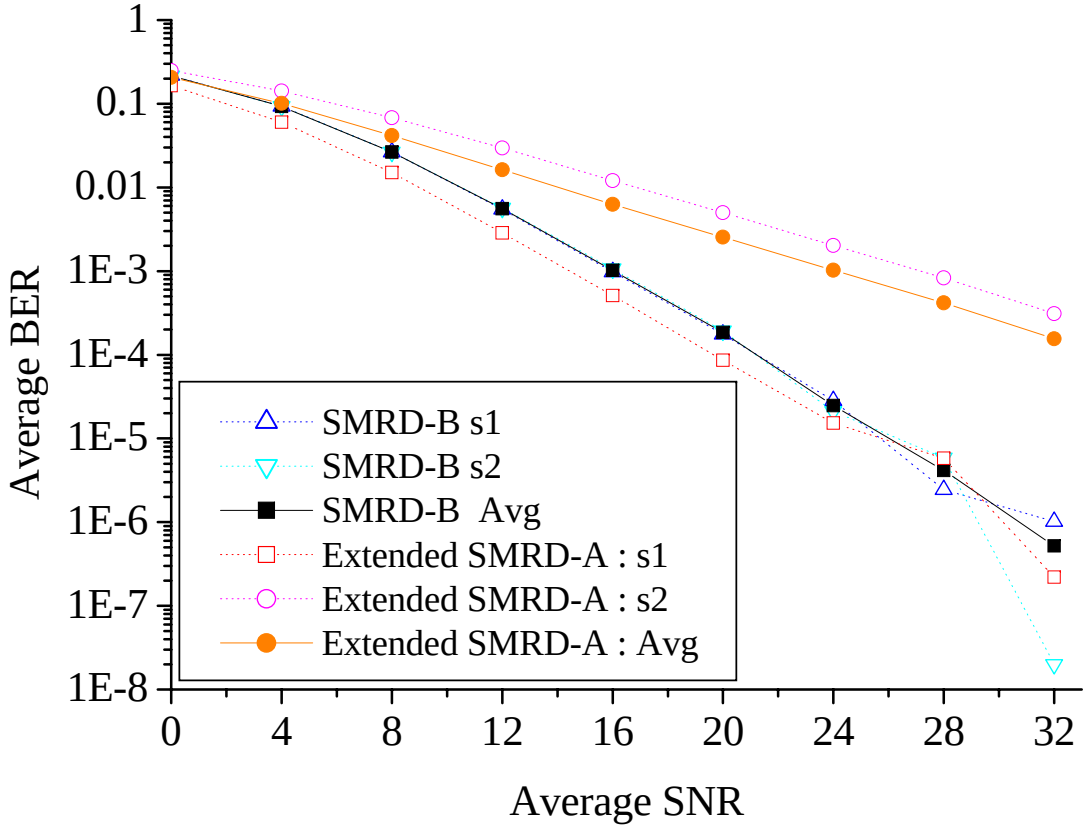
- **Extended SMRD-A vs. SMRD-B ($\overline{\gamma}_{S,R1} = \overline{\gamma}_{S,R2} = \overline{\gamma}_{S,D} = \overline{\gamma}$)**

  - Extended SMRD-A



  - SMRD-B





Summary

- **Cooperative diversity will be a useful means for enhancing throughput and outage performance in Mobile WMAN.**
- **A generic frame structure must be designed so as to accommodate various types of cooperative diversity schemes without any revision in the future.**
- **A great care must be taken as a cooperative diversity scheme is employed in a cellular environment (e.g., resource vs. interference).**
- **A new evaluation methodology might be required to assess the advantage of cooperative diversity schemes**