

Cooperative Diversity Schemes for Multi-Hop Relay System

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Purpose:

- . Propose to support cooperative diversity schemes in IEEE82.16j specification.

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Cooperative Diversity Schemes for Multi-hop Relay System

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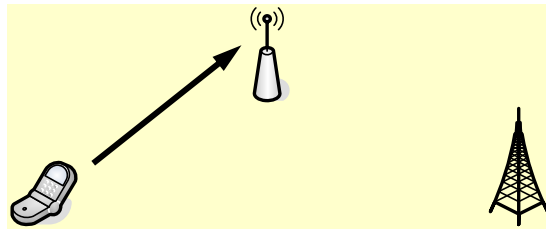
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Types of Transmission Protocols: Example

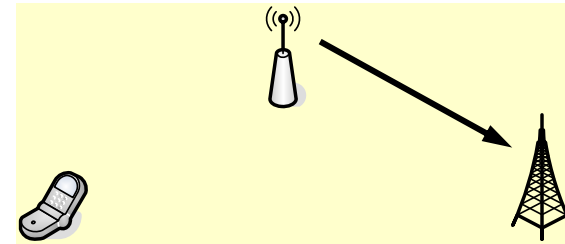
- **Simple Relay vs. Cooperative Diversity**

- **Simple Relay (SR)**

First Time Slot

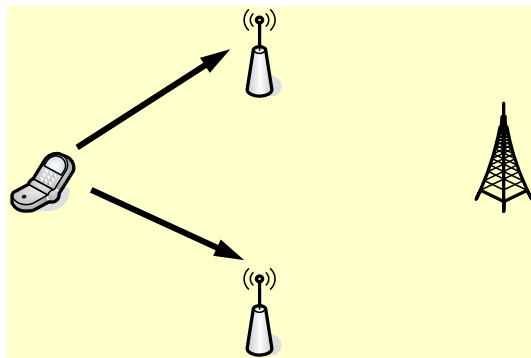


Second Time Slot

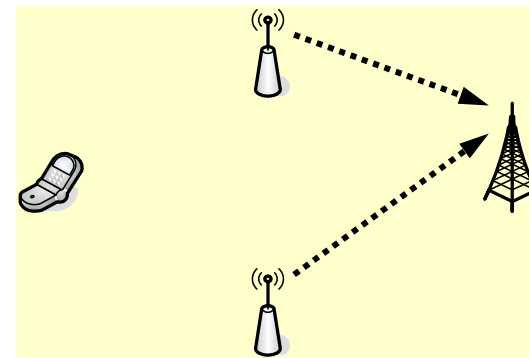


- **Simple Receive Diversity (SRD)**

First Time Slot



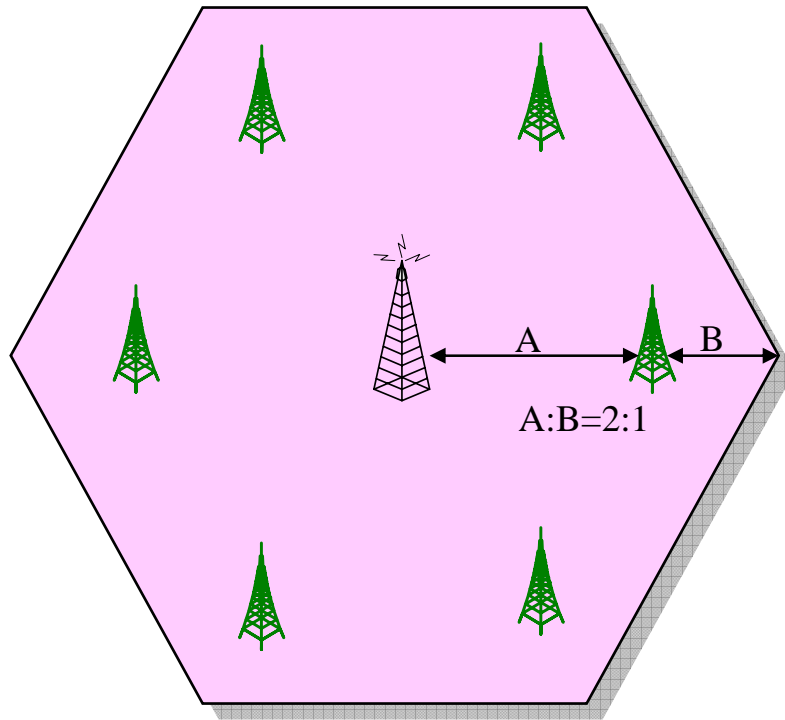
Second Time Slot



System Level Simulation (1)

- **Simulation Scenario**

- **Layout**



- **Simulation Set-up**

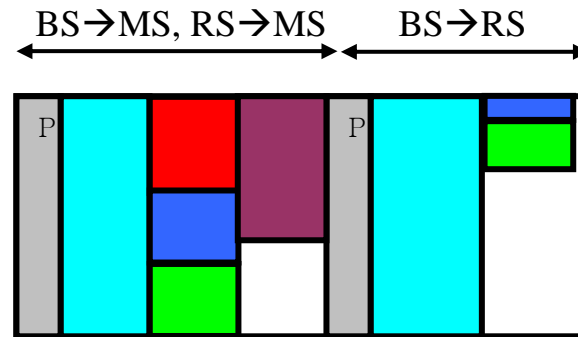
| | |
|-------------------|--|
| Cell layout | 19cell, wraparound |
| RS configuration | 6 FRS per cell, 2/3 position from BS |
| BS Power | 20W |
| RS Power | 10W |
| BS-RS Link | LOS pathloss model (shadow fading, 3.4dB) |
| BS-MS, RS-MS Link | NLOS pathloss model (shadow fading, 8dB) |
| Mobile speed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

System Level Simulation (2)

• Frame Structure & Resource Allocation: Downlink

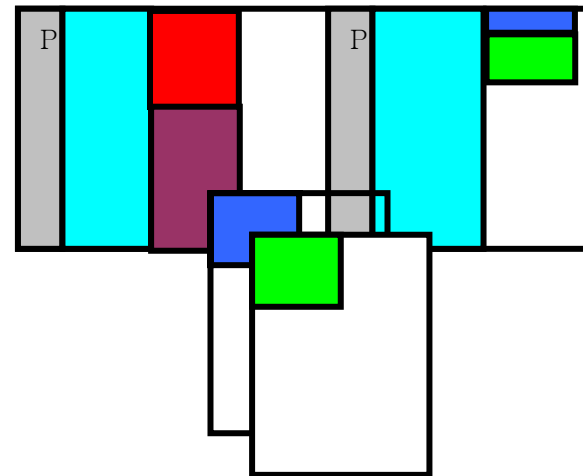
- Orthogonal allocation

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)

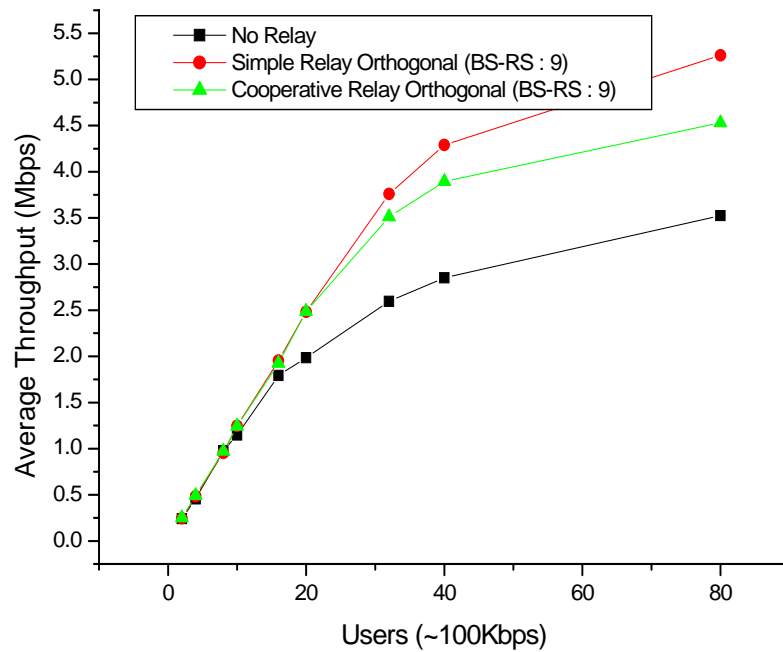
- C/I Measurement**

| | 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 | $C_{\text{Total}} = P_{\text{best}} + P_{\text{second best}}$ | $I_{\text{Total}} = \sum_{j \neq i}^{19} \left(BS^j + \sum_{r=1}^6 RS^r \right) + \sum_{j=i}^{19} \left(BS^j + \sum_{r=1}^6 RS^r \right) - P_{\text{best}} - P_{\text{second best}}$ |

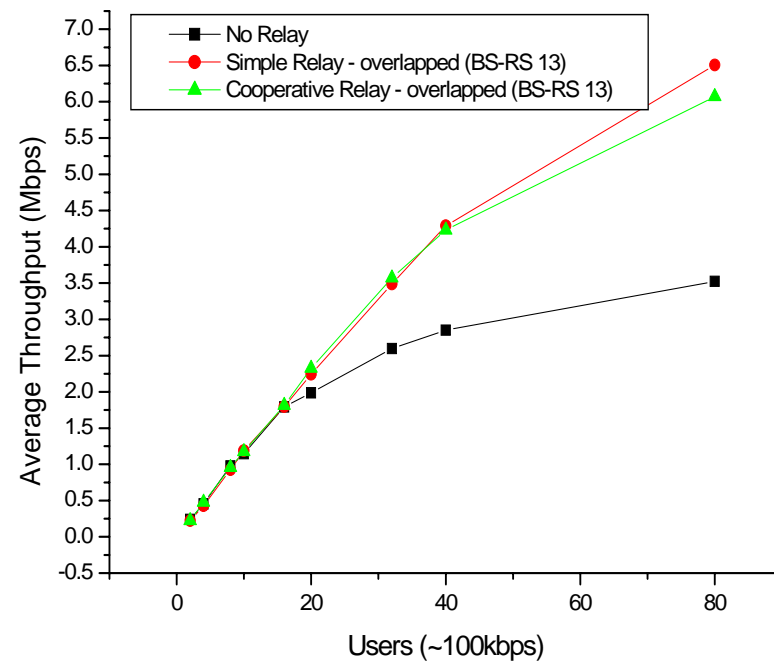
System Level Simulation (4)

- Performance Comparison: SR vs. SRD

- Orthogonal Allocation

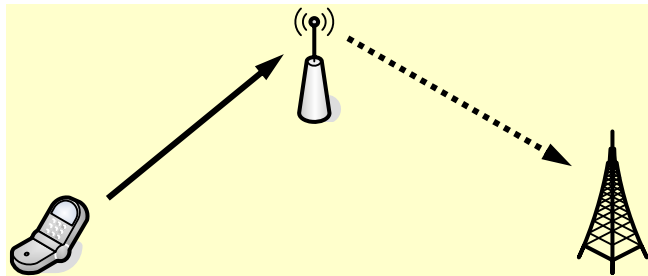


- Overlapped Allocation

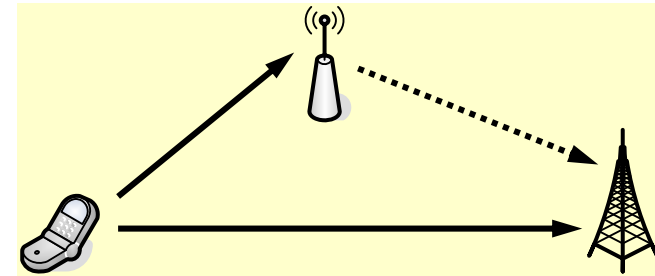


Types of Transmission Protocols: Diversity

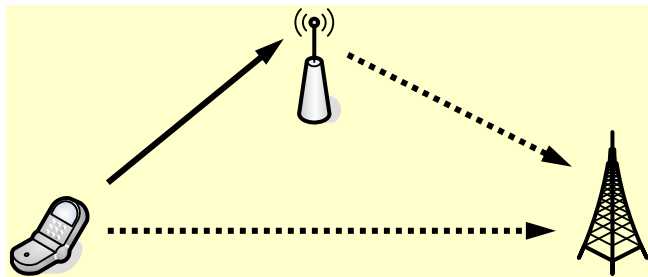
- **Simple Relay (SR)**



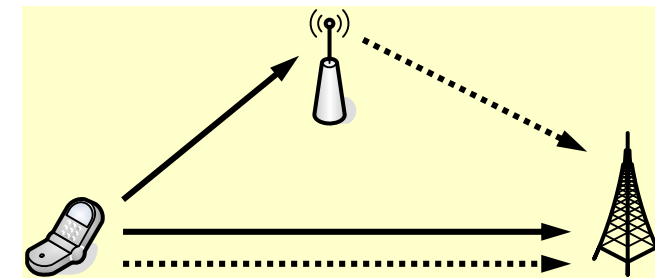
- **Receive Diversity (RD)**



- **Transmit Diversity (TD)**



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

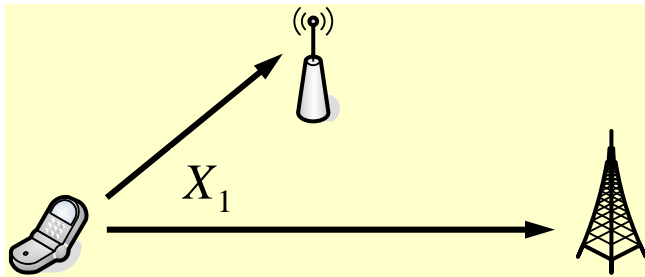


- Notes: \longrightarrow : first time slot, $\cdots\cdots\longrightarrow$: second time slot

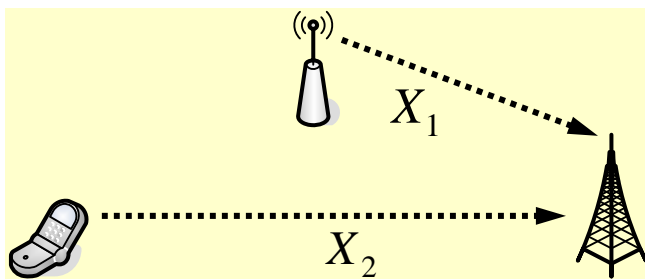
Types of Transmission Protocols: Multiplexing (1)

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

- First time slot

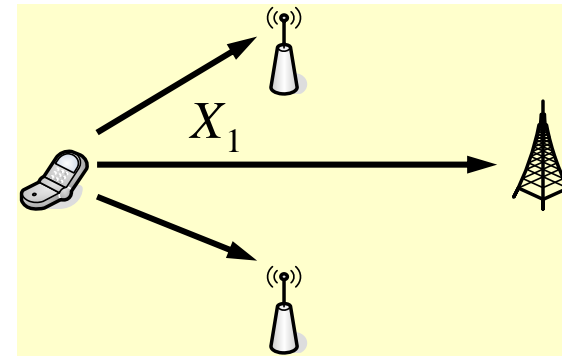


- Second time slot

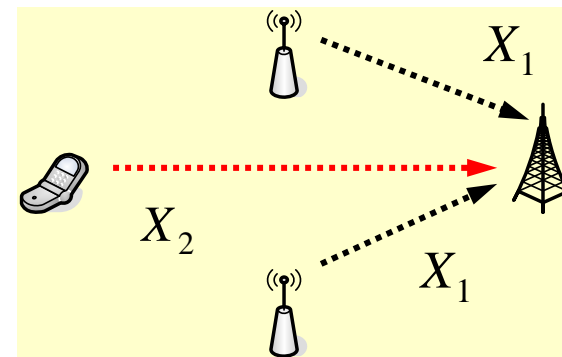


- **Extended SMRD-A**

- First time slot



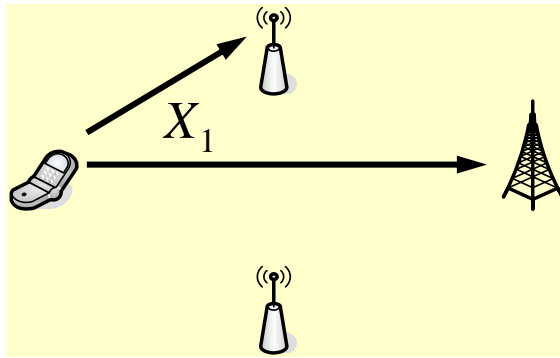
- Second time slot



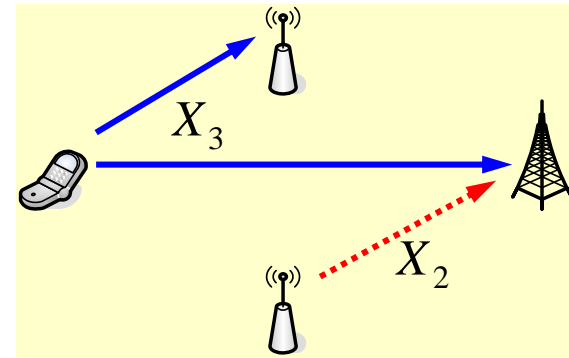
Types of Transmission Protocols: Multiplexing (2)

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

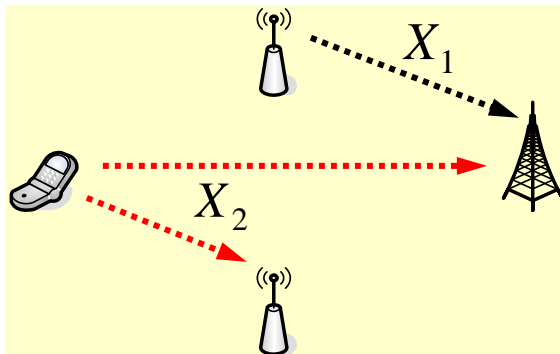
- First Time Slot



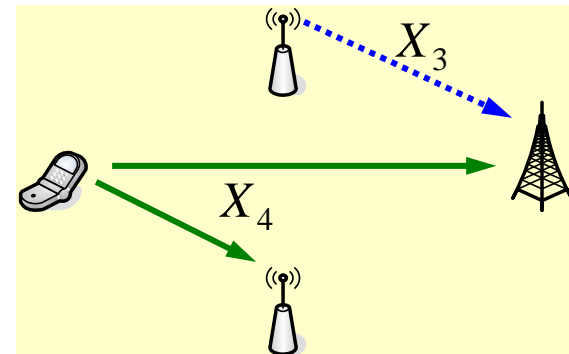
- Third Time Slot



- Second Time Slot

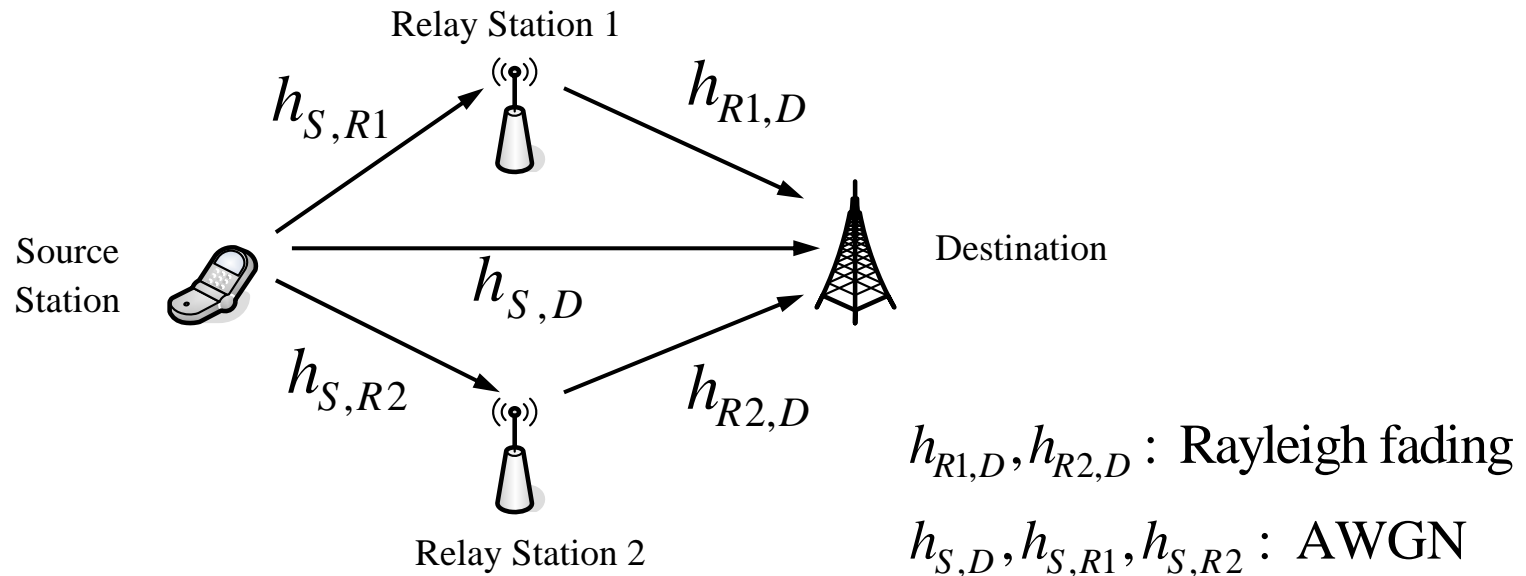


- Fourth Time Slot



Simulation Model: SMRD

- **Channel Model**



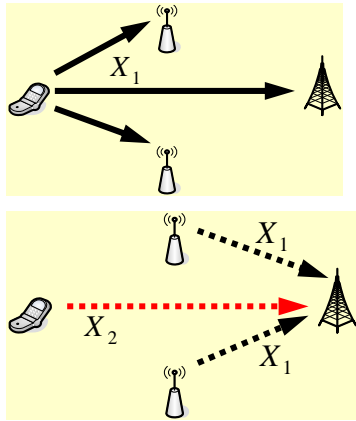
- **Assumptions**

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

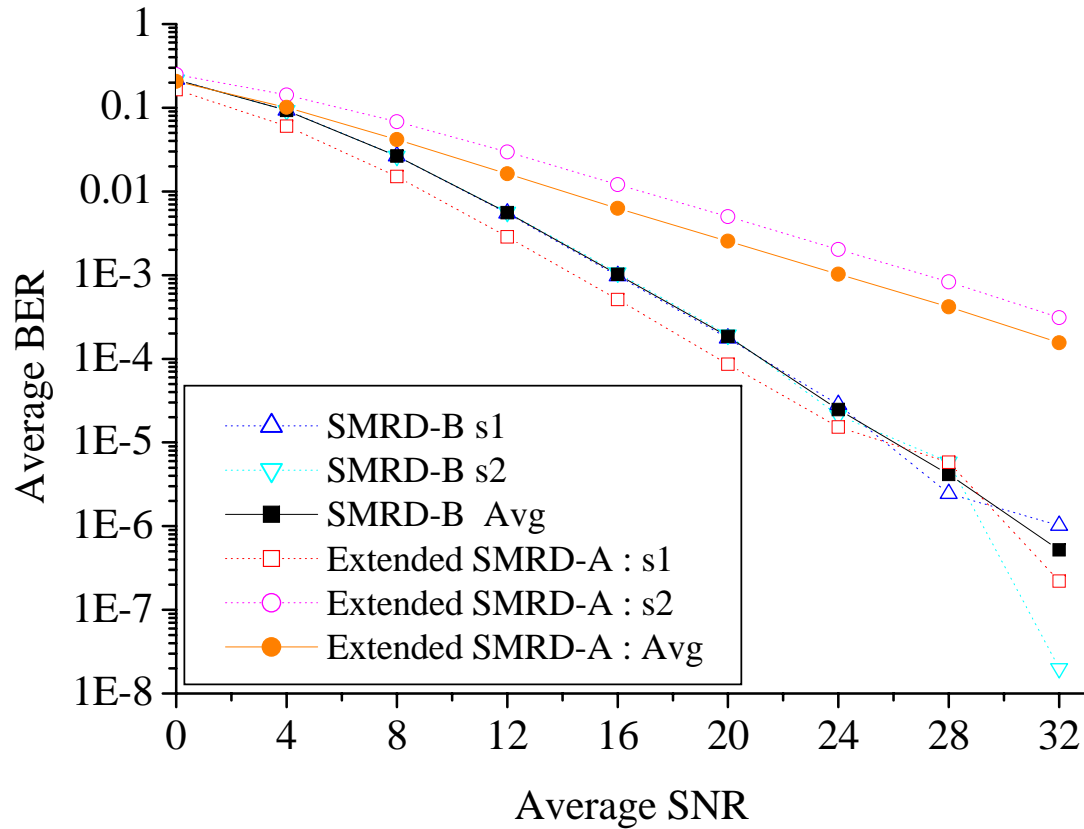
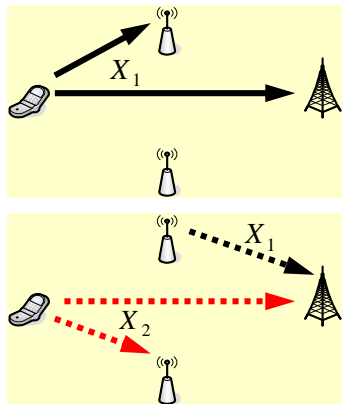
Simulation Result: SMRD

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

- 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**