Cooperative Recovery

in Heterogeneous

Mobile Networks

SECON 2008

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OUTLINE

- **Introduction.**
- **System architecture.**
- **Protocol design.**
- **Performance evaluation.**
- **Further works & Conclusion.**

INTRODUCTION

- **Compare Multicast with Unicast over wireless networks.**
  - Benefits：
    - **Distribute data efficiently.**
    - **Improve throughput.**
  - Defects：
    - **Difficult to guarantee the reception reliability of multiple recipients.**
    - **No reverse communication channel.**

INTRODUCTION

- **FEC (forward error correction).**
  - Increase transmission bandwidth requirements or message delay.

- **Multiple antennas.**
  - High cost.

- **The Cooperative Recovery Protocol.**
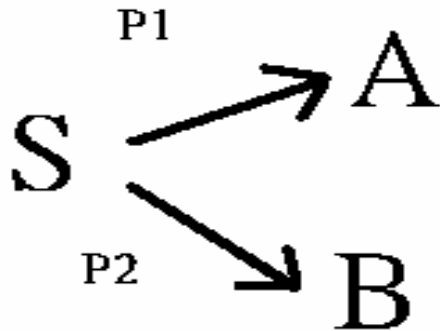 - Peer cooperation.

SYSTEM ARCHITECTURE
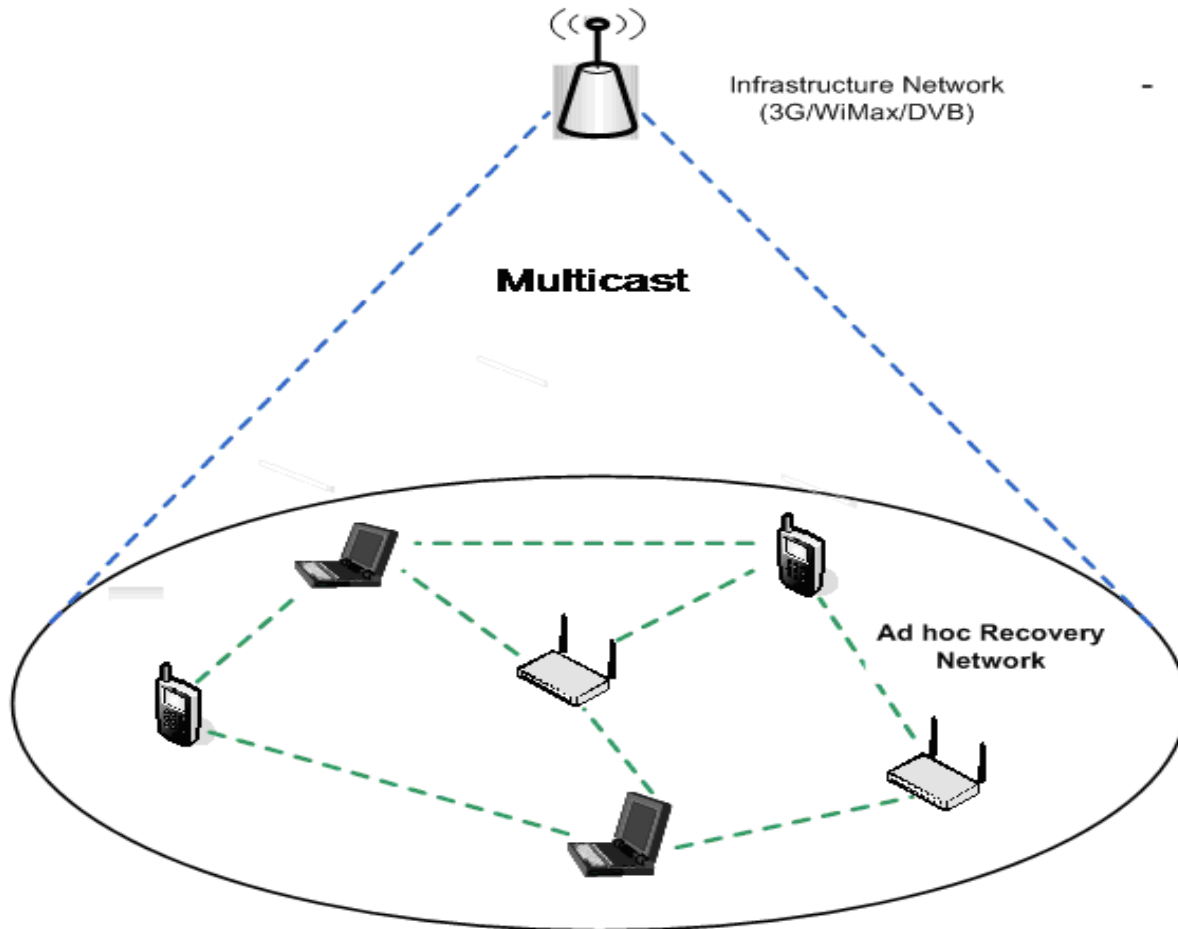
SYSTEM ARCHITECTURE

- **Two radio interfaces in device：**
  - **Connect to principal network, for receiving multicast data from BS to wireless devices.**

  - **Connect to assistant network, over which the messages and packets for recovery can be transmitted.**

SYSTEM ARCHITECTURE

- **Recovery rate**

Source S is multicasting data to devices A and B.

P1,P2<<1，so the recovery rate：$(1 - \prod Pn) \approx 1$
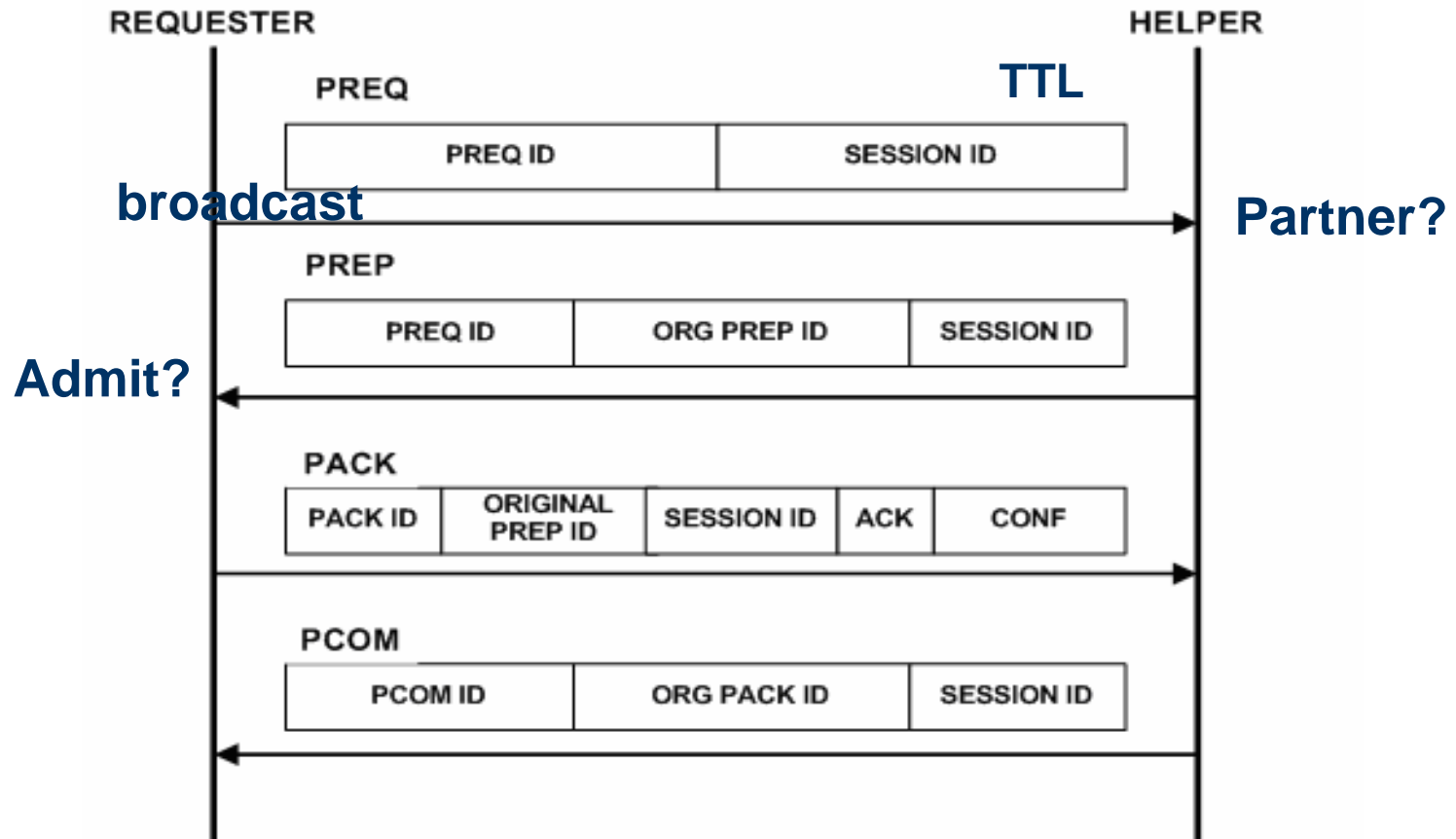
- **Related work**

  - ◆ **Use relay nodes in assistant network：Big load.**

PROTOCOL DESIGN

- **Peer Discovery and Partnership Establishment.**

- **Partnership Maintenance.**
  - Periodically check by exchanging Keep-Alive(KA) messages between them.

- **Data Recovery.**

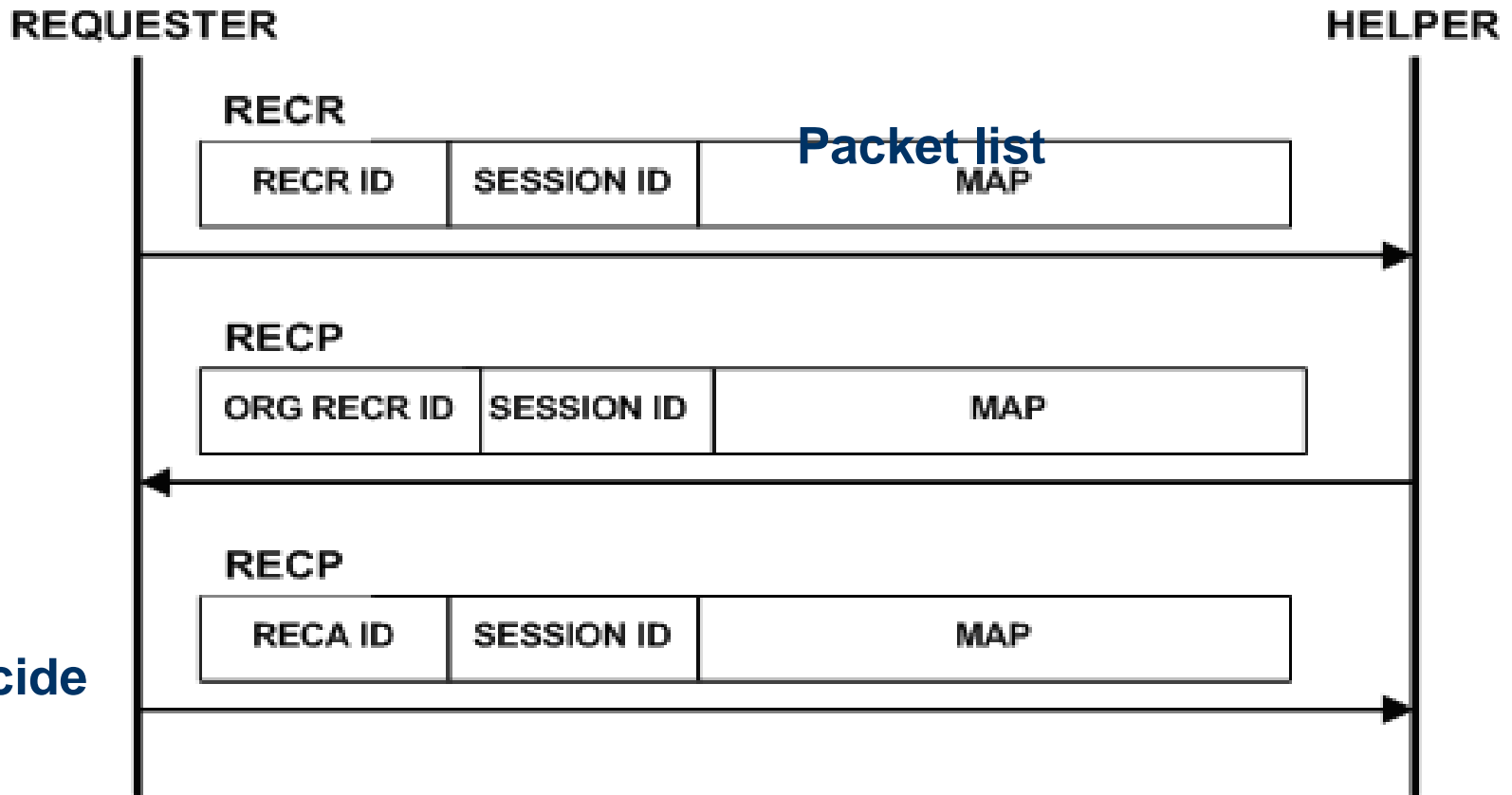# Peer Discovery and Partnership Establishment

Partnership Maintenance

- **Requester's view：**
  - A Keep-Alive (KA) unicast message is sent periodically with period K_INTERVAL.
  - The peer replies with a unicast Keep_Alive_Reply (KAR) message.
  - KAR_TIMEOUT after sent KA.
  - KEEP_ALIVE_RETRIES_LIMIT.

Partnership Maintenance

- **Partner's view：**
  - Has not received the KA message from the requester device for a time interval KEEP_ALIVE_LIMIT.

- **IF one partnership is ended，find a replacement partner.**

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Data Recovery

REQUESTER   HELPER

RECR
Packet list

RECR ID	SESSION ID	MAP

RECP

ORG RECR ID	SESSION ID	MAP

RECP

RECA ID	SESSION ID	MAP

Decide

PERFORMANCE EVALUATION

- **Methodology：**
  - **3G multicast principal network.**
  - **802.11b WLAN assistant network.**
  - **OPNET Modeler with PDUs simulating the reception of 3G multicasts session.**
- **Compare the before recovery and after recovery PDU drop rates at the wireless devices.**
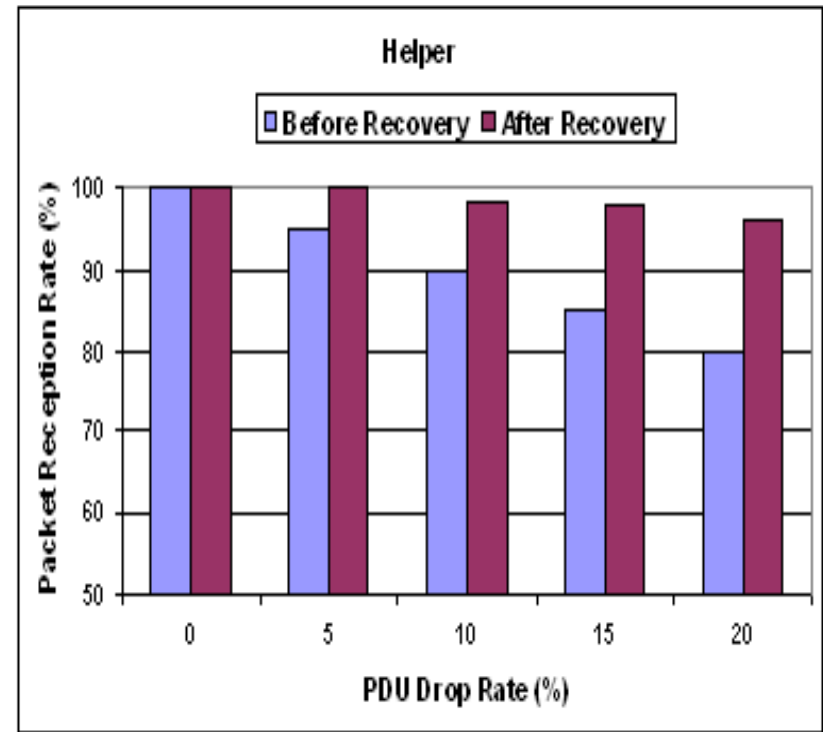
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PERFORMANCE EVALUATION

1) **Dependency on PDU drop rate.**

2) **Dependency on the number of helpers.**

3) **Effect of Recovery Network Size.**

4) **Throughput Improvement and Fairness.**

5) **Multi-hop Scenario.**

6) **Recovery Delay.**

7) **Video Encoder/Decoder Simulation.**

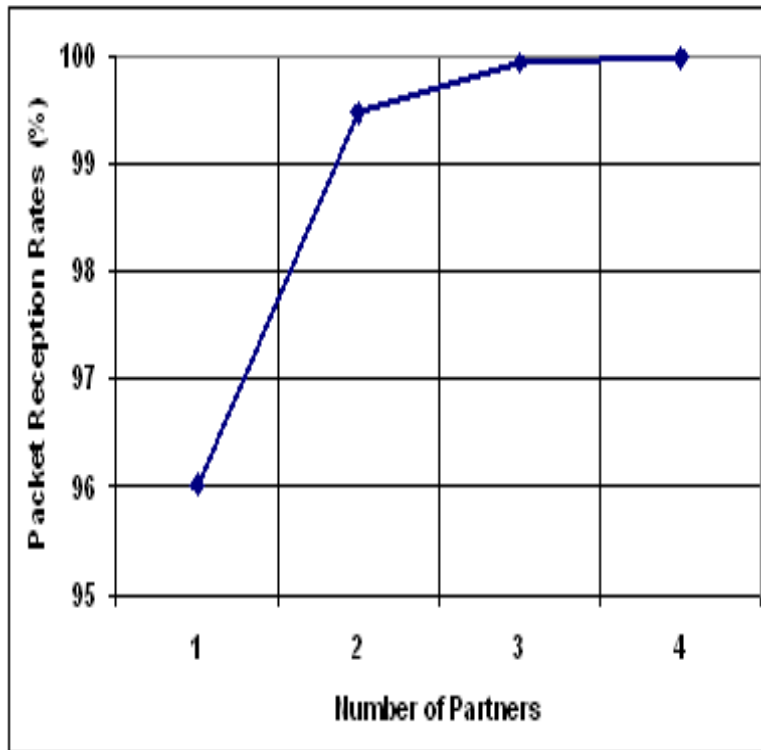# PERFORMANCE EVALUATION

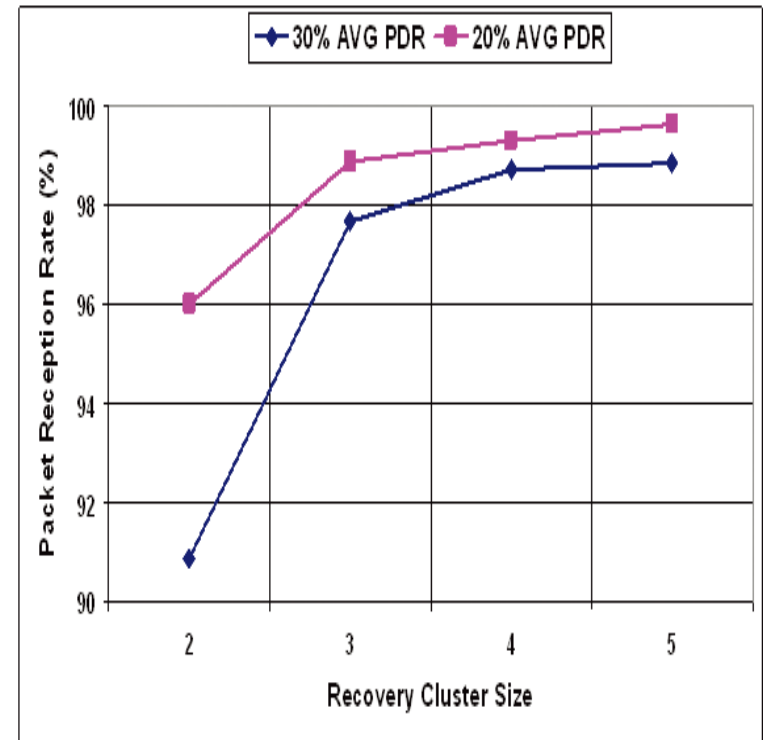## Dependency on PDU drop rate：
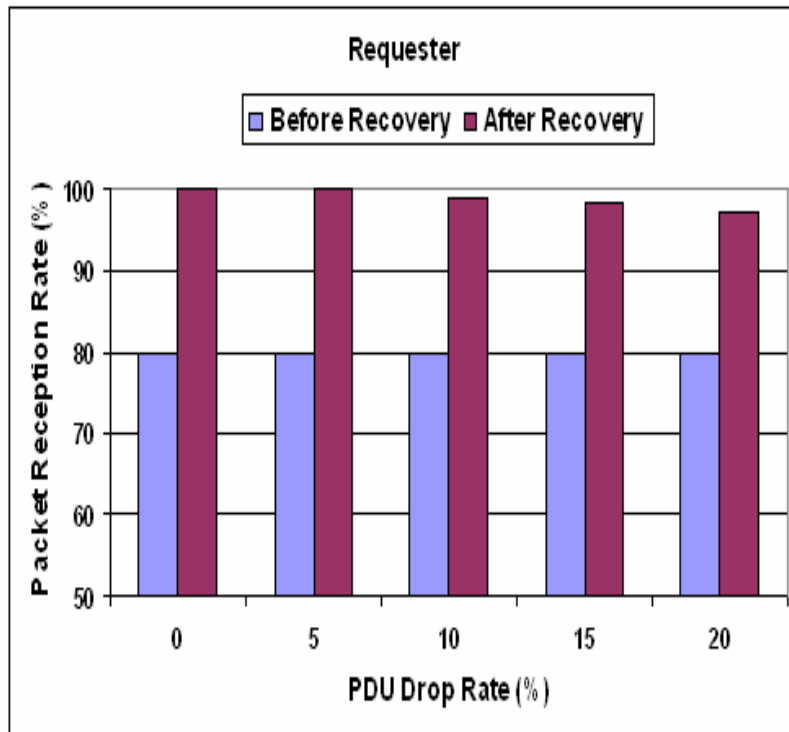
Effect of requester
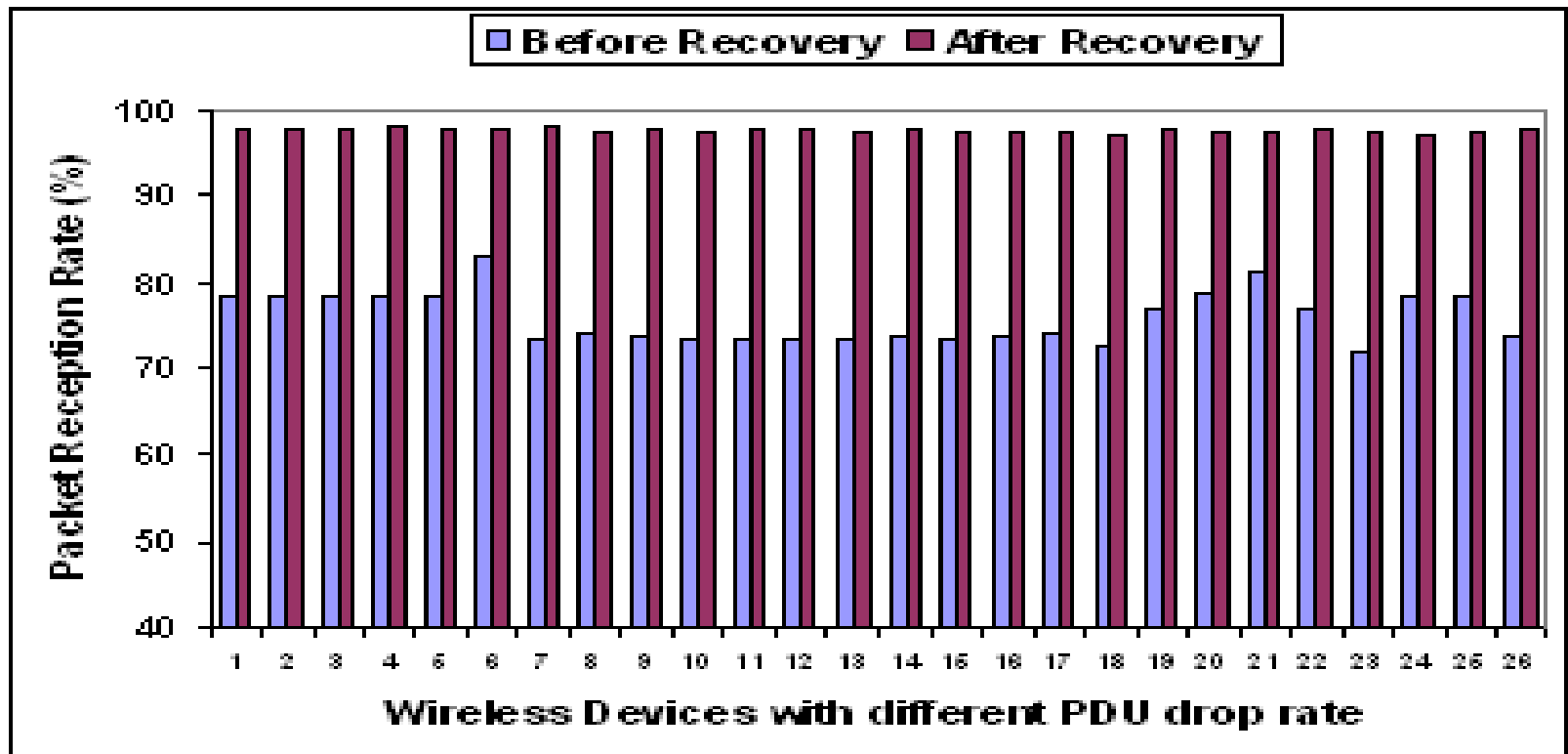

Effect of helper
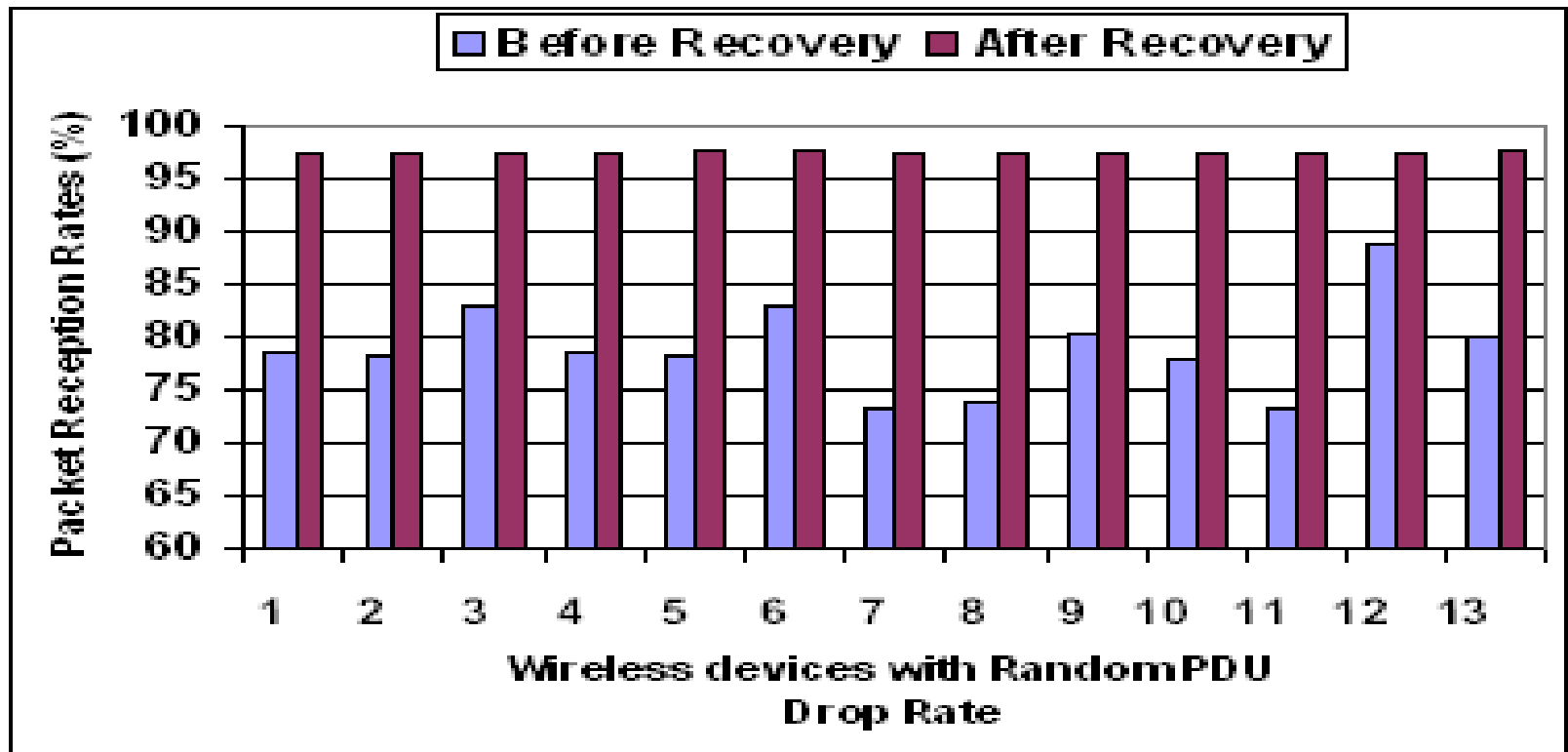
PERFORMANCE EVALUATION

Effect of number of partners

Effect of recovery network size
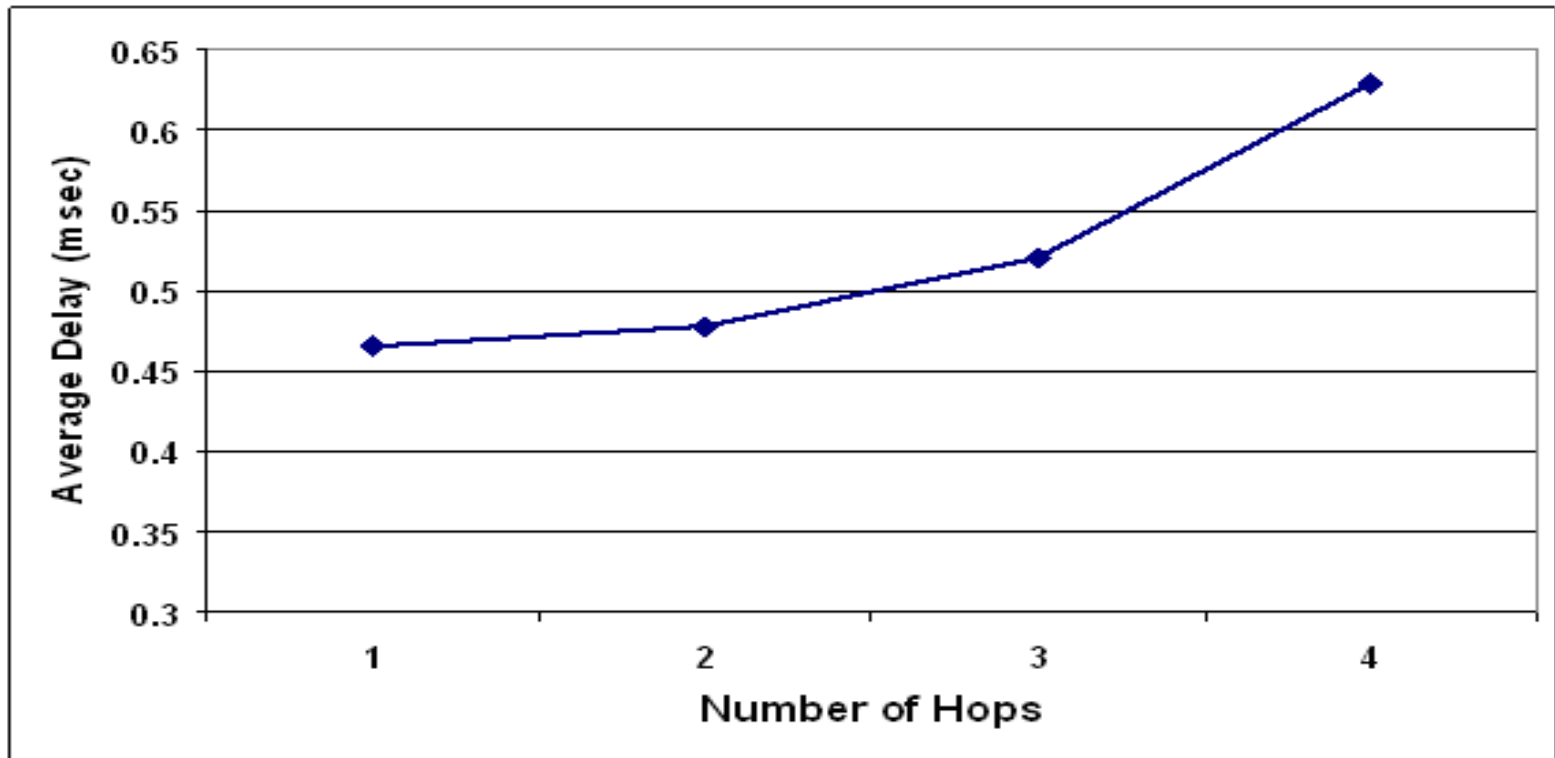
PERFORMANCE EVALUATION

Throughput improvement in a dense environment

PERFORMANCE EVALUATION

Multi-hop Recovery Scenario

PERFORMANCE EVALUATION

Peak Recovery Delay

PERFORMANCE EVALUATION

- **Video Encoder/Decoder Simulation**

TABLE I: PSNR Values

| PSNR(dB)	Y	U	V
Before Recovery	21.31	24.23	25.27
After Recovery	35.62	38.49	39.54

$$PSNR = 10 \times \log\left(\frac{255^2}{MSE}\right)$$

$$MSE = \frac{\sum_{n=1}^{FrameSize} (I_n - P_n)^2}{FrameSize}$$

FURTHER WORKS AND CONCLUSION

- **Mobility of Wireless Devices**
  - Discover a new partner or find a relay node relay the packets to the requester.

- **Partner Selection**
  - According to various criteria to optimize this partner selection process.

FURTHER WORKS AND CONCLUSION

Hierarchical ad hoc recovery network with dedicated proxies
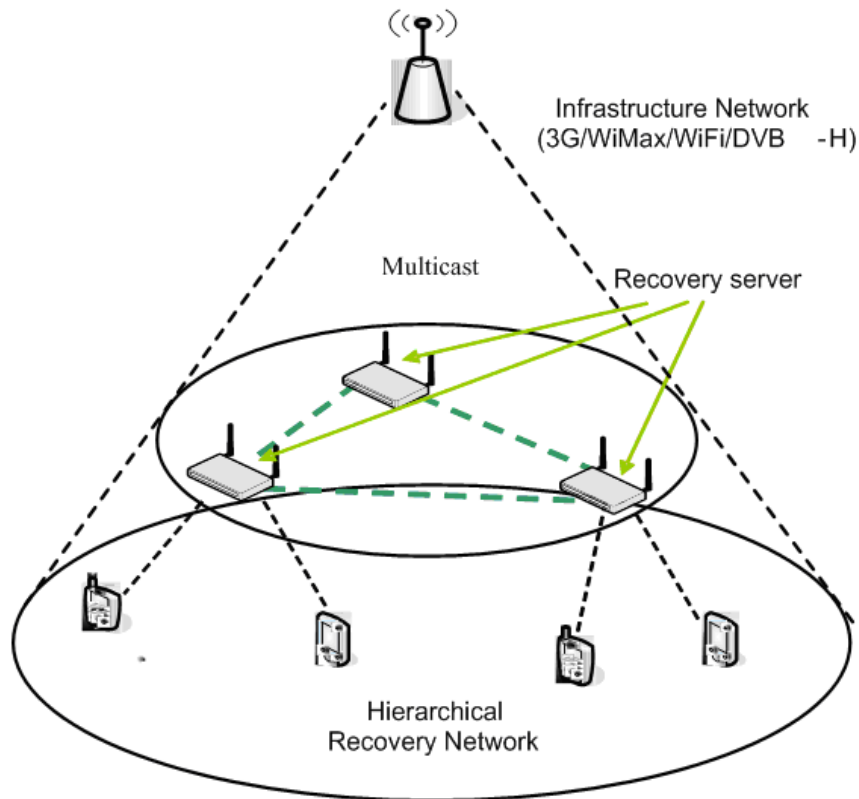
FURTHER WORKS AND CONCLUSION

- **Cooperative Recovery Scheme, which is a novel method to enhance QoS support for multicast services over a principal network (3G).**

THANKS !