



A New Cooperative Communication MAC Strategy for Wireless Ad Hoc Networks

6th IEEE/ACIS International Conference
on Computer and Information Science
(**ICIS 2007**)

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2007/9/27



Outline

- Introduction
- Cooperative System Model
- Description of Improved Cooperative Scheme
- Simulation
- Conclusion

Introduction

- Cooperative diversity, a virtual MIMO concept, has been areas of active interest among researchers.
- Cooperative MAC(CMAC) protocol[1]
- Node-cooperative stop and wait (NCSW) ARQ protocol.

Introduction

- A novel cooperative MAC strategy for slow fading Ad hoc networks has three improvements :
 - *Avoiding ambiguous ACK/NAK and diffusion of cooperation process, cooperative and non-cooperative frames are distinguished.*
 - *Traffic categories.*
 - *According to instantaneous channel conditions, the most appropriate node is selected to help the source node retransmit data.*



Cooperative System Model

- In cooperative communications, each node not only transmits and receives data for its own applications, but can also provide an alternative path for the other pairs of communicating nodes.

Cooperative System Model

- **Partner** : *neighbor nodes that have enough resources and are willing to cooperate can assist the sender node in the retransmission process by retransmitting the same copy of the previous frame.*
- A sender node and the corresponding partners form a temporary cooperation group.

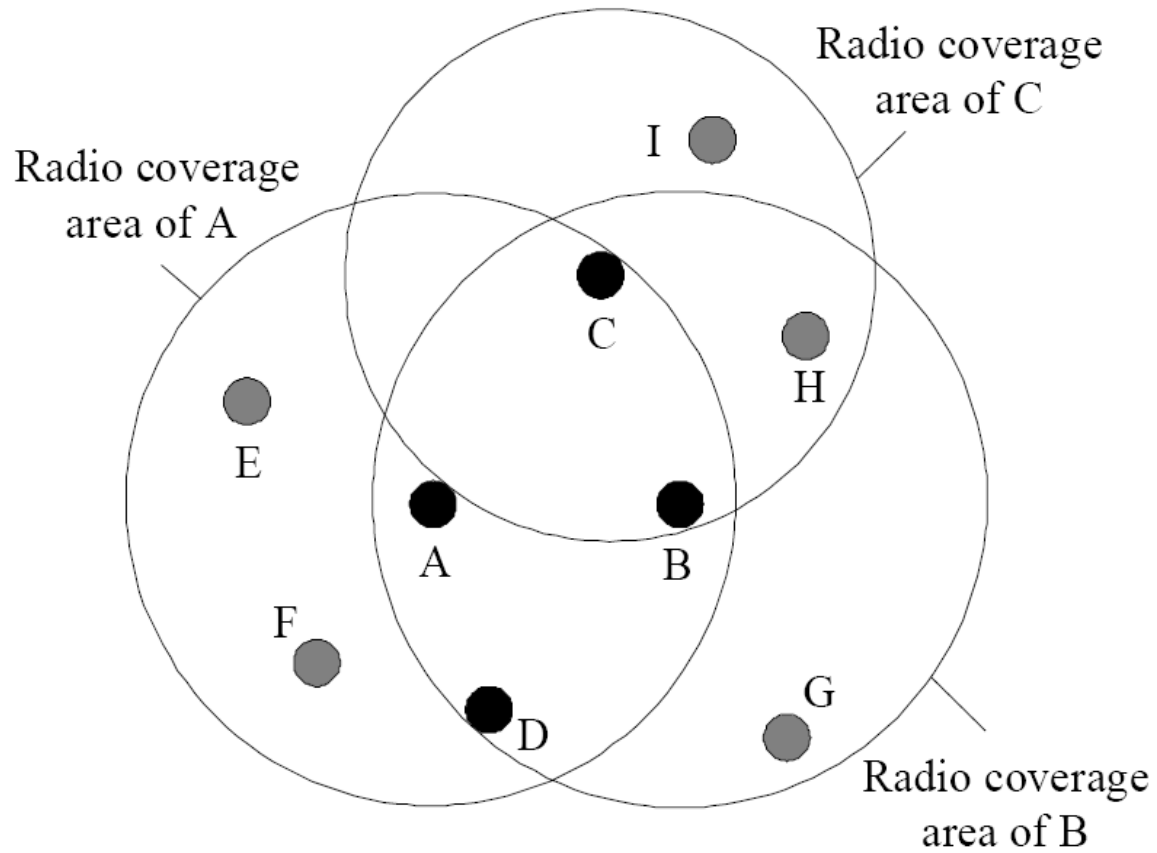


Fig. 1. Cooperation group model

Description of Improved Cooperative Scheme

- Distinguish cooperative and non-cooperative frames
 - Using the following frame number:00,01,10,10; 00,01 are used for sending frame; 01,11 are used for retransmitting frame.
 - Preventing that cooperation process diffuse from one cooperation group to another.

Description of Improved Cooperative Scheme

- Introduce traffic categories within each node
 - Since each node may act as both a source and a partner
 - Each node requires two MAC queues with the first queue being the **data queue** and the second queue, called **partner queue**.

Description of Improved Cooperative Scheme

- Set priorities among nodes in cooperation group
 - The probability of a successful retransmission depends on the relay channel.
 - When a sender fails to transmit a frame correctly, the node and its several partners will compete with one another for capturing channel to retransmit the error frame.

Set priorities among nodes in cooperation group

- How to choose the “optimal” retransmission node?
- NAK and SNR_k
- Priority-based back-off(PB) algorithm:
 - A timer from a parameter γ based on the instantaneous SNR_k . The timer of the node with the “best” end-to-end channel conditions will expire first.

$$T_k = \frac{\gamma}{SNR_k}$$

Simulation

- A pair of sender-receiver nodes and a varying number of neighbor nodes.
- The area coverage of the network is 200 m×200 m.
- Nodes' transmission range is 100 m.
- Propagation delay for the range is on the order of $1/3 \mu\text{s}$.
- The channels among the nodes are generated by the Rayleigh fading model.

Simulation

- The relative speed of mobile nodes is not more than 3km/h.
- The link data rate is 11Mbps.
- After members in a cooperation group have received NAK, we respectively implement binary exponential back-off (BEB) scheme and priority-based back-off (PB) scheme to retransmit a frame.

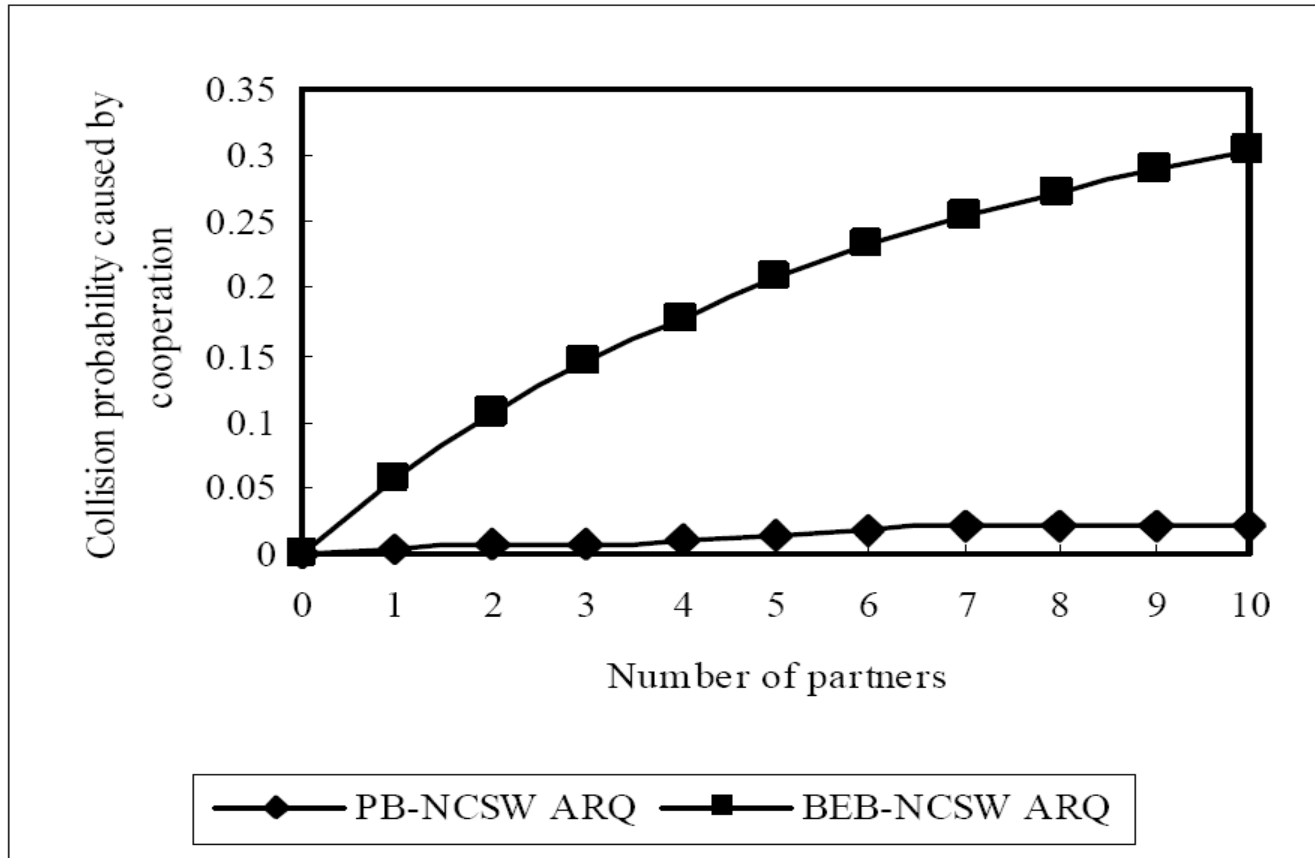


Fig. 2 Collision probability caused by cooperation under the basic access

Considering hidden terminals

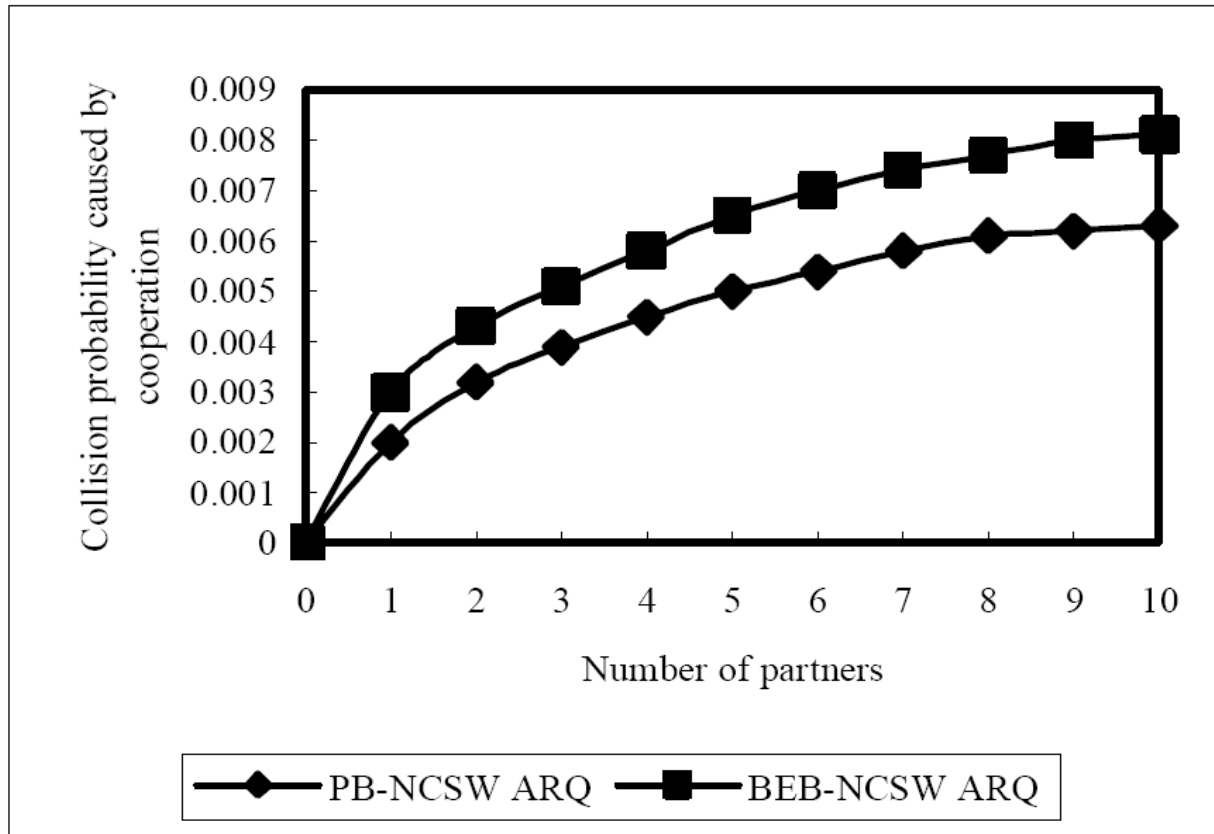


Fig. 3 Collision probability caused by cooperation under busy tone control access

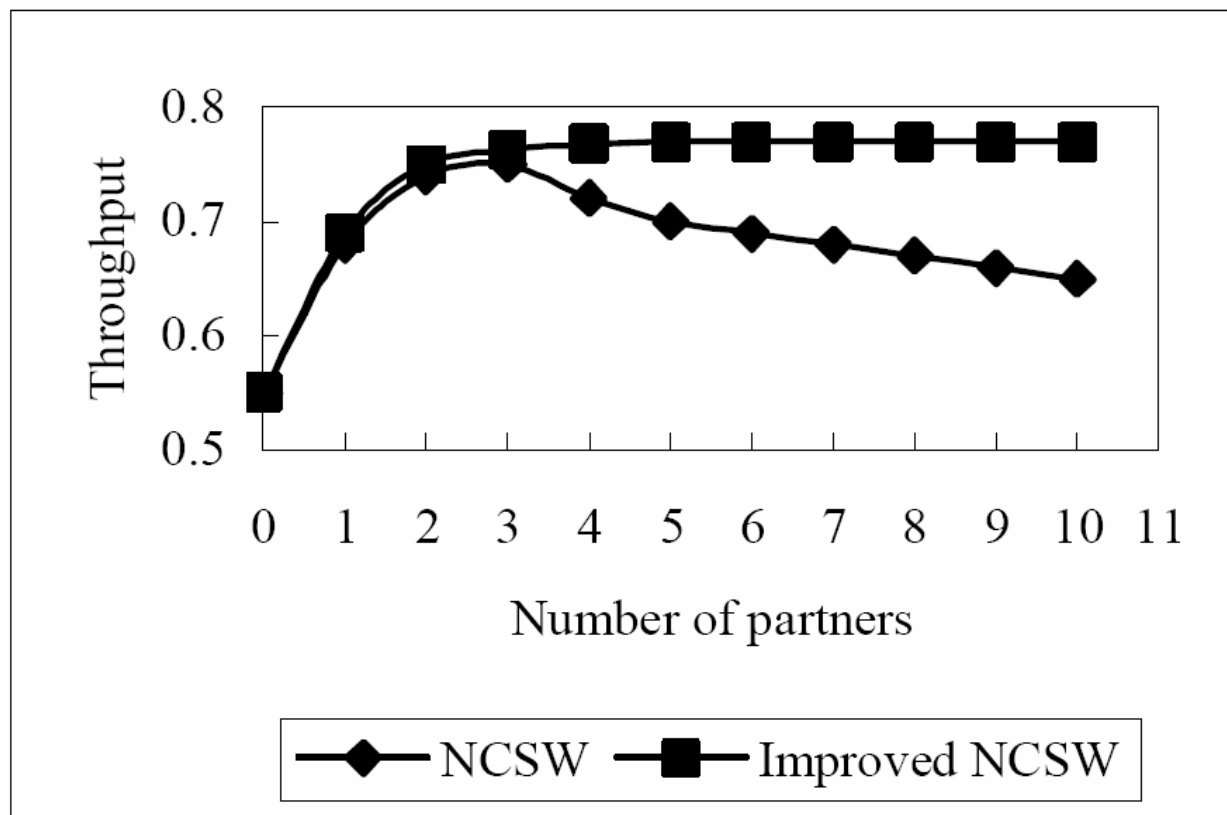


Fig. 4 Throughput of NCSW and improved scheme in an all-connected Ad hoc network

Conclusion

- A novel cooperative retransmission MAC strategy for slow fading wireless Ad hoc networks improves CMAC protocol and NCSW ARQ protocol.
 - Cooperative and non-cooperative frames are differentiated.
 - Ambiguous ACK/NAK and diffusion of cooperative process is avoided
 - The priority-based back-off algorithm is adopted in cooperation process.