Distributed Flow Control and Medium Access in Multihop Ad Hoc Networks

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Outline

- Introduction
- Impact of MAC Layer Contentions on Traffic Flows
- OPET: Optimum Packet Scheduling For Each Traffic Flow
- Performance Evaluation
- Conclusion

Introduction

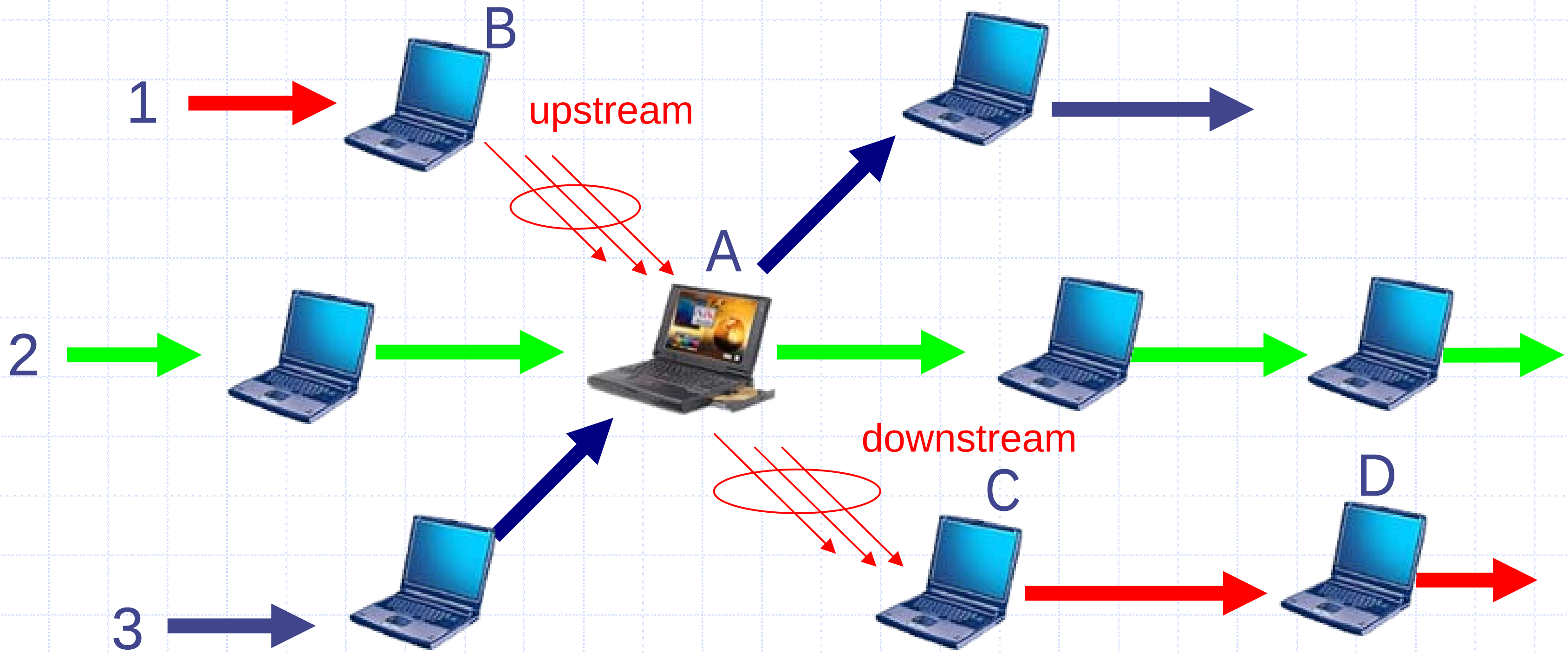
- Recent studies have shown that the performance of wireless multihop ad hoc networks is very poor.
- One important reason of the poor performance is the close coupling between ***medium contention*** and ***network congestion***

Introduction

- There are two kinds of flow contentions could result in severe collisions and congestion, and significantly limit the performance of ad hoc networks.
  - Inter-flow contention
  - Intra-flow contention

Introduction

- Intra-Flow contention
- Inter-Flow contention



Introduction

- This paper presents a framework of ***network layer flow control*** and ***MAC layer medium access to*** address the collisions and congestion problem due to intra-flow contention and inter-flow contention.

Impact of MAC Layer Contentions on Traffic Flows

❖Intra-flow contention problem

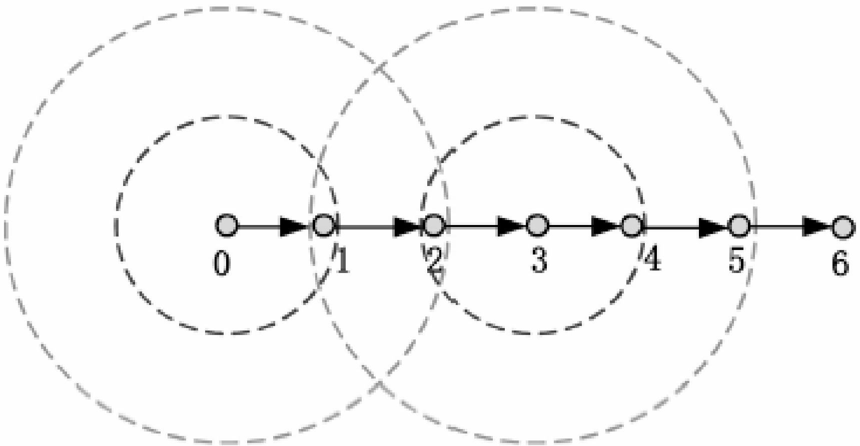


Fig. 1. Chain topology.

•The transmission of node 0 in a 7-node chain experien
interference from three subsequent nodes(1,2,3), while
transmission of node 2 is interfered with by five other n
(0,1,3,4,5).

Impact of MAC Layer Contentions on Traffic Flows

❖Interflow contention problem.

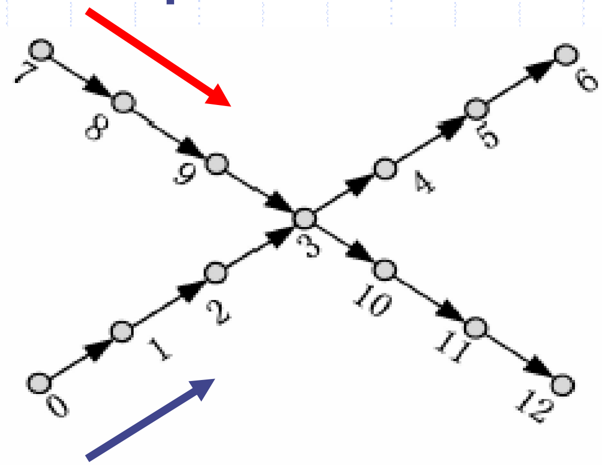


Fig. 2. Cross topology.

- Obviously, node 3 encounters the most frequent contentions and has few chances to successfully transmit packets to its downstream nodes.
- The packets will accumulate at and be dropped by node 3, 9, 2, 8, and 1.

OPET: Optimum Packet Scheduling For Each Traffic Flow

- An intuitive solution to the above problems is to allow the ***downstream nodes*** and ***the congested ones*** to obtain the channel access to transmit packets while keeping others silent.
- The objective of the proposed scheme is to approximate **Optimum Packet scheduling for Each Traffic flow (OPET)**.

OPET: Optimum Packet Scheduling For Each Traffic Flow

- OPET includes four major mechanisms.
  - Assign a high priority of channel access to the current receiver
  - Hop-by-hop backward pressure scheduling.
  - Not to allow the source node to occupy the whole outgoing queue
  - Round Robin scheduling for the queue management

Address the Intra-flow Contention Problem

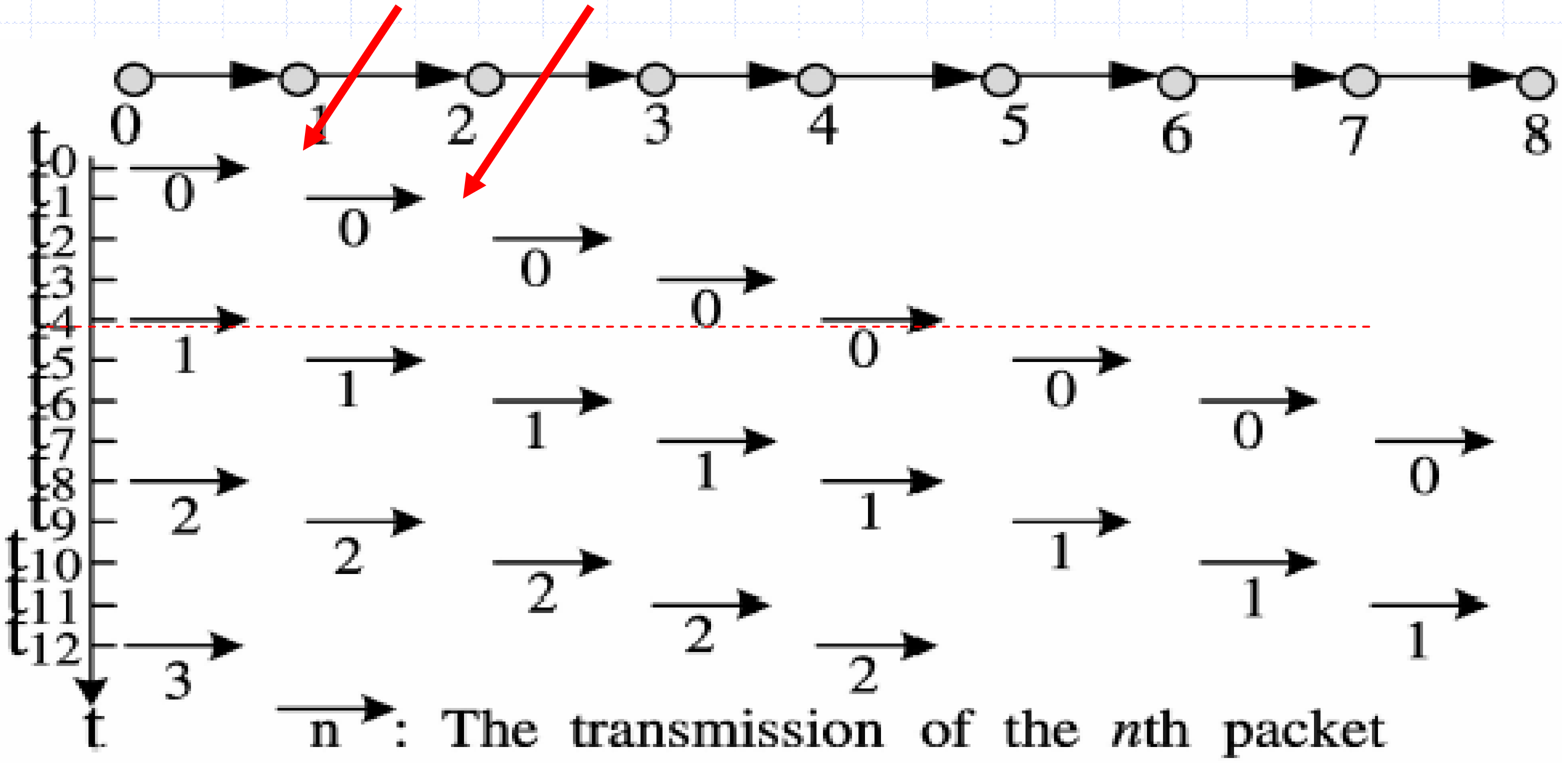
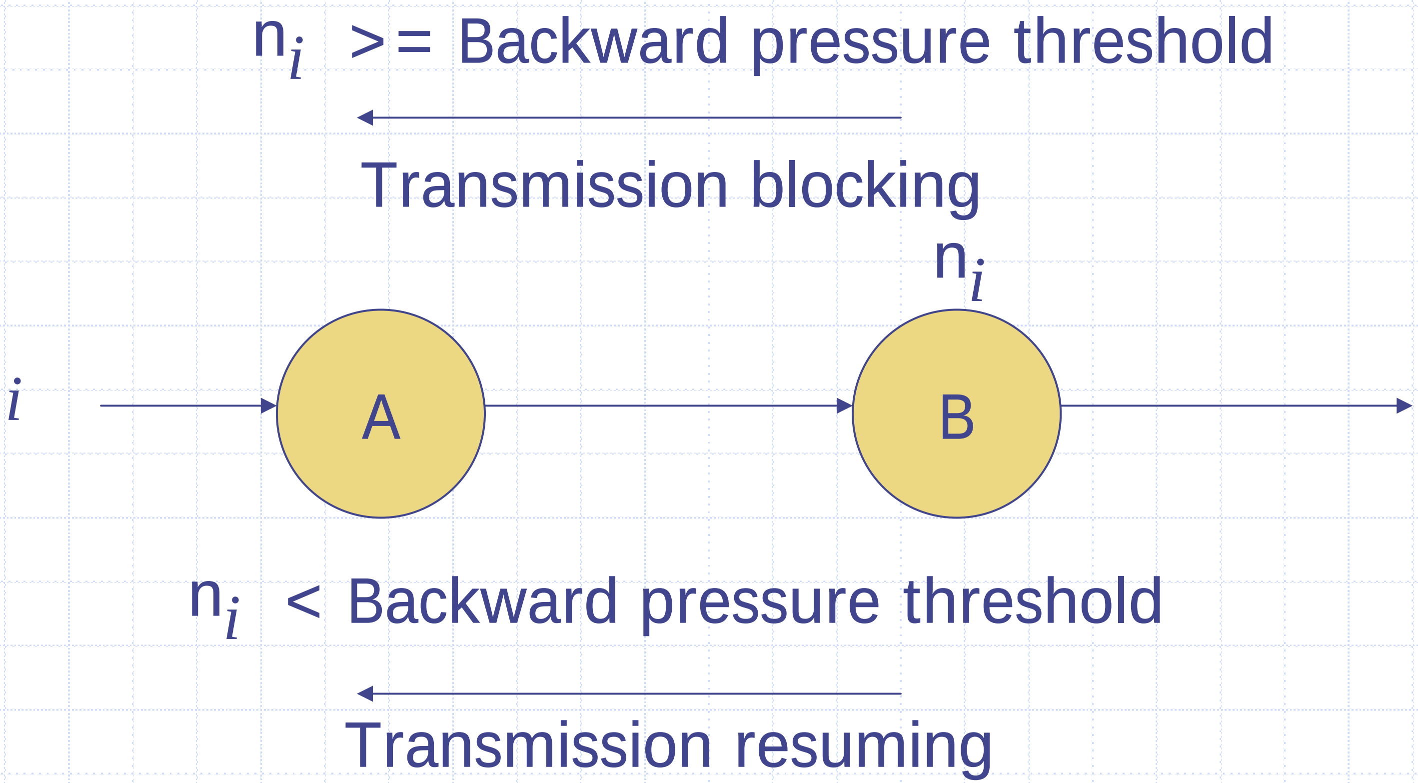


Fig. 3. Optimum packet scheduling for chain topology.

Address the Inter-flow Contention Problem



n_i denote the number of packets of flow i

Address the Inter-flow Contention Problem

Octets:	2	2	6	6	4	4	4
	Frame Control	Duration	Receiver Address	Transmitter Address	Source Address	Flow ID	FCS

RTSM frame

Octets:	2	2	6	4	4	4
	Frame Control	Duration	Receiver Address	Source Address	Flow ID	FCS

CTSR frame

Fig. 4. The packet format of RTSM and CTSR.

Address the Inter-flow Contention Problem

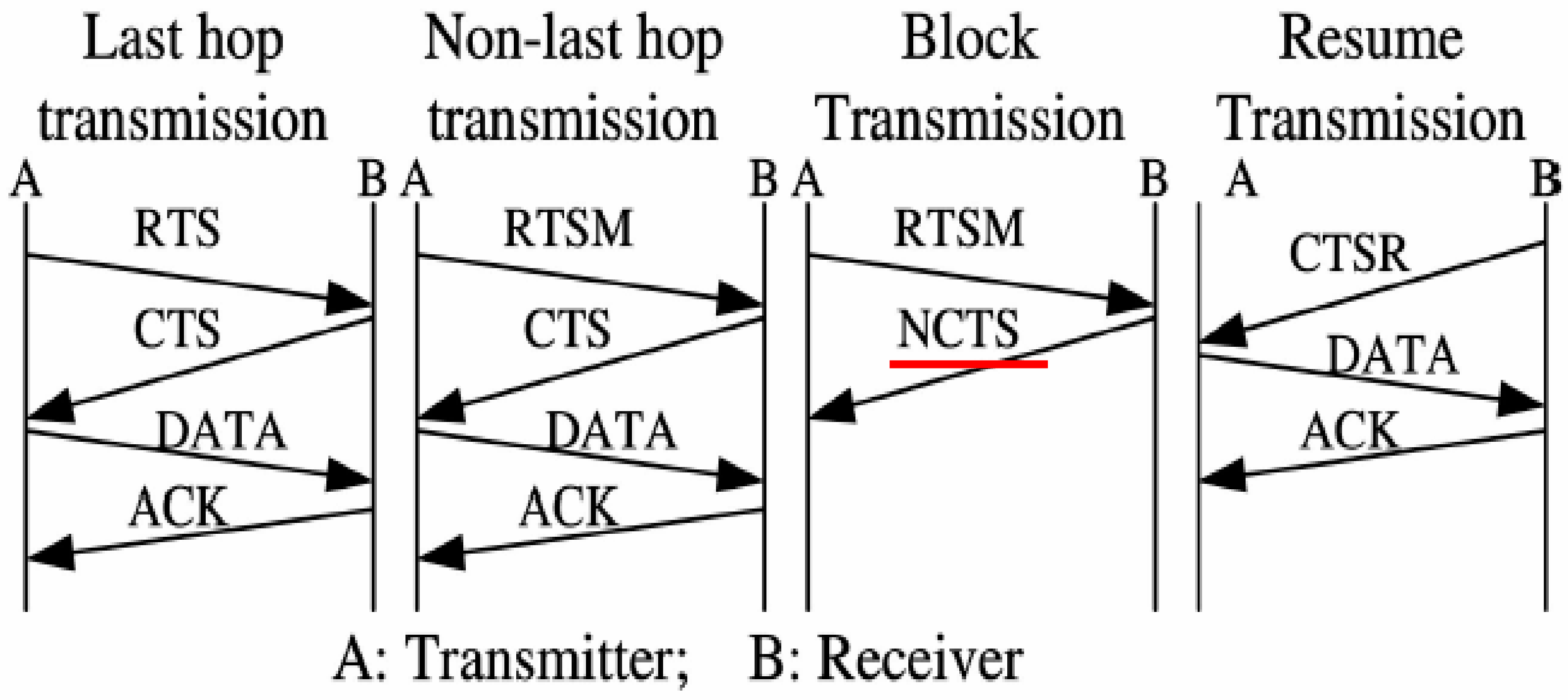


Fig. 5. Message sequence for packet transmission.

Address the Inter-flow Contention Problem

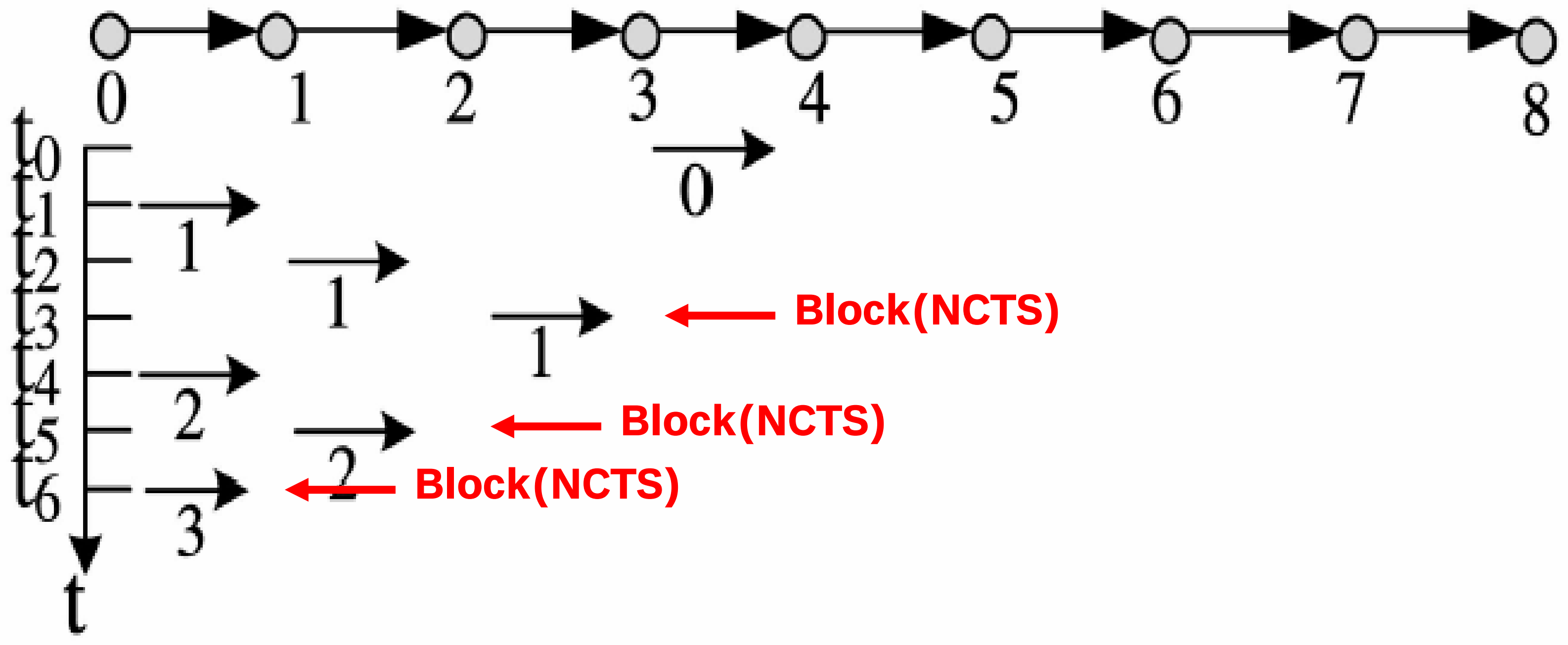


Fig. 6. The packet scheduling when congestion occurs at node 4.

Address the Inter-flow Contention Problem

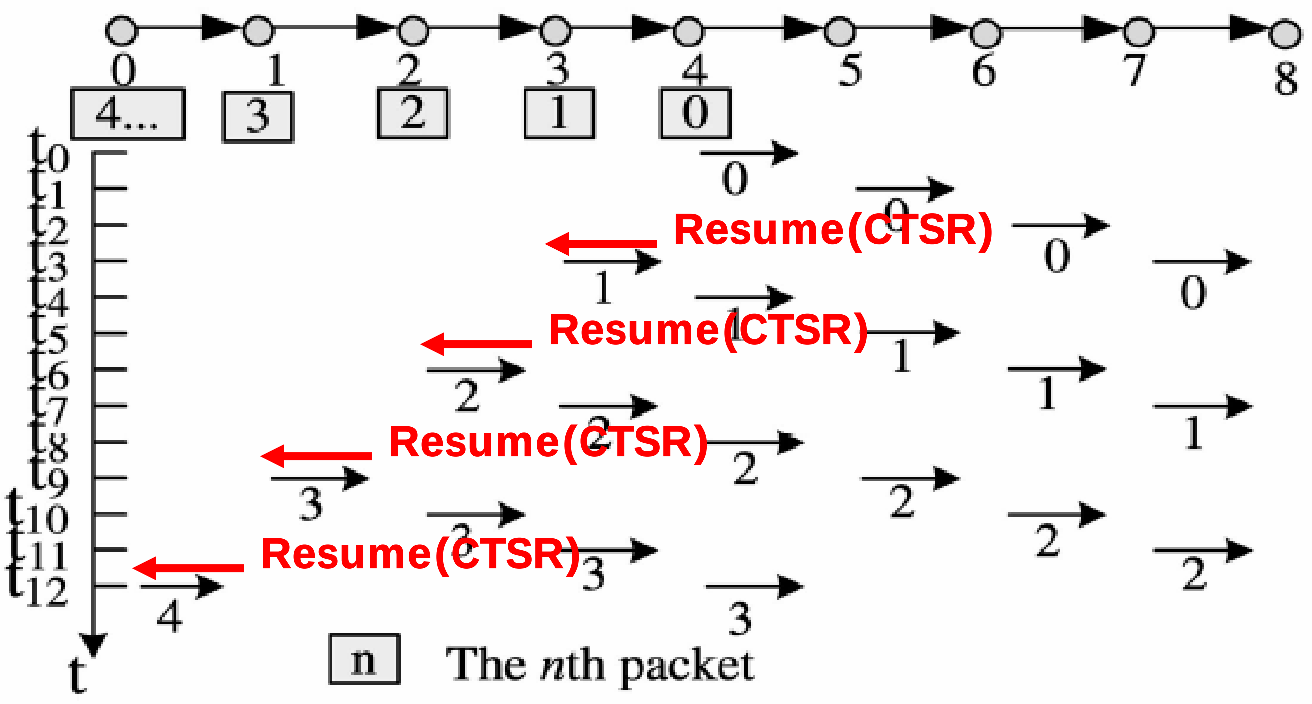


Fig. 7. The packet scheduling after eliminating the congestion at node 4.

Performance Evaluation

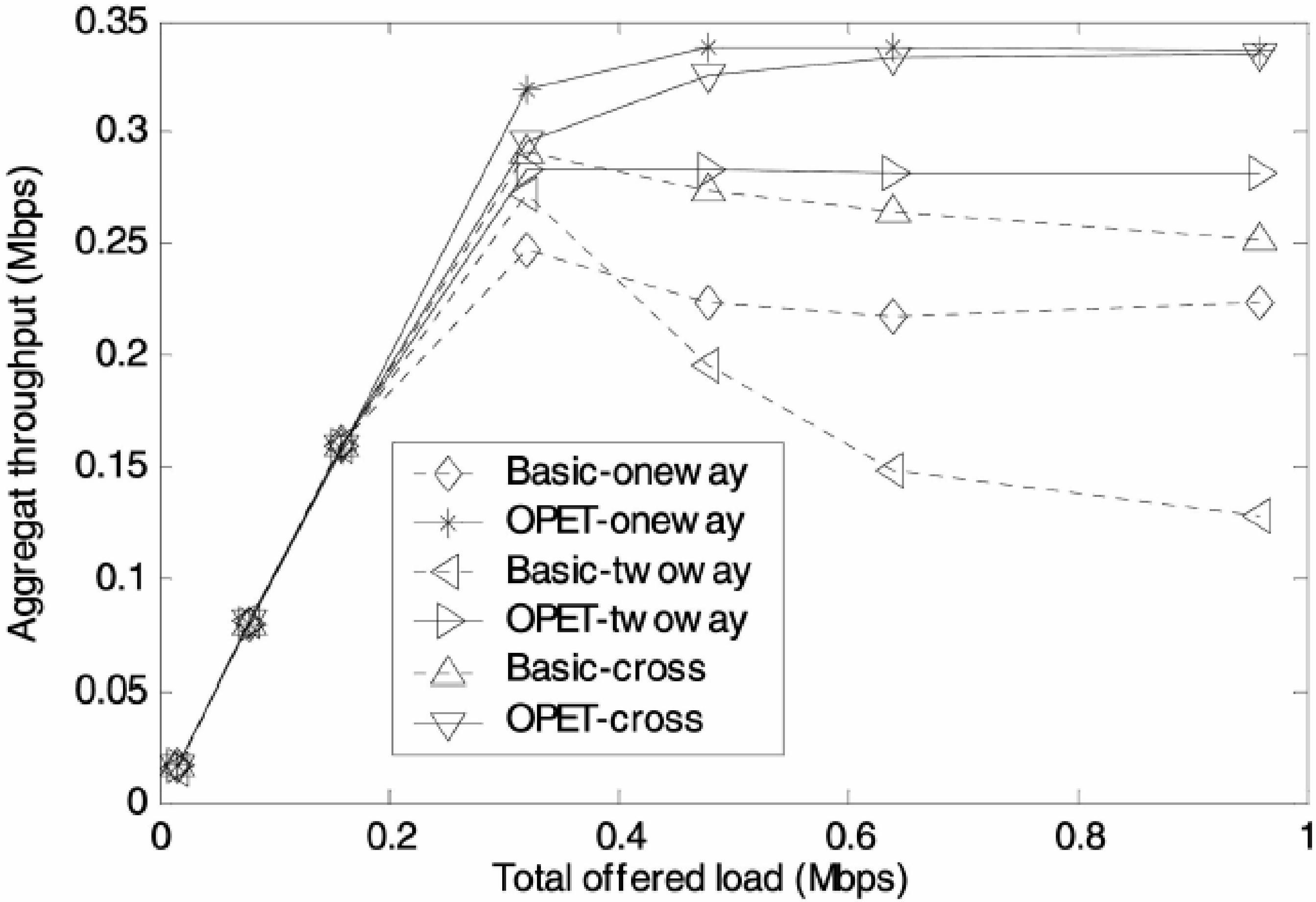


Fig. 8. End-to-end throughput in the 9-node chain topology (Fig. 3) and cross topology (Fig. 2).

Performance Evaluation

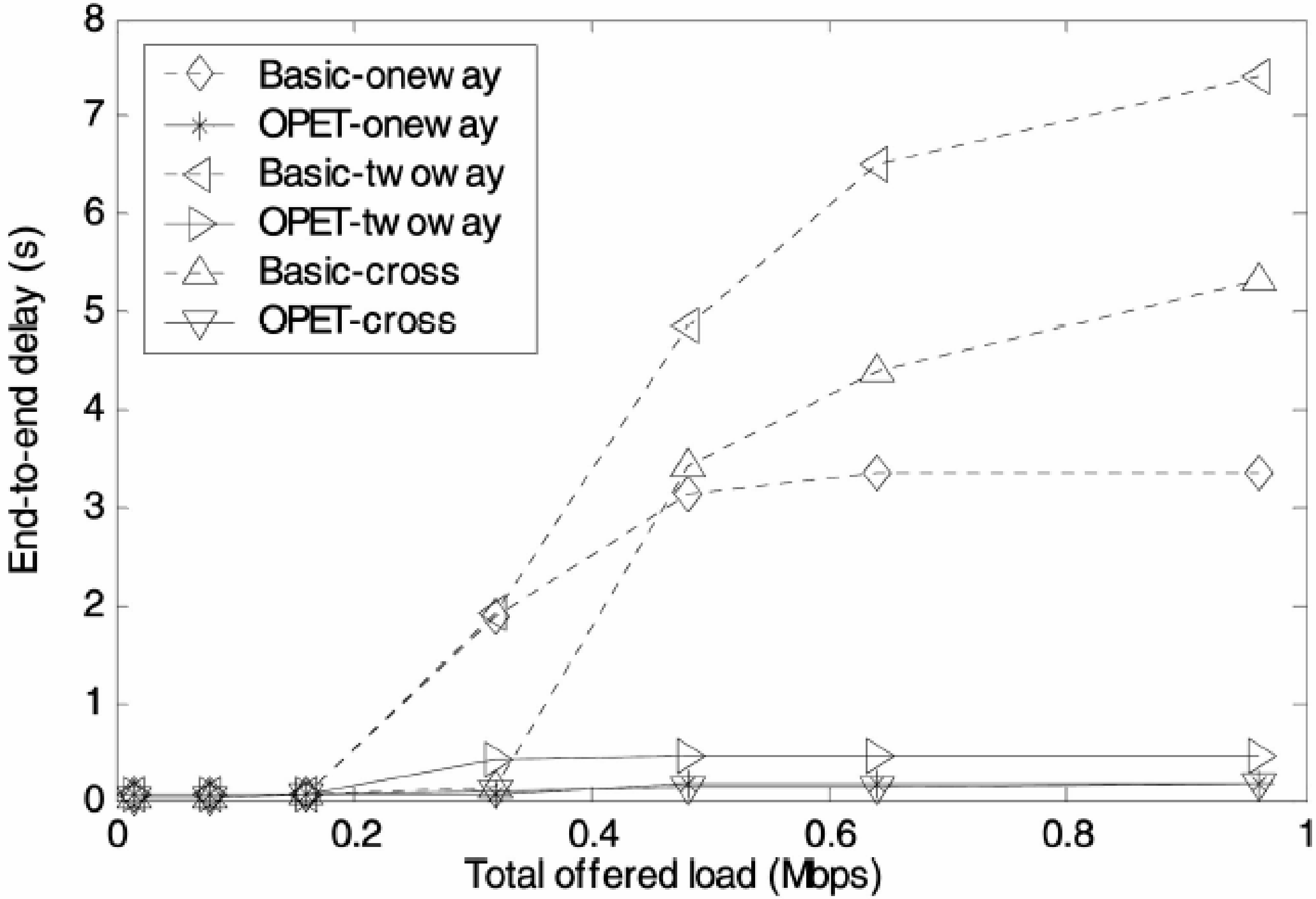
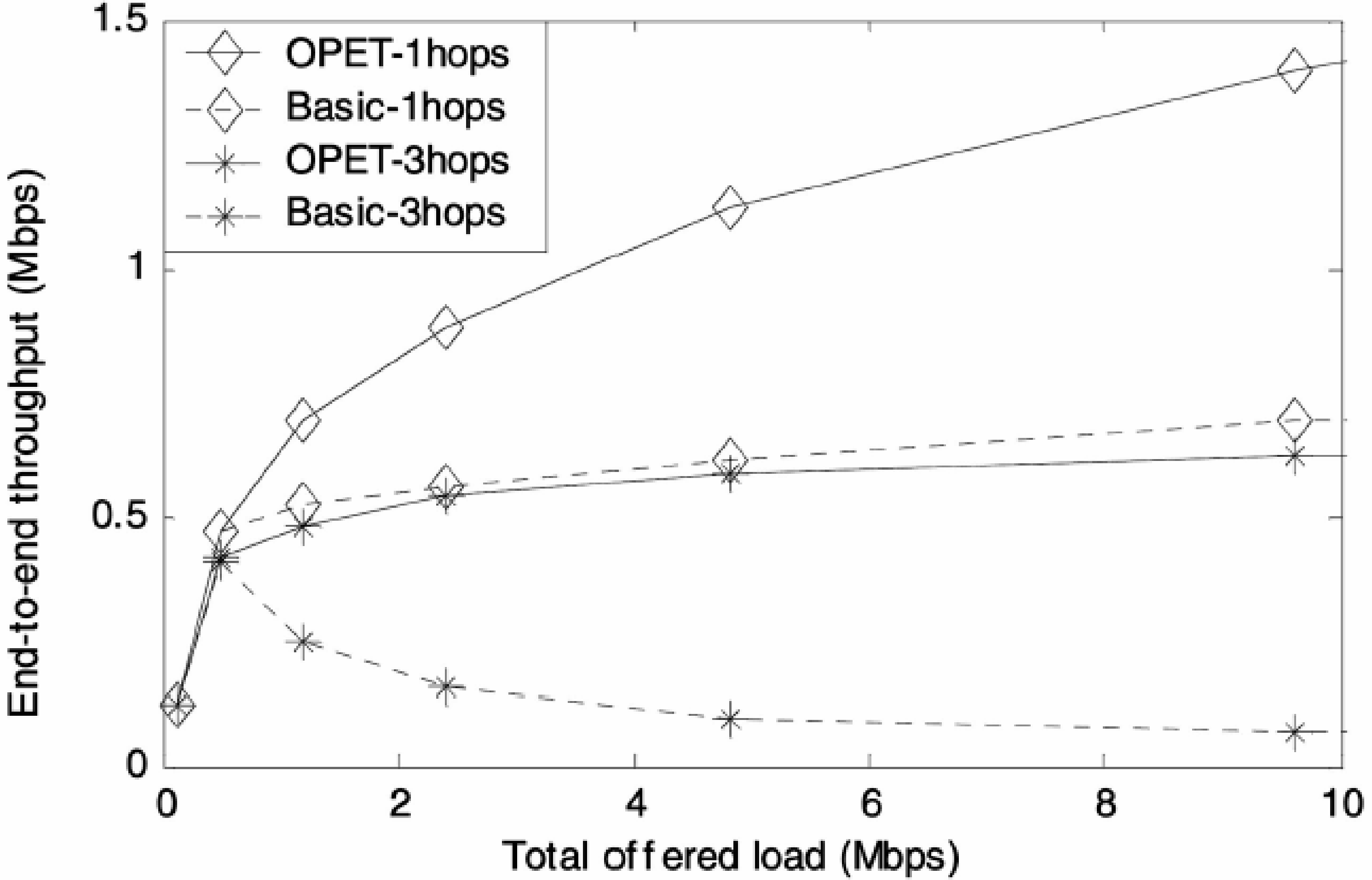


Fig. 9. End-to-end delay in the 9-node chain topology (Fig. 3) and cross topology (Fig. 2).

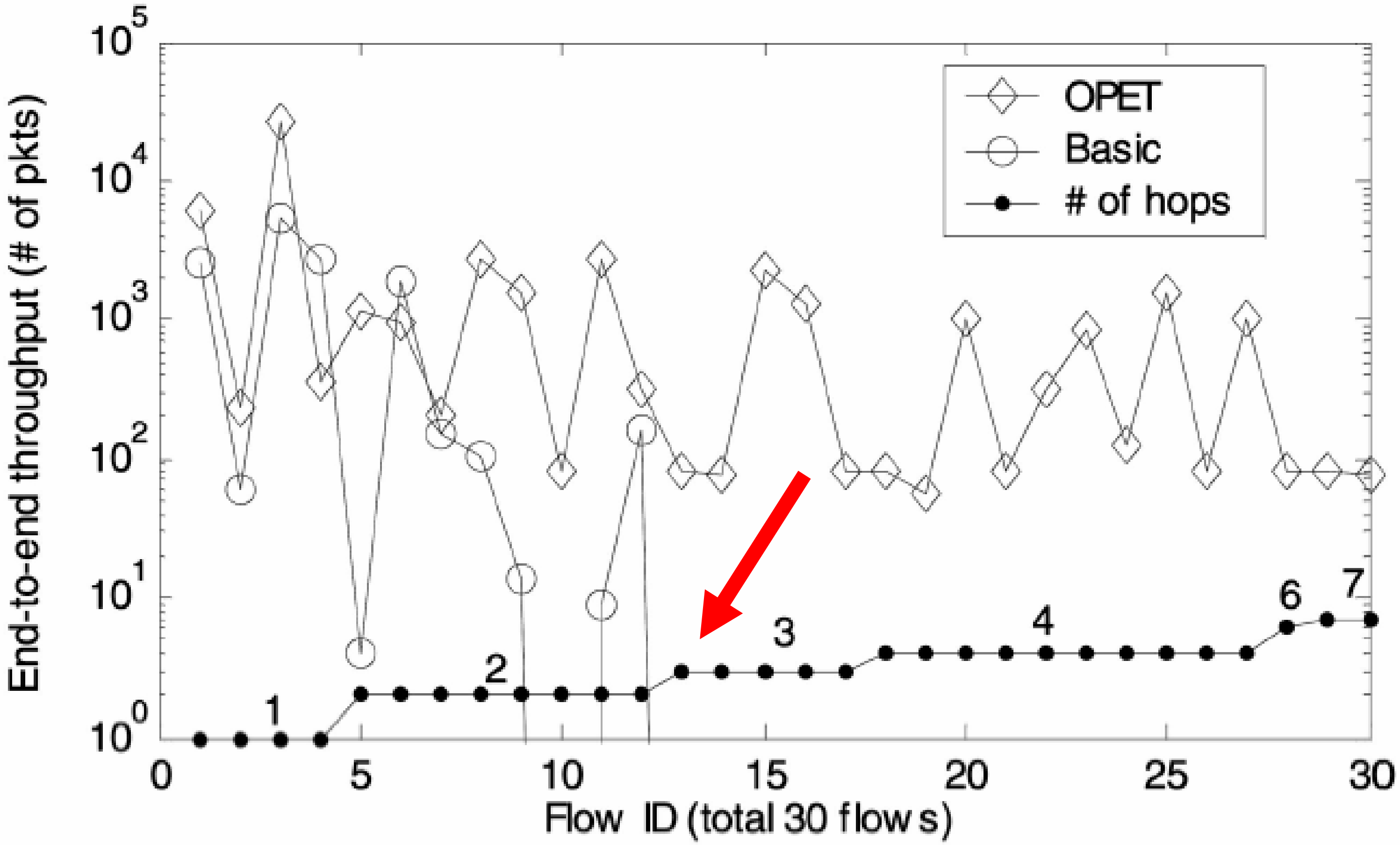
Performance Evaluation



60 nodes are randomly placed in 1,000m x 1,000m area. There are 30 flows in the network

Fig. 10. Aggregate end-to-end throughput in the random topology.

Performance Evaluation



Without hop count limitation

Fig. 11. One random example to illustrate throughput distribution among flows in the random topology.

Performance Evaluation

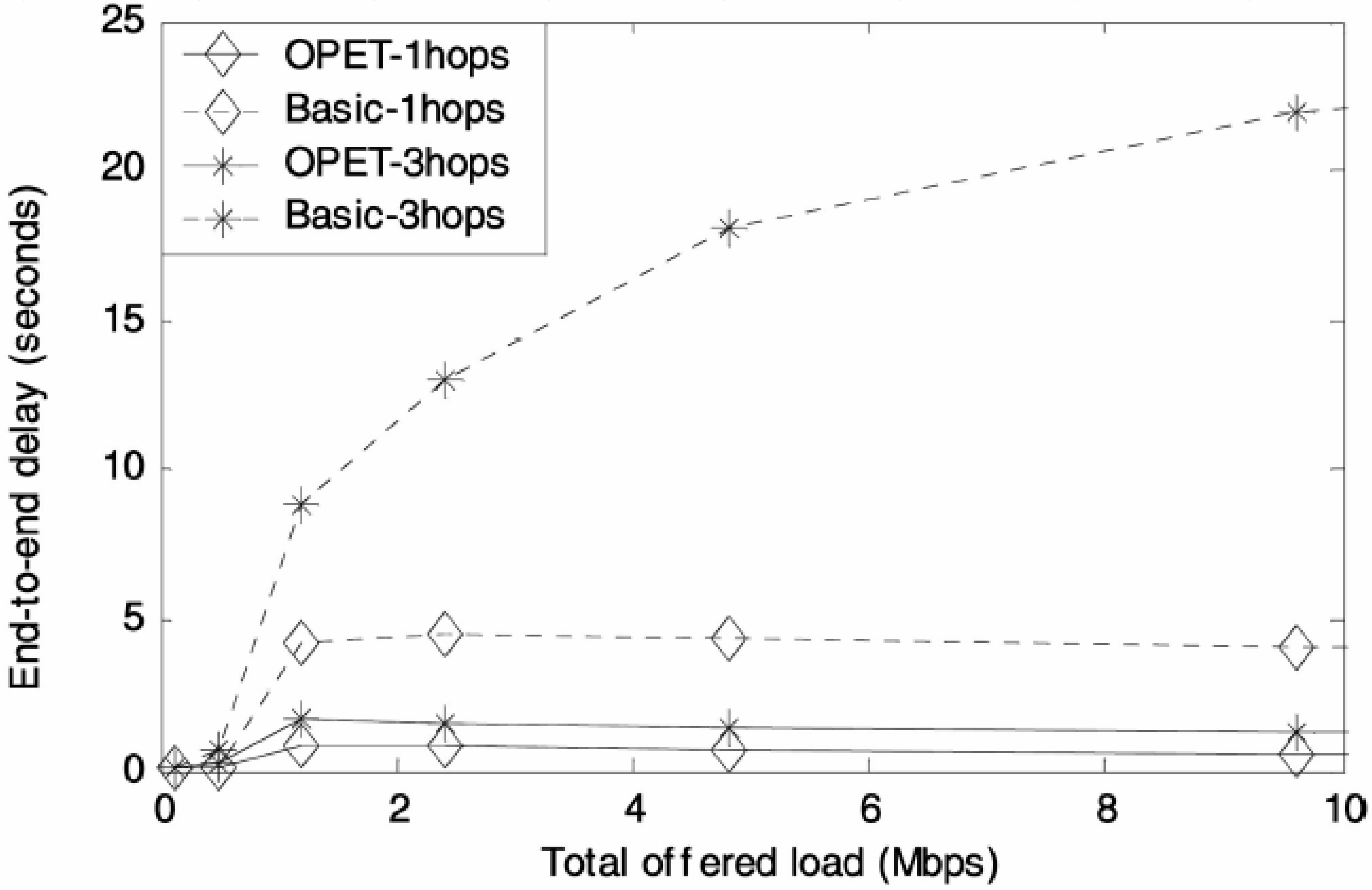


Fig. 12. Average end-to-end delay in the random topology.

Performance Evaluation

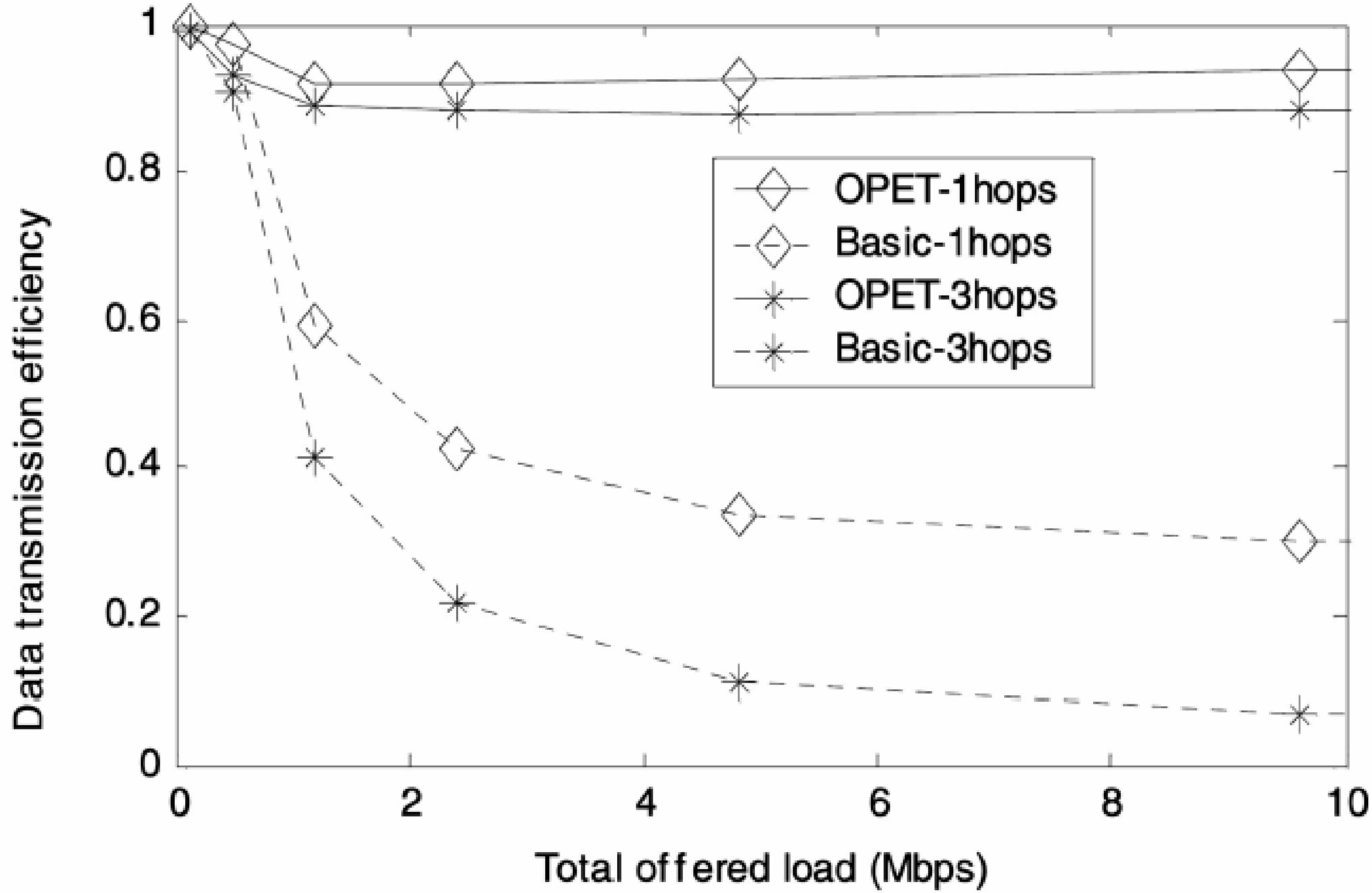


Fig. 13. Data transmission efficiency in the random topology.

Performance Evaluation

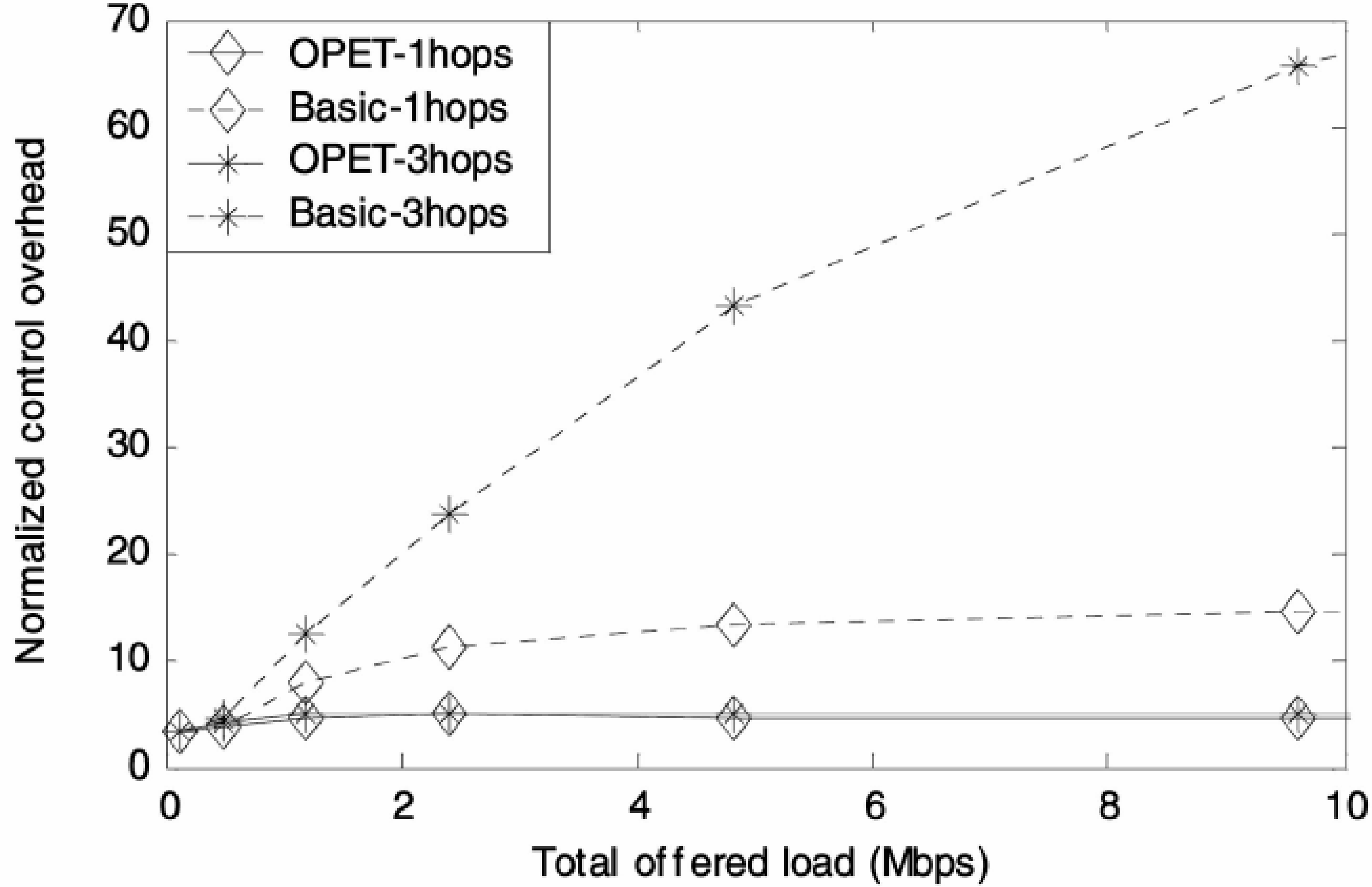


Fig. 14. Normalized control overhead in the random topology.

Performance Evaluation

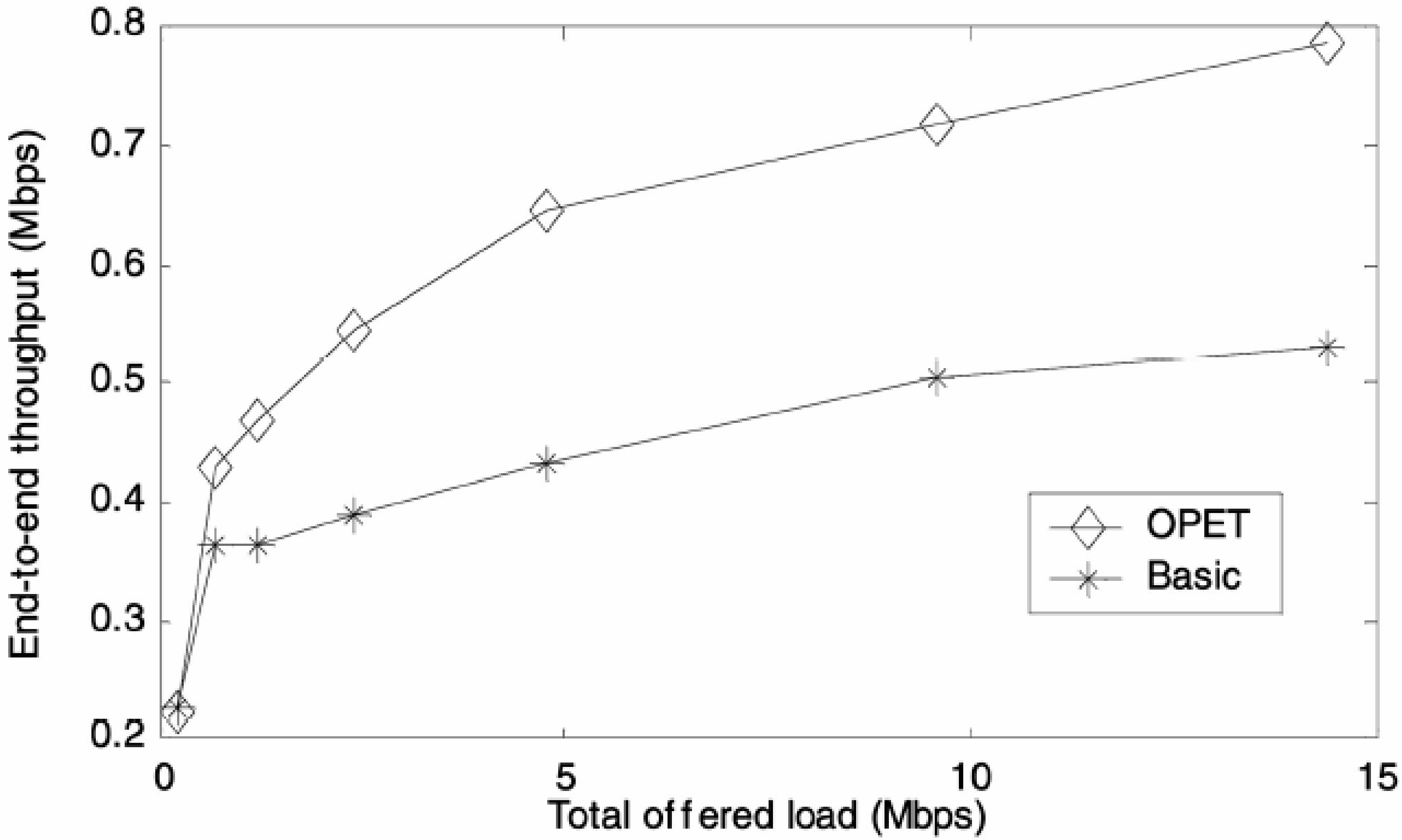


Fig. 16. Simulation results for the random topology with mobility.

Conclusion

- This paper proposes a framework of distributed flow control and media access based on which one multihop packet scheduling algorithm
- But there are no comprehensive studies to effectively address the intra-flow contention and inter-flow contention problems in multihop **mobile** ad hoc networks, which result in serious problems