A Wireless MAC Protocol Using Implicit Pipelining

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Outlines

- Introduction
- Pipelined packet scheduling
- Pipelined dual stage contention resolution MAC protocol(DSCR)
- Performance evaluation of DSCR in wireless LANs
- Performance evaluation of DSCR in Multi-hop wireless networks
- Conclusion

Introduction

Issues

- Two categories of overhead are usually associated with contention resolution.
  - One is channel idle overhead, where all contending stations are waiting to transmit.
  - Another is collision overhead, which occurs when multiple contending stations attempt to transmit simultaneously.

Goal

- Improving performance of MAC protocols
  - To reduce the channel *IDLE* and *COLLISION* overhead

Ideas

- Pipelining
  - Two stage pipeline:

1. Contention Resolution
2. Packet Transmission

Pipelined packet scheduling

RTS/CTS access method of IEEE 802.11 DCF

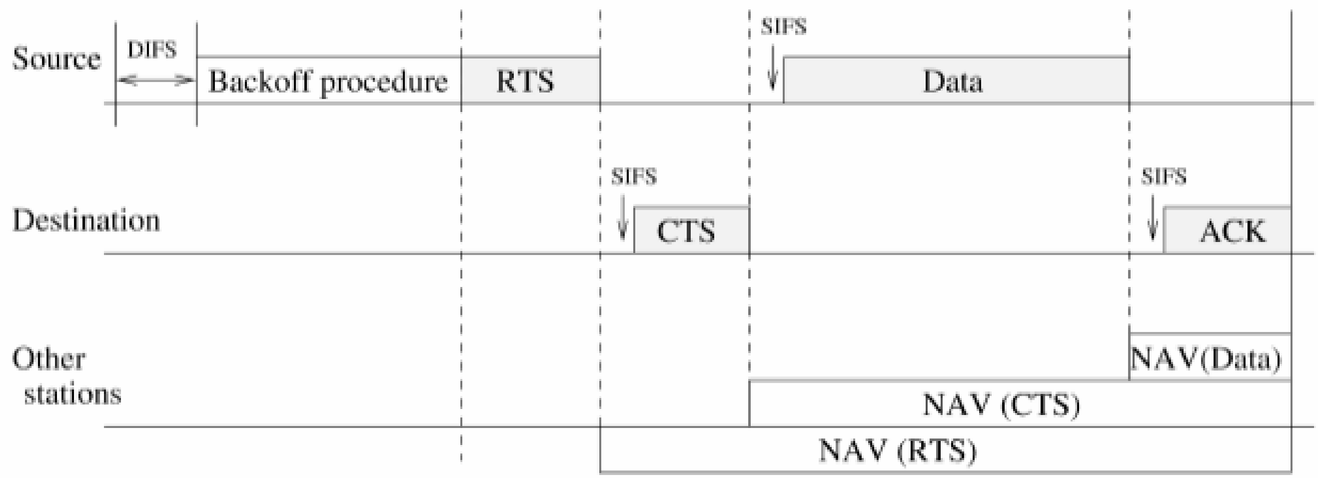


Fig. 2. RTS/CTS access method of IEEE 802.11 DCF.

Partial pipelining scheme

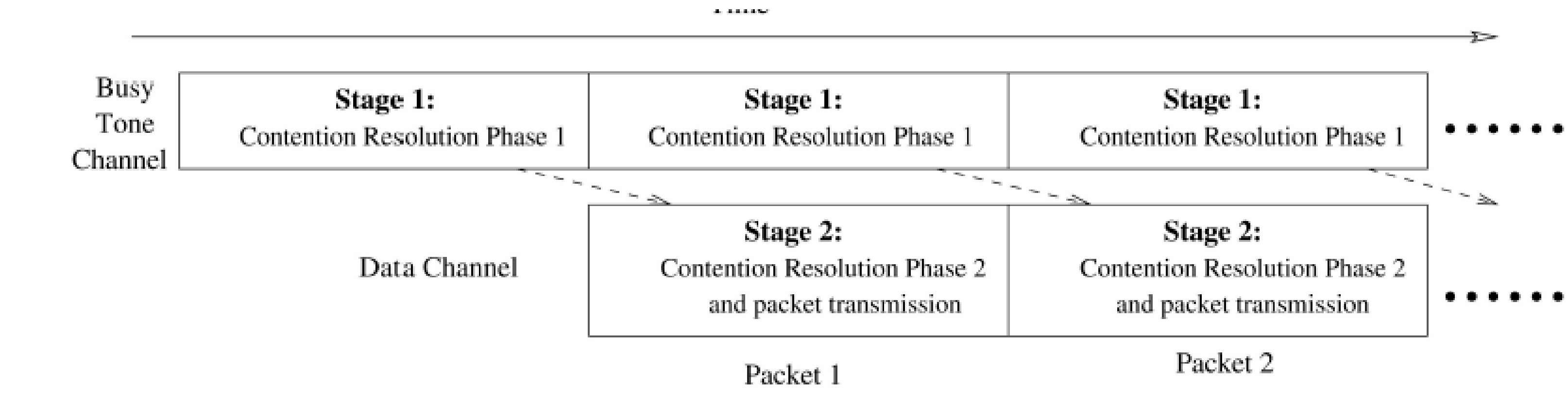
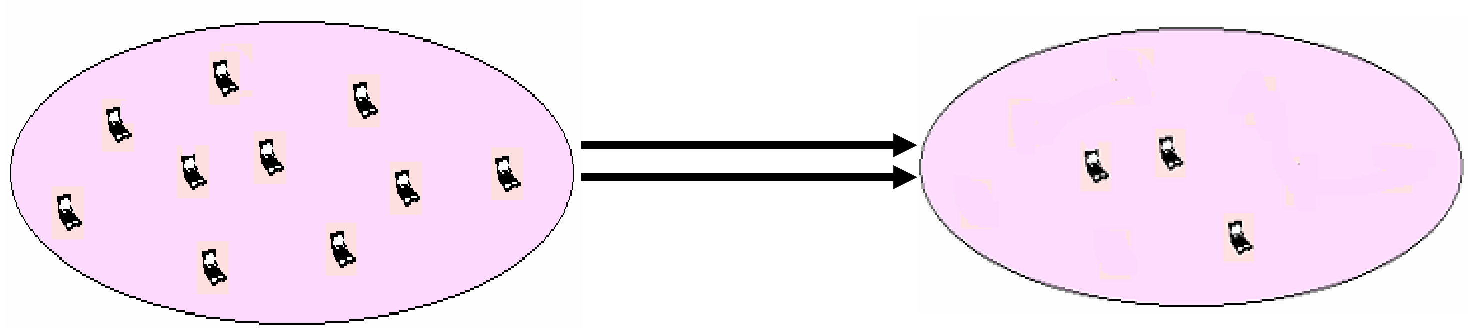


Fig. 3. Partial pipelining scheme.

Benefits of Partial Pipeline

- Only winners of stage 1 can contend channel in stage 2
  - reduces the data channel contention
  - reduces collision probability on the data channel



Stage 1 **Stage 2**

Performance of partial pipelining with and without busy tone detection

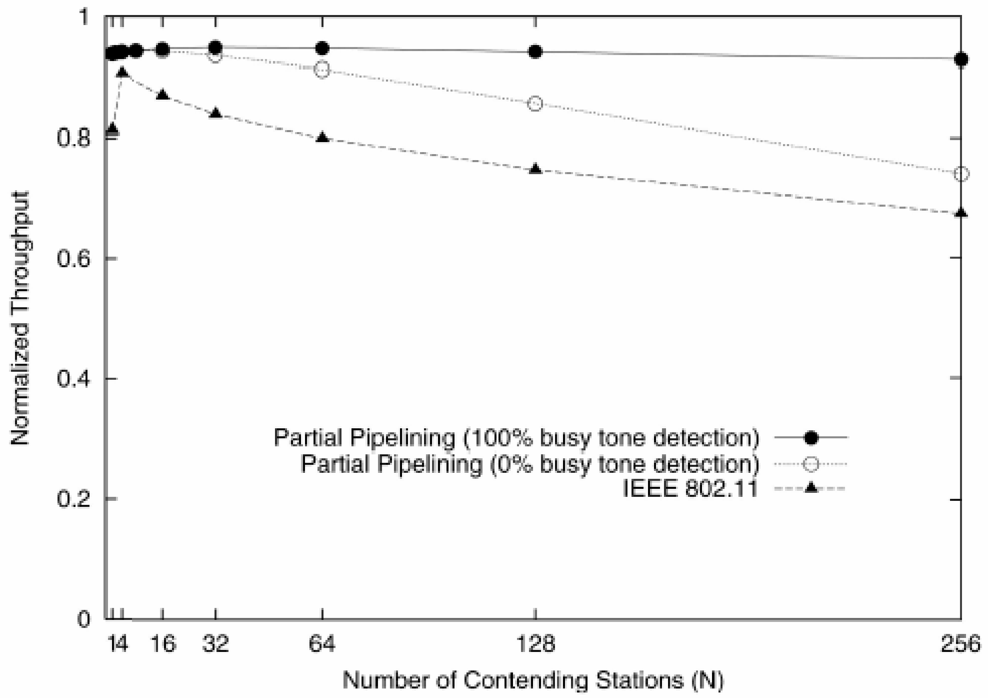


Fig. 4. Performance of partial pipelining with and without busy tone detection (packet size: 512 bytes).

Pipelined dual stage contention resolution MAC protocol(DSCR)

Implicitly pipelined packet scheduling.

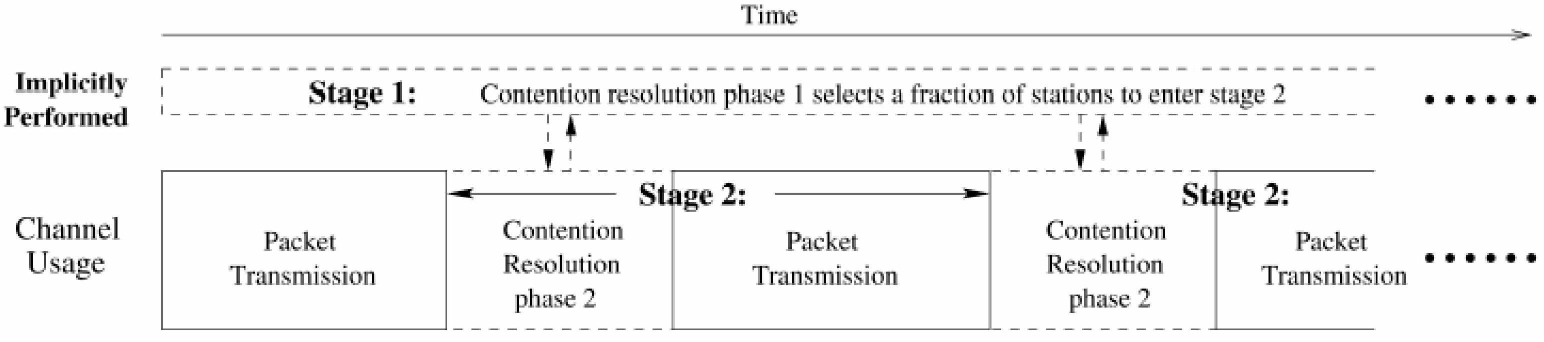


Fig. 5. Implicitly pipelined packet scheduling.

Contention Resolution Algorithm

- bc1:is associated with contention resolution phase 1. bc1 is chosen to be uniformly distributed over the interval [0, CW1].
- bc2:is associated with the contention resolution phase 2. Whenever bc2 reaches zero, a transmission is allowed.
- F:a contending station reduces its bc1 by a quantity named F. $F = 2^{tc} - 1$
  - tc: where tc represents the number of successfully transmitted packets overheard by the contending station ever since the most recent time it enters stage 1.

An example for the dual stage contention resolution of DSCR

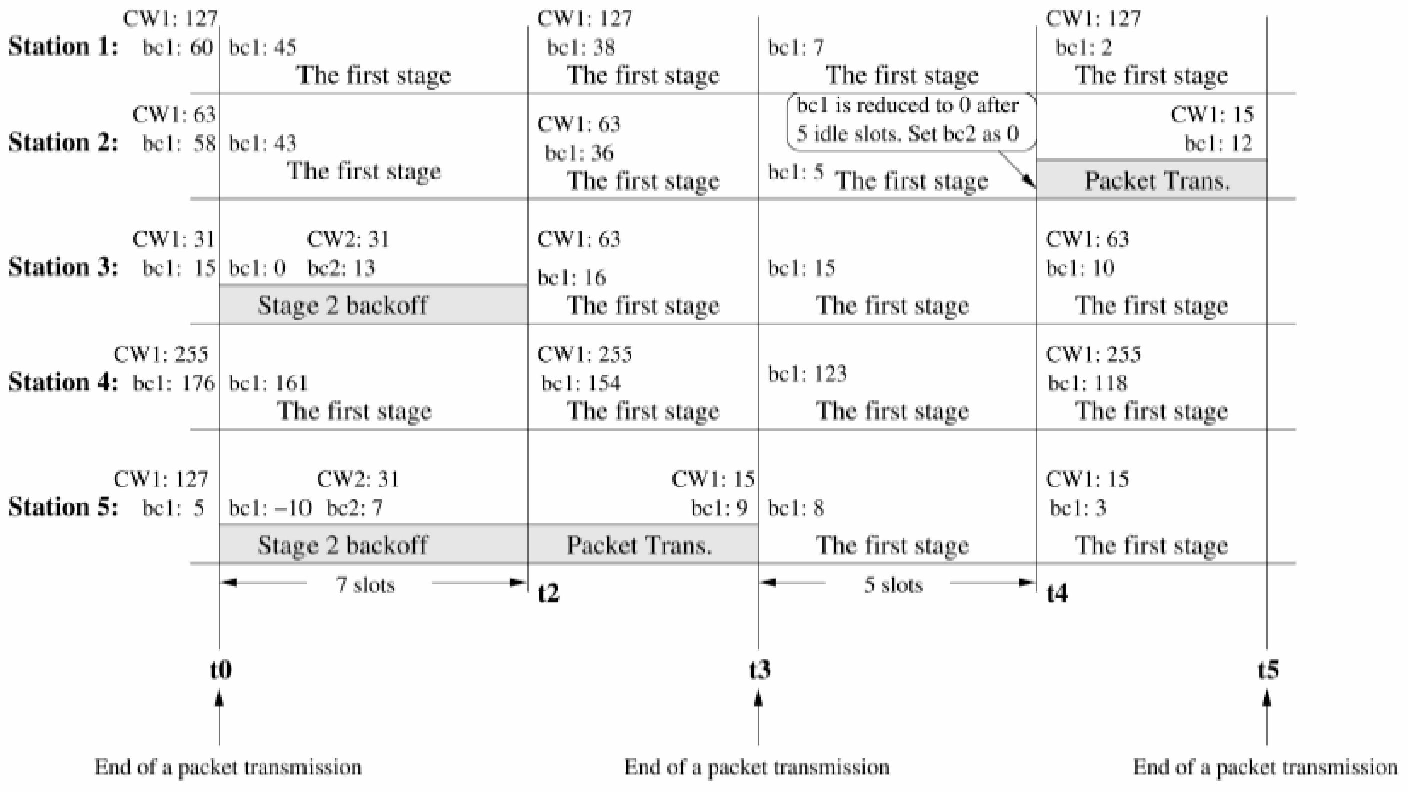


Fig. 6. An example for the dual stage contention resolution of DSCR (time axis is not drawn to scale).

A single flow.

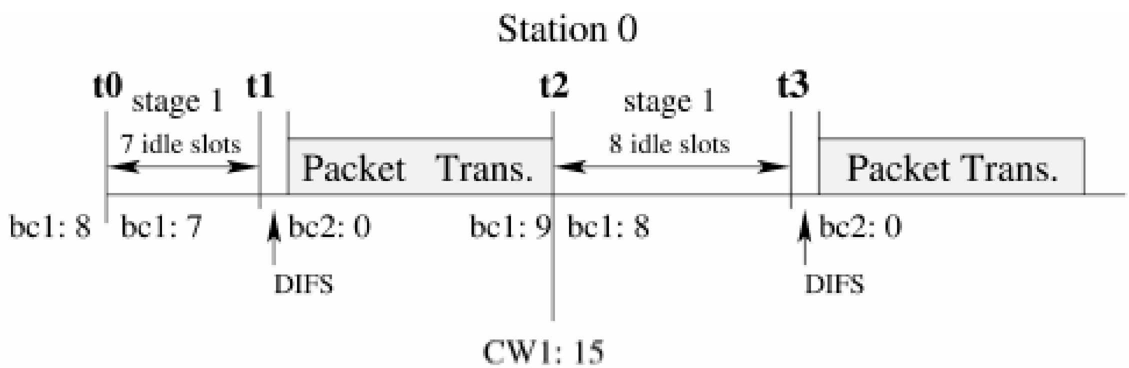
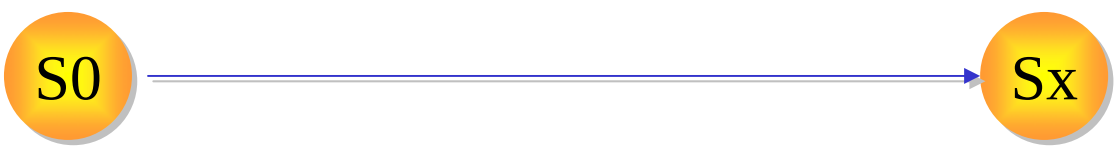


Fig. 7. A single flow.



Dynamic feedback of DSCR.

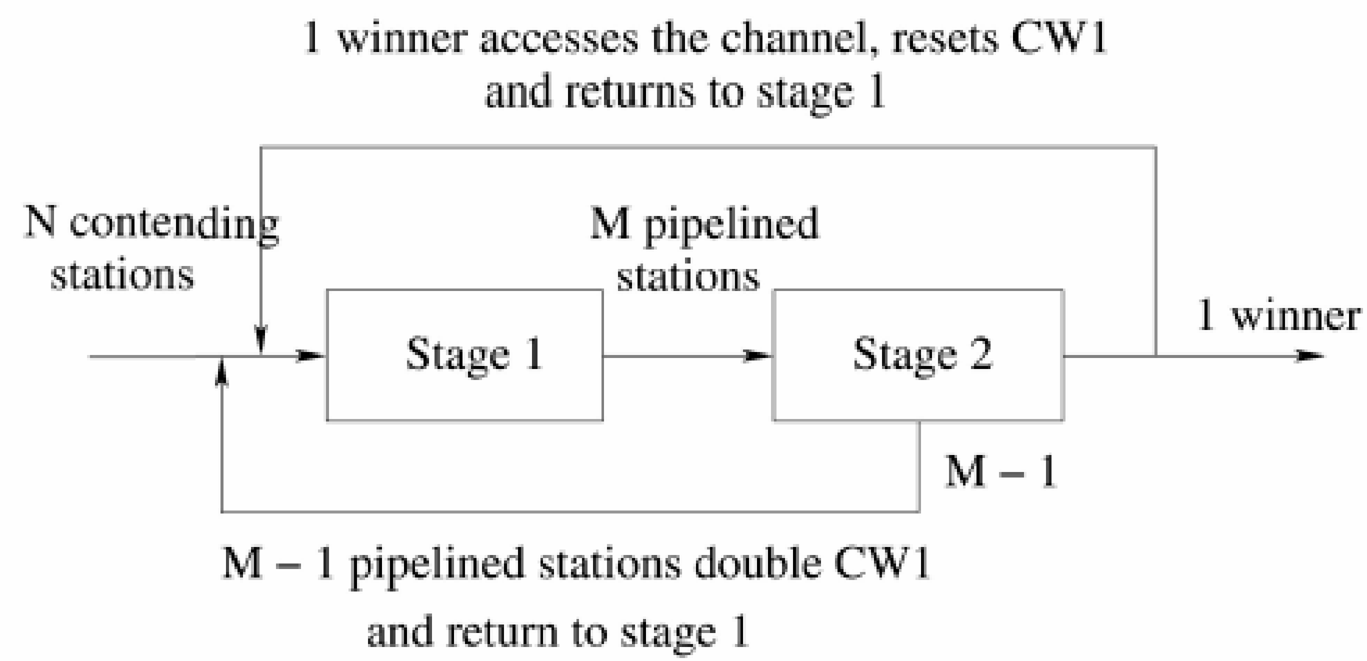


Fig. 8. Dynamic feedback of DSCR.

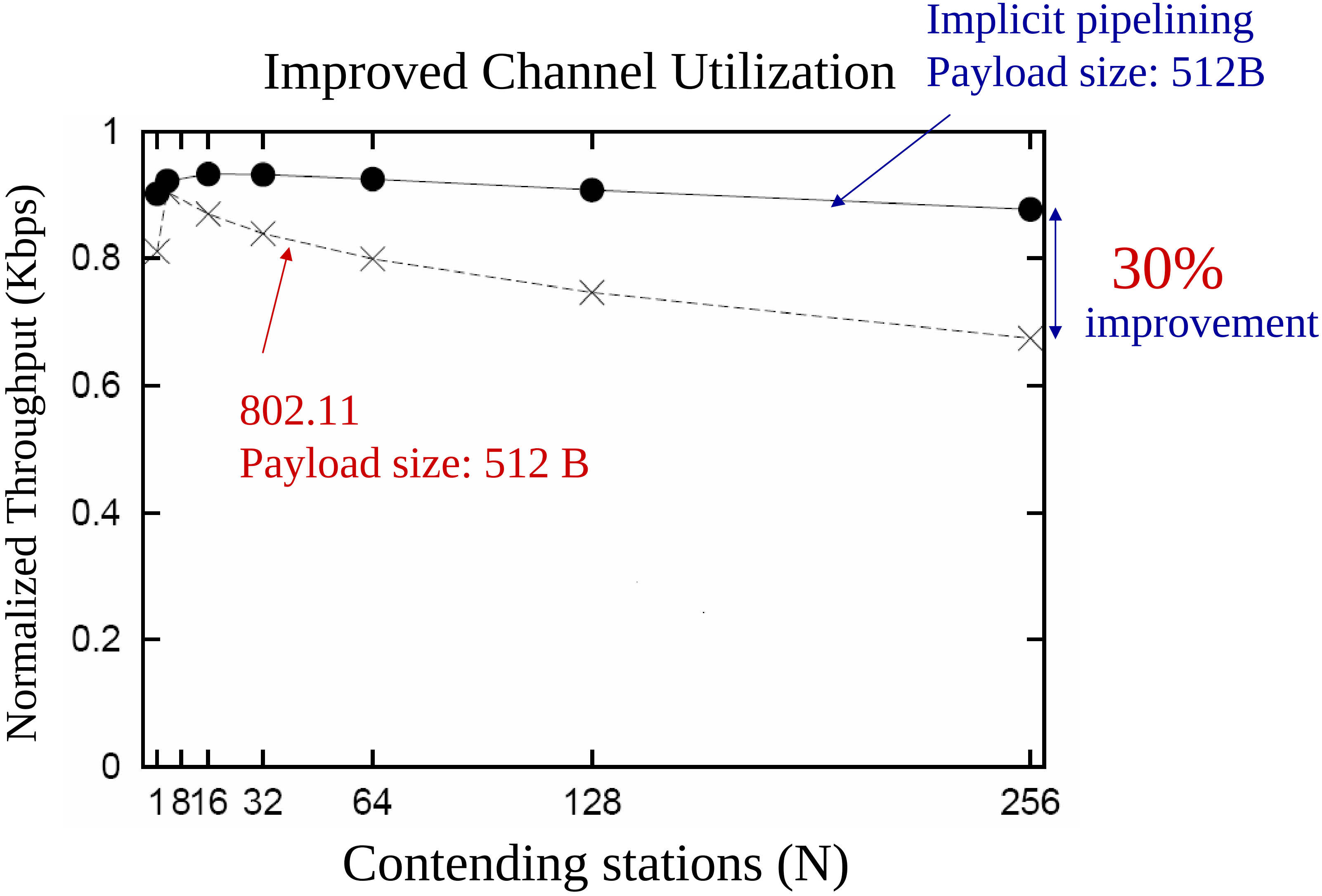
Implicit Pipelining

- Advantages compared with "partial pipelining"
  - No busy tone channel is needed
  - Can be applied to multi-hop ad hoc networks
- Disadvantage compared with partial pipelining
  - More stations may win stage 1, which leads to degraded stability in large networks

Performance evaluation of DSCR in wireless LANs

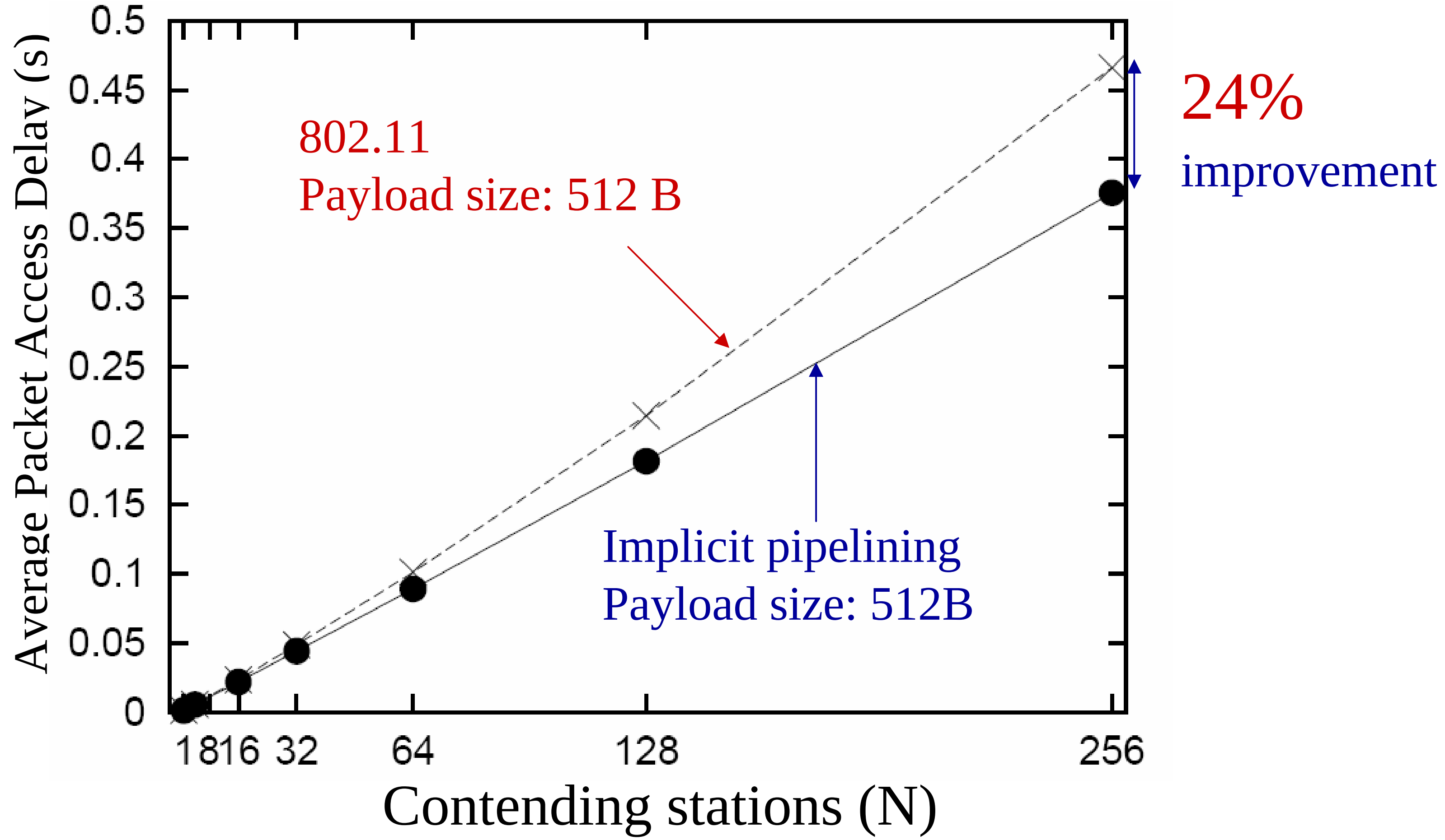
Performance evaluation of DSCR in wireless LANs

Improved Channel Utilization



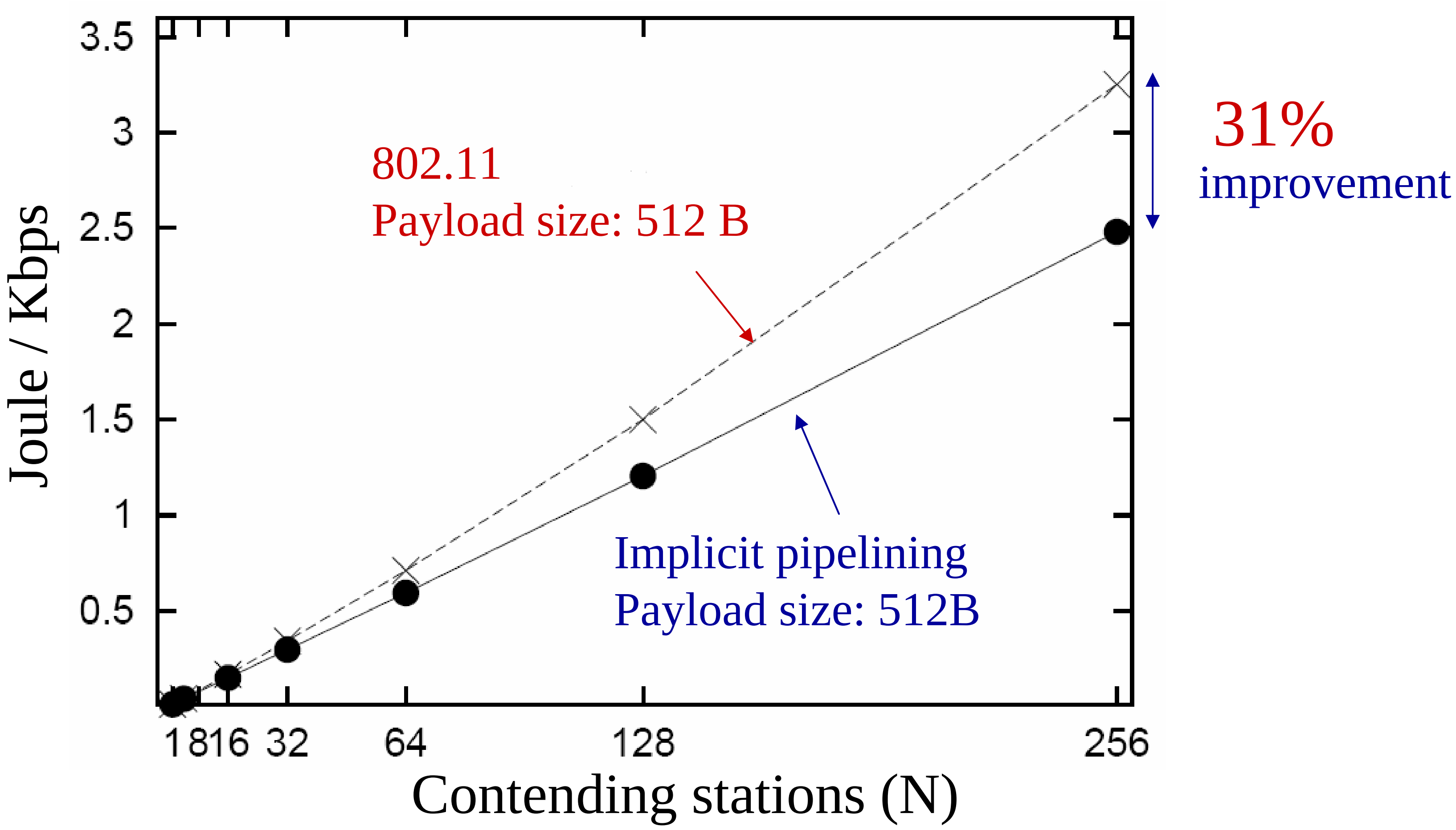
Performance evaluation of DSCR in wireless LANs

Improved Packet Access Delay

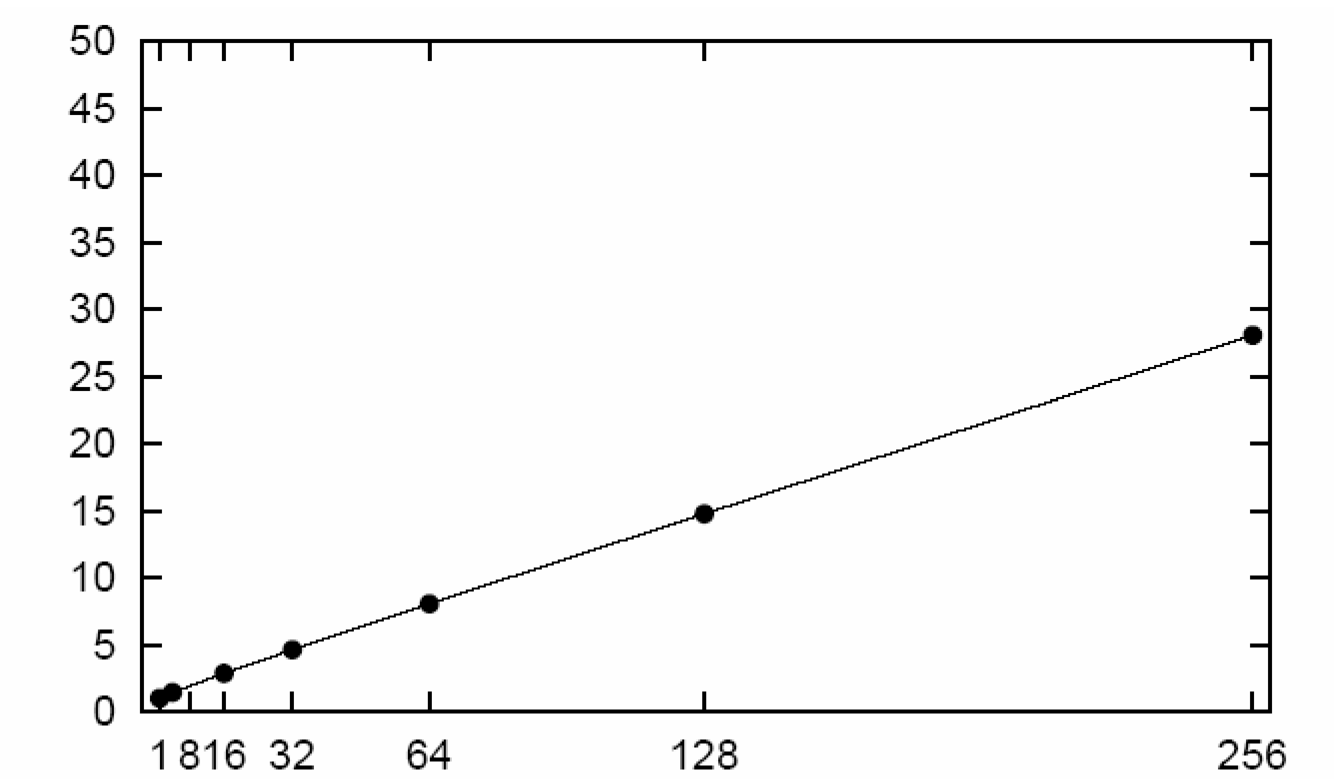


Performance evaluation of DSCR in wireless LANs

Improved Access Energy Efficiency



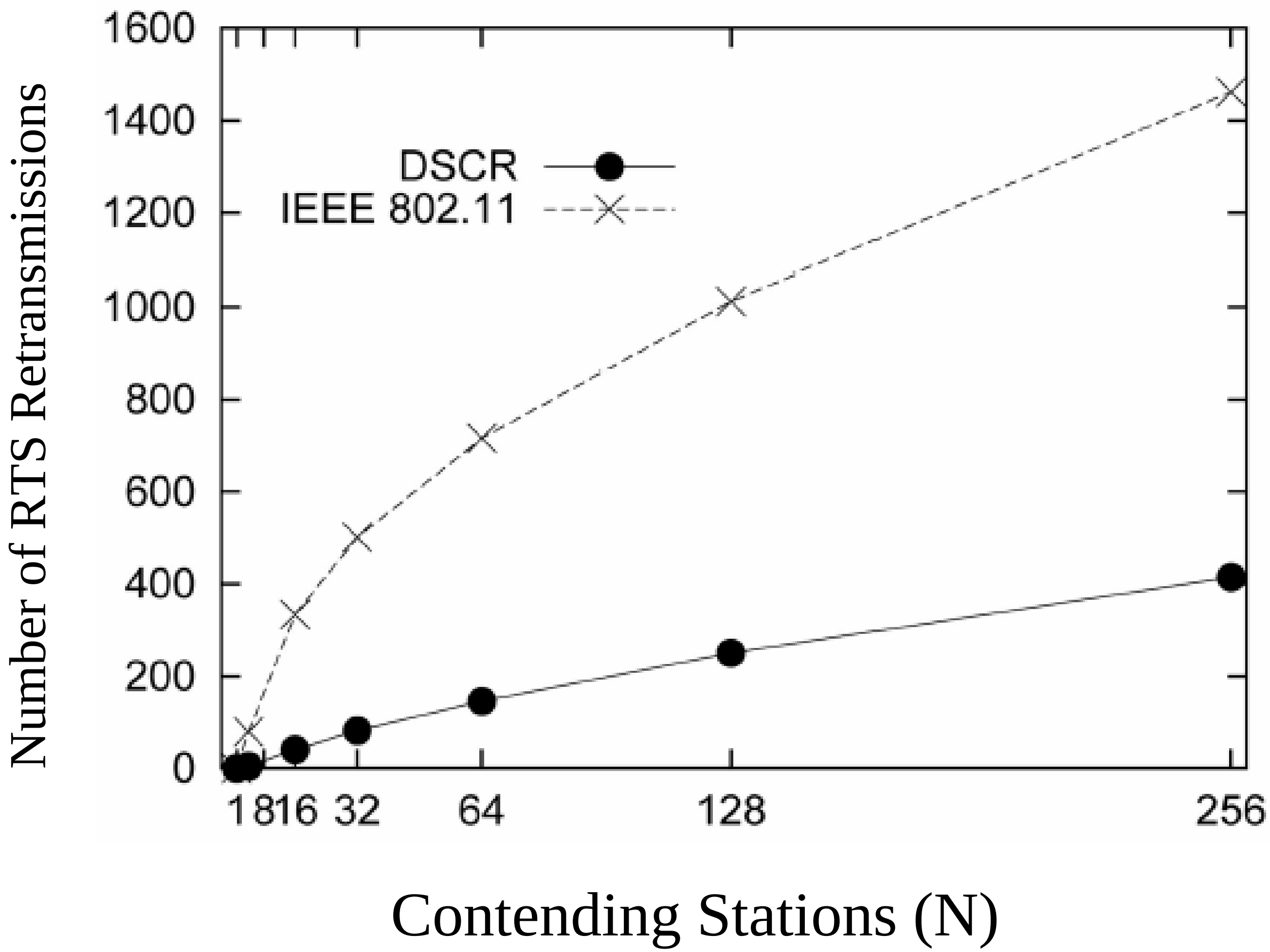
Average number of pipelined stations



Contending stations (N)

Number of Collisions Encountered

Payload size: 512 B, RTS/CTS access method



Performance evaluation of DSCR in Multi-hop wireless networks

One random multihop network

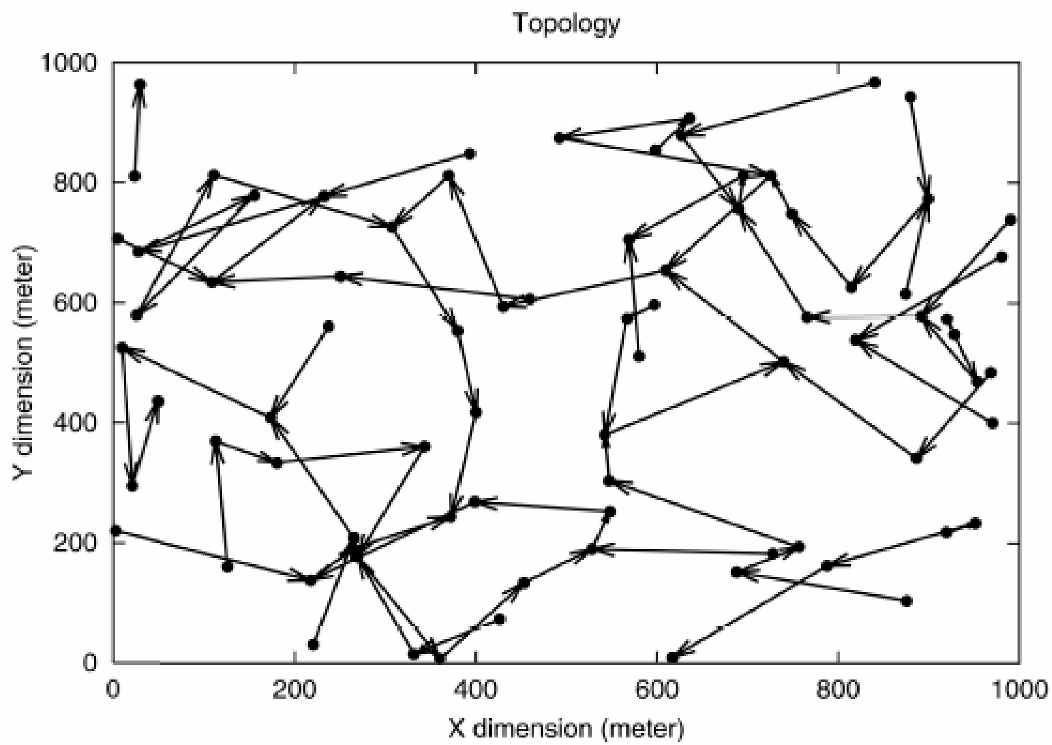
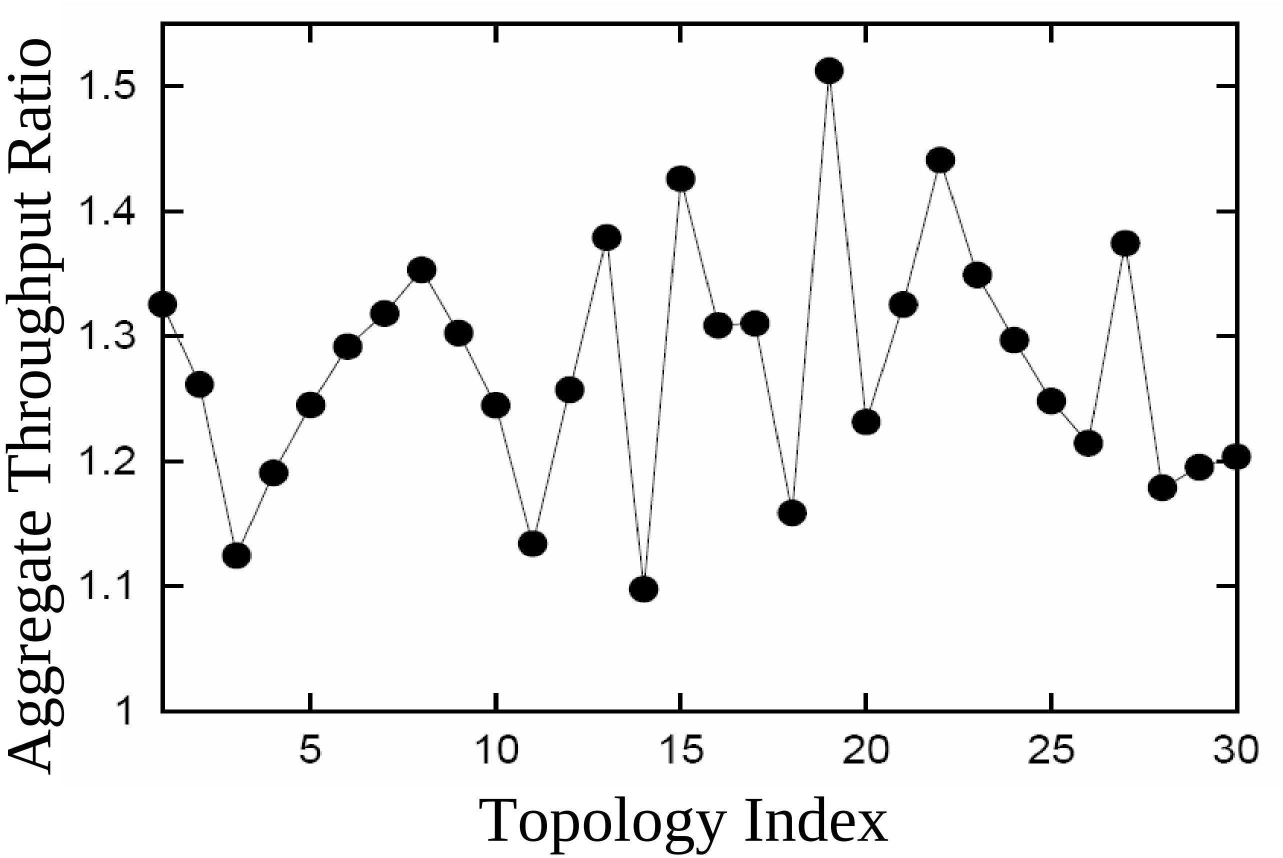


Fig. 13. One random multihop network.

Performance evaluation of DSCR in Multi-hop wireless networks

Throughput ratio of “implicit” pipelining over 802.11



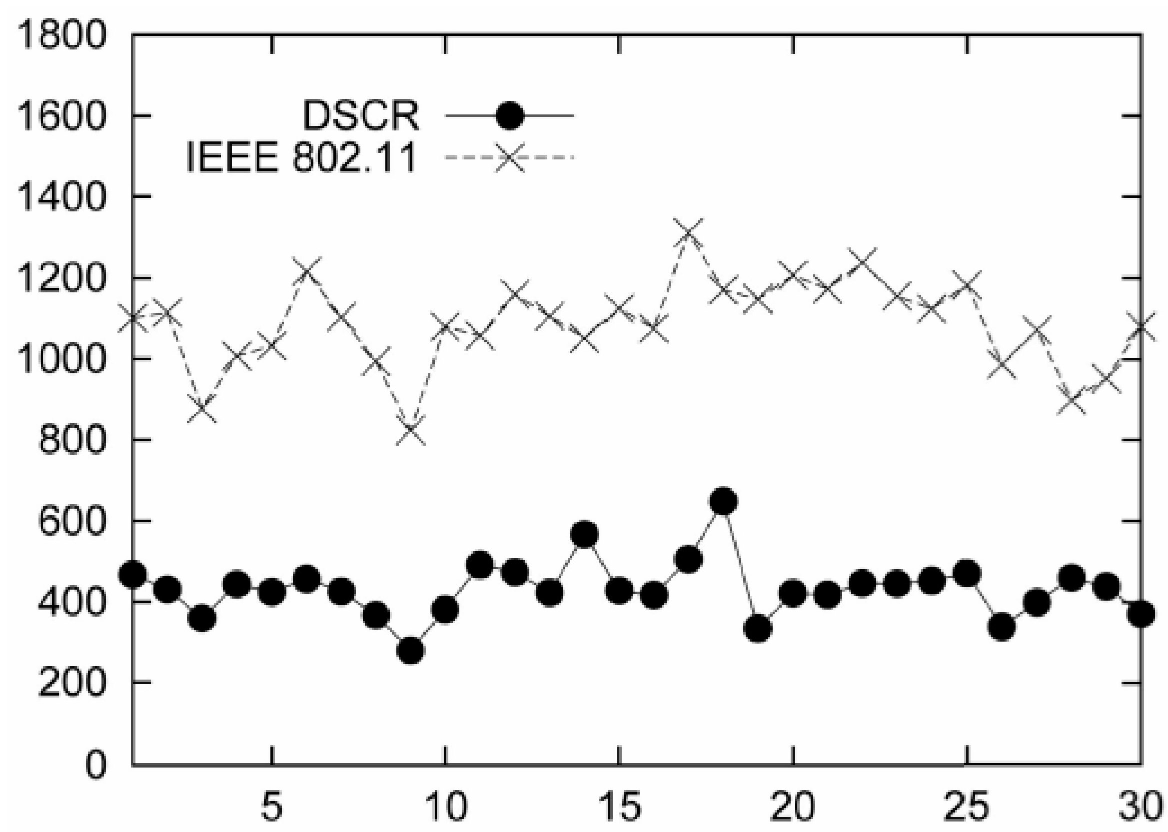
10% - 49%
Improvement

Simulated in 30 1000m*1000m random networks with 80 contending stations

Performance evaluation of DSCR in Multi-hop wireless networks

Average Number of RTS retransmissions

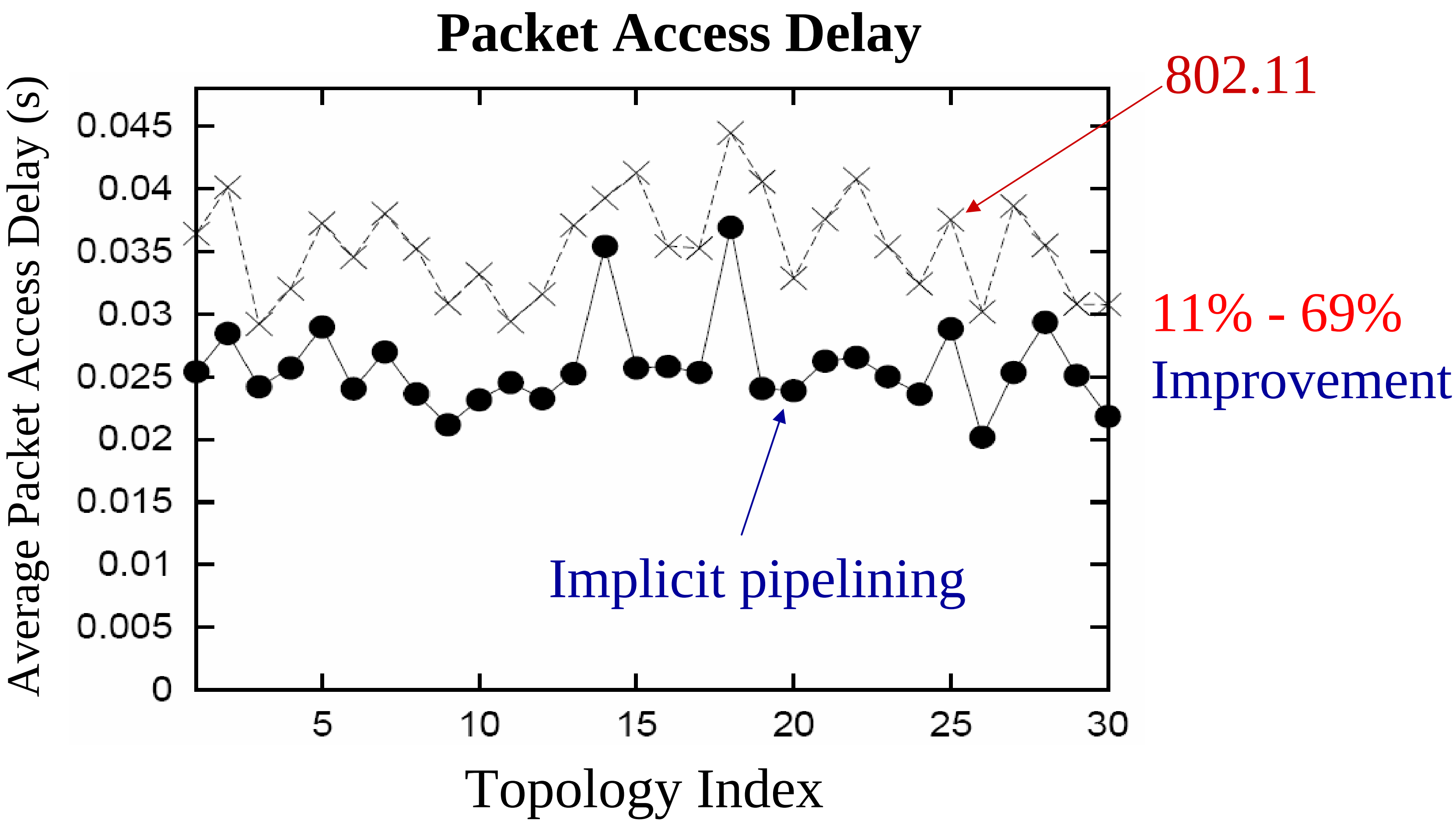
Number of retransmissions



Topology Index

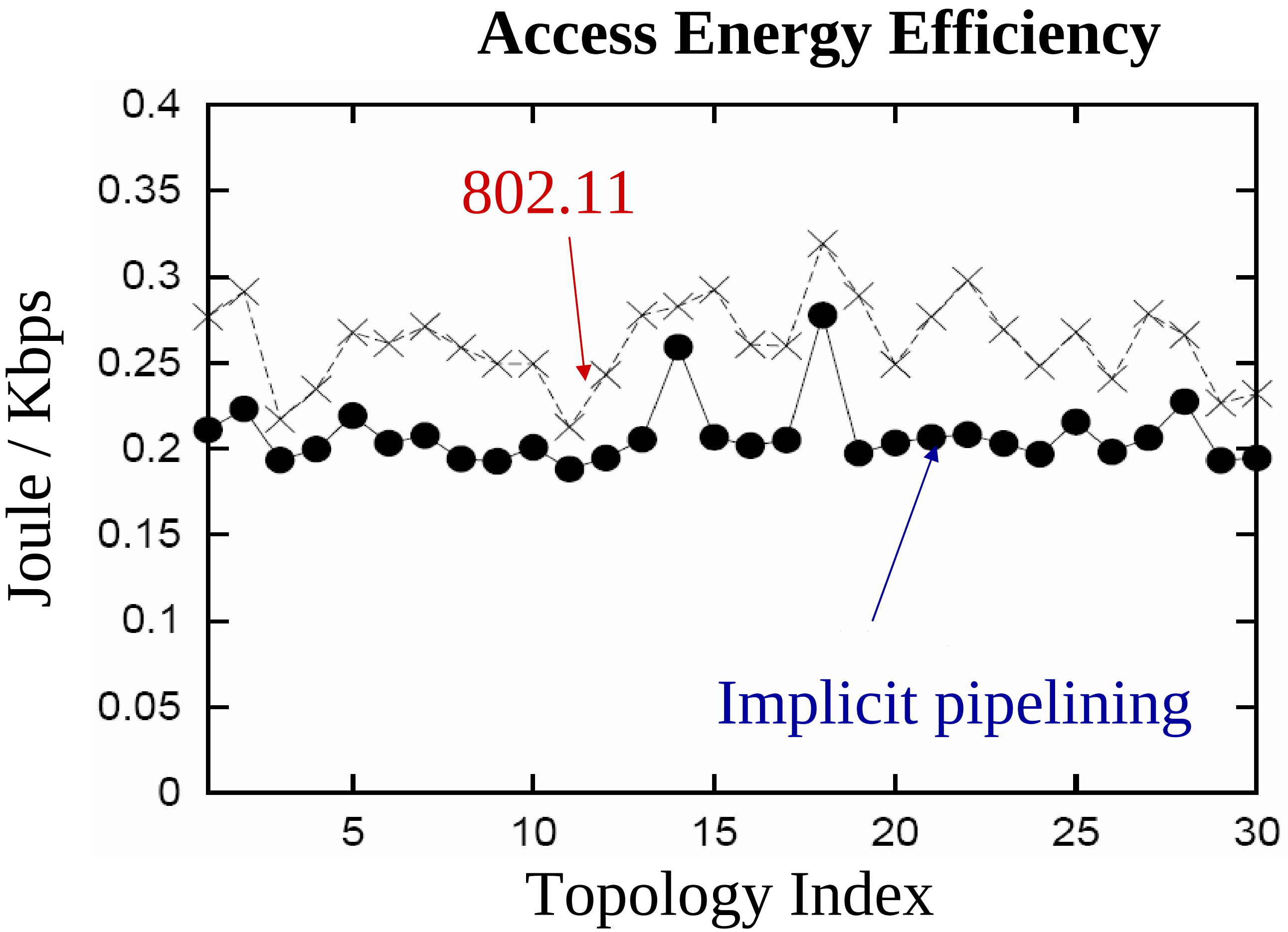
Simulated in 30 1000m*1000m random networks with 80 contending stations

Performance evaluation of DSCR in Multi-hop wireless networks



Simulated in 30 1000m*1000m random networks with 80 contending stations

Performance evaluation of DSCR in Multi-hop wireless networks



9% - 46% Improvement

Simulated in 30 1000m*1000m random networks with 80 contending stations

Conclusion

Conclusion

- pipelining techniques can be useful in improving the performance of multiple access control protocols.
- Multi-Channel
  - Choice Channel
  - Pipelining Schedule