

Routing exploiting multiple heterogeneous wireless interfaces: A TCP performance study

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A decorative graphic at the top of the slide consists of two groups of three circles. The left group has a solid light purple circle on the left, a white circle with a light purple outline in the middle, and a white circle with a light purple outline on the right. The right group has a solid light purple circle on the left, a white circle with a light purple outline in the middle, and a solid light purple circle on the right.

Outline

- Introduction
- The proposed scheme
- Simulation
- Conclusion

Introduction

The slide features a decorative header with the word "Introduction" in a large, black, sans-serif font. Above the text are two overlapping circles: a solid light purple circle on the left and a white circle with a light purple outline on the right. To the right of the text, there are three more circles: a solid light purple circle, a white circle with a light purple outline, and another solid light purple circle.

- Route failures due to mobility are the primary reason for most of packet losses in ad hoc network.
- Packet losses caused by route failures cannot be distinguished from losses due to congestion.

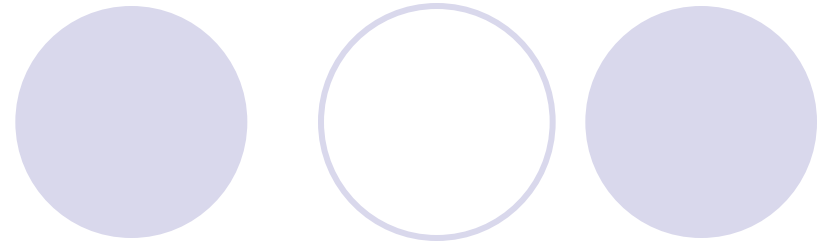


Introduction

- Exploiting multiple radios has been gaining attention as a way of improving performance of wireless networks in recent years.
- This paper proposed the possibility of utilizing multiple radios that are heterogeneous (e.g., 802.11a and 802.11b)



Introduction



- The major benefit of using heterogeneous radios is that since radios have different characteristics, a suitable radio can be dynamically chosen according to the situation.

Introduction



- 802.11a

- 5.2 GHz

- Data rate 54 Mbps

- Transmission range 32.54 m

- 802.11b

- 2.47 GHz

- Data rate 11Mbps

- Transmission range 102.16 m

Introduction

- DSR

 - Reactive

- DSDV

 - Proactive

 - The main contribution of the algorithm was to solve the routing loop problem



Dest.	Next	Metric	Seq.
...	
D	B	3	D-100

Dest.c	Next	Metric	Seq.
...	
D	C	2	D-100

Dest.	Next	Metric	Seq.
...	
D	D	∞	D-101

The proposed scheme



- Primary route

- Using 802.11a path discovered by DSR
- When a sender wants to make a TCP connection, it initiates a route discovery process over the 802.11a interface.

- Backup route

- Using 802.11b path discovered by DSDV
- In normal conditions, this alternate route is used for other purposes (e.g., exchanging control packets)

The proposed scheme

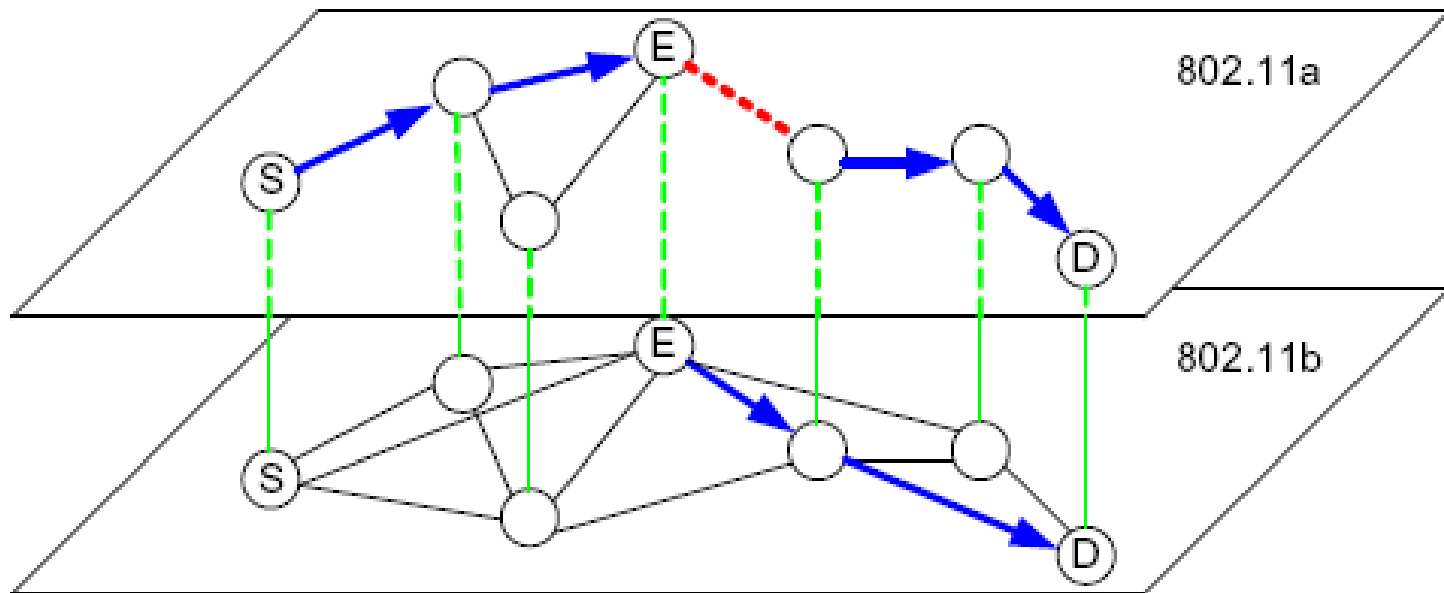
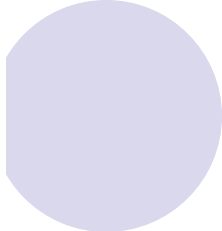



Fig. 1. A potential benefit of using multiple heterogeneous wireless interfaces. Node E can use an alternate 802.11b path when a 802.11a link (dotted red) is broken due to node mobility.



```
1:  if0 ← 802.11a NIC
2:  if1 ← 802.11b NIC
3:  run DSR protocol on if0
4:  run DSDV protocol on if1
5:  if node is a source then
6:    while (1) do
7:      if receiving RERR of DSR then
8:        initiate a new route discovery by sending RREQ
9:        move packets from if0 buffer to if1 buffer
10:       route IP packets to if1 buffer
11:      else if detecting a next hop DSR link failure then
12:        initiate a new route discovery by sending RREQ
13:        move packets from if0 buffer to if1 buffer
14:        route IP packets to if1 buffer
15:      else if receiving RREP of DSR then
16:        move packets from if1 buffer to if0 buffer
17:        route IP packets to if0 buffer
18:      else if TCP RTO expires
19:        ssthresh ← cwnd/2
20:        cwnd ← 1
21:        RTO ← 2 * RTO
22:      end if
23:    end while
```

```
24:  else if node is an intermediate node then
25:    while (1) do
26:      if detecting a next hop DSR link failure then
27:        send RERR toward the source
28:        move packets from  $if_0$  buffer to  $if_1$  buffer
29:        forward received TCP ACK on  $if_0$  toward the source
30:      else if receiving RERR of DSR then
31:        forward RERR toward the source
32:      end if
33:    end while
34:  else if node is a sink then
35:    while (1) do
36:      if receiving a TCP packet on  $if_0$  then
37:        send TCP ACK on  $if_0$ 
38:      else if receiving a TCP packet on  $if_1$  then
39:        send TCP ACK on  $if_1$ 
40:      end if
41:    end while
42:  end if
```

The proposed scheme

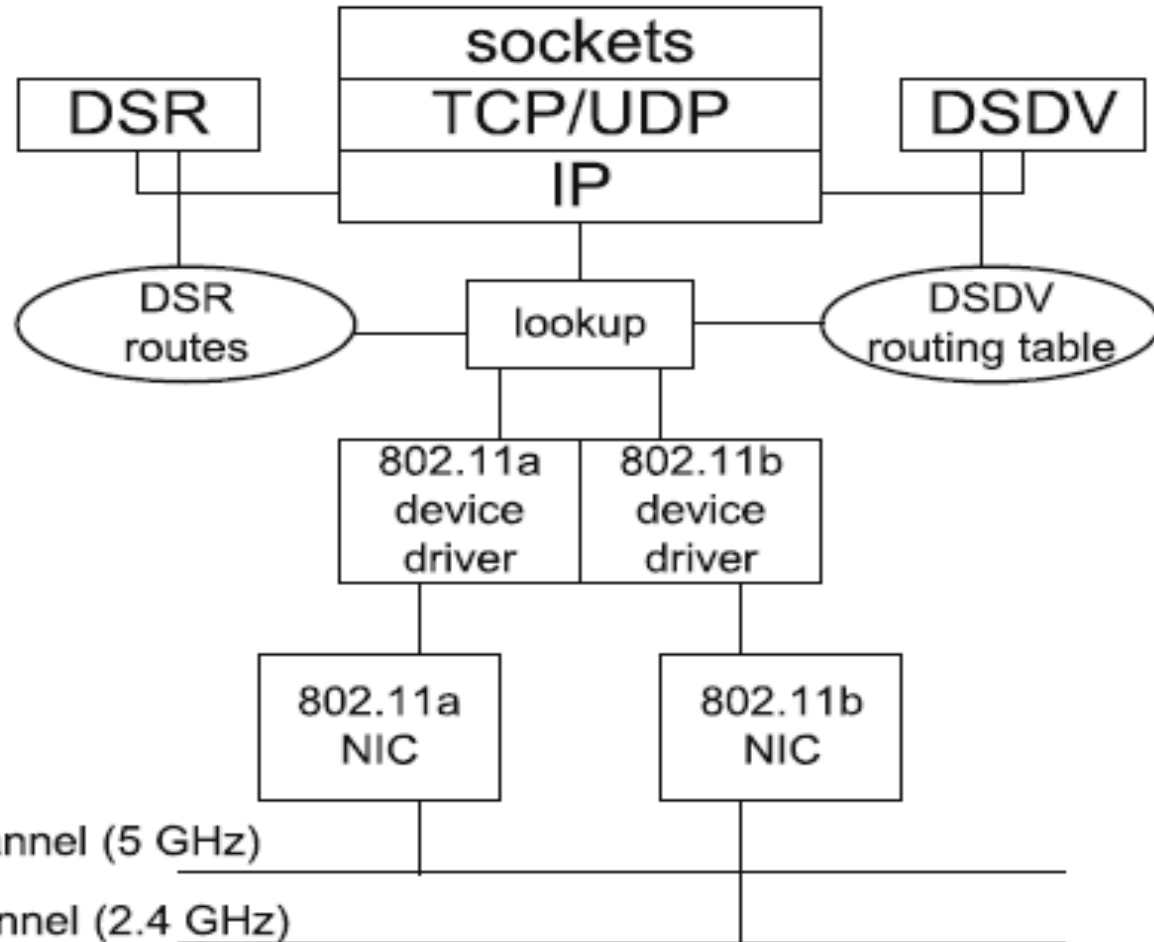
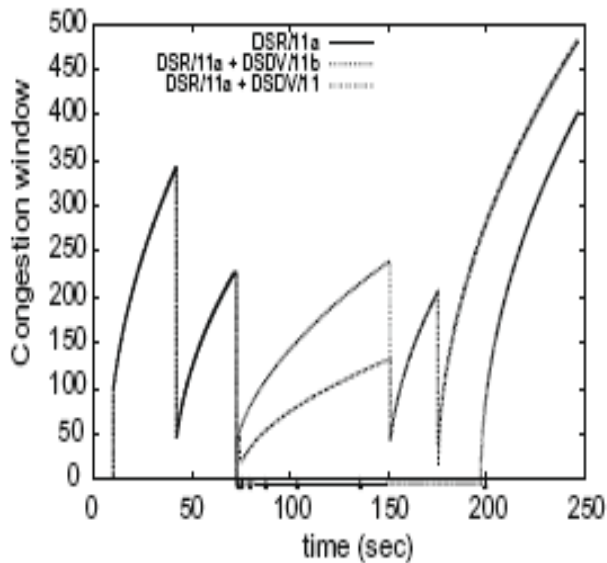
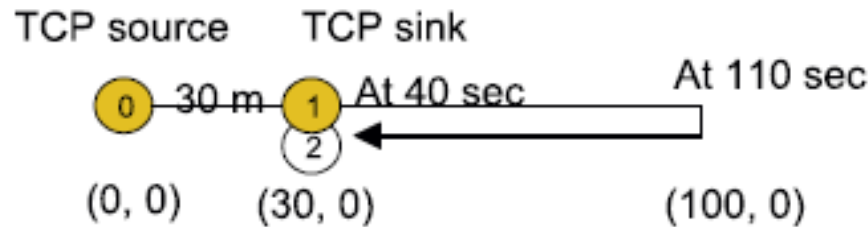


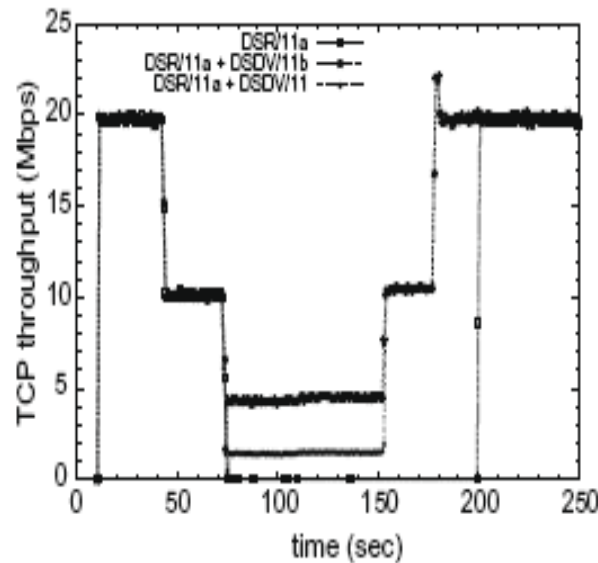
Fig. 2. Node structure.

Simulation

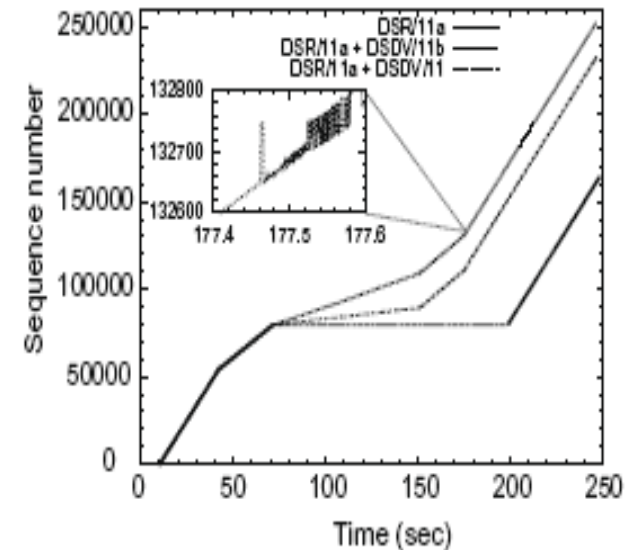
- Small-scale
- Longtime breakage , short-hop route



(a) Congestion window.



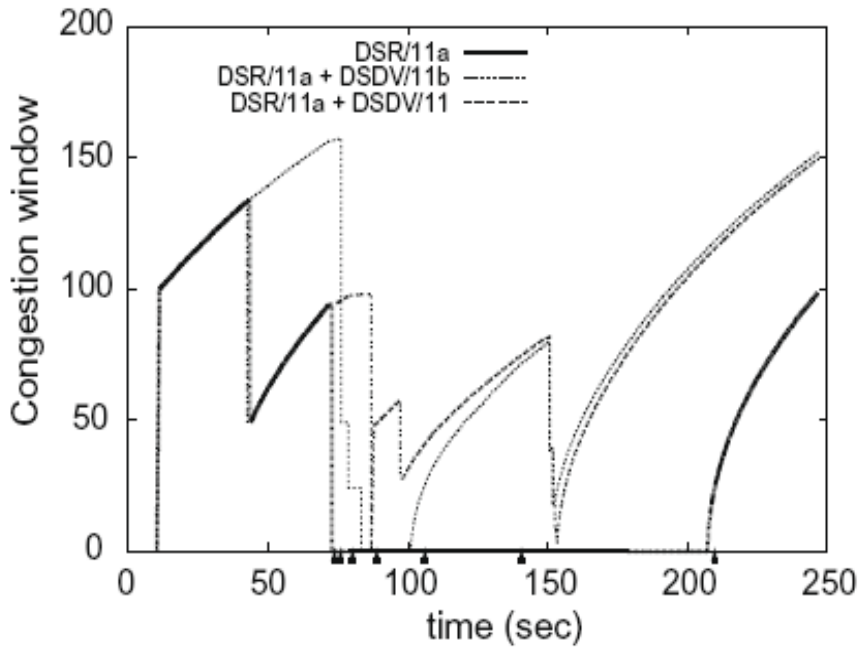
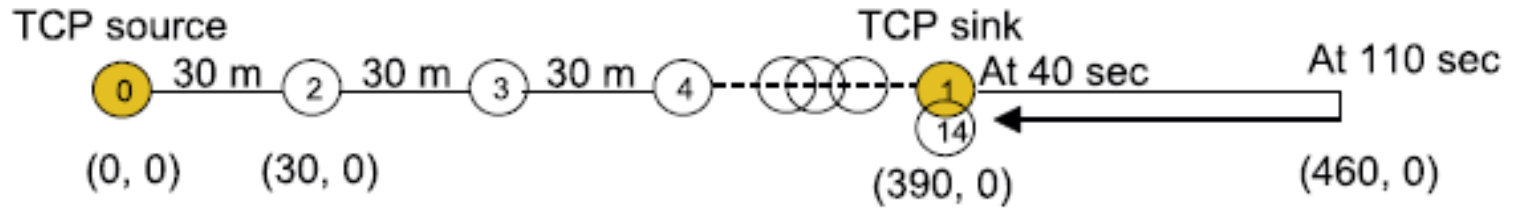
(b) TCP throughput.



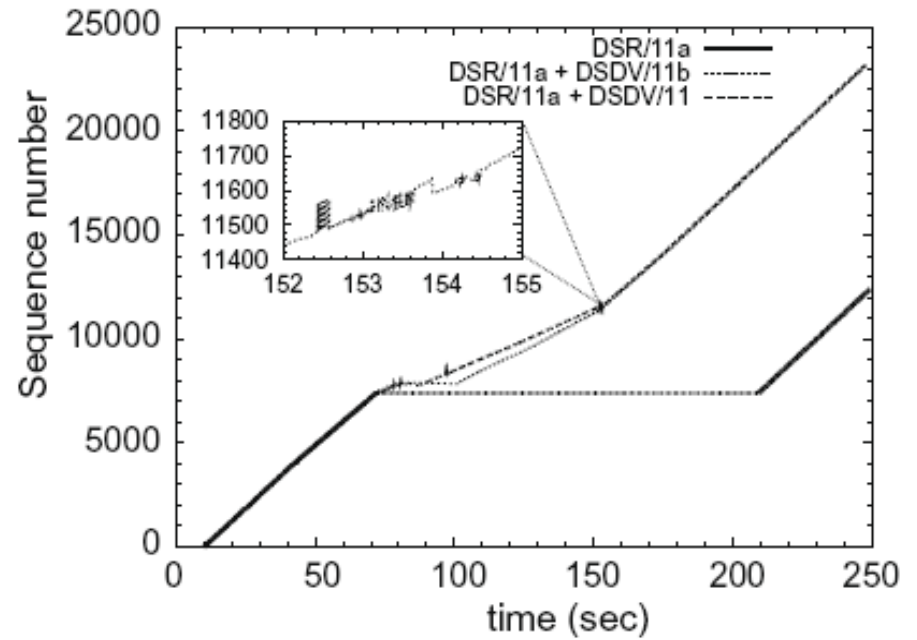
(c) Sequence number at TCP sink.

Simulation

- Longtime breakage , long-hop route



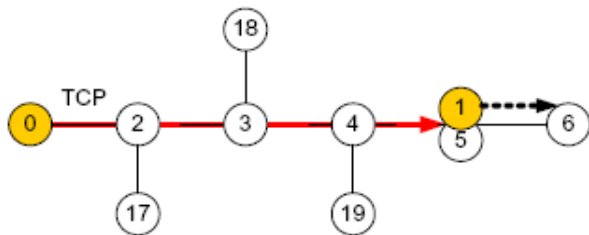
Congestion window.



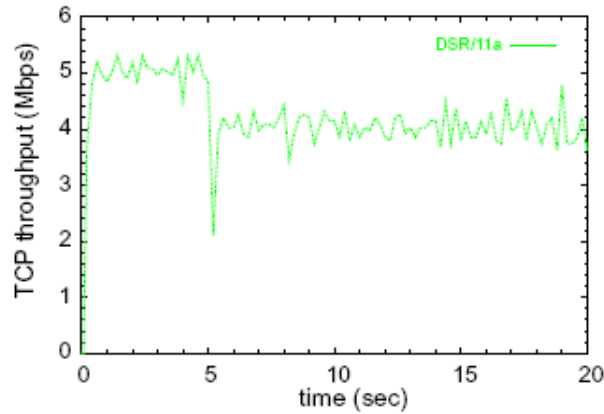
Sequence number at TCP sink.

Simulation

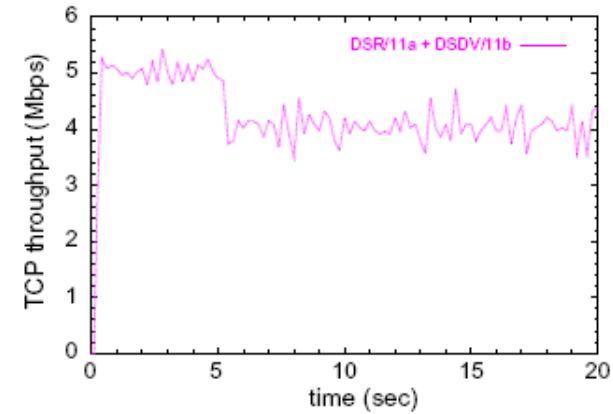
Short-time breakage , no background flow



(a) Topology.

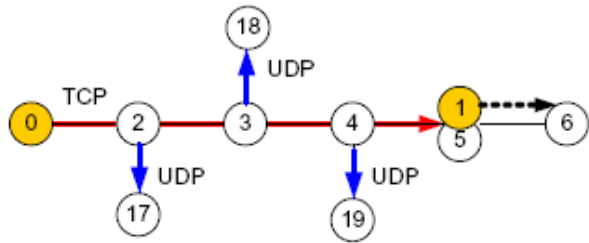


(b) DSR.

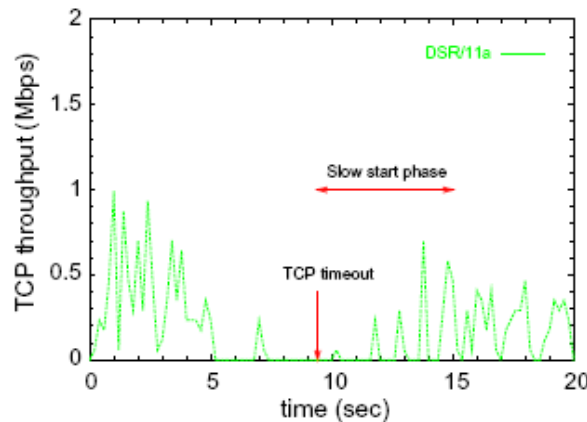


(c) The proposed scheme.

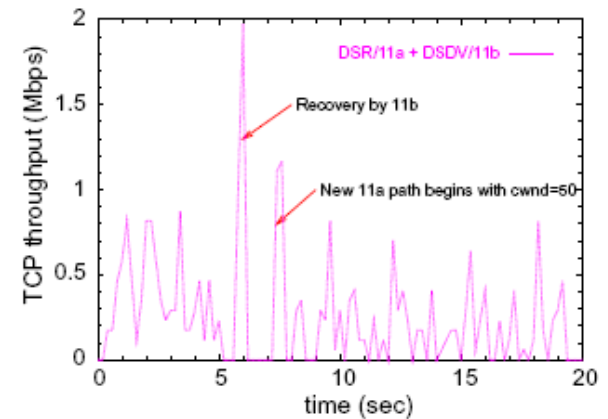
Short-time breakage , with background flow



(a) Topology.



(b) DSR.



(c) The proposed scheme.

Simulation

Impact of mobility

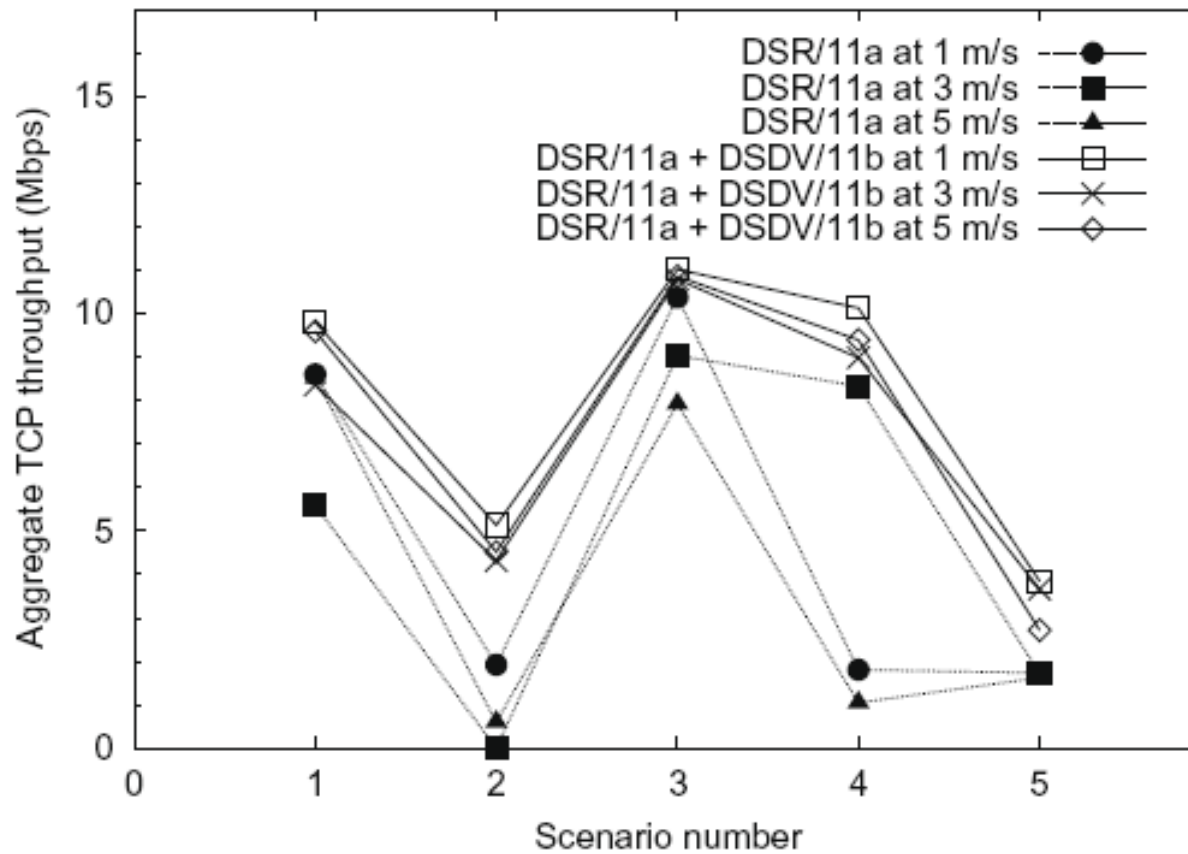
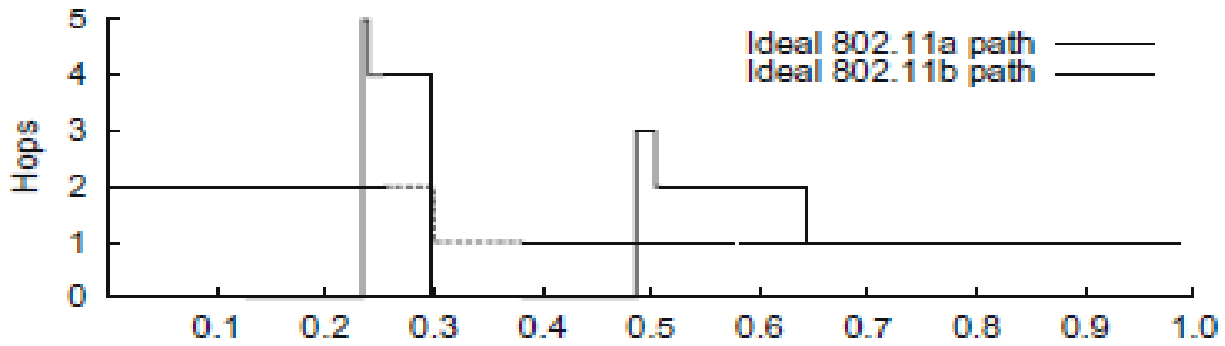
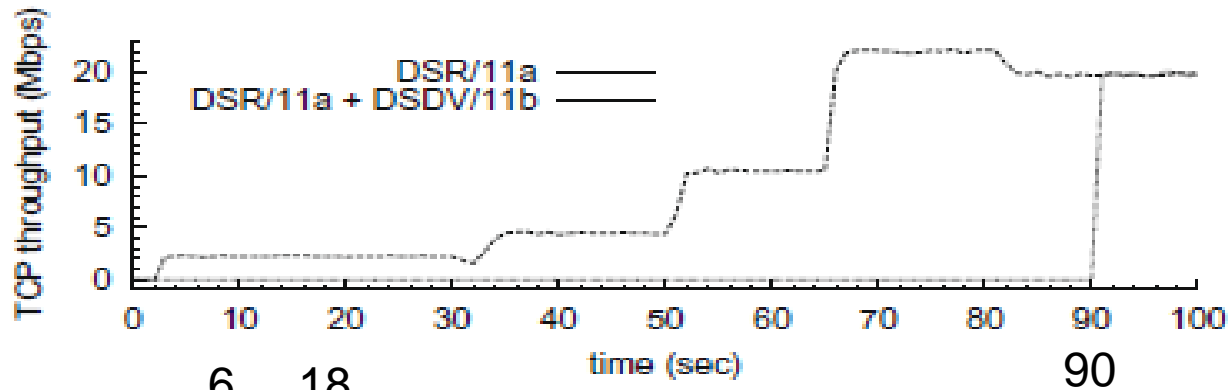


Fig. 8. Impact of mobility: TCP throughput on chain topologies.

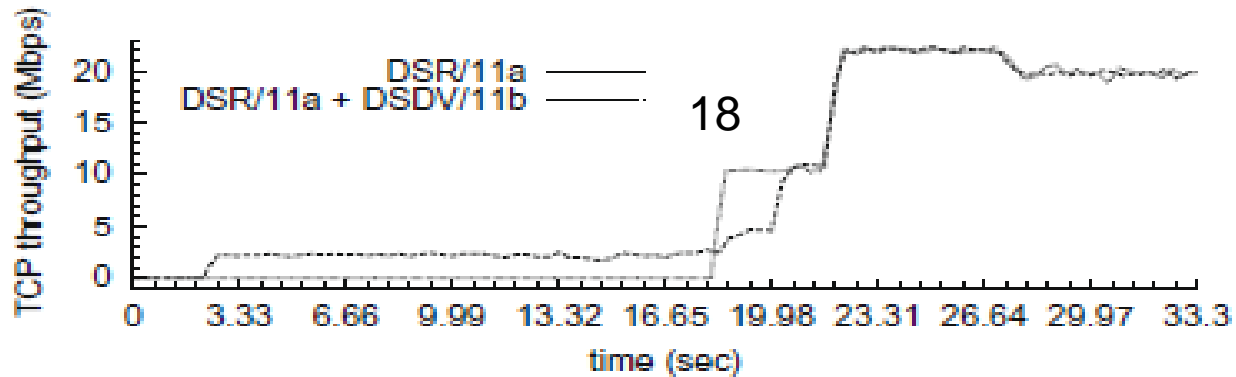
RTO=6



(a) Change in number of hops between TCP source and sink.



(b) Throughput at 1m/s.



(c) Throughput at 3m/s.

Simulation

Large-scale ; 50 nodes ; 200m*200m

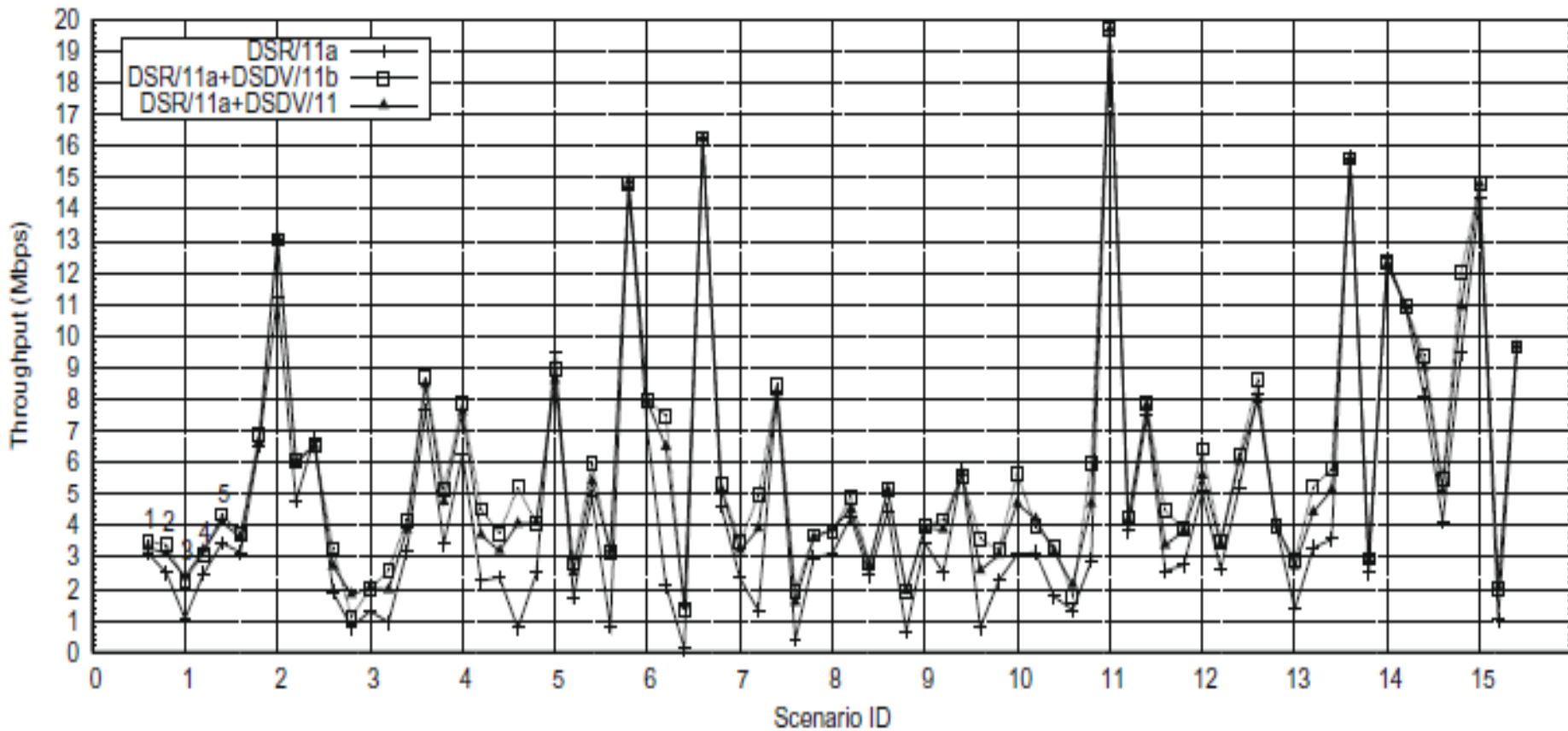
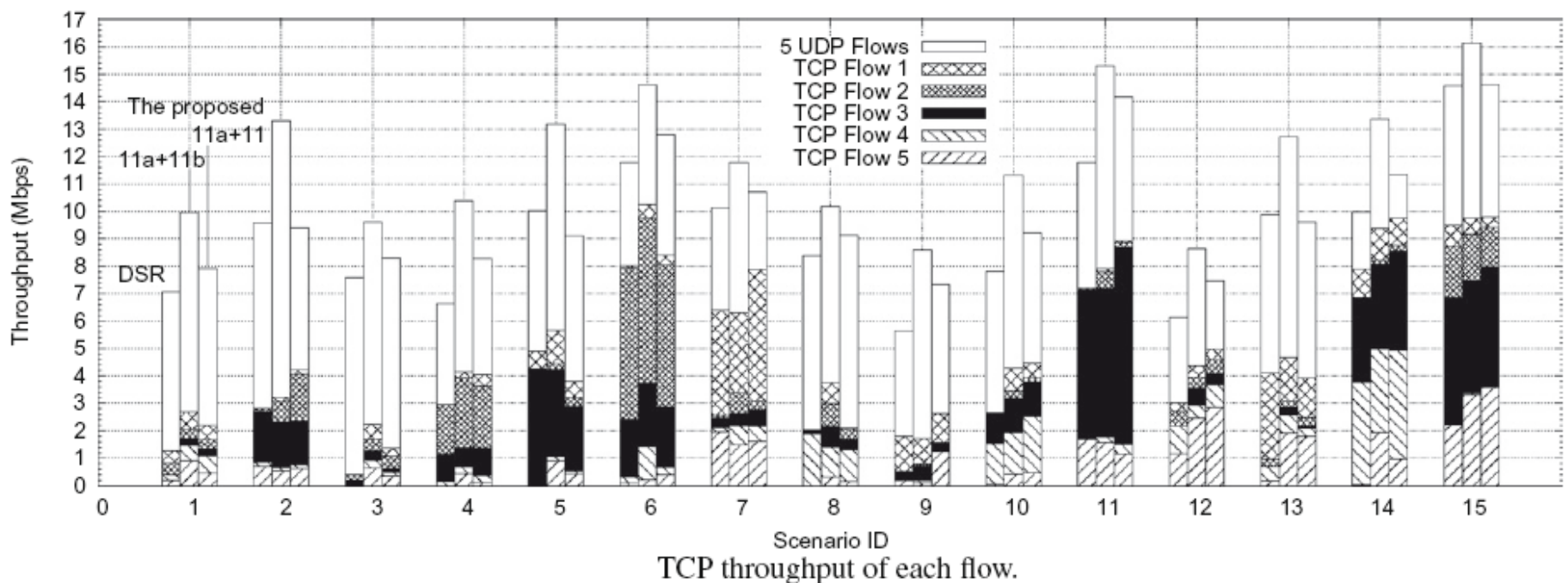
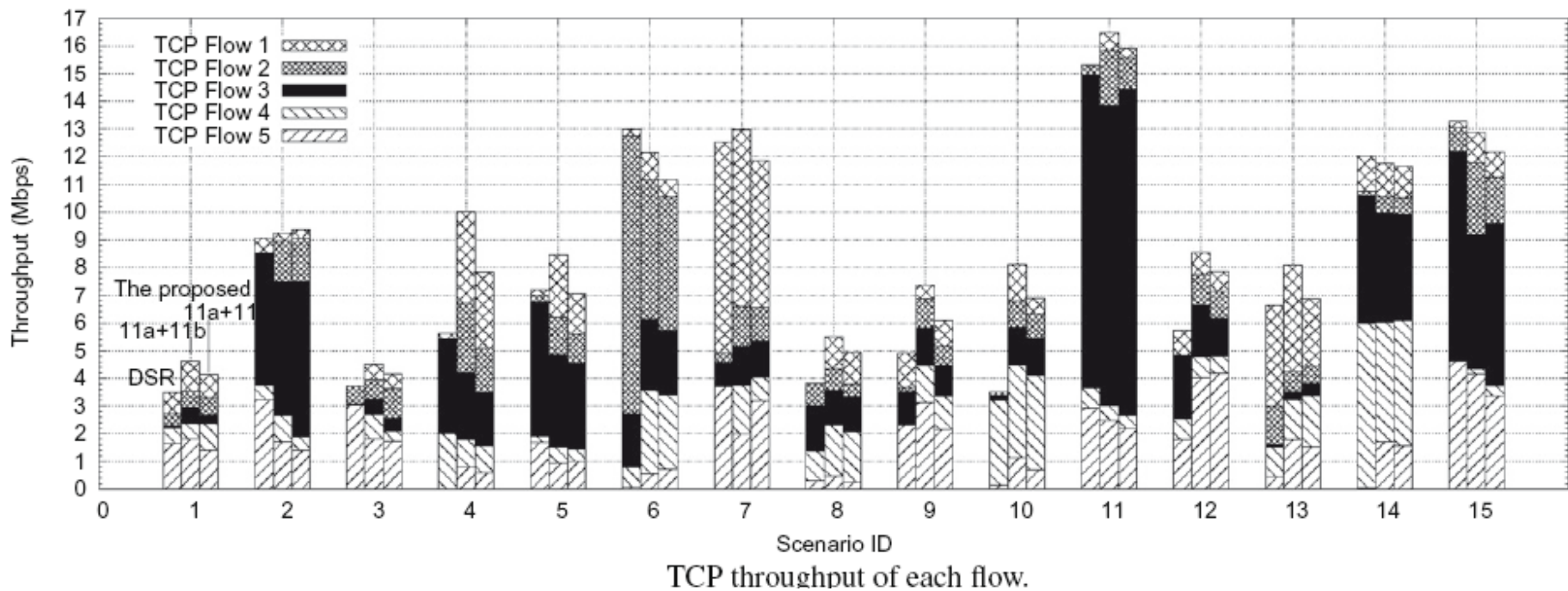


Fig. 11. Simulation of a single flow on 200×200 random topologies: TCP throughput.



Conclusions

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- This paper proposes a routing scheme that exploits multiple heterogeneous wireless interfaces on a node: a primary 802.11a interface and a secondary 802.11b (or 802.11) interface.
- This helps keep TCP flows alive and preserve the TCP window size, thereby making them more resilient to route breakage induced by mobility.