Routing exploiting multiple heterogeneous wireless interfaces: A TCP performance study

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Outline

- Introduction
- The proposed scheme
- Simulation
- Conclusion

Introduction

- 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

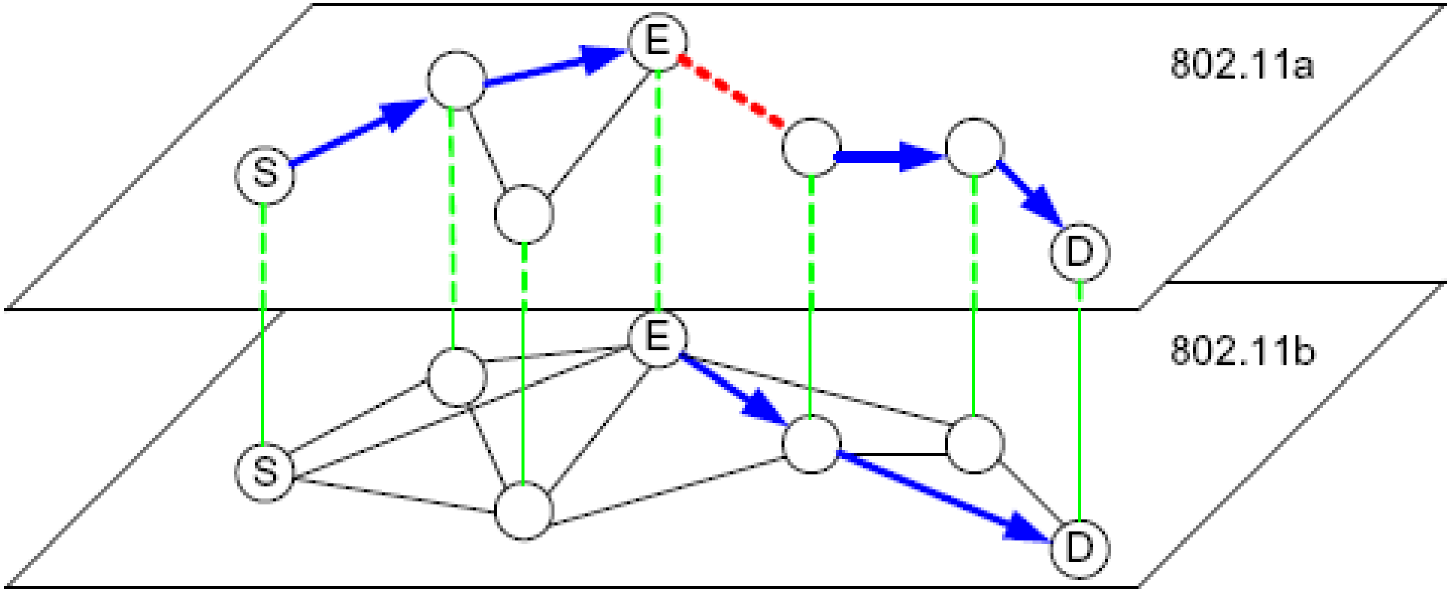


Fig. 1. A potential benefit of using multiple heterogeneous wireless interfaces. Node E can use an alternate 802.11b path when a 802.11a link (dotted red) is broken due to node mobility.

```
if_0 ← 802.11a NIC
if_1 ← 802.11b NIC
run DSR protocol on if_0
run DSDV protocol on if_1
if node is a source then
  while (1) do
    ifreceiving RERR of DSR then
      initiate a new route discovery by sending RREQ
      move packets from if_0 buffer to if_1 buffer
      route IP packets to if_1 buffer
    else if detecting a next hop DSR link failure then
      initiate a new route discovery by sending RREQ
      move packets from if_0 buffer to if_1 buffer
      route IP packets to if_1 buffer
    else if receiving RREP of DSR then
      move packets from if_1 buffer to if_0 buffer
      route IP packets to if_0 buffer
    else if TCP RTO expires
      ssthresh ← cwnd/2
      cwnd ← 1
      RTO ← 2 * RTO
    end if
  end while
```

```
else if node is an intermediate node then
  while (1) do
    if detecting a next hop DSR link failure then
      send RERR toward the source
      move packets from if_0 buffer to if_1 buffer
      forward received TCP ACK on if_0 toward the source
    else if receiving RERR of DSR then
      forward RERR toward the source
    end if
  end while
else if node is a sink then
  while (1) do
    if receiving a TCP packet on if_0 then
      send TCP ACK on if_0
    else if receiving a TCP packet on if_1 then
      send TCP ACK on if_1
    end if
  end while
end if
```

The proposed scheme

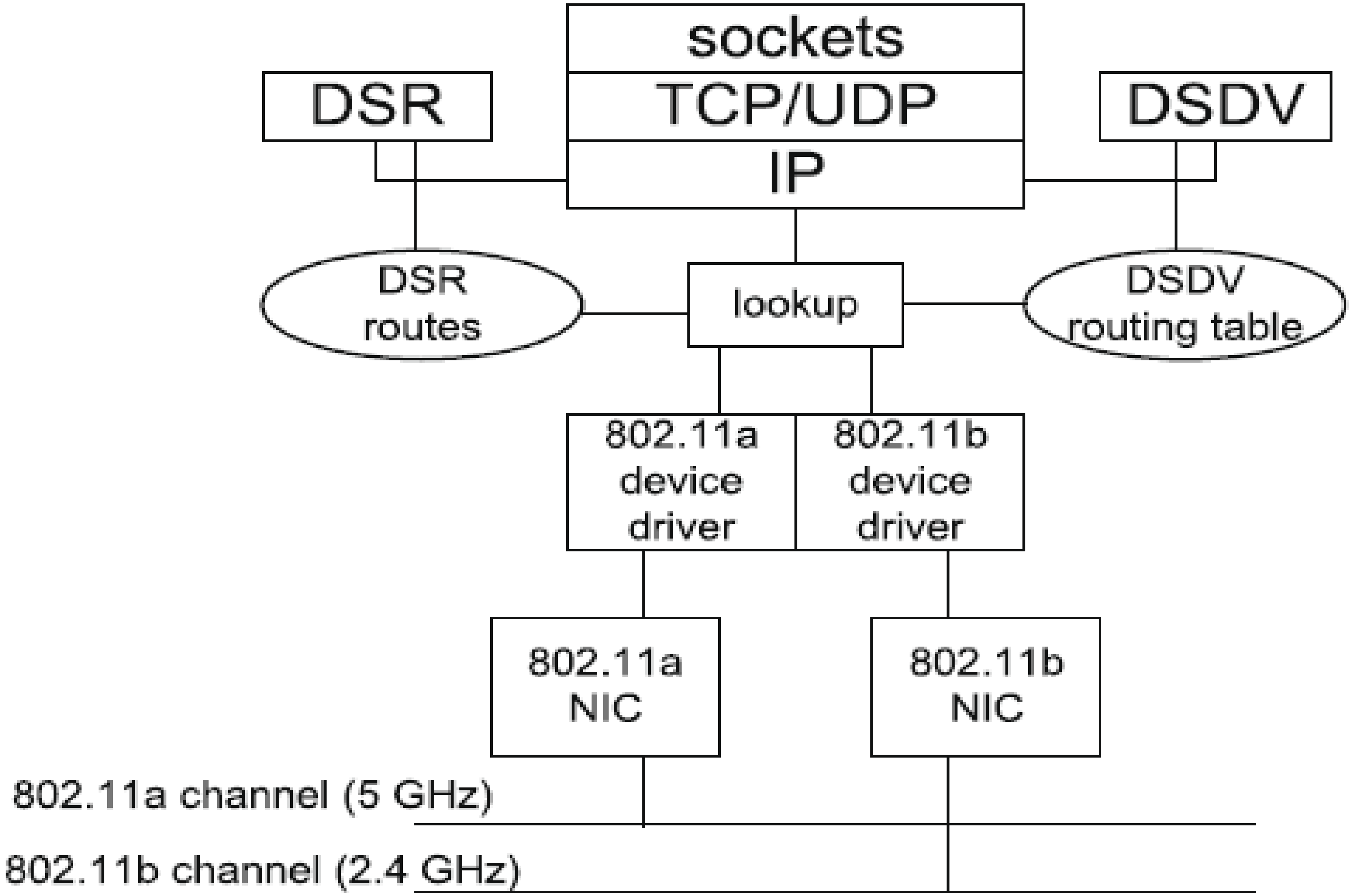
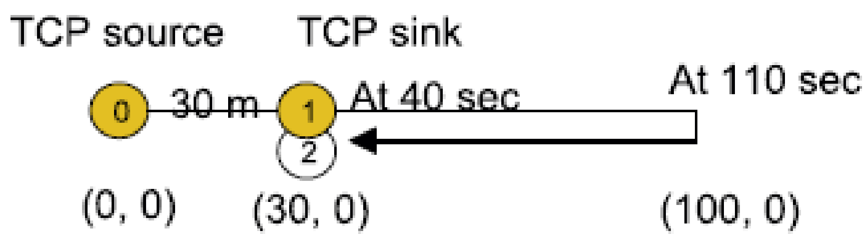
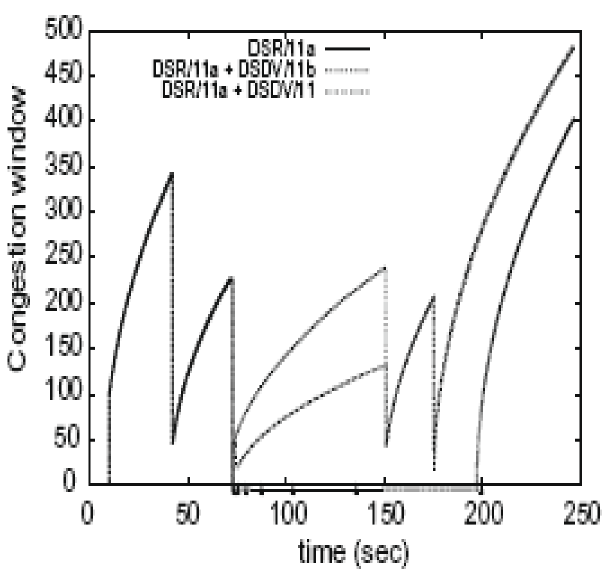


Fig. 2. Node structure.

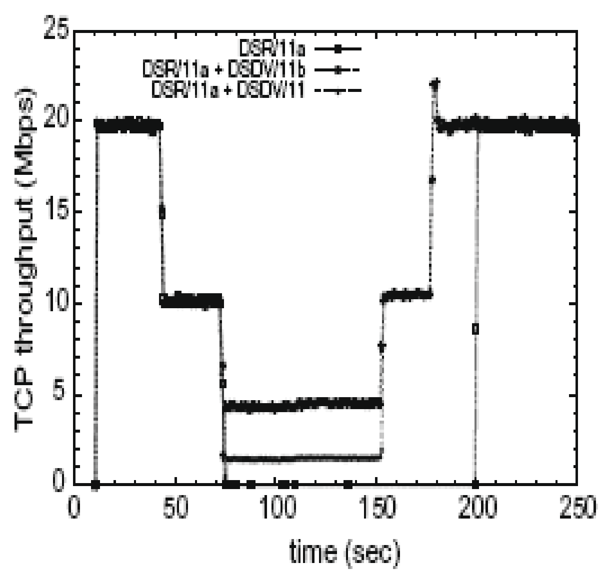
Simulation

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

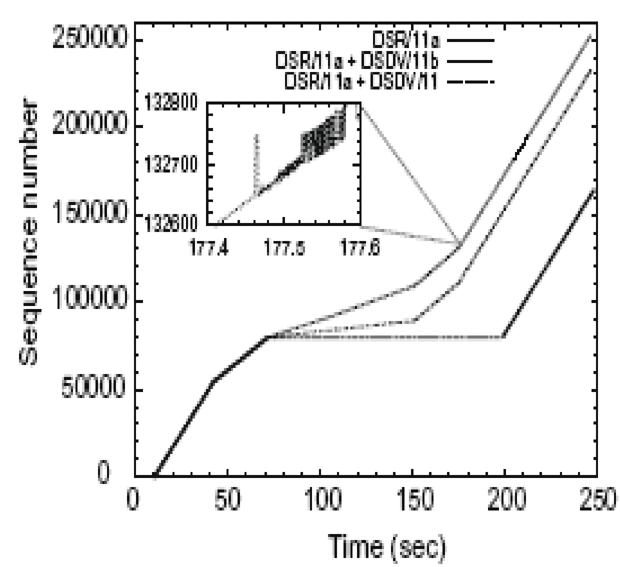




(a) Congestion window.



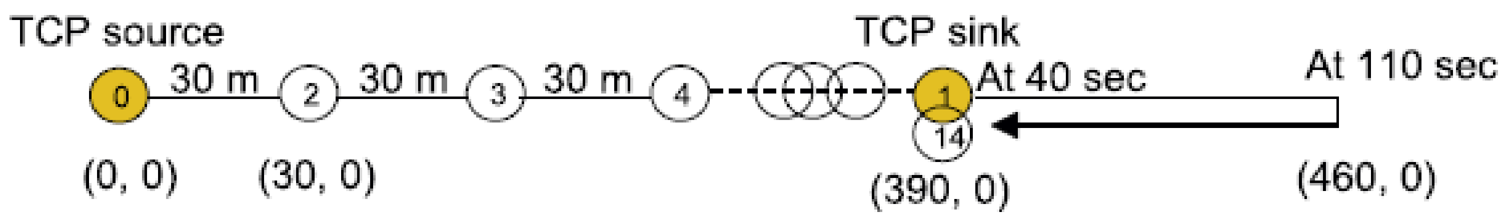
(b) TCP throughput.

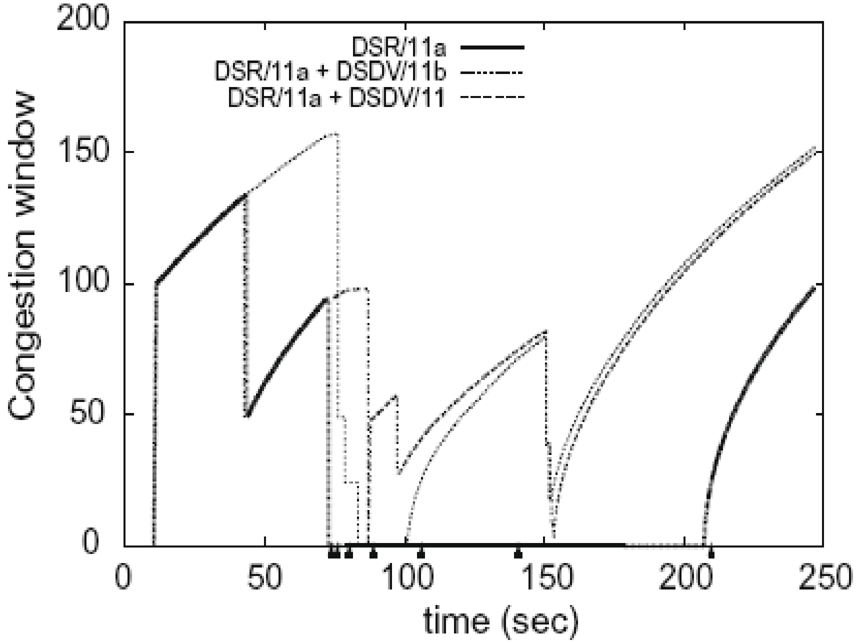


(c) Sequence number at TCP sink.

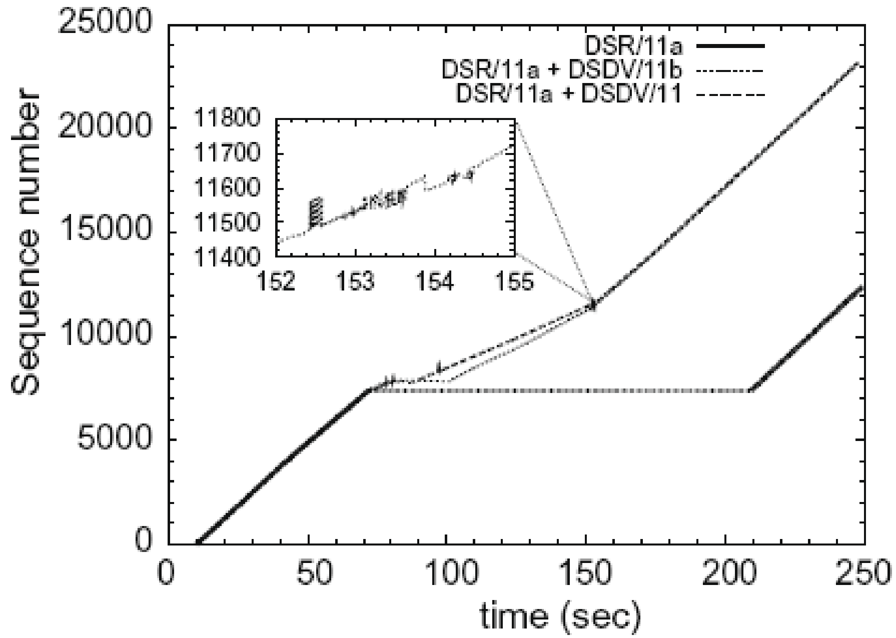
Simulation

- Longtime breakage , long-hop route





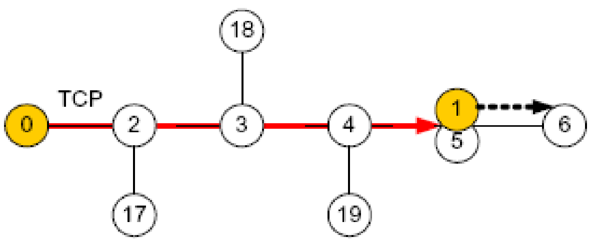
Congestion window.



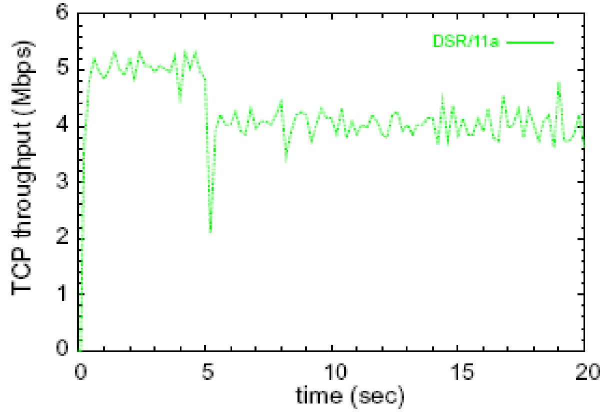
Sequence number at TCP sink.

Simulation

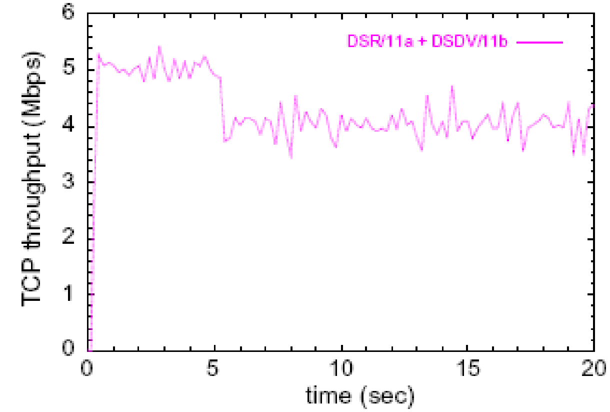
Short-time breakage , no background flow



(a) Topology.

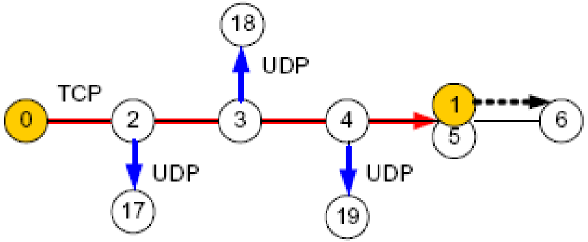


(b) DSR.

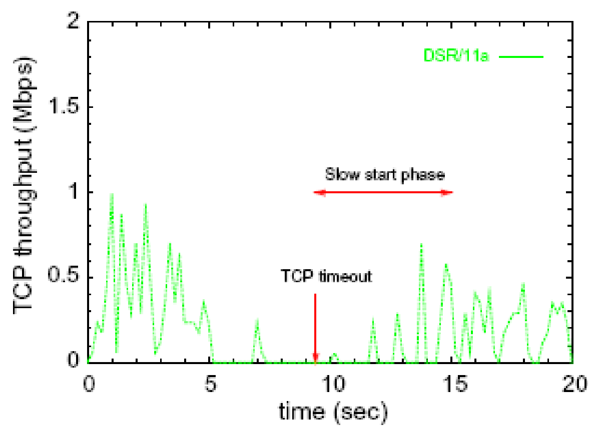


(c) The proposed scheme.

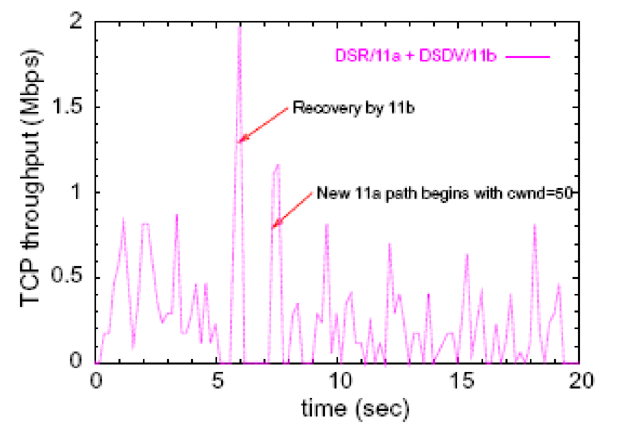
Short-time breakage , with background flow



(a) Topology.



(b) DSR.



(c) The proposed scheme.

Simulation

Impact of mobility

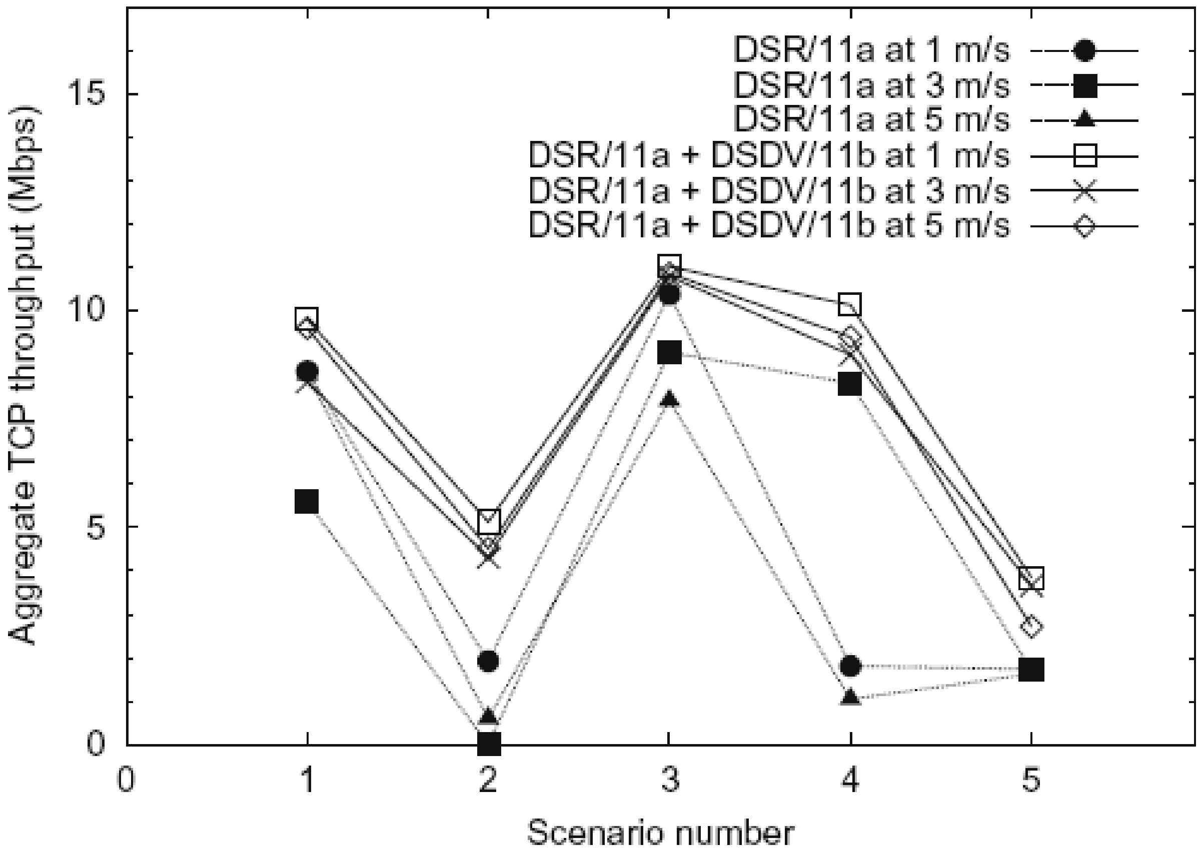
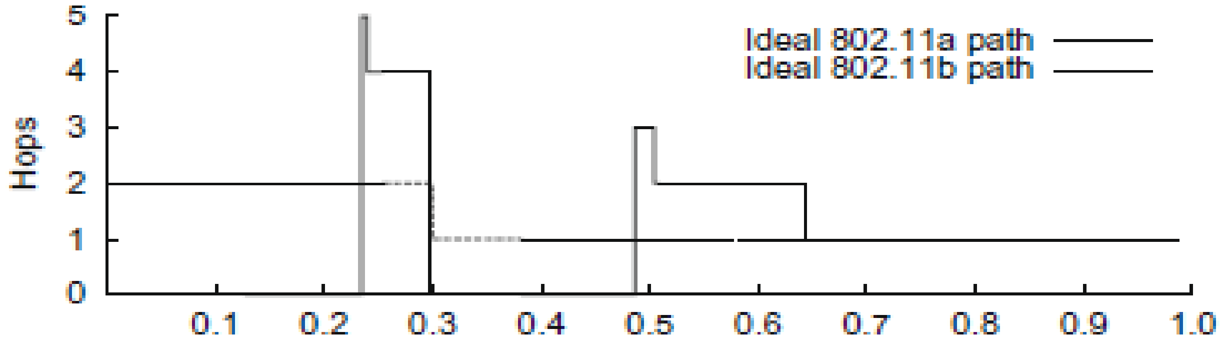
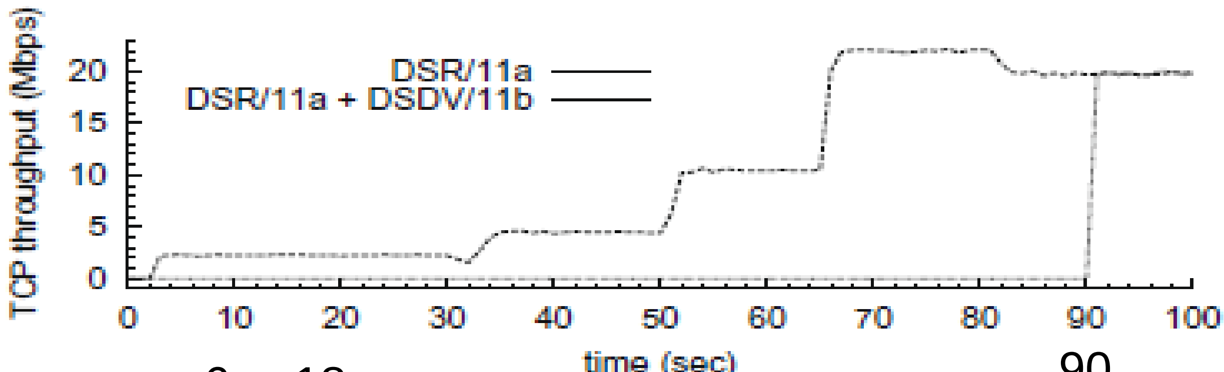


Fig. 8. Impact of mobility: TCP throughput on chain topologies.

RTO=6



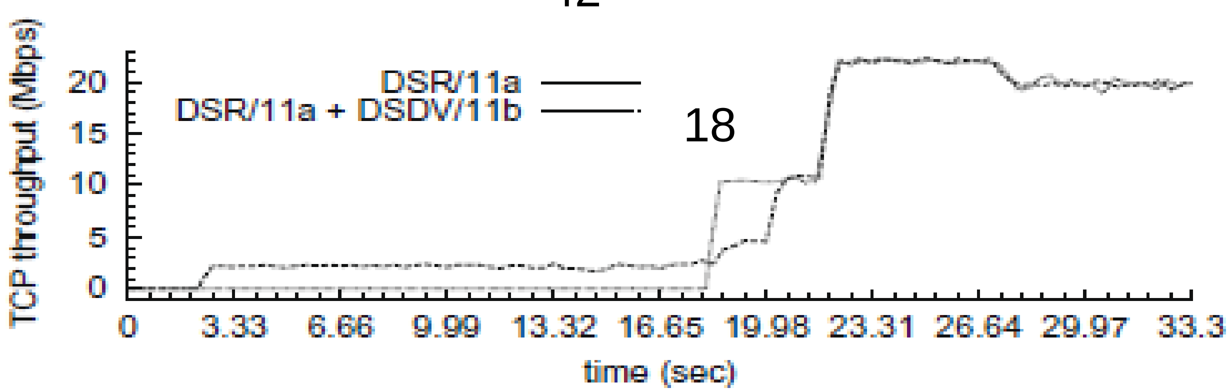
(a) ChangeinnumberofhopsbetweenTCPsourceandsink.



6 18 90

(b) Throughputat1m/s.

42



18

6

(c) Throughputat3m/s.

Simulation

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

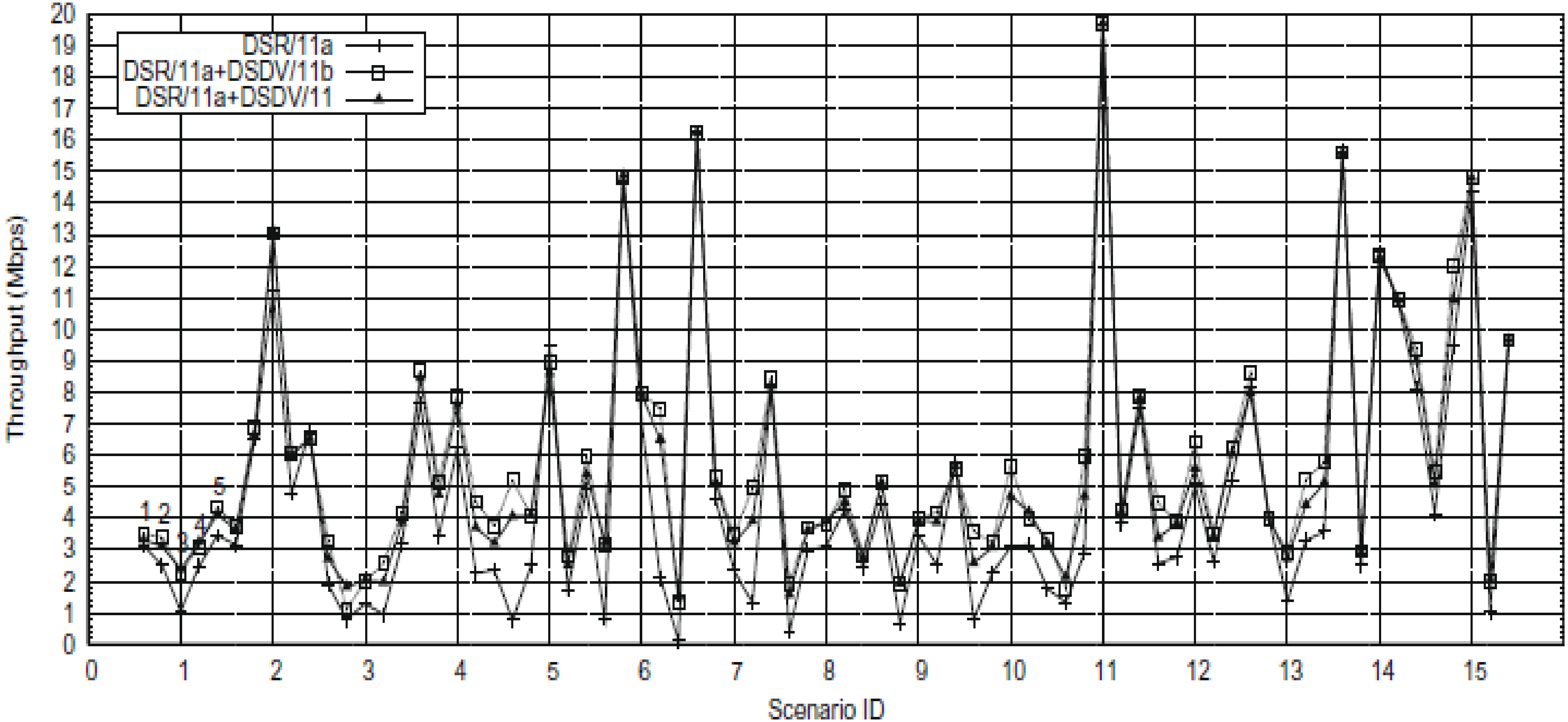
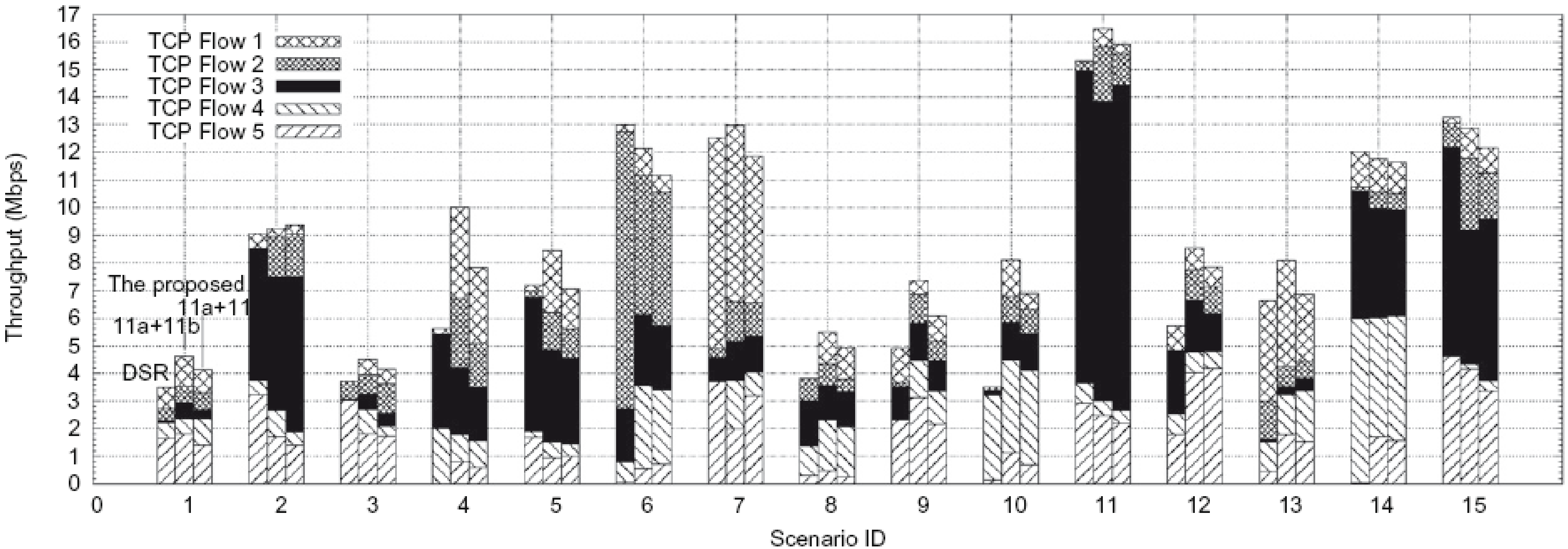
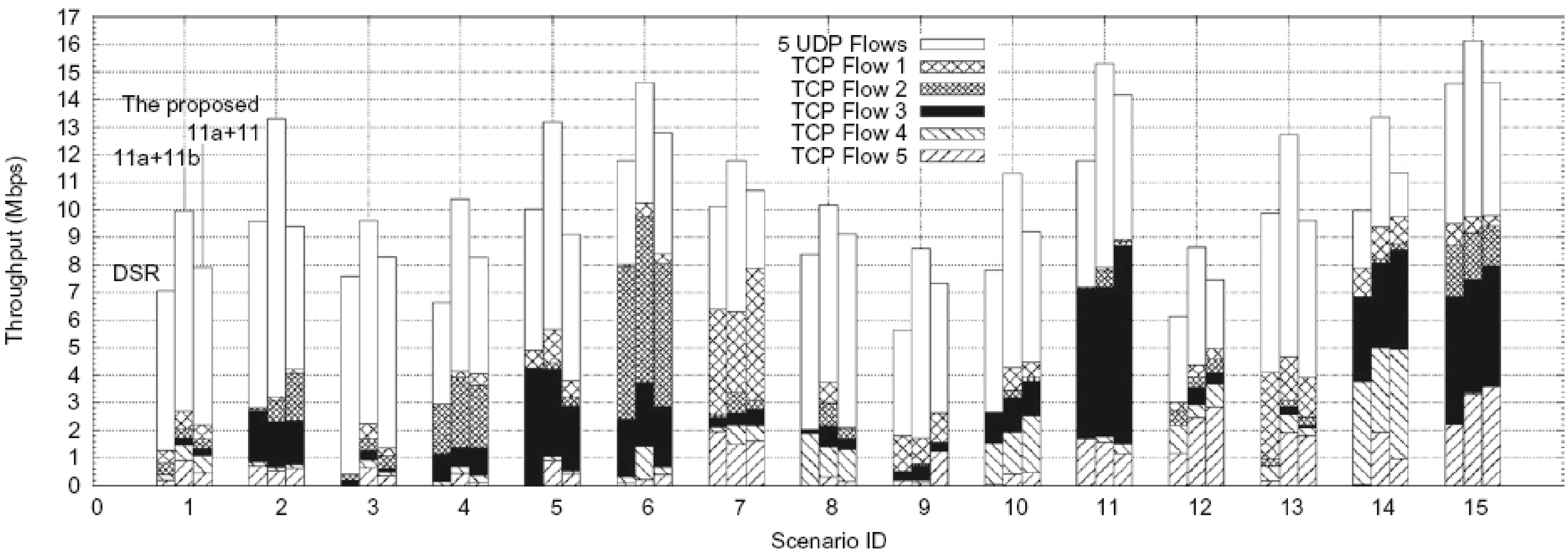


Fig. 11. Simulation of a single flow on 200 × 200 random topologies: TCP throughput.



TCP throughput of each flow.



TCP throughput of each flow.

Conclusions

- 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.