

Analysis of TCP and UDP Traffic in MANETs

Thomas D. Dyer
Rajendra V. Boppana
CS Department
UT San Antonio

MANET Routing Protocols

❖ Proactive protocols

- ◆ Maintain routes to all nodes
- ◆ Distance vector, link state
- ◆ DSDV, OLSR

❖ On-demand protocols

- ◆ Discover and maintain routes only when needed
- ◆ Lower overhead, higher throughput than proactive routing protocols
- ◆ Longer latency than proactive protocols
- ◆ DSR, AODV, TORA

❖ Hybrid protocols

- ◆ ZRP

MANET Performance Evaluation

- ❖ Previous simulation-based studies
 - ◆ UDP traffic
 - ◆ Compared routing protocols
 - ◆ Varied offered traffic, node mobility
 - ◆ TCP traffic
 - ◆ One TCP connection
 - ◆ Only throughput measured
- ❖ Our study
 - ◆ Mixed UDP and TCP traffic
 - ◆ Multiple TCP connections
 - ◆ Performance metrics other than throughput

Outline

- MANET Routing Protocols
- ❖ Performance Analysis
- ❖ Conclusions and Future Work

Ad hoc On-demand Distance Vector (AODV)

- ❖ DV routing table, one entry per destination
- ❖ Destination sequence numbers as in DSDV
- ❖ Routes acquired on demand via request-reply cycle (route discovery)
- ❖ Unused routes are expired to avoid using stale route information
- ❖ Route error packets notify precursor nodes of link failure
- ❖ Local route repair

Dynamic Source Routing (DSR)

- ❖ Uses source routing, nodes maintain route caches
- ❖ Multiple routes per destination
- ❖ On-demand route discovery
- ❖ Route error packets notify source of link failures
- ❖ Snooping, gratuitous route reply
- ❖ Intermediate node salvaging
- ❖ Stale routes can be a problem

Adaptive Distance Vector (ADV)

- ❖ A hybrid approach which seeks to combine the best features of proactive and on-demand protocols
- ❖ Distance vector algorithm
- ❖ Uses sequence numbers to avoid long-lived loops
- ❖ Proactive characteristics
 - ◆ Uses partial and full updates to disseminate routing information

Adaptive Distance Vector (ADV)

- ❖ On-demand characteristics
 - ◆ Only routes to active receivers are maintained
 - ◆ Routing updates are triggered adaptively based on network load and mobility conditions
- ❖ ADV has been shown to outperform on-demand algorithms for UDP traffic from CBR sources in networks with fairly high node mobility (Boppana and Konduru, Infocom 2001)

Outline

- ❖ MANET Routing Protocols
- ➔ Performance Analysis
- ❖ Conclusions and Future Work

Simulation Environment

- ❖ ns-2 simulator with CMU extensions
 - ◆ 50 nodes in a 1000m x 1000m field
 - ◆ Random waypoint mobility model with wraparound
 - ◆ High node mobility
 - ◆ Mean node speed of 10 m/s
 - ◆ Continuous movement (pause time = 0)
- ❖ 100 sec warm-up + 900 sec simulation
- ❖ Results averaged over 50 different scenarios

Simulated Network Traffic

❖ UDP Traffic

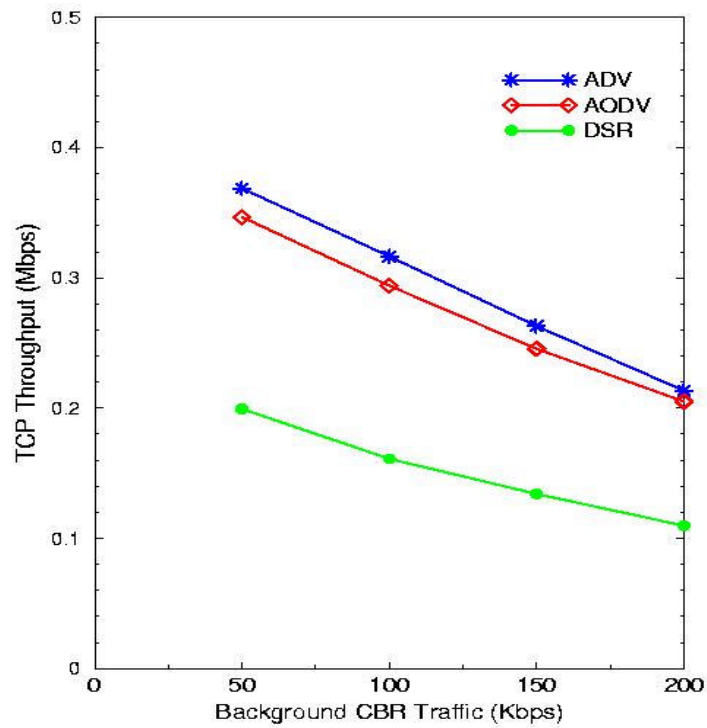
- ◆ 10 and 40 CBR connections
- ◆ Packet size: 512 bytes
- ◆ Traffic loads from 50 to 200 Kb/s

❖ TCP Traffic

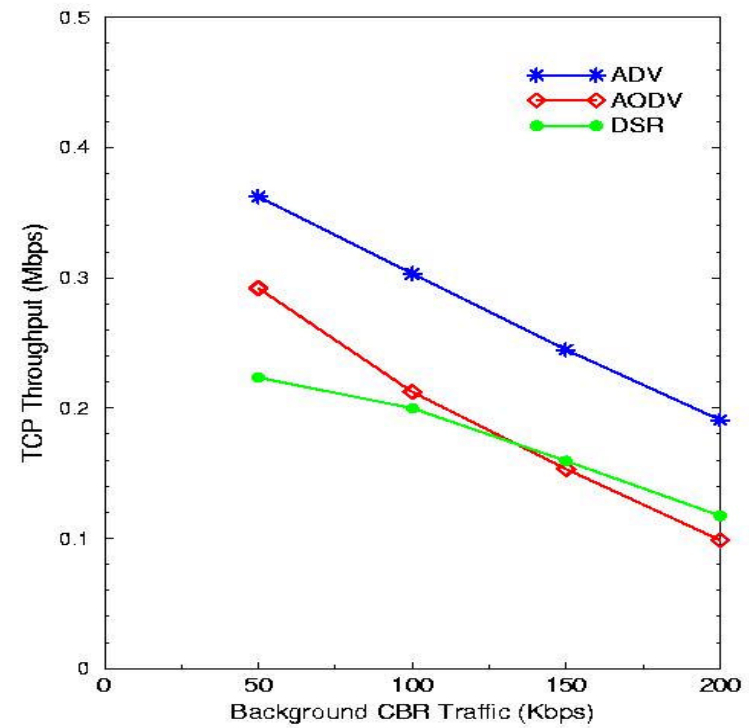
- ◆ Packet size: 1460 bytes
 - ◆ Maximum window size: 8 packets
 - ◆ Number of connections varied from 1 to 10
- ❖ Ratio of TCP traffic to UDP traffic varied from 3:1 to 8:1

1 TCP Connection Throughput

1 TCP, 10 CBRs

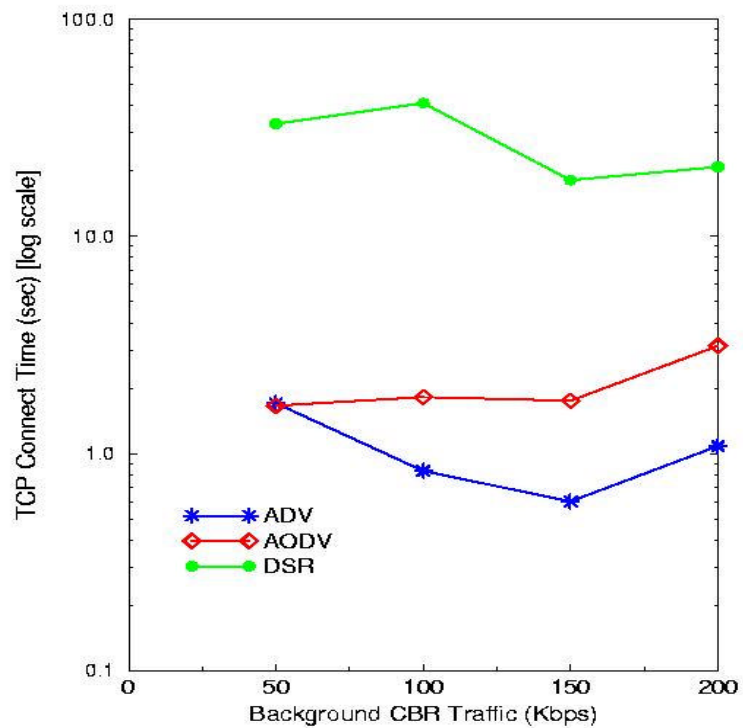


1 TCP, 40 CBRs

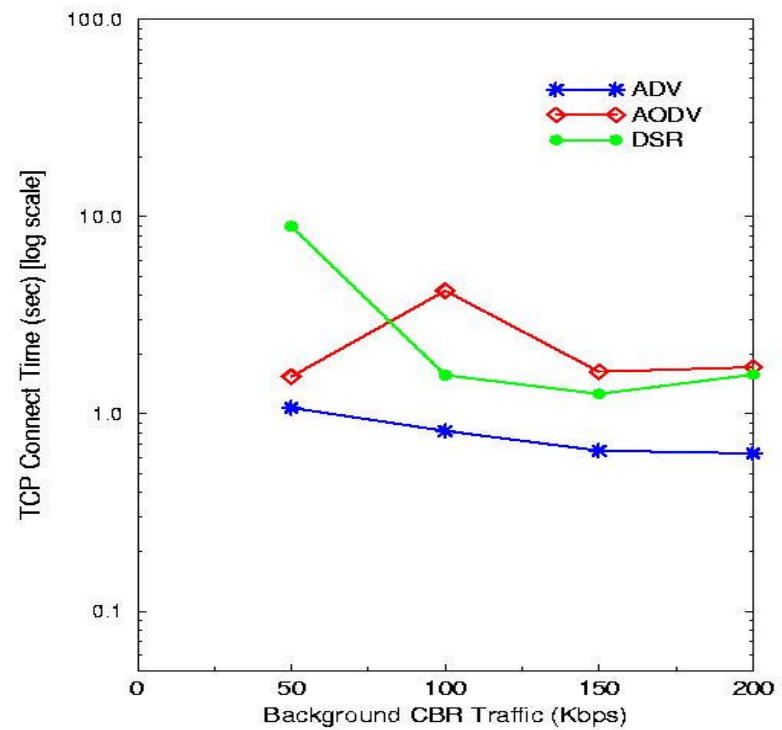


1 TCP Connection Connect Time

1 TCP, 10 CBRs

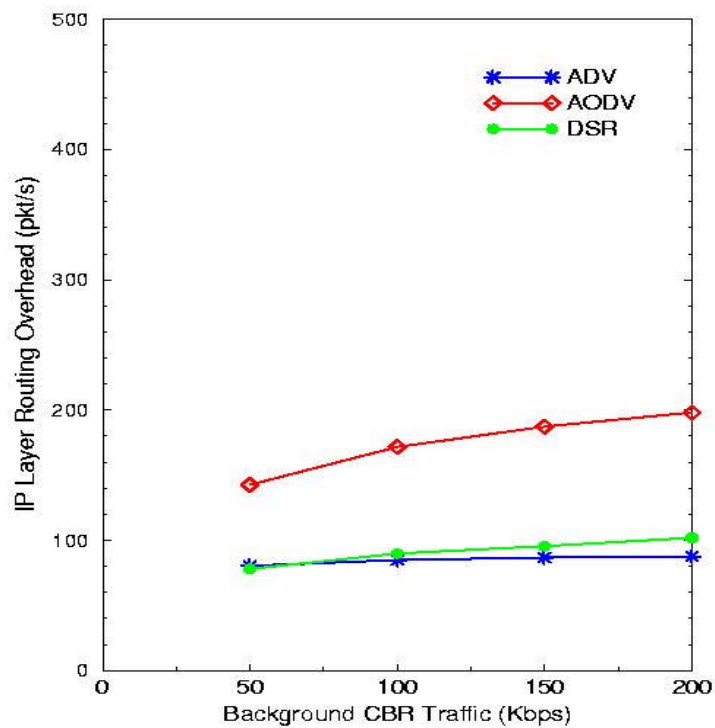


1 TCP, 40 CBRs

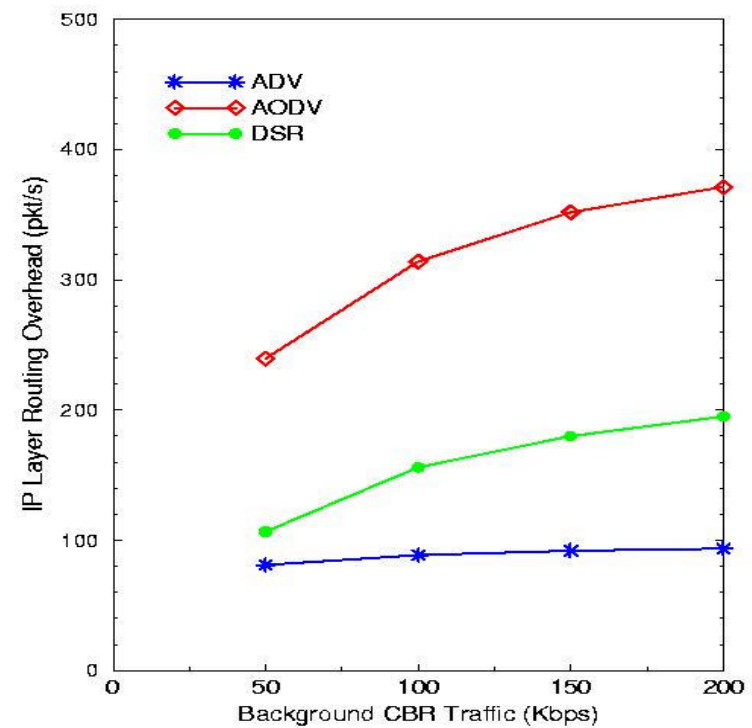


1 TCP Connection Routing Overhead (packets/s)

1 TCP, 10 CBRs

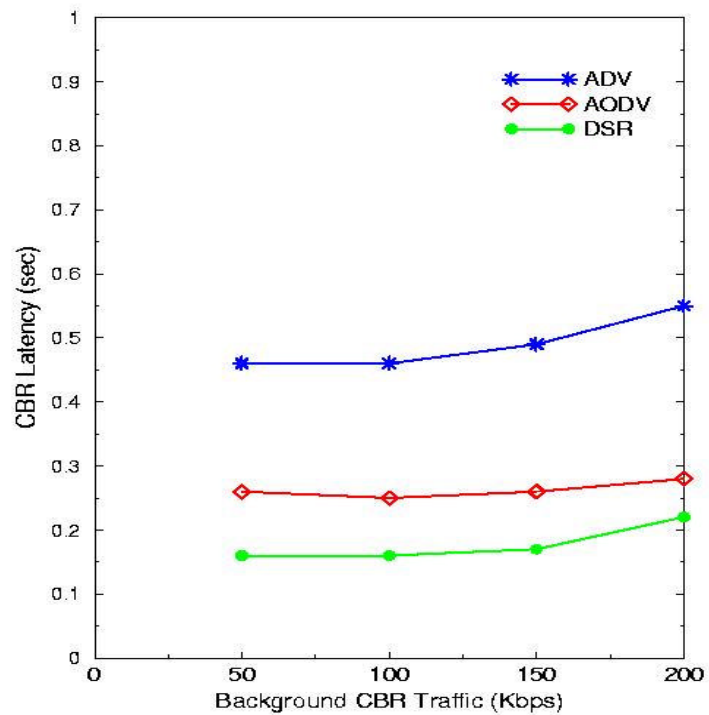


1 TCP, 40 CBRs

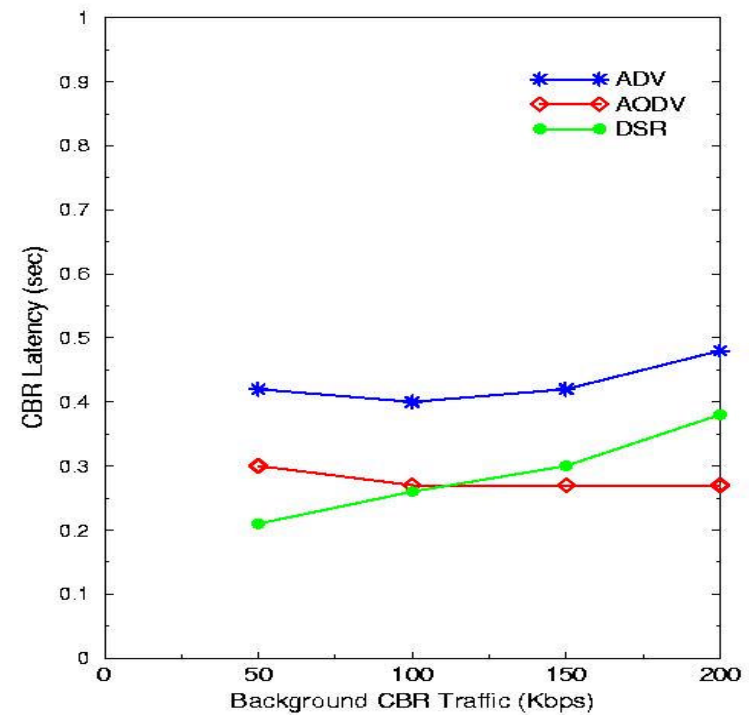


1 TCP Connection UDP Packet Latency

1 TCP, 10 CBRs

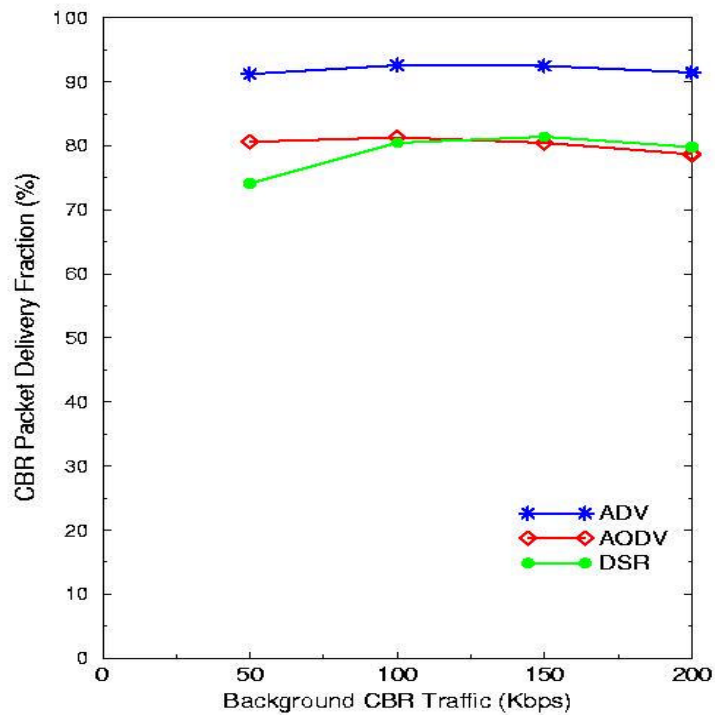


1 TCP, 40 CBRs

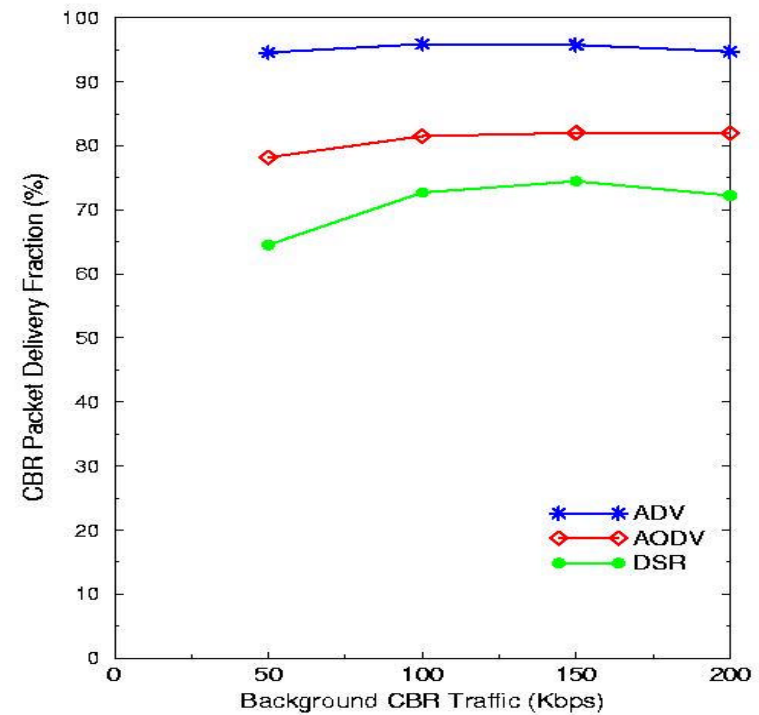


1 TCP Connection UDP Packet Delivery Fraction

1 TCP, 10 CBRs



1 TCP, 40 CBRs



Summary of Performance Analysis

1 TCP Connection

❖ TCP Connect Time

- ◆ For lower number of connections, stale routes result in long connect times for DSR
- ◆ ADV's proactive nature yields lowest connect times

❖ TCP Throughput

- ◆ For 10 CBRs, ADV and AODV comparable
- ◆ Stale routes hurt DSR throughput
- ◆ More connections lowers AODV throughput
- ◆ For 40 CBRs, ADV clearly performs better

Summary of Performance Analysis

1 TCP Connection

❖ UDP Packet Latency

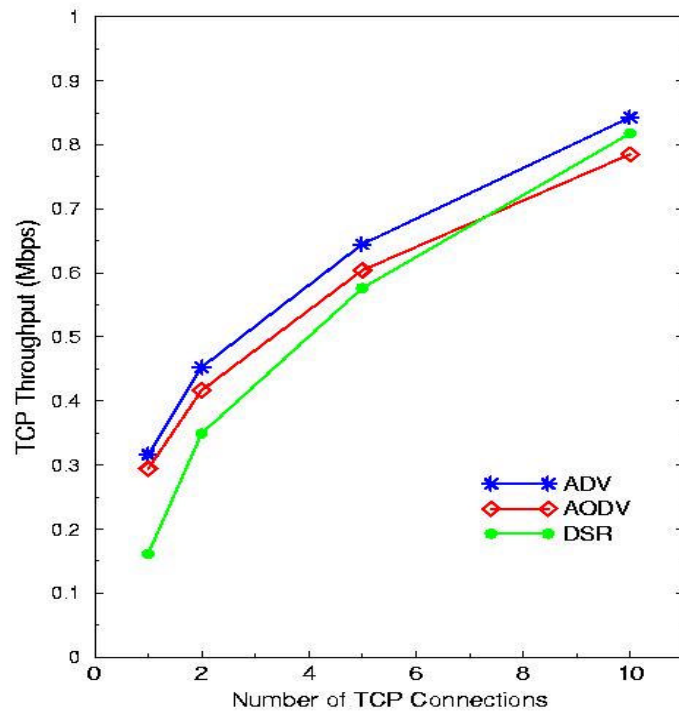
- ◆ Increases with higher offered traffic
- ◆ Highest for ADV, comparable for DSR and AODV
- ◆ None of the three algorithms saturate for the loads offered

❖ UDP Packet Delivery Fraction

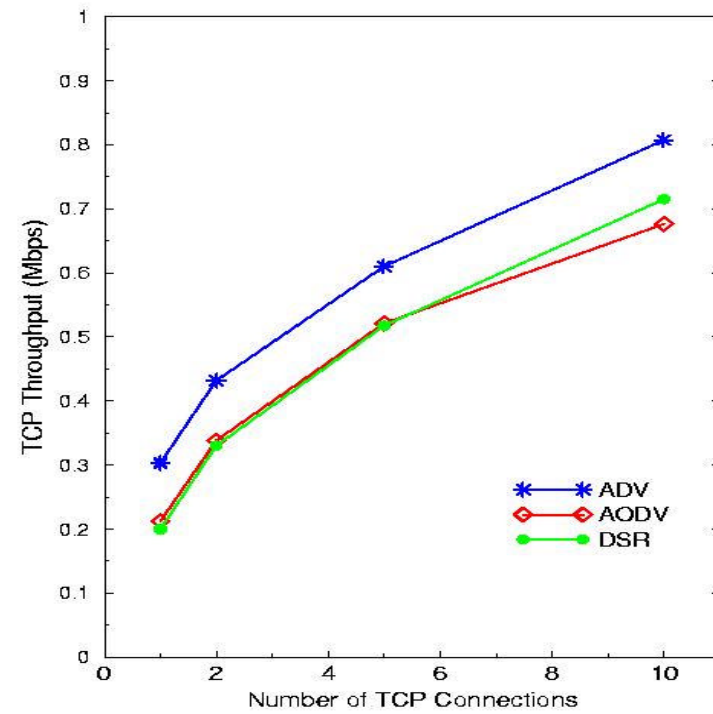
- ◆ Does not change much with load
- ◆ ADV gives slightly higher delivery rate than AODV and DSR

Multiple TCP Connections Throughput

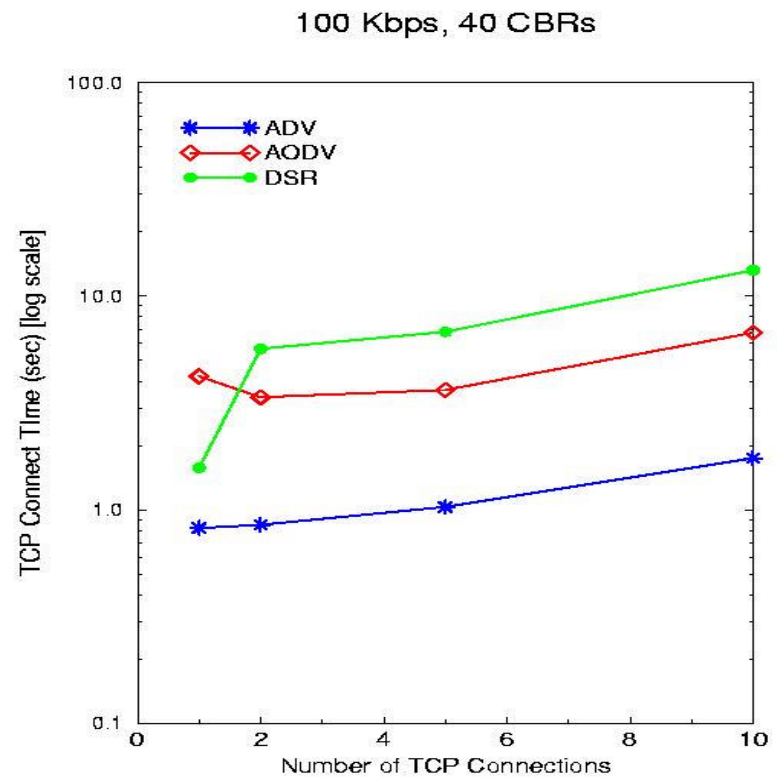
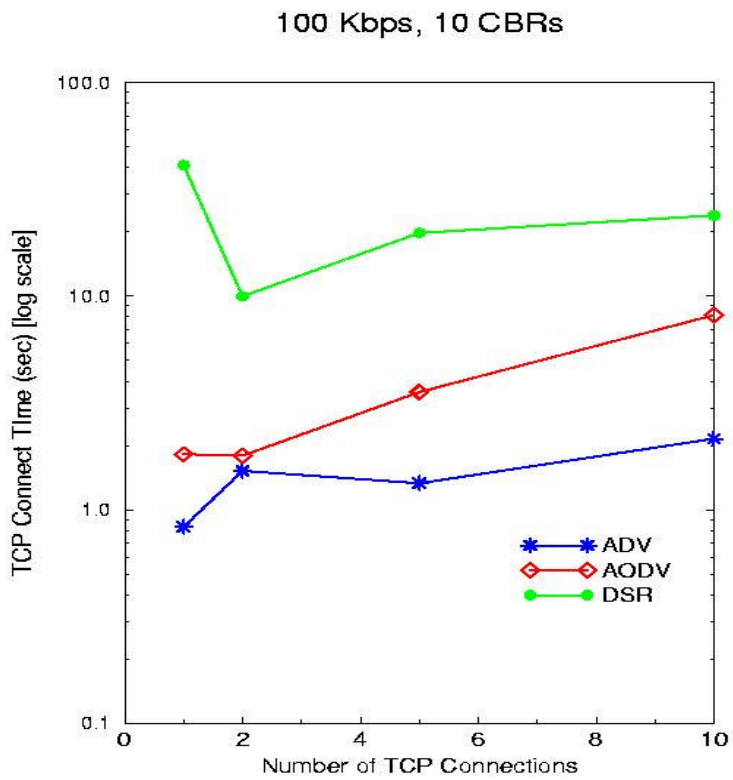
100 Kbps, 10 CBRs



100 Kbps, 40 CBRs

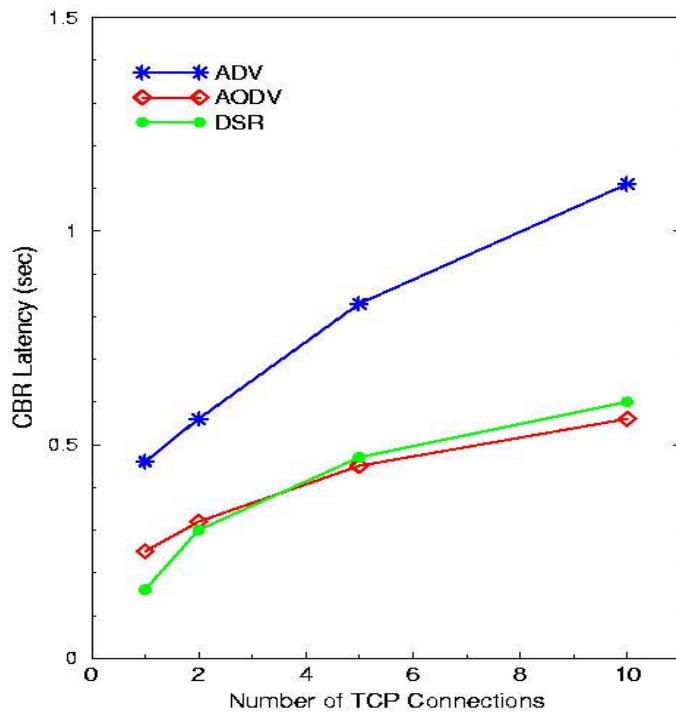


Multiple TCP Connections Connect Time

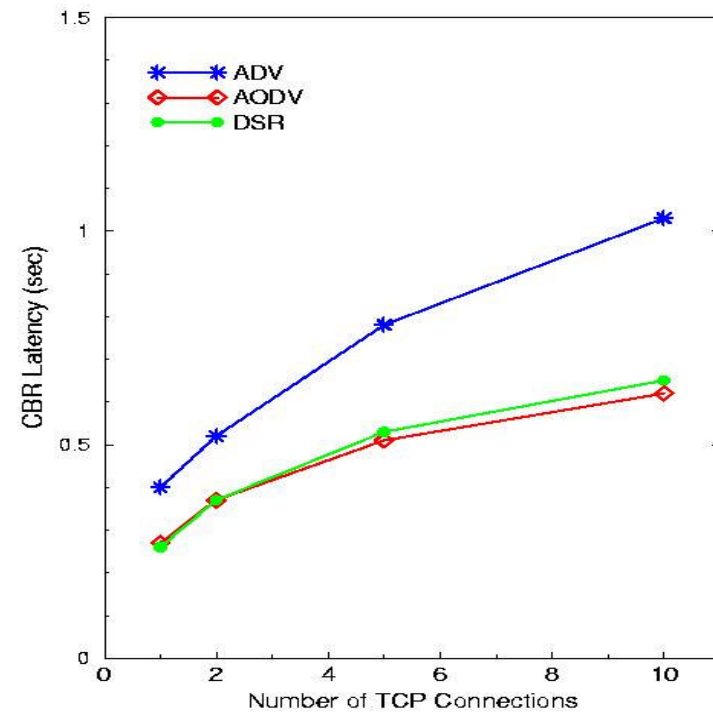


Multiple TCP Connections UDP Packet Latency

100 Kbps, 10 CBRs

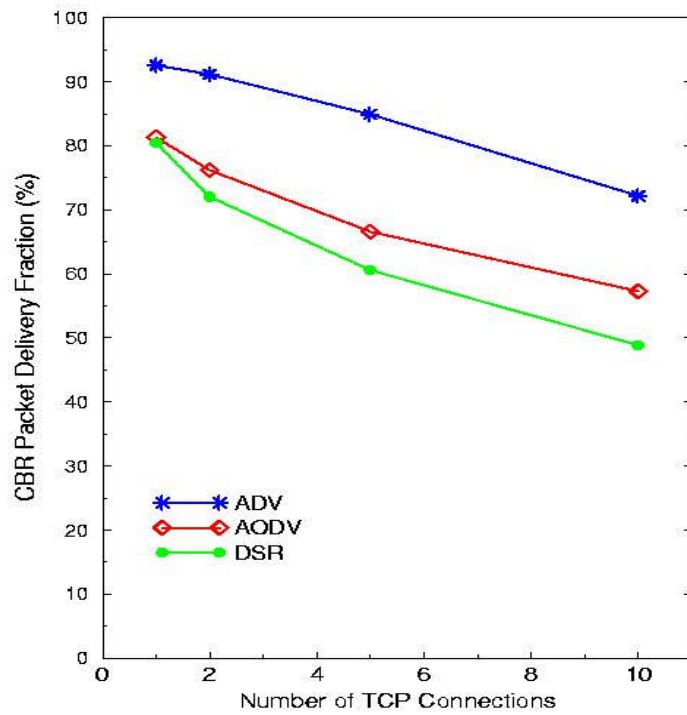


100 Kbps, 40 CBRs

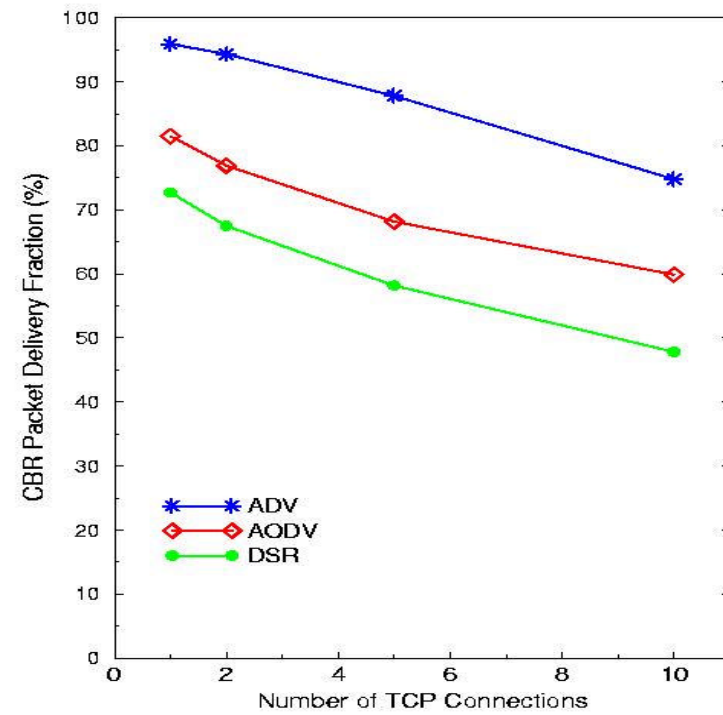


Multiple TCP Connections UDP Packet Delivery Fraction

100 Kbps, 10 CBRs



100 Kbps, 40 CBRs



Summary of Performance Analysis Multiple TCP Connections

❖ TCP Connect Time

- ◆ Times increase but not indicative of saturation
- ◆ ADV gives shortest connect times

❖ TCP Throughput

- ◆ ADV performs the best
- ◆ As number of TCP and CBR connections increases, DSR outperforms AODV

Summary of Performance Analysis

Multiple TCP Connections

- ❖ UDP Packet Latency
 - ◆ Increases with number of TCPs, no saturation
 - ◆ ADV latency twice that of DSR and AODV
- ❖ UDP Packet Delivery Fraction
 - ◆ ADV did much better than on-demand protocols
 - ◆ Biggest impact on ADV's TCP throughput
 - ◆ AODV delivered more packets than DSR

Outline

- ❖ MANET Routing Protocols
- ❖ Performance Analysis
- ➔ Conclusions and Future Work

Conclusions

- ❖ DSR suffers from stale route problem at low traffic loads, but its aggressive use of route caching and snooping pays off as traffic increases
- ❖ AODV is a steady performer, but its routing overhead can be a problem as the number of connections increases

Conclusions

- ❖ ADV's hybrid approach to routing yields better performance for TCP traffic
- ❖ ADV does a better job of handling UDP traffic simultaneously with TCP flows
- ❖ Mixed traffic scenarios are important
 - ◆ More like real world traffic
 - ◆ Can't predict interaction of TCP and UDP flows based on wired network experience