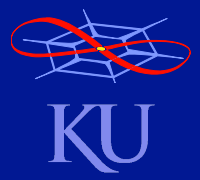
Destination-Sequenced Distance Vector (DSDV) Routing Protocol Implementation in ns-3

Hemanth Narra, Yufei Cheng,
Egemen K. Çetinkaya, Justin P. Rohrer,
and James P.G. Sterbenz



Department of Electrical Engineering & Computer Science
Information Technology & Telecommunications Research Center
The University of Kansas

rohrej@ittc.ku.edu

http://www.ittc.ku.edu/~rohrej
http://wiki.ittc.ku.edu/resilinets

Implementation of DSDV in ns-3

Abstract

Routing protocols are a critical aspect to performance in mobile wireless networks. The development of new protocols requires testing against well-known protocols in various simulation environments. In this paper we present an overview of several well-known MANET routing protocols and the implementation details of the DSDV routing protocol in the ns-3 network simulator. We analyse DSDV routing performance under various scenarios and compare its performance with the other protocols implemented in ns-3, AODV and OLSR. Our results verify the implementation of DSDV and show performance comparable to that of OLSR.

Implementation of DSDV in ns-3
Outline

- Introduction and motivation
- MANET routing protocols
- DSDV module for ns-3
- DSDV module evaluation
- Conclusions

Implementation of DSDV in ns-3
Introduction and Motivation

- Introduction and motivation
- MANET routing protocols
- DSDV module for ns-3
- DSDV module evaluation
- Conclusions

Implementation of DSDV in ns-3
Introduction and Motivation

- Mobile Ad-Hoc Networks
  - self-organization
  - dynamic topologies
  - act as both end systems and as intermediate systems
- Most prominent protocols
  - DSDV, AODV, OLSR, and DSR
- Simulation – backbone of MANET research
  - ns-2: open-source, widely used, number of deficiencies
  - ns-3: open-source, relatively new, very few routing protocols

Implementation of DSDV in ns-3
MANET routing protocols

- Introduction and motivation
- MANET routing protocols
- DSDV module for ns-3
- DSDV module evaluation
- Conclusions

MANET Routing Protocols
DSDV - Destination-Sequenced Distance Vector

- Table-driven, proactive distance-vector protocol
- One of the earliest MANET routing protocols
- Metric: hop count
- Goal: find path with least hop count to destination
- No RFC for DSDV

MANET Routing Protocols
AODV - Ad-Hoc On Demand Distance Vector

- Table-driven, reactive distance-vector protocol
- Based on the design of DSDV
- Periodically broadcasts *hello* messages
- Metric: hop count
- Goal: find path with least hop count to destination
- Standardized in RFC 3561

MANET Routing Protocols
OLSR - Optimized Link State

- Proactive link state protocol
- Exchanges topology information with neighbors
- Periodically broadcasts *hello* messages
  - to discover nodes and links
- Multipoint relaying to reduce duplicate transmissions
  - all nodes maintain MPR selectors
  - only nodes selected as MPR, will generate link state messages
- Standardized in RFC 3626

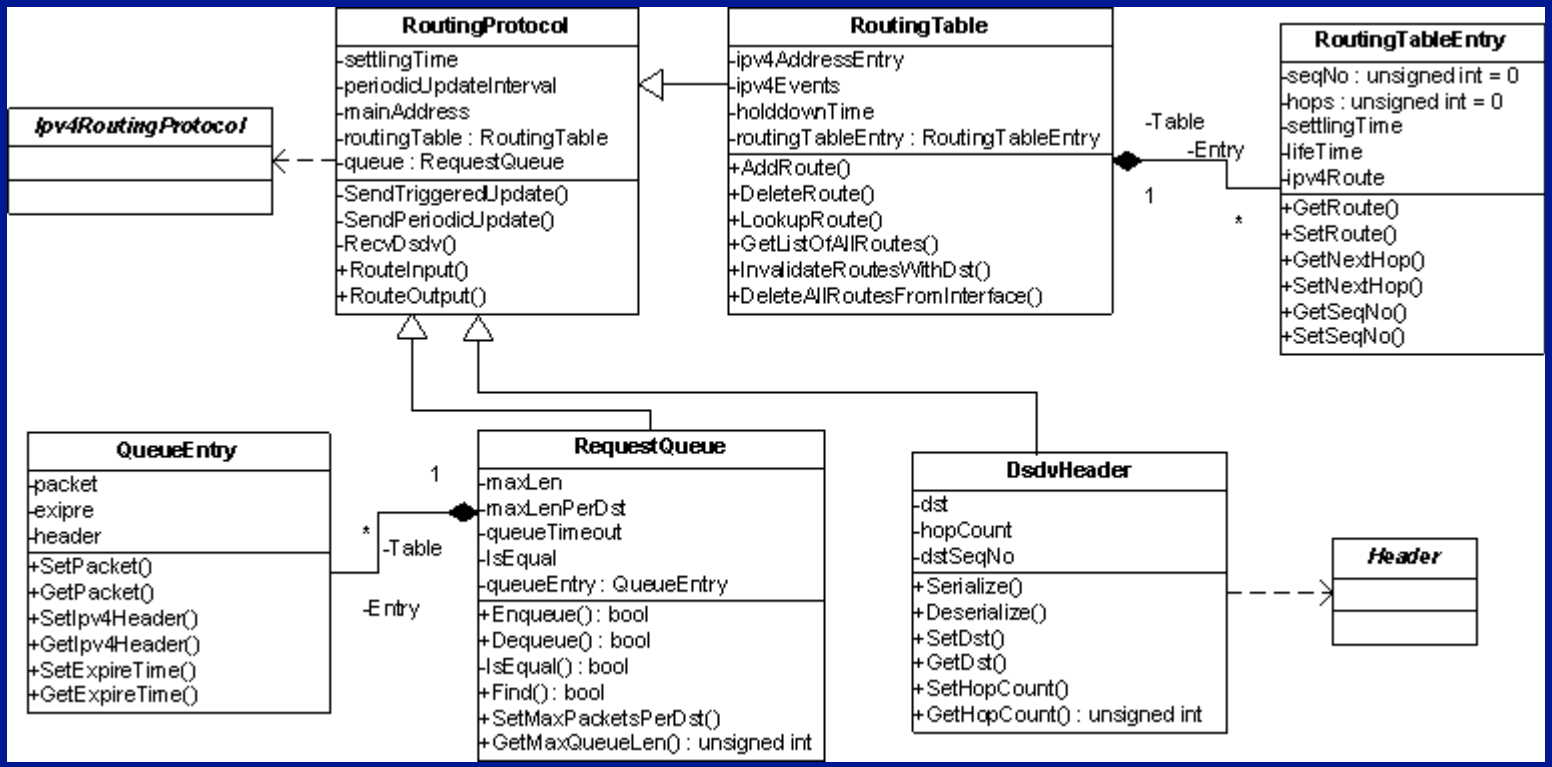
Implementation of DSDV in ns-3
DSDV Module for ns-3

- Introduction and motivation
- MANET routing protocols
- DSDV module for ns-3
- DSDV module evaluation
- Conclusions

DSDV Module for ns-3
Classes

- `DSDVHeader : Header`
  - DSDV header formats for sending control messages
- `RoutingProtocol : Ipv4RoutingProtocol`
  - entire protocol functionality
- `RoutingTable`
  - stores all updates received and is used for identifying routes
- `RequestQueue`
  - packet queue to store packets that do not have a route

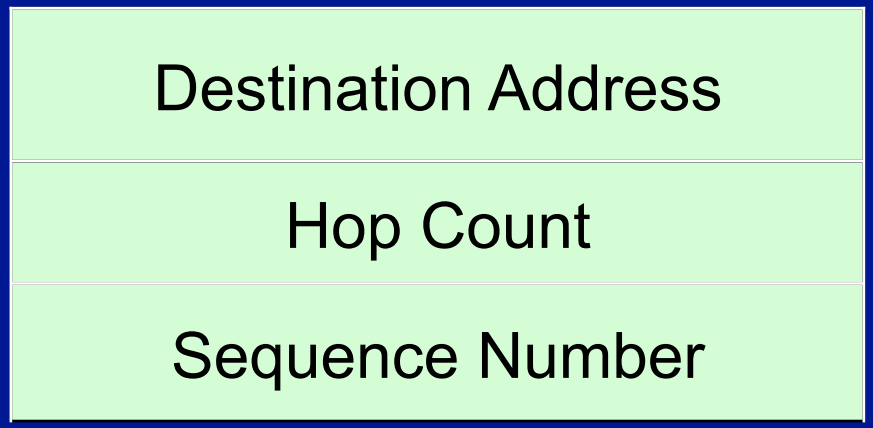
DSDV Module for ns-3
Class Interactions



- Interaction of DSDV classes with ns-3

DSDV Module for ns-3
Header

- DSDV header is 12 bytes long and 32 bit wide
  - to support simulations for large networks
  - for word alignment
- Contents
  - IP address
  - hop count
  - sequence number



DSDV Module for ns-3
Routing Table

- Creates an entry for every node based on IP address
- Attributes stored are:
  - IP address, interface address, sequence number, hop count, time for last received update, settling time
- Maintains two routing tables
  - permanent routing table
    - used for stable routes
  - advertising routing table
    - used for unstable routes
    - `SettlingTime` determines the stability of routes

DSDV Module for ns-3
Routing Advertisements

- Sends two type of update messages:
  - periodic updates
    - broadcasts entire routing table
    - sent for every periodic update interval
    - modified using attribute `PeriodicUpdateInterval`
  - triggered updates
    - broadcasts the changes since last `PeriodicUpdateInterval`
- Route aggregation
  - if enabled, aggregates updates and sends in a single packet
  - modified using the attribute `RouteAggregationTime`

DSDV Module for ns-3
Processing DSDV Updates$_1$

- A packet may contain multiple DSDV update msgs
- New updates may be re-broadcasted immediately
- If received sequence number is lower, discard update
- If received sequence number is greater:
  - received hop count not equal to local hop count
    - waits for `SettlingTime`, if enabled
  - received hop count equal to local hop count
    - broadcast the updates immediately

DSDV Module for ns-3
Processing DSDV Updates$_2$

- If received sequence number is equal:
  - received hop count < local hop count
    - wait for `SettlingTime`, if enabled and broadcast the update
  - received hop count greater than or equal to local hop count
    - discard the update
- Stale entries are removed
  - by receiving an update with odd sequence number
  - if there is no update received for,
    - `Holdtimes` × `PeriodicUpdateInterval` interval
    - `Holdtimes` is an integer value

DSDV Module for ns-3
Packet Buffering

- DSDV does not initiate route discovery mechanism
  - packets will be dropped if there is no route
- Buffering is implemented for fairer comparisons:
  - disruption-tolerant networks
  - domain-specific MANET routing protocols
- Buffering can be enabled using attribute
  - `EnableBuffering`
- Buffering can be controlled using attributes
  - `MaxQueuedPacketsPerDst`
  - `MaxQueueTime`

Implementation of DSDV in ns-3
DSDV Module Evaluation

- Introduction and motivation
- MANET routing protocols
- DSDV module for ns-3
- DSDV module evaluation
- Conclusions

DSDV Module Evaluation
Performance Metrics

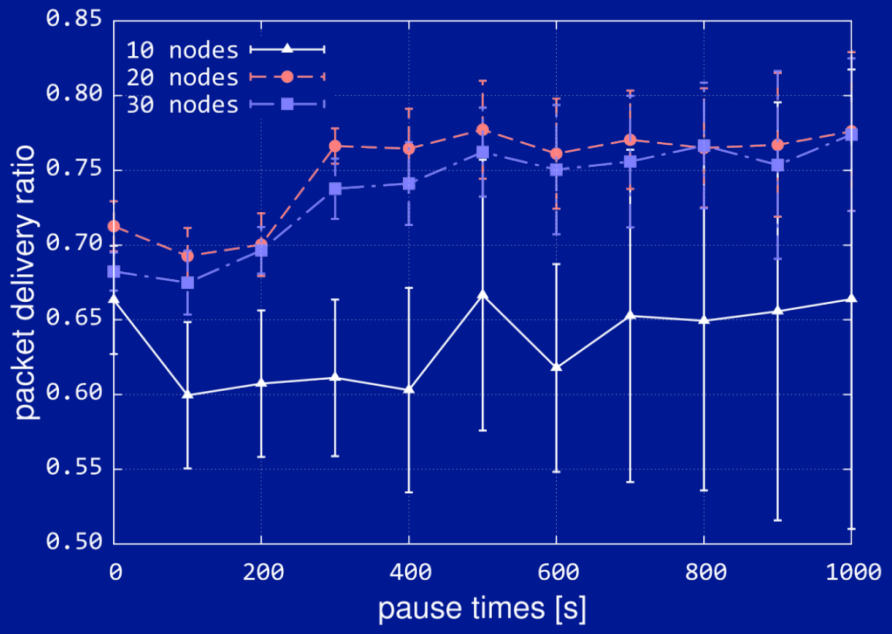
- Packet delivery ratio
  - number of packets received to those sent by application
- Routing overhead
  - fraction of bytes used by DSDV for control messages
- Delay
  - time taken to reach destination MAC from source MAC

DSDV Module Evaluation
Simulation Setup

- Simulation area: 1500 × 300 m^2
- Simulation time: 1000 s, warmup time: 100 s
- Packet size: 64 bytes
- Traffic type: CBR, Packet rate: 4 packets/s
- Link layer: 802.11b
- Transmission range: 250 m
- Mobility model: random waypoint
- Pause time: 0 – 800 s
- Velocities: 0 – 20 m/s

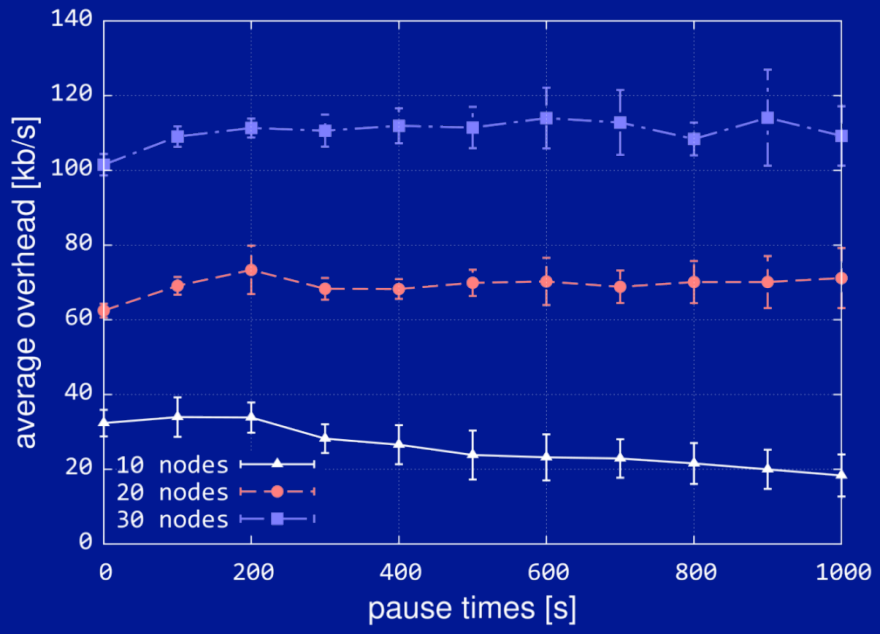
DSDV Module Evaluation

PDR with Varying Pause Time



- PDR increases with increase in number of nodes
- PDR for 20 nodes > 30; path churn & collisions

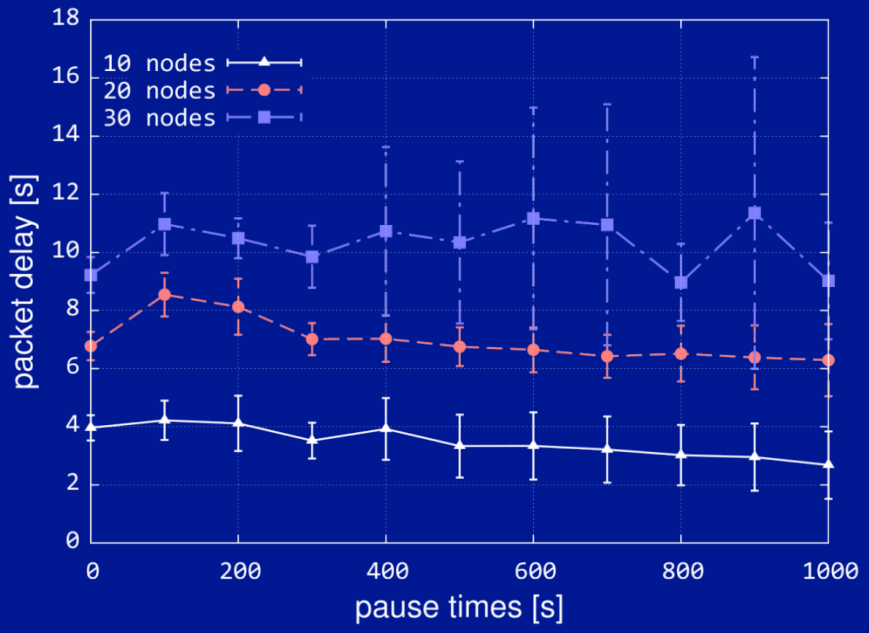
DSDV Module Evaluation
Overhead with Varying Pause Time



- Average overhead increases with number of nodes
  - sends more control messages as node density increases

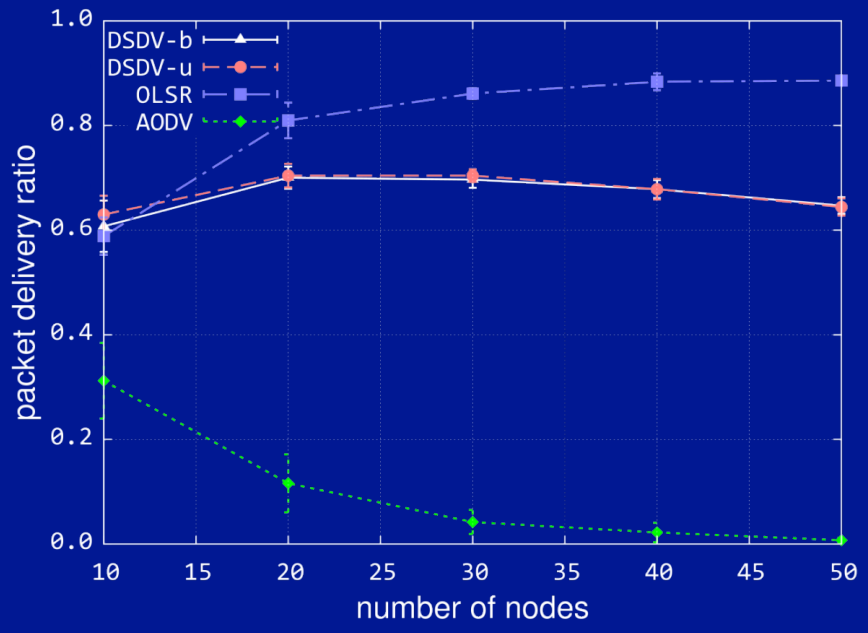
DSDV Module Evaluation

Packet Delay with Varying Pause Time



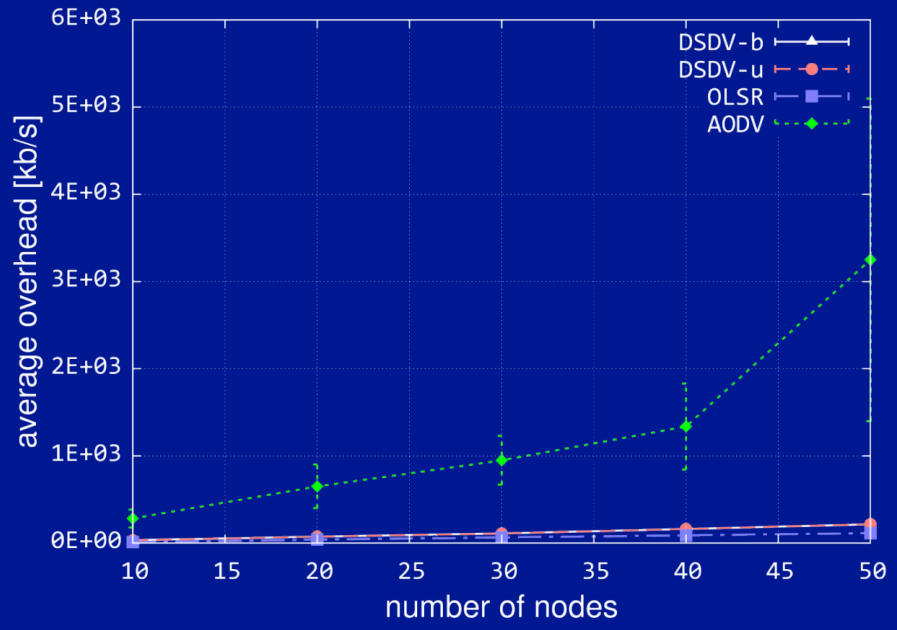
- As pause time increases nodes are immobile
  - for long durations affecting link connectivity

DSDV Module Evaluation
PDR with Varying Node Density



- OLSR outperforms AODV, DSDV-u, and DSDV-b
  - OLSR exchanges TC messages every 5 s
  - DSDV exchanges periodic update messages every 15 s

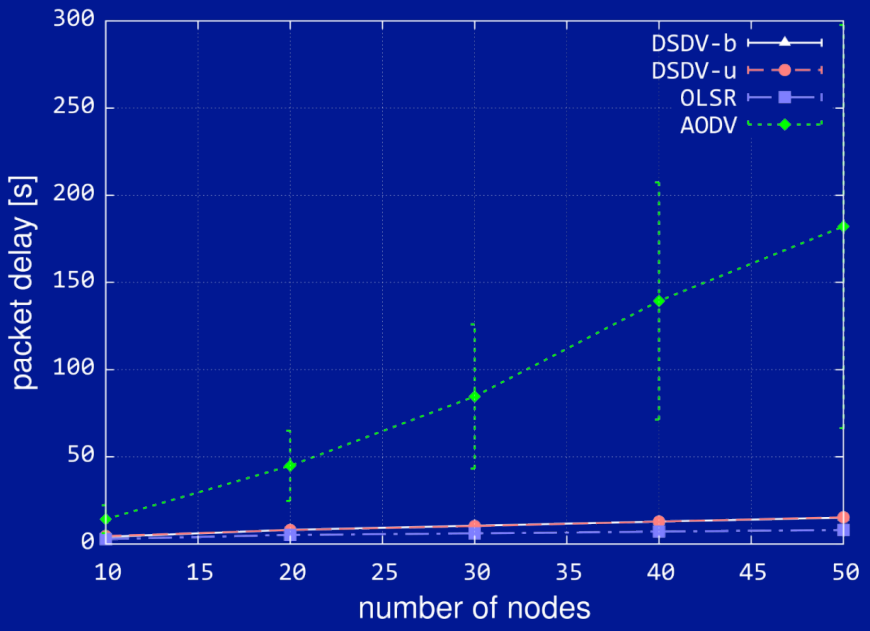
DSDV Module Evaluation
Overhead with Varying Node Density



- AODV incurs significantly more overhead
  - working with the ns-3 developer team

DSDV Module Evaluation

Packet Delay with Varying Node Density



- Packet delay slightly better for OLSR
- Both DSDV-u and DSDV-b have similar delay
  - as network is connected most of the time

Implementation of DSDV in ns-3
Conclusions

- Introduction and motivation
- MANET routing protocols
- DSDV module for ns-3
- DSDV module evaluation
- Conclusions

Conclusions

- Presented the implementation of DSDV in ns-3
- DSDV overhead is affected by the node count
  - PDR is inversely affected as the overhead increases
- DSDV included in ns-3.10
- ns-3 models coming soon!
  - DSR
  - HTTP
  - Simple TDMA MAC

Questions?

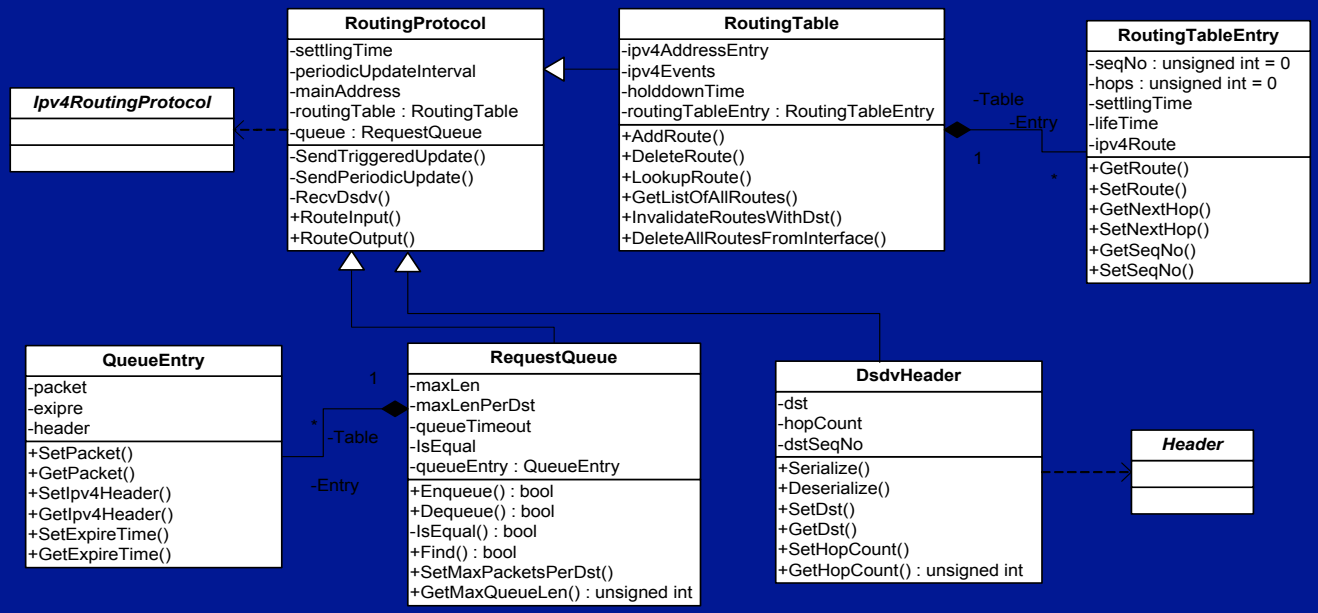
Acknowledgements

- Abdul Jabbar
- ResiliNets group at KU
- Tom Henderson
- ns-3 developers

References

- C. E. Perkins and P. Bhagwat, "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers", *ACM SIGCOMM*, pp. 234-244, 1994.
- OLSR – RFC 3626
- AODV – RFC 3561
- ns-3 network simulator, `http://www.nsnam.org`

DSDV Module for ns-3
Class Interactions



- Interaction of DSDV classes with ns-3