AODV Improvements and Measurements

Charles E. Perkins

Communication Systems Laboratory

Nokia Research Center

Mountain View, CA 94043

charliep@iprg.nokia.com

http://www.iprg.nokia.org/~charliep

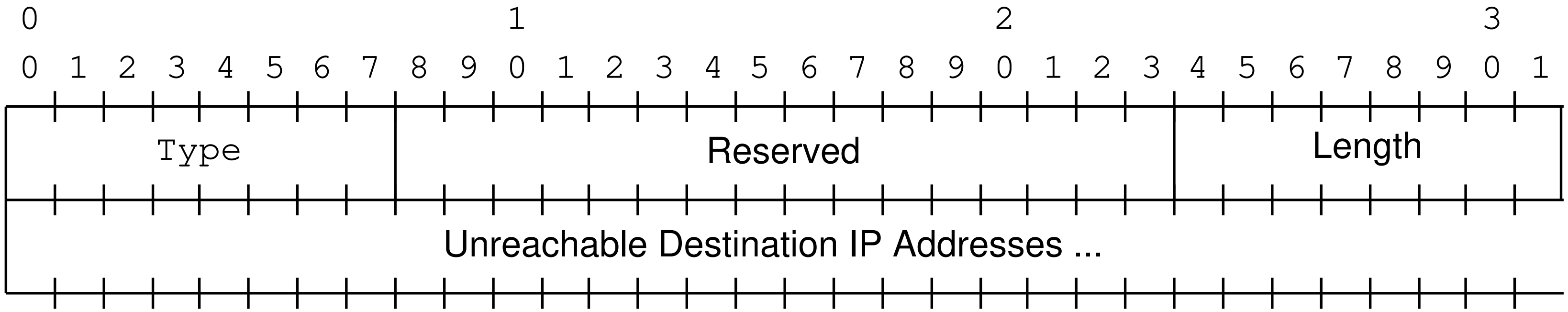
Work done with Samir Das and Elizabeth Royer

Presentation at http://www.iprg.nokia.org/~charliep/txt/ietf46/manet.ps

Outline of Presentation

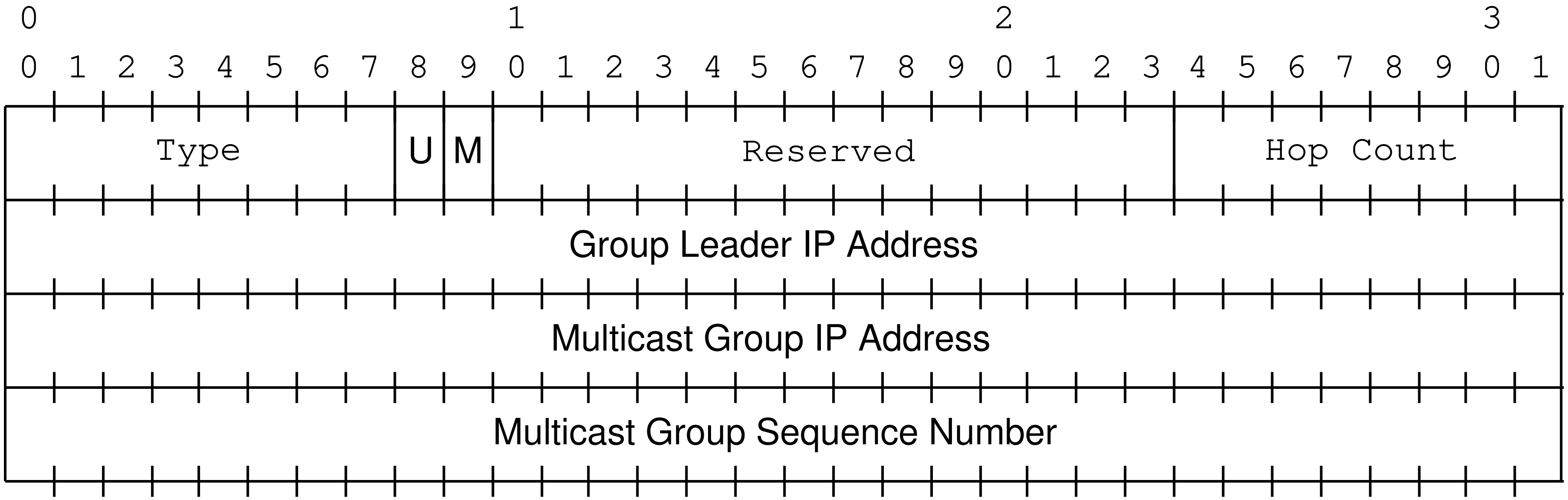
- RERR
- GRPH
- RREP
- Multicast
- Service Location
- New AODV Simulations on NS2 with CMU Wireless Extensions
- Ongoing Work on Reduction of AODV's Routing Load
- Key AODV vs. DSR Observations

RERR (Route Error)



- Used for reporting link breaks.
- Formerly done by RREP
- New format allows dissemination about each affected destination
- Typically broadcast into local neighborhood
- Rebroadcast only by precursor nodes

GRPH (Group Hello)



- New message type
- Formerly was performed by RREP, but message function was seen to be substantially different

RREP (Route Reply modification)

- Added Source IP address for programming convenience
- Added new section on forwarding

Multicast

- Inclusion of a Prune Timer after a link break in the multicast tree. (Section 10.8)
- Specification of action when multicast group leader wishes to leave the multicast group (Section 10.7)

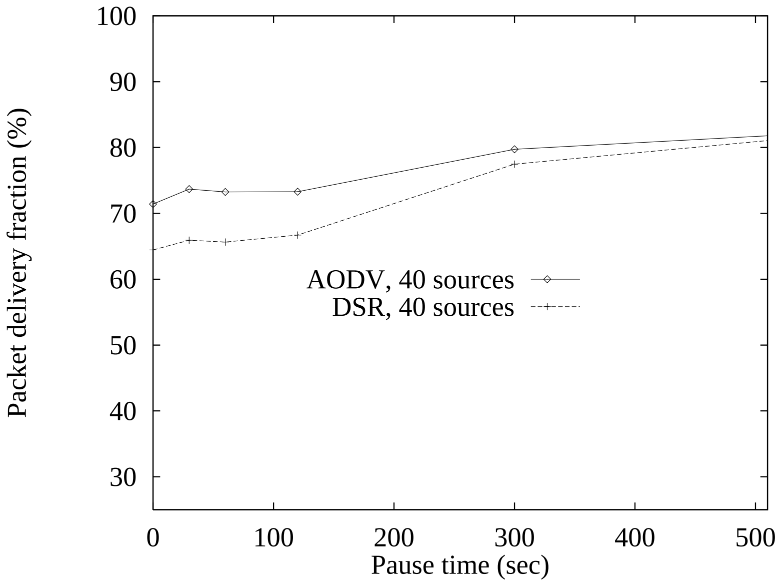
Service Location

- Removed function from base draft
- Needs to be a separate Internet draft, running at a different port

New AODV Simulations on NS2 with CMU Wireless Extensions

- 50 and 100 node simulations with various mobility and traffic scenarios
- AODV has better packet delivery fraction, throughput and end-to-end delay compared to DSR for
  - ⋆ Larger number of nodes.
  - ⋆ Higher traffic loads (more source-destination pairs, higher packet sending rate).
  - ⋆ Performance gap increases as the situation becomes more "challenging."

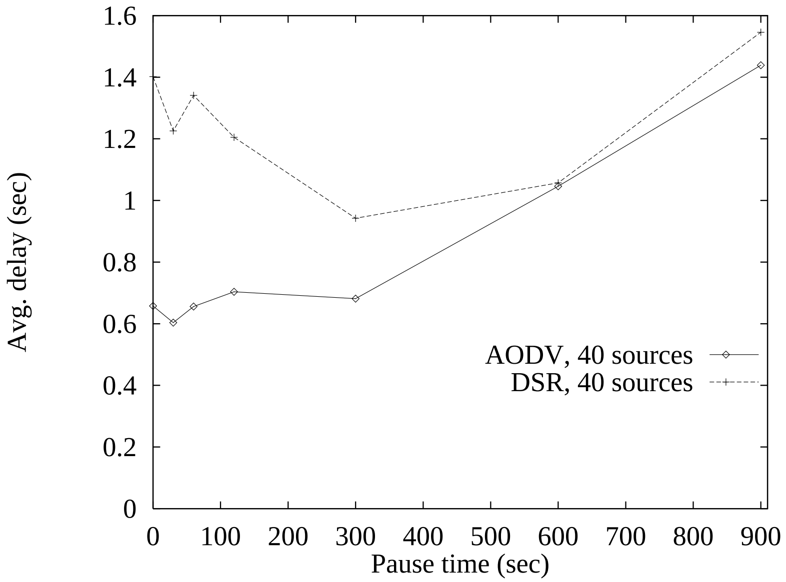
Packet Delivery Fraction Results (40 sources)



As pause time increases (tending towards less mobility), AODV and DSR begin to perform equally well

At higher mobility, AODV does better. The improvement increases with increasing node population

End to End Delay (50 nodes, 40 sources)



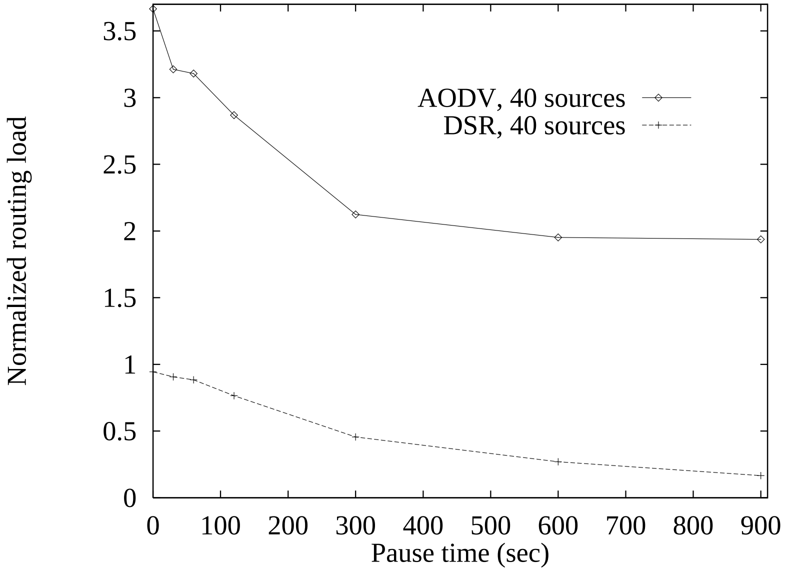
DSR still has lower delay than AODV in less challenging scenarios

- Smaller number of nodes and less traffic load.

AODV performs substantially better at greater mobility.

Again, this effect becomes more dramatic with increasing node population.

Routing Load (50 nodes, 40 sources)



AODV always has a higher routing load than DSR

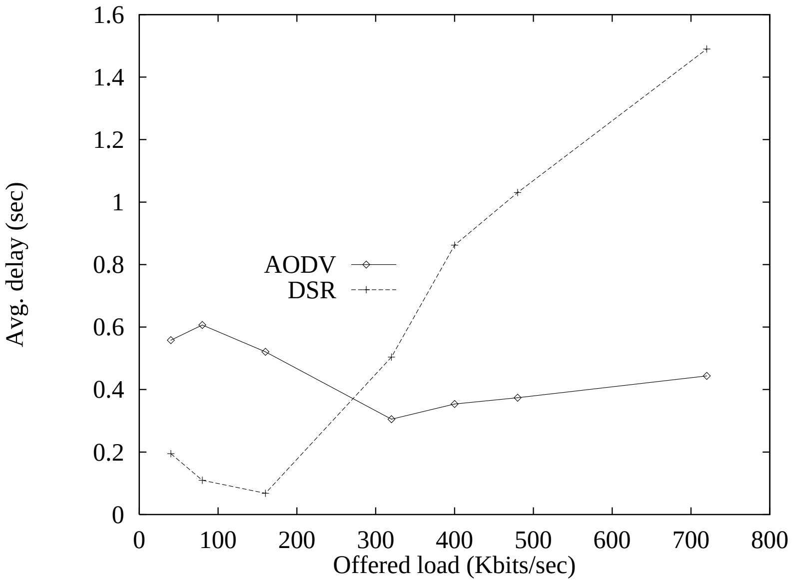
⋆ Seems not to hurt AODV's throughput and delay performance.

- effect diminishes with fewer sources or increasing node population (much less with 100 nodes).
- Note that DSDV is likely to do well at 50 nodes, 40 sources.

Ongoing Work on Reduction of AODV's Routing Load

- Use of query localization [MobiCom'99]
  - ⋆ Limits of route discovery flood within a "topological neighborhood" of the routes used in last ? time units.
  - ⋆ Neighborhood determined using an adaptive technique.
- Simulation study (100 nodes)
  - ⋆ 30-50% drop in routing load!
  - ⋆ 10-25% drop in end-to-end delay.
  - ⋆ Throughput virtually unaffected.

Load Effects on Delay (100 nodes, 10 sources)



At low loads, DSR offers better delay. As offered load increases, AODV's delay remains stable, but DSR's delay rises almost linearly.

Due to DSR's increased transmssion of RREP packets, causing more RTS/CTS/Data/ACK exchanges.

Key AODV vs. DSR Observations

- AODV
  - ⋆ Sequence numbers and route expiry timers are very helpful in maintaining up-to-date routing information.
- DSR
  - ⋆ Aggressive caching both helps and hurts.
  - ⋆ It reduces routing loads and delays, but prolongs stale routes.
  - ⋆ Multiple replies generate reply flood. Benefit unclear for larger networks.

MAC layer protocol design matters!