More Efficient Routing Algorithm for Ad Hoc Network

ENSC 835: HIGH-PERFORMANCE NETWORKS

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Outline

- Quick Overview of Ad hoc Networks
- AODV Routing Protocols
- Motivation
- Multipoint Relays Select techniques
- Implementation and Challenges
- NS2 Simulation Environment and Results
- Conclusion and Future Works
Wireless Ad Hoc Networks

Present Mobile Communication  Wireless Ad Hoc Network

Wireless LAN

Base station or access point recognizes terminal location and decides communication route.

- No infrastructure (base station, access point)
  - Network anywhere
    - (disaster stricken area, stadium)
- Key technologies
  - Routing algorithm
  - Adaptation to network topology change
  - Efficiency in frequency and power
Mobile Ad Hoc Networks (MANET)

- Host movement frequent
- Topology change frequent

- No cellular infrastructure. Multi-hop wireless links may need to traverse multiple links to reach destination
- Data must be routed via intermediate nodes.
Unicast Routing Protocols

- Many protocols have been proposed
- Some specifically invented for MANET
- Others adapted from protocols for wired networks
- No single protocol works well in all environments
  - some attempts made to develop adaptive/hybrid protocols
- Standardization efforts in IETF
  - MANET, MobileIP working groups
  - http://www.ietf.org

MANE: Mobile Ad Hoc Networks
Existing Ad Hoc Routing Protocols

Ad Hoc Routing Protocols

- Proactive
  - Table driven
    - DSDV
    - OSLR
    - WRP
    - ZRP

- Hybrid
  - Hybrid

- Reactive
  - Source-initiated
    - on-demand
      - AODV
      - DSR
      - TORA
      - ABR
      - SSR
Routing Protocols

- **Proactive protocols**
  - Traditional distributed shortest-path protocols
  - Maintain routes between every host pair at all times
  - Based on periodic updates; High routing overhead
  - Example: DSDV (destination sequenced distance vector)

- **Reactive protocols**
  - Determine route if and when needed
  - Source initiates route discovery
  - Example: DSR (dynamic source routing)

- **Hybrid protocols**
  - Adaptive; Combination of proactive and reactive
  - Example: ZRP (zone routing protocol)
Protocol Trade-offs

- **Proactive protocols**
  - Always maintain routes
  - Little or no delay for route determination
  - Consume bandwidth to keep routes up-to-date
  - Maintain routes which may never be used

- **Reactive protocols**
  - Lower overhead since routes are determined on demand
  - Significant delay in route determination
  - Employ flooding (global search)
  - Control traffic may be bursty

- Which approach achieves a better trade-off depends on the traffic and mobility patterns
Ad Hoc On-Demand Distance Vector Routing (AODV)

- Route Requests (RREQ) are flooded through entire network searching for destination
- When a node re-broadcasts a Route Request, it sets up a reverse path pointing towards the source
  - AODV assumes symmetric (bi-directional) links
- When the intended destination receives a Route Request, it replies by sending a Route Reply (RREP)
- Route Reply travels along the reverse path set-up when Route Request is forwarded
Route Requests in AODV

Represents a node that has received RREQ for D from S
Route Requests in AODV

Broadcast transmission

Represents transmission of RREQ
Route Requests in AODV

Represents links on Reverse Path
Node C receives RREQ from G and H, but does not forward it again, because node C has already forwarded RREQ once.
Reverse Path Setup in AODV
Node D does not forward RREQ, because node D is the intended target of the RREQ.
Forward Path Setup in AODV

Forward links are setup when RREP travels along the reverse path

Represents a link on the forward path
Motivations

The Lack of Scalability of AODV:

- As the number of source-destination pairs increases
  - Major control overhead of AODV is caused by “Route Query” flood packets
  - Routing overhead is proportional to the number of route queries

- As the given traffic becomes heavy
  - Heavy routing overhead causes significant effective throughput degradation

AODV : Ad Hoc On-Demand Distance Vector Routing
Proposed Modification

- Reduce routing overhead of AODV using **Efficient Flooding (Selective Flooding)**
- What’s efficient flooding?
  - Only a subset of nodes (dominating nodes) forwards a Route Query flood packet
  - In contrast, in blind flooding all nodes relay each packet at most once
- How to choose dominant nodes?
  - Multipoint Relay Sets (MPRs)

AODV : Ad Hoc On-Demand Distance Vector Routing
Multipoint Relay (MPR)

- The Concept of MPR is to reduce the number of duplicated retransmissions while forwarding a broadcast packet.
- Multipoint relay set (MPRs): subset of a node’s 1-hop neighbors, such that each of its 2-hop neighbors is a 1-hop neighbor of a node in the MPR set.
Multipoint Relay

- A node selects its Multipoint relays with two rules:
  - Any 2-hop neighbors must be covered by at least one multipoint relay
  - Try to minimize the multipoint relay set
- Note that each node independently determines its own MPR set (no global “network MPR set”)
- A node forward a flooding packet with the following rules:
  - The packet has not yet been received.
  - The node is multipoint relay of last emitter
Multipoint Relay

Diffusion of broadcast message using pure flooding

24 retransmissions to diffuse a message up to 3-hops
Multipoint Relay

Diffusion of broadcast message using multipoint relays
Implementation

The algorithm for calculating the multipoint relay table is shown below:

1. Find all 2-hop neighbors that can only be reached by one 1-hop neighbor. Assign those 1-hop neighbors as MPRs.
2. Determine the resultant cover set (i.e., the set of 2-hop neighbors that will receive the packet from the current MPR set).
3. From the remaining 1-hop neighbors not yet in the MPR set, find the one that would cover the most 2-hop neighbors not in the cover set.
4. Repeat from step 2 until all 2-hop neighbors are covered.

(MPR): Multipoint Relay
Implementation

2-Hop neighbor Table

Can only be reached by one 1-hop neighbors?

Yes

More Nodes?

Yes

Remove the nodes from table

Yes

Will the 2-hop neighbor be covered by this MPR?

Yes

Move this 1-hop node to MPR table

Find a node covers the most 2-hop nodes?
Challenges

- Because of the nature of Ad Hoc network, nodes are moving constantly. We have to keep updating each node’s movement and their neighbors.
- Each node must have the 1-hop and 2-hop neighbor information at any given time.
- This information can only be obtained by exchanging message periodically.
NS2 Simulation Environment

- Simulator: NS2-2.26
- Operating System: Linux
- Network Area: 900 * 900 meters
- Number of nodes simulated: 10, 50, 100, 150
- Max. pause time: 10s
- Max. speed: 20m/s
Results

![Graph showing the average end-to-end delay for AODV and AODV+MPR against the number of nodes.](image)
The graph shows the relationship between the number of nodes and the packets delivering ratio for two different protocols: AODV and AODV+MPR. The x-axis represents the number of nodes, while the y-axis represents the packets delivering ratio. As the number of nodes increases, the packets delivering ratio for AODV decreases, whereas for AODV+MPR, it increases.
Conclusion

- Our simulations show the MPR technique improves AODV protocol significantly by reducing the overhead and delay in dense node networks.
- With this technique, AODV can achieve better package delivery ratio.

MPR: Multipoint Relay

AODV: Ad Hoc On-Demand Distance Vector Routing
Future Works

- The AODV protocol can be further optimized by applying other techniques such as probability based methods or location based methods
References


Thank you!

Any Questions And Comments?