Robust and Scalable Geographic Multicast Protocol for Mobile Ad Hoc Networks

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Outline

- Introduction
- Related Work
- Robust and Scalable Geographic Multicast Protocol
- Performance Evaluation
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Introduction

- Group communications are important in Mobile Ad Hoc Networks (MANET)

Overhead
- Route searching
- Group membership management
- Tree/mesh structure maintenance
MANET unicast routing

- Geographic routing protocols
- Mobile node are aware of their own positions
- Source can obtain the destination’s position
- Forwarding decision
  - Destination’s position
  - One-hop neighbor’s positions learnt from periodic beaconing of the neighbors
Related Work

- Conventional topology-based multicast protocol
  - ODMRP (on-demand multicast routing protocol)
    - Maintenance of a tree-based multicast structure
    - Multicast packet forwarding

- Geographic multicast protocol
  - [6,7,8] is only applicable for small group
    - Packet header
Robust and Scalable Geographic Multicast protocol

- RSGM supports a two-tier membership management and forwarding structure
- RSGM assume every node is aware of its own position

pos: A mobile node’s position (x,y)
zone: The network terrain is divided into square zones
mZone: Member zone
zLdr: Zone leader
hZone: Home zone. To keep track of the addresses and locations of sources
mcastTable: A node records the multicast information in its mcastTable. A mcastTable contains a list of group entries and hZone information. Each group entry saves the information of a group: groupID, source list, member list, and mZone list
Zone Structure

- Mobile nodes
- Group members
- Zone leader
- Member zone

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Zone Construction

\[ a = \left\lfloor \frac{x-x_0}{\text{zone\_size}} \right\rfloor = \left\lfloor \frac{(100-0)/55} \right\rfloor = 1 \]

\[ b = \left\lfloor \frac{y-y_0}{\text{zone\_size}} \right\rfloor = \left\lfloor \frac{(100-0)/55} \right\rfloor = 1 \]

\[ x_c = x_0 + (a+0.5) \times \text{zone\_size} \]
\[ y_c = y_0 + (b+0.5) \times \text{zone\_size} \]

(zID (a,b) = (1,1))
On-demand leader election

- Fail to get zLdr information
- Query LEADER message
- Intval refresh
Local group membership management

- When joining or leaving a group, a member M sends a message \text{REFRESH} ( \text{groupId}s, \text{pos}_M ) immediately to its zLdr to notify its membership change.

- A member record will be removed by the zLdr if not refreshed for longer than \( 2 \times \text{Intval}_{\text{refresh}} \).
Local group membership management

Shorter than a distance threshold
Membership management at network range

- When a zone changes from mZone to non_mZone or vice versa, zLdr sends a REPORT immediately to S to notify the change.
- S will remove a mZone record if not refreshed longer than $2 \times \text{Intval}_{\text{zone}}$.
- Empty zone handling.
Message aggregation

- S schedules the periodic REPORT sending for the mZones. S inserts the next reporting time $t$ into the data packets.
- The zLdr of a mZone schedules its next periodic REPORT to S at the time $t + \Delta t$.
- The zLdr will form an upstream and downstream relationship according to their distances to S.
Session initialization

- To start a multicast session, $S$ floods an ANNOUNCE ($S$, $\text{pos}_S$, groupIDs) into the network by broadcasting.

- After session begins, $S$ can piggybacks its position ($\text{pos}_S$) to the multicast packets sent out to refresh its position at the receivers.
Source tracking

- S will announce its current zone as hZone by inserting its \texttt{zID} and \texttt{seqNO} of hZone in the ANNOUNCE to be flooded into the network.
- Whenever a source moves to a new zone, it unicasts a REGISTER (\texttt{zID$_{new}$}) to hZone.
- A zLdr will send REPORT to hZone if it doesn’t know S’s address or the source address maintained is outdated.
hZone

\[ zLdr \]

\[ S \]

\[ \text{REGISTER}(zIDnew) \]

\[ \text{REPORT} \]

\[ zLdr \]

\[ \text{REPORT} \]

\[ zLdr \]
Multicast Packet Delivery

- S sends each multicast packet to all the mZones, and to the member nodes in its own zone through zLdr
- For robust transmissions, geographic unicast is used in packet forwarding
Performance Evaluation

- **Joining interval**: 4s
- **Interval zone**: 6s
- **Interval refresh**: 4s

400 random node
100 member node
Zone size 400 m
Area 2400m*2400m
Performance Evaluation

(c) Avg. end to end path length vs. Maximum moving speed (m/s)

(d) Avg. joining delay (s) vs. Maximum moving speed (m/s)
Conclusions

- In RSGM, both the data packets and control messages will be transmitted along efficient tree-shape paths without the need of maintaining a tree structure.
- Scalable membership management is achieved through a zone structure.
- A home zone can avoid the periodic network-range flooding of source information.