Chapter 11. SOM: Spiral-Fat-Tree-Based On-Demand Multicast Protocol in a Wireless Ad-Hoc Network

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Presents this
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to
Yuh-Shyan Chen, Tzung-Shi Chen,
and Ching-Jang Hung

for the paper entitled
SOM: Spiral-Fat-Tree-Based on-Demand Multicast Protocol in a Wireless Ad-Hoc Network

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Outline

I. Introduction
II. Basic Idea
III. Our Proposed Protocol
IV. Performance Evaluation
V. Conclusion
I. Introduction

- Propose a new **multicast protocol** in the **Mobile Ad-hoc NETwork (MANET)**

- Develop a **simulation platform** to evaluate the performance of our protocol
Mobile Ad-Hoc Network

- **Mobile Ad-hoc NETwork (MANET)**
  - Formed by wireless hosts which may be **mobile**
  - Without (necessarily) using a **pre-existing infrastructure**
  - Routes between nodes may potentially contain **multiple hops**

- **Design Difficulty:**
  - **Node mobility**
    - Topology is changeable
Existing Multicast Protocols

- **Tree-based** multicast protocols
  - There is only path from source to destination

- **Mesh-based** multicast protocols
  - Source to destination has two or more paths
Classification of Multicast

- **Proactive Multicasting Protocol**
  - Pre-Build a Shared Multicast-Tree

- **Reactive Multicast Protocol**
  - On-Demand to Construct a Multicast-Tree
## A Comparison Table

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Proactive/Reactive</th>
<th>Multi-Path</th>
<th>Location-Aware</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBT</td>
<td>Proactive</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>AODV</td>
<td>Reactive</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>DVMRP</td>
<td>Reactive</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Tree-based multicast protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAMP</td>
<td>Proactive</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>FGMP</td>
<td>Reactive</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>ODMRP</td>
<td>Reactive</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ours(SOM)</td>
<td>Reactive</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Mesh-based multicast protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tree-Based Approach

- **CBT** [ACM SIGCOMM 93]
  - Core Base Tree protocol
  - Proactive

- **AODV** [Mobicom 99]
  - Ad hoc On Demand Distance Vector protocol
  - Reactive (or called as On-Demand)

- **DVMRP** [ACM Transactions on Computer Systems]
  - Distance Vector Multicast Routing Protocol
  - Reactive
Mesh-Based Approach

- **FGMP** [Cluster Computer 1998]
  - Forwarding Group Multicast Protocol
  - Reactive

- **ODMRP** [IEEE 8-th ICCCN ‘99]
  - On-Demand Multicast Routing Protocol
  - Reactive

- All on-demand protocols are implemented and compared in our simulator.
Drawback of Existing Protocols

- Existing on-demand protocol wastes heavy **Blind-Flood** packets

- **Reconfigure** multicast-tree frequently
  - Due to the problem of **node mobility**
The robustness of multicast-tree of existing reactive protocols is weak

The motivation of this paper is to enhance the robustness of multicast-tree
Contribution

This paper presents a special multi-path approach
  ● to enhance the robustness of multicast-tree

Propose the Spiral-Fat-Tree-based scheme
  ● Advantage: reduce the probability of re-configuration of multicast-tree
II. Base idea

The basic idea of Spiral-Fat-Tree-Based Scheme is

- Spiral-Path
- Spiral-Tree
- Spiral-Fat-Tree
A special robust-path (spiral-path) is adopted.

- This idea originated by our previous paper, which has been presented in *IEEE ICCCN 2000*, Las Vegas, U.S.A.
- To appear in *IEICE Trans. on Communications*.

Using the spiral-path to possibly construct a robust fat-tree structure.
A path

Source  Primary Path  Destination
Spiral-Path

Primary Path

Backup Path

Backup Path
A Tree Structure

(a)  

(b)  

Root
A Fat-Tree Structure
Spiral-Tree

(a)

(b)
Spiral-Fat-Tree

Root
III. Our SOM (Multicast) Protocol

- Step 1: Identify the Branch-Node
- Step 2: Construct the Spiral-Fat-Tree
- Step 3: Maintain the Spiral-Fat-Tree
Step 1: Identify the Branch-Node

- Each node periodically sends *Beacon message* within 2-hops.

- A node is said as a branch-node if there exists at least two distinct paths from a same node.
Branch-Node

Beacon message

\[ \text{Click}_{1,2} = 4 \]

\[ \text{TwoHopPath}_{1,2} = 3, 5, 4, 6 \]

\[ \text{BranchNode} = \text{True} \]
Step 2: Construct the Spiral-Fat-Tree

- **Multi-Path Searching** Phase
- **Multi-Path Merging** Phase
Multiple-Path Searching Phase

[Diagram showing a network with nodes labeled 1 to 18, and arrows indicating communication paths. Nodes are connected by paths labeled with counters and RREQ or MREQ messages.]
Merging Criterion

(a) Source node

(b) Source node

(c) Source node
A Possible Spiral-Fat-Tree
Step 3: Multicast-Tree Maintenance

- A node is said as a **failed node** if the node is moving out the original transmission radius
Case 1: The failed node is not a merged node
Case 2: The failed node is the merging node
IV. Performance Evaluation

Simulation environment

- Can choose 50, 75, 100 nodes in 500*500 meters
- Transmitter range can be 50, 100, 150 meters
- 1 source v.s. 4~12 destination nodes
- Speed 10~100 km/hr
- Five protocols are implemented and compared.
  - AODV, DVMPR, FGMP, ODMRP, and SOM.
Performance Metrics

- **RE (REachability)**
  - The number of all destination nodes receiving the data message divided by the total number of all destination hosts that are reachable, directly or indirectly, from the source host.

- **RB (ReBroadcast)**
  - The number of REQUEST packets for all mobile hosts in MANET.

- **AL (Average Latency)**
  - The interval from the time the multicast was initiated to the time the last host finishing its multicasting.
Performance of REEachability (RE)

- An efficient multicast protocol is achieved by with high REEachability (RE)
Performance of REAchability v.s. effect of Number of Mobile Hosts
Performance of REAchability vs. effect of Transmission Radius
Performance of **ReBroadcast**

- An efficient multicast protocol is achieved by with **low ReBroadcast (RB)**
Performance of ReBroadcast vs. effect of Number of Mobile Hosts
Performance of **ReBroadcast** vs. **effect of Transmission Radius**
Performance of Average Latency

- An efficient multicast protocol is achieved by with low Average Latency (AL)
Performance of **Average Latency** vs. Effect of Mobility
Performance of **Average Latency** vs. Effect of Number of Message Length
Performance of **Average Latency** vs. Effect of Number of Destination Nodes
Performance of **Average Latency** vs. Effect of Mobility with Number of Destination Nodes
V. Conclusion

- This paper proposes a novel multicast routing (SOM) Protocol
  - Spiral-path-based scheme
- Our proposed protocol is truly efficient evaluated by our developed simulation platform

Current Work
- Develop a QoS Routing Protocol using Spial-Path-Based Scheme
Homework #11:

1. What’s multicast routing protocol in MANETs?