Improving the Performance of Path Discoveries in Dense Mobile Ad Hoc Networks

IEEE CQR 2006, June 7 2006

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Agenda

• Introduction
• Proposal
• Performance evaluation
• Conclusion
“An ad hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration.”

- Does not use network infrastructure: autonomous, P2P
- Dynamic (Changing) network topology wireless and mobile environments
- Multi-hop network

Ad-Hoc network is one of key techniques to provide small devices with ubiquitous networking/computing
Applications of Ad-hoc Network  

Introduction (2)

- **Military**
  Communication: Soldier, Tank, Battleship, Fighter

- **Disaster**
  Emergency call, Shelter inducement during Earthquake, Tidal wave, Flood, Typhoon

- **New services over PAN (Personal Area Network)**
  Management of commodity warehouse, Construction work site, Shopping Mall
  Navigation at Event Place

- **ITS (Intelligent Transport System)**
  Congestion information flooding among cars
  Information retrieval from road side to car
Ad-hoc Network Structure

Introduction (3)

Node: PC, PDA and so on

Communication Area: IEEE 802.1b, Bluetooth and so on

Path Discovery and Forwarding
AODV (Ad hoc On-demand Distance Vector algorithm)

- Reactive (On-demand)
  Route is established at communication request time
  RREQ (Route request) packets are broadcast to all areas repeatedly until they reached to the destination

![Diagram of AODV routing]

- Source
- Broadcast
- Destination

- Source

\[\rightarrow: RREQ\ packet\]

\[\rightarrow: RREP\ packet\]
Overhead of re-broadcasting Proposal (2)

- Results in AODV
  - NS2 simulation
- Low path discovery success ratio because of …
  - Isolated nodes
  - Overhead of re-broadcasting

![Graph showing the relationship between number of nodes and success ratio of path discoveries.](image)

Not our focus

Our focus

Dense
Goal Proposal (3)

Requirements
• To decrease the number of broadcast packets
• To keep success ratio of path discoveries
• Not to use new control packets

Approach
• Re-broadcast control packets stochastically
  Not all RREQ packets are not broadcast
• **Need to determine the appropriate probability**
  – Decrease re-broadcasting
    • *Not* too relaxed
    • *Not* too rigid

• **Determine the probability according to these two metrics**
  – Node density: No. of received control packets
  – Path concentration: No. of active routes

• **Policy**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Probability</th>
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<tbody>
<tr>
<td>Node density</td>
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<tr>
<td>High</td>
<td>Low</td>
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<tr>
<td>Low</td>
<td>High</td>
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<td>Path concentration</td>
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<td>High</td>
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<td>Low</td>
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Metrics for re-broadcasting Proposal (5)

Node $k$ counts:
- No. of packets adjacent nodes broadcast: $\overline{N}_k$
- No. of active routes the node accommodates: $L_k$
Path Discovery in Proposed Method Proposal (6)

Each node counts:
- No. of packets: $N_k$
- No. of routes: $L_k$

Metric of node density
Metric of path concentration

Rebroadcast control packet with probability $p(k)$

$$p(k) = \min[\max(0, 1 - \alpha L_k + A_k), 1]$$

$$A_k = \begin{cases} -\beta & \text{if } N_k > \theta_h \\ +\beta & \text{if } N_k \leq \theta_l \\ 0 & \text{otherwise} \end{cases}$$
Simulation 1 Performance Evaluation (1)

• Compare our proposed method with AODV
• NS-2 simulation
  – Wireless I/F: IEEE 802.11
  – Simulation field: 250mx1000m
  – 64kbps CBR traffic
  – No. of nodes: 120, 60
• Focus on the effects of the two metrics
  – Node density
  – Path concentration
• $\theta_h$ decides “re-broadcast stochastically or not”
• If the metric $> \theta_h$, the probability $= 1 - \beta$
• AODV succeeds in path discoveries with about 77%
• As $\beta$ increases
  – No. of RREQs decreases
  – $\theta_h = 0.5 \Rightarrow$ The success ratio decreases = too rigid
  – $\theta_h = 10$: Improve the success ratio

\[
p(k) = \min\left[\max\left(0, 1 - \alpha L_k + A_k\right), 1\right]
\]

\[
A_k = \begin{cases} 
-\beta & \text{if } \bar{N}_k > \theta_h \\
+\beta & \text{if } \bar{N}_k \leq \theta_l \\
0 & \text{otherwise}
\end{cases}
\]

$\alpha = 0$, $\theta_l = 0$

$p(k)$ depends on $\beta$ and $\theta_h$
Mobile nodes  Performance Evaluation (3)

- Our proposed method
  - Decrease No. of RREQs
  - Keep success ratio
- Impact of $\omega$
  - Middle $\omega$ obtains the best performance

To consider convergence of the metric
  - $\omega$ is the key parameter of the node density metric
    - $\bar{N}_k = \omega N_k + (1-\omega)N_{k-1}$
Conclusion

• Proposed efficient on-demand routing method for dense ad-hoc networks
  – Re-broadcast control packets
• Showed simulation results
  – Improve the performance of path discoveries by our proposed method