Performance Evaluation Of Mobile Ad Hoc Networks

Kalyan Kalepu
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Committee
Dr. Chansu Yu
Dr. Dan Simon
Dr. Yongjian Fu

Outline

- Introduction
- Background on MANET Routing Protocols
- AODV
- Motivation
- Issues addressed in this Thesis
- Experimental Evaluation
- Simulation
- Conclusion
**Introduction**

**Ad Hoc Networking**

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**MANET**

- **What is a MANET?**
  - Mobile nodes, Wireless links
  - Infrastructure less: by the nodes...
  - Multi-hop routing: ...for the nodes
  - Minimal administration: no hassles
Background on MANET Routing Protocols

- Routing protocols for MANETs is divided into two types
  - Proactive routing protocol – Table driven
    - DSDV
  - Reactive routing protocol – On demand
    - DSR, AODV (DSR+DSDV)
Ad hoc On-Demand Distance Vector (AODV)

- Initial design of AODV was undertaken to improve upon the deficiencies in DSDV.
- AODV reduces the need for system-wide broadcasts to counter the problems due to the characteristics of wireless medium.
- AODV found it necessary to incorporate the on-demand route discovery and route maintenance mechanisms from DSR.

Destination Sequenced Distance Vector (DSDV)

- DSDV is derived from Distributed Bellman-Ford (DBF) algorithm.
  - DBF was designed for wired networks, so when used in wireless networks routing loops are formed.
  - Enhancements are made in DSDV to counter looping problem.
Formation of Loops when DBF is used

- X-Y-Z are connected in a triangle
- X-Z link is highly unstable
- If Y-Z link fails for a short period, it causes a routing loop Y-X-Y-Z

DSDV uses the sequence numbers to remove stale routes from the routing table of each node

- S(X) and S(Y) are the destination sequence numbers stored at node X and node Y respectively
  - If S(X) < S(Y), node X does not update routes
  - If S(X) = S(Y), node X checks for lower metric
  - If S(X) < S(Y), node X updates accordingly
Dynamic Source Routing (DSR)

- On-demand Route Discovery mechanism

**AODV**

- Uses two mechanisms for routing
  - **Route Discovery** – This mechanism is invoked when a source node has data to send
    - Route request (RREQ) – Broadcasts in search for a destination
    - Route reply (RREP) – Unicast packet by the destination/intermediate node
  - **Route Maintenance** – This mechanism responds to link failures
    - Route error (RERR) – Broadcast packet when a link fails
Contd...

Motivation

- In a Mobile Ad Hoc Network (MANET), the surrounding physical environment is an important element to be considered for its deployment.
- It is necessary to evaluate MANET in real world scenarios before actually using it in the commercial world.
Issues Addressed in this Thesis

- Comparing two MANET implementations
- Comparing the performance of MANET in an indoor/outdoor environment
- Key parameters in determining MANET performance
- Differences between simulations and the real world
- Analyzing the effects of interference in a small MANET using simulation

Experimental Evaluation

- Survey of Existing AODV Implementations
- Experimental Environment
- Evaluation Tool
- Results & Discussion
Survey of Exiting AODV Implementations

- User space implementation
  - Mad-hoc, AODV-UIUC, AODV-UU, AODV-UCSB

- Kernel space implementation
  - Kernel-AODV

Contd....

- Kernel space implementations
  - Less portable
  - Weakens memory management

- AODV-UU and AODV-UCSB were chosen
Contd....

- AODV-UU and AODV-UCSB are written in Linux and C
- Logical structure of both is the same
- AODV-UU supports *unidirectional-link avoidance*

Experimental Environment

- Experiments were conducted for static and mobile scenarios in indoor and outdoor environment
  - Static scenario - varying packet sizes
  - Mobile scenario - walking speed, fixed packet size
Performance Metrics

- Throughput – It is defined as the amount of data successfully delivered from the source to the destination in a given period of time.
- Response Time – This is defined as the time required for a packet to travel from source to destination.
- Block Size – It is defined as the ratio of total size of each data packet transmitted.

Evaluation Tool

- The following four graphs helps in analyzing the MANET properties:
  - Throughput Graph
  - Network Signature Graph
  - Saturation Graph
  - Mobility Graph
Network Connectivity Test

- **Hello**
  - Correct reception of neighboring HELLO messages
  - Correct installation of route to neighboring node
  - Deletion of route when nodes are disconnected

- **2-hop RREQ/RREP**
  - Node 1 issues a RREQ for node 3
  - Node 2 receives the RREQ, and replies with a RREP
  - Node 1 receives the RREP, install the route, and pings are correctly received

- **RERR**
  - Node 2 issues a RERR for node 3 and removes its route to node 3
  - Node 1 receives this RERR, and removes its route to node 2 also

Results & Discussion

- **Comparison of AODV-UU and AODV-UCSB**
  - Implemented a static scenario in Indoor and Outdoor environment to study the effect of unidirectional links
  - Implemented mobile scenario to compare route discovery time
Throughput Graph (Outdoor)

Throughput Graph (Indoor)
Network Signature Graph (Indoor)

Saturation Graph (Indoor)
Mobility Graph (Indoor)

Contd...

- Comparison of Indoor and Outdoor environment using AODV-UU

  - Study the effect of external environment on the performance of AODV-UU
  - AODV-UU was tested for static scenario in indoor and outdoor environment
Throughput Graph (AODV-UU)

Signature Graph (AODV-UU)
Saturation Graph (AODV-UU)

Simulation

- Simulation Tool used is *ns-2*
- Assess the credibility of the simulator by comparing simulation results with experimental results for mobile scenario
- Study the effect of interference in small MANETs
### Simulation Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Radio Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Transmission range</td>
<td>250 meters</td>
</tr>
<tr>
<td>Wireless bandwidth</td>
<td>1 Mbps</td>
</tr>
<tr>
<td><strong>Communication Model</strong></td>
<td></td>
</tr>
<tr>
<td>Traffic type</td>
<td>Constant bit rate</td>
</tr>
<tr>
<td>Packet size</td>
<td>Varying</td>
</tr>
<tr>
<td><strong>Mobility Pattern</strong></td>
<td></td>
</tr>
<tr>
<td>Node speed</td>
<td>0 m/s – 5 m/s (walking speed)</td>
</tr>
<tr>
<td><strong>Simulation Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Simulation time</td>
<td>300 seconds</td>
</tr>
<tr>
<td>Number of nodes and network area</td>
<td>5 nodes in an area 1000 x 1000m</td>
</tr>
<tr>
<td><strong>Routing and MAC Protocols</strong></td>
<td></td>
</tr>
<tr>
<td>Routing protocol</td>
<td>AODV</td>
</tr>
<tr>
<td>MAC protocol</td>
<td>IEEE 802.11</td>
</tr>
</tbody>
</table>

### Assess the credibility of the simulator
Experimental Scenario

Throughput Graph

- Simulation
- ACOFF/UU
Study the effects of Interference on MANET

- Mobility Scenario with Interference Traffic Pattern 1

Contd...

- Mobility Scenario with Interference Traffic Pattern 2
Throughput Graph

Delay Analysis Graph
Conclusions

- The effect of unidirectional links on MANETs performance is quite considerable and cannot be ignored.
- The performance of MANET can be improved in indoor/outdoor environment, by finding the critical zones
- Strong correlation between the parametric values obtained by simulation and experimental results
- As the Interference traffic increases the performance of the protocol degrades proportionally (linearly)