Design and Evaluation of a Peer-to-Peer MANET Cross-layer Approach: OnehopMANET

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## Mobile Ad hoc NETwork (MANET)

- Collection of autonomous mobile nodes, which communicate wirelessly with each other without any need to exist in existing network infrastructure.
- Does not rely on any centralised control.
- Each participated node is an end system and a router.

## P2P

- Allows peers to access any type of distributed resources and services without a need to a centralised server.
- Self-organising, adaptable, scalable, and do not depend on a central component.
- The overlay is responsible for storing and locating services.

## Similarities

- **Self-organisation**
- **Dynamcity**
- **Decentralisation**
- **Changing topology**

## Common Challenge

*Common Challenge:* maintain connectivity in dynamic and decentralised network.
Mismatching issue between overlay and underlay
OnehopMANET

- Builds structured P2P overlay similar to Chord and EpiChord.
- Builds circular address space.
- Uses cross-layering to optimize similarities between overlay and underlay.
- Scale down typical P2P traffic.
OnehopMANET

- Each peer maintains list of succeeding peers and preceding peers.
- Cache table.
- Cross-layering channel is the main source of routing entries.
- A notification board is used as a channel that manages the information sharing.
OnehopMANET

- Overlay subscribes with the notification board to get notifications of changes.
- Underlay routing protocol notifies the notification board, whenever changes occur in its routing table.
- Notification board passes the information to the overlay.
- Overlay uses this information to update its view of the network.
OnehopMANET

- Using the underlay information significantly reduces the need for overlay maintenance traffic.
- OnehopMANET can also use responses to lookup queries to update its routing tables.
- Sends lookup requests to single destinations.
Simulation

• OMNETPP: an open-source component-based C++ simulation library and framework, primarily for building network simulators.

• INET Framework: an open source communication network simulation package for OMNET++ simulation environment. The INET Framework contains models for several wired and wireless networking protocols.

• OverSim: Oversim is an open source P2P network simulators for OMNET++. It supports different structured P2P protocol and unstructured protocols.
OnehopMANET over different underlays

<table>
<thead>
<tr>
<th>Simulator</th>
<th>OMNET++</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANET Routing Protocols</td>
<td>OLSR, BATMAN, DSR, AODV, DYMO</td>
</tr>
<tr>
<td>Topology size</td>
<td>1000 m x 1000 m</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>40, 60, 80, 100, 120, 140</td>
</tr>
<tr>
<td>Mobility Type</td>
<td>Random Way Point</td>
</tr>
<tr>
<td>Measurement time</td>
<td>1000 seconds</td>
</tr>
<tr>
<td>Transition time</td>
<td>60 seconds</td>
</tr>
<tr>
<td>Lookup interval</td>
<td>10, 60 seconds</td>
</tr>
<tr>
<td>Node speed</td>
<td>1, 2, 3, 4, 5 m/s</td>
</tr>
</tbody>
</table>

1m/s Speed, 60s Lookup Frequency

5m/s Speed, 10s Lookup Frequency

80 nodes, 10s Lookup Frequency

1m/s Speed, 10s Lookup Frequency
OnehopMANET vs. Chord and EpiChord

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<td>Topology size</td>
<td>1000 m x 1000 m</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>30, 50, 70, 90</td>
</tr>
<tr>
<td>Mobility Type</td>
<td>RWP</td>
</tr>
<tr>
<td>Measurement time</td>
<td>600 seconds</td>
</tr>
<tr>
<td>Stabilisation time</td>
<td>120 seconds</td>
</tr>
<tr>
<td>Lookup interval</td>
<td>30, 10, 5</td>
</tr>
<tr>
<td>Node speed</td>
<td>5 m/s</td>
</tr>
<tr>
<td>Parallelism</td>
<td>3 for EpiChord only</td>
</tr>
</tbody>
</table>

Success ratio with 30 s lookup frequency

Success ratio with 5 s lookup frequency

Logical path length with lookup frequency 10s

Network Load with 30 s lookup frequency

Network Load with 5s lookup frequency
# OnehopMANET vs. MA-SP2P and E-SP2P

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<tr>
<td>Topology size</td>
<td>1000 m x 1000 m</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>100</td>
</tr>
<tr>
<td>Peer ratio</td>
<td>10%, 20%, 30%, 40%, 50%</td>
</tr>
<tr>
<td>Mobility Type</td>
<td>RWP</td>
</tr>
<tr>
<td>Measurement time</td>
<td>1000 seconds</td>
</tr>
<tr>
<td>Network stabilization</td>
<td>60 second</td>
</tr>
<tr>
<td>Node speed</td>
<td>0.4m/s, 0.8m/s, 1.2m/s, 1.6m/s</td>
</tr>
</tbody>
</table>

![Graph showing file discovery delay vs. peer ratio for different node speeds](image1)

- **speed 0.4 m/s**
  - 10%: OnehopMANET < MA-SP2P < E-SP2P
  - 20%: OnehopMANET < MA-SP2P < E-SP2P
  - 30%: OnehopMANET < MA-SP2P < E-SP2P
  - 40%: OnehopMANET < MA-SP2P < E-SP2P
  - 50%: OnehopMANET < MA-SP2P < E-SP2P

- **speed 1.2 m/s**
  - 10%: OnehopMANET < MA-SP2P < E-SP2P
  - 20%: OnehopMANET < MA-SP2P < E-SP2P
  - 30%: OnehopMANET < MA-SP2P < E-SP2P
  - 40%: OnehopMANET < MA-SP2P < E-SP2P
  - 50%: OnehopMANET < MA-SP2P < E-SP2P

- **speed 1.6 m/s**
  - 10%: OnehopMANET < MA-SP2P < E-SP2P
  - 20%: OnehopMANET < MA-SP2P < E-SP2P
  - 30%: OnehopMANET < MA-SP2P < E-SP2P
  - 40%: OnehopMANET < MA-SP2P < E-SP2P
  - 50%: OnehopMANET < MA-SP2P < E-SP2P
OnehopMANET vs. MA-SP2P and E-SP2P

- Network load x1,000
  - Speed: 0.8 m/s
  - Peer Ratio: 10% to 50%

- Network load x1,000
  - Speed: 1.6 m/s
  - Peer Ratio: 10% to 50%

- Failure rate%
  - Speed: 0.8 m/s
  - Peer Ratio: 10% to 50%

- Failure rate%
  - Speed: 1.6 m/s
  - Peer Ratio: 10% to 50%
Conclusion

• OnehopMANET Optimize MANET underlay to build efficient P2P overlay.
• OnehopMANET uses cross-layering.
• OnehopMANET scale down typical P2P traffic to suit MANET.
• Evaluated over different underlays.
• Compared to Chord and EpiChord and achieved better performance.
• Compared to P2P MANET systems and achieved better performance.