Simulation Analysis of the MH-TRACE Protocol

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Agenda

- TRACE Family
- Protocol Overview
- Parameter Optimization for MH-TRACE
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TRACE Family

- **Objective**: Energy efficient voice communications in MANETs.
- **Projected Applications**:
  - Mobile Groups (Military, Police)
  - Sensor networks
  - Emergency or disaster relief situations
  - ...

TRACE Family

- **SH-TRACE:** *Time-frame based MAC protocol for single-hop networks*
- **MH-TRACE:** *Extension for Multi-hop Networks*
- **NB-TRACE:** *Extension for Network wide Broadcasting*
- **MC-TRACE:** Unicasting and Multicasting
- **MR-TRACE:** *Multi-rate data transfer*
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- Parameter Optimization for MH-TRACE
- SMAC&802.11 Comparison
Protocol Overview

- Superframe
Protocol Overview

- **Superframe**
  - Frame(s)
    - **Beacon**: For synchronization and announcement of CH
    - **Contention Slots**: Slotted ALOHA with small packages to request channel access.
    - **Header**: Announce channel access by CH.
    - **IS Slots**: Information summarization by nodes transmitting
Protocol Overview

- CH Creation

http://www.ece.rochester.edu/~tavli/papers/tavli_phd.pdf
Protocol Overview

Carrier Sensing vs Receiving

Distance vs Received Power

Distance

Received Power

- Received Power
- Carrier Sensing Threshold
- Receiving Threshold
Protocol Overview

- CH Maintenance

http://www.ece.rochester.edu/~tavli/papers/tavli_phd.pdf
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Parameter Optimization for MH-TRACE

- **Aim:** To formulate the behavior of MH-TRACE under different scenarios

- **Number of Frames/Superframe**
  - Density of Nodes
  - Packet generation rate

- **Simulations**
  - 1000mX1000m area
  - 100sn simulation length
  - 5 Simulations for each node density and Nf
Parameter Optimization for MH-TRACE

TABLE 1 SUPERFRAME PARAMETERS

<table>
<thead>
<tr>
<th>Number of Frames per Superframe, Nf</th>
<th>Number of Data Slots, Nd</th>
<th>Number of Contentio Slots, Nc</th>
<th>Superframe Time, Tsf</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>12</td>
<td>16</td>
<td>24.976</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>8</td>
<td>25.060</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>10</td>
<td>24.984</td>
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<tr>
<td>7</td>
<td>7</td>
<td>7</td>
<td>25.172</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>7</td>
<td>24.992</td>
</tr>
</tbody>
</table>
Parameter Optimization for MH-TRACE

- **Smaller Nf ->**
  - Smaller co-frame cluster separation
  - Beacon Packet collision
  - Intermediate nodes hear no CH and start CH formation process

- **Increased # of Nodes ->**
  - Larger area coverage
  - After 100 nodes start to saturate
Parameter Optimization for MH-TRACE

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Parameter Optimization for MH-TRACE

- Linearly increasing load on the network
- $ms=1.0s$
- $mg=1.35s$
- $ms/(ms+mg) \times (#nodes) = \text{Avg # of trns pckts/frame/node}$
Parameter Optimization for MH-TRACE

- Data collisions increase as Nf is increased
- As average node density is increased, each data collision affects more nodes
Parameter Optimization for MH-TRACE

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Parameter Optimization for MH-TRACE

- Nf is increased, less data slots are available for each frame.
- Especially for high node densities, dropped packets increase as Nf is increased.
Parameter Optimization for MH-TRACE

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- Especially for high node densities dropped packets increase as Nf is increased.
Parameter Optimization for MH-TRACE

- Collision
- Edge effects

<table>
<thead>
<tr>
<th>Node Density</th>
<th>Avg. Number of Neighbors</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>9.82</td>
</tr>
<tr>
<td>75</td>
<td>14.73</td>
</tr>
<tr>
<td>100</td>
<td>19.63</td>
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<tr>
<td>125</td>
<td>24.54</td>
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<tr>
<td>150</td>
<td>29.45</td>
</tr>
<tr>
<td>200</td>
<td>39.27</td>
</tr>
<tr>
<td>250</td>
<td>49.09</td>
</tr>
</tbody>
</table>
Parameter Optimization for MH-TRACE

- Each dropped packet decreases the throughput by the number of neighbor nodes
  \[ f_{drop} = (\text{Avg # of Neighbors}) \times (\text{# of dropped pckts}) \]
- A trade-off between dropped packets and collisions must be done for high throughput
Parameter Optimization for MH-TRACE
Parameter Optimization for MH-TRACE

- Contention is not severe for small node densities
- As Node density is increased, the variation becomes more important.
Parameter Optimization for MH-TRACE

- Constant Delay wrt Nf
- Node Density

![Chart showing average packet delay in the agent layer vs. number of frames for different node densities. The x-axis represents the number of frames ranging from 4 to 8.5, and the y-axis represents the packet delay ranging from 0.013 to 0.018. Different node densities are indicated by colored lines and markers. For example, 50 nodes are shown with a blue line and markers, 75 nodes with a green line and markers, and so on.]
Parameter Optimization for MH-TRACE

- Higher the throughput, higher the energy dissipation.
Parameter Optimization for MH-TRACE

- Higher the throughput, higher the energy dissipation.
CONCLUSION

- MH-Trace provides a high throughput MAC layer protocol for real time packet broadcasting.
- Combination of distributed and centralized network structure.
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Thanks for Listening
Questions & Comments?