Distributed Hashing Table-based Routing Algorithm in Wireless Sensor Networks

Yurong Xu
Prof. Fillia S. Makedon
DevLab http://devlab.cs.dartmouth.edu
Content

1. Introduction of WSN (Wireless Sensor Networks)
2. WSN Architecture
3. Challenges in WSN
4. Our Term Project
5. What is DHT
6. What you should do in the project?
What is WSN?

A Wireless Sensor Networks:

is a tiny smart node collection

based on

1. Sensor Technology
2. Computation Technology
3. Wireless Technology
Generations of WSN

1. Passive WSN (RFID)
2. Active WSN (mote)
3. Mobile WSN (future)

Micro-Bug as a node of WSN (Future)

Berkeley mote

Hitachi RFID chip
What can WSN do?

- Military
  - Like Smart Dust
- Industry
  - Control Automation
- Human Life
  - Smart Home (Oxygen MIT)
  - Health Monitor for the elder
- Commerce
  - RFID
Content

1. Introduction of WSN (Wireless Sensor Networks)
2. WSN Architecture
How does WSN do them?

- Tiny digital sensors
  - Very inexpensive and can be integrated into silicon.
- Wireless Communication Component
  - Low power inexpensive RF
- Computation Component
  - Fast and cheap CPU & large memory(FLASH)
A WSN Sensor Node (EE part)

- A WSN sensor node has hardware:
  - Sensing
    - **Physical** – Magnetic, Light, Sound
    - **Chemical** – CO, Chemical Weapons
    - **Biological** – Bacteria, Viruses, Proteins
  - Wireless
    - Wireless Communication like Bluetooth, ZigBee, WiFi
  - CPU & Memory
    - Fast embedded CPU
    - Memory
    - Analog/Digit Converter
  - Power Supply
    - **Automatic power** – Solar, Vibration battery, RF Inductance
    - **Battery power** – Battery power,
A WSN Sensor Node (CS part)

- A WSN sensor node has software:
  - OS
    - Resource Management
    - Task Dispatching
  - Networks
    - PHY: guarantee the reliability of communication
    - MAC: maintain the Network
      - Include the routing algorithm etc…
  - Applications
    - How to get useful data from WSN & use it.
Content

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Challenges of WSN

- **Protocol and algorithm design**
  - efficiently communicate in especially in a large deployment

- **System design**
  - Embedded design
  - Human Implantable design

- **Security and privacy**
  - How to keep data secure
  - How to keep data private
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Our Term Project
Simulation on an Efficient Routing Algorithm in Wireless Sensor Network (WSN)

We will focus on how to implement and simulate an efficient routing algorithm which can be used in a power-constrain wireless sensor network.

In one word, want to find a route to remote node.

Why it is problem?
WSN Structures

- Structures of WSN:
  - 2 Structures:
    - Centralized
      - star (small scale)
      - tree
    - Decentralized Structure
      - mesh (our WSN)

*pink node is a base station*
Routing in Centralized WSN

- Centralized Routing (pro +, con -)

+ Simple
- a single point of failure
- impossible to store HUGE route table in a node

with *limited* resource
Routing in Decentralized WSN

- Decentralized Routing (pro +, con -)
- Example: Flooding Routing

+ Robust
+ Need no routing table
- average hops will be $O(N)$, power-consuming
Our Solution

- Decentralized
- Hash Table based (because $O(1)$ in single node)

Distributed Hash Table-based Routing Algorithm
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What is Hashing Table

- A content-indexed table
  While traditional table is address-indexed
- Example:
  Lookup (key (apple), table) = lookup ("app", table)

<table>
<thead>
<tr>
<th>Key</th>
<th>data</th>
<th>address</th>
<th>data</th>
</tr>
</thead>
<tbody>
<tr>
<td>app</td>
<td>apple</td>
<td>002</td>
<td>apple</td>
</tr>
<tr>
<td>ora</td>
<td>orange</td>
<td>003</td>
<td>orange</td>
</tr>
<tr>
<td>ban</td>
<td>banana</td>
<td>004</td>
<td>banana</td>
</tr>
</tbody>
</table>
What is Distributed Hashing Table (DHT)

- Separate a whole table to lots small tables
- Every node store one

- DHT routing algorithm
  using DHT to store the routing information
More detail in DHT routing algorithm

- A \( n \)-table space node network

<table>
<thead>
<tr>
<th># node</th>
<th>node</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>*</td>
</tr>
<tr>
<td>2</td>
<td>*</td>
</tr>
<tr>
<td>3</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>*</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Routing table for 3(^{rd} ) node</th>
</tr>
</thead>
<tbody>
<tr>
<td>3+1</td>
</tr>
<tr>
<td>3+2</td>
</tr>
<tr>
<td>3+4</td>
</tr>
<tr>
<td>3+8</td>
</tr>
<tr>
<td>3+16</td>
</tr>
<tr>
<td>...</td>
</tr>
</tbody>
</table>
What is DHT-cont.

- Chord ring

<table>
<thead>
<tr>
<th>N#</th>
<th>Dest</th>
</tr>
</thead>
<tbody>
<tr>
<td>#+1</td>
<td>.</td>
</tr>
<tr>
<td>#+2</td>
<td></td>
</tr>
<tr>
<td>#+4</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>(#+4) mod</td>
<td>2^n</td>
</tr>
</tbody>
</table>
Limited physical range of Hops

- N5.lookup(k19)

<table>
<thead>
<tr>
<th>N5</th>
<th>Dest</th>
</tr>
</thead>
<tbody>
<tr>
<td>5+2</td>
<td>10</td>
</tr>
<tr>
<td>5+4</td>
<td>10</td>
</tr>
<tr>
<td>5+8</td>
<td>20</td>
</tr>
<tr>
<td>5+16</td>
<td>32</td>
</tr>
<tr>
<td>5+32</td>
<td>40</td>
</tr>
</tbody>
</table>
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What you should do in project

- Read the paper in reference
- Understand DHT routing algorithm
- Implement it in Java or C
- Think about this problem
Multi-hot Problem in WSN for DHT

DHT Assumption

- One hop connection:
  In one network, you can easily connect with remote nodes in one hop connection.

WSN:

- Multi-hop connection:
  Connect with remote nodes in multi-hop connection because of limited physical range of wireless signal.
What you should do in project

- Read the paper in reference
- Understand DHT routing algorithm
- Implement it in 20-nodes networks
- Think about this problem
- How to improve the algorithm for this problem in 20-nodes simulation network
- Write report / presentation
Reference

- http://www.eecs.harvard.edu/~mdw/course/cs263/fa04/#gdi
Thank you 😊