ScatterWeb
Demo and hands-on

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Overview

Components for demo

Directed Diffusion for data forwarding

Automatic tree generation and image transmission

Hands-on, terminal, …
ESB2 Full Featured

- Capacitor
- LEDs
- PIR
- IR sender
- IR receiver
- Button
- Microphone
- Vibration
- Transceiver
- EEPROM
- Beeper
- μController
- Reset
ScatterFlasher
Sensor Node with Camera (prototype)

Camera facing a mirror

Picture taken and transmitted by a sensor node
Node Architecture

Separation into firmware and task
- Stable “core”
- SW updates stored in EEPROM first
- Flashing as second step
  - Synchronized (time or command)
  - Checksum

Task
- Linked against firmware
- Can use all functions
- Can register callback functions
Problem No. 1: Routing

Consider dynamic topology

- Device mobility plus changes in channel characteristics
- Separation and merging of networks possible
- Asymmetrical connections

\[ \text{Diagram of network topology at time } t_1 \]

\[ \text{Diagram of network topology at time } t_2 \]

- Good connection
- Weak connection
Routing in Ad-hoc-Networks

THE big research tasks for many years

- Far more than 100 different proposals exist
- Simple: Flooding

Reason

- Classical approaches from fixed networks fail
  - Slow convergence, big overhead
- High dynamicity, low bandwidth, low computing power

Metrics for routing

- Minimum
  - Number of nodes, data loss, delay, congestion, interference, …
- Maximum
  - Stability of network, run-time of battery driven nodes, coherence of network, …
Die Vielfalt von Ad-hoc-Routing-Protokollen

Flat

- Proactive – permanent maintenance of routes
  - FSL – Fuzzy Sighted Link State
  - FSR – Fisheye State Routing
  - OLSR – Optimized Link State Routing Protocol
  - TBRPF – Topology Broadcast Based on Reverse Path Forwarding

- Reactive – route establishment on demand
  - AODV – Ad hoc On demand Distance Vector
  - DSR – Dynamic Source Routing

Hierarchical

- CGSR – Clusterhead-Gateway Switch Routing
- HSR – Hierarchical State Routing
- LANMAR – Landmark Ad Hoc Routing
- ZRP – Zone Routing Protocol

With geo-location support

- DREAM – Distance Routing Effect Algorithm for Mobility
- GeoCast – Geographic Addressing and Routing
- GPSR – Greedy Perimeter Stateless Routing
- LAR – Location-Aided Routing
Routing in Sensor Networks

Implementation of (simplified) directed diffusion scheme [Intanagonwiwat, Govindan, Estrin, Heidemann, Silva, 2003]

Solar-aware directed diffusion
[Voigt, Ritter, Schiller, demo at ACM sensys 2003]
Localized Interactions

Interest Messages
- Interest in sensor data: Attribute/Value pair
- Gradient: remember direction of interested node

Data Messages
- Send back data using gradients
- Hop count guarantees shortest path
Solar-aware routing …

Only sensors with sufficient energy forward data for other nodes.
Solar-aware Routing

Solar-powered node

- Send status updates to neighbors
  - Either proactive or when sniffing ongoing traffic
- Have neighbor nodes reroute traffic
Simulation Results

**Localized Interactions**

- Metric: number of messages transmitted using battery

<table>
<thead>
<tr>
<th># Nodes</th>
<th>Improvement [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>26.8%</td>
</tr>
<tr>
<td>64</td>
<td>15.1%</td>
</tr>
<tr>
<td>96</td>
<td>12.1%</td>
</tr>
</tbody>
</table>

**Solar Directed Diffusion**

<table>
<thead>
<tr>
<th># Nodes</th>
<th>Improvement [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0%</td>
</tr>
<tr>
<td>64</td>
<td>10-20%</td>
</tr>
<tr>
<td>96</td>
<td>5-20%</td>
</tr>
</tbody>
</table>
Software for Controlling the Sensor Network 1

scatterMonitor 1.0

http://www.scatterweb.net

Select a connection:

- Select VCOM port for USB 430 Stick:
  - COM13:
  - COM10:
  - COM11:
  - COM12:
  - COM13:
  - COM14:
  - COM15:

- Enter/Select host for EW430Stick:

DiaDiscover:

<table>
<thead>
<tr>
<th>IP</th>
<th>MAC</th>
<th>Device</th>
<th>Version</th>
</tr>
</thead>
</table>

Ok    Cancel
Software for Controlling the Sensor Network 2
Software for Controlling the Sensor Network 3

![Software Interface]

### Neighborhood Table

<table>
<thead>
<tr>
<th>ID</th>
<th>Type</th>
<th>Firmware Checksum</th>
<th>Program Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESB430</td>
<td>0x1F4</td>
<td>0x038</td>
</tr>
<tr>
<td>5</td>
<td>ESB430</td>
<td>0x1F4</td>
<td>0x038</td>
</tr>
<tr>
<td>6</td>
<td>ESB430</td>
<td>0x1F4</td>
<td>0x038</td>
</tr>
<tr>
<td>5</td>
<td>ESB430</td>
<td>0x1F4</td>
<td>0x038</td>
</tr>
</tbody>
</table>
### Software for Controlling the Sensor Network

#### Attribute: Vibration

<table>
<thead>
<tr>
<th>Node</th>
<th>Value</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node 1</td>
<td>0</td>
<td>25.5°C</td>
</tr>
<tr>
<td>Node 2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 5</td>
<td>0</td>
<td>18.5°C</td>
</tr>
<tr>
<td>Node 6</td>
<td>0</td>
<td>23.5°C</td>
</tr>
<tr>
<td>Node 7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 9</td>
<td>0</td>
<td>21°C</td>
</tr>
<tr>
<td>Node 10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Node 15</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Debug:**

```plaintext
Scanning done
```
Software for Controlling the Sensor Network 5
Software for Controlling the Sensor Network