Object-Oriented Software Systems

http://www.ooss.dk
Research method

Experimental approach

Research areas

Programming languages

Software architecture

Pervasive computing

Software development tools

Computer science education
Outline

• Case: The LIWAS project
• About the project
• Protocols
• Other Activities
LIWAS

- Life Warning System
- Determine road condition
  - Ice, snow, water, dry, etc.
- Notify interested parties

Partners
- ISIS Katrinebjerg
- LIWAS aps
- Amfitech
Vision
Sensor classifies road
Sensor classifies road

Driver notified
Sensor classifies road

Driver notified

Other cars notified

Sensor classifies road
Sensor classifies road

Driver notified

Other cars notified

Enhanced Road Maintenance

Road Authorities

Sensor classifies road
Road Authorities

RS-232
802.11 ad-hoc mode
GSM/GPRS
TCP/IP
Research Areas

- Characteristics
  - Mobile nodes
  - Communication is done ad-hoc
  - Potentially large scale
- Research
  - Software Architecture
  - Protocols
Activities

Data mining

Experiments

Software Architecture

Protocols
Two Protocols

- Ad-hoc data dissemination
- Zone Flooding – flooding based
- Zone Diffusion – Gossip/aggregation based
- Comparative simulation study
Motivation

- Typical protocols are highly sensitive to varying network mobility/topology and chosen parameters.
- Importance of information about a location decreases with the distance to that location.
Design Goals

- Lightweight
- Few assumptions on network
- Robust to varying network density and mobility
- Local data dissemination
- Only few parameters
Zone Flooding

Special case of flooding-based geocast
Zone Diffusion
Zone Diffusion
Zone Diffusion
Zone Diffusion
Evaluation

• NS-2 simulation
• Straight road section
• Various mobility/density scenarios
  • Avg vel 50kmh, 80kmh, 130kmh
  • 100-300 nodes in fixed area
• Metrics
  • Conventional (network load)
  • Application specific (information dist, awareness percentage)
• Zone flooding achieves highest AP

• Zone Diffusion achieves good AP using significantly fewer packets than Zone Flooding

• Trade-off between high AP and low network utilization

• Primary goal AP: use Zone Flooding (and vice versa) - where is threshold?

• Broadcast interval?
General conclusions

• Zone Flooding achieves best AP in all but a few cases
• Zone Diffusion has the lowest network utilization
• Packets sent and Awareness Percentage are inversely connected
• If we can settle with an Awareness Percentage of 94.3, the Zone Diffusion protocol should always be used (no matter node mobility and density)
• Medium and fast velocity: If we can accept that our protocol sends 0.167/m2/sec Zone Flooding should always be chosen
Software Architecture

- Service oriented
- Publish-subscribe
- Modifiability
- Availability
- Testability
Deployments

Capekica/Norway
Deployments Århus Airport
Deployments

Abildskou - Falck
Some Other Activities

- Design, implementation, and study of object-oriented languages
- Advanced type concepts such as virtual classes and wildcards
- Virtual machine support for dynamic class calculi and dependent types
- Software architecture @ work
- Ethnographical studies of architects in the industry
- Architectural prototyping: experimental techniques
- Computer science education
- Software architecture in teaching
- Pedagogy of introductory programming
- Other stuff
Questions?
Zone Flooding vs. Zone Diffusion

- Use Packets Sent (PS) and Awareness Percentage (AP) as goal parameters
- Could easily be extended to include Information Distance
- Solution space
  \[ S = \{ZF, ZD\} \times \{0.017, \ldots, 100\} \]
- Pareto Optimality:
  - a solution \( s \in S \) is Pareto optimal if \( \forall t \in S: \)
  \[
  PS(t) < PS(s) \Rightarrow AP(t) < AP(s)
  \]
Zone flooding vs. Zone Diffusion

- Front is monotone ⇒
  - AP primary goal: use ZF
  - PS primary goal: use ZD

- However there is not always a primary goal…
Related Work

- **Categories:**
  - **Unicast**
    - Traditional ad-hoc routing: AODV, OLSR, …
    - Service discovery needed
    - Latency + diminished network capacity
    - Not good for safety critical applications
  - **Observation:**
    - Importance of information about a location decreases with the distance to that location.
    - (not relevant for infotainment applications)
  - **Flooding**
    - Packets are forwarded by everyone
    - Limited by various mechanisms
    - Tends to have a lot redundant transmissions
    - Zone Flooding an instance
  - **Diffusion**
    - Nodes keep a view of surroundings
    - View is periodically broadcasted
    - When a view is received it is aggregated with the local one
Simulation Model

<table>
<thead>
<tr>
<th>Class</th>
<th>Average velocity</th>
<th>Variance</th>
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<tbody>
<tr>
<td>Low</td>
<td>14m/s (50km/h)</td>
<td>1</td>
</tr>
<tr>
<td>Medium</td>
<td>22m/s (80km/h)</td>
<td>1</td>
</tr>
<tr>
<td>High</td>
<td>36m/s (130km/h)</td>
<td>1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>General parameters</th>
<th>Zone Flooding parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mac protocol</td>
<td>IEEE 802.11</td>
</tr>
<tr>
<td>Propagation model</td>
<td>Two ray ground</td>
</tr>
<tr>
<td>Transmission range</td>
<td>100 m</td>
</tr>
<tr>
<td>Simulation duration</td>
<td>200 secs</td>
</tr>
<tr>
<td>Broadcast interval</td>
<td>[0.01 ... 56] secs</td>
</tr>
<tr>
<td>Node count</td>
<td>100, 200, 300</td>
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<tr>
<td></td>
<td>Flooding zone size</td>
</tr>
<tr>
<td></td>
<td>2000 m x 10 m</td>
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<tr>
<td></td>
<td>Packet size</td>
</tr>
<tr>
<td></td>
<td>64 bytes</td>
</tr>
<tr>
<td></td>
<td>Hop count</td>
</tr>
<tr>
<td></td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Zone Diffusion Parameters</td>
</tr>
<tr>
<td></td>
<td>ER size</td>
</tr>
<tr>
<td></td>
<td>2000 m x 10 m</td>
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<td>Packet size</td>
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<td>224 bytes</td>
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<td>Cell size</td>
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<td>10 x 10 m</td>
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