Mobile and Ubiquitous Computing
Data-centric routing and storage

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Overview

- Data-centric approach to tasking a sensor network
- Directed diffusion
Data-centric approach

We want to get information from the sensor network about some type of event without knowing

- the ids of the nodes nor
- the location of nodes

that generate relevant sensor data.

- We can express our request as a series of attribute-value pairs, e.g.:
  
  type = animal
  instance = horse
  interval = 30 min
Directed diffusion terminology

- **Sinks**: nodes requesting information
- **Sources**: nodes providing information
- **Interests**: records indicating a desire for certain type of information

A typical *interest* record contains an ‘*interval*’ attribute field, which indicates the frequency with which the sink wishes to receive information about objects matching the other record attributes.
Directed diffusion goal

- Directed diffusion is suitable for addressing attribute-value requests.
- It finds good paths between sources and sinks.
- The cost of finding good paths is amortized over the period of use of the paths (assuming a long-lived request).
Directed diffusion

- Sinks generate interests that *diffuse* through the sensor network.
Directed diffusion

- Each node that receives an *interest* message stores:
  - the interest record
  - the neighbor who sent it
  - the data rate in which results are requested
  in a local *interest cache*.

The initial requested data rate is set to a very low value.
Directed diffusion

Interest cache of node N6:

<table>
<thead>
<tr>
<th>interest</th>
<th>neighbor</th>
<th>data rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>animal=elephant, ...</td>
<td>N0</td>
<td>every 1 hour</td>
</tr>
<tr>
<td>animal=elephant, ...</td>
<td>N4</td>
<td>every 1 hour</td>
</tr>
</tbody>
</table>

Event

Source
N1

Sink
N0

N0 -> N4, N6
N1 -> N2, N5, N6
N2 -> N3
N3 --> N4
Directed diffusion

- A source computes the highest data rate among all its gradients for a certain interest.
- It sends event records to all neighbors for which it has a gradient for a particular event interest.

- A node that receives an event record checks its cache to see if it has matching interests.
  - If not, it drops the message
  - Otherwise it processes the message as follows:
    - The node caches recently seen event records. If the event record has not already arrived at the node through another path, the node forwards it to interested neighbors.
Event records are propagated back to the sink through multiple paths at the initially low data rate.
The sink reinforces min-delay path, by sending the same interest to neighbor N4 with higher requested data rate.
Directed diffusion

N4 reinforces min-delay path, by sending the same interest to N1 with higher requested data rate.
Directed diffusion

The source propagates event records to the sink along the reinforced path with a high frequency.
Discussion

- Directed diffusion is a distributed algorithm – it works only with neighbor-to-neighbor interaction.
- The gradient mechanism is used to reinforce routing along the best paths.

Questions to consider when reading the paper on directed diffusion:
- What is positive and negative reinforcement and how are they used?
- Observe whether the paper on directed diffusion includes results regarding the energy-efficiency of the algorithm.
Related reading

To prepare for discussion:

• Chalermek Intanagonwiwat, Ramesh Govindan and Deborah Estrin. “Directed diffusion: A scalable and robust communication paradigm for sensor networks”. In Proceedings of the Sixth Annual International Conference on Mobile Computing and Networking (MobiCOM '00), August 2000, Boston, Massachusetts.