Ad hoc and Sensor Networks
Chapter 7: Naming & Addressing

Holger Karl
Goals of this chapter

- This short chapter looks at non-standard options for denoting the senders/receivers of messages
  - Traditional (fixed, wireless, ad hoc): Denote individual nodes by their identity
  - WSN: Content-based addresses can be a good complement

- When addresses are not given a priori, they have to be determined “in the field”
  - Some algorithms are discussed
Names vs. addresses

**Name:** Denote/refer to “things”
- Nodes, networks, data, transactions, …
- Often, but not always, unique (globally, network-wide, locally)
- Ad hoc: nodes – WSN: Data!

**Addresses:** Information needed to find these things
- Street address, IP address, MAC address
- Often, but not always, unique (globally, network-wide, locally)
- Addresses often hierarchical, because of their intended use in, e.g., routing protocols

**Services to map between names and addresses**
- E.g., DNS

**Sometimes, same data serves as name and address**
- IP addresses are prominent examples
Issues in address management

- Address allocation: Assign an entity an address from a given pool of possible addresses
  - Distributed address assignment (centralized like DHCP does not scale)
- Address deallocation: Once address no longer used, put it back into the address pool
  - Because of limited pool size
  - Graceful or abrupt, depending on node actions
- Address representation
- Conflict detection & resolution (*Duplicate Address Detection*)
  - What to do when the same address is assigned multiple times?
  - Can happen e.g. when two networks merge
- Binding
  - Map between addresses used by different protocol layers
  - E.g., IP addresses are bound to MAC address by ARP
Distributed address assignment

- Option 1: Let every node randomly pick an address
  - For given size of address space, unacceptable high risk of duplicate addresses (see exercise)
- Option 2: Avoid addresses used in local neighborhood
- Option 3: Repair any observed conflicts
  - Temporarily pick a random address from a dedicated pool and a proposed fixed address
  - Send an address request to the proposed address, using temporary address
  - If address reply arrives, proposed address already exists
  - Collisions in temporary address unlikely, as only used briefly
- Option 4: Similar to 3, but use a neighbor that already has a fixed address to perform requests
Content-based addresses

• Recall: Paradigm change from id-centric to data-centric networking in WSN

• Supported by content-based names/addresses
  • Do not described involved nodes (not known anyway), but the *content* itself the interaction is about

• Classical option: Put a naming scheme on top of IP addresses
  • Done by some middleware systems
Content-based addressing: Describe *interests*

- **Interests** describe relevant data/event
  - Used, e.g., by directed diffusion (see later chapter)
  - Nodes match these interests with their locally observed data

- **Format: Attribute-Value-Operation**
  - `<attribute, value, operation>, e.g.: <TEMP, 20° C, GE>`
  - Attributes: temperature, pressure, concentration, …
  - Operations:

<table>
<thead>
<tr>
<th>Operator name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ</td>
<td>Matches if actual value is equal to value</td>
</tr>
<tr>
<td>NE</td>
<td>Matches if actual value is not equal to value</td>
</tr>
<tr>
<td>LT</td>
<td>Matches if actual value is smaller than value</td>
</tr>
<tr>
<td>GT</td>
<td>Matches if actual value is greater than value</td>
</tr>
<tr>
<td>LE</td>
<td>Matches if actual value is smaller or equal to value</td>
</tr>
<tr>
<td>GE</td>
<td>Matches if actual value is larger or equal to value</td>
</tr>
<tr>
<td>EQ_ANY</td>
<td>Matches anything, value is meaningless</td>
</tr>
<tr>
<td>IS</td>
<td>Specifies a literal attribute</td>
</tr>
</tbody>
</table>
Matching algorithm

- Check whether an interest matches the locally available data

```java
parameters: attribute sets A and B
    // A corresponds to the interest, B to the data message

foreach attribute a in A where a.op is formal {
    matched = false
    foreach attribute b in B where
        a.key == b.key and b.op is actual {
            if b.val satisfies condition expressed by a.key and a.val then {
                matched = true
            }
        }
    if (not matched) then {
        return false
    }
}
return true;    // matching successful!
```
Geographic addressing

• Express addresses by denoting physical position of nodes
  • Can be regarded as a special case of content-based addresses
  • Attributes for x and y coordinates (and maybe z)

• Options
  • Single point
  • Circle or sphere centered around given point
  • Rectangle by two corner points
  • Polygon/polytope by list of points
  • …
Conclusion

• Addresses can be assigned distributedly

• Non-id-centric addresses give additional expressiveness, enables new interaction patterns than only using standard addresses

• These addresses have to be supported by specific protocols, in particular, routing protocols