

Ad hoc and Sensor Networks

Chapter 7: Naming & Addressing

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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:

Operator name	Meaning
EQ	Matches if actual value is equal to value
NE	Matches if actual value is not equal to value
LT	Matches if actual value is smaller than value
GT	Matches if actual value is greater than value
LE	Matches if actual value is smaller or equal to value
GE	Matches if actual value is larger or equal to value
EQ_ANY	Matches anything, value is meaningless
IS	Specifies a literal attribute



Matching algorithm

- Check whether an interest matches the locally available data

```
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

