Association

Association

- Network bootstrapping
  - Network address acquisition and name registration
  - DHCP server (query to well-known broadcast address)
  - Dynamic DNS update service
  - Zero configuration networking
    - Apple's Bonjour
- The boundary principle
  - Smart spaces need to have system boundaries that correspond accurately to meaningful spaces as they are normally defined territorially and administratively
  - Association problem: scale and scope (administrative and territorial boundaries)

Discovery Services (1)

- A directory service that takes into account volatility
  - Directory data is dynamically determined as a function of the client's context
  - There may be no infrastructure to host a directory server
  - Registered services may spontaneously disappear
  - Protocols for accessing the directory need to be sensitive to energy and power consumption
- Device and service discovery
  - API: service registration and registration management & lookup
  - A discovery service does not enable association by itself
    - Service selection

Discovery Services (2)

- Discovery service design issues
  - Low effort, appropriate association
    - Appropriate returned services and minimal human input in service selection
  - Service description and query language
    - Expressiveness must keep up with new devices and services
  - Smart-space specific discovery
    - Discovery scope and no need for a priori knowledge
  - Directory implementation
  - Service volatility
    - Appropriate handling of service disappearance

Discovery Services (3)

- Discovery bootstrapping: use the reach of the local subnet
  - Well-known IP multicast address
  - Well-known frequency hoping sequence with speed differential between discoverable and discovering devices – Bluetooth
  - Network discovery services
- Server-based versus server-less
  - Server responds with unicast address to the multicast request – Server election?
  - Caching of service descriptions
  - Push versus pull model – communicating advertisements versus communicating queries
    - Multicast messages consume bandwidth and listening devices consume energy
    - Push: wasted advertisements, tradeoff between bandwidth and energy usage, and wait time of discovery
    - Pull: multiple responses and repeat of same queries
    - Hybrid models

Discovery Services (4)

- Service volatility
  - Deregistration before disappearance
  - Leases for spontaneous disappearance
    - Temporary allocation of a resource – requires refresh
    - Tradeoff between timeliness and energy and bandwidth consumption
    - Not really a problem in server-less architectures
- Jini
  - Entirely Java-based, communication through RMI or events
  - Lookup services, Jini services and Jini clients
    - Discovery – protocol for finding lookup services
    - Joining – acquisition of discovery service stub, i.e. becoming part of the system
    - Registration of stubs and service attributes

Discovery Services (5)

- Matching on service attributes or Java typing
- Lookup services announce their existence on the multicast address
- Groups for scoping of lookup service discovery

- Discovery services and the boundary principle
  - Use of a subnet: radio signals cross boundaries, subnets and physical boundaries may not match
  - Inadequacies in service descriptions: brittleness, lost opportunities (no service description)

Physical association

- Human involvement and physical means can address discovery deficiencies
- Human input to scope discovery
- Sensing and physically constrained channels to scope discovery
  - Glyphs that provide the identifier
  - Location information for discovery server discovery
  - Physically constrained channels (background music or infrared beacon)
- Direct association
  - Address sensing (short-range wireless channel – Near Field Communication)
  - Physical stimulus (laser beam)
  - Temporal or physical correlation (two-button protocol, concurrent shaking of two devices)