Wireless Networks of Device
(WIND)

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Motivation

Networks today

Clients

Routers

Web servers

Future networks

Audio

Video

Sensors

Wireless

Mobile users

Devices
Location-based wireless services

- Spontaneous networking
- Automatically obtain actual map of region

- Communication & control
- Mobility & group communication
WIND project

• Configuration
  - Topology formation in mobile networks

• Routing
  - Protocols for mobile device networks

• Resource discovery
  - New naming system for device networks

• Adaptation
  - Congestion Manager for multimedia

• Security & privacy
  - Private location support system
Resource discovery

• Problem: advertise and locate network services
• Heterogeneous environment
  - Wide variety of devices, services, and information
• Dynamic environment
  - Mobile nodes and services
  - Variable, unpredictable performance
  - Device failures
  - Services composed of rogue nodes
Solution: Intentional Naming System (INS)

Expressiveness: Names are intentional; know what, not where

Responsiveness: Integrate name resolution and message routing to handle mobility

Robustness: Decentralized, cooperative resolvers

Easy configuration: Name resolvers self-configure into overlay network
Naming and service discovery

- Wide-area naming (DNS)
- Attribute-based systems (X.500)
- Brokers (CORBA ANSA)
- Service location protocol (IETF)
- Device discovery
  - Jini Universal plug-and-play
- Intentional Naming System (INS)
  - Mobility & dynamism via late binding
  - Decentralized, serverless operation
  - Easy configuration
Intentional names

- Expressive name language (like XML)
- Providers announce descriptive names
- Clients make queries
  - Attribute-value matches
  - Wildcard matches
  - Ranges

```plaintext
[vspace=lcs.mit.edu/camera]
[building=ne43]
[room=510]]
[resolution=800x600]
[access=public]
[status=ready]
```

```plaintext
[vspace=mit.edu/thermometer]
[building=ne43]
[floor5=]
[room=*]]
[temperature<60°F]
data
```
INS architecture

Name resolver

Overlay network of resolvers

Query

Periodic advertisement

Service

[building = 43
  [room = 510]]

[entity = camera]
Name resolver functions

- Name lookup
- Routing protocol
- Handling service mobility
- Message forwarding
- Self-configuration algorithm
Routing protocol tracks changes in the network. Name resolvers form an overlay network to resolve service names. When an event, such as a camera moving to a different room, is triggered, it updates the service mobility overlay network.
Late binding handles mobility

Name resolver

Forward to best location

Intentional anycast

Data
Intentional multicast for group communication

Name resolver

Forward along spanning tree

[building: ne-43
  [room = *]]
[entity = camera
  flag ALL]

data

[building: ne-43
  [room = 510]]
[entity = camera
  flag ALL]

[building: ne-43
  [room = 504]]
[entity = camera
  flag ALL]
Two notable properties

• Robustness
  - Distributed cooperation without centralized servers
  - Routing information about names
  - Multicast forwarding

• Self-configuration
  - Resolvemetwork topology based on network performance
  - Decentralized spanning tree algorithm
Status

• Java implementation of INS & applications
  - Active map, video delivery, jukebox, camera network (α)
  - Alpha code release for NTT

• Scalability & deployment
  - Wide-area architecture being designed
  - Standardization: MIME for devices/services (XML-based)
Summary

- Future networks will include heterogeneous devices & services
  - Configuration, routing, discovery, adaptation, security
- INS handles resource discovery in dynamic, mobile networks
  - Expressiveness: intentional names
  - Responsiveness: late binding
  - Robustness: decentralized resolvers
  - Configuration: self-configuration protocol

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