Deployment of Sensor Networks

Concepts and Tools

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Deployment

- Setting up an operational sensor network
  - Real-world settings
  - Large number of nodes
  - For realistic applications
- Key issue for real-world applications
- Requires new concepts and tools
Methodological Gap

- **Large gap** between simulation/testbed and operational real-world application
  - Working simulation/testbed operation

- **Reasons**
  - Simulation: does not capture all real-world effects
  - Testbed: few nodes, controlled environment
  - Users: Application experts, not system experts
Deployment as an Art

- Deployment issues are not well understood and mastered today
  - Almost no abstractions, few tools

- Tools mainly for simulation
  - TOSSIM, SENS, ...

- Small-scale, wired testbeds
  - Gnomes, MoteLab, Mirage, Emstar, ...

- Experience with few larger systems (>> 100 nodes)
  - Duck island, shooter localization, ...
Goals and Contributions

- **Goals**
  - Concepts and tools for efficient deployment
  - Speed up development process
  - Enable large real-world applications

- **Contributions**
  1) Network Programming (do *this*)
  2) Inspection (what is it *really* doing?)
  3) Maintenance (*how* to fix problems?)
1) Network Programming

- Problem
  - Users are application experts
  - Programming is not an isolated activity

- Approach: Global Programming Model
  - Raise level of abstraction
    - Single nodes -> whole network
    - System level -> problem orientation
  - Integration with inspection and maintenance
Example: Role Assignment

- Assign functions to sensor nodes based on node properties
  - New abstraction: “roles”

- Generic specification language
  - Ex. “Coverage”: determine few ON nodes that cover whole area with their sensors, others OFF
  - Compiled offline

- How to inspect and maintain such „programs“?

[SIGOPS EW 04, Sensys 05]
2) Inspection

- **Problem**
  - What is going on in the sensor network?
  - Real-world settings: no cables
  - Constrained resources: installing a probe alters behavior

- **Approach: Deployment Support Network**
  - Self-organizing „observation“ network
Example: Deployment Support Network

- Separate wireless network
  - Different communication channel
  - Installed temporarily alongside sensor network
- Observe sensor node states and network traffic
  - Minimum impact on sensor network
- Executes deployment-support services
- Prototype based on BTnodes

[SenSys 04, IPSN 05]
3) Maintenance

- Identify and repair misbehavior
- Leverage Deployment Support Network
  - Energy/performance profiling
  - Distributed unit testing
  - Problem identification
    - Flexible event logging
    - Distributed watchpoints and breakpoints
    - Execution replay
  - Remote re-programming
Conclusions

- Intend to provide a *deployment platform* for sensor network applications
  - Network programming
  - Inspection
  - Maintenance

- We are sitting between applications and sensor node platforms

- Need to understand
  - Application requirements
  - Platform characteristics
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