Deployment Support
A Sensor Network Maintenance Toolkit

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Today's WSN Design and Development

**Simulation**
- TOSSIM [Levis2003]
- PowerTOSSIM [Shnayder2004]
- Avrora [Titzer2005]

**Virtualization and Emulation**
- EmStar [Ganesan2004]
- BEE [Chang2003, Kuusilinna2003]

**Test Grids**
- moteLab [Werner-Allen2005]
- Emstar arrays [Cerpa03/04]
- Kansei [Dutta2005]

Specialized simulation tools for WSN applications
Fast-prototyping in a controlled environment
Closing in on the "real" experience

Figure abridged from D. Estrin/J. Elson
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**Test Grids**
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- Emstar arrays [Cerpa03/04]
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**Deployment**
- In-network reprogramming [Levis2004, Hui2004]
- Calibration and Verification [Szewczyk2004]
- Dependence on infrastructure [Szewczyk2004]

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From Proof-of-concept to Real-world WSNs

Traditional test grid
- Wired
- Immobile
- Not scalable

In-network tools
- Unreliable

Self-organizing backbone network with deployment-support services
Next-Generation Deployment-Support

Deployment-Support Network
- Temporary, minimal invasive
- Virtual connections to nodes
- Reliable, wireless, scalable

Developer Workstation

Target Sensor Network
Debugging vs. Application Demand

**Application Demands:**
- best effort low-rate data transport
- energy efficiency
- size and cost constraints

**Debugging Demands:**
- reliable data transport
- code distribution
- event-/data logging
- time synchronization
- localization

**Architecture Demands:**
- reliable medium data-rate radio
- large memory

**Architecture Demands:**
- low data-rate radio
- small memory
SNMT – Sensor Network Monitoring Toolkit

A suite of services based on the JAWS deployment-support network

- Reliable data transport / multi-hop / RPC
- Remote logging and event detection
- Code distribution / remote programming
- Long-term logging and analysis
- Power and status monitoring
- Coordinated fault injection

Target Sensor Network
JAWS Application Example

Test Setup: 20+ nodes

Event Tracing
- Time-synchronized
- Context switches
- Interrupts
Current Status

Jaws Services
- Reliable data transport / Topology Control
- Event detection / remote logging
- Code distribution
- RPC
- Node status monitoring (battery level / image versions / …)

Tools
- User interface / command center
- Database
- Analysis scripts for Matlab
- Wireless access from Laptop or PDA

Target Interfaces
- BTnode rev.3 (AVR uC)
Ongoing Work

Jaws Services
- Reliable data transport / Topology Control
- Event detection / remote logging
- Code distribution
- RPC
- Node status monitoring (battery level / image versions / …)

Tools
- User interface / command center
- Database
- Analysis scripts for Matlab
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Target Interfaces
- BTnode rev.3 (AVR uC)
- Tmote (MSP430)
Adding Services / Interfaces

**JAWS Application**
- Topology Control
- Connection Management
- Data Transport
- Caching
- Node Management

**WSN Target Application**

**Target Adapter**
- Target Control
- Programming
- Logging

**Monitor**
- Threads/IRQs
- High level context

Codesize 100 kB

- 4 kB
- 2 kB
Example

User Interface / Database

Jaws/RPC

Query

Result

Target Adapter

stub

Monitor

read sensor

PC

DSN Node

Target
Thank you!

Questions?

http://www.btnodes.ethz.ch