SensMGT Report

Wireless sensor/actuator network management/configuration applications
Plan

- SNMP Instrumentation of WSN430 Nodes
- Distributed and Piggybacked Monitoring in LLNs
- CoAP Resource Discovery using Piggybacking
- CCNx for Contiki
SNMP Instrumentation of WSN430 Nodes

Why SNMP?

- Internet Standard
- Widely Deployed
- Lightweight Implementation

https://gforge.inria.fr/scm/viewvc.php/trunk/sensmgt/?root=sensas
Our Goal

- Get SNMP running on the WSN430 nodes
- Instrument the Sensor:
  - Network Interface
  - Sensors Data
- Build a Management Interface
Contiki-SNMP (Jacobs Univ. Bremen)

- GET, GETNEXT and SET
- SNMPv1 and SNMPv3
- User-Based Security Model for Authentication and Privacy

http://code.google.com/p/contiki-snmp/
Instrumentation using Contiki-SNMP

- SNMPv2-MIB (system info)
- IF-MIB (network interface info)
- ENTITY-SENSOR-MIB (sensor data)
- ROLL-RPL-MIB (network topology info)
User Interface

- Uses ROLL-RPL-MIB to discover the sensors (rplDodagChildTable)
- Based on the Copper Firefox Extension
Implementation Issues

Size Issue:
- WSN430 only offers 48kB of ROM
- 6LoWPAN and RPL already take more than 36kB
- Only SNMPv1 was enabled (~7kB)
- gcc -ffunction-sections
- Flash and other drivers removed

Network Issue:
- Fragmentation, robustness
Distributed and Piggybacked Monitoring in LLNs

- Monitoring
  - Obtain info about the network health (signal quality, connectivity, battery level)
- Distributed Monitoring
  - Scalability (large number of nodes)
  - Local aggregation (energy efficiency)
- Piggybacking
  - Preserve channel for the primary task
Our Goal

- Devise RPL based monitoring role assignment strategies
- Develop a piggybacking library for Contiki
Poller-Pollee Monitoring Structure

- Nodes can have a role of poller or pollee
- Pushing
  - Pollee pushes data asynchronously towards the root
  - Next poller on path aggregates data
  - Periodically or event driven (threshold)
Monitoring Roles Placement

- Too many pollers causes network overhead
- Too few pollers increases distance between pollee and next poller, and might cause data loss
- Related work: Liu & Cao, “Distributed Monitoring and aggregation in wireless sensor networks”, INFOCOM’10
  - Minimizes number of pollers
  - Guarantees a maximum distance between a pollee and its poller
  - But requires specific setup & maintenance messages
  - Independent from routing overlay, poller can be further from sink
Critical parent based poller placement

- Uses additional field in DAO
- Root is poller, leaves are pollees
- If node X is the single candidate parent of one of its direct children, X becomes a poller
Critical link based poller placement

- Root is poller
- Leaves are pollees
- If Node X has a single candidate parent, X becomes a poller
K-distance Rule

- In case of dense networks, previous algorithms fail
- Use DAO to backtrack hop count since last poller
- When set threshold is reached, node becomes a poller
Poller Placement Recap

- Benefits from RPL advantages
- Small network overhead
- Protects critical links from congestion

Lahmadi, Ciarletta, Boeglin, Festor, “Routing based Roles Assignment for Monitoring 6LowPAN Networks”, ComNet’12
Piggybacking Extension for Contiki

- Devised for usage with 6LoWPAN & RPL
- Appends data to existing packets as IPv6 Hop-by-hop extension header option
  - Only piggybacks on packets with next hop equal to RPL preferred parent
- Each node has its own circular buffer
  - Piggybacking decision is hop-based, not path-based
  - Pollees put monitoring data in buffer AND piggyback data from buffer
  - Pollers fetch data from buffer, and aggregates/process (event based)
Extension Header Support

- Current implementation in Contiki is ad-hoc
  - Only supports one single RPL Option
- Redeveloped, defining a generic API
  - Find, add, remove complete extension header
  - Find, add, remove option in specific header
- Used generic API to replace ad-hoc RPL Option support
Current Issues

- Generic Extension Header API not (yet?) in Contiki source tree
- Fragmentation prevention
  - Actual 802.15.4 packet length depends on 6LoWPAN compression

Ext. headers: https://github.com/boeglin/contiki
Piggybacking: ToDo (patches in SensAS SVN?)
CoAP Resource Discovery using Piggybacking

What is CoAP?

- Internet Drafts of the Core WG
- REST compliant
- Maps to HTTP
- Designed for constrained environment
Our Goal

- Discover CoAP servers in a sensor network
- Generate the fewest possible traffic
Architecture

- RPL root is a poller, other nodes are pollees
- Pollees that also are CoAP servers periodically piggyback an ID
- Poller maintains a table of alive CoAP servers
- Table is presented as a CoAP resource
- Copper Firefox Extension is used to query the server list, then individual servers
Keepalive Mechanism

- Each table entry is associated with a timer
- When timer expires, node is removed from table
- Optionally, poller can send a ping to pollee and wait for an additional timer
- Pollee must reply within this timer, piggybacking its ID
CoAP Resource Discovery using Piggybacking Recap

- Not a standard (CoAP now uses Multicast for server discovery)
- Code not yet published (currently in a private git repo)
CCNx for Contiki

- CCN is a communication architecture built on named data
- Identification and transport of contents rely on names and not on location
- Increases the availability of data by caching
- CCNx is a protocol for the CCN communication architecture

http://www.ccnx.org/
Our Goal

- Implementation of a fully operational CCN communication stack for the Contiki operating system
- Adaptations to fit WSN constraints
CCNx Stack Overview

- Implements CCN processing functions, message forwarding and data caching
- Manages event posting to processes
- CCN Driver: handles message exchange with the lower layer
CCNx Stack Details

- Hierarchical names with components of arbitrary length
- Names in URI representation
- Content storage at intermediate nodes

Prefix:
/Temperature/Inria

Names of Contents:
/Temperature/Inria/Floor1/Office132 : 21° C
/Temperature/Inria/Floor2/Office214 : 19° C
/Temperature/Inria/Floor1/Office125 : 18° C
CCNx Messages Adaptation

- Simplified “Interest” and “Content Object” messages, to avoid fragmentation
CCNx for Contiki Recap

For further details, please check the CCNx-Contiki project website

http://ccnx-contiki.gforge.inria.fr/
Questions?