ICN in the IoT on RIOT

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Outline

1. Problems & Scenarios
2. ICN-IoT Platform: CCN-lite on RIOT
3. Content Dissemination in the IoT: Implementing Pub/Sub
Problem Space (that we look at)

• Constrained systems
  – Memory: scarce kBs
  – Storage: the least constraint (if available)
  – Operations: possibly long sleep cycles

• Communication
  – Event triggers insufficiently supported: want no push on the data plane
  – Data availability: timely at lowest price

• Naming
  – Role of contexts unclear
Typical IoT Network Scenarios

• Sparse deployment (of fixed devices)
• Inhomogeneous node coverage
• Partitioned networks
• Mobility
• Intermittent connectivity
• Selected uplinks into a cloud environment
Opportunities with ICN for IoT

• Mobility
  – Mobile devices are common for the use cases
  – Content counts, not addresses

• Security
  – False alarms may lead to shutdowns
  – Dropped alarms may lead to health risks

• Network management
  – Easy deployment and auto-configuration
  – Reducing total cost of ownership

• Network caches
  – May reduce latency for multiple services
  – Fixed devices anchor network caching
Shortcoming of ICN in the IoT

Routing on Names
• Long names, limited aggregation potentials
• FIBs (too) large, high churn potentials

Simplified Link-layer Model
• NDN assumes point-to-point or broadcast

IoT Wireless is a Broadcast Domain
• Lack of L2 mapping moves all packets to the CPU
  – Increases system load and energy consumption
• IoT link layer technologies usually restricted to short MTUs
  – Enhanced susceptibility to interference and loss
Implementing ICN in the IoT: Network Stack

Which ICN implementation?
• CCN/NDN

Which operating system for IoT?
• RIOT

Porting CCN-Lite to RIOT
• 1,000 lines of C code
• Required ROM 16 kBytes
• Required RAM 5 kBytes

CCN-lite on RIOT

• Joint development started in late 2016
• Objective: Maintain CCN-lite as a RIOT package
• Major refactoring started
  – Code reorganization
  – New source structure and include policies
  – Many bug fixes & adaptations (56 PRs closed so far)
  – Features related to IoT platforms
• Dedicated branch in CCN-lite repo: https://github.com/cn-uofbasel/ccn-lite/tree/ccnlv2
New Features

• CCN-Lite runs on a wide range of IoT devices via RIOT (analog to NDN-RIOT)
• LoWPAN support added to CCN-Lite
  – CCN-Lite implements RIOT’s recursive `netapi`
  – Inherits support for all protocols/drivers
• Multi-Transceiver /Multi-Stack-Support in RIOT
  – Enables easy gateway functions
  – ICN-MQTT gateway ready
• Two new hooks in CCN-lite
  – `on interest`
  – `on cache full`
Roadmap & Ongoing Steps

• Building a build system:
  – Modularize code dependencies
  – Produce Makefiles ...
• CI similar to RIOT environment – replace Travis?
• Enhance data structures for constrained devices
• Eliminating dynamic memory allocation
  – Provide a fixed size, dynamically usable mem-pool
  – Trade protocol state with cache
  – Limit names by a fixed max length
Content Dissemination

• How to publish data efficiently without continued node presence and huge FIBs?

• draft-gundogan-icnrg-pub-iot-00
Pub/Sub in ICN?

• Common Pub: Push on the data plane
• ICN paradigm contradicts pushing of data – still there is around
  – Unsolicited Push Message
  – Interest Notification
  – Long-Lived Interest
  – Interest polling
• What happens on the control plane?
ICN Control Plane

• Distributes routing information
• Fills FIBs → distribute names
  – Originally plain broadcast
  – Flooding according to selected routing protocols
  – Unicast push to Name Collector (PANINI)
  – Request/Response replication (Chronosync)
• Publishing = Making a name available?

Pub/Sub Approach

• Construct a rendezvous network
• RPs are content nodes
  – Gateways
  – Caches
  – Content stores (CDN replica ...)
• RPs announce prefixes
  – Prefix-specific default routing
Publishing Names

• A content producer 'tells' the new name to the content node
  – Name advertisement along default route (Panini NAM)
  • Pushing the name, not the content
Publishing Content

• The content node may request data
  – Replication to caches/deputy nodes
  – Data follows Interest
Subscribing to Content in the IoT

• Interest - following default route
  – Returns a unique content item
  – May carry a „sub“-indicator for future alerts

• Name advertisement
  – Meta table (polling)
  – NAM advertisement (broadcast/multicast)
Implementation
Questions & Discussion?

http://ccn-lite.net/

http://riot-os.org/