Tutorial proposal

A practical guide to MAC implementation and general MAC design guidelines for Body Area Networks

Subject Area: Communications and Networking, Medium Access Control Design and Implementation

Intended length: Half day

Instructor:

Athanassios Boulis, Researcher at NICTA, (conjoint) senior lecturer at Computer Science and Engineering Dept. University of New South Wales, honorary associate at School of IT, University of Sydney

Summary

The tutorial will expose attendees to issues with MAC implementation from a specifications document, and to generic design issues with BAN MAC. It will show how implementation and design are tightly linked in practice, despite the theoretical ideal of clean separation. It will offer practical advice on MAC implementation; it will examine common pitfalls with MAC design, and propose ways to guard against them. Modelling and various abstractions will be studied, as well as different ways to implement the event-driven state machines that MACs are. This will be a hands-on tutorial: writing snippets of code, testing simple MAC ideas in simulation during the tutorial, making things break and fail! The Castalia Simulator will be used for all simulation needs, offering a platform tailored to BAN MAC evaluation needs. No prior knowledge of Castalia is required.

Tutorial outline

Introduction: Issues with MAC design and implementation.

- Is MAC design another art form? Have you heard the term “MAC war”? Have you been in one?
- How do you design a MAC? How is it evaluated?
- Simulation as the starting exploration point.
- Have you implemented a MAC? The complexity turning point. Personal testimonies

How do models affect MAC design?

- Radio abstractions.
- Unreliable wireless channels.
- Clock drift.
- How would a MAC on ideal conditions look like? Construct toy example. Introduction to Castalia. Test with and without realistic models in simulation.

From specification to implementation: MACs are described in natural language. The specification document tries to capture an implicit event-driven state machine with events coming from the radio and the layer above MAC (network or application).

Since there is no rigorous language for specification, often important parts of the state machine are omitted (e.g., an action or state-change when a particular event happens at a particular state). But even when we fill in the gaps we have to implement this state machine. Usually the level of abstraction we are working is a programming language, such as C++. How do you implement this state machine? How can you be sure of its correctness? Practically you are not. The best outcome one can practically hope is to have the simplest mental model together with a solid code structure that will allow the quick discovery and correction of bugs.

- Are events predefined and set? The right abstractions. Study examples.
- Choosing your states. State-space explosion.
- Different mental models of the state machine. Combat state explosion. Try examples
- Use of timers. Try examples.
- Finding missing clauses and/or actions in specs

Bringing it all together:

- Study aspects of the baseline IEEE 802.15.6 MAC proposal [1]

Intended audience

The tutorial is intended for students, researchers and practitioners in the area of Wireless low-power Networks, such as Wireless Sensor Networks and Body Area Networks. Desired background knowledge: familiarity with generic MAC concepts such as contention access (e.g. CSMA/CA) and scheduled access (e.g., TDMA), exposure to basic communications theory and physical layer terms such as modulation and RSSI.

Prior history of the tutorial presentation

This is the first time the tutorial will be delivered. It is distilled knowledge and experience from the ongoing work of the instructor's team on MAC implementation and design, specifically for Body Area Networks. Part of this knowledge is the experiences of implementing a popular wireless sensor network MAC (T-MAC), which was published in WCNC 2010 [2]. A study on BAN MAC closely related to some of the topics of the tutorial was also submitted as a full paper in BodyNets 2010. [3]

Instructor's short biography

Dr. Athanassios Boulis is a researcher at NICTA, the Australian research centre of excellence in ICT. At NICTA he works in a BAN-related large-scale project called Human Performance Improvement (HPI). Within HPI he is the leading researcher in BAN MAC design. NICTA-HPI is part of the IEEE 802.15.6 standards task group that shapes the future standard on BAN. Dr. Boulis is also the lead architect and software engineer behind the Castalia open source simulator [4]. Castalia has been in development since 2006 (gone public 2007) and has a wide base of users in the wireless sensor networks community. In 2009 Castalia has been enriched with the BAN-specific channel models developed within HPI and aspires to be a major tool in evaluating BAN MAC proposals. Dr. Boulis' other research interest include

development of Wireless Sensor Network applications, distributed algorithms for WSN, simulation and modelling, and programming abstractions for networked embedded systems. Dr. Boulis received his PhD and M.S. diplomas at the Electrical Engineering Dept. of UCLA conducting research on wireless sensor networks under the guidance of Prof. Mani Srivastava. He received his B.S. diploma from the Electronic and Computer Engineering Dept. at Technical University of Crete, Creece.

References

[1] SMA-WiBAN, "MAC and Security Baseline Proposal", IEEE 802.15 Documents, Document no. 196, rev.2, Mar 17th 2010, https://mentor.ieee.org/802.15/documents?is_group=0006

[2] Y. Tselishchev, A. Boulis, L. Libman, "Experiences and Lessons from Implementing a Wireless Sensor Network MAC Protocol in the Castalia Simulator," IEEE Wireless Communications & Networking Conference 2010 (WCNC 2010)

[3] A. Boulis, Y. Tselishchev, "Contention vs. Polling: A Study in Body Area Networks MAC Design," Submitted in BodyNets 2010.

[4] Castalia Simulator, http://castalia.npc.nicta.com.au