

Verification of the Contiki-NG Operating System for the Internet of Things Double Linked Lists

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Context

Connected devices and services, also referred to as Internet of Things (IoT), are gaining wider and wider adoption in many security critical domains. This raises important security challenges, which can be addressed using formal verification.

Contiki [5] is a popular open-source operating system for IoT devices providing full low-power IPv6 connectivity, including 6TiSCH, 6LoWPAN, RPL, or CoAP standards. It is implemented in C with an emphasis on memory and power optimization, and contains a kernel linked to platform-specific drivers at compile-time. When Contiki was created in 2002, no particular attention was paid to security. Later, communication security was integrated.

Formal verification of the Contiki code was not performed until very recent case studies [8, 9, 2, 7, 3, 4]. These case studies were performed using the ACSL specification language [1] and the deductive verification plugin WP of Frama-C [6].

Contiki-NG ¹ is a new version of Contiki.

The Project

The goal of the project is to verify, using Frama-C and WP, the double linked lists module of Contiki-NG. Single linked lists have already been verified in two different ways [2, 3]. In this project you will consider the adaptation of these two approaches to the verification of double linked list and compare the approaches.

¹<http://www.contiki-ng.org>

Students will be given access to SSERL² (room 227, SICCS) and its machines including the Titan workstation (256 Gb of memory and 32 cores).

Requirements

Minimum Requirements

- Good knowledge of programming in C
- A taste for formal reasoning
- CS 396
- Enrolled in CS 451 for Fall 2019

Preferred Requirements

- CS 451

References

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- [3] Allan Blanchard, Nikolai Kosmatov, and Frédéric Loulergue. Logic against ghosts: Comparison of two proof approaches for a list module. In *ACM Symposium on Applied Computing (SAC)*, pages 2186–2195. ACM, 2019. doi:10.1145/3297280.3297495. Best Paper Award.
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- [5] Adam Dunkels, Bjorn Gronvall, and Thiemo Voigt. Contiki – a lightweight and flexible operating system for tiny networked sensors. In *LCN 2014*. IEEE, 2004.
- [6] Florent Kirchner, Nikolai Kosmatov, Virgile Prevosto, Julien Signoles, and Boris Yakobowski. Frama-C: A software analysis perspective. *Formal Asp. Comput.*, 27(3):573–609, 2015. doi:10.1007/s00165-014-0326-7.

²<https://sserl.github.io>

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- [8] Frédéric Mangano, Simon Duquennoy, and Nikolai Kosmatov. A memory allocation module of Contiki formally verified with Frama-C. A case study. In *CRiSIS 2016*, volume 10158 of *LNCS*. Springer, 2016. doi:10.1007/978-3-319-54876-0_9.
- [9] Alexandre Peyrard, Simon Duquennoy, Nikolai Kosmatov, and Shahid Raza. Towards formal verification of Contiki: Analysis of the AES–CCM* modules with Frama-C. In *RED-IoT 2018, co-located with EWSN 2018*. ACM, 2018.