



Development Engineer for Batteryless IoT Testbed

Student Assistant (SHK) Proposal

Shepherd [1] is a portable and open-source testbed for batteryless IoT nodes. The testbed features several embedded Linux BeagleBone boards with a custom hardware frontend, which are orchestrated and time-synchronized via Ethernet. The custom frontend enables Shepherd to record energy-harvesting traces at high rate and resolution, and to replay these traces to an attached batteryless IoT node to emulate real energy-harvesting scenarios.

A key ingredient of the emulation are algorithms to virtualize different energy harvesters, energy converters, and energy storage capacitors. These algorithms are executed on the BeagleBone by an on-board real-time processor (PRU) that is communicating with Linux running on an ARM core. The software for recording and emulation spans from the PRU over Linux kernel code to high-level Python, enabling flexible experimentation. Using the specialized PRU, however, also comes with drawbacks, such as the lack of a FPU or native multiplication.

Based on interest and background, the student assistant may choose to work on a variety of tasks offering an exciting entry point into the wide spectrum of embedded software development. Possible tasks include:

- **Unit tests for emulation algorithms:** Extending our test suite is key to ensuring correct operation of the emulation algorithms. Suitable test scenarios should be identified, implemented, and used to find bugs.
- **Optimization of real-time code:** The objective is to minimize the model error as compared to an offline implementation while still satisfying real-time constraints.
- **Bringing the toolchain up to date:** The code for the real-time unit is currently compiled with an old and proprietary compiler from Texas Instruments. Transitioning to a more recent GCC port would allow us to eliminate compiler issues and to leverage powerful new language features.

The exact scope and requirements of the work can be adjusted according to the student's interests, background, and time budget. The student will be supplied with the necessary hardware and software tools, and fully supported so that the student can focus on the actual task. Supervision will be possible in German or English.

Requirements

- Good coding skills in Python and C (depending on the task)
- Basic knowledge of Linux, microcontrollers, and electrical engineering will be beneficial

Contact

- Ingmar Splitt, ingmar.splitt@tu-dresden.de
- Prof. Marco Zimmerling, zimmerling@cs.uni-freiburg.de

References

- [1] K. Geissdoerfer, M. Chwalisz, and M. Zimmerling. Taking a deep dive into the batteryless Internet of Things with Shepherd. *GetMobile*, 2020. <https://tinyurl.com/bk592evh>.