

Semester Thesis

DCF77 Based Long-Term Timer

Motivation: Wireless IoT devices are used for numerous applications, e.g. environmental sensing. It is expected that the number of wireless IoT devices will increase significantly in the next few years. Since the available RF bandwidth is limited, it is important to efficiently use it. In addition, IoT devices are often required to have a low power consumption such that a battery lasts multiple years since frequent maintenance is not feasible.

For most communication protocols with high channel utilization (e.g. TDMA schemes), the devices need to have clocks that are tightly synchronized. Usually this synchronization is achieved with packets sent on the data channel. The idea of this thesis is to use the DCF77 time signal as an alternative source to synchronize the IoT devices without wasting channel bandwidth. DCF77 is a longwave time signal transmitter located in Frankfurt which covers a large part of Europe. Investigations on the accuracy of the DCF77 signal [1, 2] suggest that an accuracy below 1 millisecond is possible.

Task: The goal of this thesis is to design and build a timer device that generates a signal at a specified point in time by making use of the DCF77 time signal. The challenge is that the time difference between the request of the signal and the actual timer signal can be up to one day since many IoT devices transmit data very infrequently. In addition, the temporal accuracy of the generated signal should be high (in the order of a few milliseconds) and the device should exhibit a low power consumption. The following steps will be part of this thesis:

1. Familiarize yourself with time synchronization, the DCF77 longwave signal and investigate different variants of DCF77 receiver circuits.
 2. Design a DCF77 receiver circuit that provides high precision time signal detection with low energy consumption.
 3. Implement the receiver circuit and the timer functionality in hardware.
 4. Evaluate the proposed timer device in terms of timer signal precision and power consumption.
- In addition, investigate the availability of the DCF77 signal under different conditions.

Requirements: You should have basic knowledge of analog RF circuits, embedded systems and time synchronization.

Interested? Please have a look at <http://www.tec.ethz.ch/research.html> and contact us for more details!

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References

- [1] Yin Chen, Qiang Wang, Marcus Chang, and Andreas Terzis. Ultra-low power time synchronization using passive radio receivers. In *Information Processing in Sensor Networks (IPSN), 2011 10th International Conference on*, pages 235–245. IEEE, 2011.
- [2] Joannes Laveyne, Greet Van Eetvelde, and Lieven Vandeveld. Wireless synchronisation for low cost wireless sensor networks using DCF77. In *Young Researchers Symposium 2014*. EESA, 2014.

