Poster: mSync – Frames without Preambles

Bastian Bloessl and Falko Dressler

Distributed Embedded Systems Group, University of Paderborn, Germany

{bloessl,dressler}@ccs-labs.org

1. INTRODUCTION

These days the Internet of Things is about to come part of our everyday live. Already today we are surrounded by a vast amount of simple low data rate wireless systems. The applications for those systems are manifold and include weather stations, sensors in industrial automation, car key fobs, and alarm systems. Most recently, car and plane manufacturers started replacing wired sensors with wireless systems to save cabling and, thus, weight and fuel. Typically, frame-based single carrier systems are used. These rely on a preamble for synchronizing to the signal followed by a Start of Frame Delimiter (SFD) and the actual data. Due to short frames sizes, the preamble introduces considerable overhead regarding energy consumption and wireless channel occupancy.

Using the IEEE 802.15.4 O-QPSK PHY as an example, the minimal preamble length is the equivalent of 4 B compared to an ACK size of 5 B or a maximum frame size of 127 B. Another example is a Binary Offset Carrier (BOC) transceiver that we developed in the BATS project [1]. In this project we work towards equipping bats with tiny 2 g sensor motes that send 12 B frames, which can be used for combined data transmission and ranging. Since each frame includes a preamble of 2 B the overhead is significant.

To avoid this overhead we propose mSync (from mirror sync), a frame format and decoding strategy that does not rely on preamble symbols, as it uses the data symbols instead.

2. mSync

The format of a normal frame and of mSync is shown in Figure 1a where the parts of the frame that are actually sent over the air are depicted as filled boxes. With mSync the frame starts immediately with the reversed data symbols. In a first pass, this symbols are used for synchronization only, i.e., they allow receive algorithms like clock recovery to lock and, thus, detect the reversed SFD following the data. Once the SFD is detected the receiver traverses the sample stream again in reverse direction decoding the symbols. This process can be thought of producing a mirrored copy of the received signal (cf. Figure 1a). Since the frame is sent reversed the decoded data corresponds to the data of a normal frame, allowing the rest of the receiver to be left unchanged.

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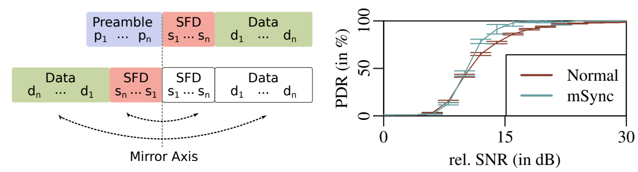

(a) Normal frame format (↑) vs. mSync (↓).

(b) Packet delivery ratio in an office environment.

Figure 1: Comparison of normal frames and mSync.

The important point is that the receiver stays locked while switching directions.

The downside of the approach is a slight increase in complexity and the increased memory demand since samples corresponding to a full-sized frame have to be stored.

3. PROOF OF CONCEPT

To show the feasibility the proposed approach, especially that it is possible to keep the receiver locked while switching directions, we implemented the algorithm in GNU Radio based on the *Mueller & Müller* clock recovery block [2]. We used the implementation for simulations and measurements in an IEEE 802.15.4 transceiver and the BATS transceiver.

Exemplary results for the BATS transceiver in an office environment are shown in Figure 1b. Since the SDRs were uncalibrated the SNR values are relative. We see that while mSync saves resources, it manages to provide similar or even better performance, indicating that the receiver also benefits from the fact that the data signal is longer than the preamble of a normal frame, leaving the receiver more time to lock. For example at the SNR level where the mSync receiver already manages to decode 100 % of all packets the normal receiver is still at a packet delivery ratio of approximately 80 %.

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4. REFERENCES

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