Simple and Efficient two-way Ranging Method for IEEE802.15.4a

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IR-UWB (Impulse Radio Ultra Wideband) is commonly used for RADAR applications. Since the UWB standard IEEE802.15.4a has been introduced in 2004, UWB is also used for communication. Even tho the standard IEEE802.15.4a allows also to perform ranging, no ranging method is mandated. Ranging devices based on IEEE802.15.4a usually exchange timing data in order to determine the distance between each other. Our approach in this work is different and can be performed without any data exchange. The main advantages are shorter and less UWB-frames, higher repetition frequency of measurements, less power consumption and higher robustness. An UWB-Frame consists of 4 parts PREAMBLE and SFD (Start Frame Delimiter) for synchronization and PHR (Physical Header) and PSDU (Physical Service Data Unit) for data transmission.
In Figure 1 a) a commonly used ranging method is illustrated. The two-way ranging is performed twice. Once for A→B and once for A←B. For A→B node A initiates a measurement by sending an UWB-frame and B is responding with another UWB-frame which contains additional timing information in its data part. The accuracy depends in how exact the detection of the pulses are in the receiver. Then A can calculate the time of flight of the UWB signal and therefore the distance. For A←B it is analog to A→B.

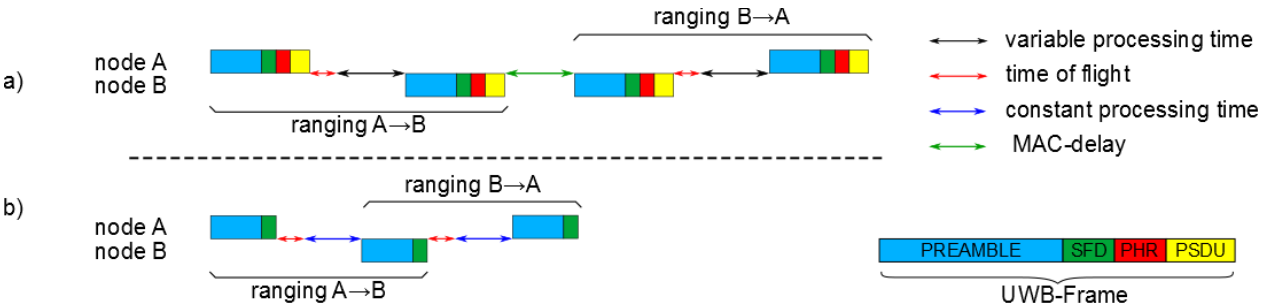

Figure 1: Comparison of different Ranging Methods

The proposed method in this work does not need to transmit additional data, therefore PHR and PSDU are not necessary anymore as illustrated in Figure 1 b). The baseband receiver is able to detect the SFD with an accuracy of 2 ns and the baseband transmitter is able to start the transmission with an accuracy of 2ns. These are the only features needed by the baseband to ensure that the response UWB-frame will always be transmitted with a predefined constant delay.
Depending on the data size and on the chosen data rate the saved time can vary from 20 us to 1228 us. For instance if the timing-data consists of 16 Bytes at the highest data rate of 27,24 MB/s with 16 preamble symbols for the synchronization then the active time is reduced by 57% for each Frame. Because only 3 uwb-frames are needed to perform ranging on both sides for A and B the overall active time is reduced by 67.85%. Processing and MAC delays are not included. Power consumption is considerably reduced by the shorter active time and also by the fact that no data has to be decoded using Viterbi and Reed-Solomon decoder. The robustness and power consumption is also increased because no data errors can occur, and the preamble detection is much more robust against interferences than data detection.