Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Preamble proposal for Long Range SUN-OFDM employing Zadoff-Chu sequences

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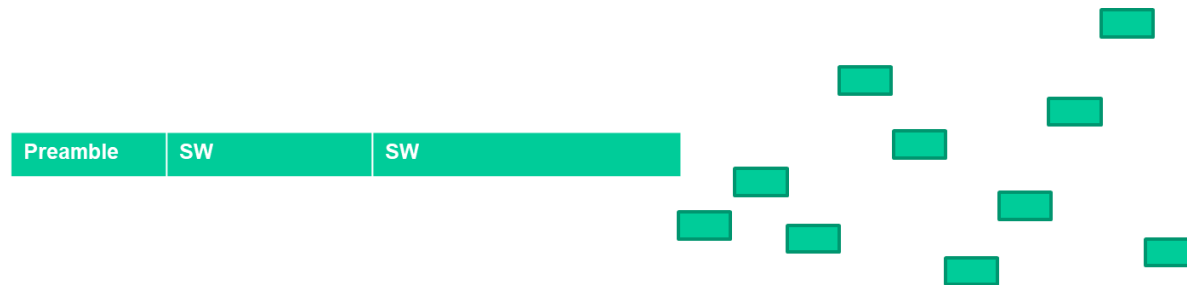
Abstract: Overview of proposed resolutions

Purpose: Discussion

Introduction:

- A single carrier preamble was presented in 802.15 [1]:

  - **Three pre-defined advertiser tones (-12,-2,12).** Only one of them is used for a given TX

- The single tone preamble can be sensitive to co-channel interference and frequency selective fading

  - The preamble tone could be blocked by another transmission

- In this presentation a preamble scheme is proposed with improved frequency diversity, providing better tolerance to narrow band interference.

Preamble requirements:

- Tolerant to narrow band interferers

- Detection sensitivity -120 ~ -130 dBm

- Low PAPR (< 2dB)

- Low detection complexity

  - Low power consumption while searching for Preamble

- IP reuse of HW present in SUN-OFDM transceivers
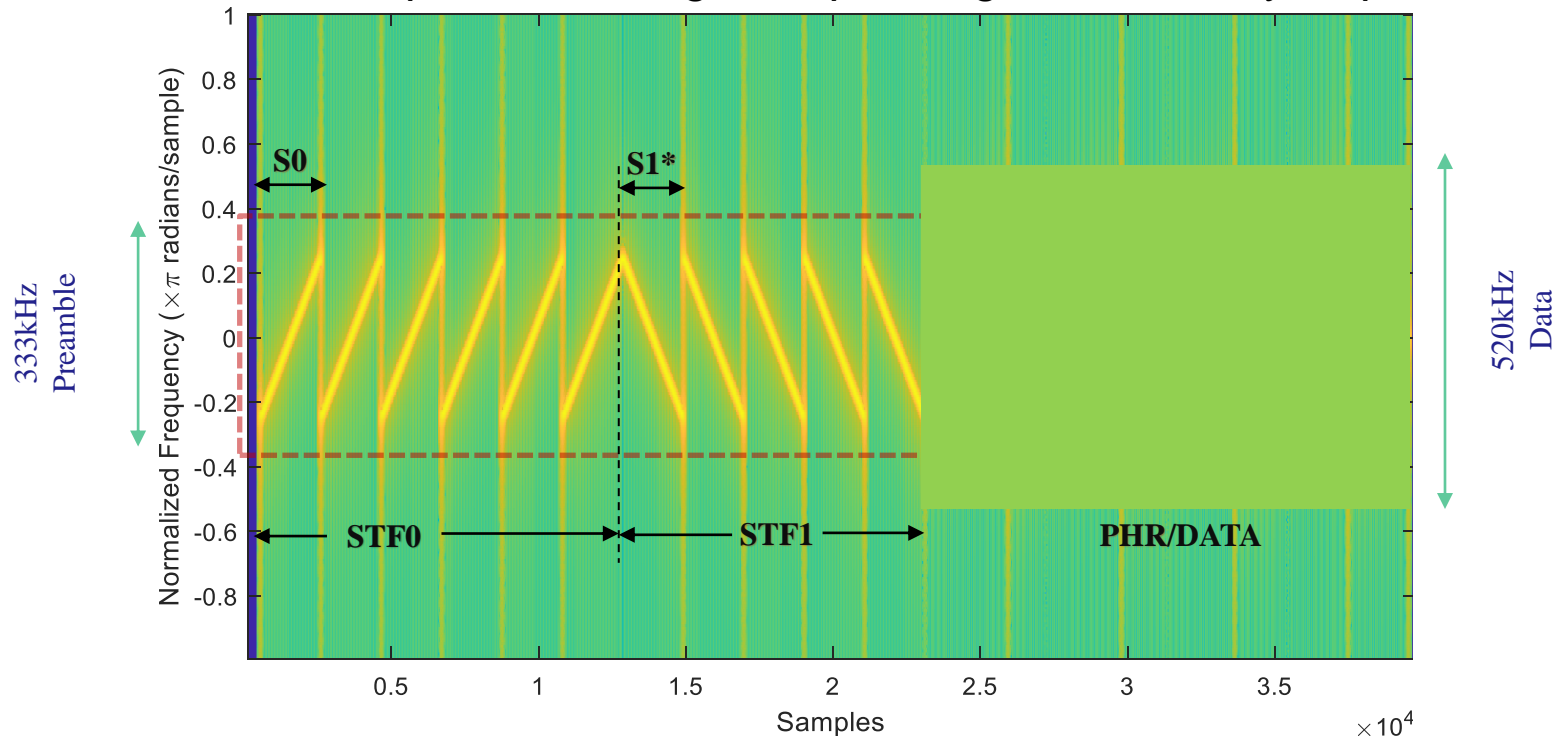
Precoded-OFDM preamble:

- Based on CAZAC sequence
  - CA: Constant Envelope → low PAPR
  - ZAC: Zero Autocorrelation → good detection properties
  - E.g: generalized ZC (Zadoff-Chu) sequence

$$S_{GZC(N,P,Q,U)}[n] = \exp\left(j\left(P + \frac{2\pi}{N}\frac{Q}{2}n + \frac{2\pi}{N}\frac{U}{2}n^2\right)\right), \; 0 \leq n \leq N\text{-}1$$

  - Distinct slope (frequency vs time) can be used suppress detection of other networks (e.g. CSS transmissions)
  - Slope is determined by *U*, *N*, *Fs*
  - If *N* is prime, DFT of ZC sequence is another ZC sequence
  - ZC preambles are used in the 3GPP LTE air interface [2]
   - Combined with an OFDM payload

Precoded-OFDM preamble, example 1:

- Preamble bandwidth: 333 kHz

- Can be divided into two parts

  - STF0 → for preamble detection and symbol time synchronization

  - STF1 → for synchronization (SFD)

- Scalable: preamble length, depending on sensitivity requirement

Precoded-OFDM preamble, example 2:

- Different STF0 and STF1 sequences, could be pre-negotiated to filter out undesired transmissions.

- Besides SFD, ZC can also be used to transmit data:

  - PHR could also be transmitted with ZC sequence (after STF1)

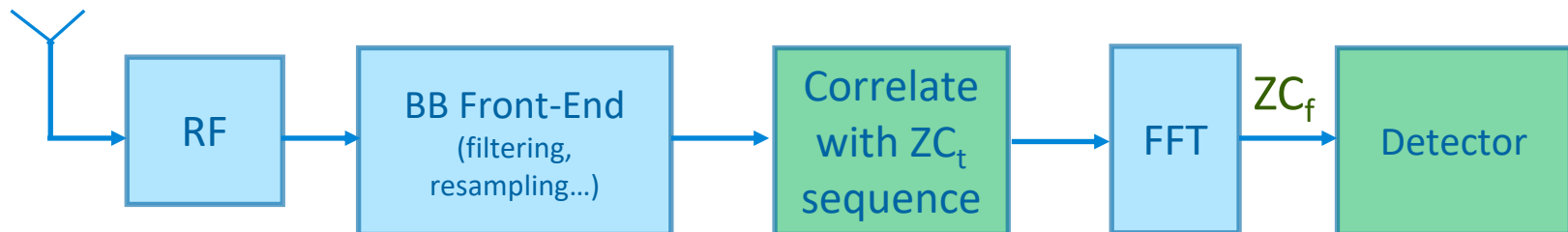 - DATA could also be transmitted with ZC sequence instead of single carrier OFDM
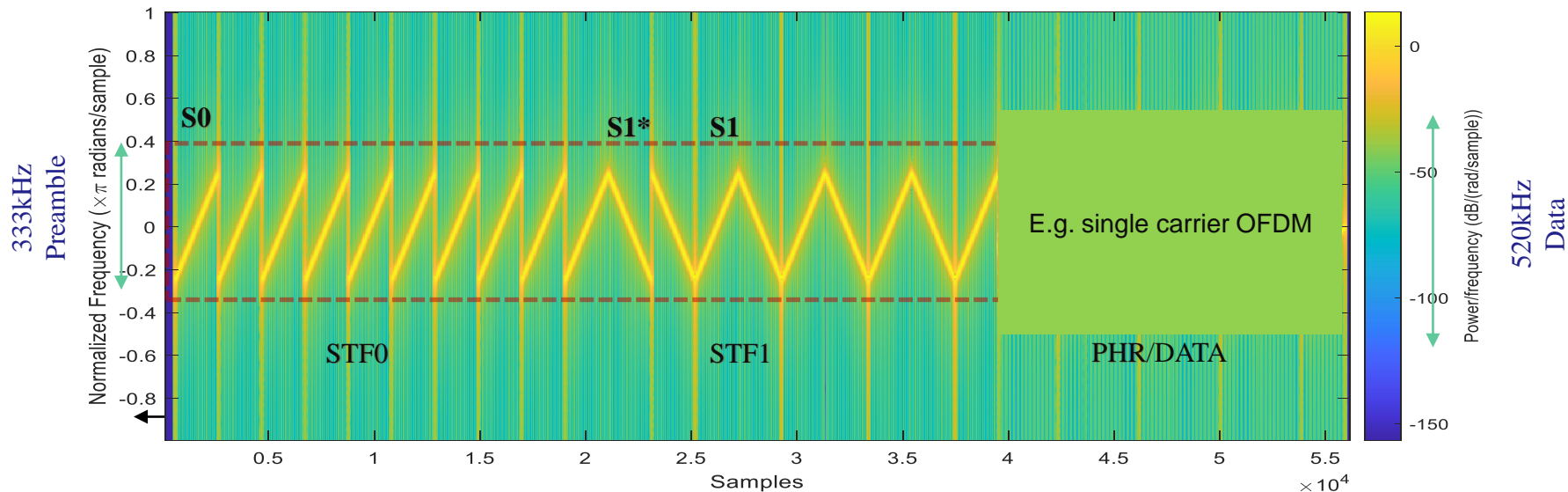
Extensive reuse of SUN-OFDM IP:

- Tx block diagram
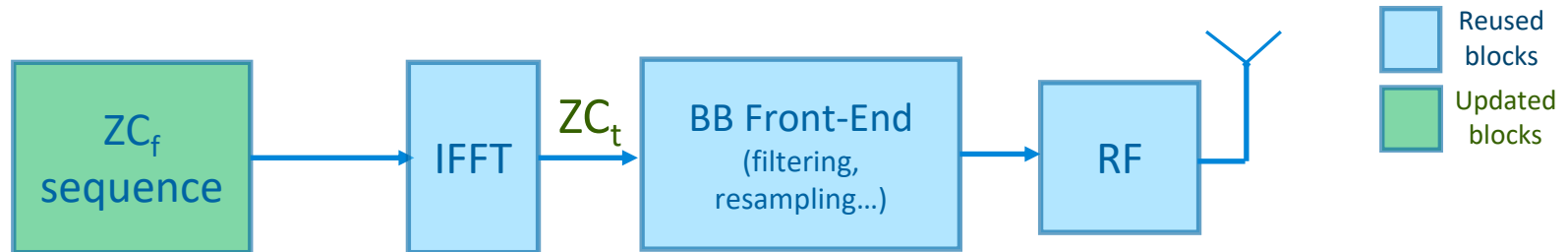
- Rx block diagram

Conclusion:

- A low complexity preamble is proposed with:

    - Improved frequency diversity, and hence, tolerant to NB interference

    - Low PAPR for high efficiency PA

    - Reuse of OFDM hardware is possible

    - Estimated detection sensitivity (1% error rate):

Duration @333kHz	Sensitivity (AWGN)
~30 ms	-130dBm
~18 ms	-128dBm
~14 ms	-126dBm
~8 ms	-124dBm

References:

[1] Low data rate extension of the OFDM PHY, IEEE 802.15, DCN: 15-23-0261-02

[2] ETSI TS 136 211 V9.0.0