

Introduction

The ZigBee communication can be easily and severely interfered by Wi-Fi interference. Error recovery, as an important means for ZigBee to survive Wi-Fi interference, has been extensively studied in recent years. Many recent studies have observed the bursty nature of ZigBee in-packet corruptions under Wi-Fi interference. However, existing error recovery approaches overlook the burstiness, and thus require either unnecessarily complex FEC code design or packet retransmissions. In this work, we exploit the corruption burstiness to design a novel FEC coding using simple XOR operations (called ZiXOR). ZiXOR is based on simple XOR operations and uses fine-grained in-packet RSSI sampling to detect corruptions without CRC bytes, achieving high computation and memory efficiencies. Experiments show that ZiXOR greatly outperforms existing works in terms of throughput.

Corruption Burstiness

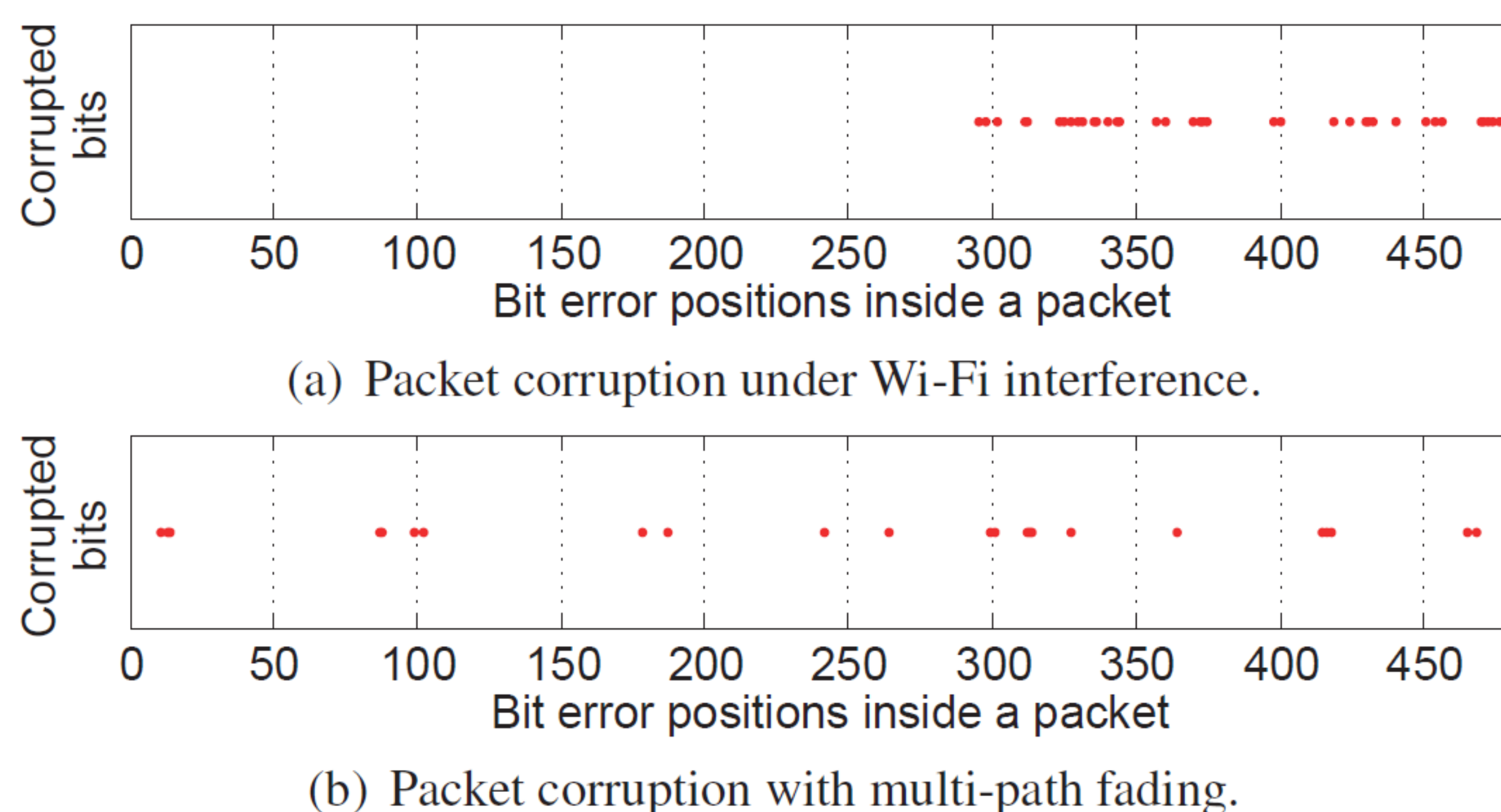
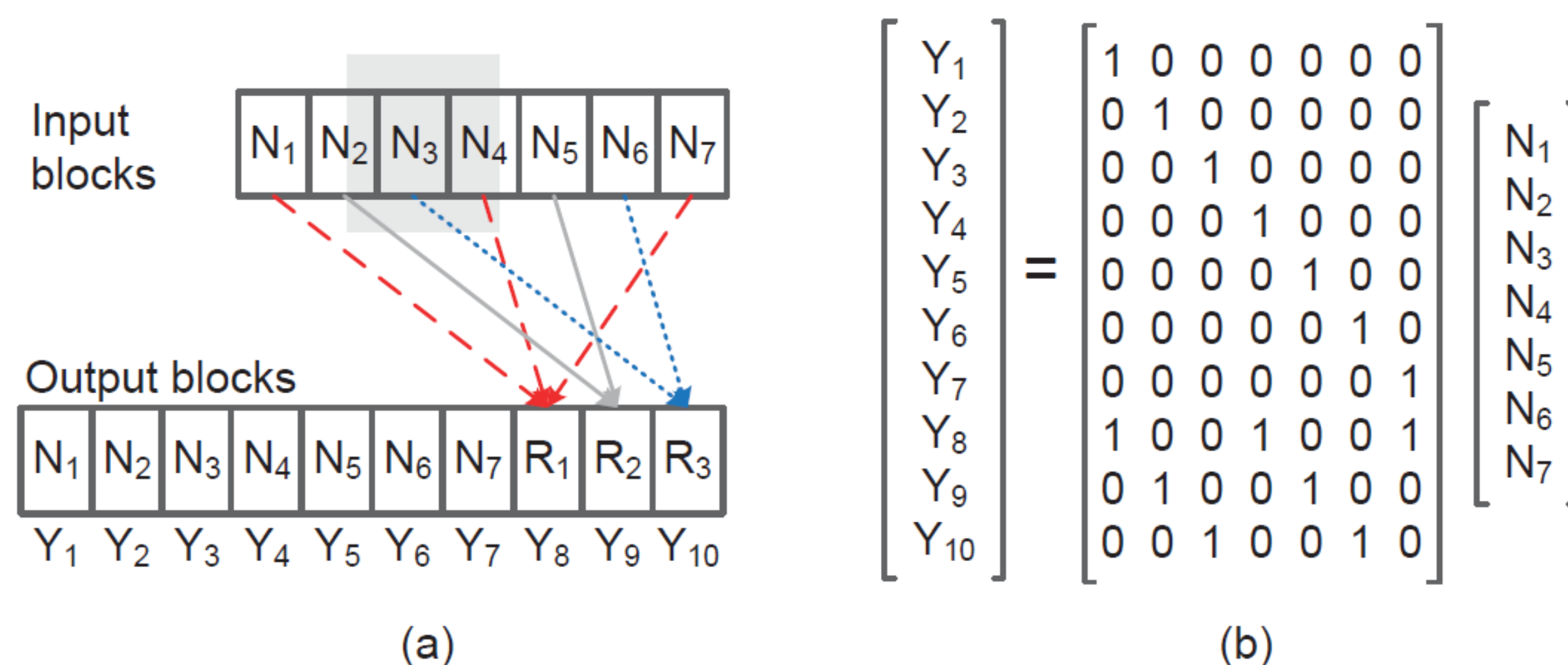


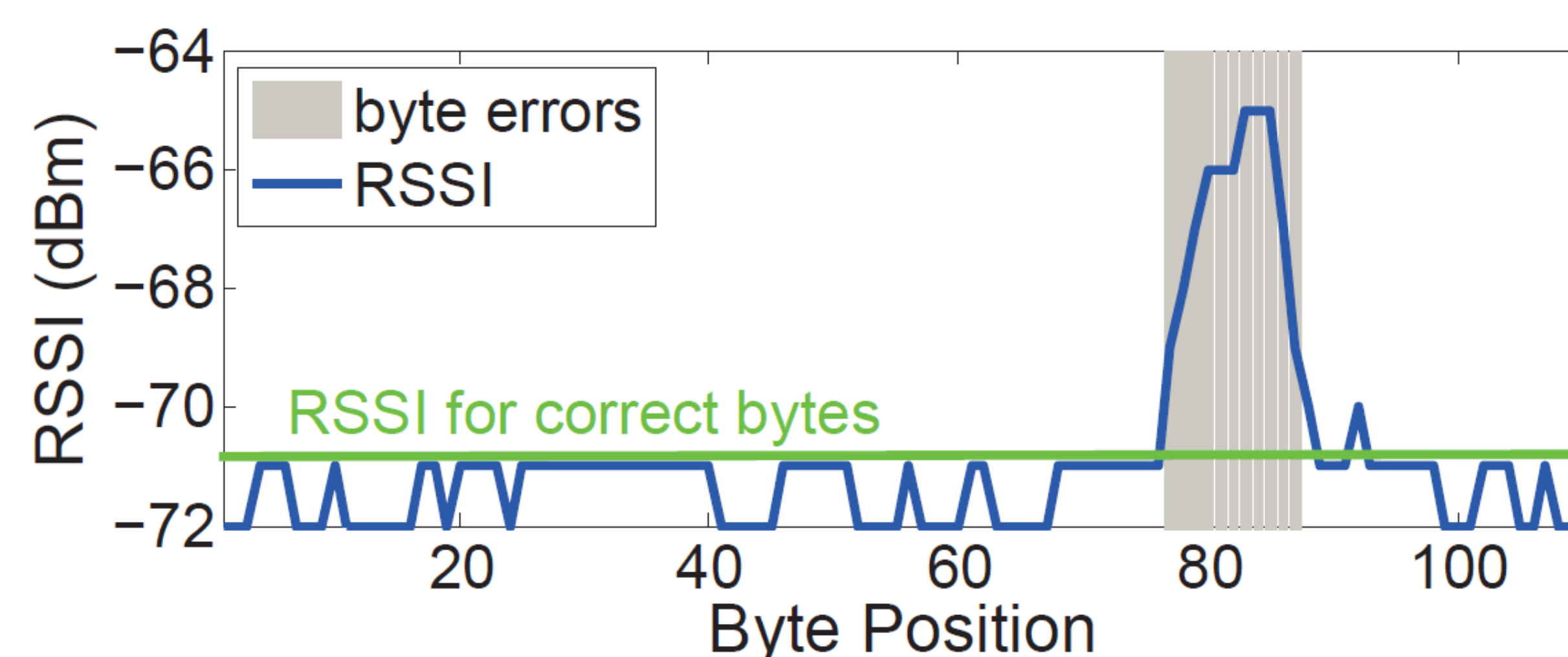
Fig.1(a) shows the in-packet corruptions under Wi-Fi interference and Fig.1(b) shows the in-packet corruptions with multi-path fading. We can see that, the corruptions are highly bursty under Wi-Fi interference. Existing FEC works assume the errors are randomly distributed, leading to unnecessarily complex coding designs. Based on this known characteristic of ZigBee corruptions, we may have chance to greatly reduce the coding complexity.

Key Idea



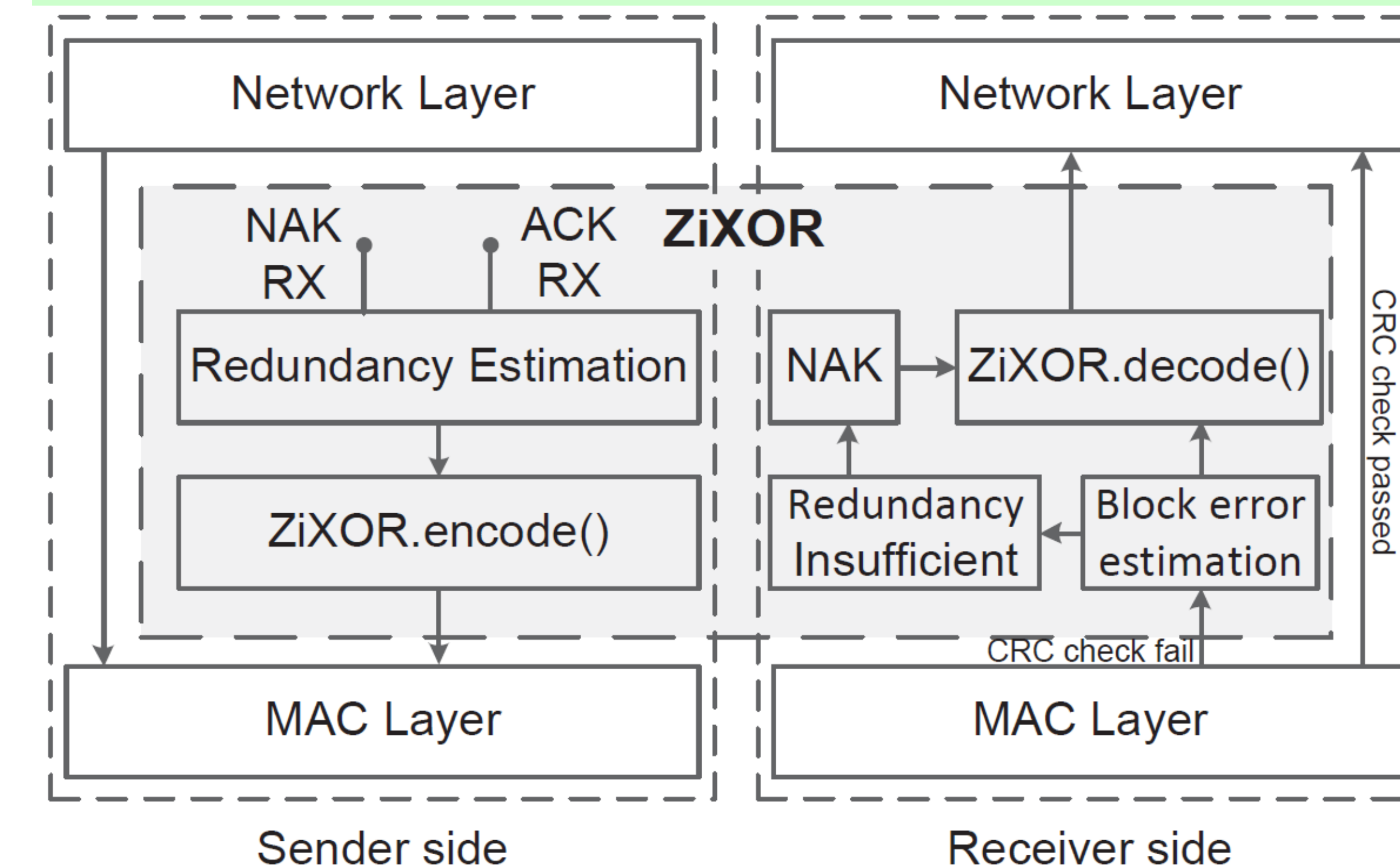
We would like to apply XOR coding because it is quite lightweight compared with other FEC codes such as RS code and BCH code. However, the main challenge to exploit XOR coding for error recovery is that multiple erroneous blocks may be encoded in the same block and thus cannot be decoded. With the bursty nature of corruptions, we can select one block for encoding every b blocks, where b is the burst length, such that each encoded block contains only one erroneous block at most (as shown in the above figure).

RSSI Sampling



Block error detection is another key problem. If we use block CRCs, there will be much overhead. To solve this problem, we use the fine-grained in-packet RSSI sampling technique. The above figure show the in-packet RSSI values of a corrupted packets. The grey parts denote erroneous bytes. We can see that the RSSI values corresponding to the byte errors are much higher than RSSI values of other positions.

ZiXOR Design



There are three key components in ZiXOR.

Block error estimation (Receiver side). In order to avoid the block CRC overhead, we detect block errors using fine-grained in-packet RSSI sampling technique.

Redundancy estimation (Sender side). The number of redundant blocks essentially reflects the burst length. We use moving average to estimate the length.

ZiXOR.encode() and ZiXOR.decode(). Implementation of the above key idea.

Evaluation Results

