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

Submission Title: [Update for FEC and CDR]
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Re: []

Abstract: [Additional information on FEC and CDR]

Purpose: [Contribution to IEEE 802.15.7 VLC TG]

# Simple experimental set-up

Setup:

- VLC Transmitter circuit
- VLC Receiver circuit
- Oscilloscope

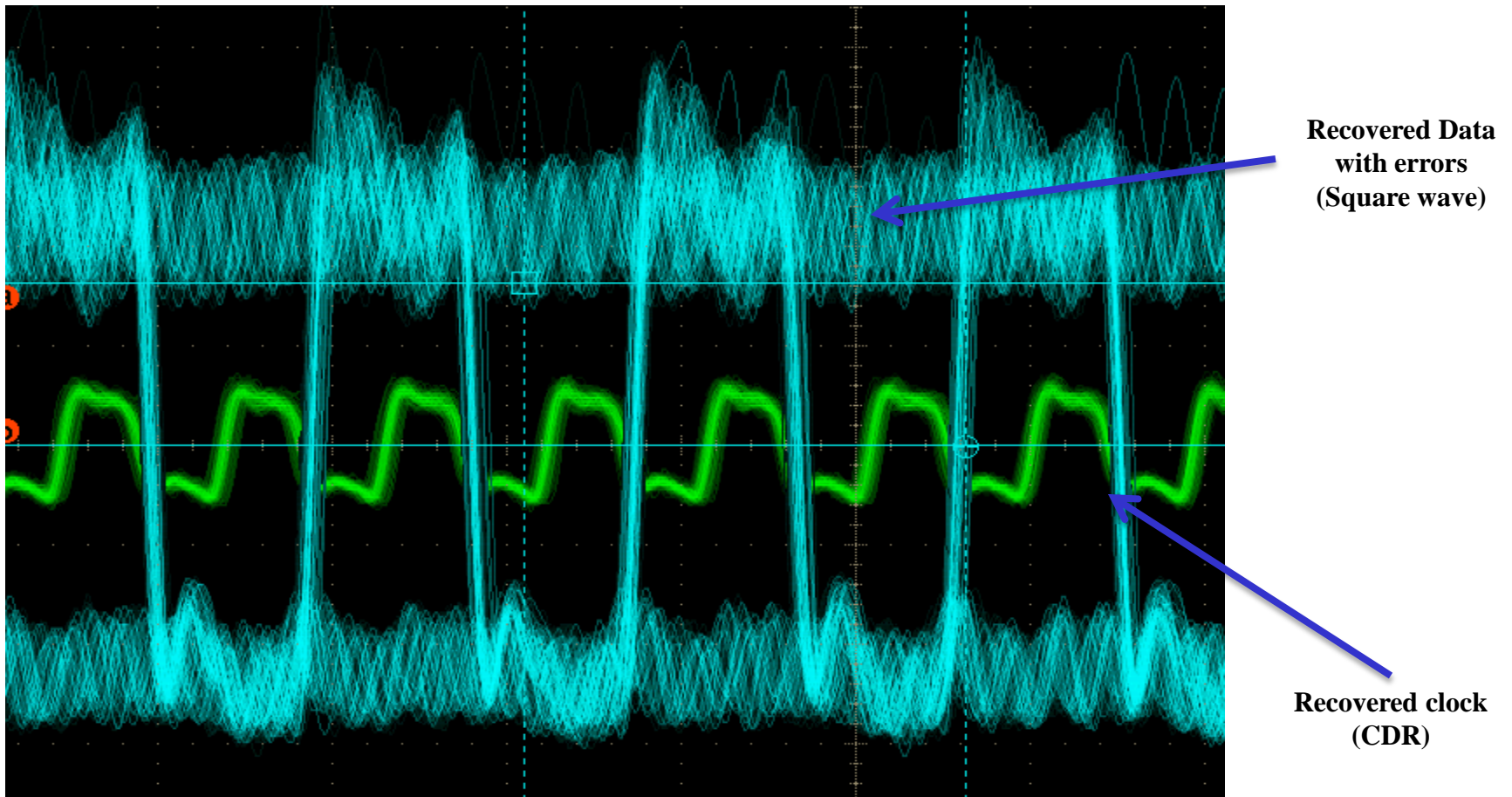## Experiment:

- Input square wave signal for data and see effect on receiver in the scope.
- Move the transmitter further away
- See degradation in data recovery (BER)
- See degradation in clock recovery

Clean signal (short distance)

Recovered Data
(Square wave)

Recovered clock
(CDR)
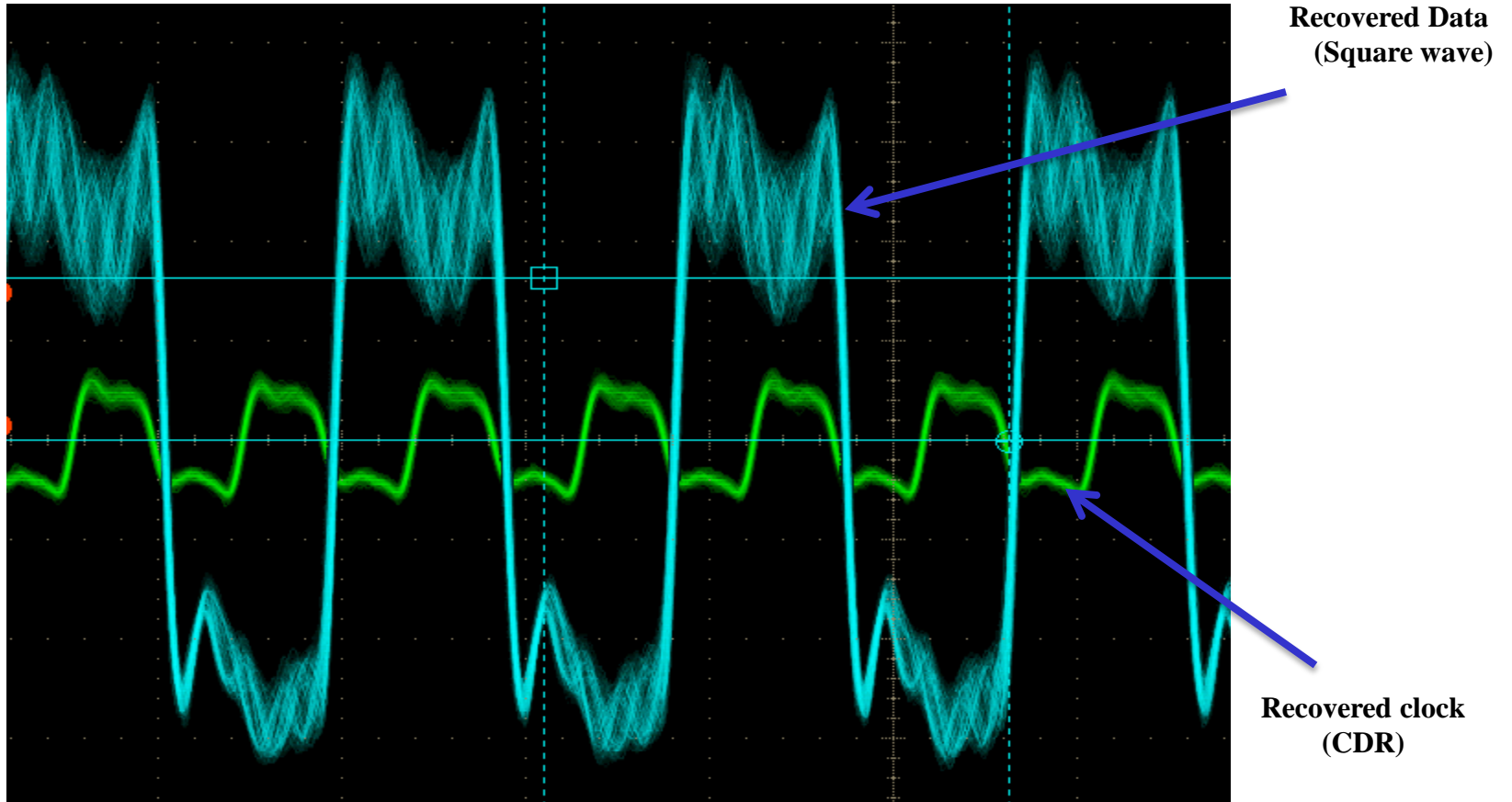
Errors in data (larger distance)

**Recovered Data
with errors
(Square wave)**

**Recovered clock
(CDR)**

Experiment results

Without FEC, such a packet would fail FCS and would be discarded. FEC can help with data recovery.

However, in order for FEC to work, we need to make sure we are able to recover the clock successfully from the transmission

The results verify that it is possible to maintain CDR lock even though the data contains errors [The clock recovery unit is only looking for frequent transitions that are stable and does not care about the data]

Helping clock recovery

Preambles have multiple functions in VLC

- Assisting clock recovery (synchronization)
- Detection of current piconet's transmission in presence of noise and interference
- Rejection of unwanted networks for power savings and better performance
- Marking start of packet header

Updated preamble presented in 733r0

Maximum transition bit pattern is necessary for fast locking and clock recovery

Preamble pattern for detection of current piconet or rejection of other piconets is not useful until clock recovery is attained

Updated preamble proposed in 733r0 to help CDR

Send fast locking pattern before preamble

Reduces the number of preamble repetitions needed for VLC

10101010 ….	Preamble Pattern repetitions

Fast locking pattern

(clock recovery)

Topology dependent preamble pattern
(rejection of unwanted networks)

FEC

Once locking is guaranteed by use of preambles, it is an easy task to clean errors using a FEC

There are different choices for FEC available.

We need to choose one suited for VLC

FEC requirements for VLC

Should work reasonably well in the presence of hard decisions

Should work well with short packets and long packets (different applications)

Should work well with line codes such as 8B10B.

We propose the use of RS codes for VLC

Advantages of a RS code choice

RS code can be implemented well for hard decision decoding systems (can work with soft decisions also for better performance at, of course, increased complexity)

RS codes can be shortened for short packets (do not need to transmit zeros to fill block length)

RS codes work well with burst errors, that are typically seen with line codes. [passive correction]

RS codes can also make use of flagged erasures [half of the line code symbols are invalid at the receiver]. If the 8b10b code flags the received codeword as invalid, RS code can correct twice the number of erasures as errors. [active correction]

Convolutional code does not perform as well as RS code, even with an interleaver added to spread burst errors out of a line code.

Simulation set-up details

All RS codes in the figure are (255, 203) codes, and all convolutional codes are rate-1/2 (constraint length = 7, generators = $[171, 133]_{octal}$).

All decoders are hard-decision decoders.

SNR_{8B10B}= SNR/1.5625 (not SNR * 8/10 = SNR/1.25, see Intel contribution for details).

passive 8B10B-RS: No erasure information passed from the 8B10B decoder to the RS decoder.

active 8B10B-RS: Erasure information passed from the 8B10B decoder to the RS decoder.

In the 8B10B-conv scheme, there are a very simple interleaver.
 Bytes = reshape(convDecoder_output, numberBytes, 8), where numberBytes>1000.

Simulation results [AWGN]
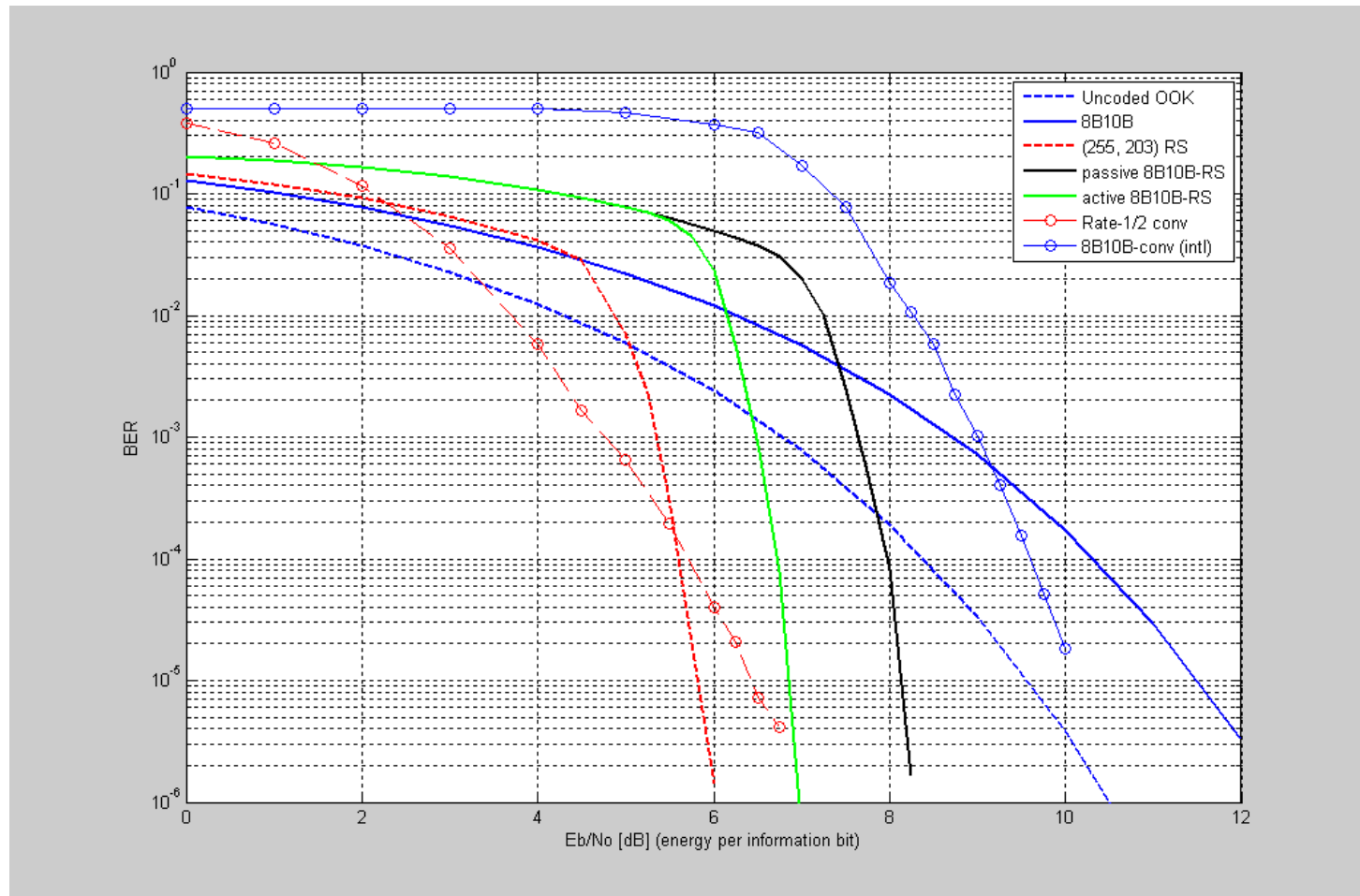
Summary

FEC is important for VLC. However, we need to make sure we can recover the clock via the preamble before we can use the FEC for the header and payload

We propose the use of RS code for VLC

- Hard decision decoding
- Short and long packets
- Can correct burst errors from line codes
- Can make use of erasures for better performance