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

Submission Title: [Cyclic-redundancy-check Codes for Header-check Sequence]
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Re: [15-07-0693-03-003c-compa-phy-proposal.pdf]

Abstract: [Generator polynomial of CRCC for HCS is modified to fit the change of header and subheader lengths at the Atlanta Meeting]

Purpose: [Modification of generator polynomial of CRCC for HCS in the baseline document]

Notes for this proposal

We have already proposed a new cyclic-redundancy-check code (CRCC) for a header-check sequence (HCS) as a part of the CoMPA's proposal at the Montreal Meeting in May 2007 (15-07-0693-03-003c).

In spite of the proposer's intention, the CRCC for HCS shown in the first cut of the baseline document was the conventional one, i.e. ITU-T (CCITT).
Furthermore, we would like to modify the generator polynomials of our CRCC because the header and subheader lengths were changed at the Atlanta Meeting.

Consequently, we hope modification of the generator polynomial of the CRCC in the baseline document.

Motivation

- Undetected error of header possibly induces an improper file transfer.

- There exist some shortened cyclic-redundancy-check codes (CRCCs) whose undetected-error probabilities are significantly lower than that of CCITT for header-check sequence (HCS).

Technical notes

The optimum CRCC depends on the header length.
Thus we modified the generator polynomial of CRCC for HCS to fit two changes at the Atlanta Meeting.

In this presentation, the generator polynomial for combined PHY and MAC header is changed from that proposed by CoMPA at the Montreal Meeting because the header length was changed from 128 bits to 176 bits at the Atlanta Meeting.
Two generator polynomials are prepared because a MAC subheader with a length of 656 bits for a frame aggregation mode was also proposed at the Atlanta Meeting.

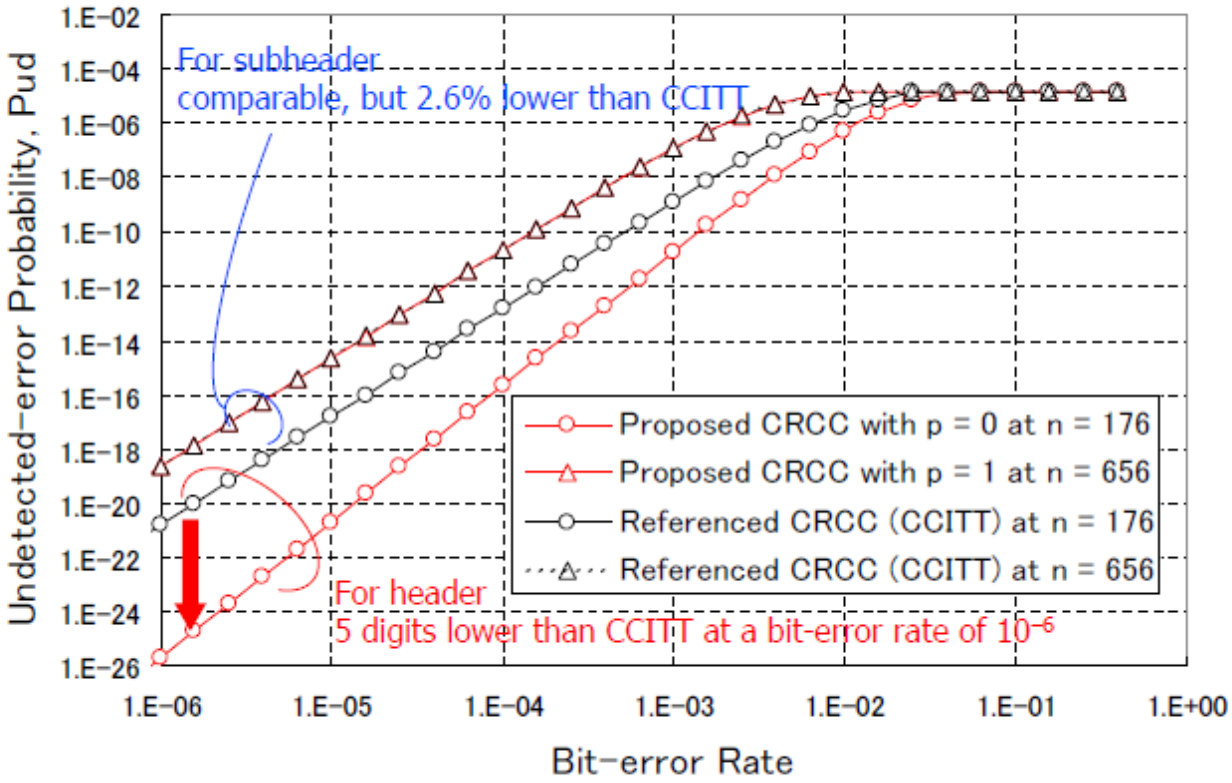
The HCS for 60 GHz PHY in 15.3c can be different from that for 2.4 GHz PHY in 15.3 because the protection mechanism used to validate the MAC header is PHY dependent, as is defined in Section 7.2.6 in the IEEE802.15.3-2003 Standard.

Performance of proposed CRCC

Generator polynomials

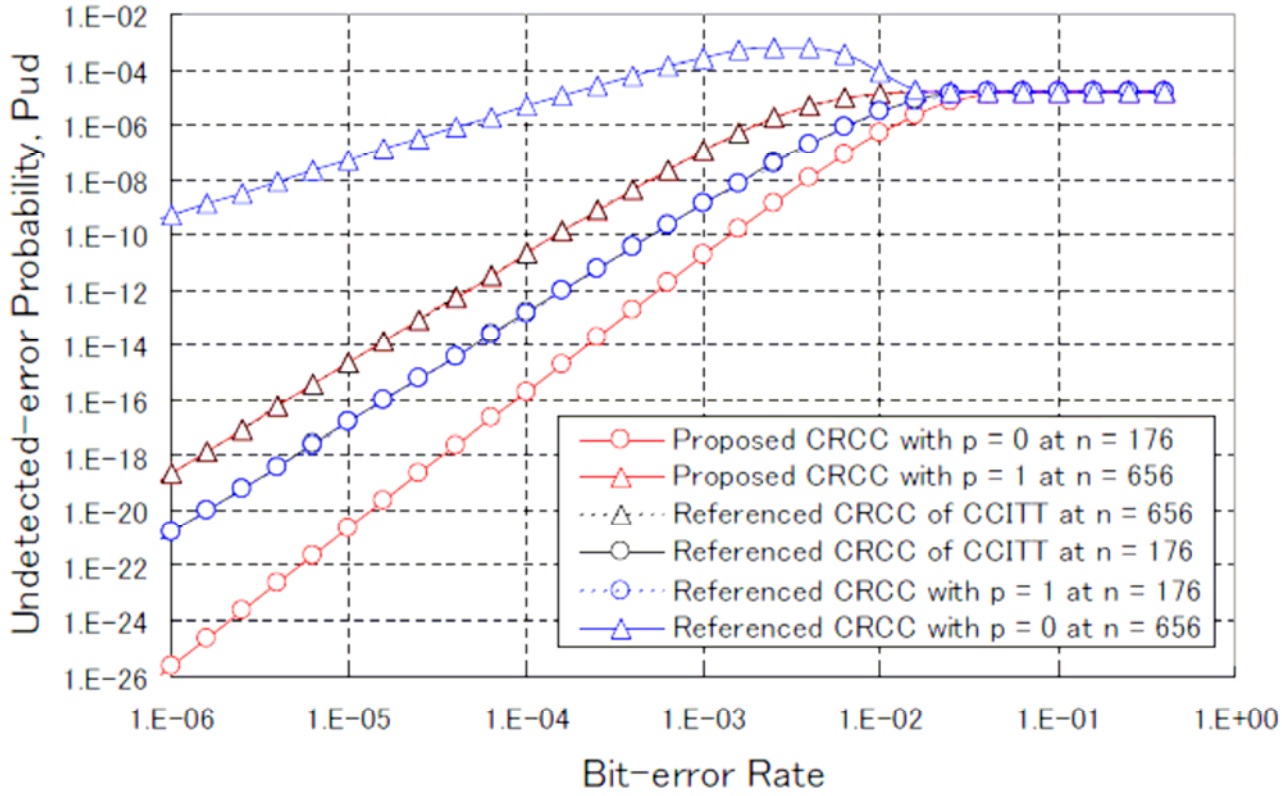
Proposed CRCC: $x^{16}+(1-p)(x^{15}+x^8+x)+p(x^{13}+x^2)+1$

Referenced CRCC (CCITT): $x^{16}+x^{12}+x^5+1$



Undetected-error probabilities as a function of bit-error rate

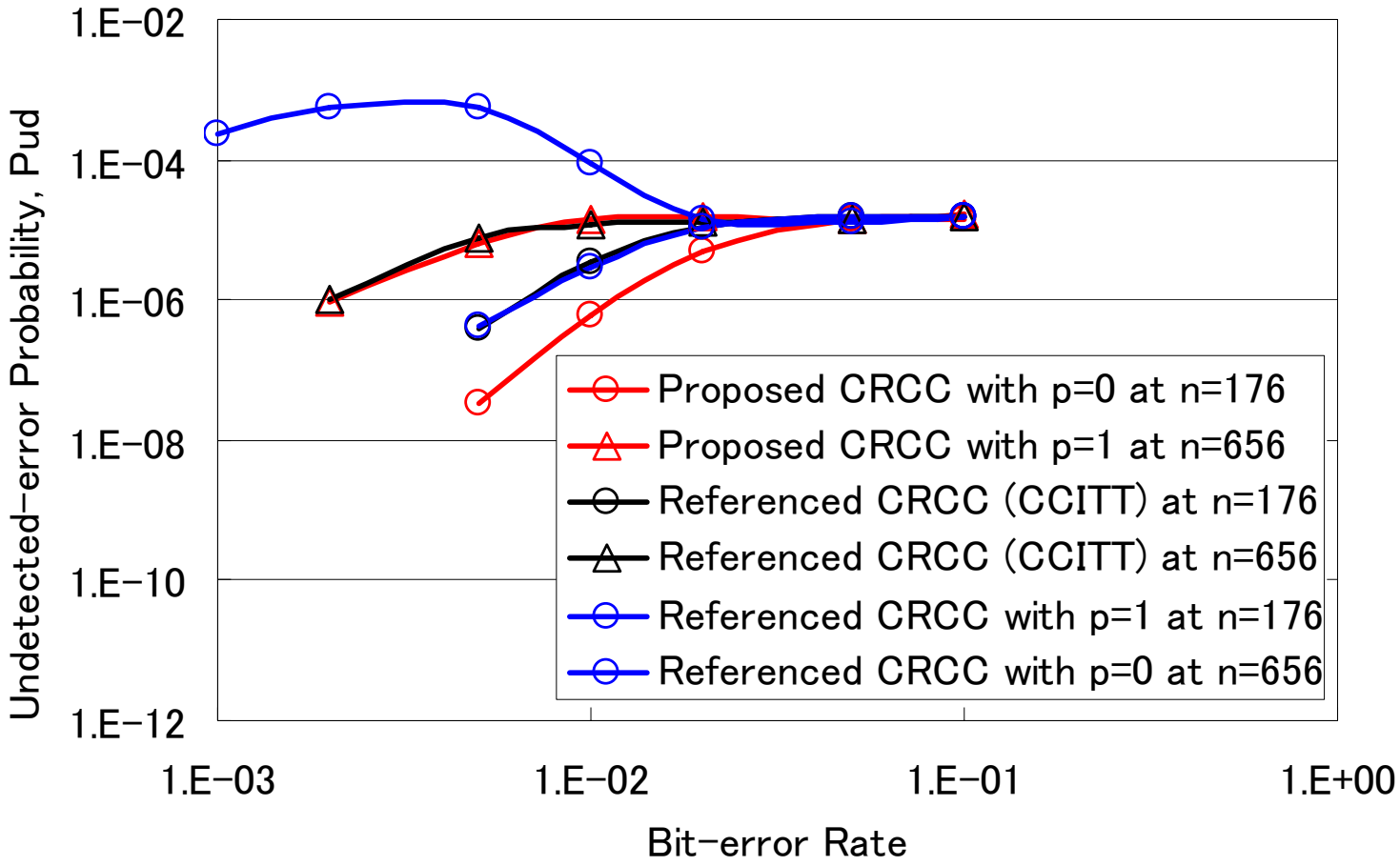
Why the dual CRCC?



- If CRCC with $p = 0$ is used for header and subheaders, the P_{ud} at $n = 656$ is higher than that of CCITT.
- If CRCC with $p = 1$ is used for header and subheaders, the P_{ud} at $n = 176$ is 4.6% lower than that of CCITT. However, the P_{ud} of proposed CRCC with $p = 0$ at $n = 176$ is 5 digits lower than that of CCITT.

It is better to change the value of "p" depending on the header.

Bit-by-bit simulation



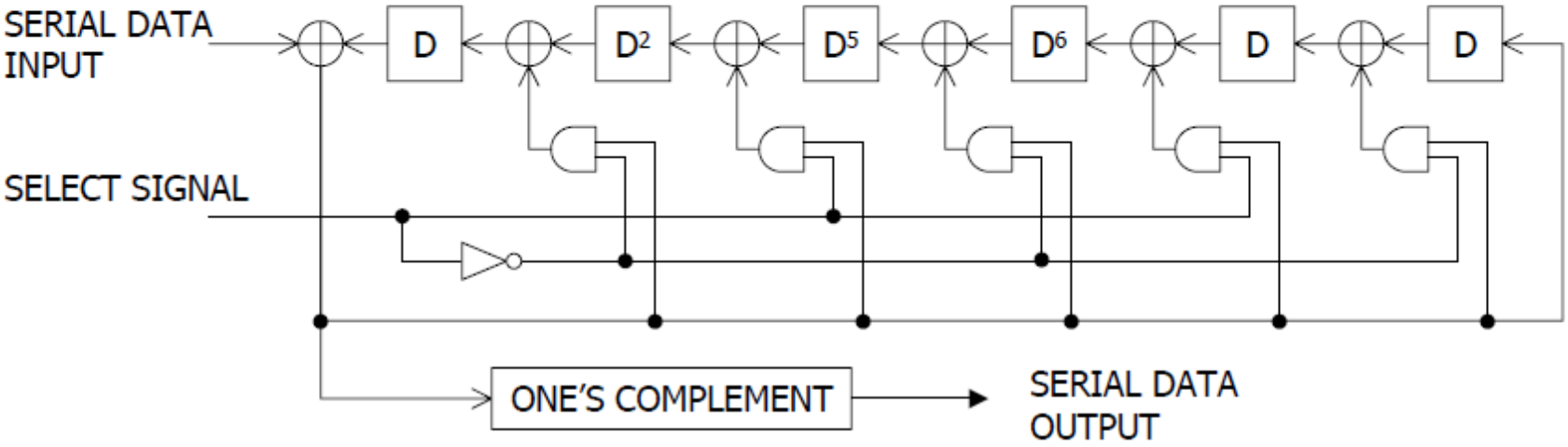
A block diagram of encoder

The increase of size of hardware of the serial encoder for the dual CRCC is just 8 gates compared with that for single CRCC.

Proposed generator polynomial: $G(x) = x^{16} + (1-p)(x^{15}+x^{8}+x) + p(x^{13}+x^{2}) + 1$

p = 0: for combined PHY and MAC headers

p = 1: for MAC subheaders



Summary and conclusion

- The undetected-error probability of the proposed CRCC for combined PHY and MAC headers was significantly lower, e.g. 2 digits lower at a bit-error of 10^{-3}, than that of CCITT.

- The undetected-error probability of the proposed CRCC for MAC subheaders was comparable with that of CCITT, but still approx. 3 % lower than that of CCITT.

- The increase of size of hardware by changing the parameter “p” was negligible for the proposed dual CRCC.

There is no technical reason to choose CCITT for HCS.