IEEE 802.11
Wireless Access Method and Physical Layer Specifications

Title: **Error Control in IEEE 802.11 Frame Formats**

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Abstract: **This paper analyses the choice of CRC in IEEE 802.11 MAC.**

1. Introduction

This paper looks at the method of error control within IEEE 802.11 MAC frames and propsoes a change to the choice of CRC.

(The paper was written by Simon Black of Symbionics, who is not able to present it in person).

2. Discussion

The current draft proposes that we have an 8 bit CRC (CRC-8) protecting some control frames. The longest of these frames is the RTS which is 16 octets (128bits) in length plus the CRC. The danger is that an 8 bit CRC will give an unnaceptably high undetected error ratio. The 8 bit CRC will give us detection of all single bit errors, all double bit errors as long as the generator polynomial has a factor with at least three terms, any odd number of errors if the polynomial contains a factor (x+1), any burst error for which the length of the burst is less than the length of the CRC and most larger burst errors [1]. Assume that we can find an 8 bit CRC that will provide two bit error detection. This will give us an undetected frame error ratio of approximately 4×10^{-7} for a channel bit error ratio of 1×10^{-4}. For single bit error detection the undetected frame error ratio will be approximately 9×10^{-5}. These undetected frame error ratios are probably unacceptably high. We therefore deduce that the 8 bit CRC is insufficient.

Let us consider use of a 16 bit CRC. The CCITT CRC-16 has minimum distance $d_{min}=4$ for block lengths up to 32767bits [2]. This would therefore offer $d_{min}-1=3$ bit error detection over the 18octet RTS frame (144bits) and thus an undetected frame error ratio of approximately 1.7×10^{-9} for a channel bit error ratio of 1×10^{-4}. There is a more optimum 16 bit code for short block lengths that has $d_{min}=6$ for block lengths up to 151bits (undetected frame error

ratio tending towards zero according to my calculator). We could therefore deduce that a 16 bit CRC would be sufficient for RTS/CTS/ACK/POLL and ATIM frames. (Code C1 in reference [2] g(x) = 236545 in octal notation).
The 16 bit CRC is however insufficient to provide a suitably low undetected error ratio over a 2048 octet (maximum length) data frame. The IEEE802 standard 32 bit CRC is therefore chosen . This has d_{min}=4 for block lengths less than 11454octets [3].

3. Conclusion

To avoid the necessity to provide for two different CRCs we propose the IEEE802.3 CRC algorithm for all frame types. The penalty for this simplification is an increase in control frame length of two octets.

4. References

[1] Cyclic Codes for Error Detection; W peterson and D Brown; Proceedings of the IRE, January 1961.

[2] Optimum Cyclic Redundancy-Check Codes with 16-Bit Redundancy; Guy Castagnoli, Jurg Ganz and Patrick Graber; IEEE Transactions on Communications; Vol 38 No 1 Jan 1990.

[3] ISO/IEC 8802-4 Token Passing Bus Access Method and Physical Layer Specifications