Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**Clarification of the AES-CBC mode**	
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Re:	This is a response to Sponsor Ballot 16e on P802.16e/D7.	
Abstract	The document contains suggestions on the changes in IEEE P802.16e-D7 that would clarify the AES-CBC mode.	
Purpose	The document is submitted for review by 802.16 Working Group members.	
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Clarification of the AES-CBC mode

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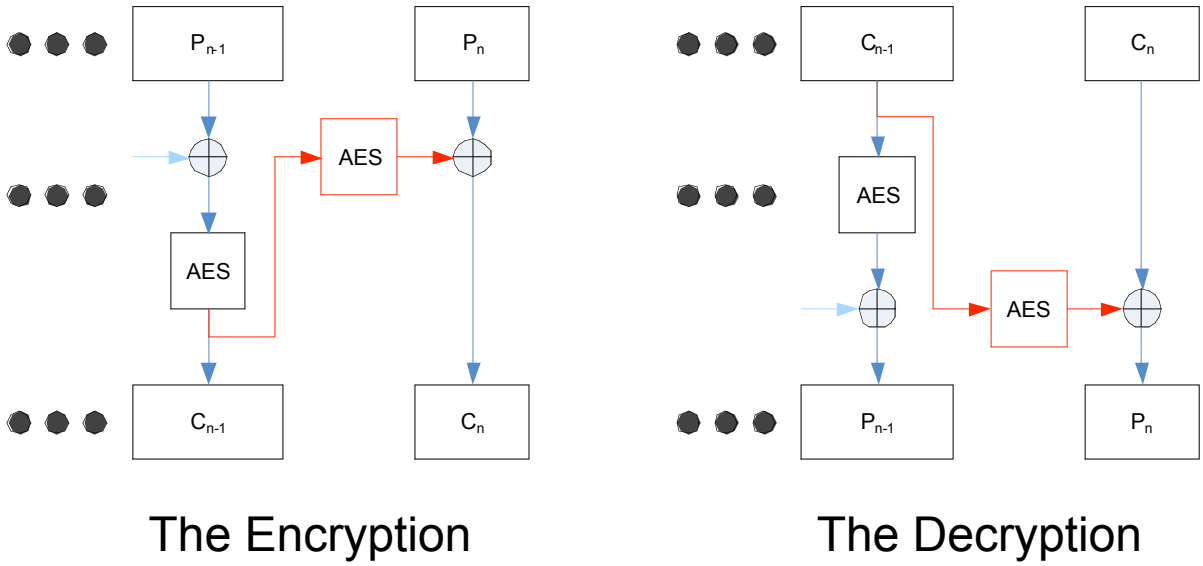
1 Problem Statements

There is no description about the problem of residual termination block processing, when the final block size is less than the cipher block size.

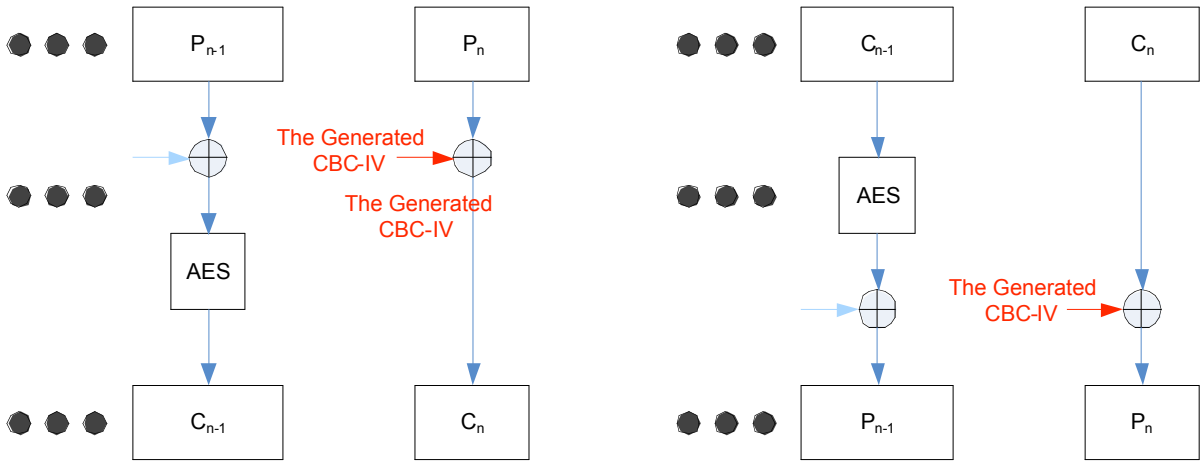
2 Overview of Proposed Solution

2.1 Remedy 1: Similar method to the DES-CBC mode



The Encryption The Decryption

2.2 Remedy 2: Using the generated CBC-IV



The Encryption The Decryption

3 Proposed changes to IEEE 802.16e/D7

3.1 Remedy 1: Similar method to the DES-CBC mode

[Modify text in subclause 7.8.4.3:]

7.8.4.3 Data encryption with AES in CBC mode

If the data encryption algorithm identifier in the cryptographic suite of an SA equals 0x03, data connections associated with that SA shall use the CBC mode of the US Advanced Encryption Standard algorithm [NIST Special Publication 800-~~38C~~38A, FIPS 197] to encrypt the MAC PDU payloads.

Residual termination block processing shall be used to encrypt the final block of plaintext when the final block is less than the cipher block size. Given a final block having n bits, where n is less than the cipher block size, the next-to-last ciphertext block shall be AES encrypted for the second time, using the electronic code book (ECB) mode, and the most significant n bits of the result are XORed with the final n bits of the payload to generate the short final cipher block. In order for the receiver to decrypt the short final cipher block, the receiver AES encrypts the next-to-last ciphertext block, using the ECB mode, and XORs the most significant n bits with the short final cipher block in order to recover the short final plaintext block. This encryption procedure is depicted in Figure 9.4 of Schneier [B42].

In the special case when the payload portion of the MAC PDU is less than the cipher block size, the most significant n bits of the generated CBC-IV, corresponding to the number of bits of the payload, shall be XORed with the *n* bits of the payload to generate the short cipher block.

3.2 Remedy 2: Using the generated CBC-IV

[Modify text in subclause 7.8.4.3:]

7.8.4.3 Data encryption with AES in CBC mode

If the data encryption algorithm identifier in the cryptographic suite of an SA equals 0x03, data connections associated with that SA shall use the CBC mode of the US Advanced Encryption Standard algorithm [NIST Special Publication 800-~~38C~~38A, FIPS 197] to encrypt the MAC PDU payloads.

Residual termination block processing shall be used to encrypt the final block of plaintext when the final block is less than the cipher block size. Given a final block having n bits, where n is less than the cipher block size, the most significant n bits of the generated CBC-IV, shall be XORed with the *n* bits of the final block plaintext to generate the short cipher block. In order for the receiver to decrypt the short final cipher block, the receiver XORs the most significant n bits of the generated CBC-IV with the short final cipher block in order to recover the short final plaintext block. In the case when the payload portion of the MAC PDU is less than the cipher block size, the residual termination block processing shall be applied.