# End to End Data Protection with Encryption

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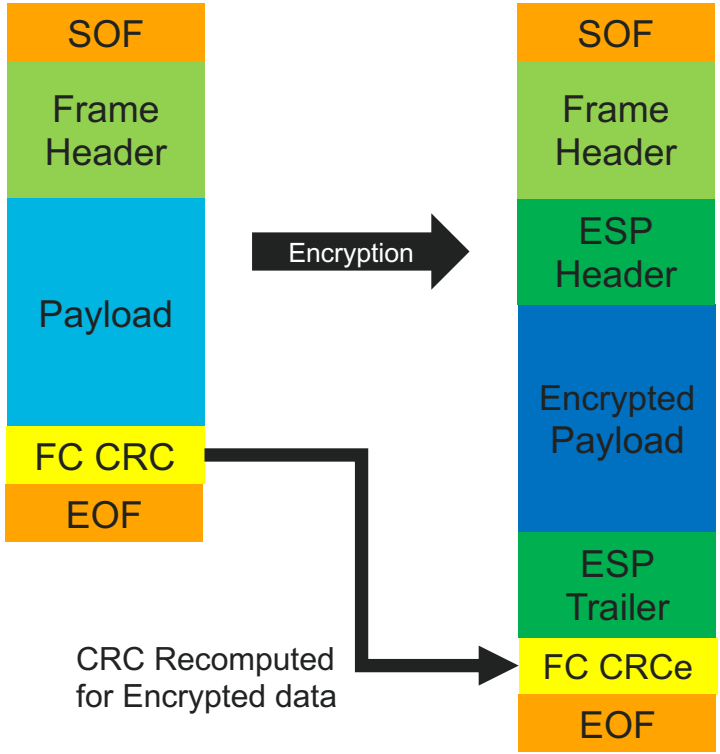
# Goal

- Provide uninterrupted end-to-end data protection
  - Never allow a window where undetected corruption can take place
  - Focus of this presentation is the encryption/decryption phase for FC-SP-2 based encryption

- Encryption protection
  - Window of risk during encryption/decryption process
    - An error in the crypto engine can result in undetected corrupted data
    - This error could be the result of a memory error or other source

# FC ESP Encryption Process



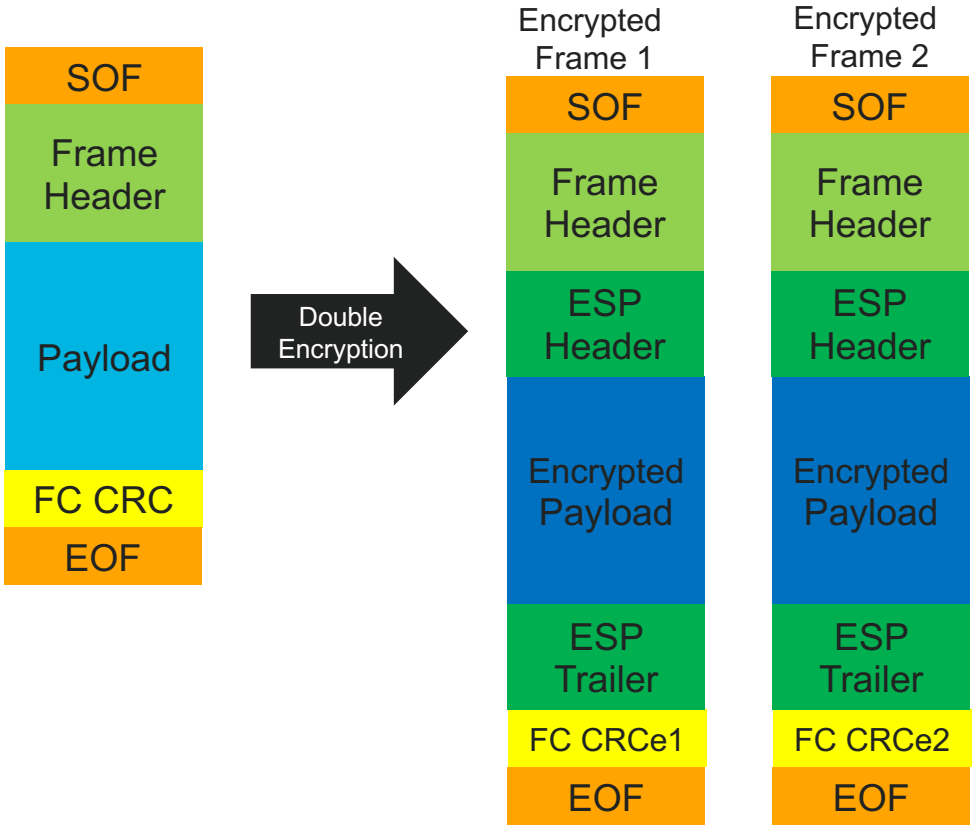

- During Encryption process, FC Frame CRC recomputed on encrypted data
  - This leaves a window of vulnerability during which errors could be introduced
  - An error during the encryption process could introduce undetected data corruption
  - This violates the premise of end-to-end data protection
  - (NOTE: The same type of vulnerability also exists during decryption)
- NOTE: ICV (Integrity Check Value) in the ESP_Trailer does not cover this
  - Computed AFTER payload is encrypted

# Why does T10 DIF or NVMe Protection information not cover this?

- T10 DIF and NVMe Protection Information are an FC-4 feature
  - Not under control of the Fibre Channel transport
    - May or may not be implemented or enabled by the devices

- The goal is to have **Transport** level end-to-end protection

# FC ESP Double Encryption Process




- One solution
  - Encrypt the data twice and compare the results
  - If CRCe1 and CRCe2 are equal then data integrity has been maintained and encrypted frame can be transmitted
  - This would also be done on the receiver side as a double decryption
- Downside to this approach
  - Added complexity and possible extra latency to encryption/decryption process
  - To do efficiently, may require dual encryption/decryption engines
- Pro
  - This approach does not require any change to the Standard

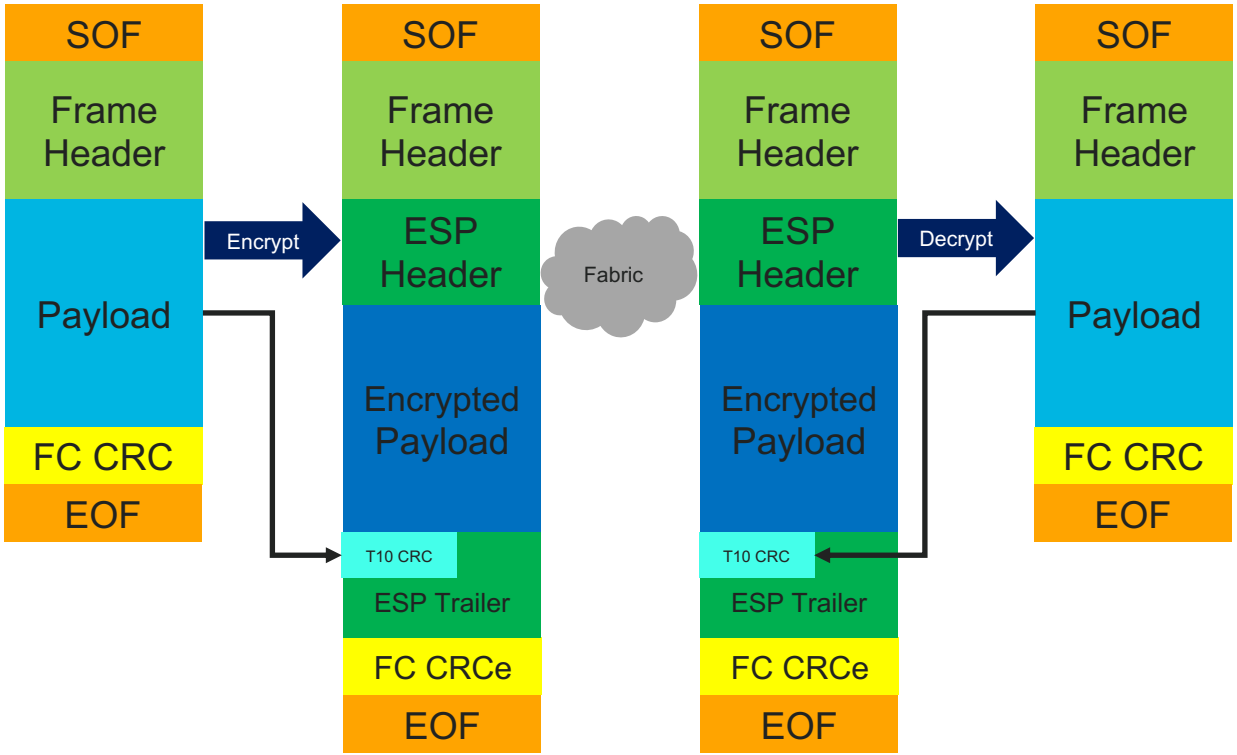
# Proposed Solution

- Propose adding an optional 16-bit CRC field to the ESP Padding
  - CRC would be computed before encryption takes place on the transmitter and checked after decryption on the receiver
  - Allows for overlapping data protection with FC Frame CRC (or other data checking as done by implementation)
  - Proposing basing CRC on T10 DIF CRC

- Pros
  - Does not require double encryption/decryption
    - Instead simple fast CRC calculation

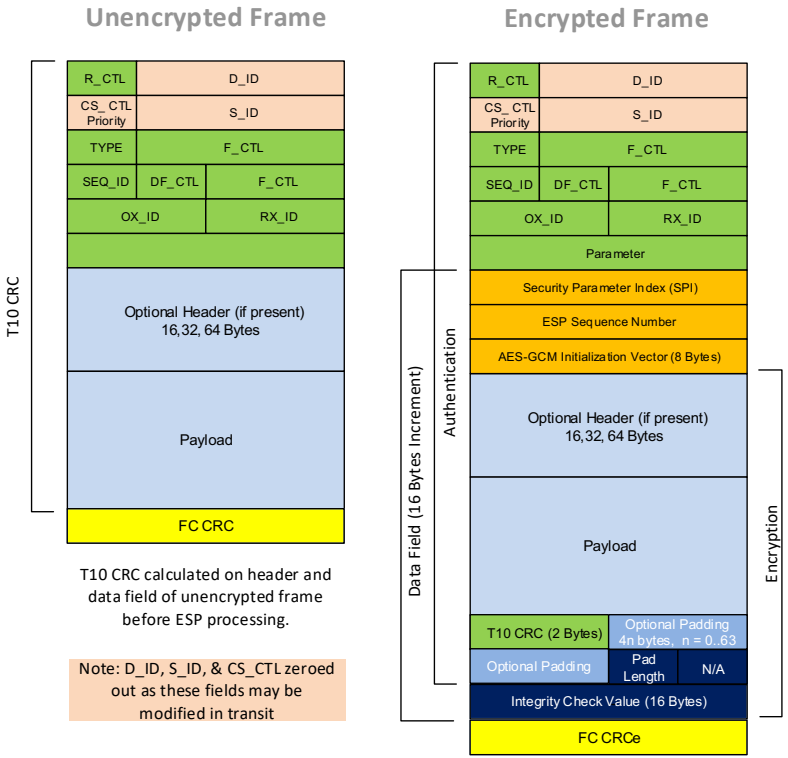
- Cons
  - Requires Standard change
    - But, if we make it optional/negotiable allows for older implementations

# FC ESP Encryption/Decryption Process Proposal




- Overlapping protection
  - On Transmit
    - T10 CRC computed
    - Data encrypted
    - FC CRC recomputed as FC CRCe
  - On Receive
    - FC CRCe checked
    - Data decrypted
    - Decrypted data checked against T10 CRC
- Note: Implementations may not present full FC Frames from/to the encryption engine, but this mechanism works even if there is simply a check on the data going into/out of the encryption engine
  - What matters is that T10 CRC checks that data was not corrupted during encryption/decryption

# Frame Format Proposal




- Add 16 bit T10 DIF CRC to beginning of ESP padding
  - 16 bits is the minimum pad length
- T10 DIF CRC is calculated across
  - Unencrypted payload + Other optional headers
  - FC Frame header with D_ID, S_ID, and CS_CTL set to zero
    - This is the same as done for the Integrity Check Value in the ESP_Trailer

# Other Details

- Other details to be determined
  - Negotiation on support of use of T10 DIF CRC in ESP_Trailer padding
  - Potentially allow CRC negotiation to support newer 32 bit and 64 bit DIF defined in T10

# Summary

- End-to-end data protection is important for enterprise customers

- Proposal is to allow for a standardized, optional, backward compatible data check field on the encrypted data
  - By adding CRC field to ESP padding

- Thoughts?

# Questions from previous T11 meeting

- Is there a 16-byte (128-bit) TX alignment requirement?
  - No
- ESP Trailer Pad Length:  Does the value include the CRC or not ?
  - Yes, the CRC just replaces the first 2 bytes of the Pad
- ESP Trailer Pad Pattern/Sequence: following CRC –does it start at 0x1 or 0x3 ?
  - 0x3 – The CRC just replaces the first 2 bytes of the Pad
- Other Encryption Methods supported ? Such as ENCR_NULL_AUTH_AES_GMAC ? Not encrypted but with ESP_Headerand ESP_Trailer.
  - Other methods could be supported, but they are not part of our current proposal  - Should they be?

# More questions for previous T11

- There are other alternatives without modifications to the standard –Implement a protected engine – a multitude of different options
  - Maybe, but that's not our proposal since it doesn't give you an interoperable end-to-end protection
- Why T10 CRC ?  Why not FC CRC ?
  - We use the T10 CRC because it is 16 bits and that will fit in the minimum PAD length (thus, no changes to payload size)
  - Any other CRC algorithms (i.e., more BITS) would require more complicated changes
- Interesting: FC Frame header in CRC but ESP Header and Encryption IV is not.
  - The CRC calculation is done on the same fields as the ICV – This simplifies deployment
- If We're Changing The Standard… –Option to expose additional parts of the original frame in clear text –Example: Optional Headers, such as VMID Device Header for the fabric
  - We are not against this, but would like to see it done in a new proposal

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# Thank You


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