Compatibility of Cut-Through Forwarding with Existing Standards

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Introduction

- Nendica initiated the "Nendica Study Item: Cut-Through Forwarding in Bridges and Bridged Networks [CTF]" on 2021-03-11
  - https://1.ieee802.org/nendica-ctf/
- An IEEE 802 Tutorial proposal is being planned
  - CTF: Draft IEEE 802 Tutorial request (802.1-21-0025-01)
    - https://mentor.ieee.org/802.1/dcn/21/1-21-0025-01-ICne.pdf
  - CTF: Merged draft slides proposed for an IEEE 802 Tutorial (802.1-21-0024-00)
    - https://mentor.ieee.org/802.1/dcn/21/1-21-0024-00-ICne.pdf
- Nendica discussions have raised interest in ensuring that the 802.3 perspective is represented in the tutorial and that it results in 802.3 participants understanding what is required from 802.3 in order to support CTF in bridged networks
  - relationship of CTF to Ethernet is addressed on Slide 47 of 802.1-21-0024-00
- Although the 802.3 perspective is not currently represented, we can read IEEE Std 802.3 for an understanding of the issues.

Slide Title: *Problem Statements: Introduction*

Key quotes:

- *The standardized MAC Service Interface treats frame transfers between MAC and Bridge as atomic operations that transfer entire frames (from destination address to frame check sequence) as a whole:*
  - *MA_DATA.request (frame transmission)*
  - *MA_DATA.indication (frame reception)*
- *Due to the atomic property of these operations, the MAC Service Interface cannot support CTF.*
- *IEEE WG 802.1 and IEEE WG 802.3 are asked to collaborate on a solution that allows CTF in Bridges.*
- *None of the subsequent contents shall imply a requirement to change the standardized MAC Service Interface!*
- *It is not intended to shift present and potential future functions from IEEE 802.3 to IEEE 802.1 or vice versa!*
- As recognized in the slide, this explanation is incomplete.
  - It says "The subsequent content details the problem further." implying material TBD.

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Service Interface

- The MAC Service Interface is an *abstract* description.
  - moreover, *shall* is not used, and no conformance statements are associated
- MA_DATA.request and MA_DATA.indication represent transfer of a set of information elements.
  - No presumption is made about the format or sequence of how those elements are carried across the interface.
- Slide 47 suggests that parameters must be transmitted across the interface "as a whole" (e.g., perhaps via a buffer pointer).
  - However, that is not a requirement of the service specification.
- Service interface theory is described in 802.1AC § 7.2
  - *The primitives of the MAC Service comprise a data request and a corresponding data indication, each with [parameters]... Taken together these parameters are conveniently referred to as a frame, although this does not imply that they are physically encoded by a continuous signal on a communication medium, that no other fields are added or inserted by other protocol entities prior to transmission...*

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MAC Functional Model per 802.3

- IEEE Std 802.3, 4A ("Functional model of the MAC method"):
  - *It is important to distinguish, however, between the model and a real implementation. The model is optimized for simplicity and clarity of presentation, while any realistic implementation shall place heavier emphasis on such constraints as efficiency and suitability to a particular implementation technology or computer architecture... it is the behavior of any MAC sublayer implementations that shall match the standard, not their internal structure...*
  - *The handling of incoming and outgoing frames is rather stylized in the procedural model, in the sense that frames are handled as single entities by most of the MAC sublayer and are only serialized for presentation to the Physical Layer. In reality, many implementations will instead handle frames serially on a bit, octet or word basis. This approach has not been reflected in the procedural model, since this only complicates the description of the functions without changing them in any way.*
- If the MAC Service Interface does not demand store-before-process, does IEEE 802.3 support cut-through?

Transmission per 802.3 §4A

- 802.3 § 4A (normative)provide full-duplex MAC model
- Regarding transmission:
  - *When a MAC client requests the transmission of a frame, the Transmit Data Encapsulation component of the full duplex MAC sublayer constructs the frame from the client-supplied data. It prepends a preamble and a Start Frame Delimiter to the beginning of the frame. Using information provided by the client, the MAC sublayer also appends a Pad at the end of the MAC information field of sufficient length to ensure that the transmitted frame length satisfies a minimum frame-size requirement. It also prepends destination and source addresses, the length/type field, and appends a frame check sequence to provide for error detection.*
    - But FCS and padding may be provided by MAC client, avoiding computational delay.
  - No demand that function TransmitDataEncap [builds the frame] completes before function TransmitLinkMgmt begins its the transmission
    - and Fig 4A-1 does not show a sequential relationship between the two
  - It seems that 802.3 does not demand store-before-transmit.

Reception per 802.3 §4A

- See 802.3 § 4A.2.9
- *ReceiveFrame operation is synchronous. The operation does not complete until a frame has been received.*
- Some of the checks could be conducted before the frame has been completely received (e.g. DA validation; minimum frame size)
- Overlength frame may be handled by truncation, so that need not be known in advance.
- No *Length* validation to conduct when *Length/Type* is an Ethertype.
- *passReceiveFCSMode*: static variable that enables passing the FCS to the MAC client and blocks pad stripping
- But FCS validation and alignment check (integral number of bytes) are required and cannot be conducted before the entire frame is received.
- 802.3 §4A does not specify any action if the frame is determined to be invalid except to indicate the invalidity.
- However…

Cut-Through Restriction

- Critical requirement is found in 802.3 § 3.4
  - *An invalid MAC frame shall be defined as one that meets at least one of the following conditions:*
    - [Length inconsistent with length value in Length/Type field]
    - [Not an integral number of octets]
    - [FCS invalid]
  - *The contents of invalid MAC frames shall not be passed to the LLC or MAC Control sublayers. Invalid MAC frames may be ignored, discarded, or used in a private manner by MAC clients other than LLC or MAC control.*

- It appears that this inhibits cut-through.
  - It is difficult to see how cut-through reception could ensure that 3.4 is not violated.
- For cut-through consistency with IEEE Std 802.3, one approach would be to specify a new static parameter in 802.3 § 4A.2.9 (similar to *passReceiveFCSMode*) that could eliminate some validity checks

Summary

- I do not think that the MAC Service Interface is a barrier to cut-through operation.
- I agree with the views in Slide 47 that "None of the subsequent contents shall imply a requirement to change the standardized MAC Service Interface!," but other aspects of IEEE Std 802.3 are involved.
- Cut-through operation seems to be precluded by IEEE Std 802.3 §3.4 in combination with §4A.2.9.
- I believe that the tutorial should include an 802.3 subject matter expert to address these points authoritatively.
- In parallel, problems statements related to IEEE Std 802.1Q should be examined and reported in the tutorial. Note, for example:
    - 6.5.5 *The minimum additional transit delay introduced by a Bridge is the time taken to receive a frame plus that taken to access the media onto which the frame is to be relayed. Note that the frame is completely received before it is relayed as the Frame Check Sequence (FCS) is to be calculated and the frame discarded if in error.*
    - Does this simply reflect the MAC requirement, or something separate?
    - Any associated normative text should be identified.

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