

Cut-Through Forwarding (CTF) in Bridges and Bridged Network – Considerations on Modelling, Compatibility and Locations

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Introduction

- The discussion on April 27, 2022 based on contribution https://www.ieee802.org/3/ad_hoc/ngrates/public/calls/22_0427/jones_nea_01_220427.pdf provided several insights on understanding different concerns on CTF/the proposed project P802.1DU.
- This slide set
 - summarizes the author's interpretation of the concerns, and thoughts/options on addressing these,
 - is on further discussing and analyzing concerns,
 - is an individual contribution (not a WG statement), and
 - limits on the first topics listed in the following.

Topics and Aspects from April 27

- Topics

- Main CTF operation – frame transmission start before reception completed
- Frames with inconsistent FCS
 - Processing by the 802.3 MAC
 - Passing between 802.3 MAC ↔ MAC Client (bridges in the context of this slide set)
 - “FCS stomp” variations
- Management counters
- Options for locating CTF in IEEE 802 WGs and projects

- Aspects

- Modelling
 - In existing 802 Stds
 - In new 802 Stds for CTF (P802.1DU)
- Conformance/Compatibility
 - Of existing S&F implementations – related to 1.2.2 of the P802.1DU CSD draft
 - Of existing CTF implementations – no strong relationship to existing 802 Stds

Aspects over Topics

Topic \ Aspect	Modelling: Existing 802 Stds	Modelling: New 802 Stds on CTF	Conformance/Compat.: Existing S&F Impl.	Conformance/Compat.: Existing CTF Impl.
Main CTF operation	X	X	X	[X]
Frames with inconsistent FCS: Processing by 802.3 MACs	X		X	
Frames with inconsistent FCS: Passing between 802.3 MACs ↔ MAC clients (bridge)	X		X	
Frames with inconsistent FCS: "FCS stomp" variations		X		X
Management counters		X		X
Locating CTF in IEEE 802 WGs/projects		X		

Stds 802, 802.1Q,
802.1AC and MAC
Stds (802.3)

- "New Features" for CTF
- No existing 802 Stds
- Only for diagnosis

P802.1DU, MAC WGs?

Main CTF Operation

Main CTF Operation: Introduction

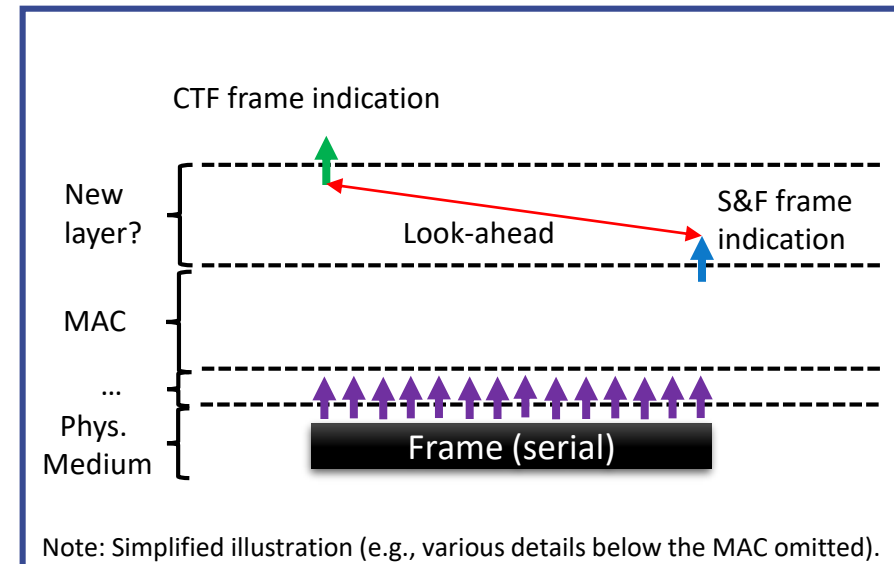
- Author's recollection and interpretation of related concerns discussed:
 1. Changing the 802.3 MAC model could be a huge Stds development task.
 1. The 802.3 MAC, as it is right now, passes frames to higher layers (i.e., Std 802.1AC) as atomic unit after the end of serial reception by the MAC sublayer.
 2. CTF could require serial transfer from MAC sublayer to higher layers.
 2. Existing S&F implementations conformant to IEEE Stds 802, 802.1AC and 802.1Q could be non-conformant/incompatible with P802.1DU.
- Related items presented on April 27 (https://www.ieee802.org/3/ad_hoc/ngrates/public/calls/22_0427/jones_nea_01_220427.pdf)
 - Slide 5
 - Slide 7
 - Slides 8 (except “without error”)
 - Slides 9
 - Slide 10 (except “properly formed”)
 - Slide 11 (except “without error”)
 - Slides 12 and 13

Main CTF Operation: Modelling (1)

- At least two approaches for **modelling** the main CTF operation were presented
 - Modelling limited “as much as possible” to externally visible behavior (e.g., <https://www.ieee802.org/1/files/public/docs2021/new-specht-ctf-802-1-1121-v01.pdf>)
 - Modelling by look-ahead of frame reception service primitive invocations (<https://mentor.ieee.org/802.1/dcn/22/1-22-0015-01-ICne-idealistic-model-for-p802-1du.pdf>)
- The second approach, modelling by look-ahead of frame reception service primitive invocations, is considered in the following:
 - Appears good for progressing discussions in the joint NEA/Nendica ad hoc meetings
 - Along the idea of showing potential approaches to address concerns for discussion

Main CTF Operation: Modelling (2)

- Modelling by look-ahead of frame reception service primitive invocations (<https://mentor.ieee.org/802.1/dcn/22/1-22-0015-01-ICne-idealistic-model-for-p802-1du.pdf>)
- Summary of the approach
 - Look-ahead of S&F frame indication primitive invocations (i.e., on RX), resulting in new CTF frame indication primitive invocations a frame duration earlier. I.e.:
 - **Atomic (and instantaneous)** invocations on per-frame resolution.
 - **No need for serial transfers from MAC to MAC client at a resolution below frames (e.g., octets)!**
 - Similar look-ahead approaches are found in the models of lower sublayers in IEEE Std 802.3-2018 [“prescient” functions in some PCS clauses, Reconciliation Layer (65.2.3.4.5) and MAC Merge Sublayer (99.4.7.4)]
 - Could be done in P802.1DU (e.g., located on top of where the ISS is in 802.1AC)
 - **No need for changing the 802.3 MAC!**



Main CTF Operation: Conformance (1)

- Author's Interpretation of the Concern

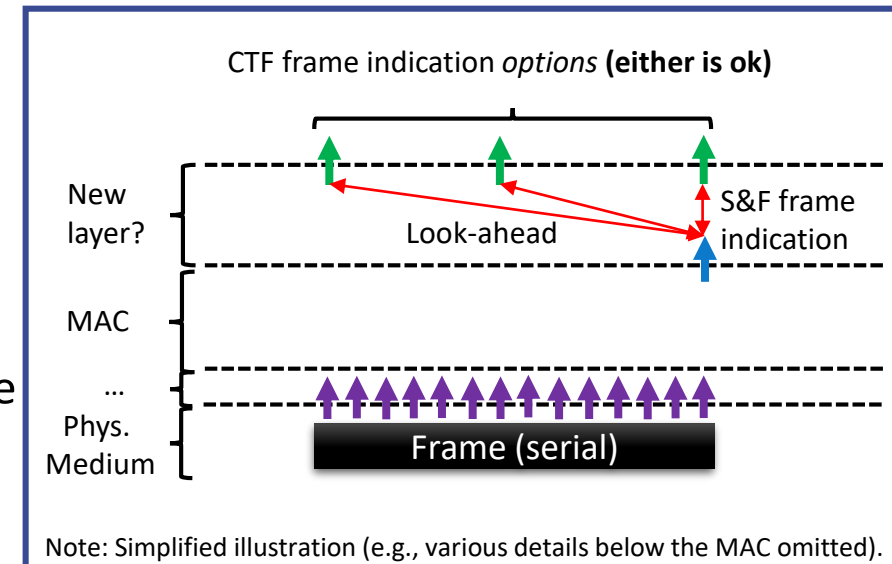
As soon as P802.1DU would require bridge implementations to start frame transmission (TX port) prior to completed frame reception (other RX port), existing S&F implementations conformant to IEEE Std 802, IEEE Std 802.1AC and IEEE Std 802.1Q could turn out non-conformant to P802.1DU.

- A technical approach

- Extend the look-ahead based modelling approach by permitting CTF frame indication primitive invocations within an implementation-dependent range
 - Earliest: The frame duration earlier than the (non-CTF) indication
 - Latest: At the same time as (non-CTF) indication primitive invocation

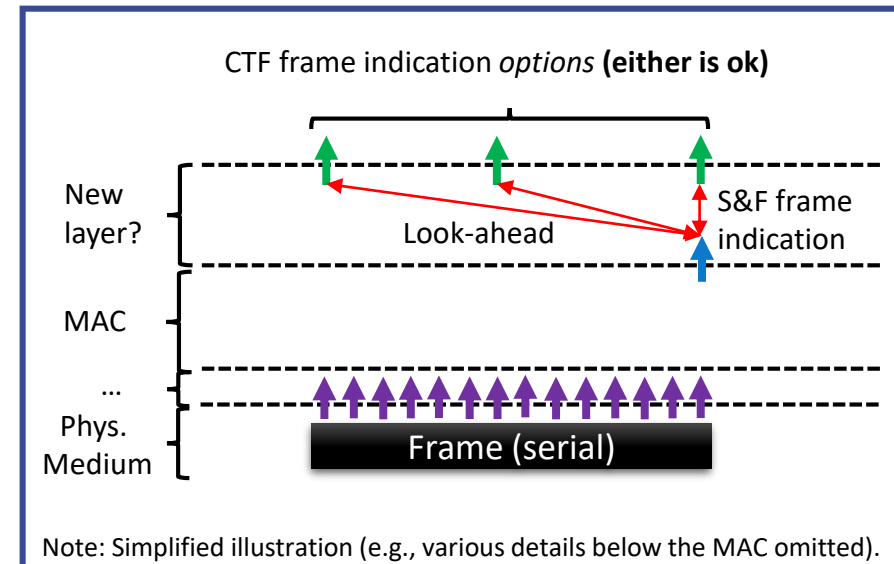
→ **Conformance of existing S&F implementations**

(even if frame transmission start prior to compete frame reception is not supported by an existing S&F implementation)



Main CTF Operation: Conformance (2)

- Thoughts on compatibility with IEEE Std 802, 802.1AC and 802.1Q
 - CTF frame indications earlier than the associated S&F frame indication are like an optional feature of bridge implementations
 - Similar, several amendments to 802.1AC and 802.1Q introduced optional features (e.g., new traffic shapers)
 - **It may be acceptable if WG 802.1 would answer “Yes” in “1.2.2 Compatibility”** of the P802.1DU CSD draft (similar to past amendment projects)
 - **WG 802.1 would be responsible for maintaining compatibility** during development of P802.1DU
- Necessary but not sufficient ...
 - The main CTF operation may be the most important topic to with regard to “1.2.2 Compatibility” in CSD drafts of P802.1DU, but not the only one.
 - Achieving “1.2.2 compatibility” = “Yes” by retaining elements as optional features may apply for elements from topics other than the main CTF operation (next slides).



FCS: Processing by 802.3 MACs

FCS: Processing by 802.3 MACs: Introduction

- Author's recollection and interpretation of related concerns discussed:
 - CTF would require the 802.3 full-duplex MAC in to:
 - Accept frames with inconsistent FCS during reception for subsequent processing by MAC clients.
 - Transmit frames from mac clients with passed inconsistent FCS.
 - The processing full-duplex MAC is clearly specified in A4 of 802.3, and does not allow for this.
- Related items presented on April 27
(https://www.ieee802.org/3/ad_hoc/ngrates/public/calls/22_0427/jones_nea_01_220427.pdf)
 - Slide 10 (“properly formed”)
 - Slide 11 (“without error”)

FCS: Processing by 802.3 MACs: 4A of 802.3

- References in IEEE Std 802.3
 - 802.3, 4A.2 (precise specification of the full-duplex MAC/Pascal model)
 - 802.3, 4A.2.9 (Frame reception)
 - Received frames with inconsistent FCS result in properly set output variables of function ReceiveFrame(...) with return value/ReceiveStatus = *frameCheckError* or *alignmentError* in function ReceiveDataDecap(...)
The precise specification of the 802.3 full-duplex MAC does not require changes for receiving frames with inconsistent FCS
 - 802.3, 4A.2.8 (Frame transmission)
 - rame transmissions by function TransmitFrame(...) with input variable *frame_check_sequence* set by the MAC client (and *fcsPresent* = *true*) are without further checking whether or not *frame_check_sequence* is consistent
→ **The precise specification of the 802.3 full-duplex MAC does not require changes for transmitting frames with inconsistent FCS**
 - See also:
 - Slide 61 of <https://mentor.ieee.org/802.1/dcn/21/1-21-0037-00-ICne-ieee-802-tutorial-cut-through-forwarding-ctf-among-ethernet-networks.pdf>
 - Slide 23ff. of <https://mentor.ieee.org/802.1/dcn/21/1-21-0051-07-ICne-ctf-discussing-next-steps.pdf>

→ **No change of the 802.3 full-duplex MAC precise specification required for processing frames with inconsistent FCS.**

FCS: Passing between 802.3
MACs ↔ MAC clients (bridge)

FCS: Passing between MAC ↔ MAC clients: Introduction

- Author's recollection and interpretation of related concerns discussed:
 - 802.1 AC, 11.1 Only frames with consistent FCS cause MUNITDATA indications.
 - 802.3, 2.3.2.3: MA_DATA indications are only reported to MAC clients with consistent FCS (“received without error”) according to 2.3.2.3:
Such frames are reported only if they are validly formed, received without error, and their destination address designates the local MAC entity.
 - 802.3, 4A.2.9 is defining frame errors (recap).
- Related items presented on April 27
(https://www.ieee802.org/3/ad_hoc/ngrates/public/calls/22_0427/jones_nea_01_220427.pdf)
 - Slide 6
 - Slide 10 (“properly formed”)
 - Slide 11 (“without error”)
 - Slide 12
 - Slide 13

FCS: Passing between MAC ↔ MAC clients: 802.1AC

- P802.1DU (new base standard) could deviate from 802.1AC with regard to the definition frames with error, but it seems this is not needed.
- 802.1AC, 11.1
 - *Each M_UNITDATA indication corresponds to the receipt of an **error-free** MAC frame from a LAN*
 - **No M_UNITDATA indication for frames in error**
- ... 802.1AC, 2nd paragraph in clause 13
 - *All **error-free received user data frames** give rise to M_UNITDATA indication primitives. A **frame that is in error, as defined by the relevant MAC specification**, is discarded by the MAC entity without giving rise to any M_UNITDATA indication.*
 - **Definition of “frame in error”/“error free frame” per MAC standard (e.g., 802.3), not 802.1AC**

FCS: Passing between 802.3 MACs ↔ MAC clients: 802.3

From 2.3.2.3 of 802.3: *Such frames are reported only if they are validly formed, received without error, and their destination address designates the local MAC entity.*

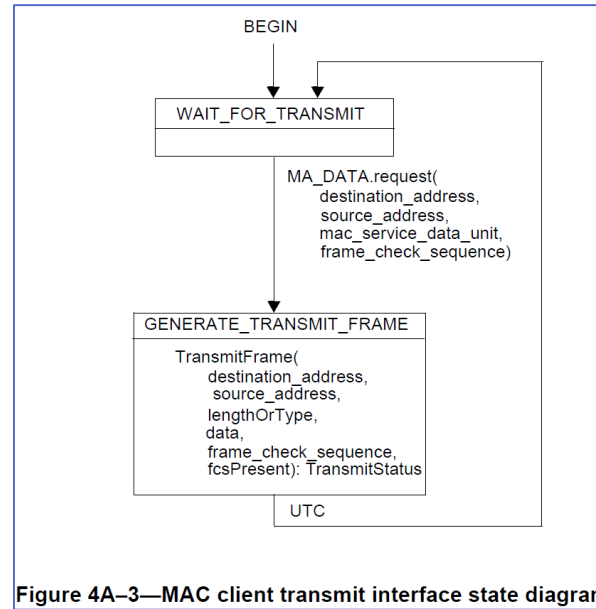


Figure 4A-3—MAC client transmit interface state diagram

Source: IEEE Std 802.3-2018

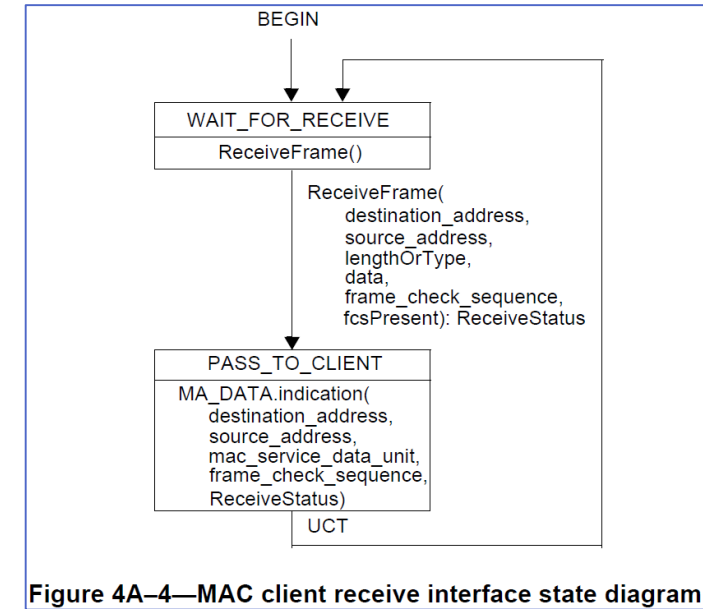


Figure 4A-4—MAC client receive interface state diagram

Source: IEEE Std 802.3-2018

• Recap (prev. slides):

- Allowing 0-time between M_UNITDATA indication and CTF frame indication would allow conformance of P802.1DU and existing S&F implementations
- No change of the 802.3 full-duplex MAC precise specification required for processing frames with inconsistent FCS.

→ Clarification desirable (802.3WG):

- Is 4A.2.9 defining “received without error” (i.e., excludes frames with inconsistent FCS) or is there another definition meant in 2.3.2.3 of 802.3?
- Is the statement from 2.3.2.3 in conflict with the precise specification of the 802.3 full-duplex MAC/what is the relationship between both?
- Does 2.3.2.3 apply for Bridges at all (due to “destination address designates the local MAC entity”)?
- Are there other statements in 802.3 (outside of 4A) similar to the one in 2.3.2.3?

→ Does not matter at all for case 0-time between M_UNITDATA indication and CTF frame indication:

- Even if frames with inconsistent FCS would be included in “frames in error”, CTF frame indication and M_UNITDATA indication **could be 100% identical**

Summary, Conclusion & Proposals for WG 802.1

Topic \ Aspect	Modelling: Existing 802 Stds	Modelling: New 802 Stds on CTF	Conformance/Compat.: Existing S&F Impl.	Conformance/Compat.: Existing CTF Impl.	
Main CTF operation	X	X	X	[X]	<div style="background-color: #fff9c4; padding: 5px;"> Stds 802, 802.1Q, 802.1AC and MAC Stds (802.3) </div>
Frames with inconsistent FCS: Processing by 802.3 MACs	X		X		
Frames with inconsistent FCS: Passing between 802.3 MACs ↔ MAC clients (bridge)	X		X		
Frames with inconsistent FCS: "FCS stomp" variations		X		X	<div style="background-color: #e1f5fe; padding: 5px;"> -"New Features" for CTF -No existing 802 Stds -Only for diagnosis </div>
Management counters		X		X	
Locating CTF in IEEE 802 WGs/projects		X			<div style="background-color: #e0e0e0; padding: 5px;"> P802.1DU, MAC WGs? </div>

Summary & Conclusion

- Modelling a new CTF frame indication by look-ahead, at the time of M_UNITDATA.indication or earlier, is an approach to realize the main CTF operation in P802.1DU
 - Treats frames as atomic unit
 - Allows CTF, but does not enforce it (allows compatibility of existing S&F implementations with P802.1DU)
 - CTF main operation would be a new optional feature in P802.1DU, but not mandatory (like new shapers in 802.1Q)
 - **No change of MAC Stds (802.3) would be mandatory for compatibility to P802.1DU**
- Processing frames with inconsistent FCS
 - The 802.3 full-duplex MAC precise specification does this already
 - **No change of the 802.3 full-duplex MAC precise specification would be required**
- Passing frames with inconsistent FCS between 802.3 full-duplex MAC and MAC client (bridge)
 - The 802.3 full-duplex MAC precise specification does this already
 - Other statements in Std 802.3 (at least 2.3.2.3) require clarification, however, ...
 - ... the outcome does not matter for case CTF frame indications at the time of the associated M_UNITDATA.indications.
 - **No change of MAC Stds (802.3) would be required**

Proposals for WG 802.1 (for Discussion in Nendica)

- Latest PAR&CSD drafts of P802.1DU

- PAR: <https://www.ieee802.org/1/files/public/docs2022/du-draft-PAR-0122-v01.pdf>
- CSD: <https://www.ieee802.org/1/files/public/docs2022/du-draft-CSD-0122-v01.pdf>

- PAR: Update the scope (5.2) - add a definition of the modelling to the scope of P802.1DU, enable CTF

“This standard specifies Cut-Through Forwarding (CTF) in Bridges based on the IEEE Std 802.1Q Bridge architecture. CTF Bridges interconnect individual IEEE 802 Local Area Networks (LANs) via different or identical Media Access Control (MAC) methods.

This standard models the CTF operation, frame transmission start before frame reception completed, by look-ahead functions (similar to prescient functions established in 802.3) that (a) enable the CTF operation in bridges that support it, and (b) allow compatibility to this standard of bridges that do not support it.

For bridges that support the CTF operation, this standard specifies additions to the procedures in published IEEE 802.1 Stds, including 802.1Q, 802.1AC, 802.1CB, for processing frames that are subject the CTF operation.

This standard also specifies requirements and recommendations for the usage of CTF in bridged networks including IEEE Std 802.1Q bridged networks.”

- CSD: Change compatibility (1.2.2)

- *“Will the proposed standard comply with IEEE Std 802, IEEE Std 802.1AC and IEEE Std 802.1Q?”*
→ *“NoYes”*
- *“If the answer to a) is no, supply the response from the IEEE 802.1 WG.”* → empty

Thank You for Your Attention!

Questions,
Comments,
Opinions,
Ideas?