Cut-Through IEC/IEEE 60802

Contributor group

Ademaj, Astrit <astrit.ademaj@tttech.com>
Steindl, Guenter <guenter.steindl@siemens.com>

Abstract

This document describes a selection of cut-through related mechanisms in order to support the implementation of traffic classes that need short latency requirements over a relatively large number of hops.

Its intended to use and extend the forwarding process from IEEE 802.1Q.

Log

V1.0	2019-08-30	Initial version
V1.1	2019-09-20	Edinburgh version

Content

1 References

Mick Seaman, Running with Scissors, Cut-Through in bridged Networks, IEEE 802.1 contribution, available at:
<http://www.ieee802.org/1/files/public/docs2019/new-seaman-cut-through-scissors-0119-v01.pdf>

2 Scope of Cut Through

2.1 Limitations

Assumption:

- Supported data rates from 10 Mbps to 2,5Gbps
- Supported topologies are linear, star, tree and ring
- To be combined 802.1Q features needs to be defined

3 Cut-through needs in Industrial Automation

3.1 Introduction

Ethernet TSN shall cover the requirements of the existing and future industrial automation systems.

The data delivery guaranties for the isochronous traffic require lower latency than IEEE 802.1Q standard “store and forward” network infrastructure may be able to provide. In order to the fulfill these requirements different Vendor and/or System-Provider specific solutions are developed by using the mechanism referred as Cut-through switching.

In the course of the IEEE 60802 or the IEC this mechanism shall be standardized for bridges as this mechanism is necessary to fulfill the industrial automation use cases.

3.2 CT – requirements

An IEC/IEEE 60802 bridge:

- Shall provide the capability for cut through per input port and per output queue
- Shall be configurable which queues can use the cut-through forwarding mechanisms
- Shall report the cut-through delays through the management protocol. This information shall be available in the data sheet. independentDelayMin and independentDelayMax shall be used to identify the cut-through delays.
- Shall support existing mechanism for handling of erroneous long frames which are forwarded as CT frames, too. Faulty cut-through traffic (erroneous long frames) shall be shortened when being forwarded and thus, removed over time to limit the occupied bandwidth on the path of the CT frames.
- Shall handle a Cut-through frame during the forwarding process with the same rules as a Store-Forward (SF) frame, including policing, forwarding decisions and VLANs.
- Shall support CT for peer to peer links from 10 Mbps to 2,5 Gbps
- Shall show no other externally observable difference between SF and CT (besides the stated ones) than a shorter latency and possible forwarding of CRC errored frames.

3.3 CT – proposed solution

Today: IEEE standard specifies that the switch starts the forwarding process after a frame is completely received and validated.

Tomorrow:

The forwarding process may start after the reception of the first 64 bytes (configurable) are received. Because of such a forwarding process, a frame that is not completely received may be put on the transmit queue and can be used by the transmission selection.

In addition, it is required to specify a method for invalidating the frame transmission as soon as an error is detected with the goal to shorten the frame as much as possible. Thus, invalid frame fragments should be shortened as much as possible by each hop and be removed by

the hop as soon as the remaining frames size is shorter than MinFrameSize to avoid “circulating frame fragments”.

If the bridge operating in cut-through already started forwarding and detects that the frame is damaged or truncated, it shall append the error sequence foreseen in IEEE 802-3:2018, 27.3.1.2.2 and then stop further transmission of that frame.

All other 802.1Q existing mechanisms will still work, but an additional “late” error handling mechanism is needed for “late” error detected frame underrun, invalid frame and incorrect frame.

The cut-through support is implemented per queue, and it can be configurable which queues can use the cut-through forwarding mechanisms. This influences the transmission selection

- if CT is activated the transmission selection will start the forwarding process as soon as a frame descriptor is assigned to a queue.
- if deactivated, the transmission selection will start the forwarding process as soon as a frame descriptor is assigned to a queue and the frame is completely received by the switch.

Before starting CT forwarding, it shall be checked that the Qbv gate is open for a specific queue at least for queueMaxSDU (see 802.1Qbv). If a received frame is detected oversize (> queueMaxSDU) after forwarding has started, the forwarded frame shall be truncated on egress to queueMaxSDU size and no valid CRC shall be added.

First CT fragments (smaller is better):

- 32 bytes (supported by some of the todays vendor specific implementations)
- 64 bytes (mandatory)
- 128 bytes

Shortening by each hop (more is better):

- 8 bytes (mandatory)
- 16 bytes (supported by some of the todays vendor specific implementations)
- 32 bytes

Frame handling in case of shortening (IEEE 802-3:2018, 27.3.1.2.2):

- Support TX_ER to invalid the frame
- Offer byte-granular shortening
- Adding Error Code
- for 10Mbps/100Mbps:
  1-3 Error-Code Nibble, Frame will be shipped with unearthed nibble number!
- for 1Gbps:
  2 Error-Code Nibble, Frame will be shipped with even nibble count!

- for <10Gbps:
  ??? Error-Code Nibble, Frame will be shipped with even nibble count!

3.4 CT – Integration model

Figure 1 shows in principle the needed extensions to the existing IEEE 802.1Q forwarding model.

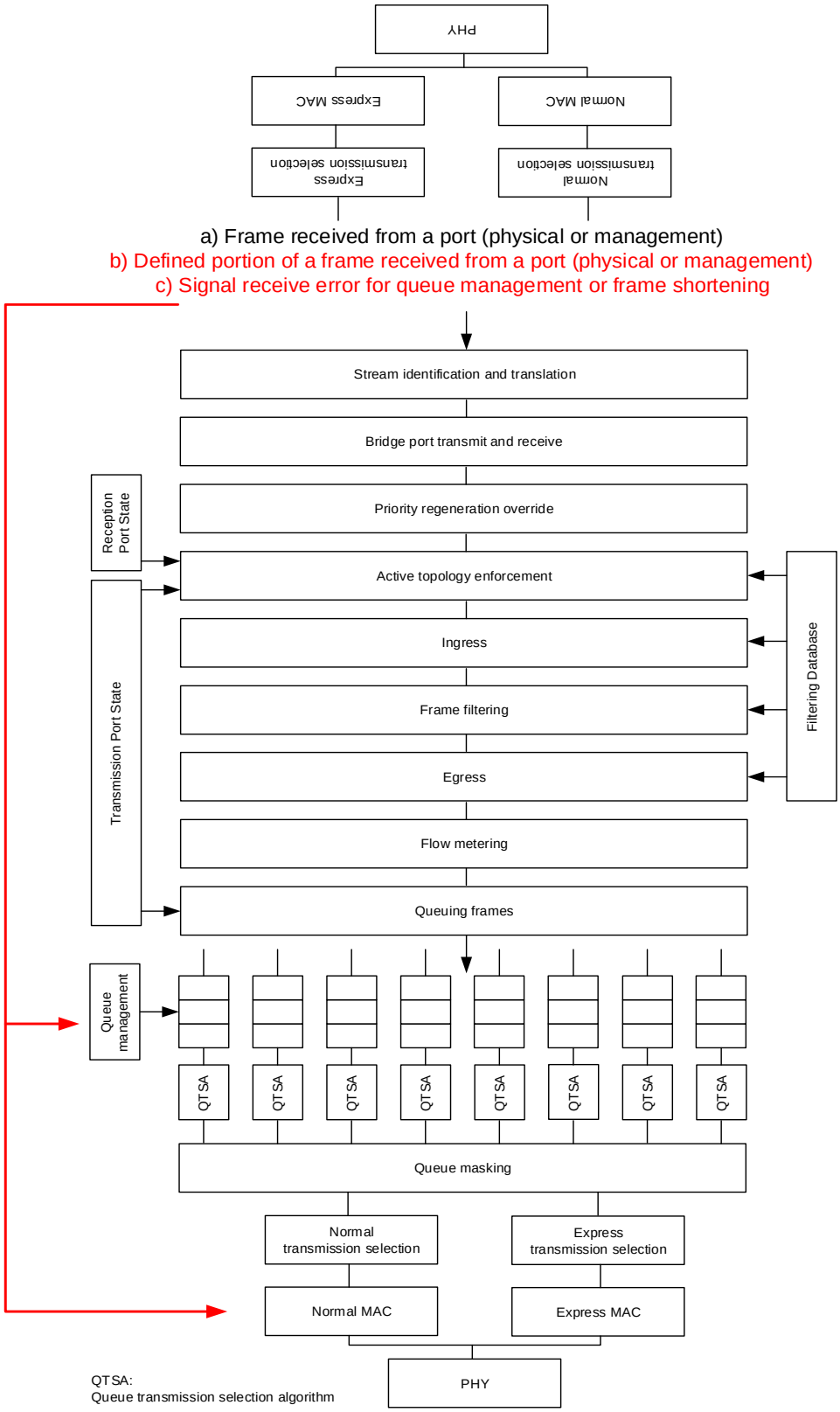

Figure 1 – CT addon to the forwarding process