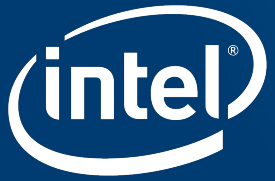

TSN Project

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TSN Introduction

Time-Sensitive Networking (**TSN**) is a set of standards under development by the Time-Sensitive Networking task group of the IEEE802.1 working group.

TSN is a technology extended from the audio and video field to the industrial, automotive, and mobile communication fields, originally derived from the application requirements of the audio and video field, called AVB (AudioVideo Bridging, Audio Video Bridging), which is used to solve the high bandwidth and high reality of audio and video networks timeliness, high transmission quality requirements.

The standards define mechanisms for the time-sensitive transmission of data over deterministic Ethernet networks.

TSN Use

Large bandwidth
Audio and Video Synchronization

IEEE802.1Q

Lidar
Audio and Video Synchronization
Internet of Vehicles interaction
Security

IEEE802.1AVB
IEEE802.1AS

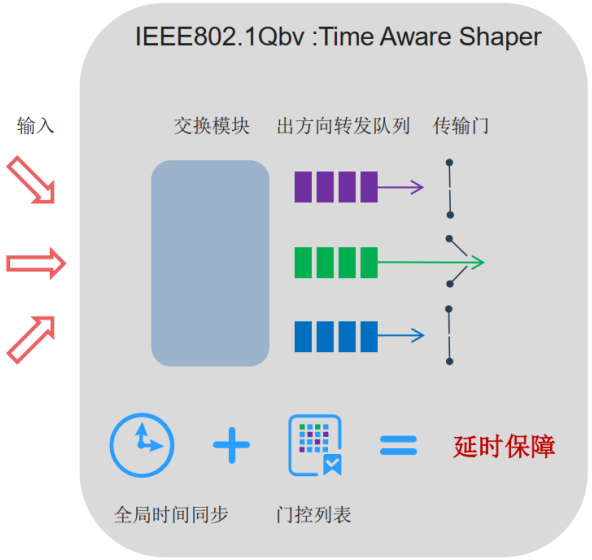
IoT data interaction
Internet of Vehicles interaction
Security

IEEE802.1ASrev
IEEE802.1Qbv
IEEE802.1Qbu
IEEE802.1CB
IEEE802.1Qcc

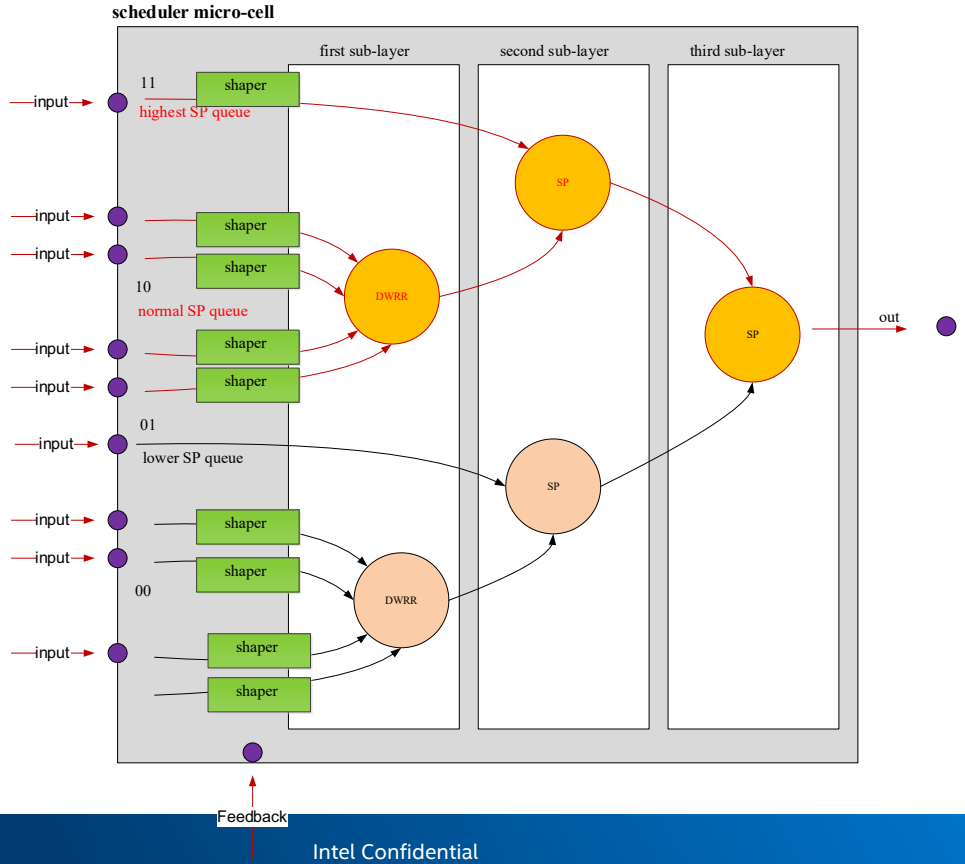
IEEE802.1Qbv

The Core principle of TSN is time-based traffic scheduling and management.

In the TSN network, TAS(Time Aware Shaper) which is a time-based queue scheduling method, is standardized as 802.1Qbv.



Scheduler


scheduler micro-cell
first sub-layer
second sub-layer
third sub-layer
input
11
shaper
highest SP queue
SP
input
input
shaper
shaper
DWRR
10
normal SP queue
SP
out
input
input
shaper
shaper
01
input
lower SP queue
SP
input
input
shaper
shaper
DWRR
00
input
shaper
shaper
Feedback

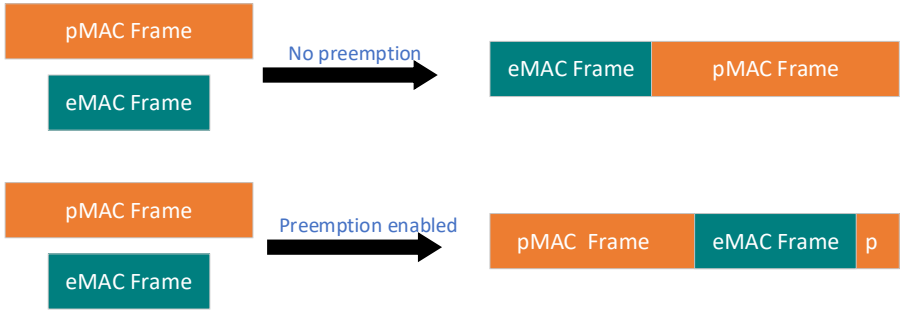
IEEE802.1Qbu

Qbv Problem: It may have a priority inversion problem, the queue continues to transmit low-priority frames, resulting in high-priority frames not being transmitted in time.

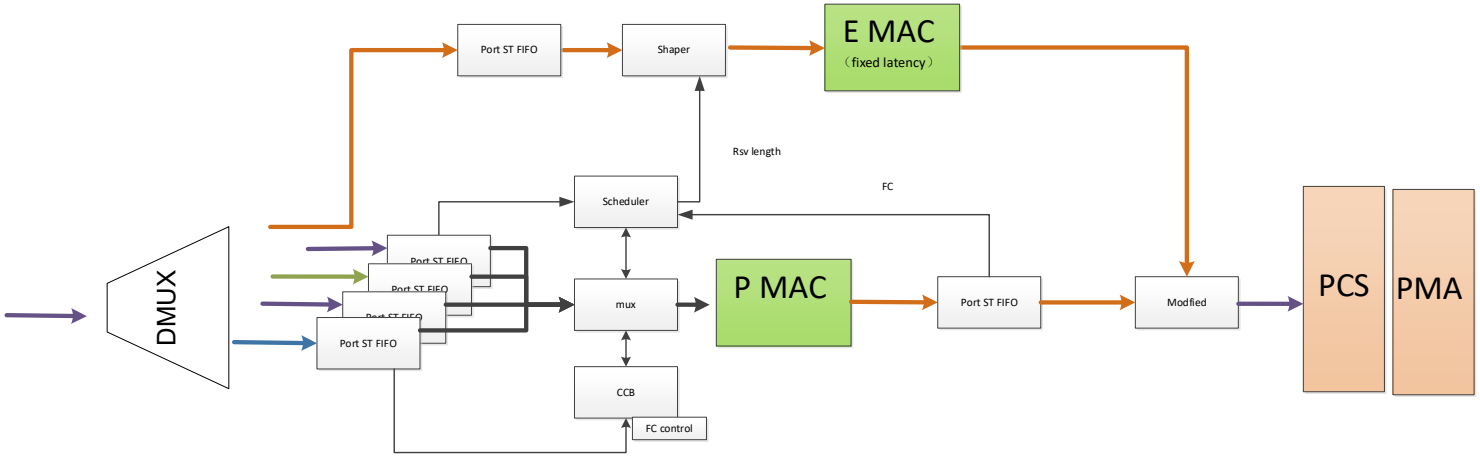
TSN introduces frame preemption mechanisms (802.1Qbu and 802.3br) that can interrupt the transmission to allow the transmission of high priority frames, and then resume transmission of previously interrupted messages to provide bandwidth for high priority frames and delay protection.

IEEE802.1Qbu

802.3br divides a given bridge egress interface into two MAC services, named pMAC (preemptable MAC, Preemptive MAC) and eMAC (express MAC, fast MAC). Based on the implementation of 802.3br, 802.1Qbu sends data packets classified into pMAC frames and eMAC frames. A pMAC frame that is being transmitted can be preempted by an eMAC frame. After the transmission is complete, the transmission of pMAC frames can be resumed.

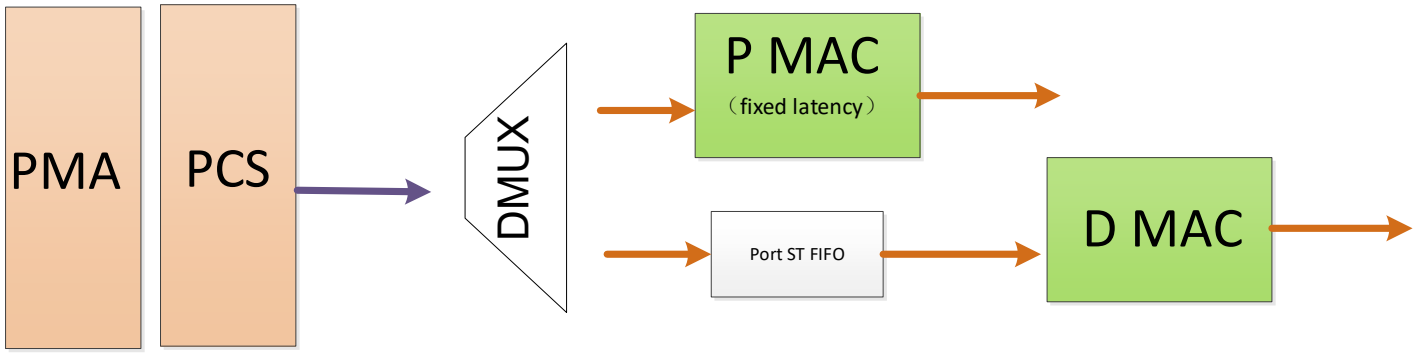


TSN TX Overview



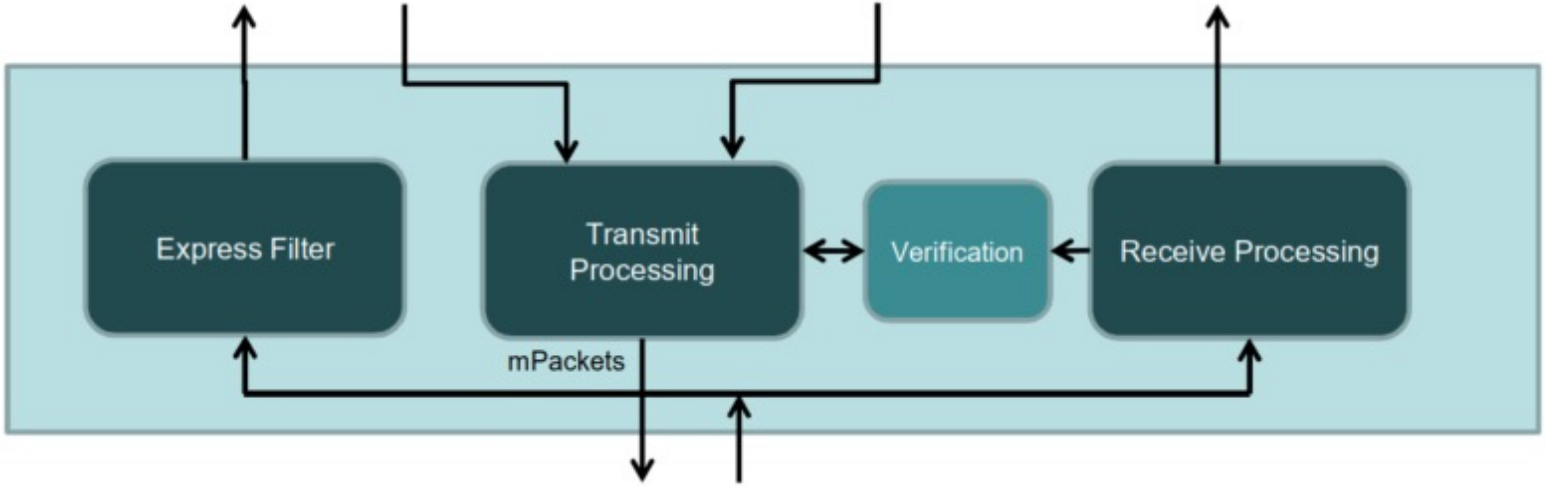
TSN TX Overview

TSN RX Overview

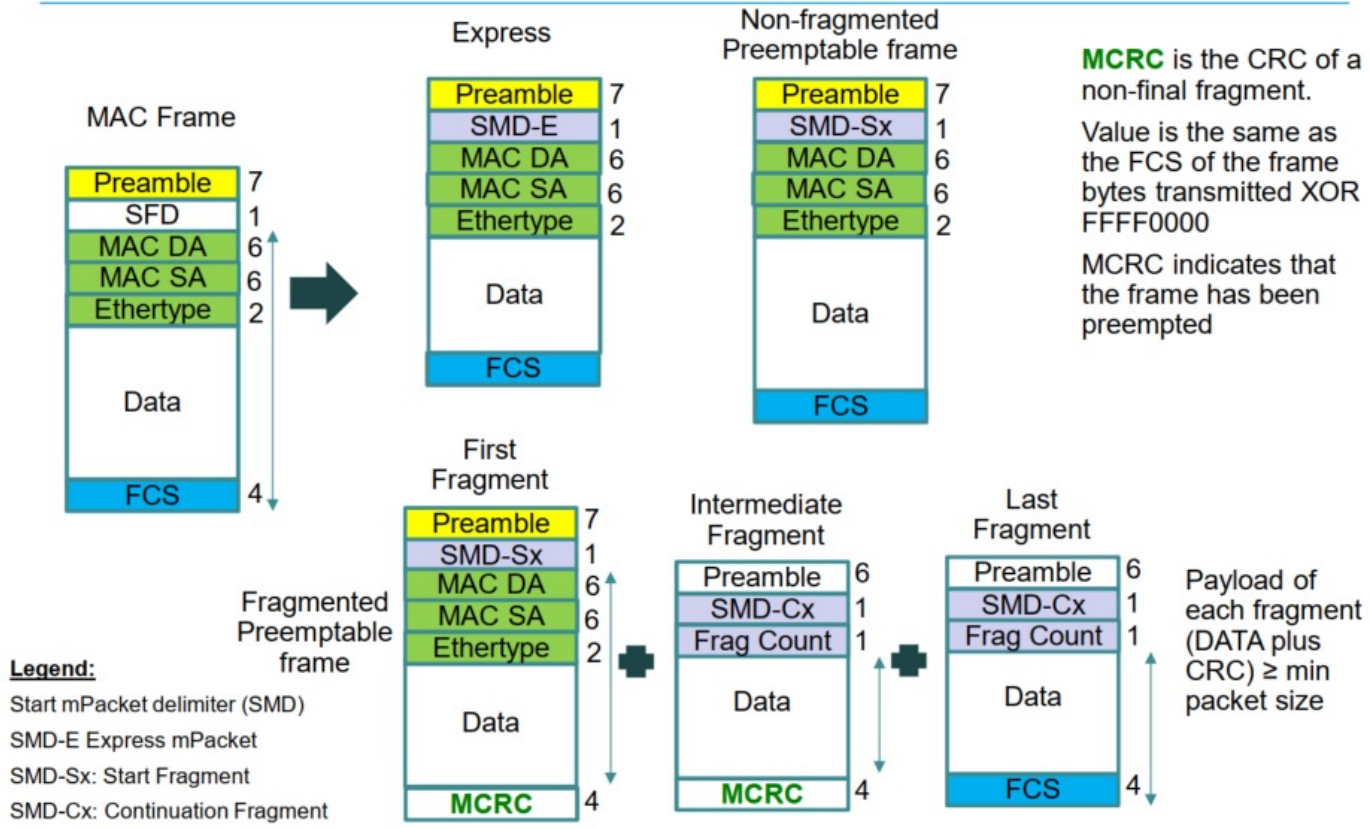


TSN RX Overview

MAC Merge sublayer



mPacket format



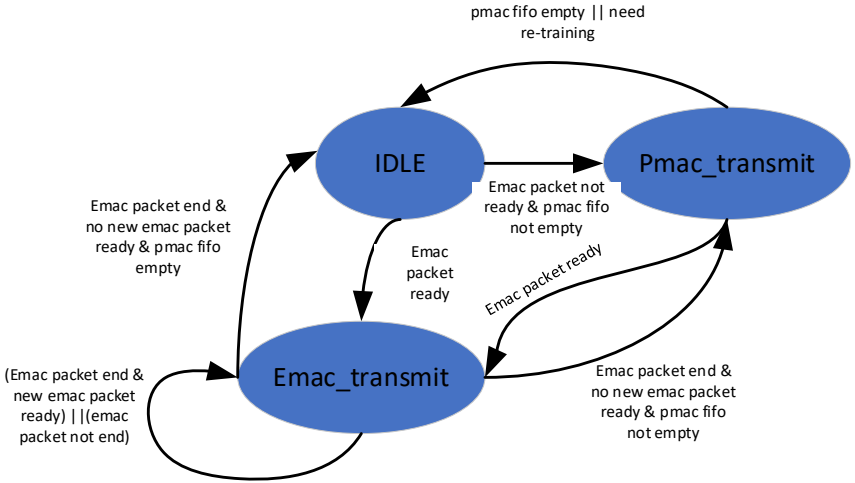
SMD and Frag count encoding

mPacket type	Frame#	SMD
SFD (express)	NA	0xD5
SMD-Sx Premptable frame start	0	0xE6
	1	0x4C
	2	0x7F
	3	0xB3
SMD-Cx Non-initial fragment	0	0x61
	1	0x52
	2	0x9E
	3	0xAD
Verify		0x07
Respond		0x19

Frag Count	Frag
0	0xE6
1	0x4C
2	0x7F
3	0xB3

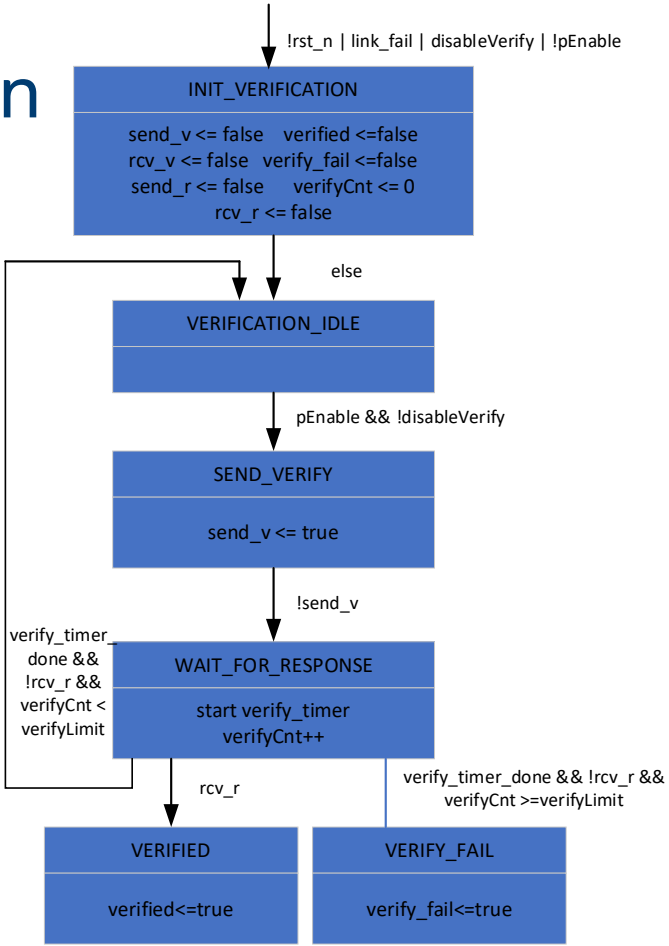
Information about the frame count prevents reassembling an invalid packet if the final mPacket of one preemptable packet and the initial fragment of the next preemptable packet are lost.

Transmit Processing



Transmit processing receives packets from the eMAC and pMAC.
When a packet is preempted, transmit processing appends the mCRC to the non-final mPackets. For the final mPacket of a preempted frame, the CRC field contains the CRC of the preempted MAC frame (the FCS field).

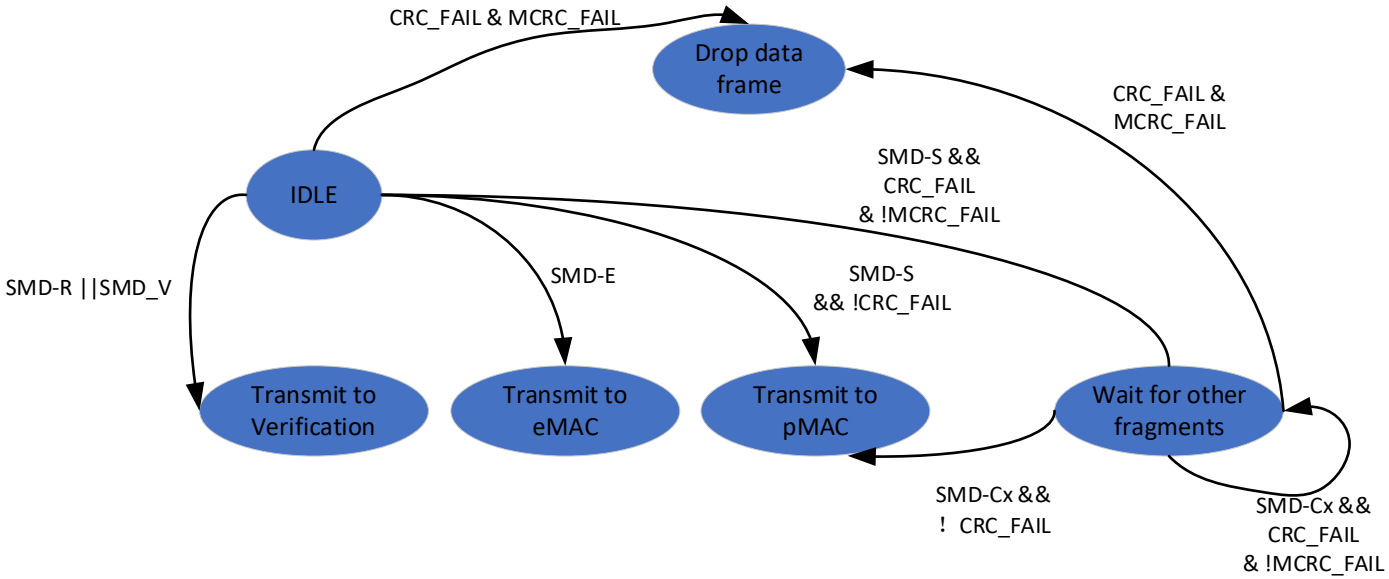
Verification



Verification checks that the link can support the preemption capability. If verification is enabled, the preemption capability shall be active only after verification has completed successfully.

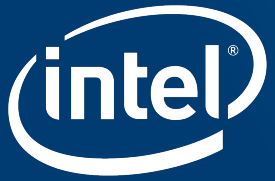
If the preemption capability is enabled but has not verified yet, the MAC Merge sublayer initiates verification. Verification relies on the transmission of a verify mPacket and receipt of a respond mPacket to confirm that the remote station supports the preemption capability.

Receive Processing



Express Filter

The Express filter checks the SMD of each received mPacket. If an mPacket contains an SMD-E, the Express filter passes to the eMAC. If the SMD contains any other value, Express filter ignores the mPacket.



Thanks !