# 3GPP 23.501

## Vertical_LAN Item #1.1: Support for PSFP based Hold and Forward Buffering rule

2020-04-03

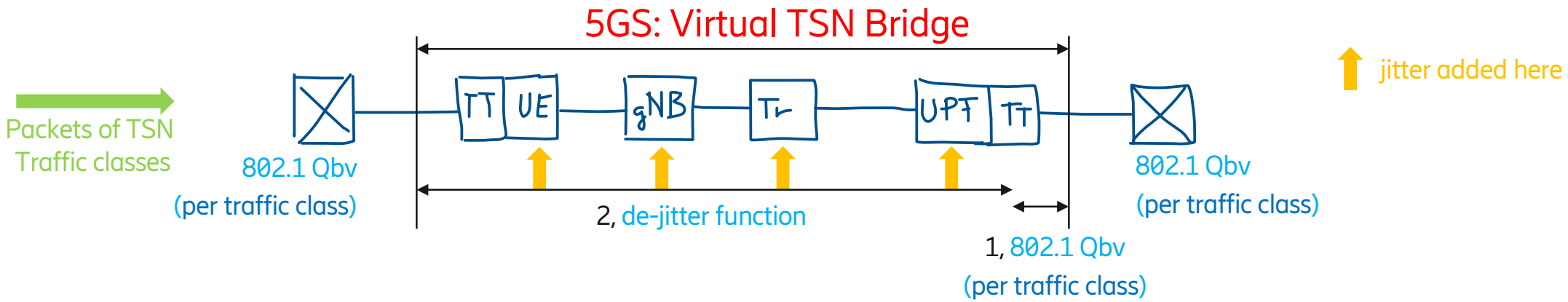
# Conclusion

- Every TSN bridge has to provide a deterministic behavior, so that traffic arrivals at next-hop is known.
  - This is achieved by limiting the jitter accumulated in the 5GS bridge. For the 5G system acting as "virtual TSN bridge", the NG-RAN introduces fundamentally jitter due to e.g. slot structures and TDD patterns, which exceeds the jitter tolerable by 802.1Qbv operation. 3GPP RAN in Rel-16 did not specify a solution to compensate its jitter, but identified "applying de-jittering buffer at the edges of the 5G systems" [3GPP TR 38.825, section 6.5.2] as one solution.
  - 5GS must provide moderate jitter between its port pairs for each traffic class associated with 802.1Qbv operations. A de-jitter component is needed to interwork with a connected Qbv domain.
  - See next slides for detailed analysis.
- Solution in Rel-16:
  - S2-2001801: it does not contain a de-jitter function.
  - S2-2002164: the proposed solution is not correct, it does not specify Hold and Forward buffer operations. No details provided how this will work.
  - S2-2002055: working solution for specification of Hold and Forward buffer, but not adopted.
  - Leave any solution out of Rel-16 and instead keep the NOTE that it is up to implementation.

# 23.501, Hold and Forward function

## One slide summary

- 5GS must behave as a virtual TSN bridge
- 5GS should not spoil the latency engineering when inserted in a TSN bridged network applying 802.1Qbv Scheduled Traffic
  - 802.1Qbv is not able to handle scenarios where ingress jitter is bigger than the gating cycle → 5G should not introduce such jitter
- Two components are needed for proper operation:
  1. 5GS fully implements IEEE Std 802.1Qbv to the level of being fully compliant to 802.1Qbv
  2. 5GS must provide moderate jitter between its port pairs for each traffic class associated with 802.1Qbv operations, which requires: De-jitter function inside 5GS




Sum of jitter in 5GS can destroy usage of 802.1Qbv in the TSN network → 23.501 has to provide solution, e.g., de-jittering

# Root cause of problems

## Deterministic transport over 5GS

- There are several factors that impacts the design of a TSN Network.
- Latency tools of TSN are used in order to minimize jitter of the egress traffic of a TSN Bridge, to ensure that buffers at next hop are not exhausted

- Note:
  - Although, 802.1Qbv is a per Traffic Class tool,
  - The use of 802.1Qbv is engineered through the entire network that bounded latency is provided for per TSN Streams

# 802.1Qbv

## Characteristics which are important to note …

- 802.1Qbv uses a single queue per Traffic Class (TC)
  - Packets of Streams (belonging to the same TC) are stored in the same queue, therefore they can influence each-other (e.g., what order they have been arrived in the egress queue). [See 802.1CM, Annex B]
- 802.1Qbv gate open/close pattern is derived from several factors
  - Characteristics of served Streams (periodicity, packet size, latency budget, etc.)
  - Packet level arrival of Streams
    - Ingress jitter of a given Stream (the bigger the jitter the more complicate to design Qbv pattern)
    - Relative arrival time to other Streams

# 802.1Qbv
## Known limitations

- Typical ranges for 802.1Qbv open/close pattern
  - Use case document of IEC/IEEE 60802 refers to typical network cycle range: 30 usec … 10's of msec

  [http://www.ieee802.org/1/files/public/docs2018/60802-industrial-use-cases-0918-v13.pdf]
  - Qbv open/close pattern (gate cycle) has a similar periodicity
- 802.1Qbv is not able to handle scenarios where the ingress jitter is bigger than the gating cycle . Depending on use-case scenario (number of Streams, their characteristics, network topology, etc.) at least an order of magnitude smaller ingress jitter is strongly recommended.
- Therefore, due to the jitter of some 100's usec collected by TSN Streams in a 5GS, industrial use-cases working in the lower part of the above network cycle ranges faces strong difficulties without a de-jitter function. (e.g., 400usec jitter → at least 4ms network cycle)
- Further information on "Cycle timing models in industrial applications" can be found in [http://www.ieee802.org/1/files/public/docs2018/60802-enzinger-cycle-timing-models-0718-v04.pdf]

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