Stream Identification and Shaping for Avionics

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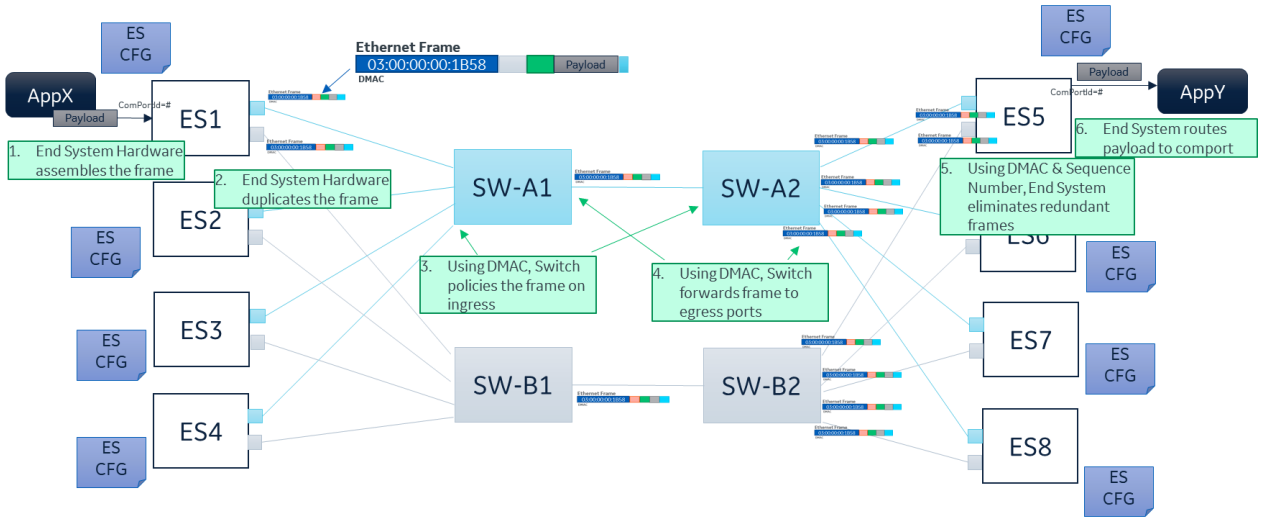
Objective

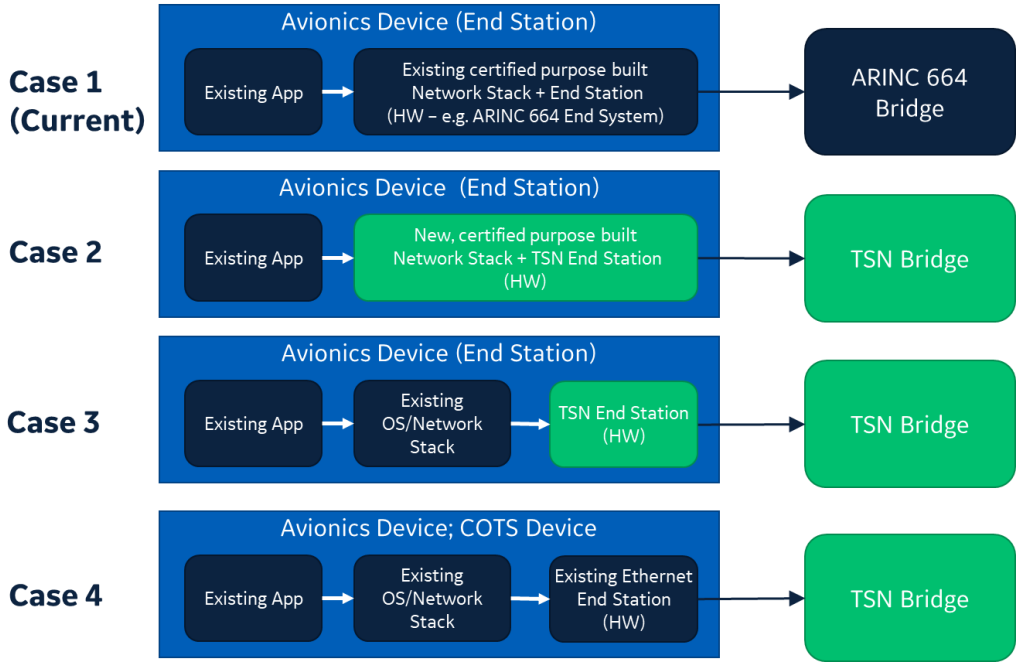
- ***Integrator use cases in avionics***
- ***Stream identification requirements for 802.1DP***
- ***Stream identification proposal***
- ***Mapping of stream shaping with stream identification***

Reference

Stream Identification for Avionics Networks - 19 Jan 2021

https://www.ieee802.org/1/files/public/docs2022/dp-schavey-stream-identification-0122-v03.pdf





Presented stream identification in existing Avionics networks and potential TSN use case scenario

Integration Use Case

Stream Identification Analysis

Assumptions

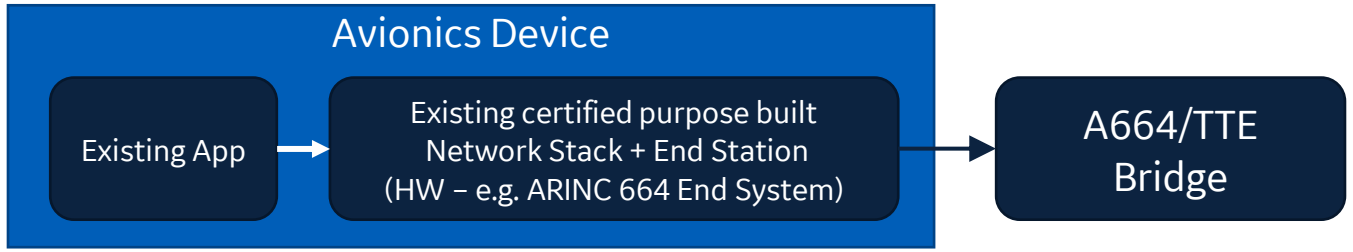
1. If application (and supporting network stacks) use special DMAC addresses for each stream (e.g. mulicast addresses for each stream), NULL stream identification is sufficient for both end stations and bridges. This is our ideal use case.

2. End Station vs Bridge approach: Given a choice, it is preferrable to add stream identification requirements on end stations as opposed to bridges. This addresses the problem at the source and makes bridges both simpler (cost effective, certifiable) and interoperable with existing (A664/TTE) bridges that essentially do null stream identification (without the VLAN ID part)

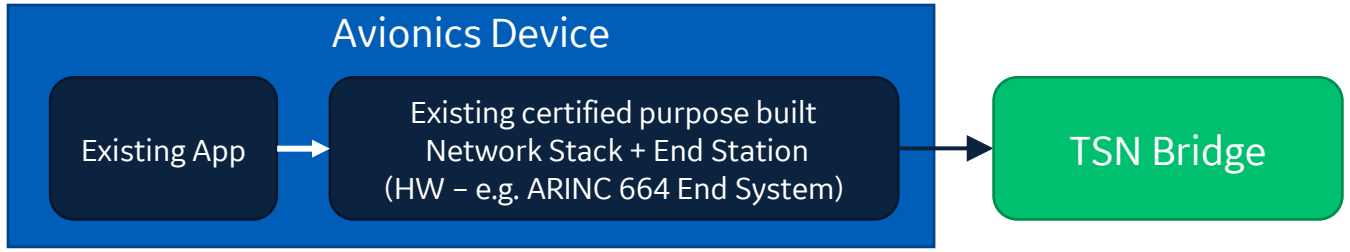
3. Conventions such as use of one DMAC prefix constant (with 2 bytes stream IDs) for a given domain should be left to the integrator.

Stream Identification Requirements Based on Integration Use Cases

Existing Aerospace Deteministic Ethernet Networks



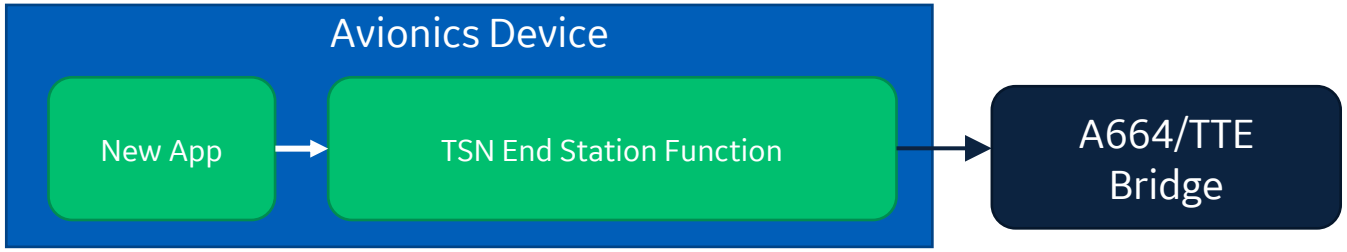
Use Case 1a: Integrate existing LRU with TSN Bridge



Existing Bridges only use mulicast DMAC to perform policing and fwding.

TSN Bridge: **Null Stream Identification**
TSN End Station: n/a

Use Case 1b: Integrate TSN EP with existing Bridge



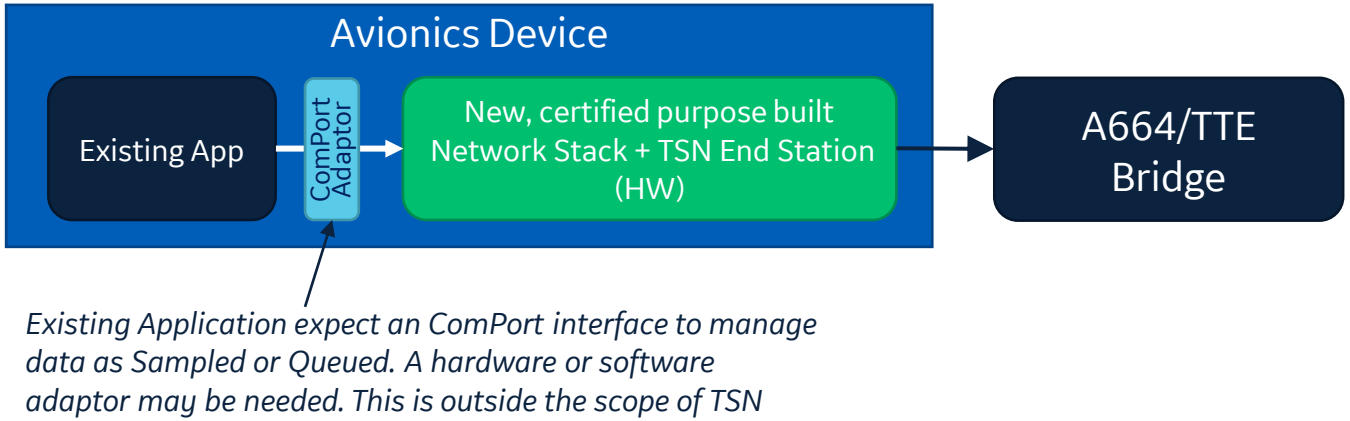
Existing End Systems only use multicast DMAC perform traffic shaping and FRER.

TSN Bridge: n/a
TSN End Station: **Null Stream Identification**

NOTE:
Must not use VLAN Tag to comply with A664 conventions
If it is required to exchange information with existing end systems, the IP header must comply with A664/TTE conventions

Stream Identification Requirements Based on Integration Use Cases

Use Case 2a: Replace Existing End Station with TSN End Station



Existing End Systems only use multicast DMAC perform traffic shaping and FRER.

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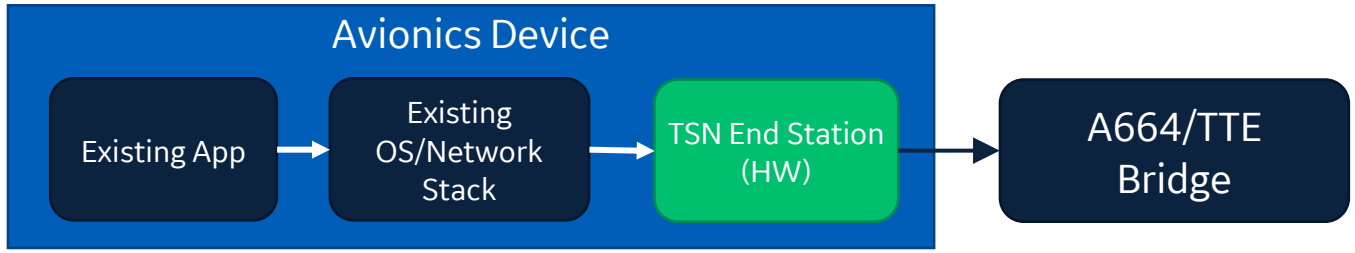
TSN Bridge: n/a
TSN End Station: **Null Stream Identification**

Use Case 2b: Replace Existing End Station with TSN End Station

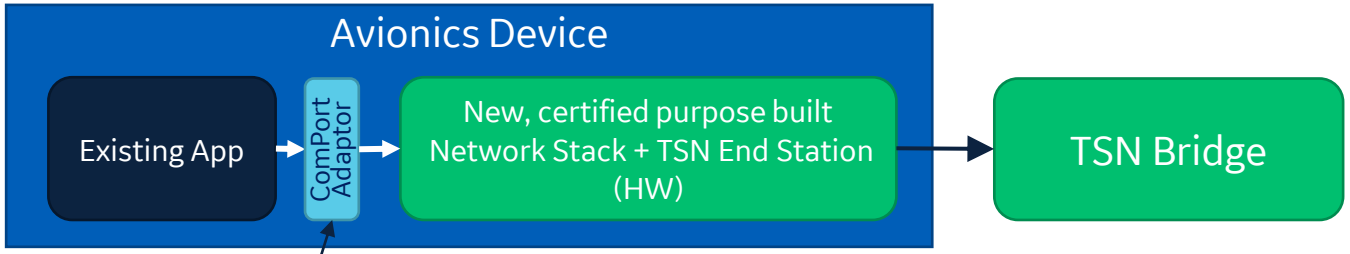


Existing stack will fully assemble the frame. The L2 & L3 headers must be transformed by the TSN End Station to comply with the Integrator network conventions.

TSN Bridge: **Null Stream Identification**
TSN End Station: **IP + Active MAC Identification**

Stream Identification Requirements Based on Integration Use Cases

Use Case 3a: Integrate existing App to TSN Network

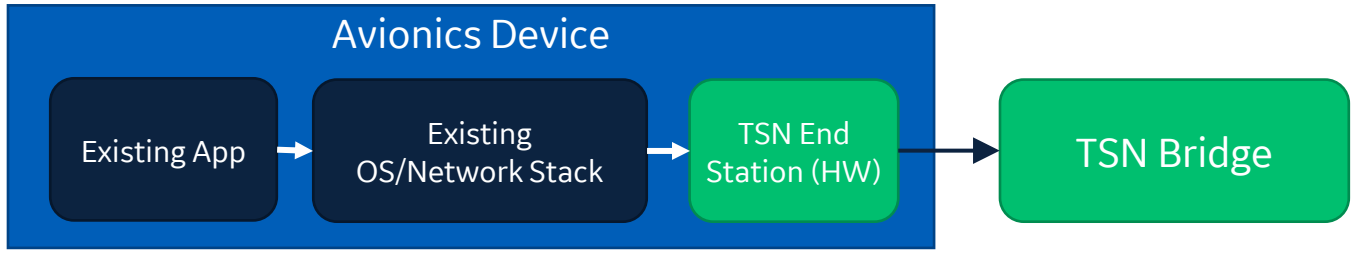


Existing Application expect an ComPort interface to manage data as Sampled or Queued. A hardware or software adaptor may be needed. This is outside the scope of TSN

Currently no restrictions or recommendations exist for Stream Identification. We recommend the continued use of Null Identification for ease certifiability and implementation.

TSN Bridge: **Null Stream Ident. recommended**
TSN End Station: **Null Stream Ident. recommended**

Use Case 3b: Integrate existing App/OS with TSN Network



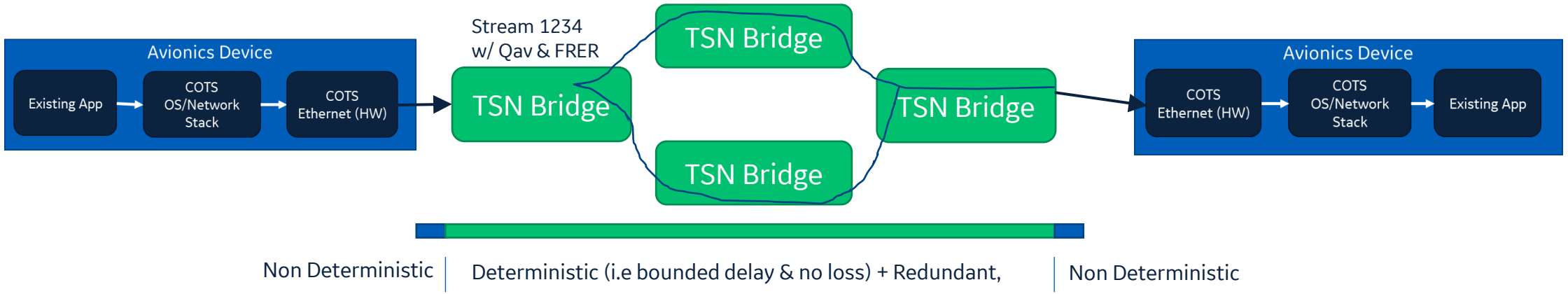
The existing stack will fully assemble the frame. Assuming the integrator has established L2/L3 addressing conventions, those headers will need to transform to comply with the Integrator network conventions.

TSN Bridge: **Null Stream Ident. recommended**
TSN End Station: **IP + Active MAC Ident. recommended**

Alternative: *if num streams between every talker-listener pair = 1*
TSN Bridge: **Null + Source Stream Ident.**
TSN End Station: **Null + Source Stream Ident.**

Stream Identification Requirements Based on Integration Use Cases

Use Case 4: Integrate existing Best Effort LRU to TSN Bridge



- A Network Integrator may desire a fully deterministic network backhaul but still allow best effort, COTS ethernet devices to participate.
- TSN could enable this new use case by leveraging TSN Bridges to shape streams, police and perform FRER over the backhaul of the network

TSN Bridge: **Null Stream + IP + Active MAC Identification recommended**

Alternative: *if num streams between every talker-listener pair = 1*
TSN Bridge: **Null + Source Stream Ident.**

Summary and Stream Identidicaiton Proposal

Integration Use Cases	TSN End Station Stream Id Method	TSN Bridge Stream Id Method
1a - Integrate existing LRU with TSN Bridge	n/a	Null
1b - Integrate TSN LRU with existing Bridge	Null	n/a
2a - Replace Existing End Station with TSN End Station	Null	n/a
2b - Replace Existing End Station with TSN End Station	Null, Active MAC, IP	n/a
3a – Intergrate Existing App with TSN Network	Null	Null
3b - Integrate existing App/OS with TSN Network	Null, Source, Active MAC, IP	Null
4 - Integrate existing Best Effort LRU to TSN Network	n/a	Null, Source, Active MAC, IP

Proposed End Station Requirements:

1. TSN End Stations **shall** support Null Stream Identification where VLAN ID optional
2. TSN End Stations **shall** support IP Stream Identification
3. TSN End Stations **shall** support Active MAC Stream Identification
4. TSN End stations **may** support Source Stream Identification

Proposed Bridge Requirements:

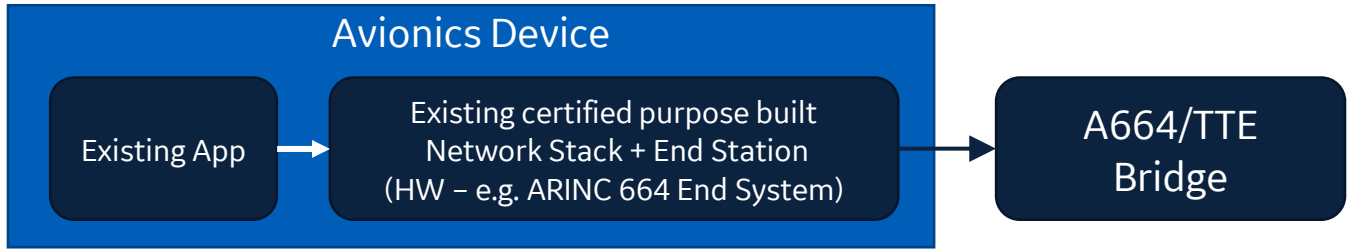
1. TSN Bridges **shall** support Null Stream Identification where VLAN ID optional
2. TSN Bridges **may** support IP Stream Identification
3. TSN Bridges **may** support Active MAC Stream Identification
4. TSN Bridges **may** support Source Stream Identification

Integration Use Case

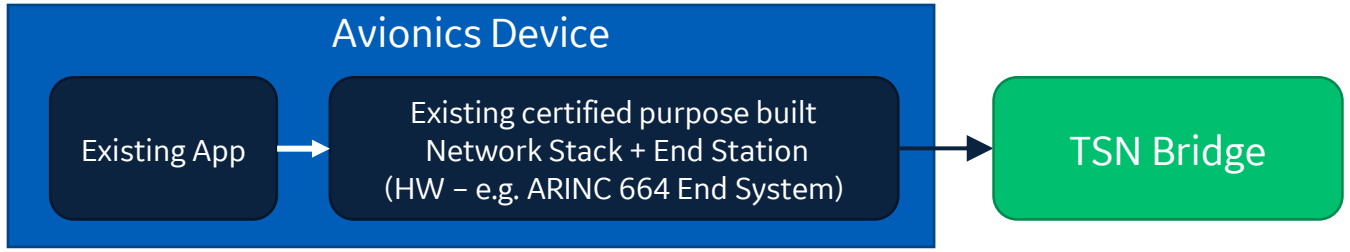
Stream Shaping Analysis

Stream Shaping Requirements Based on Integration Use Cases

Existing Aerospace Deteministic Ethernet Networks



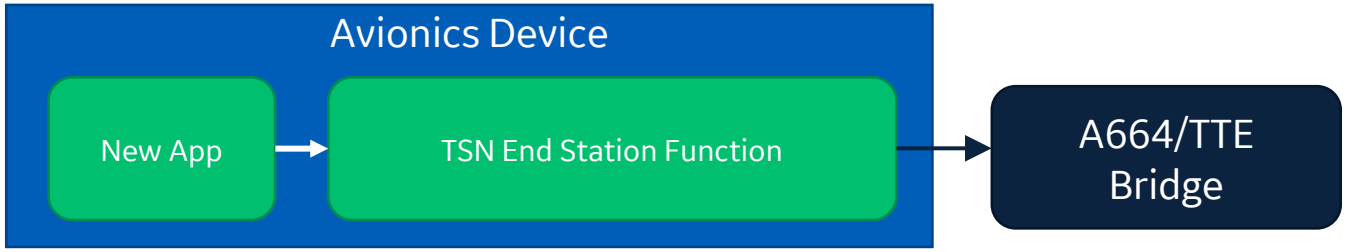
Use Case 1a: Integrate existing LRU with TSN Bridge



Existing Bridges only perform policing. No shaping required

TSN Bridge: **none (async profile)**
TSN End Station: n/a

Use Case 1b: Integrate TSN with existing Bridge

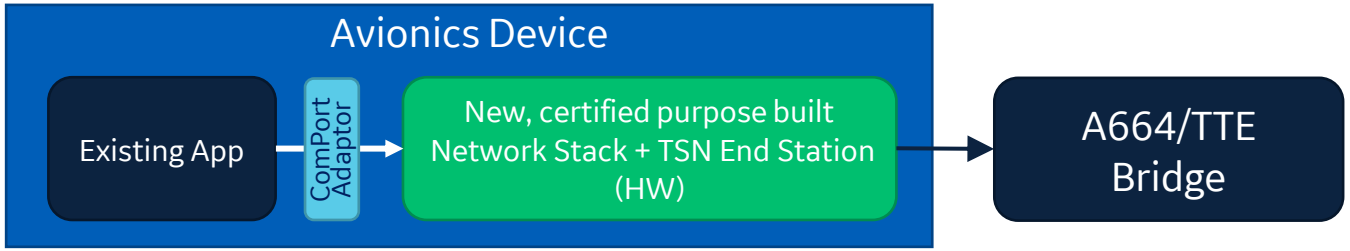


Existing End Systems use frame based, rate constrained shaping. Time Trigger VLs are not compatible with Qbv and QAS, thus not supported

TSN Bridge: n/a
TSN End Station: **Qav**

Stream Shaping Requirements Based on Integration Use Cases

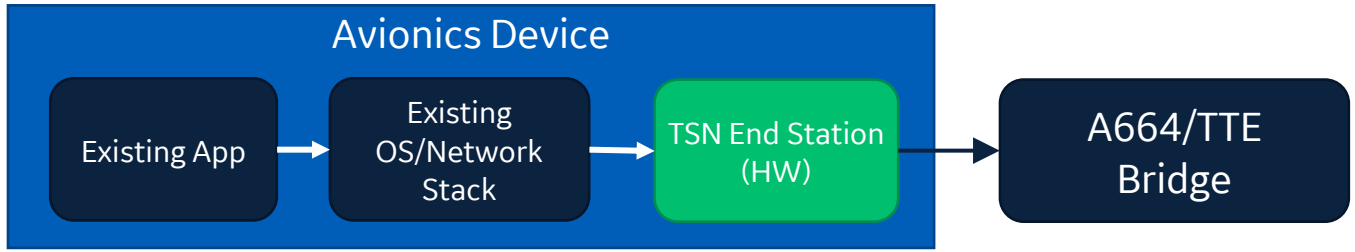
Use Case 2a: Replace Existing End Station with TSN End Station



Same as Use Case 1b

TSN Bridge: n/a
TSN End Station: **Qav**

Use Case 2b: Replace Existing End Station with TSN End Station

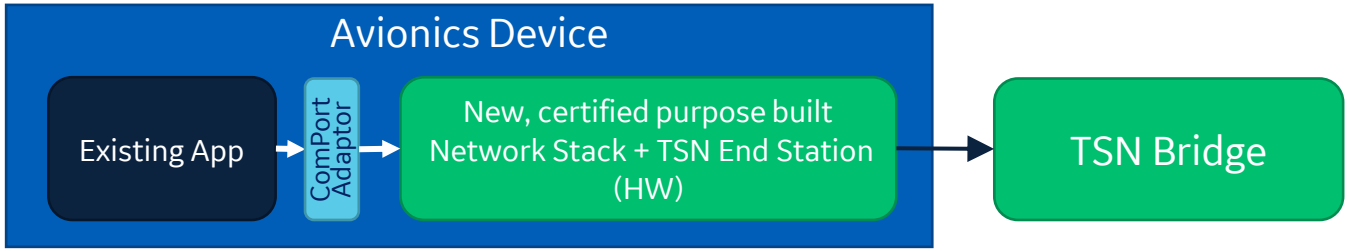


Same as Use Case 1b

TSN Bridge: n/a
TSN End Station: **Qav**

Stream Identification Requirements Based on Integration Use Cases

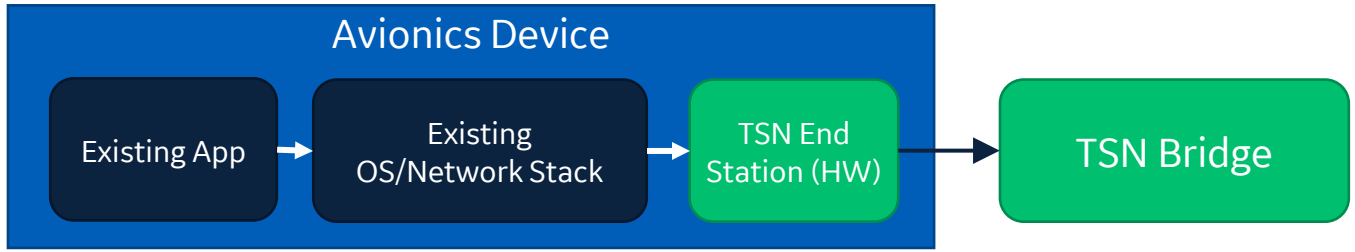
Use Case 3a: Integrate existing App to TSN Network



The existing applications rely on either rate constrained or isochrononos communication.

TSN Bridge: **Qbv* (see slide 16)**
TSN End Station: **Qav, Qbv**

Use Case 3b: Integrate existing App/OS with TSN Network

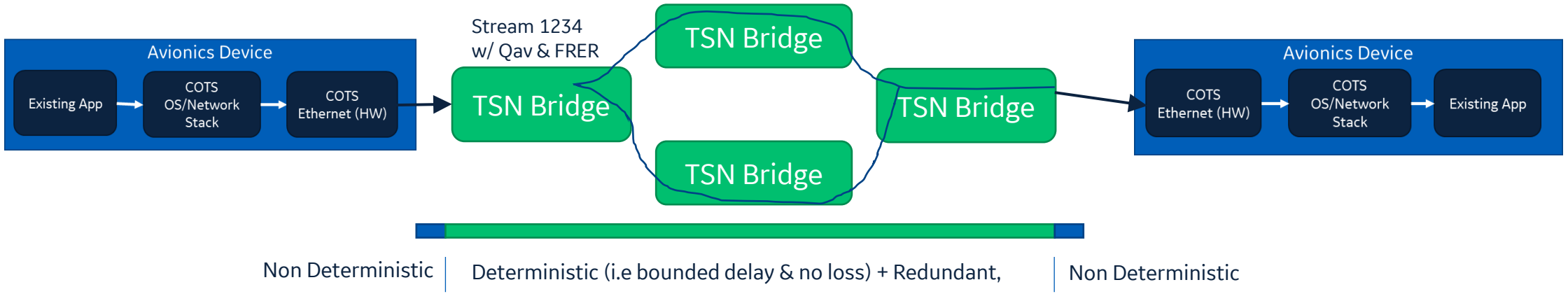


Same as 3a.

TSN Bridge: **Qbv* (see slide 16)**
TSN End Station: **Qav, Qbv**

Stream Identification Requirements Based on Integration Use Cases

Use Case 4: Integrate existing Best Effort LRU to TSN Bridge



- A Network Integrator may desire a fully deterministic network backhaul but still allow best effort, COTS ethernet devices to participate.

- TSN could enable this new use case by leveraging TSN Bridges to shape streams, police and perform FRER over the backhaul of the network
- Due to the asynchronous and bursty traffic from the Best Effort end stations, use of Qav would fit well while Qbv may be challenging

TSN Bridge: **Qav recommended, Qbv optional**

Special consideration when mixing Qav and Qbv shaped traffic

- Asynchronous profile:
  - The network carries only Qav shaped traffic.
  - Can be supported with end stations doing rate constrained shaping (e.g. Qav) and Bridges doing no shaping
- Synchronous profile:
  - The network carries both Qav and Qbv shaped traffic
  - End stations need to support both Qav and Qbv
  - Do bridges also need to support both Qav and Qbv? answer seems to be yes. Otherwise, the Qbv gating induced delays disrupt delay calculations normally done for a Qav-only network.

Summary and Stream Shaping Proposal

Integration Use Cases	TSN End Station Stream Shaper Method	TSN Bridge Stream Shaper Method
1a - Integrate existing LRU with TSN Bridge	n/a	n/a
1b - Integrate TSN LRU with existing Bridge	Qav	n/a
2a - Replace Existing End Station with TSN End Station	Qav	n/a
2b - Replace Existing End Station with TSN End Station	Qav	n/a
3a – Intergrate Existing App with TSN Network	Qav, Qbv	Qbv
3b - Integrate existing App/OS with TSN Network	Qav, Qbv	Qbv
4 - Integrate existing Best Effort LRU to TSN Network	n/a	Qav, Optionally Qbv

Proposed End Station Requirements:

1. TSN End Stations **shall** support IEEE 802.1 Qav for async profile
2. TSN End Stations **shall** support IEEE 802.1 Qav and Qbv for sync profile

Proposed Bridge Requirements:

1. TSN Bridges **may** support IEEE 802.1 Qav for asynchronous profile
2. TSN Bridges **shall** support IEEE 802.1 Qav and Qbv for synchronous profile

Backup

Stream Identification as defined in 802.1CB and 802.1 CBdb

Stream Identification Function	Active/passive	Examines	Overwrites
Null Stream identification	Passive	destination_address, vlan_identifier	None
Source MAC and VLAN Stream identification	Passive	source_address, vlan_identifier	None
Active Destination MAC and VLAN Stream identification	Active	destination_address, vlan_identifier	destination_address, vlan_identifier, priority
IP Stream identification	Passive	destination_address, vlan_identifier, IP source address, IP destination address, DSCP, IP next protocol, source port, destination port	None
Mask-and-match Stream identification function	Passive	destination_address, source_address, mac_service_data_unit	None