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# Aerospace and Defense Use Cases for Scheduled Traffic and PSFP

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# Purpose/Agenda

1. Discuss TSN for Aerospace and Defense applications
2. Discuss reference use case for scheduled traffic and PSFP
3. Establish market need (potential CSD) for MinSDU Filtering enhancement

**References:**

- IEEE Std. 802.1Q-2022
- Minimum Frame Size Filter for PSFP – presented at IEEE 2026 March Plenary https://www.ieee802.org/1/files/public/docs2026/new-jabbar-psfp-MinSDUsize-0326-v02.pdf
- Filtering Enhancements for Dependable 802.1 Networks – presented at TSN TG Meeting on Mar 23, 2026 https://www.ieee802.org/1/files/public/docs2026/new-jabbar-filtering-enhancements-0326-v02.pdf
- Filtering Enhancements for Scheduled Networks – contribution at TSN TG Meeting on July 6th 2026 https://www.ieee802.org/1/files/public/docs2026/new-jabbar-filtering-enhancements-0726-v01.pdf
- Filtering Enhancements for Scheduled Traffic – presented at IEEE 2026 July Plenary https://www.ieee802.org/1/files/public/docs2026/new-jabbar-filtering-enhancements-0726-v01.pdf

# Purpose/Agenda

1. Present Aerospace Use Case for Scheduled Traffic and PSFP
2. Support the potential PAR/CSD for MinSDU Filtering enhancement

**References:**

- IEE
- Mi
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- Filt
  https://www.ieee802.org/1/files/public/docs2026/new-jabbar-filtering-enhancements-0726-v01.pdf
- Filtering Enhancements for Scheduled Traffic – presented at IEEE 2026 July Plenary
  https://www.ieee802.org/1/files/public/docs2026/new-jabbar-filtering-enhancements-0726-v01.pdf

- **This contribution presents use cases for scheduled traffic and PSFP to inform the working group on market needs**
- **It is not meant to be a justification for MinSDU filtering – a first principles-based reasoning for MinSDU without dependencies on use cases has already been presented.**

# Aerospace & Defense Platform Networks

- All modern platforms are digitally distributed systems: *sensors, actuators, controllers, displays coordinating for platform operation*
- Communication system forms the “nervous system” or “digital backbone” (DBB) connecting the distributed components
- TSN is an “open” (MOSA compliant) solution for a platform-wide communication system/network
- Applicable to aircraft, space craft, and ground vehicles
- TSN-based DBB requires a platform-wide network <u>design, analysis, and configuration</u> since communications are fully engineered/coordinated

# Aerospace and Defense Network Characteristics

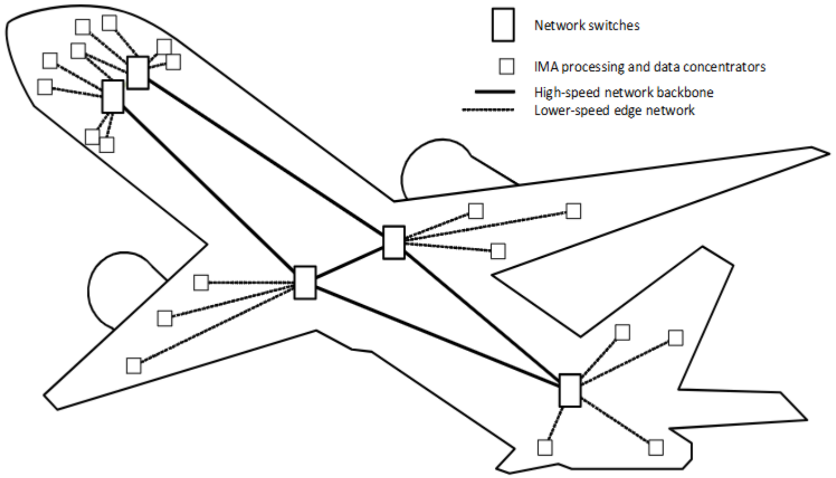



**Figure 6-2—Commercial integrated modular avionics depiction**

- Static engineered network
  Static topology – topology and devices fixed at design time
  Static applications – cycle times & frame sizes fixed at design time
- Relatively few, slow changes over time – network config process recomputed before deployment
- Relatively small topologies (see figure below)
- Fully centralized configuration (see config slide)
- Integrity, availability, fault-tolerance requirements (see reqs slide)

**Table 6-2—Summary of aerospace use cases**

| Characteristic | Current use | | Known/ desired new use | Use case driving the most restrictive bound |
|---|---|---|---|---|
| | Lower bound | Upper bound | | |
| Number of nodes | 5 | 100 | 500 | Large Passenger Aircraft (ACD) |
| Physical topology | Bus (command/response protocol), Point-to-point/ multipoint, Ring (daisy chained), switched star or combination | | Hybrid—Ring and Star | N/A |
| Number of switch hops | 0 | 5 | 15–30 | Large Passenger Aircraft (PIESD) |
| Max number of streams per switch | 50 | 2000 | 4096 | Large Passenger Aircraft (ACD) |

# Aerospace & Defense Network Requirements - Relevant for this Discussion

| Requirements | Description | Enabling TSN Feature |
|---|---|---|
| Determinism | Non-stochastic network behavior – fixed or very tightly bound latencies with time-aligned transmissions | Enhancements for Scheduled traffic (on a synchronous network) with rigorous network engineering |
| Fault Tolerance against faulty streams | Faulty streams that violate their MaxSDU, MinSDU, or Transmit Schedule do not impact other streams in the network | Per-Stream Filtering and Policing with rigorous network engineering |
| Change Management | Addition of new streams and/or talker/listeners does not impact the operation of the existing streams (under certain conditions) | Enhancements for Scheduled Traffic with rigorous network engineering |

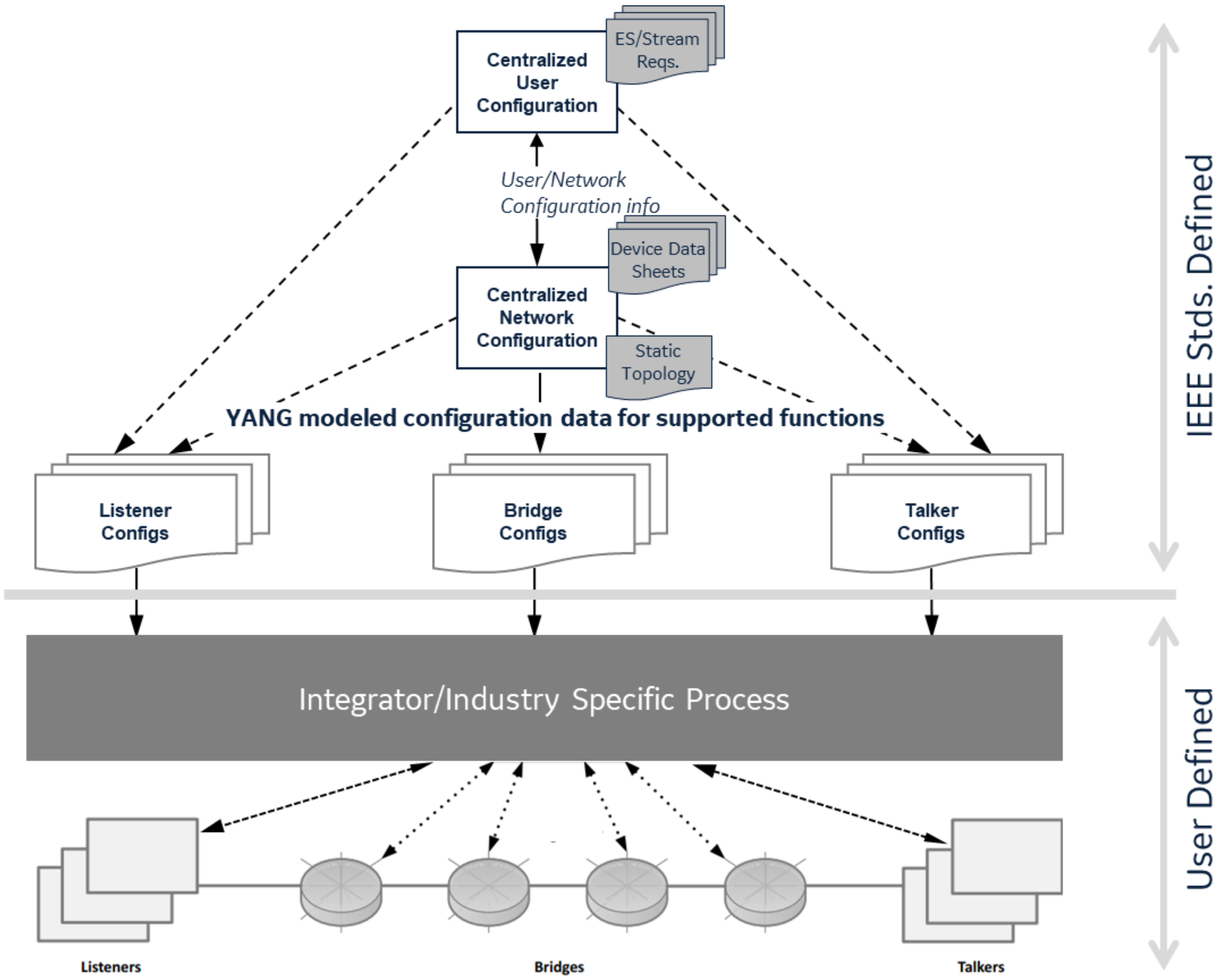
Note: The full set of requirements are not listed here for brevity. For example, other aspects of fault-tolerance include tolerance to node and link failures, tolerance to faulty end systems and bridges, tolerance to timing faults, etc.

# No Free Lunch – Rigorous Network Engineering

- Rigorous network design, configuration, verification, and validation processes exists in aerospace and defense industry
- Rigorous tool qualification standards exists to ensure correct configuration that meets the requirements.
- Design Assurance Levels (DAL) and Tool Qualification Level (TQL) dictated by DO-178C, D0-254, and DO-330 standards.

# TSN Aerospace Profile (IEEE 802.1DP) Configuration Model

- Engineered network with static topology
- Changes trigger the re-configuration process
- Fully centralized configuration model
- No direct comms between ES/Bridges and CUC/CNC
- Design/Engineering tool generates all input to CUC/CNC
- File based configuration for all end stations and bridges
- Integration and configuration across multiple TSN device vendors for an aerospace vehicle to be driven by YANG modeled configuration data.
- DP drives the interoperability

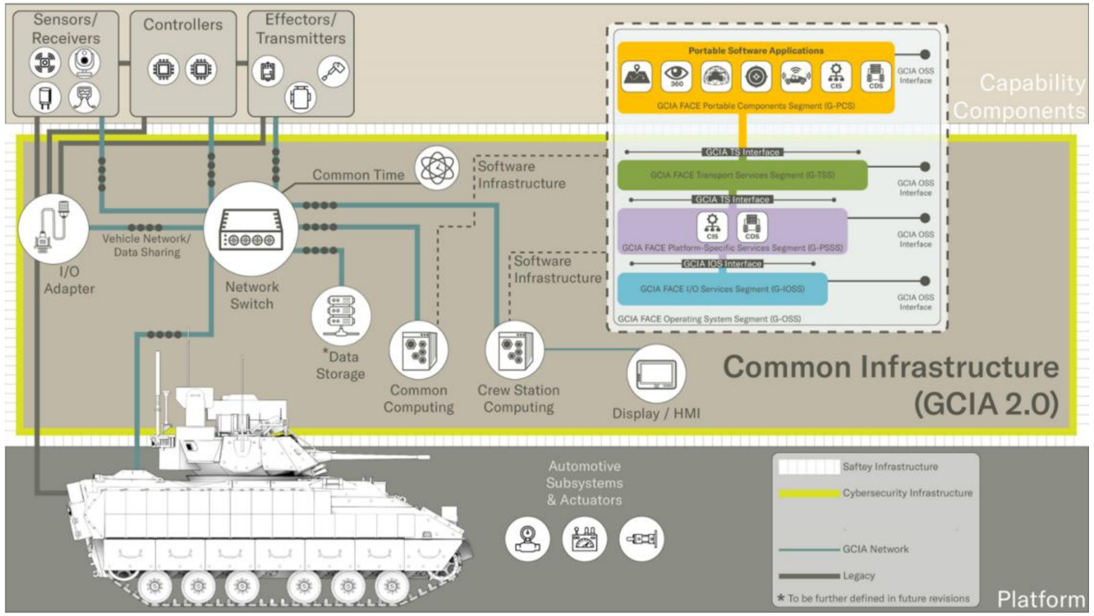


# – Use Cases – Reference Examples

# Ground Vehicles Use Case

- Ground Vehicles require precise and reliable data network between interconnected systems such as navigation, targeting, and comms
- Susceptible to data loss, delay, and jitter – e.g., Tank's fire control system requires precise timing to synchronize/align targeting data with the firing mechanism.

- Ground Combat Systems Common Infrastructure Architecture (GCIA)
  - Mixed criticality traffic with safety-critical functions and general-purpose applications.
  - Deterministic communication network supporting modular architecture
  - Requires TSN-based network and components to enable a converged network with strict timing and isolation guarantees




Source: Ground Common Infrastructure Architecture, Alan Cichosz, CTPI, [Online]

*[Source] S.Bush and A.Jabbar, "Analysis of Time-Sensitive Networks for Mission-Critical Systems", GVSETS 2025*

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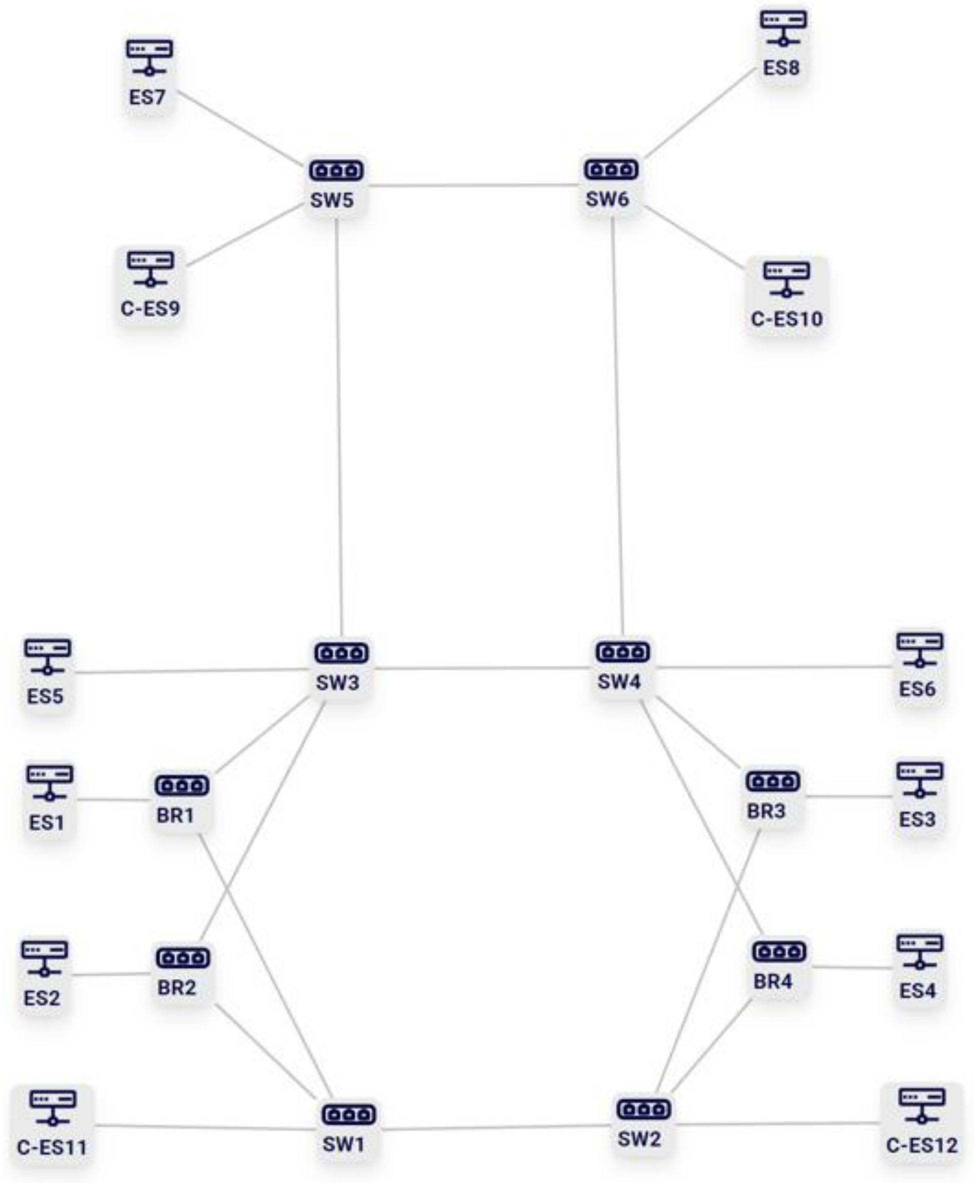
# Ground Vehicles Use Case

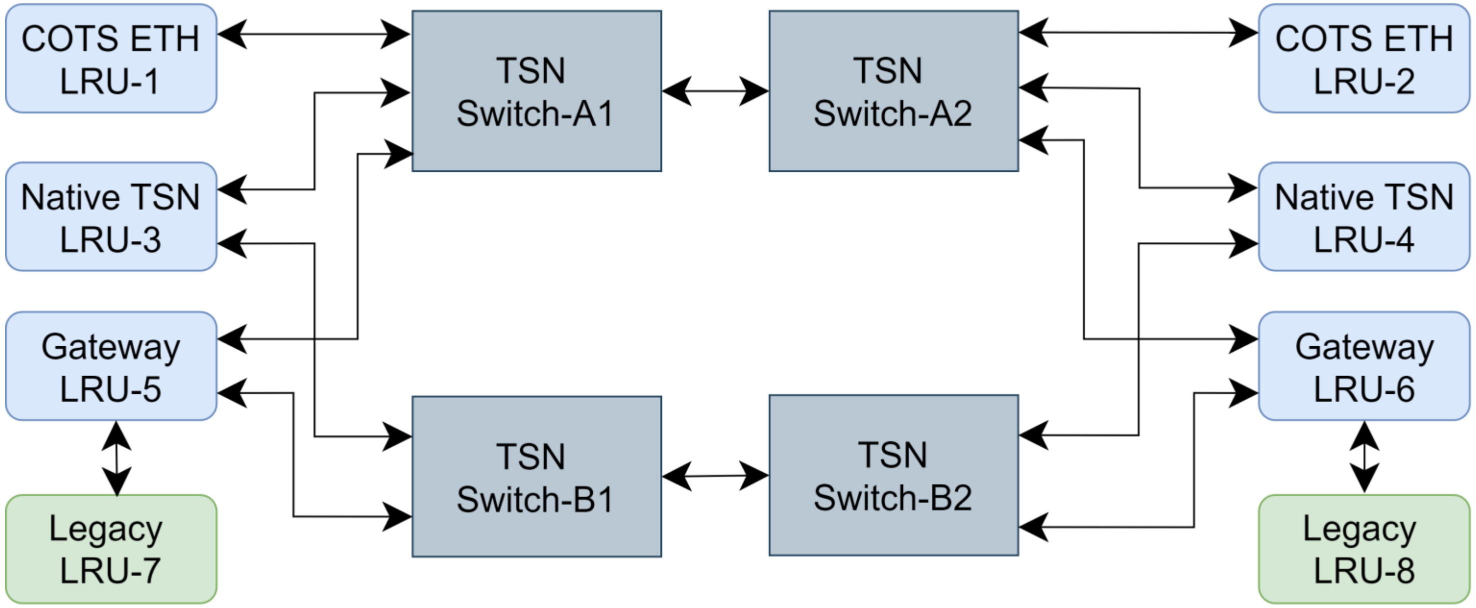
Reference Example:

- Emulating two zones (e.g., Turret and Hull)
- 6 main switches
- 12 end systems (including bridged-end systems)
- 25 to 100 scheduled data streams operating at 100 to 1000 Hz
- Fixed frame size for each stream. Size ranging from 800 to 1500 Bytes
- Strict Priority Streams for video and other non-cyclic traffic




*[Source] Bush, Jabbar, "Analysis of Time-Sensitive Networks for Mission-Critical Systems", GVSETS 2025*

# Aerospace Reference Implementation




**Features Deployed**

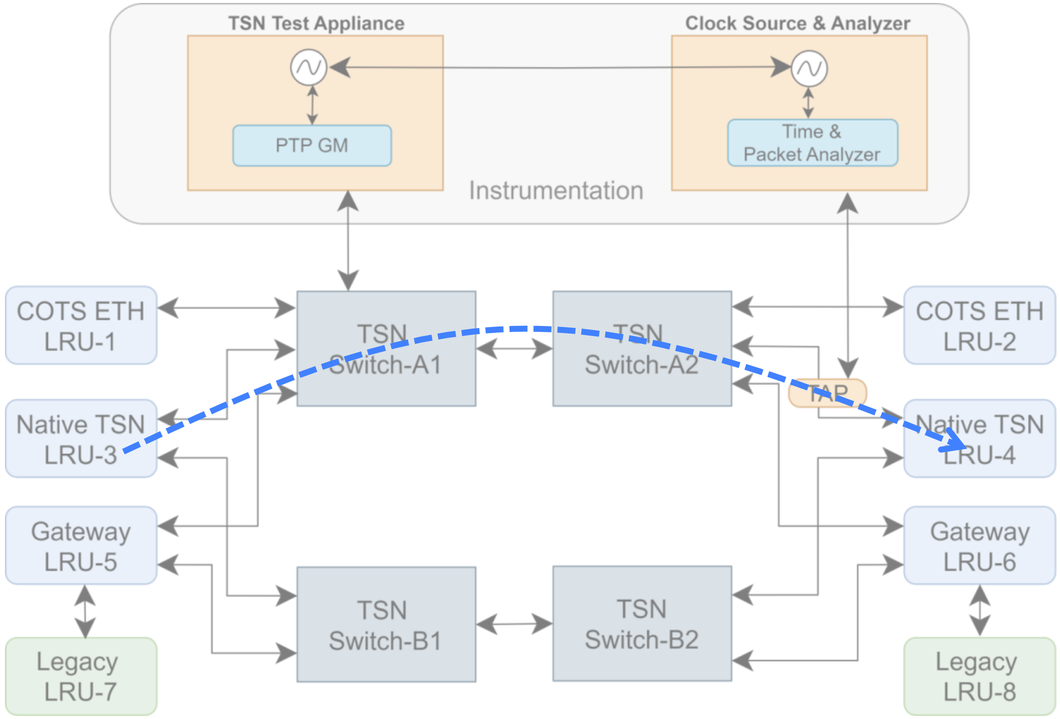
- Time Synchronization: gPTP
- Determinism: Time Aware Scheduling
- Logical Isolation: PSFP
- Reliability: FRER

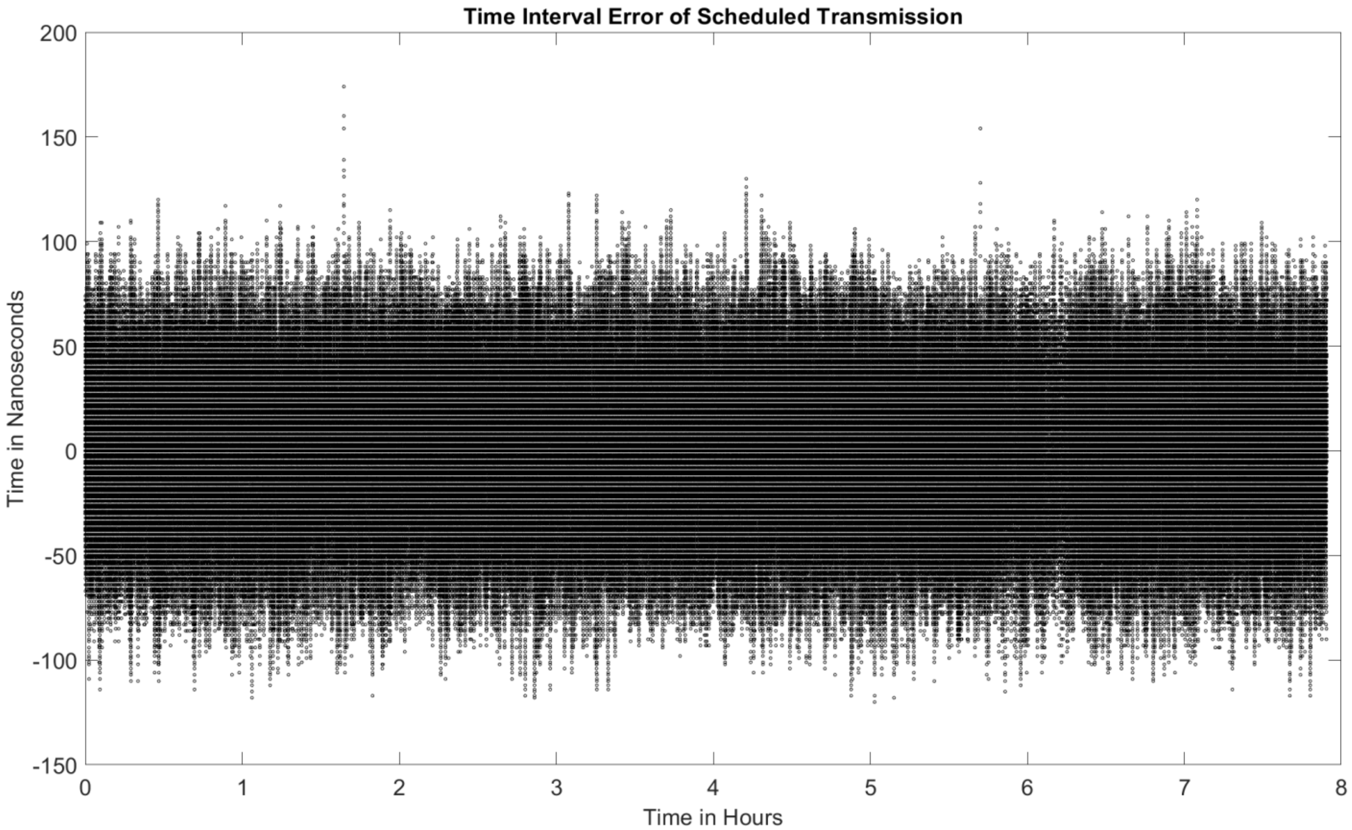
**Traffic Types**

- Native scheduled streams
- COTS ethernet streams (high priority & best effort)
- Legacy streams translated via gateway to scheduled stream

*[Source] A. Jabbar, P. Janakaraj, "TSN-Based Zonal Architecture for Digital Backbone", VFS FORUM80, 2024*

# Aerospace Reference Implementation: Scheduling



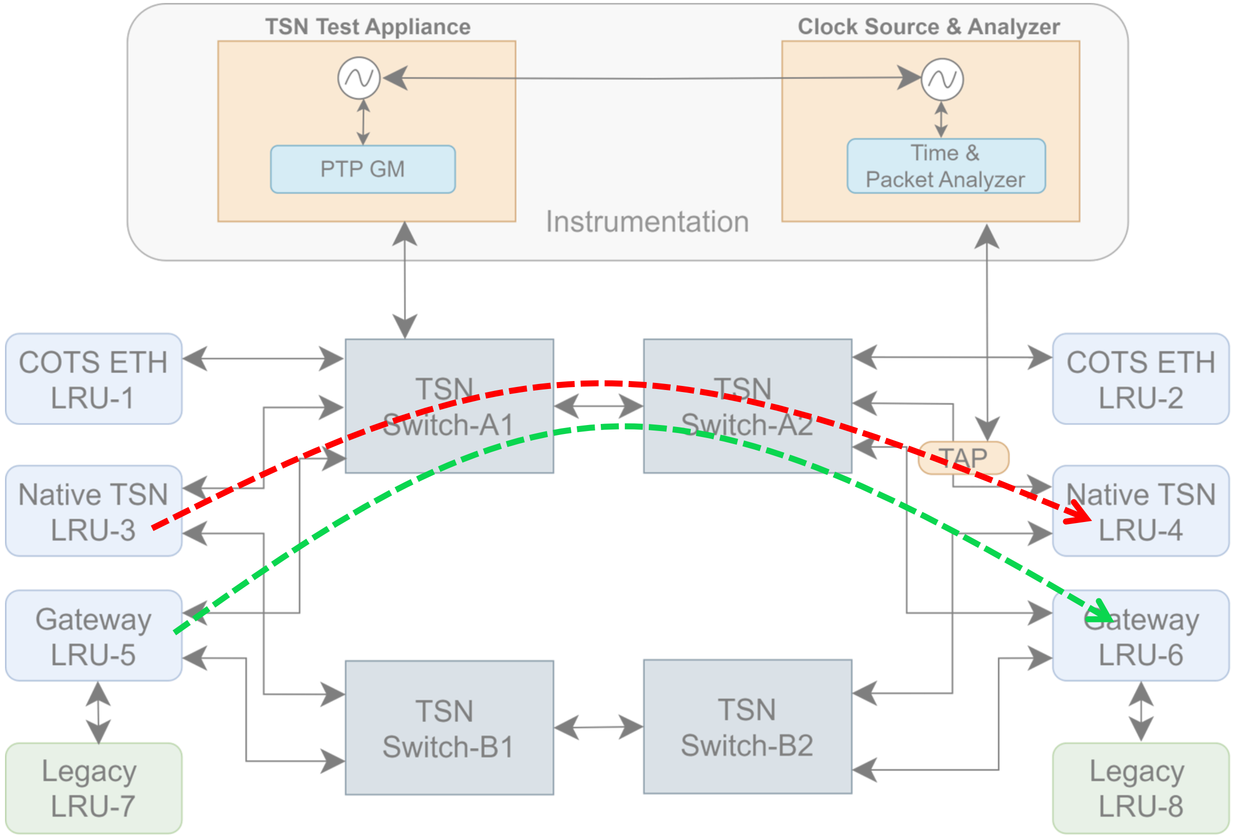




**Observations**

- 10 msec periodic stream in a converged network carrying mixed-criticality traffic
- Data transmissions at precisely scheduled offset based on synchronized time (in window arrival)
- Stable packet delay variation < 300 nanoseconds over a period of 8 hours

*[Source] A. Jabbar, P. Janakaraj, "TSN-Based Zonal Architecture for Digital Backbone", VFS FORUM80, 2024*

# Aerospace Reference Implementation: PSFP




**Observations**

Stream faults detected and isolated at Switch A1

1. Maximum frame size exceeded by red stream
2. Transmission schedule violated by red stream

*[Source] A. Jabbar, P. Janakaraj, "TSN-Based Zonal Architecture for Digital Backbone", VFS FORUM80, 2024*

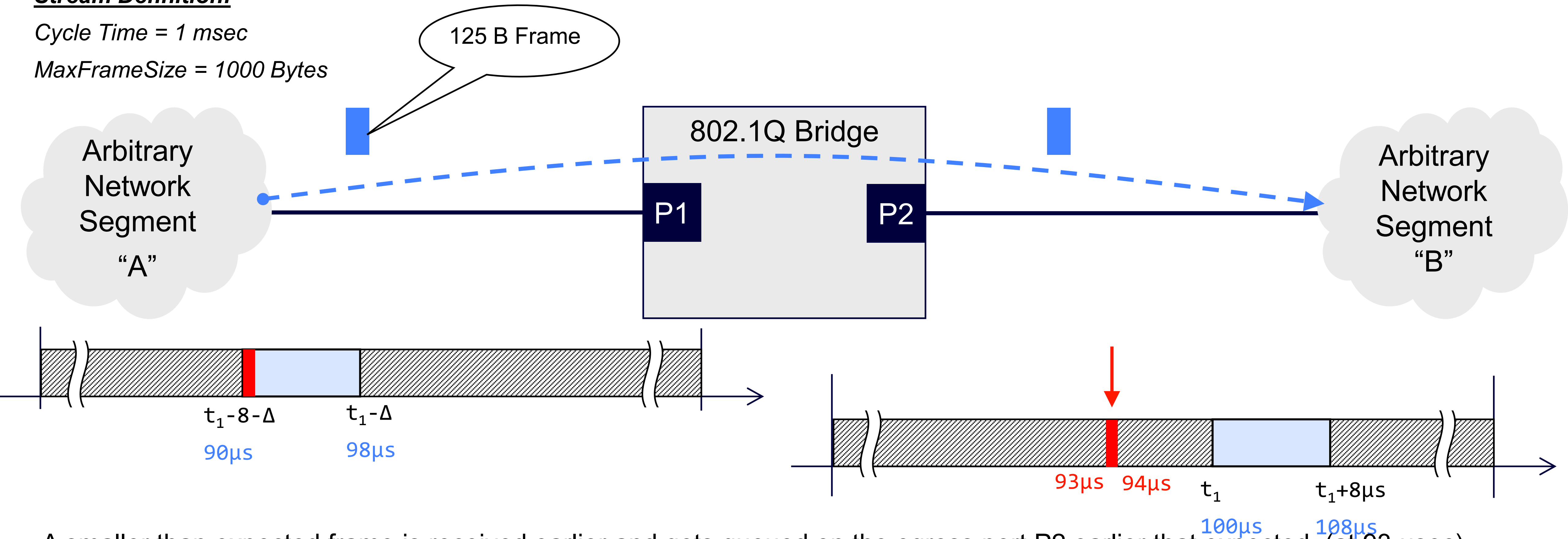
# MinSDU Filtering Enhancement

# Robustness to disruptive transmission: Smaller than expected frame size

***Stream Definition:***

*Cycle Time = 1 msec*

*MaxFrameSize = 1000 Bytes*




A smaller than expected frame is received earlier and gets queued on the egress port P2 earlier that expected (at 93 usec)

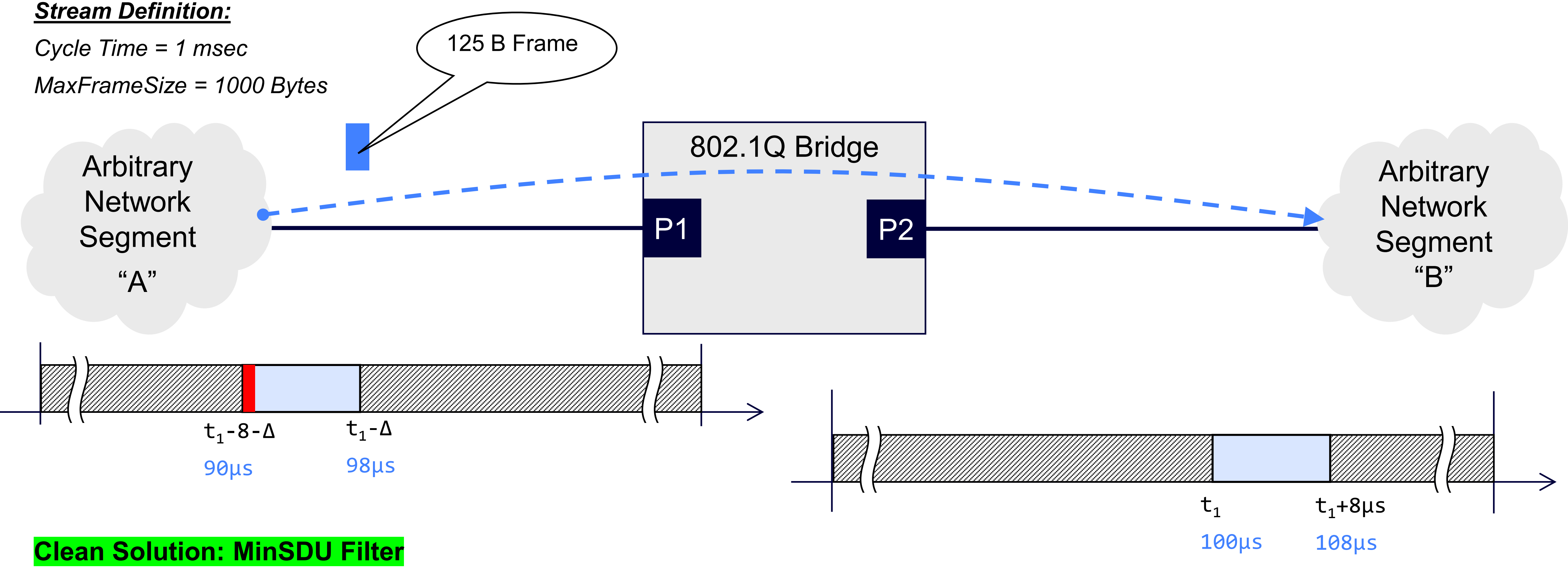
- If the queue gate is open (for a different stream), the errant frame will take that transmission slot
- May disrupt other streams scheduled in that window
- Stream Gating does not block this frame. MaxSDU Filter does not block this frame

# Robustness to disruptive transmission: Solution to Smaller than expected frame size

***Stream Definition:***

*Cycle Time = 1 msec*

*MaxFrameSize = 1000 Bytes*




**Clean Solution: MinSDU Filter**

- A smaller than expected frame is a faulty frame and must be discarded
- MinSDU size filter detects smaller than expected frames and **discards the frame**. Transmit widow goes unused on P2

# Summary

1. Discussed the use of TSN in aerospace and defense along with requirements and applicable TSN features
2. Presented reference examples for aerospace and defense applications
3. Established the market need for MinSDUSize filtering

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