Asynchronous Traffic Shaper in an Aircraft Cabin Use-case

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Introduction

The use of **TSN** (Time Sensitive Networking) is considered for various avionics use cases [1, 2] with a profile IEEE 802.1DP in development. This poster presents an **aircraft cabin use-case** with a TSN configuration using **Asynchronous Traffic Shaper (ATS)**.

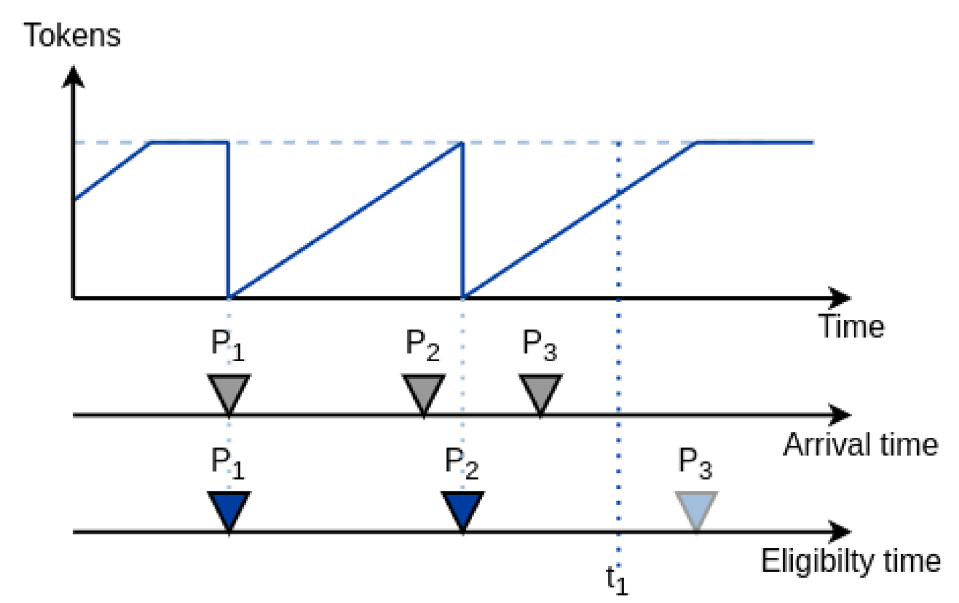

Figure 1:ATS for three consecutive frames of a stream.

Use-case

Cabin announcements require a maximum delay of 20 ms from source to speaker, they have the strictest time requirement within the aircraft cabin. All streams are processed on a **central server**, which is connected to all network nodes in a **star-chain topology**. [3] Figure 2 shows the longest path one such announcement stream can take. The source and spreaker each are located on the last hop of a longest chain. Frames need to take the maximum amount of hops to and from the central server.

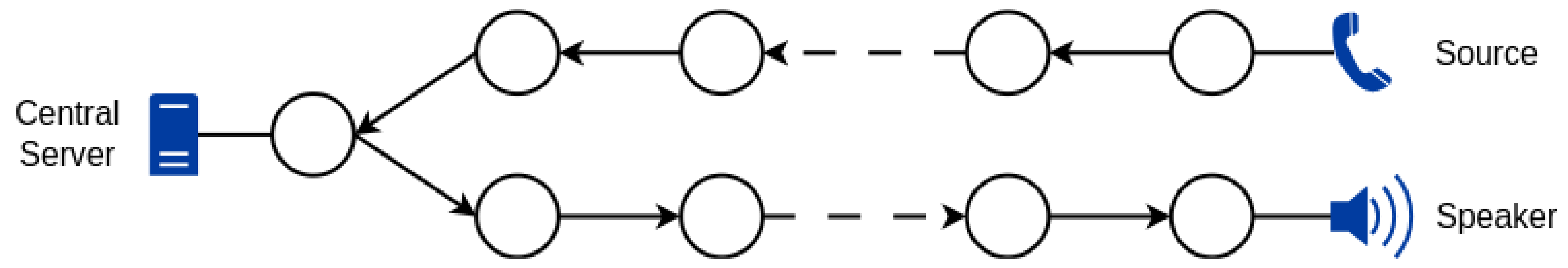

Figure 2:Longest paths of cabin announcements streams.

Asynchronous Traffic Shaper

ATS is defined in IEEE 802.1Qcr, providing **per stream shaping** based on a **token bucket algorithm** and **independent of time synchronization**. Each incoming frame is assigned an *eligibility time* by the **ATS scheduler** for its stream. Figure 1 shows how Frame P_1 and P_2 both become eligible when there are enough tokens, either on or soon after arrival. The in- and decrease of tokens depends on the *CommittedInformationRate* and *CommittedBurstSize* parameters of the scheduler. A third parameter, *MaximumResidenceTime*, leads to frame drops if the calculated eligibility time is later than $arrivaltime + MaximumResidenceTime$ (Frame P_3). The frame is then queued according to priority, the **ATS transmission selection** algorithm marks the frame as selectable if the eligibility time is reached. All selectable frames are transmitted in order of their eligibility time. [4]

Impact on Delays

It is necessary to identify critical points in the configurations to determine if it is feasible to use ATS for the cabin announcement use-case.

The specific **Network topology** has two characteristics that require a deeper analysis.

- The **central server** introduces a bottleneck. Every stream in the network has to go through the hop to the server.
- **Chains** increase the delay due to potentially long paths. Cross-traffic has additional impact on each hop.

ATS Configuration needs to cover edge cases in the stream behaviour.

- Streams may have a **higher data-rate** than configured in the network, for example due to clock-drift on the source.
- Frames may be delayed by cross-traffic leading to **unexpected bursts** on the path.

Delay analysis via Simulation

Simulations of the use-case can help analysing if the delay requirements can be met. OMNet++ 6.0.1 [a] and INET 4.5.0[b] were used for this work. Several scenarios were designed to quantify the impact of the network topology and identify robust ATS configurations.

[a] www.omnetpp.org
[b] inet.omnetpp.org

Limits of the Implementation

- Simulations inherently lack full case-coverage, found delays are not the worst-case
- Influence of network topologies on ATS is not yet investigated[5]
- Use-case implementation based off estimations for cross-traffic
- Scenarios use single configuration for other TSN mechanisms

Conclusion

- Network topology, stream definitions and ATS configuration all impact the delay of streams
- Simulations help estimate delays for use case, but are unable to show worst-cases
- ATS is not fully analyzed yet

References

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