Analysing Termination and Consistency in the AVB's Stream Reservation Protocol

Abstract

The Audio Video Bridging (**AVB**) Task Group from the IEEE proposed a series of standards to provide **Ethernet** with **soft real-time guarantees**. Later on, the group was renamed to Time-Sensitive Networking (**TSN**) and its scope was broadened to provide new services to more **critical applications**. The Stream Reservation Protocol (**SRP**) stands out among the projects developed by the groups, as it is key to **bound the transmission delay** and to **minimize frame loss** due to **lack of resources**. Nonetheless, SRP was originally designed for audio/video applications and does not take into account properties that are important for critical systems; such as termination or consistency. In this work we study the **termination and consistency** of the reservations using **AVB's SRP**. We used **UPPAAL** to model the protocol and to **verify the properties**. We see that SRP does neither provide termination nor consistency, we discuss how the lack of these properties can impact critical applications and we propose a series of solutions.

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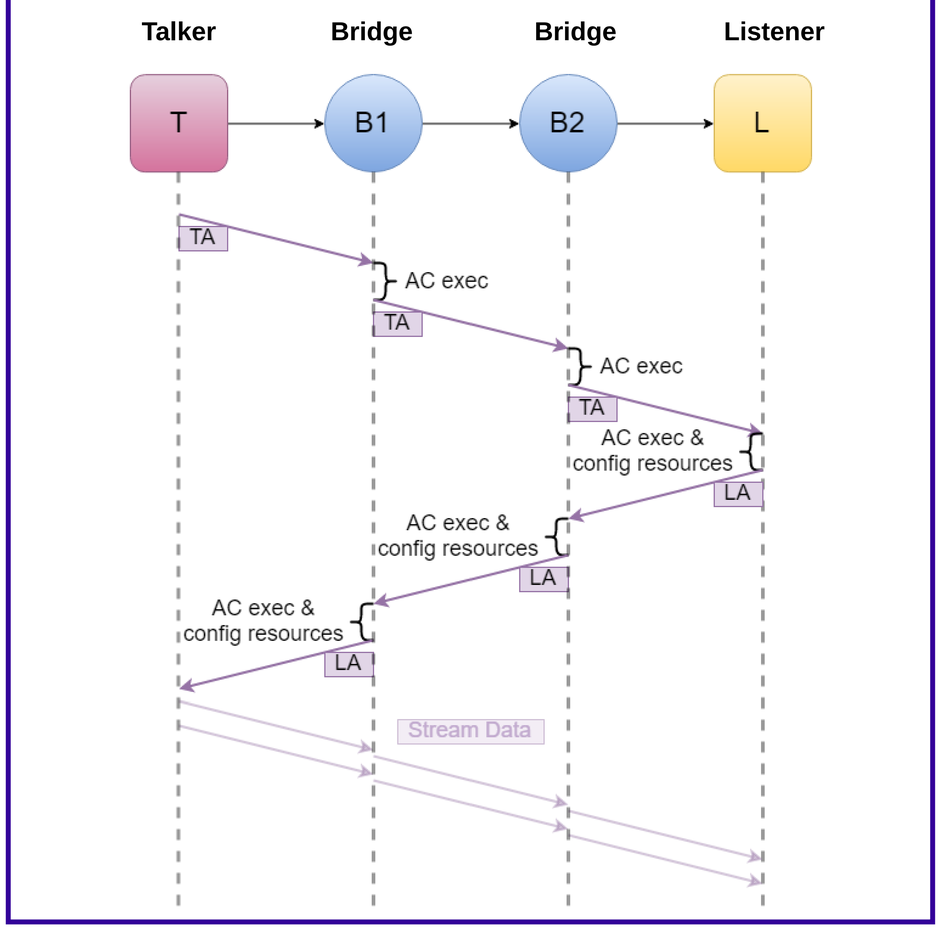
1. SRP Overview

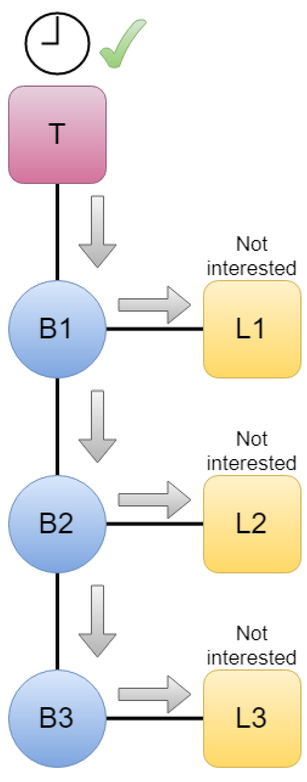


2. Evaluation of the Termination

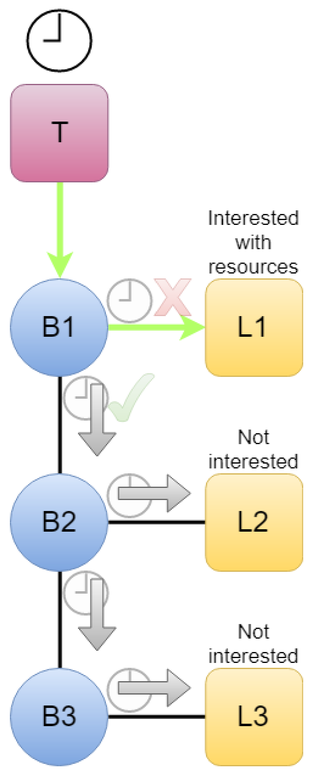
Type of issue: Listeners not interested in the stream do **not respond** to the TA and this can cause a **termination issue** in **bridges** and in the **talker**.

Solutions:

- **Termination for the Application:** Use timeouts in talkers that are large enough to guarantee that the response of all interested listeners could reach the talker. When the timer expires the talker knows that there are not interested listeners so it can delete the stream using mechanisms already present in the SRP.
- **Termination for the Infrastructure:** Use timeouts in every port of the bridges that are large enough to guarantee that the response of all interested listeners could reach the bridge. The timers should be configured to guarantee that the timer that expires the first is located in the bridge nearest to the talker and we would introduce the mechanism to delete the stream also in bridges in order to delete it in the whole path.



Termination for the Application

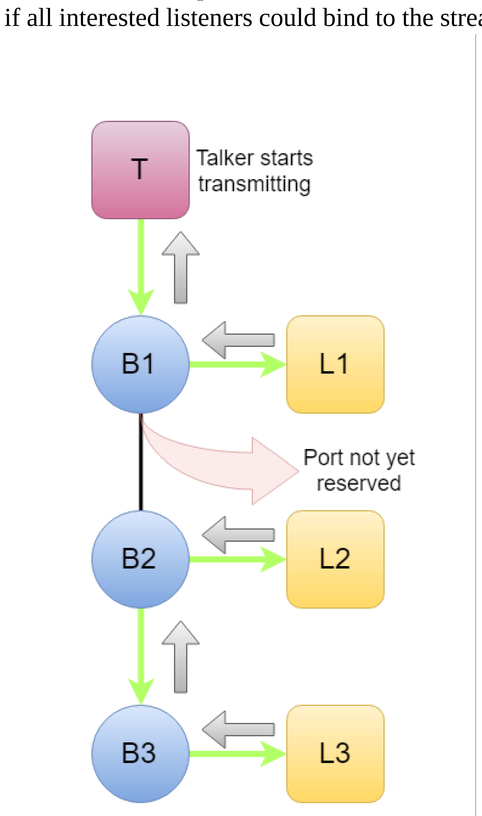


Termination for the Infrastructure

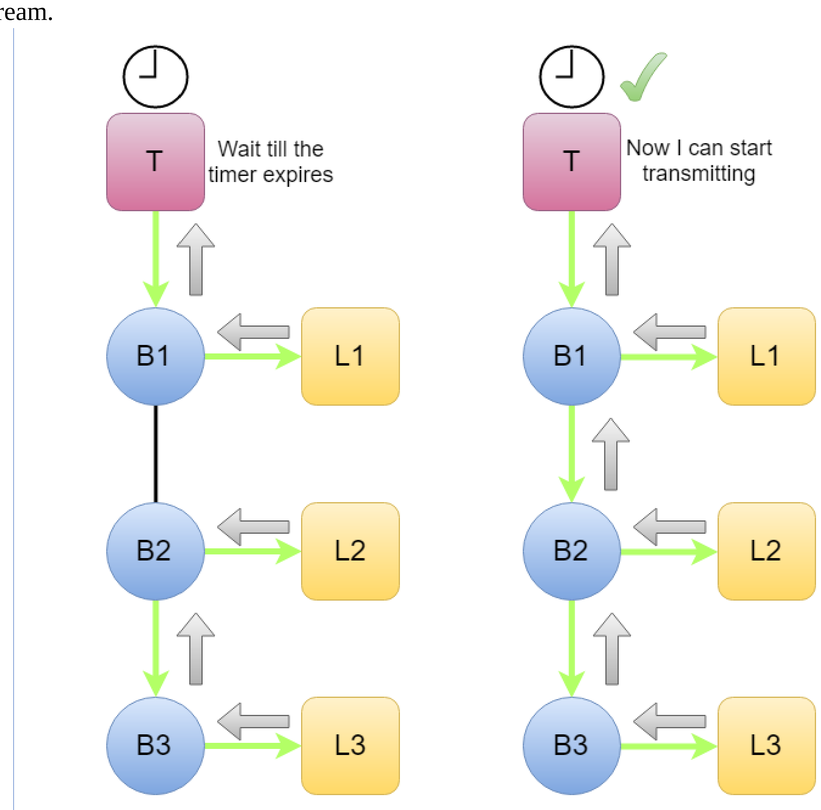
3. Evaluation of the Consistency

Issues at the Application level: Once the **SRP is concluded,** it is possible that a **talker can only communicate stream data to a subset of listeners due to a lack of resources, generating** an unnoticed **inconsistency** in the exchange of the stream data. Additionally, Any **talker** can **start transmitting** frames through a stream **before** it receives the **response** from **all listeners**. This can happen, as the paths between a talker and different listeners may differ in length and end-to-end delay. Therefore, a **listener** willing to bind to the stream, with enough resources throughout the whole path towards the talker, **may miss the first frames transmitted by the talker**. This would lead to a lack of consistency in the input of the listeners, which could be a problem if they have to carry out coordinated actions.

Solution: Use timeouts in talkers that are large enough to guarantee that the response of all interested listeners could reach the talker. When the timer expires the talker knows that all listener responses had enough time to have been received so it can start transmitting if all interested listeners could bind to the stream.



Inconsistency at the Application level

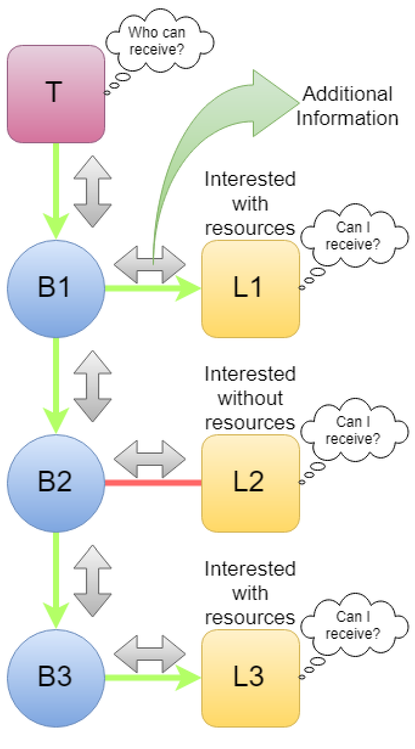


Consistency at the Application level

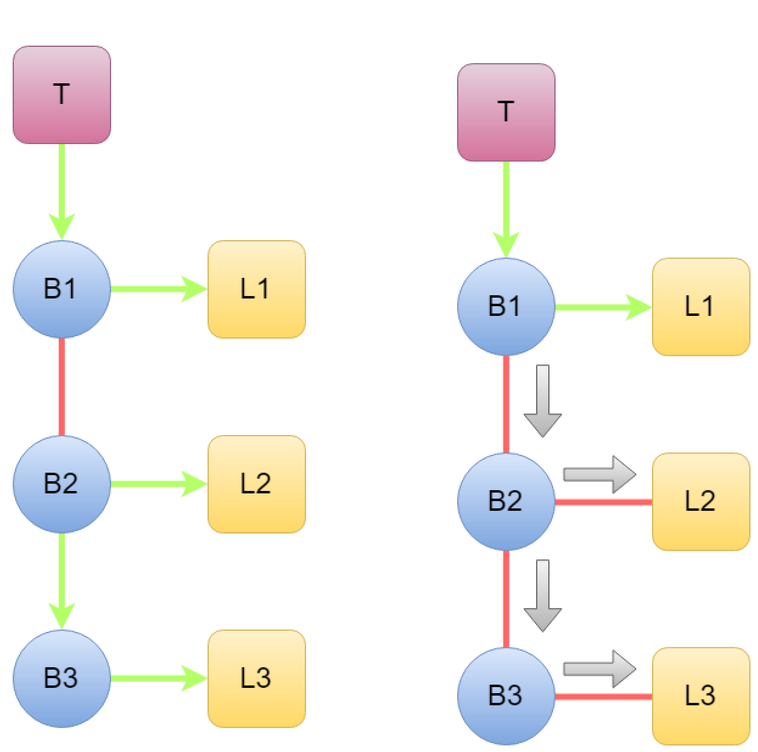
Issues at the Infrastructure level: Previous solutions restrict some features of SRP that may be interesting for certain applications. For this reason, we now **abandon** the **all-or-nothing approach,** and instead we aim at guaranteeing that all devices share the **same view of the network.** Additionally, **bridges can reserve resources inconsistently** due to a lack of **information exchange.**

Solutions:

- **Same view of the network :** Exchange of information so talker can know who can receive and listeners can know if they can receive.
- **Consistent reservation in bridges:** Bidirectional transmission of the decisions.



Same view of the network



Consistent reservation in bridges

4. Conclusions

We used **UPPAAL** to identify multiple scenarios in which **SRP** does not provide **termination nor consistency**.

5. Future Work

We have designed some **possible solutions** and in the future we will implement them in the **UPPAAL model checker** to validate them.

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