Timing analysis of rate-constrained traffic in TTEthernet using network calculus

TTEthernet is a deterministic, synchronized and congestion-free network protocol based on the Ethernet standard and compliant with the ARINC 664p7 standard network. It supports safety-critical real-time applications by offering different traffic classes: static time-triggered (TT) traffic, rate-constrained (RC) traffic with bounded end-to-end latencies and best-effort traffic, for which no guarantees are provided. TTEthernet uses three integration policies for sharing the network among the traffic classes: shuffling, preemption and timely block. In this paper, we propose an analysis based on network calculus (NC) to determine the worst-case end-to-end delays of RC traffic in TTEthernet. The main contribution of this paper is capturing the effects of all the integration policies on the latency bounds of RC traffic using NC, and the consideration of relative frame offsets of TT traffic to reduce the pessimism of the RC analysis. The proposed analysis is evaluated on several test cases, including realistic applications (e.g., Orion Crew Exploration Vehicle), and compared to related works.