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Scheduling Real-Time Constant Bit Rate Flows over a TDMA Channel

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Abstract

We consider a scheduling problem in which real-time Constant Bit Rate (CBR) flows must be scheduled over a TDMA channel. Scheduling is performed by a central scheduler which is responsible for all bandwidth allocations. Each flow has QoS requirements that include bit rate, delay, and delay jitter. In order to provide the requested QoS a flow must get fixed size bandwidth allocations at periodic intervals. Our model of the problem is derived from a scheduling problem that appears in centralized access networks such as CATV, broadband wireless access, and passive optical networks. In these networks real-time CBR flows are used to deliver voice and other real-time applications that generate fixed size data packets on a periodic basis.

The scheduling problem is analyzed in both its offline and online settings. We focus on the case where grant intervals are an integer multiple of each other. In this case the scheduling problem can be modelled as a variant of bin packing where bin sizes can be modified in a constrained manner. We show that deciding whether a set of CBR flows can be scheduled is NP-complete whenever there are two or more different grant intervals. Several scheduling algorithms are suggested and their performance is investigated. We relate the performance of the algorithms to parameters such as grant sizes and tolerated jitter, and derive conditions under which our scheduling algorithms are optimal.