Token Account Algorithms: The Best of the Proactive and Reactive World

Many decentralized algorithms allow both proactive and reactive implementations. Examples include gossip protocols for broadcasting and decentralized computing, as well as chaotic matrix iteration algorithms. In proactive systems, nodes communicate at a fixed rate in regular intervals, while in reactive systems they communicate in response to certain events such as the arrival of fresh data. Although reactive algorithms tend to stabilize/converge/self-heal much faster, they have serious drawbacks: they may cause bursts in bandwidth consumption, and they may also cause starvation when the number of messages circulating in the system becomes too low. Proactive algorithms do not have these problems, however, nodes waste a lot of time sitting on fresh information.

We propose a novel family of adaptive protocols that apply rate limiting inspired by the token bucket algorithm to prevent bursts but they also include proactive communication to prevent starvation. With the help of our traffic shaping service, some applications approach the speed of the reactive implementation, while maintaining strong guarantees regarding the total communication cost and burstiness. Due to the proactive component we can help maintain a certain level of activity despite losing messages due to faults or the application semantics. We perform simulation experiments over synthetic network topologies as well as over a real smartphone availability trace. Our results indicate a fourfold speedup in a broadcast application, and an order of magnitude speedup in the case of gossip learning, when compared to the purely proactive implementation.

Everyone is welcome.