Dynamic tree-splitting algorithm for massive random access of M2M communications in IoT networks

ABSTRACT

Enabling machine-to-machine (M2M) communications on cellular networks will provide a promising future for smart cities and the Internet of Things. M2M systems involve a huge number of connected devices that may synchronously be activated to react to some event. This massive synchronous access causes intensive congestion and collisions in the random access channel (RACH), which is used as a first step to access network resources. In this article, we introduce a dynamic tree-splitting (DTS) algorithm to resolve RACH collisions for delay-sensitive devices during burst arrival scenarios. The DTS algorithm assigns a specific number of preambles to the collided devices for their next access attempt. The number of preambles is determined based on the mean number of collisions in each random access opportunity, with the aim of increasing the utilization of preambles. A mathematical analysis of the proposed algorithm is presented as well as the derivations of throughput and access delay. The analysis and simulation results show that DTS reduced access delay and increased RACH throughput by approximately 12%, compared to recent benchmarks, with a mean of three preamble transmissions and a success rate above 0.98, which indicates the efficiency and reliability of the proposed algorithm.

Keyword: Cellular Internet of Things (IoT) networks; Collision resolution; Dynamic treesplitting (DTS); Machine-tomachine (M2M); Massive random access