Mathematics > Probability

Heavy traffic limit theorems for a queue with Poisson ON/OFF long-range dependent sources and general service time distribution

Wanyang Dai

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In Internet environment, traffic flow to a link is typically modeled by superposition of ON/OFF based sources. During each ON-period for a particular source, packets arrive according to a Poisson process and packet sizes (hence service times) can be generally distributed. In this paper, we establish heavy traffic limit theorems to provide suitable approximations for the system under first-in first-out (FIFO) and work conserving service discipline, which state that, when the lengths of both ON- and OFF-periods are lightly tailed, the sequences of the scaled queue length and workload processes converge weakly to short-range dependent reflecting Gaussian processes, and when the lengths of ON- and/or OFF periods are heavily tailed with infinite variance, the sequences converge weakly to either reflecting fractional Brownian motions (FBMs) or certain type of long-range dependent reflecting Gaussian processes depending on the choice of scaling as the number of superposed sources tends to infinity. Moreover, the sequences exhibit a state space collapse-like property when the number of sources is large enough, which is a kind of extension of the well-known Little's law for M/M/1 queueing system. Theory to justify the approximations is based on appropriate heavy traffic conditions which essentially mean that the service rate closely approaches the arrival rate when the number of input sources tends to infinity.

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