

The multi-threshold queue - An innovative traffic model

N. Baër

August 27, 2012

Abstract

We consider a single server queueing system in which arrival rates and service rates are controlled by a threshold policy. This threshold policy is modelled by a two-dimensional Markov Chain describing the queue length and the stage of the queue. Arrival rates and service rates depend on the stage but not on the queue length. The stage of the queueing system changes when an arrival occurs at an upper threshold, or when a departure occurs at a lower threshold. This $M/M/1$ multi-threshold queue can be seen as a Level-Dependent Quasi-Birth-and-Death process and we use matrix analytic methods to find the stationary queue length distribution and mean sojourn time.

We use this $M/M/1$ multi-threshold queue to model highway traffic flows. We show that with this queueing system we can obtain the Fundamental Diagram, one of the key elements in highway traffic analysis. This Fundamental Diagram closely resembles empirical data.

Keywords: Threshold queue, Hysteresis, Matrix Analytic Method, Traffic Theory.