Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Non-Equilibrium Statistical Physics of Currents in Network Queuing MICHAEL CHERTKOV, Los Alamos National Laboratory, VLADIMIR CHERNYAK, Wayne State University, DAVID GOLDBERG, Massachusetts Institute of Technology, KONSTANTIN TURITSYN, Los Alamos National Laboratory — We present a framework for studying large deviations of currents in a queuing network viewed as a non-equilibrium system of interacting particles. The network is completely specified by its underlying graphical structure, the number of servers (type of interaction) at each node, and the Poisson transition rates between nodes/stations. We focus on analyzing the statistics of currents over the network for the class of stable (statistically steady) networks. Some of our results are general (and surprising) explicit statements and some are conjectures, validated on a network with feedback which allows an independent spectral analysis. In particular, we show that for sufficiently strong atypical currents the system experiences a dynamical transition into a "congested" regime, characterized by the saturation of certain servers in the network. We also discuss possible applications of these results for the analysis and control of traffic flows in transportation networks and of scheduling power flows in electric grids.

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Date submitted: 20 Nov 2009 Electronic form version 1.4