Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Observation of the Braess Paradox in Electric Circuits LADIMER NAGURNEY, Department of ECE - University of Hartford, ANNA NAGURNEY, University of Massachusetts Amherst — User-optimized network systems may exhibit counterintuitive phenomena such as the Braess Paradox where, when adding an additional link to the network, the cost increases for every user. While traffic networks are a prime example of networks exhibiting this paradox, it has been observed in telecommunications networks and in physical networks such as mechanical spring, fluid flow, and nanoscale networks. This work demonstrates that the Braess Paradox occurs in macroscopic electric circuits consisting of only passive components: resistors and diodes. We identify the electrical quantities that correspond to the network flows and costs and illustrate the mapping of the cost functions to ideal components. We use the solution of the Kirchoff Law nodal equations to demonstrate that the Braess Paradox will be observed in the electrical network of ideal components. These nodal equations also predict that the Braess Paradox can be observed in networks implemented using real components. We construct several macroscopic electric circuits that represent different cost functions and show that the Braess Paradox occurs when the experimentally measured voltage across the circuit increases as an additional link is added. We conclude by extending this work to cases where the demand is varied.

Ladimer Nagurney
Department of ECE - University of Hartford

Date submitted: 11 Nov 2016 Electronic form version 1.4