Optimization of data transfer rate in networks by differential equations with queueing delay

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First, we consider a simple network with one user and one server, and see how the data transfer rate changes. The problem is described by a differential equation containing discontinuity and an implicitly defined state-dependent delay coming from a queueing process at the server. We show existence and uniqueness of the solution, and prove existence of periodic solutions in two special cases using fixed point index theory.

After these, we describe a network model with more users and servers, with a similar but more complex system of equations. We also show existence and uniqeness in this case, and write the system of equation determining equilibria, that is also nontrivial. By examples, we see that the system can have a lot of equilibria, sometimes infinitely many, depending on parameters of the network.

[1] T. Alpcan, T. Basar, A Utility-Based Congestion Control Scheme for Internet-Style Networks with Delay, *IEEE INFOCOM* (2003).

[2] P. Ranjan, R. J. La, E. H. Abed, Global Stability with a State-Dependent Delay in Rate Control, *Proc. Conference on Time-Delay Systems*, Belgium (2004).