Observer design for networks and distributed control

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1 Introduction

Networks of switched servers are all around, e.g. manufacturing systems, supply chains, urban traffic networks, etc. When the layout and policy of the network is known, under certain conditions it is possible for a server to reconstruct the global state of the system. Therefore, we propose to use the idea of observers for deriving distributed policies for switching networks. The following steps can be distinguished:

- Development of a proper definition of observability and tests for observability.
- Design of observers for arbitrary observable networks.
- Stability analysis of distributed control policies.
- Design of distributed controllers for switching networks.

2 Supply Network

As a start, to gain more insight in deriving observers for networks, we consider *demand driven supply chain networks*. An example of this network is depicted in Figure 1 where X is a retailer facing an uncertain bounded demand d by its customers. The retailer can choose to order at suppliers S_i, by respectively u_i, with $i = 1,2,3$. The suppliers order their products at a warehouse. Time delays are represented as circles, e.g. transportation time. The retailer is considered with inventory, backlog and ordering costs. Knowing the costs and all states of the network, an optimal control strategy can be derived by the combination of *robust optimal control* and *dynamic programming*. However, it is not likely for a retailer to know the inventory positions of the suppliers. Therefore, the goal is to derive an observer to observe the order-up-to levels of the suppliers and their inventory position from orders u_i and the amount of delivered products. Using these observations we hope to retrieve the optimal controller.

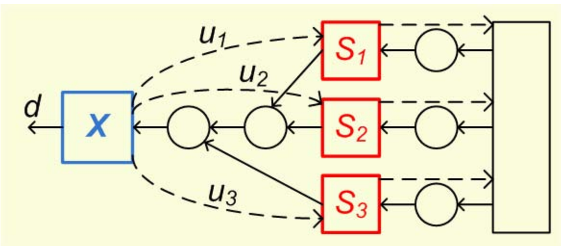

Figure 1: The demand driven supply network.

3 Switching Servers

In [1], Kumar and Seidman presented the *reentrant switched system* shown in Figure 2. A single job-type is considered which first visits machine A, then machine B, then machine B again, and finally machine A again. The system parameters are input rate λ, maximal process rates μ and the times for setting up buffers σ. It is shown in [2] that it is possible to come up with tailor-made distributed controllers by using the notion of observability. We are looking for a general methodology of this approach.

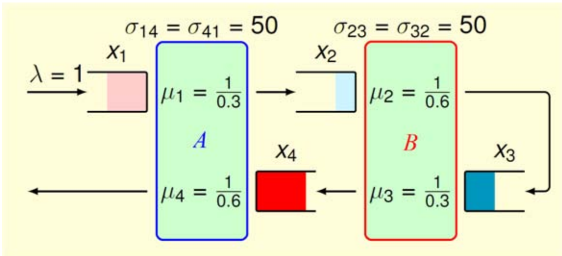

Figure 2: Network of [1].

Acknowledgement

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References

[1] Kumar, P.R. and T.I. Seidman, *"Dynamic instabilities and stabilization methods in distributed real-time scheduling of manufacturing systems,"* IEEE Trans. Automat. C., Vol. 35 (3), 289-298, 1990.

[2] Lefeber, E. and J.E. Rooda, *"Controller design for flow networks of switched servers with setup times: The Kumar-Seidman case as an illustrative example,"* Asian Journal of Control, Vol. 10 (1), 55-66, 2008.