Communication Networks in Control: New Dimensions of Complexity

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During the history of control, the system complexity steadily increased. First simple first order systems were studied. Then higher order linear systems and finally nonlinear and uncertain systems have been investigated and by now a good level of understanding has been achieved. Since in practice many application relevant systems are composed of several subsystems, the analysis and design of interconnected systems and Multi-Agent Systems (MAS) became increasingly important, but introduced a new dimension of complexity: the topological complexity. First, simple and regular topologies between the subsystems where considered. Nowadays, the investigation of large and time-varying topologies between the subsystems is state-of-the-art. Traditionally, the communication links between the subsystems are assumed to be perfect. However, real communication links, e.g. via ethernet or WLAN, are not perfect. In particular in packet-switched networks, the information exchange suffers from packet loss and delay. The influence of these non-ideal links on control systems is currently investigated thoroughly in the area of Networked Control Systems (NCS), where the plant and controller are connected via an imperfect network. Hence, the incorporation of appropriate link models adds a third dimension of complexity to control theory: the link complexity. In this talk, we give an overview on recent trends how to deal with both the topological complexity and the link complexity in control theory. Thereby, we mainly focus on two topics: high-order linear and nonlinear Multi-Agent consensus problems with and without communication delays as well as Networked Control Systems with packet-switched networks.