Dynamic Management of Systems of Systems via Constraints Negotiation

Master thesis topic proposal

Student: Shahbaz Ali
Study Program: Automation & Robotics

Examiner: Prof. Dr.-Ing. Sebastian Engell
Supervisors: Ing. Radoslav Paulen, PhD.

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The complexity of control of large-scale dynamic systems represents a major obstacle in application of advanced process management solutions in the processing industry. The systems in chemical production lines consist usually of several production units (subsystems) which are coupled among each other by streams of material and energy. Together with different (local) authorities performing decisions in subsystems, this classifies the operation of the chemical site as a system of systems. The decentralized and distributed control approaches are introduced in this context in order to coordinate the optimal distribution of shared resources and to distribute the complexity of optimal production coordination among the local unit controllers and an upper-layer coordinating agent. This distribution may be achieved in different ways depending on the amount of information shared between the units and between the individual unit and coordinator. The more information is shared, the more complex the resulting optimization problem gets, however, the better convergence towards global optimum can be expected for the coordination scheme.

The goal of this master thesis is to develop a coordination mechanism that is based on limited information on the constraints and the economics of the subsystems that are available to the central coordinating instance, e.g. the actual operational performance, sensitivities to key constraints and operational limits. The coordination mechanism will use an iterative negotiation-like process where the proposed time-varying constraints are used by the local agents to recompute their optimal operation including the transients to the new operating point and this information is fed back to the coordinator for an improvement of the proposed regime.

Tasks and work plan:

- Literature overview of the existing algorithms for coordination in decentralized control schemes by negotiation of constraints
- Study of the performance of selected methods
- Extension of the most promising methods based on inclusion of the surrogate models of the subsystems based on sensitivity information
- Evaluation of the performance of designed coordination strategies by numerical simulations