FIPSE-6 Short Presentation 1d

Distributed Decision Making and Flexible Process Operations for Sustainable Supply Chains

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ABSTRACT

With Industry 4.0 turning into reality, manufacturing processes in a supply chain network are becoming distributed cyber-physical systems which also generate, process, store and communicate large amounts of data. With horizontal integration of supply chain, manufacturers source raw materials and utilities from multiple suppliers and produce products to order for various down-stream operators. To improve their sustainability, energy-intensive processes (e.g., aluminum smelters) are increasingly powered using renewable energy, where the cost and availability may fluctuate due to renewable intermittency. As such, businesses in the process industry need to have the flexibility to dynamically adjust the production rate and specifications of products, and deal with raw materials with diverse specifications and time-varying energy costs to remain energy and resource efficient. Furthermore, operators in a supply chain have to make decisions in a distributed manner to optimize their own economic benefit, based on limited information on other operators. Another example is distributed control and coordination of multi-type renewable energy generators and storage systems. This calls for a new paradigm of distributed flexible manufacturing and decision making.

The open problems/challenges include:

1. How to develop a distributed decision making/process control approach (e.g., using Self-interest Distributed Economic Model Predictive Control) that optimizes individual players' operations to maximize their self-interest while ensuring the stability and/or achieving a global objective of entire supply chain?
2. How to integrate the market/operational decisions with real-time process operation and control to deliver the intended optimized outcomes? This requires a reference-independent nonlinear control approach that delivers flexible process operations to track any feasible reference profile generated by the optimizer.
3. An operator, while may have a good model of its own process/operation, typically only has access to limited information on other operators. How to utilize the large process/business data for distributed decision making in absence of unknown dynamics of other players? How to utilize the statistical information of supply chain data to determine the best solutions in a probability sense?

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