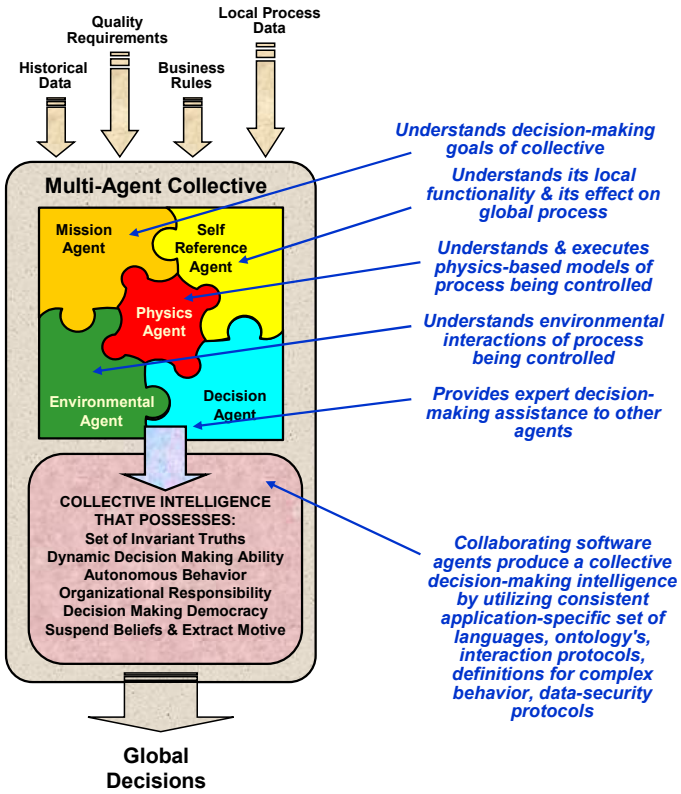
Scientific Computing Within the ORNL Modeling & Simulation Group: ACS Expertise - Distributed Software Agents

The ORNL Modeling and Simulation Group (MSG) develops sophisticated numerical solutions for a wide range of scientific, engineering, and operational applications. MSG's core competency is computational physics and engineering, and within our analysis of complex systems (ACS) focus area we have considerable expertise within the Operations Research discipline; specifically the application of intelligent agents to the design of network-centric process-management software architectures. Central to MSG's software-architecture design philosophy is the concept of a multi-agent collective (MAC), and the organization of MAC's into a distributed system to produce an intelligent decision-making collective.

MAC's can be conceptualized as a cooperating collective of application-specific software agents with the aggregate intelligence to address control issues that impact global process operation such as process physics, economics, near- and long-term term production requirements, interconnectivity, failure recovery, data bandwidth, physical complexity, and control system dynamics. The figure to the right illustrates this concept for a generic industrial process-control requirement.



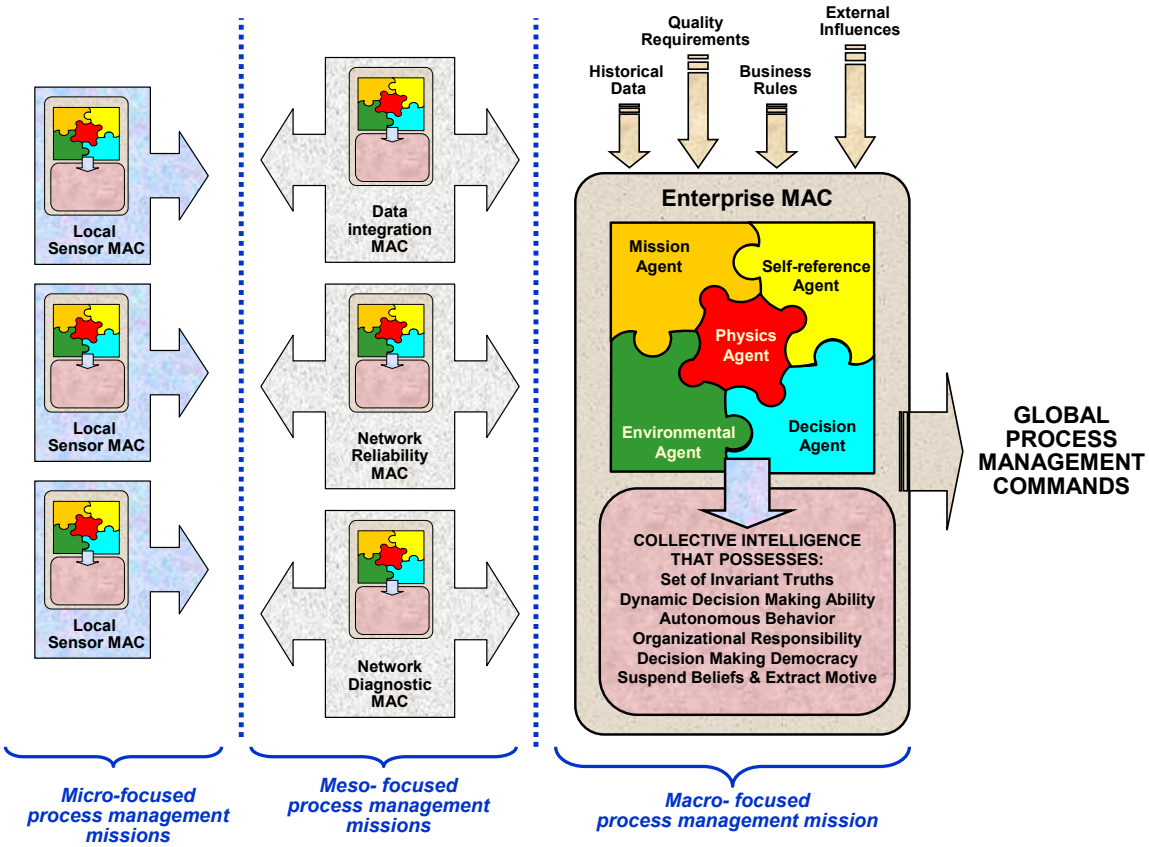
A globally focused industrial process management system is created by organizing multiple goal-oriented MAC's into a hierarchical application-specific measurement and control system. The figure below illustrates the multi-layered structure of such a system for a generic process-control application. As the graphic shows, the management system's functionality is derived from distributing MAC's across the complete process-control and network-management decision-making spectrum.

The MAC-based process measurement and control methodology is extremely flexible. Potential applications include, but are certainly not limited to, the following.

- Measurement and control systems for manufacturing processes that gather disparate *local* data, reason about its *global* implications, and then make control decisions that advance the safety, operational life, and economic viability of the entire process.
- Management systems for network-centric information grids that continually determine the state of the grid, and then dynamically control its configuration and operation to provide reliable operation regardless of traffic volume or equipment health.
- Anticipatory diagnostic and prognostic systems that would acquire real-time sensor-data as well as historical design, maintenance, and operating data from process equipment to determine their health, and than recommend modified operating conditions that would delay anticipated failures and allow the equipment to meet its near-term production requirements.

POC: David M. Hetrick
(865)576-7556/hetrickdm@ornl.gov
http://computing.ornl.gov/cse_home/cms/cmshome.shtml

MSG's expertise with global process-management systems represents an extremely versatile modeling and simulation resource for a broad range of R&D, industrial, homeland defense, and military applications. We welcome the opportunity to discuss your potential applications and ways MSG can contribute to a solution.



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