

The DARPA Control of Agent Based Systems (CoABS) Program and Challenges for Collaborative Coalitions

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As the number and availability of information sources (COTS¹, GOTS² and military special-purpose) increase, current military command and control systems including those supplemented with commercial off-the-shelf technology are overburdened in an effort to bring the right information to the right participants at the correct time. Military operators bemoan their inability to find mission-critical intelligence and operations information, which must be both manually filtered and routed. Providing better integration, at an information management level, between diverse information systems is a key to providing the information superiority needs as described in "Implementing Joint Visions 2010." To increase the military user's productivity and, by extension, our military capability, we need a next generation of software which is able to help users deal with complex tasking. The system must help the warfighter get needed information, help the user solve difficult problems, route useful information and otherwise enable more informed and rapid. Arising from research in the areas of distributed artificial intelligence and mobile software are computational "agents" designed to provide these capabilities. For the military, software agents will be critical force multipliers that free military personnel from having to do simple tasks which can be automated and assist personnel with difficult tasks. And as our military forces are drawn down, software agents will become increasingly important for retaining our ability to meet crises effectively.

A crucial need for the modern military is the ability to rapidly assemble a set of disparate information systems into a coherently interoperating whole. This must be done without system redesign and may include interoperation with non-DoD governmental systems, with systems separately designed by coalition partners, or with COTS and open-source systems that are not built to a pre-existing government standard. The Control of Agent Based Systems (CoABS) program explores the technical underpinnings of such run-time interoperability of heterogeneous systems, and develops new tools for facilitating rapid system integration in practice. As large-scale integrated systems are deployed, greater stress is placed on the communications infrastructure and on the management of information resources across the system. Techniques developed for agent-based computing, particularly those of mobile agents and agent-communication languages, will help both in the facilitation of this multi-systems integration and in controlling the information flow to alleviate bandwidth saturation and degraded quality of service.

The CoABS program goal – to achieve a comprehensive and scalable approach to software agent interoperability is divided into the following three tasks. (1) Agent Grid. The objective of this task is to develop a set of tools as the basis for upgrading military legacy systems to exploit agent technology using the concept of a "grid adapter." The grid adapter minimizes the integration effort required by focusing on the connection mechanisms instead of the client components. This involves wrapping legacy systems using a middleware approach which is service-based and which includes logging/reporting tools. (2) Agent Interoperability Standards. The objective of this task is to define standards to support agent interoperability, including agent-human interaction, agent-agent communication, agent-software interfaces, and agent management and control. And, finally, (3) Scaling of Agent Control Strategies. This task develops and tests agent control strategies for monitoring, coordinating, controlling, and managing agent collections, ranging from simple tasks involving the cooperation of small agent teams to highly complex interactions involving thousands of individual agents. This task also provides guaranteed behaviors for agents, even in unreliable networks. Areas of interest include knowledge sharing techniques; team formation and coordination through modeling of plans, commitments, and intentions; and computational markets including protocols for auctions and voting.

Success in military operations involves carrying out high-tempo, coherent, decisive actions and information is a key enabler in this process. In addition to the problems of integrating single-service and Joint capabilities into a coherent force, the nature of Coalition (multi-national) operations implies a need to rapidly configure incompatible, "come-as-you-are" or foreign systems into a cohesive whole in an open, heterogeneous, diverse and dispersed environment. DARPA is researching the use of agents within Coalitions, working collaboratively with the 16 partners of an international Coalition Agents Experiment (CoAX) (Allsopp et. al. 2001; Allsopp et.al. 2002).

¹ COTS = Commercial Off-The-Shelf.

² GOTS = Government Off-The-Shelf.

It is always perilous to predict the future, but it is also foolish to ignore clear trends that surely will affect the future. Thus it is predicted that there will be increasingly capable physical robotic things, software agents of complex functionality, and humans. The challenge is to bring these three into a synergistic synchronization that makes the whole -- the team -- capability greater than the sum of the parts. It is the thesis of this presentation that to achieve such an objective will require interdisciplinary research and development approaches that exceed such efforts attempted in the past. It is critical that barriers to collaborative efforts, however unintentional, be eliminated. This will require recognition that the goal is real, worthwhile, and to be sought as a military and economic exigency.

During this final year in the CoABS program, the focus will be placed on demonstrating all of the technologies that have been developed during the last five years, as well as the transition programs that anxiously await this technology. Transition programs include Joint Experimentation Programs, Navy Expeditionary Sensor Grid, Air Force Joint Battle Infosphere, and various Army Agent Based programs.

References

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