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Defense Industry Applications of Autonomous Agents and Multi-Agent Systems

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Preface

The future capabilities of modern armed forces are often characterized by terms like "Network Centric Warefare" (NCW), "Network-Enabled Capabilities" (NEC) or "Network-Based Defence" (NBD). All of these approaches share the common idea that the application of modern communication and information processing technologies will result in a very efficient and effective utilization of resources available to commanders. By utilizing state of the art techniques from Electronics and Computer Science defence theorists hope to be able to create force structures that are more responsive, cost effective and agile than their opponents; if knowledge is power NCW seeks to translate battle field information into fighting power.

The first step toward realizing these visions is to be able to gather, distribute, correlate, process and inference over the information generated by field assets such as sensors and personnel as well as information held in databases, practice manuals and logistics information systems. Herein, the most important resource is information and hence information gathering, distribution and processing is the key factor for mission effectiveness. The resulting scenarios of networked armed forces require

- a flexible and very reliable interaction infrastructure which collect and process information to assist decision making
- the integration of unmanned systems in the battlefield
- the organization of agile logistics
- the modeling and prediction of adversary intent
- intelligent training

Most of these applications run in highly decentralized and heterogeneous environments and/or require embodiment of autonomous, intelligent decision making. These characteristics make the defense application domain appropriate for the deployment of the technologies, techniques and algorithms provided by researchers working in the fields of Intelligent Agents, Autonomous Agents and Multi-Agent Systems (jointly referred to as AAMAS technologies).

These days AAMAS researchers provide high quality of fundamental research results in various sub-fields of agent technology such as formal models of cooperation and coordination, game theory and mechanism design, models of argumentation and negotiation and formal (logical) reasoning about multi-actor scenarios. As well as working on these theoretical topics the AAMAS community also addresses application oriented subfields such as distributed planning, collective robotics, information retrieval and distributed learning, modeling trust and reputation among actors, intentional modeling, task and resource allocation or multi-agent modeling or simulation. Readers are referred to e.g., international conference on Autonomous Agents and Multi-agent Systems (http://www.aamas-conference.org/)

[1,2] and IEEE/WIC/ACM International Conference on Intelligent Agents Technology (http://www.cs.sjsu.edu/wi07/iat/) [3], Cooperative Information Agents workshop series (http://www-ags.dfki.uni-sb.de/~klusch/IWS-CIA-home.html) [4] or International Conference on Industrial Applications of Holonic and Multi-Agent Systems (http://gerstner.felk.cvut.cz/HoloMAS/2007/) [5].

AAMAS technologies are not investigated in isolation. AAMAS research is supported not only by universities, research institutes and national/international grant agencies but also by important industrial stakeholders, the defense industry in particular. Military organizations are traditionally a supporter and an early adopter of innovative technologies and AAMAS technologies are no exception. While involvement of conventional industries in AAMAS research emphasizes on fast return on investment, defense support and interest in AAMAS technologies facilitates slightly longer adoption lifecycle. This approach gives a balance between time and resources for fundamental research, prototyping and demonstration as well as experimental deployment of a particular research idea or concept. At the same time as providing an appropriate domain of application of AAMAS techniques defence applications provide AAMAS researchers with stimulating new challenges in the shape of the constraints of bandwidth, energy and processing power available to their applications.

As the knowledge of successful applications of agent technology in military domains is dispersed in specialized workshops and symposia, we have brought these reports together here to provide a clear picture of the state of the art in this field at this time, and to promote further investigation and interest in this increasingly important topic.

This book is a selected collection of recent published and refereed papers drawn from workshops and other colloquia held in various venues around the world in the last two years. The book logically follows the effort of the editors towards communicating the research results to the industrial community and trying to bridge the gap between researchers and industrial engineers. When editing the book, the editors leverage their experiences in establishing the AAMAS Industry track back in 2005 [6], organizing the DAAMAS workshop informally in New York in 2004 and formally in Utrecht in 2005 [7] and working in the Defence Technology Centre programs in the UK.

Papers in this book describe work in the development of command and control systems, military communications systems, information systems, surveillance systems, autonomous vehicles, simulators and HCI. The broad nature of the application domain is matched by the diversity of techniques used in the papers that are included in the collection. The collection provides, for the first time, an overview of the most significant work being performed by the leading workers in this area. It provides a single reference point for the state of the art in the field at the moment and will be of interest to Computer Science professionals working in the defense sector, and academics and students investigating the technology of Intelligent Agents that are curious to see how the technology is applied in practice.

As mentioned earlier the book is a collection of independent, unlinked chapters. The readers are welcome to read the chapters in the order of their choosing. In order to give some guidance, the book is organized in three loosely structured sections. The first four chapters describe multi-agent approaches to organization of the information infrastructure, data collection and resource matchmaking. This section is complemented with the application chapter on agent deployment in military logistics. The following three chapters provide technical information about agent deployment in the manned and unmanned air traffic control. The last three chapters of the collection are about the use of agents for simulation and training. The second and third sections are naturally overlapped by the chapter on simulation of fighter pilots.

The editors hope that the book will provide a valuable reference, will contribute to the discussion about exploitation potentials of agent technology in the defense industry and initiate implementation of further innovative applications and deployment exercises.

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