

THE INTERNATIONAL TECHNOLOGY ALLIANCE IN NETWORK AND INFORMATION SCIENCE A U.S.-U.K. COLLABORATIVE VENTURE

GREG CIRINCIONE AND JAY GOWENS

A landmark collaboration known as the International Technology Alliance (ITA) in Network and Information Sciences has been initiated by the U.S. Army Research Laboratory (ARL) and the U.K. Ministry of Defense (MoD) [1]. On May 12, 2006, awards were made to a consortium of industrial and academic organizations from the United States and the United Kingdom, led by International Business Machines Corporation and IBM United Kingdom Limited [2]. This consortium, along with ARL and MoD, establish an international research alliance that will jointly conduct collaborative research focused on enhancing distributed, secure, and flexible decision making to improve networked coalition operations. The Alliance expects to achieve research results that would not have been possible without the synergies gained from robust U.K.-U.S. collaborations.

THE ITA CONCEPT

This new Alliance represents a new way of conducting collaborative research. The ITA aims to challenge government, industry, and academia to adopt a new way of working. It seeks to break down barriers, build relationships, develop mutual understanding, and work in partnership to develop technology for the U.S. and U.K. military. The ITA concept takes the best features from the United Kingdom's Defense Technology Centres (DTCs) and the U.S. Army's Collaborative Technology Alliances (CTAs) and applies them internationally by:

- Fostering close collaborations between government, academic, and industry researchers in both countries
- Creating a critical mass of researchers focused on solving military technology challenges central to future coalition military operations
- Enabling staff rotations among all organizations in the Alliance
- Facilitating rapid/affordable transition of technologies with an innovative transition model

A key aspect of the ITA is that it is structured and managed to foster an open collaborative research environment to support deep collaboration among researchers in the Alliance, including between government and private sector researchers. To develop a shared understanding and cultivate these collaborations, the Alliance encourages frequent technical interchanges and long- and short-term staff rotations. To further spark innovation, the Alliance will hold summer boot camps each year at a U.S. or U.K. university where researchers can share ideas and work across technical areas.

THE ITA CONSORTIUM TEAM

The ITA Consortium, led by International Business Machines Corporation and IBM United Kingdom Limited, includes some of the top industrial and academic organizations from the United States and the United Kingdom. This Consortium was awarded a joint fundamental research agreement for a basic period of performance of five years, with an optional five-year extension. It has a nominal value of \$135.8 million over the potential 10-year period. The research component is funded by the U.K. MoD, U.S. DoD, and some of the Consortium members. Two separate technology transition awards were made to be used to rapidly exploit research results. The consortium consists of 24 organizations, as shown in Table 1.

THE RESEARCH PROGRAM

The International Technology Alliance in Network and Information Sciences is focused on enhancing distributed, secure, and flexible decision making to improve coalition operations. The basic tenet of network-centric operations/network-enabled capabilities is that a robustly networked force will improve information sharing and collaboration, in turn enhancing shared situational awareness — all of which would dramatically increase the mission effectiveness of coalition forces.

The research results of the ITA will be transitioned to provide a secure infrastructure for the formation and operation of ad hoc coalition combat teams. Future combat scenarios require operation in dynamic and mobile environments with a reliable secure networking and sensor information infrastructure to support enhanced decision making. The focus is on jointly addressing the physical, social, and cognitive aspects of this coalition decision making network — a complex system of systems.

MOTIVATION, TECHNICAL CHALLENGES, AND RESEARCH BARRIERS

Network science is still in its infancy even for physical networks such as large-scale, multitiered, multihop, fully mobile ad hoc networks. Although we have a good understanding of wired networks, and point-to-point and cellular one-hop wireless communications, we only have very limited information and network theories to describe scaling laws and behavior of large-scale complex mobile ad hoc networks (MANETs). Furthermore, to understand fully the performance of a coalition network, the physical network must be jointly studied with cognitive and social networks to understand the global performance metric — the effectiveness of network-centric coalition decision making.

For the physical/information network, the underlying wireless medium is fundamentally different from that in the wired medium in that the link is broadcast in free space, making it subject to interruption, fading, and errors. Because of the required tight coupling between physical, medium access control (MAC), and networking layers in a wireless network, the parameter space potentially spans the entire protocol stack, making it both large and interconnected. The coupling also makes performance evaluation of protocols and metrics global rather than local; thus, one must model cross-layer inter-

(Continued on page 16)

(Continued from page 14)

actions well. For sensor networks, there is a lack of formalism to assess and describe the quality of sensor information and the impact of that quality on decision making. For command and control/social networks, there is a lack of fundamental knowledge of command processes, cognitive processes, the impact of cultural variables on decision making, and the formation of emergent behaviors.

Many research barriers exist in network and information sciences, including the lack of adequate theoretical results, which hinders the development of efficient simulation and modeling tools, and thus exploration of the design space. Basic research advances can build the foundation by developing a mathematical and scientific framework with proper metrics, language, structures, and processes — providing a constitutive understanding of physical, social, and cognitive networks.

COLLABORATIVE APPROACH

The ITA strategy is to exploit the broad expertise found in academia, industry, and government in both countries. The approach is to engage strong multidisciplinary researchers to jointly understand and address the root cause of technical challenges that span network theory, security across a system of systems, sensor information processing and delivery, and distributed coalition decision making. To make a significant impact on the effectiveness and survivability of coalition forces, these researchers will jointly address the underlying phenomena of the physical (mobile ad hoc wireless and sensor networks), social (people, organizations, cultures), and cognitive (perceptions, beliefs, decisions) domains.

TECHNICAL AREAS

The ITA research program is organized into four technical areas (TAs) and comprises 12 research projects, three projects in each technical area. The technical areas are described below.

TA1: NETWORK THEORY

A fundamental understanding of network behavior is essential to create and maintain such a network, one that must self-organize in response to changing network deployment in different phases of an operation; changing user/platform membership of the networks; changing topologies due to movement of the nodes and users; constrained connectivity; and widely varying communication

U.S. members	U.K. members
Lead: IBM Corporation	Lead: IBM United Kingdom
Universities: Carnegie Mellon University City University of New York (HBCU) Columbia University Pennsylvania State University Rensselaer Polytechnic Institute University of California, Los Angeles University of Maryland University of Massachusetts	Universities: Cambridge University Cranfield University Imperial College Royal Holloway University of Aberdeen University of Southampton York University
Industry: BBNT Solutions The Boeing Company Honeywell Klein Associates	Industry: Logica CMG Roke Manor Research Systems Engineering and Assessment

■ **Table 1.** *The International Technology Alliance in Network and Information Sciences.*

patterns imposed by military operations. Furthermore, these networks must account for other constraints and requirements that include mobile and highly dynamic users, the need to remain undetected, unreliable and disappearing sensors and resources, heterogeneity in resource capabilities and protocols, uncertain, partial, and/or erroneous information about network state, severe energy constraints, and high reliability requirements.

The focus of this TA is on:

- Developing the theoretical foundations for the analysis and design of wireless and sensor networks
- Mathematical frameworks and models of interoperations and bounds on their performance
- Biologically inspired self-organization techniques

TA2: SECURITY ACROSS A SYSTEM OF SYSTEMS

Coalitions that come together in ad hoc groups with common goals, perhaps only for a short period, require that interoperation among groups with different security policies be negotiated and security policy decisions made online in real time, not as design-time activities. Furthermore, security architectures and infrastructures must be composed and operational in a resource-constrained environment without the benefits of guaranteed network connectivity and centralized security services. Coalition networks must maintain secure operation while the underlying network of networks self-organizes, during highly mobile and dynamic missions, with unreliable and intermittent

connectivity, without centralized security services, under severe resource constraints, and with significant risk of node capture or subversion.

The focus of this TA is on:

- Policy-based security management to enable secure and flexible community of interest formation
- Security architectures and mechanisms that support resource-constrained wireless MANETs
- Theoretical foundations for dynamic risk management

TA3: SENSOR INFORMATION PROCESSING AND DELIVERY

This research seeks to provide the fundamental underpinnings for sensor information processing and delivery from distributed multimodal sensor systems within adaptive sensor networks, where the network of sensor nodes can exhibit heterogeneity in a variety of dimensions. Coalition decision making is dependent on information obtained through the collaborative deployment and operation of sensor networks and data fusion elements that process and deliver data from a large collection of heterogeneous sensors.

Sensor networks and the data they generate are powerful tools that can aid in achieving situation awareness, and support context-aware decision making and other high-level military operations. Wireless sensor networks in military contexts offer severe deployment, operational, and management challenges due to their operation in hostile, dynamic, unpredictable, resource constrained, heterogeneous environments,

(Continued on page 18)

(Continued from page 16)

which makes their long-term predictable operation difficult.

The focus of this TA is on:

- Characterization of the quality of information extracted from the various sensory sources
- Coordinated and collaborative deployment of heterogeneous wireless sensors and data processing (or fusion) elements
- On-demand management of the sensor information infrastructure complexity during mission planning and execution to enable availability of information as required by higher-level functions

TA4: DISTRIBUTED COALITION DECISION MAKING

A coalition operation usually entails an ad hoc arrangement, between two or more “units” or “organizations,” acting together in order to pursue a common objective. Such coalitions are formed where a commonality of interests exists between nations, be it political, eco-

nomie, or military, allowing coalitions members the benefit of mutual aid in promoting their interests and securing against real or perceived threats. They are usually created for specific purposes and for a limited duration. Coalition operations are very different from unilateral operations because they engender a number of organizational, operational, political, and cultural challenges that are unique to the operational environment and the specific composition of the coalition. Organizationally, coalitions can be very complex, with different groups bringing their own unique cognitive and collaborative styles (culture), doctrinal languages, technological capabilities, and core competencies. This blending of capabilities makes possible certain operations that a single coalition member could not or would not conduct unilaterally.

The focus of this TA is on:

- A framework for agile, adaptive collaboration among humans and software agents engaged in collaborative decision making
- Gaining an understanding of the command processes within coalitions as well as the processes at work in determining their external interactions

tions as well as the processes at work in determining their external interactions

- Gaining a shared understanding of the temporal dynamics and information infrastructure of operationally diverse situations

CONCLUSIONS

The ITA in Network and Information Sciences represents a new way of conducting collaborative research by fostering close collaborations between government, academic, and industry researchers in the United States and United Kingdom. The Alliance seeks to develop the scientific foundations for complex and dynamic networked systems of systems to enable the a priori prediction of the behaviors of dynamic networks that are critical to coalition operations. The approach is to engage strong multidisciplinary researchers to jointly address challenges that span network theory, security across a system of systems, sensor information processing and delivery, and distributed coalition decision making. Ultimately, the success of this new collaborative venture will be measured in the impact its research has on the effectiveness and survivability of coalition forces.

REFERENCES

- [1] Project Arrangement to the DOD-MOD Research and Developments Projects (RDP) Memorandum of Understanding, (DOD-MOD A-05-0022) between the Secretary of Defense of the United States of America and the Secretary of State for Defence of the United Kingdom of Great Britain and Northern Ireland Concerning the Network and Information Sciences International Technology Alliance (NIS-ITA), April 26, 2000.
- [2] Detailed information is available at <http://www.research.ibm.com/titans>

BIOGRAPHIES

GREGORY H. CIRINCIONE (CIRINCIONE@ARL.ARMY.MIL) is a senior engineer at the Army Research Laboratory, Adelphi, Maryland, where he leads secure MANET networking efforts. He is the Co-leader for Security Across a System-of-Systems technical area within the ITA, and is the Cooperative Agreement Manager for the Communications and Networks Collaborative Technology Alliance. His research interests are in the areas of policy-based security management, energy-efficient key management, and intrusion detection for mobile ad hoc and sensor networks.

JAY GOWENS (gowens@arl.army.mil) is the senior executive service director of the Computational and Information Sciences Directorate and chief information officer (CIO) of the Army Research Laboratory, Adelphi, Maryland. He manages basic and applied research programs in computer science, high-performance computing, networking, and machine language translation. As CIO, he is responsible for all aspects of operating the Army Research Laboratory network connecting five major Laboratory locations across the country.

TELECOM TESTING MADE SIMPLE



TDM

VoIP

Wireless

USB Based T1/E1 Analyzer

- * Analysis and emulation of all signal types
- * All protocols HDLC, ISDN, SS7, CAS, GSM, & more
- * Capable of T1 /E1 visualization, capture, storage, & more
- * Easy to handle & portable
- * Remotability and scripting

Other Test Products



T1/E1 OC-3/STM-1



Wireless VQT



T1/E1 2-wire CO Simulator



Wireless/VoIP/TDM Protocol Analysis

GL Communications Inc.
 301-670-4784 * info@gl.com * www.gl.com