

Sensor, Data and Information Sharing for Coalition Operations

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Abstract. The ability to flexibly and securely share data and information among multiple disparate teams is critical to coalition operations. This paper discusses two transition projects from the joint US/UK International Technology Alliance (ITA) research program in Network and Information Sciences. The transitioned projects are sponsored by the Office of the Secretary of Defense (OSD)'s Coalition Warfare Program (CWP) and provide extensible frameworks for coalition data-to-decisions (D2D) research and technology development. The first project deals with networking and interoperability of disparate coalition Intelligence, Surveillance, and Reconnaissance (ISR) assets operating at the “edge” of the network. The second project deals with distributed federation of disparate NATO data sources to allow all-source analysts to process and exploit structured/unstructured data. This data is then disseminated “within” the network (e.g., an analytical cell). Both projects use distributed policy management to facilitate data and information sharing while conforming to the information sharing policies among the coalition partners. The paper discusses the two CWP projects and their coalition D2D related applications.

1. Introduction

a. International Technology Alliance (ITA)

In 2006, the US Army Research Laboratory (ARL) and the UK Ministry of Defence (MoD) established a collaborative research alliance with academia and industry partners called the *International Technology Alliance* (ITA) to address fundamental issues in *Network and Information Sciences* to enhance the abilities of the US and UK to conduct coalition operations. The ITA is a unique UK-US collaborative venture. It is a highly multi-disciplinary research program that focuses on coalition needs and seeks to develop a mutual understanding and strong US-UK partnerships among the government, academia and industry participants. The Alliance has also facilitated the rapid transition of technologies using an innovative transition model that augments the basic research program with established transition vehicles for independent technology transitions in the US and UK. In the first five years of the program, there were a number of significant research outcomes as evidenced by over 600 papers, a number of patents, and a number of transition projects including two joint projects sponsored by OSD's Coalition Warfare Program. The Alliance is achieving basic research results that would not have been possible without the synergies gained from robust UK/US collaborations, especially in the areas

of secure networking and distributed information processing that support coalition decision making.

The ITA program is organized in multiple Technical Areas (TAs) with cross-TA research themes to facilitate collaborative research for Network Centric Operations. From 2006 to 2011, there were four TAs: (1) *Network Theory*, (2) *Security Across a System-of-Systems*, (3) *Distributed Information Processing and Delivery*, and (4) *Distributed Coalition Planning and Decision Making*. As the program evolved, the focus has shifted toward hybrid networking and security and coalition data-to-decisions (D2D). As the result, the ITA was reorganized in 2011 and now has two integrated TAs: (1) *Coalition Interoperable Secure and Hybrid Networks* and (2) *Distributed Coalition Information Processing for Decision Making* [1].

b. ITA Transition via Coalition Warfare Program

The ultimate measure of success of ITA program is the impact its research has on improving the US and UK ability to conduct coalition operations. As such, technology transitions are critical. The ITA program adopts a broad-base transition strategy: (1) constantly engaging the military user communities and stakeholders, (2) leveraging on-going ISR and ISTAR related programs in the US and UK respectively, (3) identifying and targeting coalition organizations, programs and activities, and (4) working with ITA industrial partners to facilitate commercial development of ITA technologies. There are a number of US only and UK only transitions and two key transitions that are joint US/UK transitions to date via the Coalition Warfare Program. The CWP is an OSD initiative to support international cooperative technology development that enables coalition forces to operate more effectively across the full spectrum of multinational operations. The goals are to accelerate delivery of high-quality solutions for the warfighter, to improve US interoperability with coalition partners, and to strengthen global partnerships. For a project to be eligible for advanced development funding, it must meet three requirements: an international agreement with the coalition partner¹, equitable resourcing from the coalition partner, and Combatant Commander(s) endorsement and transition commitment [2].

The CWP is the key transition enabler for the ITA developed technologies and has been the sponsor of two major coalition projects: (1) *ITA Sensor and Policy Software Tools and Protocols for Networking of Disparate ISR Assets* or *ITA Sensors and Policy* for short and (2) *ITA Policy Controlled Information Query and Dissemination* or *ITA Controlled Dissemination* for short. The remainder of the paper discusses these two CWP projects and their coalition D2D related applications.

2. CWP Project on ITA Sensor and Policy

The CWP project on ITA Sensor and Policy was funded in 2009 with COCOM support from US Central Command (CENTCOM). The resulting technologies from this project are being demonstrated in coalition field experiments. The project is comprised of team members from US ARL, UK Defence Science & Technology Laboratory (Dstl), IBM US and IBM UK. As the long project title suggests, the goal of this CWP project is to develop a set of sensor and policy software tools and protocols that will enable rapid assembly/dynamic control of ISR assets, and

¹ Project Arrangement (PA) to the US DoD and UK MoD Research and Developments Projects MOU dated April 26, 2000 (DoD-MoD A-05-0022) between the Secretary of Defense on behalf of the United States of America and the Secretary of State for Defence of the United Kingdom and Northern Ireland Concerning the Network and Information Sciences International technology Alliance (NIS-ITA).

policies that govern the sharing of sensor assets and the dissemination of data and information to support multiple and dynamically changing coalition missions. The CWP project exploits two key technology components researched and developed within the ITA, namely the *Sensor Fabric* and the *Policy Management Toolkit* [3-5].

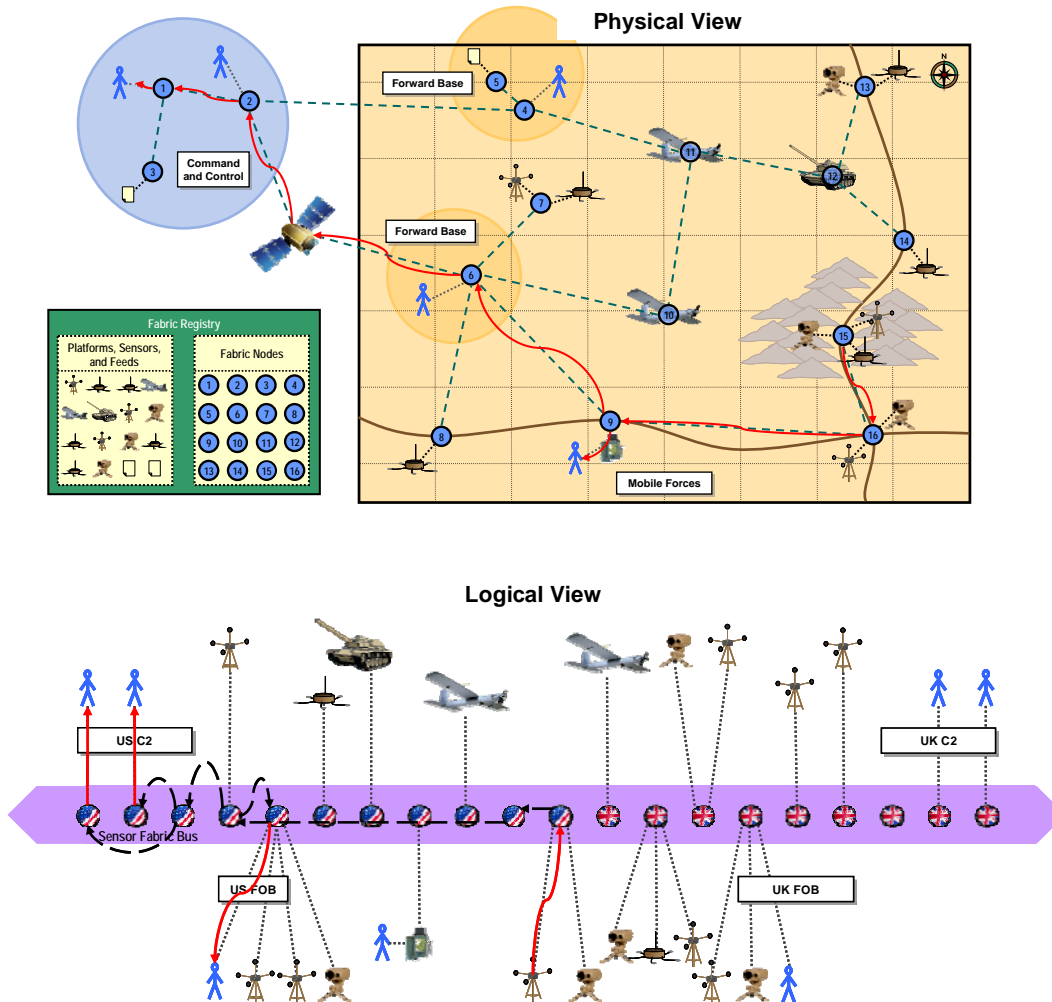


Figure 1: The Sensor Fabric is a flexible and extensible Services Oriented Architecture (SOA) style framework. Via the Sensor Fabric, an ad-hoc network of ISR sensor/platform nodes (physical view) can be viewed as an agile style service bus, with transparent handling of connections, routing and data and information dissemination (logical view).

The Sensor Fabric is a flexible and extensible middleware infrastructure (and associated software tools) that addresses interoperability and networking challenges by providing a unified framework for sensor identification and discovery, sensor access and control, and sensor data and information consumability within a coalition environment. Software tools such as routing protocols, data fusion algorithms, and distributed policies can be implemented within the fabric framework to facilitate timely dissemination of data and information only as needed and with proper safeguards defined by the respective coalition partners (see Figure 1).

The Policy Management Toolkit consists of a set of flexible and extensible software modules that were developed to perform a variety of management functions on sets of policies applicable

to sensors, sensor platforms, and networks. Some of these policies include local command and control (C2), platform control, sensor and system control, sensor information access control, information flow protection, information extraction. This toolkit consists of four basic elements: a policy manager (PM), a policy repository (PR), a policy enforcement point (PEP), and a policy decision point (PDP) as shown in Figure 2.

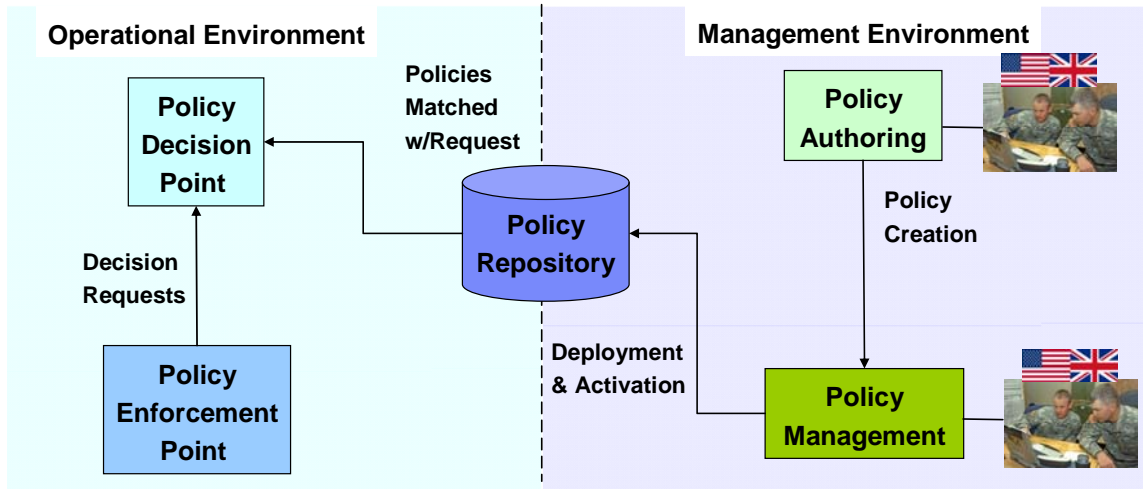


Figure 2: The Policy Management Toolkit is distributedly implemented at each fabric node in the network.

A key metric of success for a CWP sponsored project is to be able to transition coalition technology to Technology Readiness Level 6 (TRL-6) or higher. For the CWP project on ITA Sensor and Policy, a series of field trials was targeted to show the technology working in operational environment.

The most recent field experiment took place at Camp Roberts, CA in June 2011. The field experiment was conducted jointly with researchers from the *Institute for Collaborative Biotechnologies* (ICB) on an applied research project on “Heterogeneous sensor networks: a bio-inspired overlay architecture.” The ICB project involves demonstration of bio-Inspired strategies to navigate an unmanned aircraft system (UAS) data harvester from an ad-hoc network of sparsely distributed ground sensor assets that can not communicate with each other but can communicate with the UAS flying within the vicinity of the assets [6]. The goals for field trial included:

- Demonstrate and assess interoperability of a disparate set of sensors and sensor networks from two different organizations – ITA (assigned the “US” affiliation) and ICB (assigned the “coalition partner” affiliation)
- Demonstrate and assess coalition interoperability and data sharing
- Conduct cross platform tipping and cueing
- Integrate US and coalition assets/policies

Figure 3 shows an ISR scenario involving a US (i.e., ITA) and a coalition partner (e.g., ICB) protecting the camp area around a runway. The US has a distributed network of acoustic sensor arrays (designated by red circles) and a pan/tilt camera (designated by a solid red square) mounted on a tower. The networked acoustic arrays provide wide area coverage, and can detect

and locate acoustic transient activities such as mortar and artillery firings simulated by three propane cannons (designated by solid blue squares), and cue the camera on top of the tower to provide visual surveillance of the area of hostile activity. The coalition partner has a distributed network of single-microphone low-power unattended ground sensors (UGSs) (designated by solid yellow circles), an UAS with a visual camera onboard (designated by a UAS icon), and a second UAS data harvester (not shown in figure) dedicated to collect data from the distributed acoustic UGSs. Under policy control, the fabric enabled the sharing of the location information of transient activities with the Coalition assets which could then verify its own localization results and task the UAS with the camera to fly over the area of interest to provide real-time visual confirmations of hostile activities. The field experiment was a success for the ITA team (and the ICB team) and the Sensor Fabric and Policy Management technology developed under the CWP program were successfully demonstrated in an operational environment [5].

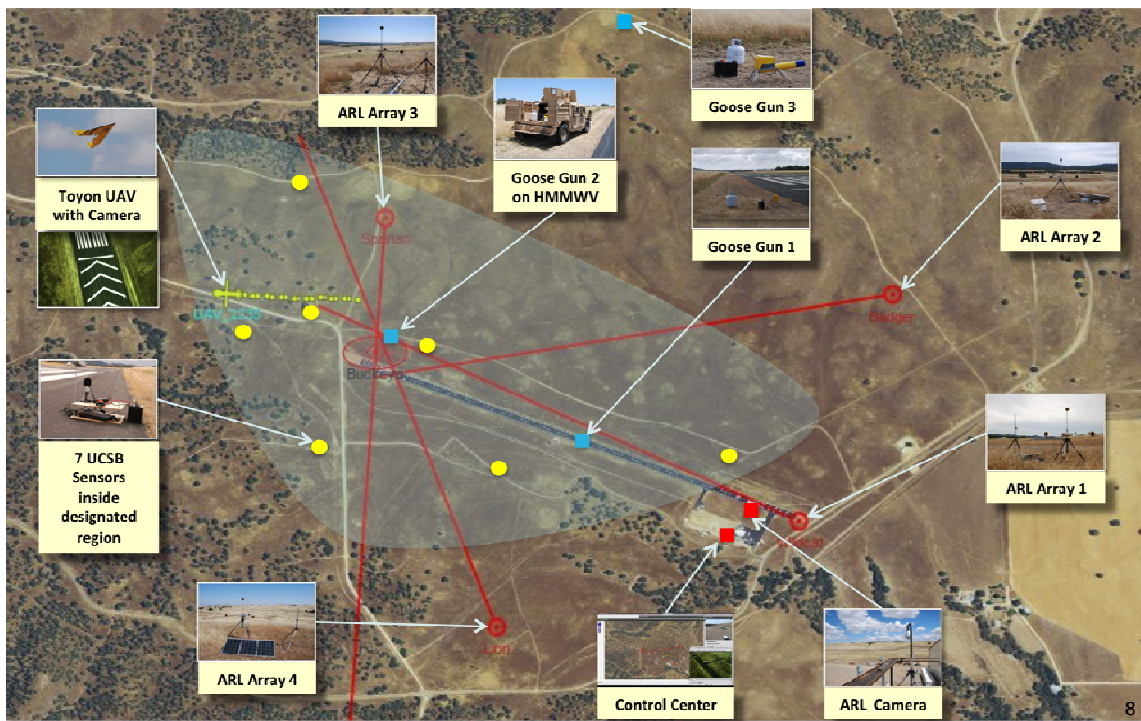


Figure 3: Camp area protection ISR scenario with a US (i.e., ITA) sensor network (4 acoustic arrays + 1 fixed mounted camera) and a Coalition (i.e., ICB) sensor network (7 low-cost UGS + 1 UAS with video camera onboard + 1 UAS data harvester).

3. CWP Project on *ITA Controlled Dissemination*

Building on the success of the CWP project on ITA Sensor and Policy, a second CWP project on ITA Policy Controlled Dissemination was funded in 2011 with COCOM support from TRANSCOM and NORTHCOM. The resulting technology will be transitioned to places like the *Intelligence Fusion Center (IFC) in Support of NATO*. Similar to the first CWP project, the second CWP project is also comprised of team members from US ARL, UK Dstl, IBM US and IBM UK.

This CWP project addresses some of the challenges in sharing and disseminating intelligence data and information reports. For example, Coalition partners may want to provide limited information or limit the type of nature of the information to other partners. This requires information access policies need to be supported transparently and the underlying technology needs to be flexible to adapt to the dynamic coalition environment. Thus, the goal of this CWP project is to develop an extensible capability of performing distributed federated query and information dissemination across a coalition network of distributed disparate data/information sources with access-controlled policies. The CWP project exploits two key technology components developed within the ITA, namely the *Gaian Database* and integrated *Policy Access Decision and Enforcement Tools* which build up on the Policy Management Toolkit in the first CWP project. The Gaian Database (GaiandB) is a Dynamic Distributed Federated Database (DDFD) that addresses a need to share information among coalition members by providing a means for policy-controlled access to data across a network of heterogeneous data sources. GaianDB implements a SQL-compliant Store-Locally-Query-Anywhere (SLQA) approach providing software applications with global access to data from any node in the database network via standard SQL queries (see Figure 4). Security policy is stored locally and enforced at the database node level reducing potential for unauthorized data access and waste of network bandwidth [7-8].

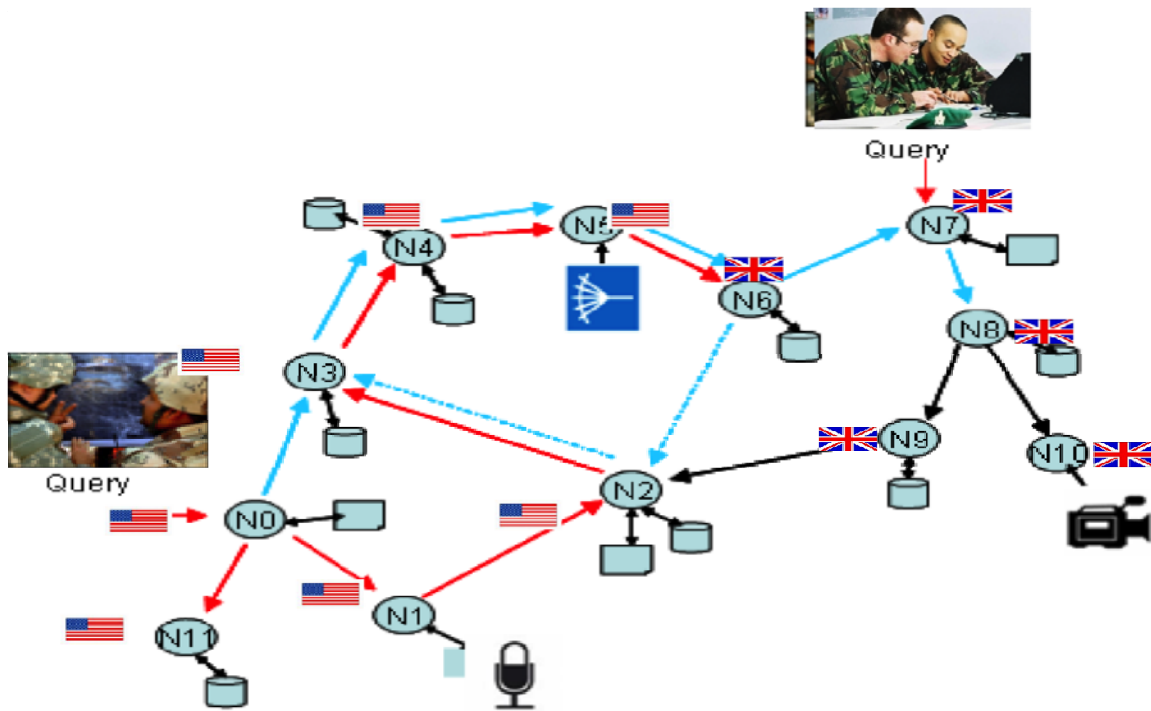


Figure 4: An implementation of a Gaian DB that is based on Store-Locally-Query-Anywhere (SLQA) approach with integrated Policy Access Decision and Enforcement Tools for coalition data and information sharing.

The end goal of this CWP project is to demonstrate the GaianDB and with associated policy management technology within an operation environment like the IFC. Figure 5 shows a use case in which NATO analysts perform queries across a network of disparate intelligence

databases such as Coalition Share Database (CSD), Combined Information Data Network (CIDNE) and Tactical Ground Reporting System (TiGR). The Gaian DB allows the users to perform queries anywhere on the network. The Policy Access Decision and Enforcement Tools will allow access the data and information reports base on the user's affiliations and access credentials. An initial demonstration of this technology using a sample unclassified set of documents was performed at the IFC in November 2011.

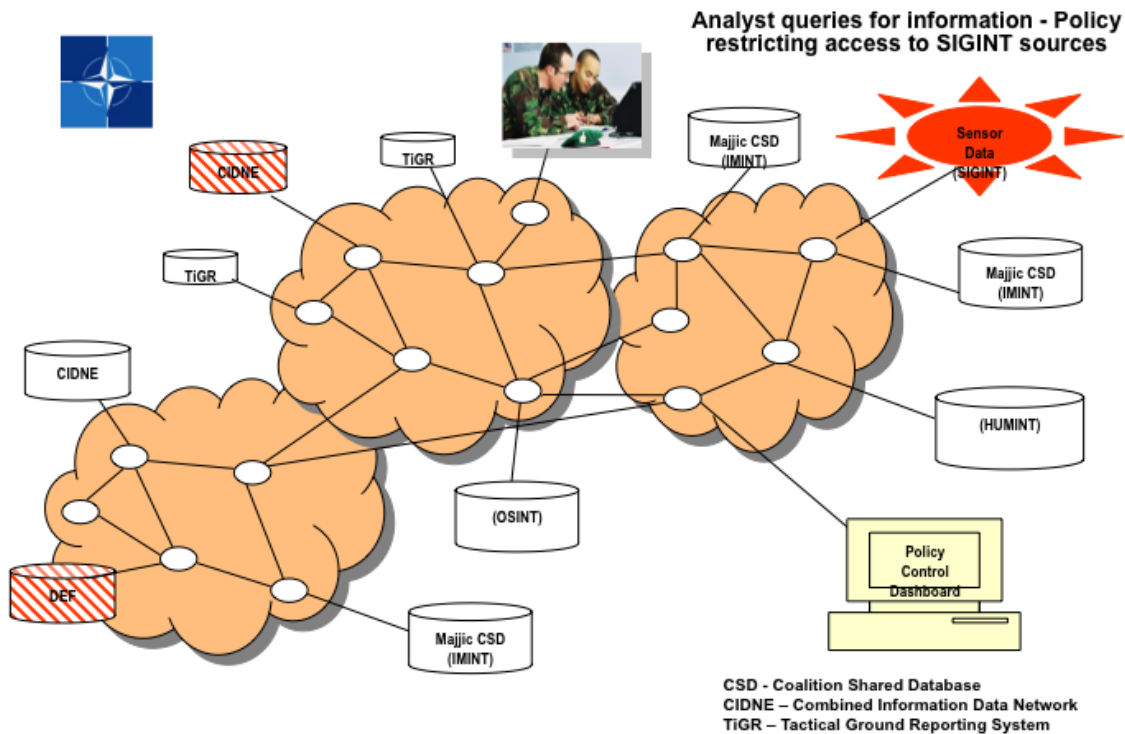


Figure 5: A use case within a NATO intelligence environment to be demonstrated using the Gaian DB and Policy Access Decision and Enforcement Tools.

4. Summary and Future Work

The ITA program seeks to develop the fundamental underpinnings to enable secure, dynamic, decision-enabled information flow for tactical military operations in a coalition environment. The key focus is enabling the rapid and secure formation of ad hoc teams to enhance coalition decision-making. In this paper we describe Coalition Warfare Program projects where information processing and policy management tools are being demonstrated that allows intelligence surveillance and reconnaissance assets to adapt to changing conditions and missions and to facilitate the sharing and disseminating of intelligence data and information reports.

Key issues to be addressed in future work include enhancing these technologies to support the rapid composibility of disparate networking, information, and security infrastructures. Techniques are needed for security for dynamic distributed data services, methods to manage the movement of data, information, and services across the network based on content and context.

In addition, another ITA team with members from ARL, US Army Communications-Electronics Research, Development (CERDEC), Boeing and IBM UK are working on a third CWP project proposal building on the Gaian DB infrastructure for exploitation of coalition data and information using controlled natural language research within the ITA.

5. Reference

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