2006 ICCRTS
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Dynamic Collaborative Action Teams: Implementing a Transformational Concept

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ABSTRACT

The emergent vision for Command and Control (C2) depends on agility in a dynamic operational environment. Responsiveness to new, challenging crises will require dynamically assembled teams working together in virtual, collaborative environments equipped with essential, relevant resources (personnel, tools, data, and processes). Previously Salamacha, et al[1] proposed a framework for managing these so-called Dynamic Collaborative Action Teams (DCATs). This paper is a sequel to the original concept paper and provides a pragmatic discussion of the challenges associated with actually implementing the DCAT concept. Implementations of key elements of the DCAT framework are presented including:

- patterns for crisis-related operations that can be applied and customized in real-time to support dynamic activation of workspaces and teams;
- integrated and interoperable collaborative environments composed to address unique operational needs;
- facilitated improvement through easily accessible lessons learned; and
- improved patterns for future operations

This paper addresses the technical and policy structures required for viability of the DCAT concept and framework. The paper also explores the linkage between DCAT as a model for both training and warfighting operations while postulating how this linkage can help create and validate best practices for conducting C2 in a net-centric operational environment. Training is discussed in the context of a broader way forward strategy.

George Abitante, Scott Cost, Steve Forsythe, Anil John and Kim Richeson contributed to the concepts and technical discussions presented in this paper. The authors appreciate their inputs and valuable insights.

Key words: Collaboration, patterns, dynamic activation, virtual resource broker

1. Introduction

In today's dynamic and ever changing world, Command and Control (C2) processes must also become more dynamic and capable to remain effective. The emergent vision for modern C2 includes agile, dynamic operations where responsiveness to new, challenging crises will require dynamically assembled teams working together in virtual, collaborative environments equipped with essential, relevant resources (personnel, tools, data, and processes).

[1] Reference (1)

C2 in current and future operations is, in part, characterized by:

- an emphasis on agility,
- dynamic self-defining patterns of collaboration,
- distributed, collaborative decision-making across echelons, services, agencies & coalitions,
- rapid integration of varied, dynamic, and often unanticipated sets of capabilities, and
- participation based on knowledge and capabilities.[2]

The capabilities being deployed for the operational environment of the future will address, at least in part, gaps identified from recent operations, such as [3]:

- limited ability to rapidly identify necessary participants across command levels for planning, action, and/or response
- limited ability to collaborate in an efficient/timely manner to perform dynamic planning and response and
- difficulties identified in achieving actionable information for command in dynamic environments.

The Johns Hopkins University Applied Physics Laboratory (JHU/APL) has been developing a framework to support the activation and operations of Dynamic Collaborative Action Team(s) (DCATs). Previously, Salamacha, et al[4] outlined a framework to support the management of DCATs. This sequel to the original concept paper provides a pragmatic discussion of the challenges associated with implementing the innovative DCAT C2 concept. *Technical* challenges include achieving interoperability across inherently heterogeneous development and operating environments (platforms, tools, etc.). *Procedural* challenges include identifying and bringing collaborators together, tasking them to support the team's activities, and equipping them with the appropriate tools, data, applications and processes that support effective collaboration in the dynamic environment.

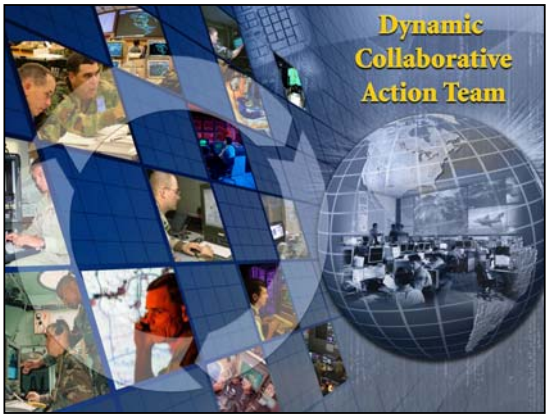

Figure 1 DCAT Concept: Conceptual visualization of a distributed collaborative action team.

JHU/APL's involvement in a number of related endeavors has underscored the fact that the successful implementation of innovative C2 concepts starts with good design. The desired level of agility and interoperability is not assured merely through

[2] References (2), (3), (4), (5)
[3] Reference (6), (7), (8), (9), (10)
[4] Reference (1)

the successful deployment of the Global Information Grid (GIG) alone; good design is essential to realizing these goals. This paper discusses implementation issues in the context of recent efforts that have contributed to our understanding of the way forward for the deployment of innovative C2. As a result, we have a better understanding of how to implement and employ the DCAT framework to support net-centric C2. These insights are shared in this paper for their potential benefit to others working towards net-centric transformation.

2. Dynamic Collaboration: Stresses and Challenges

Collaboration is an important integral component of C2 and the GIG promises to facilitate new collaborative capabilities with the potential to enhance Command and possibly re-define Control. Collaboration extends beyond information sharing. It can deliver a common view of the battlespace, provide decision aids, and improve the sharing and synchronization of decisions. Capabilities, workspaces and processes deployed within the GIG need to support these various aspects of collaboration. Collaboration environments and processes should reflect the needs of different users. For example, commanders may require coarser levels of detail and a broader, more comprehensive collaborative view than that of the subordinates supporting them. Subordinates operating as a dynamic collaborative action team will conduct both individual tasks (e.g., compiling an assessment) and collaborative tasks (e.g., consolidating inputs from different members). Common awareness of team health and status is essential to operating effectively as individuals and as a team. The following discussion highlights how user needs impact the implementation and employment of collaboration capabilities and processes.

The Commander

The GIG, and collaborative workspaces in particular, can provide a commander with unprecedented access to information and subordinates. "One of the most important pieces of information for a commander is whether or not his subordinates understand his image of the battlefield."[5] This is even more the case in distributed operations involving numerous and sometimes ad-hoc participants. When the commander is not able to personally meet with subordinates to conduct decision briefings, the collaborative workspace can serve as a venue for disseminating decisions and provides a common context in which those decisions can be understood.

Effective use of the GIG environment has emerged as an early fundamental challenge for commanders and their subordinate teams. A frequently voiced concern points out that, even in its nascent form, the net-centric operational environment "has increasingly enabled senior leadership to become involved in the finest details of force employment….it encourages higher-level leaders and their staff to try to micro-manage the fighting."[6] One could argue that this is not a technology issue but rather one of human nature; I can, therefore I do. In reality, collaboration environments and effective

[5] Reference (11)
[6] Reference (12)

use of new collaboration capabilities is still evolving. Over time, a body of best practices will emerge. These practices will need to be captured in a framework that makes them available during new, dynamic operations. The embodiment of these practices within the collaborative workspace will contribute to an environment that allows commanders to achieve a high level of confidence that their image of the battlespace is shared and their decisions are well understood. As unique operational demands arise, dynamically composeable workspaces will allow commanders to adjust their collaboration practices. Perhaps as the structure allowing all this is put in place, what should be done will more often take precedence over what can be done and the balance between centralized and decentralized execution will be defined by command best practices and not technology.

The Dynamic Collaborative Action Team

A dynamic collaborative action team activated in support of a mission will engage in collaboration activities spanning information exchange, brainstorming, reviewing, negotiating, consolidating, task assignment, and handing-off, as well as deciding and disseminating.[7] Members of the team may come from different operating environments (e.g., tools and processes) but they will interact as a team in some common workspace. The team may be cross-functional and include different types of users and supporting sub-teams. The team may also interact with other teams supporting the same mission or other, related missions and collaborative environments.

The interaction with other teams working on related activities is an important characteristic of the dynamic collaborative action team concept. Synchronization of multi-team activities for the mutually beneficial exchange of information will be facilitated by the net-centric capabilities inherent to the Global Information Grid (GIG). Multiple teams may synchronize their activities and collaborate because they are working as sub-units within the same mission activity. However, with the availability of Core Services on the GIG, teams from different interest and responsibility communities may discover each other and form meta-teams that derive this mutual benefit.

By necessity the collaborative workspace is a heterogeneous environment that includes tools and processes found across the DoD along with others unique to commands and organizations. Typically, members are allowed to customize their individual workspaces but are still expected to operate effectively as a team or collection of sub-teams. An overarching structure is imposed based on Standing Operating Procedures (SOP) and Tactics, Techniques and Procedures (TTPs). This structure is enhanced by best practices derived from previous, similar operations that are employed to achieve mission effectiveness and team cohesiveness. Beyond procedures, best practices also include other items such as tools, data, people and processes. The team must also deal with unanticipated needs. The collaborative action team workspace

[7] Group collaboration activities are based on Reference (13). The authors include deciding *and* disseminating. Reference (3) and Reference (11) address whether commanders actually make decisions within the collaborative environment. While the team will make collaborative decisions regarding assessment and recommendations, commanders are more likely to use the workspace to synchronize and disseminate decisions.

must include an ability to add additional tools, data and new team members, integrated "just-in-time" according to the demands or rhythm of the mission's operation.

3. Examining the DCAT Framework

The DCAT framework, depicted in Figure 2, outlines an overarching process methodology for creating and managing collaborative teams activated to respond to dynamic, "non-routine"[8] operations. This framework was initially outlined in a paper presented at the 10th Annual ICCRTS (Reference (1)). The DCAT framework includes:

- the construction of DCAT patterns prior to activation (both baseline and variants)
- discovery and customization of a relevant DCAT pattern for the new activity
- activation of an actual DCAT (workspace and team) using a pre-defined pattern
- support for collaborative activities conducted during DCAT operations through the integration of processes and workflow into the workspace, and support for managing the health and status of the team,
- and de-activation and archival of the DCAT to capture improved patterns and lessons learned.

The DCAT framework addresses people, processes, tools and data utilized during the team's lifecycle. Reference (1) provides a detailed, scenario-based description of how the DCAT framework works.

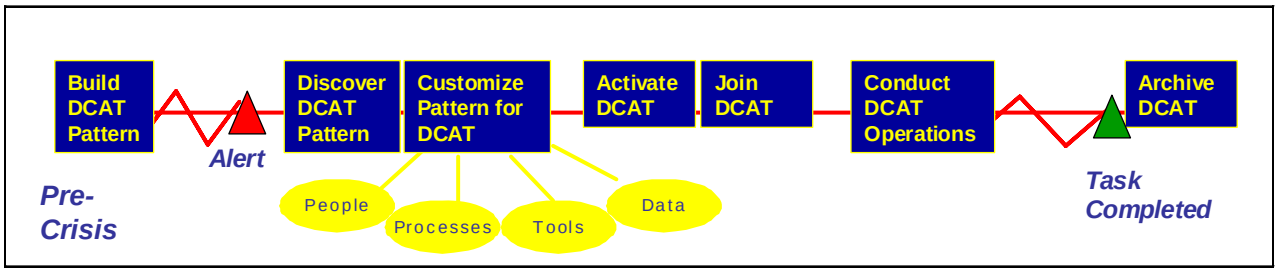

Figure 2: DCAT Framework

The DCAT framework is defined by the four key concepts depicted in Figure 3. These concepts are: patterns, dynamic activation, flexible and integrated workspace and facilitated improvement.

[8] The phrase"dynamic, non-routine" encompasses a wide range of dynamic operations that include crisis situations as well as composeable, on-demand training. While the DCAT framework has the potential to improve routine and planned operations, more significant improvements are expected in ad-hoc situations, both operations and training. Incorporation of the DCAT framework into routine and planned activities, however, is expected to yield best practices and recommended procedures that can be employed in more time critical, ad-hoc situations.

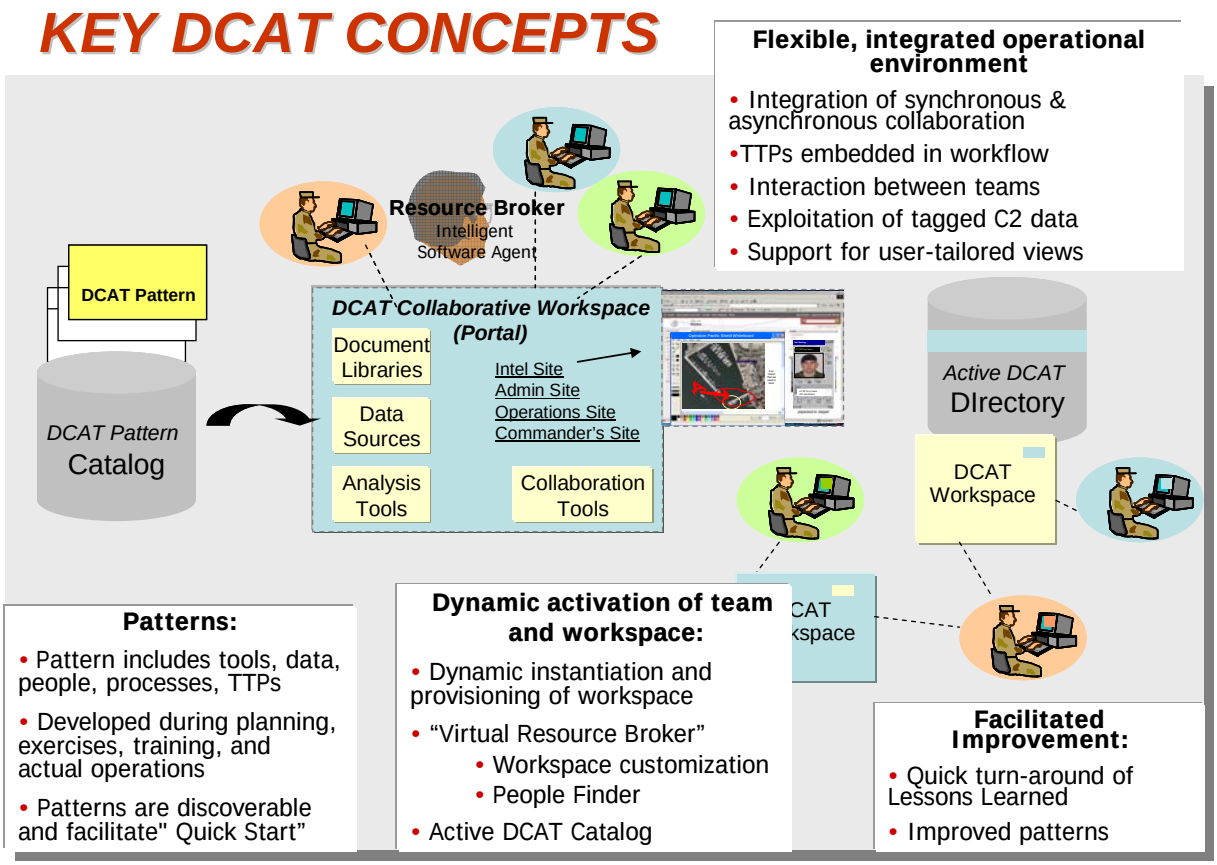

Figure 3: DCAT Key Concepts

Patterns, Facilitated Improvement

A DCAT pattern nominally captures and delivers the "80% solution" of component parts needed to establish an actual DCAT for a given mission or operation. When quickly creating a distributed team in a collaborative workspace, the DCAT pattern provides an effective initial structure for the workspace and team. A pattern includes the objectives, the roles and authorities for participants, the required set of tools, and the guidelines (e.g., TTPs) for the execution of the DCAT. The pattern also provides templates for the workspaces to be activated during DCAT operations. In some cases workflow is embedded in the workspace. Workspace templates include content, such as key documents and product templates, authoritative data sources, and portlets[9]. Workspace content and structure is customized according to the needs of the DCAT to better suit its unique operational situations although some constraints may be implemented to enforce best practices.

DCAT patterns are developed through advanced planning, training and exercises. Wargames and exercises are excellent venues to practice the creation, use

[9] As used here, the term portlets also includes Web parts (.NET terminology).

and refinement of the DCAT capability. Lessons learned from these activities can be used to modify patterns and improve the library of available DCAT patterns. Variant patterns can be created to tailor base patterns to better suit the operational needs of a given command. The DCAT framework also allows a pattern to be saved and archived at the conclusion of an operational DCAT to serve as a pattern for similar, future DCATs. All of these options contribute to facilitated improvement and provides future collaborative teams the benefit of the data and tools used, best practices employed, and the roles adopted by similar teams. The ability to leverage past patterns is a powerful advantage over current collaborative planning, training, and operations. Facilitated improvement also involves capturing lessons learned and tagging these lessons with their underlying DCAT pattern. Lessons learned from past collaborative operations will be recorded, standardized, and easily retrievable rather than potentially lost in the memories of participants.[10]

DCAT patterns are stored in a data catalog[11] and retrieved using a service, discoverable through Universal Description, Discovery and Integration (UDDI). This service provides the ability to find and retrieve DCAT patterns and is one of several fundamental DCAT Support Services. Each pattern includes metadata that can be used by the pattern matching feature to assist an action officer or even an automated activation process in selecting the best pattern to employ in a crisis situation.

An important and powerful feature of the DCAT pattern system lies in the opportunity to find and implement the most appropriate pattern, regardless of its original use or location. This feature requires a common, standard way of storing patterns. Currently, the primary structure for a DCAT pattern consists of the set of portal templates used to construct the associated collaborative workspaces. All other elements of the pattern (e.g., role descriptions and procedures) are captured as content embedded in the template. Pattern management must be implemented in a platform agnostic manner.

Dynamic Activation

DCAT patterns allow for quick activation of a new collaborative team. DCAT Activation involves the creation of a workspace provisioned with the appropriate resources. The template provided in the DCAT pattern captures the workspace layout

[10] There's an old adage that no news travels as fast as bad news. In recent years, there have been instances where emails detailing lessons learned and associated concerns and criticisms were disseminated throughout the DoD community at lightning speeds that rivaled even the most optimal projections for GIG performance. Facilitated Improvement attempts to introduce a structured process for sharing critical lessons learned in the context of a dynamic operational environment.

[11] Lessons Learned are also assumed to be stored in a data catalog. As stated, Lessons Learned collected from a DCAT instantiation are tagged with the underlying pattern. Guidance for the types of catalogs that will be established within the GIG is not yet fully defined. Patterns and lessons may well be stored in separate catalogs. Commands may establish "command" catalogs to store their DCAT patterns. A "master" catalog may be established to manage the various catalogs. Regardless of the final implementation, the critical features that must be preserved are the ability to discover the existence of relevant DCAT patterns, regardless of their origin, and access these patterns to quickly activate a new dynamic collaborative action team.

and content. Current technology supports the implementation of these workspaces as portals that can be provisioned with data sources, documents, tools, etc. Portal tools support the creation of new portal sites using templates. However, DCAT Activation also includes the formation of the team.

A critical component of successfully activating and leveraging a DCAT is finding the individuals with the requisite experience, skills and command authorization needed to support DCAT activities. Sometimes, individuals needed for collaborative sessions are known by name, but many times they are not. Criteria specified in a DCAT Request for Support may include, for example, desired occupational specialties, military rank, length of service, organization affiliation, standing operational team membership, previous operational experience and deployments, education, previous training and certification, familiarity with tools, and unique skills. This data is typically stored in a variety of different repositories. Notional databases and a catalog for managing personnel data repositories are depicted in Figure 4.

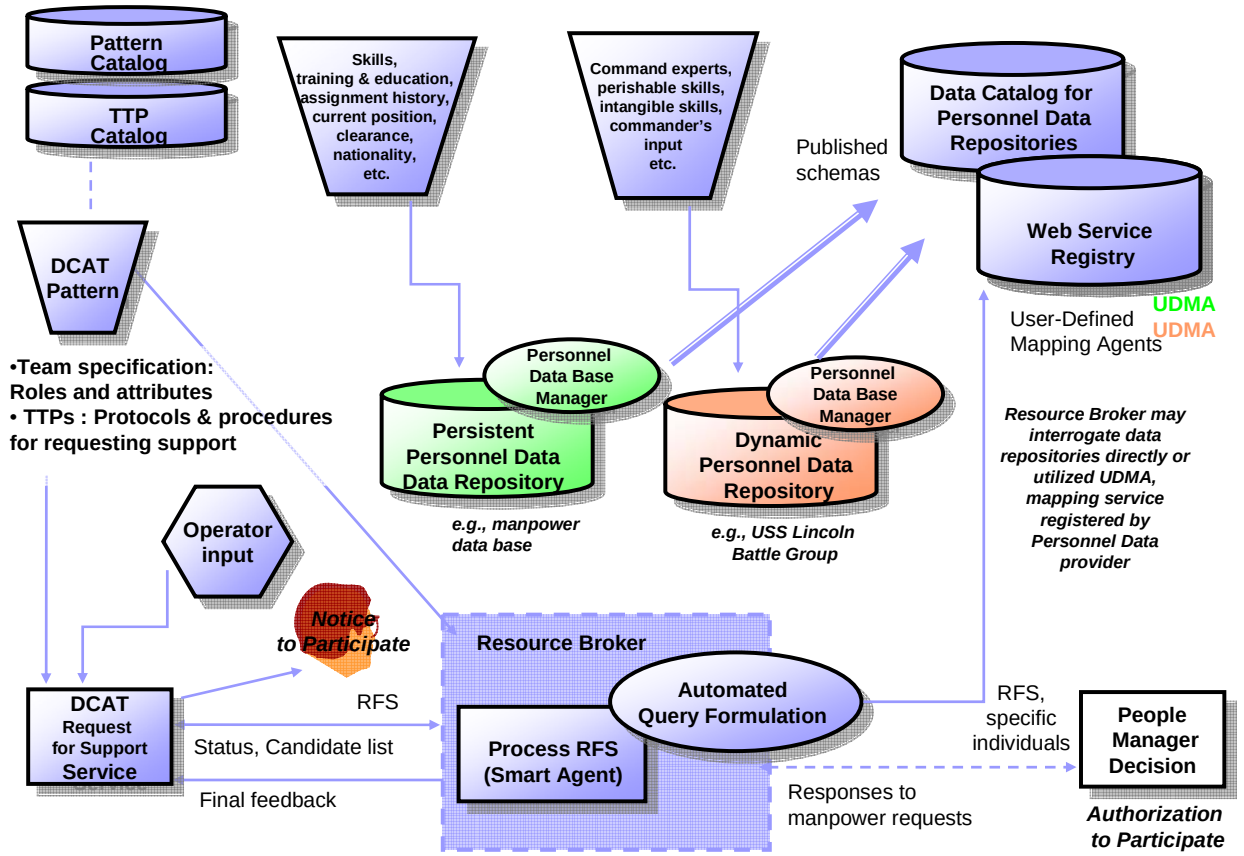

Figure 4: DCAT Resource Broker (Conceptual View)

The Global Force Management[12] Data Initiative[13] is implementing a centralized means of retrieving DoD deployment and human resources data maintained by different organizations. Such a capability would clearly benefit the DCAT framework as a data source for dynamically finding people.

[12] Reference (26)
[13] Reference (27)

As depicted in Figure 4, the Virtual Resource Broker[14] uses knowledge management technologies to query heterogeneous databases and smart-agent capabilities to semantically interpret and implement a DCAT Request for Support (RFS). A Request for Support is included in and associated with a DCAT Pattern and TTPs. The TTPs pertain to requesting personnel support and serve as business rules for Resource Broker operations. The Resource Broker finds data of interest, correlates data from different sources, and subsequently maps DCAT criteria to individuals. These individuals are then sent a Notice to Participate (NTP) that includes their assigned roles and privileges. An individual's role identifies their functional responsibilities and how they should interact with other DCAT members. However, before individuals can receive a NTP, they must first be empowered to participate in the DCAT. The DCAT framework solicits authorization (if required) in accordance with the business rules for the individual or command and forwards notices to the desired participants. This process implements the practices and protocols defined by the entity activating the DCAT. Individuals will support a DCAT for a limited duration of time while remaining stationed at their normal duty assignment.

The Figure 4 conceptual view reflects several technical and policy assumptions:

- The Virtual Resource Broker will have access to personnel data repositories, either directly or via a web service developed by the data provider
- TTPs pertaining to RFS and NTPs are accessible and can be incorporated into the workflow to facilitate DCAT activation processes

The final component of dynamic activation is registering the existence of the DCAT. This would be implemented using an Active DCAT directory/catalog (see Figure 3) and web services capable of interrogating the directory to discover existing DCATs of interest. Policy is required to ensure that active DCATs are registered as a matter of routine procedure.

Flexible, Integrated Operational Environment

Key features of a "flexible, integrated" operational environment include:

- **Integration of Synchronous and Asynchronous Collaboration:** To interact with each other, team members will use synchronous collaboration tools that include text chat, voice, whiteboarding, VTC, and web meetings. Simultaneously they will employ an asynchronous collaboration tool, i.e., the portal environment. Ideally, presence between these two environments is shared and improved patterns capture team interactions in both environments. Information (e.g., documents and visualizations) can be shared seamlessly across these environments.
- **TTPs Embedded in Workflow:** TTPs may represent the greatest potential for innovation in the conduct of C2 activities. As previously stated, the primary structure for defining a DCAT pattern is a portal template. All elements of the

[14] The Resource Broker is the subject of a separate paper presented at the 11th Annual ICCRTS, titled "Support for Dynamic Collaborative Action Teams". Scott Cost of JHU/APL is the author.

pattern (e.g., role descriptions and procedures) are captured as content embedded in the template. The structure of the workspace represents a body of TTPs for conducting mission activities in a collaborative manner. Procedures and protocols for requesting support are represented in the business rules specified for the Resource Broker. Orchestration of services facilitates TTPs for data acquisition and dissemination of team products. These are just some examples of how TTPs may be embedded in the workflow implemented in the DCAT workspace.

- **Interaction Between Teams:** Individuals may simultaneously participate in multiple DCATs and/or Communities of Interest (COIs). These different groups will utilize some of the same data services and alerts. Also, an active DCAT might produce an available pre-defined and registered Rich Site Summary (RSS) feed as part of its operations. The Uniform Resource Locator (URL) for this site is identified at the time the DCAT is registered as being active and is therefore also discoverable. Other DCATs and COIs can subscribe to the RSS feed to receive information relevant to the operations of the host DCAT.
- **Exploitation of Tagged C2 Data:** C2 data such as Commander’s Guidance, Commander’s Critical Information Requests, Battle Rhythm schedules, etc. will be equipped with metadata tags and stored in a manner that allows them to be discovered by search services. This data is integrated into documents and even directly into the collaborative workspace.
- **User-tailored Views:** There is a growing acceptance that users must be able to customize their workspace to meet their (individual) needs. One term being used is User Defined Operating Picture (UDOP). This degree of flexibility is inherent in portal environments. Questions about potential implications for the “common” workspace are addressed in Section 3.2.

4. Making the DCAT Framework Viable

The DCAT framework does not imply a single capability implementation. In fact, it is unlikely that a “one size fits all” implementation of the DCAT framework will be promoted, accepted or even advised. DCAT implementations will share the underlying concept of a composeable, common workspace comprised both of components unique to organizations or commands as well as common services used enterprise-wide.

Many of the technical challenges impacting the implementation of the DCAT framework are common to other initiatives being developed for the net-centric GIG environment. Sufficient bandwidth at the locations hosting DCAT members is critical to effective collaboration. Robust (standardized and interoperable) collaboration environments and tools as well as security services are required to support heterogeneous teams. This is particularly true for inter-agency positions not necessarily directly connected with the DoD GIG. New knowledge representation and data models

are needed to further improve information sharing.[15] A few select technical implementation issues are addressed in the next several sections.

Interoperability Across Collaborative Workspaces

Substantial effort is being expended to establish guidelines and standards that will enable the development of a GIG that does in fact yield interoperability at the network, message/data, and semantic/ontological levels. This challenging endeavor must contend with a dynamic and evolving technical environment. An essential element of the emergent GIG strategy is to have web services provide data in a platform-agnostic manner. In terms of the DCAT framework, this means that the same data services can be discovered and consumed regardless of the portal environment in which a workspace is implemented. However there are interoperability issues even in the "last GIG sprint". DCAT design must employ existing strategies[16] in a manner that ensures interoperability and an end-state that is platform-agnostic.

Another consideration is the human interface that allows a user to view the data within the collaborative workspace. Discussions of design tackle issues related to web parts, portlets and standards that can potentially allow even these components to be platform-agnostic. We assert that implementation of the DCAT framework is feasible even with the current state of technology and standards. As the standards and best practices are being defined, workarounds exist. The biggest challenge may actually involve developing a wide range of the web parts and portlets and them making them accessible to a wide range of users. This is largely an undertaking driven by the Assistant Secretary of Defense (ASD) Networks and Information Integration (NII) as part of the Net-Centric Data Strategy. It will require adoption of consistent vocabularies and ontologies as well as the participation of owners of useful data sources. It is largely assumed that end-users (not data service providers) will develop portlets. The reason is that users know best how they want to utilize data, including visualizations available through a collaborative workspace. However, cost is a critical issue - who pays for the development of portlets? This makes a compelling argument for instituting a framework of catalogs to capture portlets and facilitate their re-use, akin to the GIG UDDI registries that manage and facilitate the sharing of data services and, as described in this paper, DCAT patterns.

Commonality Versus Customization

A consideration alluded to earlier in this paper is the balance between the "common" aspect of a collaborative workspace and customization of the workspace to yield a user-tailored UDOP. One can imagine a scenario where each DCAT member

[15] In the case of DCAT, this means developing new formats to categorize data needed to support DCAT management. Examples of key types of information and formats include: extended personnel skills, expertise and experience information [to include collaboration skills], Commander's Intent, Strategic Objectives, scope of Operational and Tactical Objectives, Rules of Engagement, inter-agency coordination points and agreements, etc.

[16] "Contract first" is an example of a design strategy that promotes interoperability.

has customized his or her workspace so that at first glance it may not be apparent that the team is working on the same problem. Admittedly, this may be a greatly exaggerated scenario, but experimentation and training is required to better understand the degree of flexibility that should be allowed vice the constraints needed to preserve shared situational awareness and synchronization, which are fundamental objectives of the common workspace. One could argue that it is most critical to ensure that common data sources are used, and that tools and visualizations could be unique. Perhaps only common tools that manage the activities of the team itself (scheduler, presence, etc.) should be mandated. This violates the underlying premise of the DCAT pattern, namely that best practices pertaining to tools, processes, etc. should be leveraged to ensure mission success in dynamic, ad-hoc operations. The bottom line is that the right balance between customization and standardization in a warfighting context is not fully understood (after all, these capabilities are still evolving) and should be the focus of cognitive studies.

DCAT TTPs

The military uses TTPs to understand, describe, and practice the activities needed to succeed in the dynamic environment of modern combat. In particular, DCAT TTPs address collaborative activities and span technology (tools and data), people, processes and phases of operation. Two major insights about DCAT TTPs have emerged from our work on the framework. Given the composeable and flexible nature of the collaborative workspace, DCAT TTPs need to provide guidance for constructing the workspace and using it effectively. DCAT TTPs may even constrain workspace customization to ensure that shared situational awareness is achieved. DCAT TTPs will encompass best collaboration practices for different mission situations and different collaborators.

The second insight is that TTPs will be treated as data; they will be tagged and capable of being discovered. The templates that define the structure of the DCAT workspace represent a set of DCAT TTPs. Role definitions, responsibility assignments, and access controls that define team membership are another set of DCAT TTPs. TTPs will be integrated directly into the collaborative workspace, perhaps as a document included in a document library or maybe as a portlet that automates a process. Finally, TTPs may need to be modified dynamically. To this end, flexible implementation of business rules is a consideration in a JHU/APL research project dealing with the Virtual Resource Broker.

Security

One of the biggest challenges to the effective deployment and operation of the GIG is providing the requisite information assurance at the enterprise, transport, data, service and application layers. Any service or application deployed to the GIG must adhere to rigorous security requirements to maintain this assurance. The suite of DCAT capabilities will be no exception, and in fact, may face even more challenges because of its collaborative nature. Some of the issues that will need to be addressed are as follows:

- The GIG will span multiple security levels and applications and services must be designed to work in this type of environment. User information will be passed across security levels, which will provide special challenges to the DCAT Resource Broker, in particular. As GIG Implementation guidance is developed in this area, DCAT must pay attention.
- There is a notion of Single Sign-On that is receiving much attention in the GIG community. Users of portals will only want to “log-in” once to get authenticated and authorized, and not with each invocation of the backend services they are consuming (which would greatly reduce productivity and timeliness). The DCAT Framework will benefit as this process is defined and refined to support GIG operations.
- As security core services are developed and implemented, DCAT capabilities will need to interact with them and provide its own application-level information assurance as specified in evolving GIG implementation guidance.

The bottom line is that DCAT will ultimately be a set of net-centric capabilities that will need to adhere to the security requirements of the GIG. We do not expect that the security challenges presented above will in any way limit the capabilities defined in this paper.

5. Way Forward

JHU/APL continues to make significant internally funded investments in a number of initiatives that are helping the Laboratory shape its role in support of the next generation of Command and Control. Insights gained from these initiatives are beginning to prove beneficial to the DoD community as well as other stakeholders at Federal and State government agencies and organizations. JHU/APL has additionally undertaken sponsored tasks that benefit both the specific sponsors as well as the broad community who will profit from the power and promise of net-centric operations.

DCAT concept development was initiated by JHU/APL as an internally funded Research and Development project. Over the past two years, DCAT has been presented to a wide cross-section of the DoD community in several forums. Two initial versions of the concept have been implemented; one in an internally funded experiment and the second in a sponsor funded prototype. The original concept has been refined and extended based on feedback from the DoD community and our experience with the implementation projects. Both the concept and initial capability implementations continue to mature through ongoing internal investments and sponsor tasking. We believe that the DCAT concept has matured to the point where it can be applied in an operational environment. Our next step will be to identify an approach for this deployment. One potential approach under consideration is to establish a generalized DCAT capability as a workspace within the Defense Online (DOL) Portal. DOL users would then be encouraged to leverage the DCAT capability to problems of their choosing.

Through our interaction with a broad cross-section of stakeholders in many DoD and other government organizations, we have also been encouraged to consider the application of a DCAT capability in other non DoD domains. The concept of rapidly assembling teams of qualified and knowledgeable people and equipping them with all the necessary relevant resources in a collaborative environment has broad application. As the potential user population becomes more familiar and more comfortable with the availability of networked resources, collaborative tools and workspaces, the use of net-centrically enabled capabilities such as DCAT will become second nature. For this capability to deliver the most powerful impact on our nation's ability to respond to emergent and dynamic issues, all stakeholders must invest in enabling net-centric access to relevant data. This data-centric enablement of personnel data repositories, sensor data, and other relevant information feeds will empower users of capabilities like DCAT. Maturation and adoption of standards along with the development of the necessary vocabularies and ontologies to bridge organizational differences will also deliver important steps forward to leveraging the power and promise of net-centrically enabled capabilities such as DCAT.

DCAT Framework Applied to Training

The current training mantra promoted by Defense Secretary Rumsfeld in his vision on the "21st Century Transformation of U.S. Armed Forces" requires warfighters to train like they fight and fight like they train. Perhaps the opposite is also true – how warfighters train may help define how they fight, at least how they use the collaboration capabilities of the GIG to fight effectively. JHU/APL has explored how the DCAT Framework might be applied to dynamic, distributed, collaborative training.

From various DoD interactions we have received feedback that the DCAT Framework appears to be directly applicable to distributed team training; especially in supporting the fundamental need of multiple people collaborating together across geographic distances to increase skill or knowledge. DCAT would be advantageous in the two overarching training paradigms: planned team training and unscheduled, or ad-hoc team training. The latter represents a dynamic training capability, which is a requirement of the Training Transformation Initiative.[17]

In the first case, members of the training team and instructors are most likely known. The DCAT Resource Broker may have less utility, although it can certainly identify individuals in the planning stage and allow unknown individuals to be invited dynamically. DCAT Patterning, however, would be of great use to not only capture the key people, data, tools, and experiences of the training session, but also to standardize this pattern for similar, future training sessions. In the second case, DCAT Patterning may have less utility since ad-hoc sessions are probably smaller and less standardized. The DCAT Resource Broker, however, would be of great utility to dynamically find and integrate subject matter experts, instructors, co-trainees, or individuals who have taken similar training in the past. In both cases, the DCAT registry will allow users initially outside the training team to "find" and potentially join the training sessions real-time.

[17] Reference (14), Reference (15)

The DCAT Framework could ultimately bring together knowledge and people across the training network (e.g., Joint Training and Experimentation Network (JTEN)) and operational network (soon to be the GIG) to maximize the amount of learning and skill-building that can be done in a short time. At full capability, DCAT could build the foundation for any type of team training, including distributed ad-hoc just-in-time (JIT) training, SME consultation, instructor-led virtual classrooms, or mission-specific operation planning and preparation.

The synergy between the DCAT Framework applied to training and the framework as a means of managing collaboration during actual operations has additional implications:

- training sessions can produce DCAT patterns and collaboration-related TTPs;
- ad-hoc team training can provide insights in how the framework can address trust issues associated with an ad-hoc team.

JHU/APL Net-Centric C2 Testbed

Nothing can replace hands-on experience. This is proving to be especially true in the implementation of the GIG environment. It is also considerably true in the development of related concepts, such as DCAT, that will operate in the GIG environment. In FY04, JHU/APL began investing in the creation and exercising of an internally funded project called the JHU/APL Net-Centric C2 Testbed. This project and other, related projects created a cross-campus mini-GIG testbed for exploring, developing, testing, and evaluating Net-Centric concepts. One of the fundamental objectives of this multi-year project is to perform end-to-end, independent evaluation of net-centric C2 from applications and services to the GIG infrastructure, using validated metrics and measurements. In FY06, in addition to expanding the capabilities of the GIG test-bed, the project is focusing on C2 processes and decision-making, external connectivity and partnerships, more detailed and tangible metrics and measurements, and added emphasis on homeland security and defense.

The JHU/APL Net-Centric C2 Testbed has proven to be a microcosm of what we expect the Net-Centric Transformation will look like across DoD. The staff involved in this project is learning about the power and challenge of Net-Centricity through hands-on experience. In the process of tackling the challenges associated with net-centric transformation, JHU/APL continues building a strong foundation of technical expertise in this domain. The creation and exercise of this mini-GIG environment has provided an ideal opportunity for the evolution of the DCAT Framework. The Net-Centric C2 Testbed delivers Net-Centric connectivity to numerous Programs (DoD and other), platforms, data sources, and multi-secure domains (CLASSIFIED and UNCLASSIFIED). As we have created and exercised multiple vignettes within various scenarios, collaboration has emerged as one of the most pervasive areas of interest and relevance across these vignettes and scenarios. DCAT can therefore benefit from this environment and has an even greater opportunity for rapid concept framework evolution. This is especially true with the Testbed's available system of measurements and metrics which provide insight into the effectiveness of this capability.

Net-Centric Implementation Documents (NCIDs)

Good design is essential to making the promise of the GIG viable. Participation in the definition of that design provides a better understanding of how GIG objectives will be achieved and what structures need to be put in place. NCIDs, sponsored by the ASD/NII, are being developed to provide one-stop enterprise-level technical guidance for implementation of the GIG. These documents are intended to be a single reference that contains functional and performance requirements for GIG functions. The NCIDs establish GIG behavior and context necessary to achieve the Net-Centric vision.

The NCIDs Applications and Other Services (A&S) documents represent one of the segments that comprise NCIDs. ASD(NII) commissioned the A&S segment team to define the implementation and interoperability guidelines for applications and other services that will be deployed to the GIG. JHU/APL is the Segment Lead for A&S, and additionally has key leadership roles in several other segments, including Transport, Information Assurance and Enterprise Management. We have also been tasked to give direct support to the ASD(NII) Senior Systems Engineer as he spearheads this effort. Experience gleaned from this foundational work has been critical in continuing the development of our knowledge and expertise in leading edge GIG implementation strategies.

Use of DCAT in a C2 Mission Application

JHU/APL has been supporting a sponsor in applying the DCAT concept to an actual C2 process. The implementation of the concept turned out to be far simpler than originally estimated, due to a change in the implementation approach. The original implementation approach had been to develop a stand-alone pattern builder tool that would be used to define the complete structure and content of a DCAT site. As the project proceeded, it became apparent that a much simpler and more direct approach was possible. The project team developed a DCAT site using a commercial portal product and the facilities it provided. The portal provided a built-in capability to save and restore the site definition and, optionally, any content. Using this capability, it was possible to save multiple patterns and subsequently select any one of these to be restored and given a new name. In other words, a blank pattern could be developed for each anticipated specific mission, and the appropriate pattern could be used as a basis to rapidly create a new portal site to support each new mission when it was initiated. Also, it proved to be very simple to build a portlet to send out Notices to Participate as the first step taken after the DCAT was stood up.

Using this approach, it was possible to quickly create a very rich DCAT portal site specifically designed to support a specific C2 process. The site contained on the order of a dozen pages and 50 customized portlets developed by customizing COTS portlets provided by the portal product and using other screen design tools. In addition, 5 custom portlets were developed by software developers to access external Web services or do some other special processing.

While the DCAT site development was done using a specific portal product, it is anticipated that any portal product would have the ability to support the definition of templates and therefore to support the DCAT concept. A next step is to survey the most widely used portal products and verify that this is the case.

In summary, the DCAT Framework has the potential to transform how dynamic C2 operations are conducted - before, during and after specific crises and events occur. The DCAT Framework itself is being implemented in a technical environment that is still evolving. The incremental build of a composeable capability, an in-depth awareness of GIG development strategies, and continued interaction with the warfighting community are all essential elements of a way forward to making the DCAT Framework a viable, transformational C2 concept.

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