Unclassified Information Sharing and Coordination in Security, Stabilization, Transition and Reconstruction Efforts

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ABSTRACT

The emergence of new doctrine is enabling security, stabilization, transition and reconstruction (SSTR) operations to become a core U.S. military mission. These operations are now given equal priority to combat operations. The immediate goal in SSTR is to provide the local populace with security, restore essential services, and meet humanitarian needs. The long-term goal is to help develop indigenous capacity for securing and providing essential services, therefore, many SSTR operations are best performed by indigenous groups with support from foreign agencies and professionals. Large scale disasters, however, are an example where military support can enhance the value of SSTR operations. Without the means to effectively coordinate groups across the civil-military boundary, basic assistance and relief operations may be severely impeded. This paper will describe a conceptual portal, ShareInfoForPeople, which incorporates advanced Information and Communication Technology to enable collaboration, coordination and information sharing across the civil-military boundary in support of SSTR.

Keywords: *agent software; agent technology; collaborative work systems; enterprise IS; information architecture; information infrastructure; knowledge management; knowledge sharing; military IS; non-governmental organization*

INTRODUCTION

With the signing of the Department of Defense Directive (DoDD) 3000.05, *Military Support for Security, Stabilization, Transition and Reconstruction (SSTR) Operations* into policy (U.S. DoD, 2007), SSTR operations have become a core U.S. military mission that the DoD must be prepared to conduct and support. These operations are now given equal priority to that of combat operations. The immediate goal is to provide the local populace with security, restore essential services, and meet humanitarian needs. The long-term goal is to help develop and maintain: indigenous capacity for securing

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14. ABSTRACT

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essential services, a viable market economy, rule-of-law, democratic institutions, a robust civil society. These operations are conducted to help establish order, while promoting and advancing U.S. interests and values.

This article will begin by briefly describing SSTR operations and provide notional examples. Next, we will describe the capabilities of the ShareInfoForPeople portal (https://www.ShareInfoForPeople.org) to enable coordination and information sharing across the civil-military boundary during SSTR operations. We will then discuss the utilization of this portal in the Navy's Trident Warrior experiment. Lastly, we describe future development activities and technical challenges that remain to be investigated within our portal environment. We will conclude with a brief summary.

SECURITY, STABILIZATION, TRANSITION, AND RECONSTRUCTION

SSTR operations are conducted outside the boundaries of U.S. lands and territories, and information and communication technology (ICT) capabilities are critical enablers for the conduct of these missions. While there are similarities within the ICT systems for the employment of automated information systems between domestic and international partners, policy and structural frameworks create a different workflow for each side with regard to information dissemination and coordination. We will limit our scope to examples of military operations outside of U.S. borders.

Many SSTR operational tasks are best performed by indigenous groups, with support from foreign or U.S. civilian professionals. Complex disasters are an example where military involvement and support for SSTR operations can provide significant value to foreign governments and non-governmental organizations (NGOs), which may already be under great stress to respond in a timely and effective manner. The command and control structure, resources, and assets that the military can offer in such situations can shorten the response time line. However, without the means to properly coordinate the efforts of such a large and diverse group which spans the civil-military boundaries, basic assistance and relief operations may be severely impacted leading to delays or waste in the overall response cycle.

In SSTR operations, the U.S. military supports the Department of State and works with non-DoD partners, which may include select military units of other nations NGOs, international organizations (IO), and private volunteer organizations. Large-scale disasters are one example where proper coordination between participating organizations can increase the effectiveness of the overall response. A key element in the success of SSTR operations is the ability of the U.S. (or other lead activity) to obtain and process information about the situation and status of participating partners, while disseminating (or making accessible) the widest amount of relevant information to the partners in the ad-hoc coalition. Through the sharing of unclassified information via an appropriate ICT framework, the goal is to increase the level of coordinated activity among all of the participants. As illustrated in the following notional scenarios, SSTR operations are subjected to non-traditional and unanticipated partners:

- **Disaster relief:** Following a tsunami in the western Pacific, the U.S. Navy has been designated Combined/Joint Task Force Commander for U.S. military disaster relief operations involving an island nation that experienced severe destruction from several 50-foot waves. Coalition partners include naval elements from various Pacific Rim nations, for example, Australia, Thailand, Japan, China, South Korea, and India. Ground/air elements from these same countries are involved in delivering relief supplies and distribution of those supplies is being managed by a combination of efforts by the host nation, the United Nations, USAID, and international relief organizations such as the Red Cross.
- **Humanitarian assistance:** Following a period of severe drought and dislocation of

local peoples, the U.S. Army is designated Combined/Joint Task Force Commander for humanitarian assistance operations in a region of sub-Saharan Africa. Coalition partners include the United Nations, Doctors without Borders, and the International Red Cross.

While these are notional examples, recent history reveals that the initial years of the 21st century have witnessed numerous large-scale crises such as the Indian Ocean tsunami and Kashmir earthquake. There have also been longer-term, multi-faceted emergencies such as those in Sudan. The United States has been involved as a part of multi-national coalition missions, including the Balkan states, Afghanistan, and Iraq. The U.S. has also provided humanitarian assistance in response to devastating natural disasters around the world. Increasingly, the scale and scope of such events involve both civilian and military components.

The next section will describe the ShareInfoForPeople portal that is being developed to enable collaboration and information sharing across the civil-military boundaries in support of SSTR operations. The purpose is to enable non-traditional and unanticipated partners to share information and better coordinate activities with the civilian and military components.

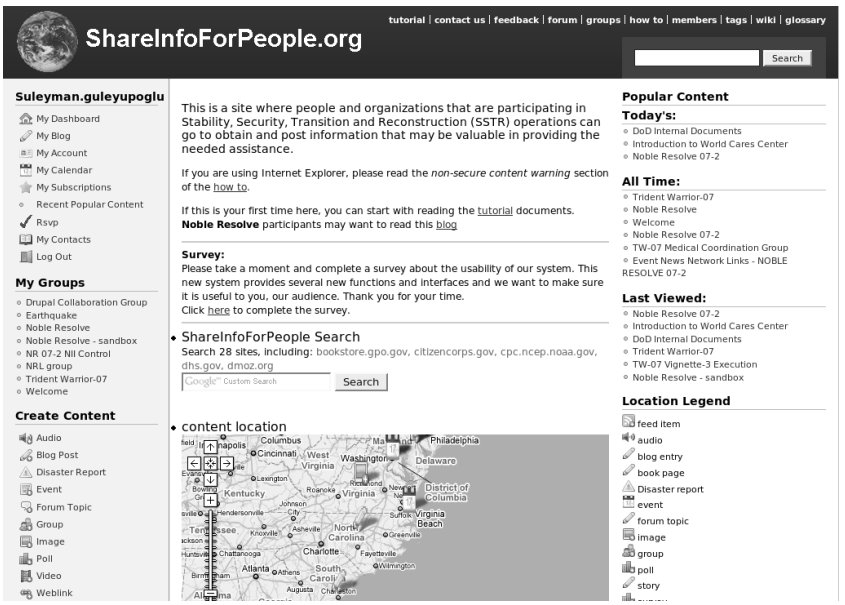
INFORMATION AND COMMUNICATIONS TECHNOLOGIES FOR SSTR

The Internet is driving emergent behavior in personal and group communications and is leading to new forms of interaction, as witnessed through many social network Web sites that are growing in popularity such as MySpace.com, Flickr.com, Craigslist.org, Wikimapia.com, and so forth. These, and similar Web sites, are leveraging new trends in collaboration such as Web 2.0 (e.g., mashups) to enable social networking. A few characteristics of the Web 2.0 may include the use of Real Simple Syndication (RSS), Weblogs (aka blogs), wiki's and social book marking which enable Web sites to be highly interactive (at a personal level). Some of the capabilities associated with mashups may include the ability to aggregate or transform content from remote sites through Web-browser-based applications. These applications generally provide simple and convenient programming interfaces to easily ingest or interact with new content. The benefits of aggregating, transforming, or even creating new content enables new ideas and concepts to emerge, which then become discoverable and accessible from within the site, or to other sites through mechanisms such as RSS.

The DoD is also embracing Web 2.0 and is actively leveraging these technologies in order to understand their value in improving collaboration and helping to achieve coordinated activity in SSTR operations. This article will describe a specific implementation of such a system called ShareInfoForPeople that is being funded by Office of Secretary of Defense—Networks and Information Integration to explore methodologies for unclassified information-sharing capabilities across the civil-military networks in support of SSTR operations.

As can be seen in Figure 1, ShareInfoForPeople provides a set of tools through a Web browser interface to enable real-time coordination and information sharing based on open standards and frameworks. The infrastructure is implemented using the Drupal (2007) content management system (CMS) and many of the baseline information sharing and collaboration tools have been contributed through the Drupal open source community. Drupal is a very modular open source software written in PHP hypertext processor language. It was chosen due to the very broad development community and user base, as well for its many "off-the-shelf" modules that can be extended as needed to suit the particular problem domain. While other frameworks have the potential to provide similar advantages ("Ruby," 2007), Drupal was chosen as the framework since it is already a complete CMS, without requiring additional programming effort to build CMS functionality. In addition, the fact that it is a community driven open source project means that it is easier to transition the system to the partner organizations

Figure 1. The ShareInfoForPeople.org opening screen



without imposing an investment burden on them for expensive software licenses. Furthermore, the use of open source software has been approved in IT systems within the Department of the Navy, which also demonstrates a paradigm shift within DoD towards the acceptance and use of open source software (Rendleman, 2007). This should lead to an opportunity to improve collaboration and coordination between the civil groups and military components as both are migrating towards open source software, and our portal may be able to serve as a baseline. The primary capabilities of ShareInfoForPeople include the following:

- **Fully indexed site:** Content is indexed based on user-specified meta-data tags to enable searching of local content. When a user creates and uploads content to the site such as images, audio, blogs, and so forth there is an opportunity for the user to specify meta-data tags that serve as an index mechanism, in order to facilitate searching from within the site.
- **GeoRSS and RSS feeds:** RSS and GeoRSS technology is utilized to incorporate the latest content from TRITON and Information Management and Mine Action Programs (iMAPP) as well as from other sites that support such feeds. The use of GeoRSS enables the coding of geospatial information within traditional RSS feeds and allows ShareInfoForPeople to display these geospatially referenced feeds using its local mapping interface.
  - TRITON (https://maps.nswc.navy.mil) is a scalable Web application architecture engineered to integrate and visualize geospatial data. It can be linked to databases or information and near real-time data feeds. It integrates imagery on-the-fly and dynamic map services from other organizations. TRITON is currently serving static images via GeoRSS to ShareInfoForPeople to demonstrate the initial proof-of-concept. User feedback on desired future capabilities within ShareInfoForPeople will enable us to expand our interactions with TRITON.

  - The iMMAP focuses on the larger concerns of war including the realities of an overstretched military; how America goes to war; and the civilian casualties of war. The iMMAP is involved in public education/news gathering and supports distribution of such information. Similar to TRITON, iMMAP is providing GeoRSS feeds to ShareInfoForPeople to demonstrate proof-of-concept.
- **Collaborative authoring:** ShareInfoForPeople currently supports a wiki capability (Figure 2) to promote collaboration and dissemination of shared knowledge. A community-driven approach should enable convergence towards accurate and reliable information being shared.
- **Upload or create content:** ShareInfoForPeople provides tools to upload content such as video, audio (Figure 3), and images within a group-based structure. Users can provide a title to what is being uploaded; upload the files by browsing their local directory; provide a description of the content; and define meta-data tags describing the content so that the tags can be indexed and used to facilitate search. The user can specify the group in which to make that content visible and can also place the content on a map by specifying a latitude and longitude coordinate (or by clicking directly on the map). Only a few of these items are mandatory during the upload process. Additional content such as blogs, events, and disaster assessment reports can be created within the site.
- **Image annotation capability:** ShareInfoForPeople permits users to annotate images as well as describe the annotation through free-form comments. A user can click on a particular image that is stored within the site, which will subsequently reveal an interface as shown in Figure 4. This interface permits the user to add, edit, delete, or hide notes. After the user clicks on "add note," a note is created by drawing a bounding box over the area of interest on the image, which can be moved or resized by the user. These notes can contain a subject and free-form comments describing the overlaid note. Furthermore if coordinates are associated with the image, it can be geo-referenced on a corresponding map (seen at the lower right corner of the Web page in Figure 4).

Figure 2. The ShareInfoForPeople Wiki pages

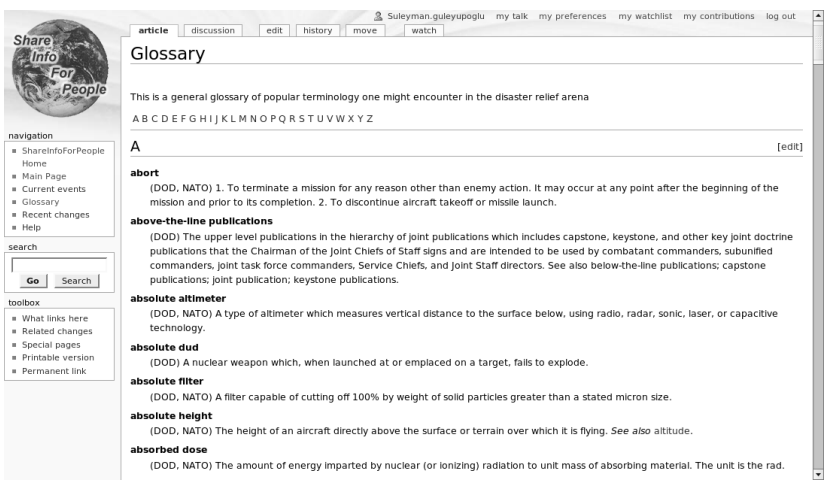


Figure 3. Screenshots showing how to upload audio content

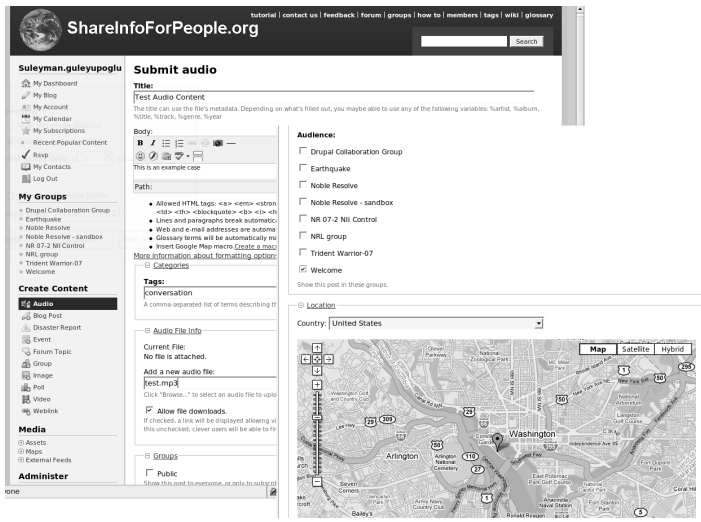
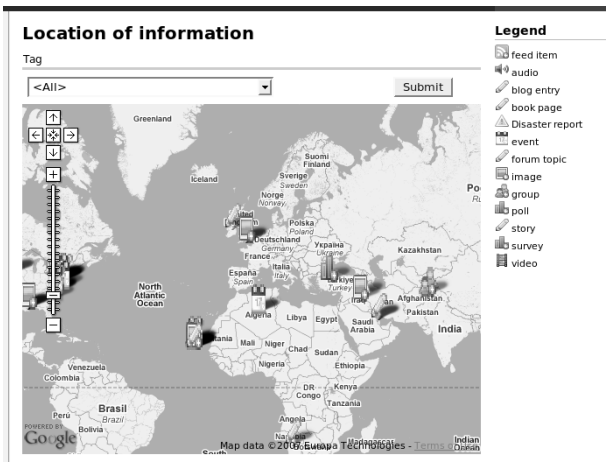


Figure 4. Image-annotation capability

- **Content can be geo-tagged and displayed on a map:** The mapping capability leverages COTS solutions to maximize interoperability (e.g., Google Maps). Figure 5 shows the Google Map interface within ShareInfoForPeople. The content on the map can be clicked, and a pop-up area will appear that provides additional description.
- **Subscription-based e-mail notifications:** All *subscribed-to* content generates e-mail alerts. For example, one can enable e-mail notifications through the user account settings. This will allow users to receive e-mail notification when new content has been posted to a group. Furthermore, e-mail notifications can also be provided when a user has replied to a discussion thread within a group.
- **Searchable subject matter expert (SME) registry:** When users complete their per-

Figure 5. ShareInfoForPeople map display



sonal information such as expertise or skill sets through the account preferences area in ShareInfoForPeople, this information gets indexed. This will facilitate searching, so that users can easily find individuals who are able to offer specific services, support, or other assistance during a crisis situation. People publish as much information about themselves as they are comfortable in sharing with other users of the site.

- **Multi-lingual chat:** In addition to the typical asynchronous mode of communication associated with Web portals, the site offers a multi-lingual chat capability. Each user is assigned a Jabber ("What is Jabber," 2007) chat account that can be used with a locally installed application or through Web-based interface. This allows on-the-fly translation and communication between users who do not share a common language.
- **JPEG metadata discovery tool (JMDT):** As a means of discovering additional information, ShareInfoForPeople interfaces with JMDT (2007). This allows users to run keyword queries from ShareInfoForPeople to search for images indexed within JMDT. In addition, GeoRSS feeds can update site users on any new image indexed by JMDT. These feeds can be filtered by keywords to provide only relevant images.

The current implementation of ShareInfoForPeople provides the foundation on which to build more sophisticated capabilities, as specific requirements emerge from experimentation and other forms of user feedback. Furthermore, the philosophy of ShareInfoForPeople has been to use free and open software and standards to enable interoperability with other systems. We envision this approach will offer an increased opportunity to instantiate an enterprise-wide capability composed of loosely coupled, agile systems that provide synergistic capabilities. The next section discusses our involvement in experimentation, followed by a discussion of near term development activities.

EXPERIMENTATION IN TRIDENT WARRIOR 2007

The ShareInfoForPeople portal underwent user experimentation during the Trident Warrior experimentation in March 2007. Trident Warrior is a yearly exercise designed to provide a venue for technology experimentation that supports the Navy's FORCEnet vision. The focus of the experimentation in March addressed Maritime Domain Awareness (MDA). However, there were additional, related scenarios as a complement to MDA.

The ShareInfoForPeople portal was used by various civil and military groups to coor-

dinate and share information in response to a hypothetical scenario consisting of a bird-flu outbreak on the Cape Verde Islands off the coast of West Africa. The portal was used by various groups from the NGO medical communities as well as those from Commander, Second Fleet in response to the events in the scenario to discuss medical logistics issues, post information on status of activities, share images on local geography, and so forth. Through participation in this experiment we were afforded an opportunity to collect valuable feedback from the civil and military communities in order to improve the future capabilities of our portal. Future experiments are also being planned in the Joint Forces Command's Noble Resolve experiment series which also focuses on civil-military information sharing.

NEAR TERM DEVELOPMENT ACTIVITIES

While the current implementation of ShareInfoForPeople provides a basic set of capabilities and functionality needed for collaboration and information sharing, there are still a number of areas to investigate and further prototype. Since our system is architected using the Drupal framework, we expect to leverage modules already being developed by the Drupal community and modify those as needed to meet the requirements of our user community. In addition, three primary areas for future exploration include social network analysis (SNA), OpenID, and task management capabilities.

Social Network Analysis

The current capabilities of ShareInfoForPeople provide a mechanism to search for users based on their skill set or expertise. The emerging concepts and ideas associated with SNA have the potential to add significant value within the information sharing environment. Research and tools from the SNA community may allow users to understand who the experts are in the SSTR community and to whom and how they are linked. As a simple example, social maps that depict connectivity between users in the context of their discussion threads, and the ability to filter the social map based on specific keywords are likely to provide the foundation to enable the community to identify service providers or those that may offer similar services or capabilities. The ability to rate individuals within the social network may also be an important aspect in building trust within the community of users. This is particularly important during pre-deployment prior to any crisis situation so that some level of trust and common understanding can be achieved. Furthermore, pre-deployment interactions can help in the development of concept of operations or doctrine to provide guidance during real-life situations by helping people or organizations form the bonds of working together. One of the challenges, however, will be to effectively visualize such a network or efficiently filter through the various dimensions of information contained in the social network.

Identity and Site Access Management

The need to protect sites from malicious behavior and limit participation to those actually involved in responding to a crisis, in addition to the sheer number of sites that one needs to interface with to gather information with which to respond to complex emergencies drives users to have multiple accounts/passwords to accomplish their work. The ability to get timely access to new sites, as well as remember and manage passwords can be a significant obstacle in gaining access to critical information in real-life emergency situations. Having single-sign-on access to a federation of sites that have agreed to common security criteria would improve tremendously the user's ability to discover and access the appropriate information. An ability to logon to the site using the OpenID (2007) standard will likely provide those advantages and benefits. This will enable users to log on once and seamlessly navigate to and from sites that must be password protected by relying on the OpenID service provider to verify the identity of the user.

Effectively Delegating and Managing Tasks

Another key area that is currently being explored is the application of techniques to coordinate tasks across a large and diverse group of users such as first responders and those in command centers. While information-sharing capabilities are a necessary first step, in a real disaster or crisis situation it is very likely that there will be thousands of groups containing hundreds of discussion threads. The discussion threads are likely to evolve to contain descriptions of who can offer services such as shelter (service providers) or who may need shelter and where they are currently situated (service requestors). The biggest challenge will be to automatically extract such information from the discussion threads. Manual processes are likely to be slow and inefficient. Therefore, techniques to automatically extract these descriptions from the online discussions and translate those into representations that can be manipulated by tools will be required. This is an area where we expect to leverage other work from natural language processing. Capturing such information could also be achieved by users completing structured templates or forms, and it is likely that some combination of free text extraction and forms would be used or available to the users.

Once information can be extracted and translated into a more structured representation (or is already available in a structured form) then it becomes easier to manipulate and use that information to match service providers to service requestors. We expect to develop algorithms that provide the underlying capabilities to enable such a matching. As an example, in related research we have developed several approaches for the global optimal assignment of resources, such as people or organizations, to activities based on the *Hungarian algorithm* (2007). These algorithms will be further enhanced to enable users or organizations to negotiate between the allocated assignments (e.g., accept, decline, etc.).

TECHNICAL CHALLENGES

On one end of the spectrum, activities may be (re)allocated or negotiated at emergency command centers, which have a reliable communications backbone, and promulgated to those in the field. However, at the other end of the spectrum, where actual users are likely to negotiate activities with each other, the communications environment may be unreliable. These "disadvantaged users," however, may be able to access a mobile version of the ShareInfoForPeople portal and maintain minimal functionality for uploading or creating content, annotating images, participating in discussion threads as well as negotiating activities between each other. However, given the chaotic and communications-challenged environments in which these types of systems will likely operate, it is conceivable that there may be users who get disconnected from each other in the field or with those at some remote command centers. There is a real challenge, from a network perspective, to ensure connectivity. This presents an opportunity to leverage research from the field of mobile wireless networking and intelligent agent-based applications to help alleviate these problems.

Mobile Ad-Hoc Network Environments

Critically damaged areas with degraded or no infrastructure (e.g., transportation, communication, etc.) provide a challenge in SSTR operations. We focus our discussion on the communications infrastructure. The ability to coordinate a large and diverse group of first responders begins with the ability to communicate guidance or orders, while receiving situation reports from those in the field. The lack of a stable communications infrastructure will negatively impact the efforts of those that need to coordinate and share information. Recent technological advances in mobile ad-hoc networks (MANET) are key enablers in the deployment of net-centric cooperative multi-agent systems in disaster areas. MANET technology holds the promise of enabling communications between first responders when the local communications

infrastructure is unusable. These networks support mobile entities, connected through a wireless network that supports discovery and self-organization through peer-to-peer message exchanges, leading to an increase in the robustness of the overall network. Figure 6 shows a comparison of MANET with high performance networks and the mainstream Internet.

Although MANET technology is advancing to enable connectivity between mobile users, there still may be circumstances in which users get disconnected (examples such as distance between users or the affects of the environment on signal propagation). In order to improve the overall success of the deployment of MANET, new approaches and techniques that enable users to communicate to the maximum extent possible utilizing whatever network bandwidth is available will be needed.

The concept of "network-aware" coordination is emerging and is depicted in Figure 7. In such an approach, the users or application are aware of the state of the network, thereby allowing the applications to adapt in order to "work around" network constraints, while the network is aware of the state of the applications or mission needs in order to better handle traffic flows. Such cross-layer information exchange is important to enable a more robust communication strategy for the first responders in order to support their coordination activities. To the extent possible, coordination strategies

Figure 6. Communications and networking issues

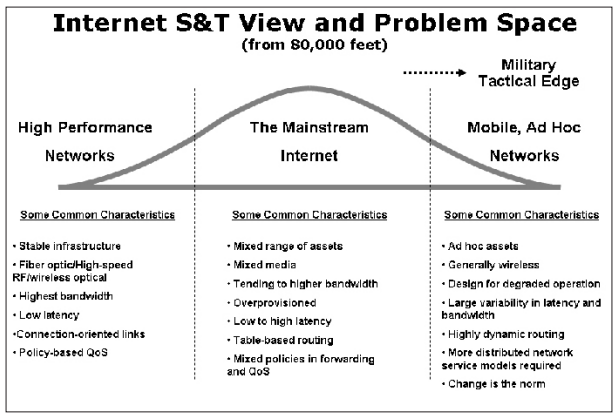
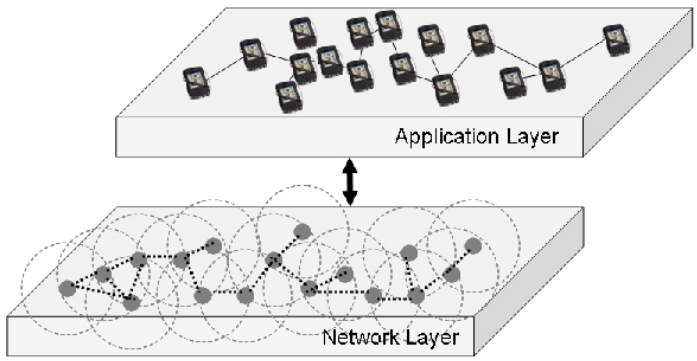


Figure 7. Network-aware coordination



also have to be robust against message loss and equipment failures.

A few of the research issues in network-aware coordination include defining measures for determining network congestion or other types of failures such as loss of connectivity within the network, in order to provide such measures and parameters to the application layer. The key challenges for the application layer include how to best utilize that information in order to adapt communication strategies (e.g., sharing images that are smaller in size, prioritizing certain information, or identifying certain nodes to act as communications relays). Such a feedback loop may be continuous, so that the network could support larger bandwidth exchanges as congestion is proactively alleviated in the network.

Distributed Planning and Multi-agent Systems

Research may also be leveraged from the field of multi-agent planning, re-planning, and scheduling between heterogeneous coordination entities. Distributed techniques such as automated plan merging and negotiation tools between responders may resolve local conflicts and issues without an entire re-planning effort. While coordination tools have been directed towards assisting human-to-human collaboration, software agents can be introduced to reduce interdependence by providing fast and robust solutions, bypassing delays in human response such as information gathering tasks. Specifically, coordination software agents may help incident commanders in directing large-scale teams and to gather information for situational awareness.

SUMMARY AND CONCLUSION

This article has described the ShareInfoForPeople portal to enable coordination and information sharing between the civil and military communities in support of SSTR operations. The architecture is based on the Drupal framework, an open source CMS being managed under General Public License (GPL). Furthermore, the philosophy of ShareInfoForPeople is to embrace free and open source software and standards as much as possible to enable future interoperability with other portals that provide similar or complementary capabilities. We have also briefly described how ShareInfoForPeople was used at the Trident Warrior 2007 experiment in order to gather user requirements.

The article has also described future development activities such as the planned leverage of modules already being developed by the Drupal community, which will be tailored to meet the needs of the ShareInfoForPeople users. In addition, technologies such as social maps will be investigated, as well as single-sign-on to enable users to seamlessly interact with other sites and portals. Because the latter technology is in its infancy, the challenge will be to find supporting hubs or portals that will be prepared to integrate with our portal using this capability. The ability to manage and negotiate tasks across the civil-military boundary are also worthy of exploration in order to improve coordination. Lastly, we have described some of the open challenges that remain such as network aware coordination, to enable ShareInfoForPeople to be robust in response to an increase in the number of mobile users during a real crisis situation.

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