Network Science Workshop 2007 Discussion Topics

This workshop brings together academic, government, and industrial participants to discuss the nature of Network Science as an emerging discipline and to discuss the applicability of network science technologies to Net-Centric Operations.

As a means to generate discussion on thinking about Net-Centric problems, we offer two current research efforts at the United States Military Academy (USMA) for your consideration. These two research problems will serve as the focus of a panel during the workshop, but also should be used as a thread throughout the workshop. As panels and speakers introduce various initiatives, look at how these initiatives could apply to the projects outside the domain in which they are briefed. The following multidisciplinary projects fit into the category of ***Power to the Edge*** activities discussed in http://www.dodccrp.org/publications/pdf/Alberts_Power.pdf and faces the Network Science challenges discussed in http://www.nap.edu/catalog.php?record_id=11516

Please select two of the following questions and review the two projects described below. Please address the issues raised in the questions with respect to the projects and email your responses by 17 April to LTC Ron Dodge (ronald.dodge@usma.edu). Thank you!

Project Questions:

- Network Science often dwells on the center of the graph. These projects are operating on the periphery of the human and computer network. What do we know or need to know about network activities at the edge of the network?
- Information at the periphery of networks: Is it the same as or different than information at the core of communication, computer and human networks?
- Should the Human and Computer networks be considered as one? Or are there benefits in treating them separately?
- Assuming that we know the location and activities of a tactical unit, how do we avoid interrupting soldiers at a critical moment in order to relay IED information? That is, how to we model decision processes in small-unit tactical settings in order to prioritize competing cognitive activities?
- Is the Ancile device or TiGRNet intrusive to a soldier's mission? Can the devices be integrated such that they avoid this drawback?
- What are the tools available to adequately model the cognitive processes and measure outcomes in order to prioritize competing cognitive processes?
- What are the tools available for modeling man-machine interface issues to develop analytical models and metrics for choosing among alternative interface and display technologies?
- What are the tools available today to adequately model the communication links being used at squad and platoon level?
- How can the data amassed by the TiGRNet system be indexed to be usable in real time by other Army systems?
- Assuming that we know the location and activity of a tactical unit, how do we build a predictive model of communication capabilities for squads and platoons on the move in urban areas in order to estimate the amount of data feasible to relay to a given tactical unit at a given time?
- For "Power to the Edge" considerations for effects-based analysis of outcomes a "DIME on PMESII" framework of understanding and altering battlespace state has been proposed. That is, choosing among alternative Diplomatic, Information, Military, and Economic (DIME) actions is expected to produce a different battlespace state defined in terms of Political, Military, Economic, Social, Infrastructure, and Information (PMESII) outcomes. The idea of the "strategic corporal" is that actions at the tactical level may dramatically alter the extent to which strategic outcomes are achieved. Recent counter-insurgency (COIN) operations discussions have involved considerations concerning how to balance nation-building

activities with government and non-governmental agencies with security operations. *In your own Network Science discipline, what are the technologies **available today** that should be brought to bear in the Ancile and TiGRNet problem, to better understand the battlespace state, and assist in choosing actions which produce desired outcomes?*

- In your own Network Science discipline, what are the technologies **that need to be developed in order to be** brought to bear in the use of Ancile or TiGRNet, to better understand the battlespace state, and assist in choosing actions which produce desired outcomes?

o Application of the Ancile System to Warning Soldiers about Improvised Explosive Devices

Background:
The existing Ancile device, http://www.ancile.net , is under development through a research partnership between USMA and PM Battle command. Ancile provides warning messages to individual soldiers whenever they are threatened by incoming indirect fire munitions. These messages are generated by existing tactical systems such as the Forward Area Air Defense Command and Control (FAAD C2) system based on inputs from sensors such as the Light-weight Counter Mortar Radar (LCMR). Ancile imposes no requirements on these systems other than the use of an available connection port.

Ancile System:
The Ancile system consists of two primary components: (1) a gateway device to the Tactical Internet to receive and relay Strike-warning messages to (2) the pager devices, which warn individual soldiers of incoming, indirect-fire ordinance by providing a vibration, a tone, or both. The *Ancile pager* is made up of a single board computer, a global positioning system (GPS) receiver, and a radio frequency transceiver. It operates on commercially available batteries and has a minimalist user interface consisting of an audio alarm and a power switch. The *Ancile bridge* is mounted on a vehicle or placed in a tactical operations center. The bridge exposes two communications interfaces: one to the tactical communications network, and the other to the Ancile wireless network. Its purpose is to filter, translate, and relay messages from the tactical internet to the Ancile devices and vice versa.

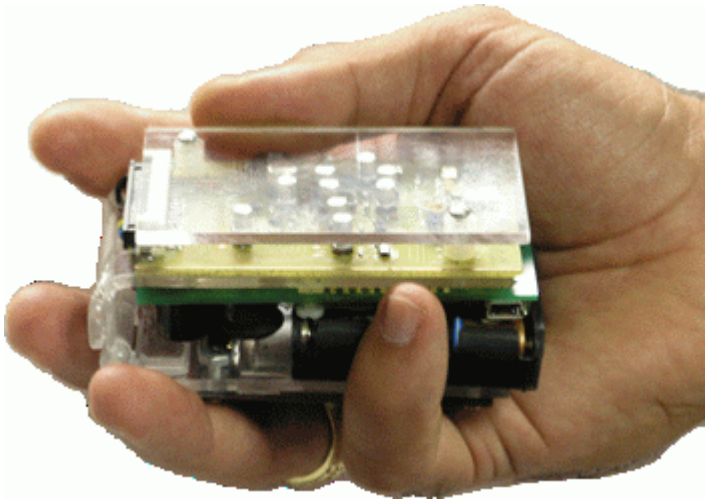

Figure 1 Ancile prototype

The Ancile system prototype has been shown to interface with at least two existing tactical systems: FAAD C2 and the Area Missile Defense Work Station (AMDWS). This interface is facilitated by these systems' use of standard Internet Protocol (IP) sockets and the eXtensible Markup Language (XML). It is reasonable to assume that Ancile bridges would be able to interface with any other system that uses these protocols.

The Ancile pagers receive binary messages in a proprietary communications protocol over RF. These messages are currently comprised of a predicted point (latitude, longitude, and altitude) and time of impact for the incoming projectile as well as a danger radius around this point expressed in meters. If the message is a duplicate, the pager discards it. Otherwise, the pager checks whether the time of impact is in the future and whether the user's location is within the danger circle. If both conditions are met, the user receives an alert. If the event is in the future and the pager is configured as a relay, it will forward the message to other pagers that may not have received it.

The prototypes were successfully tested during a mortar live-fire event at Yuma Proving Grounds in the spring of 2005. A commercial company has licensed the technology from the U.S. Government to develop and field a commercial product in 2008.

Ancile IED warning:
While the Ancile system was designed to warn dismounted soldiers about incoming indirect fires, while tracking and reporting these soldiers' locations to command and control systems; with small adaptations, this system could potentially be used to warn soldiers about improvised explosive devices (IED) in their vicinity. In this paper we outline ideas for investigating changes to Ancile that may improve the dismounted soldier's situational awareness with regard to IEDs.

We are beginning a project to extend the Ancile device capabilities to reach back to the Tactical Internet (and beyond) in order to warn soldiers of possible proximity to Improvised Explosive Devices (IEDs). The project is a joint effort of the Department of Behavioral Sciences and Leadership (BS&L) and the Department of Electrical Engineering and Computer Science (EE&CS) and is sponsored by the Joint IED defeat office (JIEDDO).

TIGRNET (AKA TGR)

Background:
Tactical Ground Reporting Network (TIGRNET) is an information-centric network application that provides data collection and reporting capabilities to army users, enabling company and platoon-level knowledge sharing. TIGRNET provides a map-based user interface optimized for military application and supports multi-media and GPS input as well as distributed search and caching capability. Designed to provide high availability, TIGRNET is resilient to network disconnects and black out periods. The highly intuitive visualizations allow soldiers to quickly review all available intelligence including places, events, people, and objects for efficient and timely battlefield awareness and increased combat effectiveness.

TiGRNet System:
Specifically, The Tactical Ground Reporting Network (TiGRNet) is a tool that consists of a GPS enabled digital camera and a database that allows a soldier returning from a patrol to easily download his/her observations, thoughts, pictures, digital voice recordings, short digital movies, and other information about the patrol. The small digital camera- GPS system has a ruggedized case so it can handle being dropped. This tool provides a way to tell the story of the patrol and capture detailed information in a format that hasn't previously been available.

Defense Advanced Research Projects Agency initiated the project and it is now under PEO-C3T and has completed a MANPRINT Analysis by Army Test and Evaluation Command (ATEC). DARPA developed the project while observing Army patrol leaders using operations orders, maps and photos to give patrol members an overall idea of the situation. Usually, these maps and photos are not connected to each other, and without extra effort such as connecting the photos to the map with string or labels, they are essentially unmapped locations in the Soldiers' minds. TiGRNET makes the linkage between the photos and satellite maps by using embedded GPS location information in the pictures. The display map, similar to images one can find on Google Earth, uses the camera's GPS abilities by mapping where the pictures were taken.

Figure 2 TiGRNet Camera

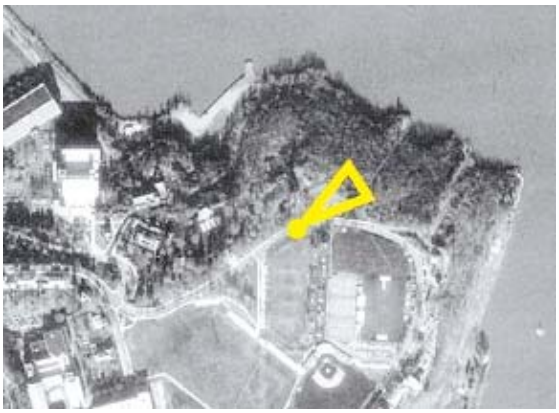

Figure 3 Imagery of Trophy Point is imposed by TiGRNET on satellite imagery.

TiGRNet has many practical applications in the military, including reconnaissance, surveillance, battlefield handoffs, trend detection and IED prevention. For reconnaissance, this is a powerful tool that allows its users to visually convey a precise situation, location, face or general area.

Note from 1LT David A. Shamsi, Scout Platoon Leader, C TRP 1-7 CAVALRY 1BCT 1CD

"Before every mission the most important part that goes into the planning process is the intelligence. Before TIGRNET, I really did not get very much information on targets or objectives. All I got was need to know things. Where I was going and who I was going after. As a leader there is much more that I feel I need to know. Such as what all has happened along routes that I am traveling, what is the history of the objective area, who is involved with the people that we are going after and where else have they been known to be located. In the past if I wanted to get this information, I would have to go to the intelligence office and request this information far in advance. With TIGRNET, I can go to the computer minutes in advance and learn everything I need to know about a mission. TIGRNET has definitely changed the way I handle my mission planning timelines. I do not set a concrete plan until I check TIGRNET and get all the information.

On the flip side of the information flow; gathering information is one of the primary missions of being a scout. The majority of the missions that my platoon does are recons. As scouts, we are constantly adding to the intelligence piece of the battle. A problem that we had was that we were always turning information in but we never saw the products that were created from the information. They always went up, but rarely came back to the platoon level. TIGRNET has allowed me and my men to see that the information that we gather is not useless. We are able to look at areas that we are going or have been to and see the pieces that we added. Not only that but we are able to see the information that other units have added and are able to get the entire picture of an area."