S-6 Associate

A unified approach to building and managing Network Operating Environment within the context of tactical missions and other warfighting functions

Melinda Gresham, Josip Pilipovic
Space Terrestrial & Communications Directorate
U.S. Army RDECOM - CERDEC
Aberdeen Proving Ground, Maryland

Eric Drucker, Larry Lafferty
Veloxiti Inc.
Alpharetta, GA
ericdrucker@veloxiti.com
larrylafferty@veloxiti.com

***Abstract*—A data fusion software capability called the S-6 Associate is being developed at Aberdeen Proving Ground inside the Space and Terrestrial Communications Directorate at the Communications-Electronics Research, Development and Engineering Center. This intelligent cognitive software will assist the battalion (BN) S-6 and his staff manage complex tactical communications networks while increasing the networks' agility, efficiency, and responsiveness, whether a unit is stationary or on the move. This intelligent tool leverages proven technology to help soldiers manage existing network resources more efficiently, including soldiers without in-depth network administration skills.[1] Once fielded, the S-6 Associate will enable battalions to build a Network Common Operating Picture (N-COP) and perform NetOPS monitoring and management under conditions of rapid changes in tactical movement. In addition, it will cooperate with WIN-T NMS to ensure communications from division down to company/platoon level. N-COP will allow commanders to see how bandwidth is used for mission-critical information and how network failures affect the current mission.**

Keywords—NetOPS, Network Management Tools, Tactical Radio Management, Communications Planning, Combat Communications, Dynamic Communications Planning Ttool

I. INTRODUCTION

In the U.S. Army, "If you're not communicating, you're camping." [2] The Space and Terrestrial Communications Directorate (S&TCD), Communications-Electronics Rsearch, Development and Engineering Center (CERDEC) is working on a revolutionary solution called the S-6 Associate that will dramatically improve the S-6's ability to quickly and accurately configure and manage the Warfighter network and information systems. The S-6 Associate is currently a TRL 5 demonstration system[1] and is slated for evaluation in exercises during FY 2014. Given all of the S-6 responsibilities outlined in FM 6-02.43, there are three critical problems the S-6 Associate will address in support of the communication function.

1. *S-6 Network Operations (NetOPS) task assistance.* Of particular importance is the S-6 task for development of a network design to support the initial operations plan and the dynamic replanning of network resources as events unfold. The S-6 Associate will integrate tools supporting network management, spectrum management, information dissemination management, and information assurance.

2. *Integration of stovepiped processes*. Currently the S-6 is hampered by stovepiped processes that drive the S-6 to use a large number of different tools to manage the network, stressing the S-6 span of control. Current network components are initialized in different ways using different tools and are manually intensive to manage. Choosing the right tool is critical in detecting network problems before they impact the operations plan.

3. *Command staff coordination.* The S-6 has little time to coordinate with the staff, especially the S-3 and S-2. Alerting the S-3 and S-2 when the network is unable to support the evolving operation is critical. The S-6 Associate will assist the S-6 by allowing the creation of template "plays," which are coherent sets of network choices which put the network into mission-specific states.

II. THE S-6 ASSOCIATE VISION FOR COMMUNICATIONS ON THE MOVE

Providing robust, adaptable network communications down to the company is increasingly complex and increasingly vital. This challenge is not simply a unit S-6 issue. For current missions, synchronization of the network with the mission and intelligence, surveillance

[1] TRL = Technology Readiness Level. See http://www.hq.nasa.gov/office/codeq/trl/trlchrt.pdf

reconnaissance (ISR) resources is a necessity. We will address these issues in the context of company and platoon operations, as illustrated in the following two examples.

Consider this well known "communications on the move" example. Maintaining communications during combat is a serious challenge with serious costs when communications are lost. On March 23, 2003, the 507th Maintenance Company, part of a larger force on the move, lost radio with the Battalion (BN) Headquarters (HQs) and became disoriented. After a series of wrong turns, the unit stumbled into an Iraqi Army ambush. Five vehicles in the convoy were equipped with radios, but the soldiers in the other vehicles had handheld radios whose batteries had run down. The event resulted in significant casualties, one of whom was PFC Jessica Lynch, later famous for her rescue by U.S. Special Forces.

Consider the same situation with the S-6 Associate. Imagine an environment where the most recent intelligence on enemy activity, all operations information from the publish and subscribe server (PASS), and all chat servers (up to 10 servers, 5,000 rooms) are being monitored and all this information is being fed into a knowledge base supporting operations, intelligence, fires, and signal. The knowledge base for S-6 would monitor factors that affect radio frequency communications, such as spectrum management, weather, and friendly and enemy jamming. This information is used along with the latest intelligence and operations reports from mIRC chat and the ABCS. The S-6 Associate would have understood the location of the front line trace of the lead vehicles, the rate of march of Lynch's convoy, the weather conditions affecting communications, and enemy reports. It would have provided a recommendation to the signal officer that a re-trans vehicle needed to be forwardly deployed to support the mission, hours before the convoy lost communications and was ambushed. The S-6 Associate would also have a recommendation for the best line-of-sight location and a recommendation for security of the re-trans vehicle.

III. The S-6 Associate Vision for Static Support and Stability Environment

Stability and support is a critical warfighting function. In October 2009, a U.S. Platoon outpost in Afghanistan was almost overrun by insurgents. As reported by the Associated Press, hundreds of insurgents armed with automatic rifles and rocket-propelled grenades stormed a pair of remote outposts near the Pakistan border, killing eight 8 U.S. Soldiers and capturing more than 20 Afghan security troops. The loss of communication between the platoon and company was a major contributor to the tragic event.

Now envision a world where the S-6 Associate and its counterparts, the S-2, S-3, and FSO Associates, provide contextually relevant mission support. When critical events occur, the S-6 Associate's core function is to monitor network connectivity, including communications between the platoon and company. If the situation degrades, as in October 2009, the S-6, in coordination with the S-3 and S-2, would have looked for and provided the best coalition ISR air assets to support aerial re-trans.

The S-6 Associate's key benefit in both of these scenarios is that it overlays the network over the mission, thereby enabling the S-6 to support the critical needs of units performing this mission.

IV. How Does the System Work?

A. How does the S-6 Associate know what it knows about intelligence and operations?

The S-6 Associate shares its architecture with the S-2, S-3, and FSO associates. These associates are data fusion and decision support systems tailored for particular command roles. They function as intelligent agents to monitor services like Command Post of the Future (CPOF) and PASS as well as chat. Furthermore, they alert the commander's staff to commander's critical information requirement and priority information requirement events as they occur.

Chat rooms are a critical information source. There is an enormous amount of information flowing through numerous chat rooms in a battlespace at any time. The relevance of this information is often determined too late to be useful or is missed entirely by those participating in the chat. A lightweight client was developed to monitor chat and Battle Command Services and to glean critical information more rapidly, and with greater reliability, than can be done manually. The intelligent presentation services (IPS) receive chat service monitors the chat rooms and performs natural language processing to filter chats occurring among Soldiers throughout the Area of Operation. By easing the burden of monitoring overwhelming amounts of data, the system enables the commander and his staff to make rapid decisions based on timely updates and improved situation awareness.

The S-6 Associate Expert system will build knowledge about current mission and tactical network status. This will be used by the S-6 Associate to recommend possible course of action to S-6 in when network failure is detected.

B. *System of Systems approach: How do these pieces fit?*

As shown in Figure 1, the S-6 Associate is a system of systems. It uses a number of different NetOPS tools to gather information such as linkage of IP-based radios, bandwidth restrictions, signal propagations/constraints, spectrum management data and computer network defense data. The integration point for these various tools is a component known as the Intelligent Presentation Services Data Distribution System (DDS).

IPS is a service-oriented architecture services and user interfaces (UIs) publish and subscribe to topics of relevance to the functionality each service provides. IPS supports rapid application development and integration via code generation based on Extensible Markup Language (XML) schemas. Service developers implement XML data contracts using IPS schemas and use the IPS code generator to generate a proxy that enables their service to communicate through the DDS layer to other services. IPS uses data topic subscription and publication through its DDS and integrates all UIs and data sources as services.

Code generation abstracts the details of the DDS application program interface (API). This enables the developer or integrator to focus on his service's functionality without concern for the destination of his data or the source of his subscribed data. The IPS code generator produces a consistent interface for all services to use in communicating through the DDS. It enables decision aids to monitor data flows in the DDS without extra hops or pass-throughs, and ensures type-safe, consistent communication among services. By focusing the programming details of the DDS API in generated proxies, IPS narrows the debugging of communications to a single point. A single change can be made to the code generator, and the proxies regenerated, as opposed to changing communication code in multiple services.

V. Current Work

A properly implemented associate system will *not replace* people but rather help them manage complex tasks more effectively. In many cases, the best way to help users is to help them perform tedious and time-consuming tasks—the kinds of tasks that can overwhelm even the most skilled S-6 officer. The current S-6 development effort focuses on two particular problems.

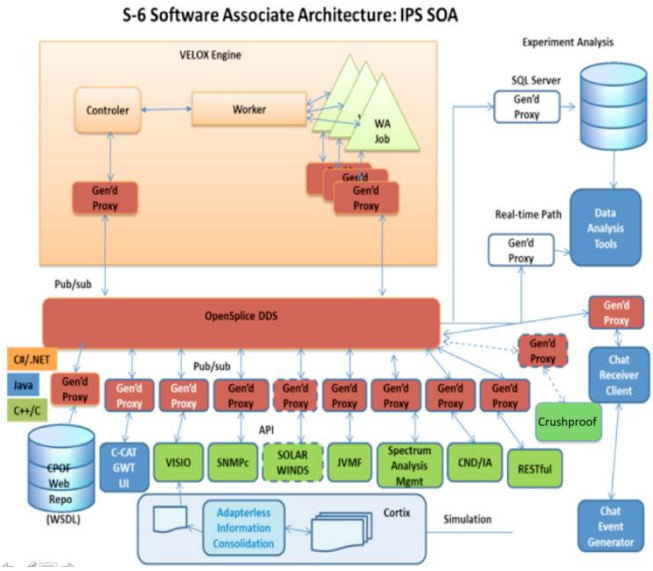

Figure 1. System Architecture for the S-6 Associate System

First, the system helps the S-6 staff configure and initialize a unit's network. Higher echelons typically dictate the configuration for a unit's network—i.e., the IP addresses to be used, spectrum allocation, and so on. The process today is tedious and error-prone. Using a text file, the S-6 creates a Visio diagram—a picture—of the network. Once the Visio representation is accurate, the S-6 then can use several different network management tools to *manually* initialize the network's components—i.e., to set device IP's, specify radio spectrums, and so on.

Secondly, the system being developed integrates data from a number of different NetOPS tools, so that the S-6 staff can see *in one place* everything relevant to managing the tactical network.

A. *The Visio Plug-in for Network Planning and Configuration*

Veloxiti has developed automated methods for drawing the layout of a unit's network and entering configuration data for different NetOPS tools. The starting point for this process is a text file formatted using the lightweight directory access protocol database interchange format (LDIF). This text file, which is typically provided by a unit's higher echelon, contains IP addresses, domain names, unit reference numbers, and role names. This LDIF data is supplemented by network configuration and connectivity data to form a single data source coined "LDIF Plus." Using the LDIF Plus data, the S6 network planner automatically generates a full network diagram in Visio. An example of the generated

network diagram can be seen in Figure 2. This diagram can be edited/updated by a user.

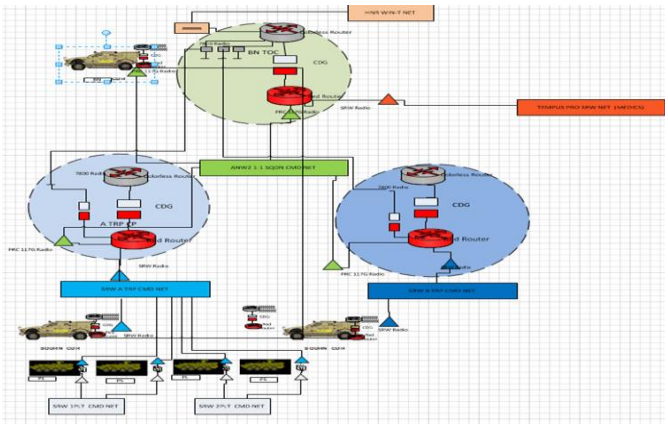

Figure 2: The Visio Interface Tab for the S-6 Associate Network Planning Application

Having a Visio diagram is only the first step in network initialization. Once satisfied with the network as portrayed in Visio, the S-6 can publish the network specification to the IPS. This published network specification can be used for automatically initializing the various devices and network management tools used by the units.

The S-6 Associate thus eliminates two tedious and error-prone tasks. First, the signaling staff doesn't need to manually create a Visio network diagram. Second, the staff doesn't need to manually configure their network management tools. The efficiencies gained from eliminating these two tasks are significant.

B. Network Tool Integration

S-6 staff members use a variety of different NetOPS tools for tactical network configuration and management. The Simple Network Management Protocol (SNMPc) application, is one of the most commonly used tools.

The SNMPc network manager is a network management system that provides real-time monitoring using the SNMP v1, v2c, and secure SNMP v3 protocols for networks of any size. The SNMPc network proxy subscribes to the network plan published by the S6 network planner via IPS. It automatically populates the SNMPc network map, thereby making it unnecessary for the S-6 to manually configure SNMPc. This automation saves a significant amount of time.

SNMPc provides several kinds of data. First, it generates alerts ("traps") when network failures occur. For example, SNMPc can detect when a device goes off-line. In addition, SNMPc provides network flow data that can be used for determining which links in a network are being under- or over-utilized. The SNMPc IPS proxy publishes all of these data to the DDS bus where any IPS service may subscribe to them.

C. Position-Location Information (PLI) and the Joint Variable Message Format (JVMF) Interface

The system's JVMF proxy listens on a multicast socket for tactical radio PLI data. These data are published to IPS, and the S-6 Associate builds an N-COP terrain map picture, which integrates position information for BN Command Post (CP), CO CP, vehicles, and all other nodes in the tactical network.

D. The N-COP User Interface

Commanders have long understood the value of a common operating picture. The N-COP is the S-6 staff's COP. As shown in Figure 3, the N-COP is, in part, a geographical display of the network's status. It provides an integrated view of device status and network connectivity with a geographic focus. It also includes drill-down tabs (not shown in Figure 3) that allow the S-6 to explore the network's condition in detail. The S-6 Associate system will enable BN S-6 and commanding staff to visualize the functioning of the network in the support of ongoing missions.

The N-COP's geographical view is important because it enables the integration of data across staff roles, including data about the network and mission data from systems such as CPOF. As would be expected, the S-6 staff's view of the world is tactical network centric. Also as would be expected, the S-2, S-3, and FSO associates provide COP's tailored for their specific staff roles. *Military events* are the "glue" that ties these views together. When a significant event occurs—a downed aircraft, perhaps—the S-6, S-2, S-3, and FSO associates all receive event alerts that are tailored to specific roles. The N-COP is configured today to display critical battlefield events on the map so that the S-6 staff can take whatever steps necessary for ensuring our troops can communicate when responding to the event. Future releases of the S-6 system will incorporate network domain knowledge designed to help the staff resolve network and communications problems.

The S-6 Associate (graphical user interface) GUI is a Web application that may be viewed in any web browser or hosted in a framework such as the Army's Battle Command (BC) Web. The S-6 Associate GUI is intended to be accessed by a warfighter's personal platform, such as a PC, laptop, or handheld device. The server-side

process of the S-6 Associate GUI lies on the IPS bus as well and is able to publish and subscribe to any of the messages in the IPS.

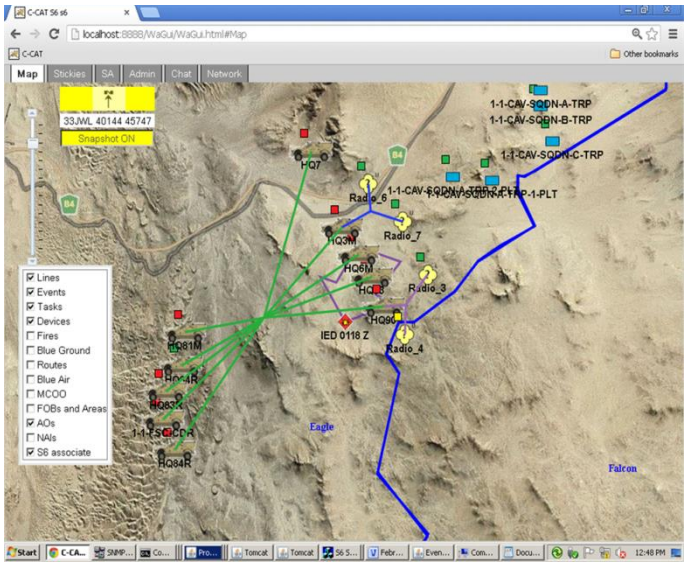

Figure 3: The User Interface with real time network monitor during combat operations

Currently, the S-6 Associate GUI subscribes to planned networks from the S-6 network planner, network device status messages from the SNMPc IPS proxy, and PLI data from JVFM messages. This data is overlaid on the COP in the S-6 Associate GUI to give a real-time network status view as seen in Figure 3.

The S-6 Associate reduces a Soldier's cognitive workload by filtering less critical data and by prompting the Soldier with critical updates, alerts, and recommendations tailored to his role and situation. The S-6 Associate puts MIL-STD-2525b symbol icons on the map, pans and zooms to new events, populates alerts in a table, provides recommendations, and prompts the soldier with other critical updates in a fraction of the time it would take the Soldier to glean the same information manually from disparate sources.

IV. ONGOING AND FUTURE WORK

The current S-6 system is a first step. Future work will most certainly include integration of the S-6 Associate with other network management tools. For example, Veloxiti has performed the initial technical work required for integrating SAM, a spectrum management application developed by the Antennas and Spectrum Analysis Division of S&TCD . SAM can forecast radio frequency propagation loss over irregular terrain and seawater for ground-based and air-borne radio transmitters and receivers. Integration with SNMPc Online will allow the S-6 Associate to collect network flow data provide by the router in the CP and vehicles and collected by SNMPc Online using IPFIX, Internet Protocol Flow Information Export protocol. This data will be associated with links on the N-COP display.

To support system test and evaluation, the current system has also been integrated with a component known as the data analysis tool (DAT). The DAT can connect to and monitor multiple running associates. It can also run in recall mode, where the analyst may select associates from a past "run" and analyze their behaviors as stored in the DAT's log database.

IV. CONCLUSIONS

This technology is a game changer in the world of communications management and NetOPS. Since the signal corps has had balloons, the commander has always asked the S-6, "Why can't I communicate?" The signal officer has always been reactive to the Commander's demands because it has always been too difficult to understand what was happening on the battle in the operations and intelligence functions. It has been only recently, with the power of computers and the software that runs them, that the signal officer can be on par or ahead of operations and intelligence counterparts in the management of the network operations to support tactical operations from squad level all the way up to Corps level.

The S-6 Associate is a powerful combat multiplier. It enables a unit commander to understand network status in the context of the unit's mission. Computer horsepower, intelligent middleware, and a dwindling DOD budget have converged at a point in time favorable for deployment of intelligent systems, such as the S-6 Associate, in the near future.

ACKNOWLEDGMENT

This research is being supported and sponsored by the Network Operation Branch, S&TCD, CERDEC, U.S. Army.

REFERENCES

[1] 2011-12' Battle Command Essential Capabilities for US Army PM-Mission Command April 2010 COL David Moore

[2] GEN JD Thurman quote, Commanding General National Traing Center Fort Irwin 2001 during unit AAR.