Commercial Technology Will Quickly and Dramatically Upgrade Vital Blue Force Tracking Network

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One of the first military communication systems to realize the promise of network-centric operations is the Blue Force Tracking (BFT) global messaging system. The situational awareness gained from the Force XXI Battle Command Brigade and Below − Blue Force Tracking (FBCB2-BFT) includes a clear digital view of the battlefield with the geographic location of individual soldiers, weapons, command posts, vehicles, and operational facilities. The system also provides for the delivery of messages and other types of information to ground vehicles including tanks, armored personnel carriers, and infantry fighting vehicles, as well as U.S. Army rotary wing aircraft. Numerous stories from the battlefields of Iraq and Afghanistan recount how moving units were able to identify friendly forces that they at first thought might be enemy threats, saving lives each time.

Now the satellite industry is at work developing a BFT system upgrade that will increase the accuracy and capacity of this vital network, and stretch its capabilities out to the farthest edge of tactical operations. The goal is to make it faster and easier to send and receive the short, instant messages that update the digital battlefield view.

The system approach is based on spread spectrum technology which can dramatically reduce latency and increase the number of simultaneous users in high density operational environments.

The introduction of a proven commercial satellite technology will accelerate the system upgrade and quickly get the capability into the hands of the warfighter. This paper describes the technologies being used for the upgrade and the system level improvements that will result. The high density waveform is expected to increase simultaneous return links from four to 30, cut round-trip latency from minutes to less than two seconds, and boost messages per minute from a maximum of 600 to 5000.

I. Introduction

One of the first military communication systems to realize the promise of network-centric operations is the Blue Force Tracking (BFT) global messaging system. The situational awareness gained from the Force XXI Battle Command Brigade and Below − Blue Force Tracking (FBCB2- BFT) includes a clear digital view of the battlefield with the geographic location of individual soldiers, weapons, command posts, vehicles, and operational facilities. The system also delivers messages and other types of information to ground vehicles including tanks, armored personnel carriers, and infantry fighting vehicles, as well as U.S. Army rotary wing aircraft. Numerous stories from the battlefields of Iraq and Afghanistan recount how moving units were able to identify friendly forces that they at first thought might be enemy threats, saving lives each time.

The ubiquity of BFT provided the impetus to upgrade and improve the BFT for the warfighter to meet a very aggressive prototype schedule. This included the requirement to use commercial off the shelf (COTS) technologies when feasible. The result is a program for upgrade and improvement which meets an aggressive schedule and achieves all objectives of the FBCB2-BFT program. Figure 1 shows the system architecture for the FBCB2-BFT Network using SATCOM. In particular, the figure highlights in blue the proven COTS products and technologies for upgrades to the BFT.

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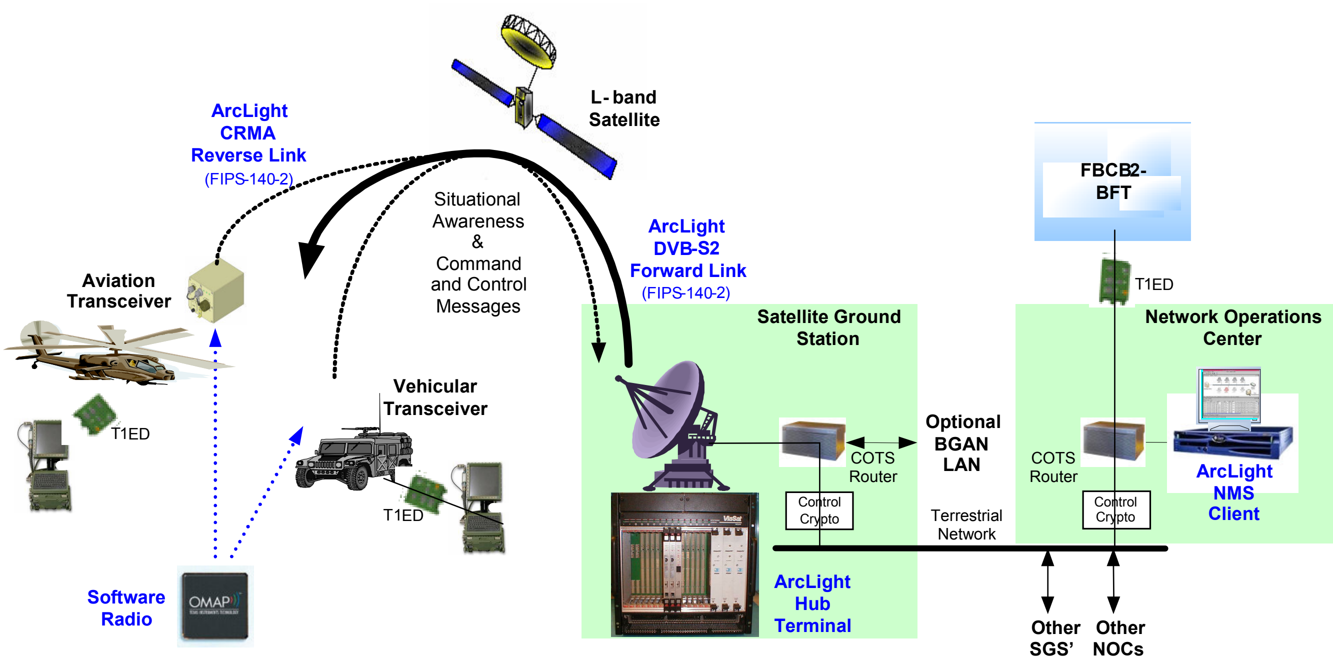

Figure 1: The FBCB2-BFT Satellite Network Upgrade System Architecture leverages existing technology

The remainder of this paper will focus on the COTS technologies that are key to the projected improvements to the BFT:

- Section II – Context for the technologies in terms of the system level improvements base on upgrades to the BFT system
- Section III – Discussion of several of the major technologies for the BFT system
- Section IV – Shows a prototype transceiver based on the COTS technologies
- Section V – Programmatic view of the BFT improvement program

II. Blue Force Tracking (BFT) Satellite Network Improvements

To satisfy the requirements, both threshold and objective, the BFT Satellite Network will be upgraded to achieve one to two magnitude improvement over the current BFT system. In general, the upgraded BFT Satellite Network will achieve FBCB2-BFT goals of a high-capacity, low-latency, secure situational awareness, and command and control data delivery service through rugged, low-cost remote transceivers. In addition, the system will have significant potential for future growth.

In particular, the system approach is based on spread spectrum technology to reduce latency and increase the number of simultaneous users in high density operational environments. Table 1 shows the operational performance improvements as designed for the upgraded BFT Satellite Network.

	Current SATCOM	Upgraded System
Forward Link	**2.637 kbps (50% duty cycle)**	**Up to 256 kbps (100% duty cycle)**
Reverse Link	**2.637 kbps**	**3.0 kbps**
Number of Reverse Link Simultaneous Transmissions (Max)	**~4**	**~30**
Round Trip Link Latency	**Up to 5 to 10 min**	**< 2 sec**
Number of 100 byte messages/minute on 1 satellite channel in reverse link	**600 Max**	**>5,000**
IP Routable	**No**	**Yes**
Full Duplex	**No**	**Yes**
Meets Environmental Requirements	**No**	**Yes**

Table 1. Performance Improvements of the Upgraded BFT Satellite Network

In addition, the upgraded BFT will have incorporate link layer encryption certifiable to FIPS 140-2, Level 2.

III. Specific Technologies for BFT

To achieve the improvements under an aggressive schedule as described above, we have leveraged a number of COTS products and technologies. These include:

- DVB-S2 standard for a high performance waveform
- Open Multimedia Application Platform (OMAP)
- FIPS 140-2 Security Architecture
- L-Band RF Technology
- Spread Spectrum (ArcLight®) Waveform

ArcLight. The cornerstone technology for the BFT upgrade is the high performance ArcLight VSAT Network and Waveform, which has been successfully used in communications-on-the-move systems for land vehicles, ships, and aircraft, fixed wing, and rotary wing. The Forward Link is based on the second generation Digital Video Broadcast (DVB-S2) over Satellite standard waveform to support Internet Protocol packet delivery over a satellite. The Reverse Link is based on ViaSat Code-Reuse Multiple Access (CRMA), which is designed as a fully random-access system, but doesn't suffer from the inefficiencies of TDMA-based random access.

CRMA overcomes the need of TDMA systems to pre-assign transmit time slots of valuable satellite resources to each transceiver, regardless of whether they need the assignment. When scheduler inefficiencies are considered, the theoretical throughput of TDMA is critically impacted such that CRMA outperforms TDMA whenever there are a large number of users with dynamic traffic needs. Figure 2 illustrates a trade-off when traffic may be "unpredictable". In a typical FBCB2-BFT application, the traffic is likely to be skewed toward the unpredictable end of the scale, given that a high percentage of terminals will be moving and their transmission needs will be difficult to predict. Moreover, CRMA doesn't incur a slot re-assignment time penalty as experienced by TDMA systems.

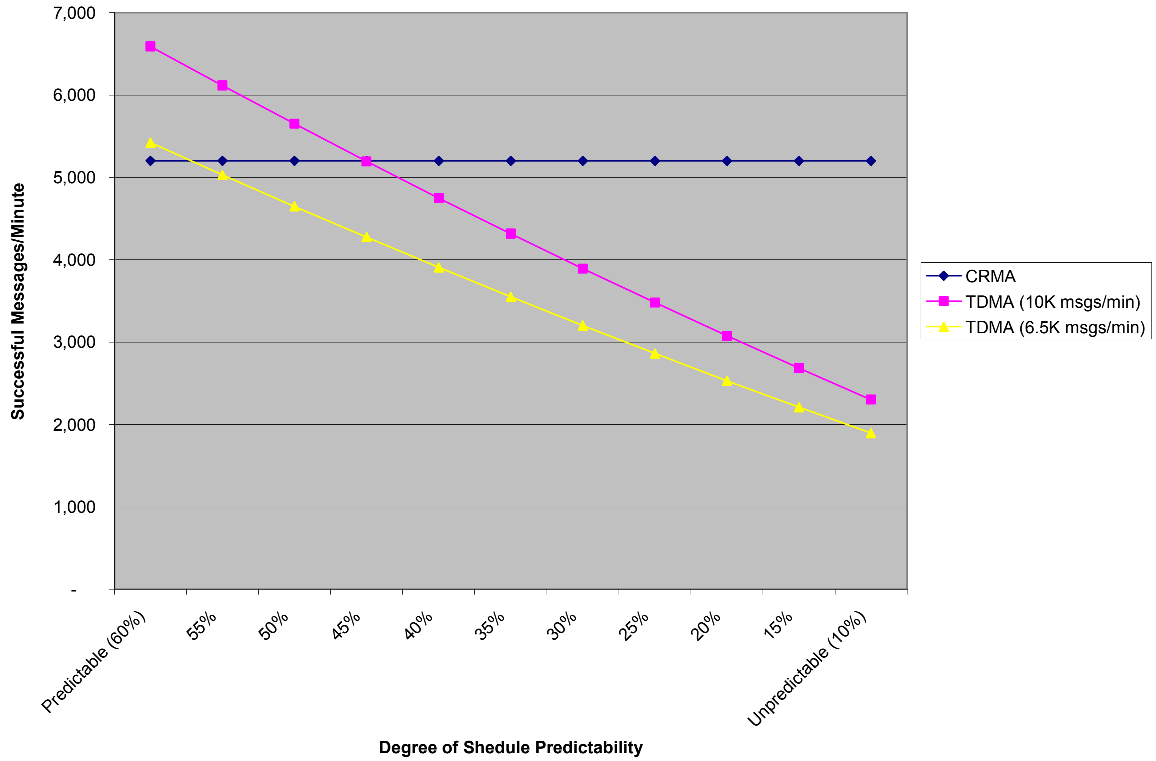

Figure 2. CRMA Performance (>5000 message/minute) unaffected by Unpredictability vs TDMA

Software Programmable Components. The Hub, Network Operations Center and Network Management System are derived from the commercial ArcLight VSAT System, used for both fixed and mobile applications. These components can be programmed to accommodate different channel bandwidths of different L-band satellite systems. Furthermore, the transceivers support software download of new waveforms such as BGAN-X. Recently, INMARSAT announced the air interface for BGAN-X "sparse mode" will be based on the GMR-2 air interface. This air interface will accommodate the significant gain increase afforded by the new BFT antenna assembly and will be easily incorporated by a software download to the transceiver hardware.

Low-cost Transceiver Designed for the Warfighter. The Vehicular and Aviation transceivers are based on a Texas Instrument's OMAP, which is used in commercial cell phones. Other transceiver elements provide the same level of high performance, while ensuring the overall cost is kept to a minimum. Moreover, the new COTS-based system, shown in Figure 1, provides the lowest risk path to integration of the BFT transceiver and T1ED. It also provides a growth path for the integration of the transceiver with Type 1 Encryption for space-constrained applications including the extension of BFT to dismounted soldiers.

IV. Prototype Receiver

The requirement for the BFT upgrade is to accommodate operation between 70°N Latitude and 70°S Latitude on satellites that range in performance from Inmarsat-4 to Inmarsat-3. The BFT upgrade uses the same electronically-steered antenna for both the aviation platform and vehicular transceiver. Both aviation and vehicular transceivers meet revised HRS requirements with the new antenna, and meet performance requirements at low elevation angles on Inmarsat-3. The height of the vehicular transceiver with radome and base is approximately 4.5 inches. The vehicular transceiver is designed to fit in the current FBCB2-BFT footprint. Figure 3 shows a rendering of the complete transceiver.

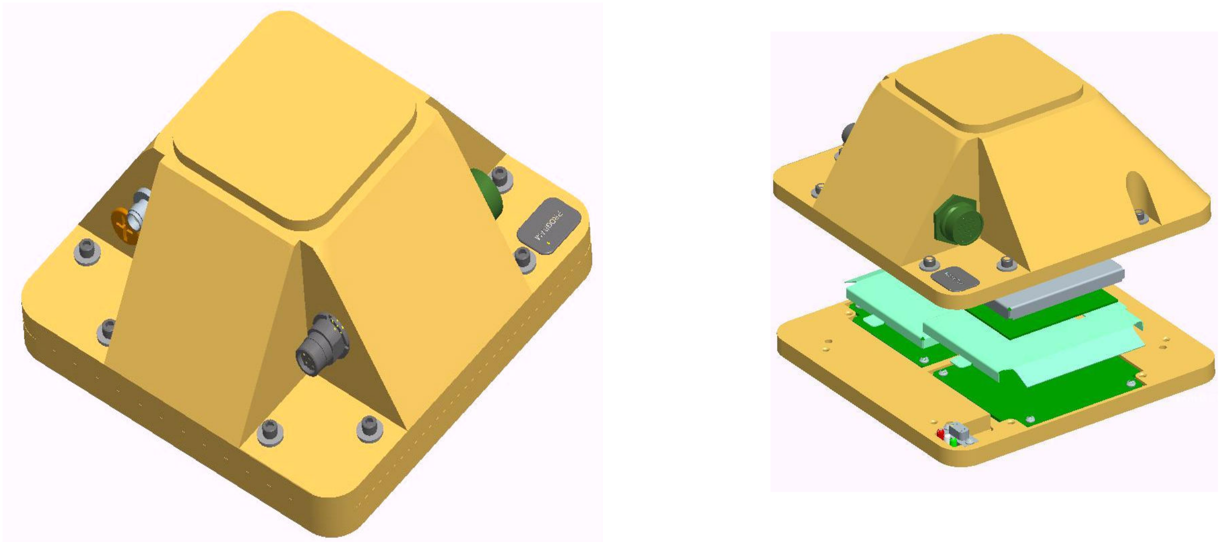

Figure 3. Ground Transceiver Form Factor (with Radome) and Exploded View

V. BFT Program Schedule

ViaSat, Inc. has been selected by Northrop Grumman and the U.S. Army for the FBCB2-BFT Satellite Network Upgrade Program. Northrop is the FBCB2 System Integrating Contractor. The contract, signed in March 2007, includes a 52 week period of performance to produce prototype transceivers, ground station equipment, and a NOC. The production and fielding plan is for 100,000 units.

In summary, the new COTS-based FBCB2-BFT upgrade program will provide a high performance satellite network system meeting the cost, schedule and technical requirements of the U.S. Army. The foundation of the approach leverages existing commercial technologies and system components, and links them with a common architecture and design.