ARMY'S USE OF SATELLITE COMMUNICATIONS IN SUPPORT OF FORCE XXI

BY

PAUL CHERNEK

SEMINAR 16

STUDENT #17

LESSON A-20

RESEARCH PROJECT

ARMY’S USE OF SATELLITE COMMUNICATIONS IN SUPPORT OF FORCE XXI

OUTLINE

PURPOSE

REFERENCES

BACKGROUND

OPERATIONAL OVERVIEW

PRE-DEPLOYMENT PHASE

EN-ROUTE PHASE

EARLY/FORCED ENTRY PHASE

FORCE BUILD UP TO A FULLY MATURE THEATER OF OPERATIONS

- SINGLE CHANNEL SATCOM OPERATIONS
- MULTI-CHANNEL SATCOM OPERATIONS
- SATCOM ACCESS, PLANNING, AND CONTROL

CONCLUSION

APPENDICES

ARMY'S USE OF SATELLITE COMMUNICATIONS IN SUPPORT OF FORCE XXI

PURPOSE

The purpose of this research paper is to provide high level insight into the Army's operational use of Satellite Communications (SATCOM) in support of Force XXI. It is intended as a supplement to the Advanced Military Satellite Communications (MILSATCOM) Capstone Requirements Document (CRD). This paper provides necessary operational information to support the documented Army requirements for future SATCOM, in upcoming requirements versus performance versus cost trade-off analyses, as the DoD pursues the next generation SATCOM systems.

REFERENCES

The references used in preparation of this paper are listed in Appendix A. Additionally, information provided in various face to face discussions with Army users over the past two years also contributed to the preparation of this paper.

BACKGROUND

A SATCOM system is comprised of three principle segments: space, control, and user. The space segment includes the satellite or spacecraft with its various support and payload systems. The payload in the case of SATCOM systems is the communications subsystem. There are three aspects to the control segment: spacecraft control, payload control, and network control. The user segment consists of air, sea, and land based terminals which access and utilize the space segment.

The Department of Defense (DoD) has a continuing requirement for satellite communications (SATCOM) systems to satisfy its information transfer needs. The DoD currently employs a "system of systems" architecture with systems providing service in the military frequency bands of UHF (200-400 Mhz, 1.2 - 1.3 Ghz, 1.5 - 1.6 Ghz), SHF (7- 8.5 Ghz), and EHF (43 - 45 Ghz uplink; 20.2 - 21.2 Ghz downlink). Each frequency band has unique properties and offers different advantages/capabilities (see figure 1 for SATCOM systems currently used to support DoD). The Global Positioning System (GPS) depicted in figure 1, however, is a special system that provides a positioning, navigation and timing capability. Because of the unique requirements and operational use of GPS, a separate, in-depth discussion is truly required to adequately address the system use. Therefore, GPS will not be addressed further in this paper. The combination of all frequency bands provides a robust, complementary service. However, even with these military systems, today's requirements exceed current military capabilities and thus, the DoD augments these systems with services provided by the commercial sector. These systems operate in the UHF L-band (1.61 to 1.62 Ghz), and S-band (2.4-2.5 Ghz), and SHF C-band (4-6 Ghz), Ku-band (12-14 Ghz), K-band (17.3-20.2 Ghz) and Ka-band (27.5-30 Ghz). Use of commercial systems, however, are subject to host nation approval and landing rights issues. Leasing of commercial SATCOM overseas can be very expensive (up to 10 times the rate for a similar service provided in the U.S.). Also, international agreements may preclude the use of international satellites for military actions. The bottom line is it takes a proper mix of military and commercial satellite systems to fully meet the needs of the DoD.

The current DoD military owned and operated SATCOM systems have finite lives. Within the next ten years, these systems will require replenishment. More importantly, the current systems do not possess the requisite capabilities to support the information demands of the future warfighting environment. Recent studies and analyses, in reaffirming the twin pressures of growing warfighter information demands, both in the near and far term, and the degradation of legacy SATCOM systems, have begun the process to recommend and select a follow-on architecture that balances satisfaction of user needs against programmatic, funding, and technological constraints.

Beginning in mid 1994, DoD conducted a two-phased study to identify user requirements and examine alternative approaches to meet these demands for the post-2005 timeframe. The results of these preliminary analyses made several recommendations regarding specific system-level tradeoffs and provided a starting point for future, in-depth system design tradeoffs and studies.

As a continuation of this process, the DoD Space Architect (DoDSA) initiated a study in December 1995 with the support of the entire DoD SATCOM community to address the need for a detailed follow-on space-based communications architecture. In a concurrent effort, the Air Force Space and Missile Systems Command (AF/SMC) initiated a Program Research and Development Activity (PRDA) with representatives of the commercial SATCOM community to identify innovative, cost-effective and mission-effective means of employing commercial SATCOM systems and services for support of current and future DoD operations.

These studies culminated with a briefing to the Joint Space Management Board (JSMB) on August 29, 1996, to review the conclusions of the DoDSA's study. The Space Architect recommended and the Deputy Under Secretary of Defense, Space (DUSD-Space) endorsed a set of objectives and transition goals, and a transition strategy leading to a future MILSATCOM architecture that would significantly enhance support to the warfighter, well beyond the planned capabilities. This new architecture would be achieved in an incremental fashion over the next 20 years to ensure uninterrupted support to operations, while aggressively pursuing enhanced future support.

The JSMB approved these objectives, goals and strategy, in concept, with the understanding that long-term resource decisions would be predicated upon a requirements versus cost analysis. The JSMB directed DUSD-Space, in conjunction with the Joint Staff, the Services, and the Defense Agencies, to develop an organizational structure that would further define the selected architecture and develop an affordable roadmap to guide the Department's transition towards that future goal. That affordable architecture must consider both space and terrestrial system trades for end-to-end communications infrastructure.

The objective of this effort is determine, in a holistic manner for all of the DoD's satellite communications needs, the "right mix" of DoD-owned systems and leased commercial market services that does the best job of meeting our current and future requirements. This effort is geared for completion in time to affect the 99 Adjusted Program Objective Memorandum (APOM) and the 00 POM.

In January 97, the Joint Requirements Oversight Council (JROC) endorsed the DUSD-Space's plan to determine the "right mix" and develop a "transition road-map". USSPACECOM has the requirements "piece" of that work and therefore a major role in determining the "right mix". In today's cost constrained environment, tough trade-offs must be made between costs, capabilities, and satisfied requirements. The final recommendations should therefore be accomplished by senior warfighters who understand the operational implications of such trades and can participate in a direct dialogue with the acquisition community. To that end, USSPACECOM has been chartered by the JROC to convene a series of "Senior Warfighters' Forums". USSPACECOM, together with the Joint Staff, Services, and DoD Agencies participation, will capture the resultant "right mix" and affordable (threshold) requirements they support in a revised Advanced MILSATCOM Capstone Requirements Document (CRD) for JROC validation in August 1997. DUSD-Space will then take the overall "road map", covering the next twenty years, to the JSMB in January 1998.

The Advanced MILSATCOM CRD contains high level operation requirements and describes the totality of the DoD's SATCOM requirements in a summary format. The detailed data used to feed the CRD is contained in a Defense Information Systems Agency (DISA) data base, developed as the result of Commanders-in-Chief's (CINC's), Services', and Agencies' forecasts of future requirements, called the "Emerging Requirements Data Base (ERDB)." The

ERDB captures detailed satellite terminal data rate throughput estimates and link or network connectivities.

The detailed operational use concept for each of the CINCs, Services, and Agencies is not reflected in either the CRD or ERDB. As stated above, an understanding of the operational implications of the trades to be conducted is essential to determining the “right mix”. This paper, therefore, serves as a supplement to the Advanced MILSATCOM CRD and is intended to provide to those who will be further detailing the architecture, and those performing the trade-off analyses, the information with respect to the Army’s operational use of SATCOM to support the future Army Force XXI. The intent of this paper is to provide a single, consolidated document describing the Army’s use of SATCOM. It by no means encompasses the totality of all envisioned operational deployments/missions/scenarios. Rather, it highlights the more stressful operational deployments scenarios that would drive the architecture design. For additional detailed information, it is recommended that the reader consult the referenced documents.

OPERATIONAL OVERVIEW

The National Security Strategy (NSS) of Engagement and Enlargement promotes enhancing our security by maintaining a strong defensive capability, promotes cooperative security measures, works to open foreign markets and spur global economic growth, and promotes democracy abroad. The NSS is founded on deterrence and the capability to project power to safeguard our national security interests and objectives. Military force remains an indispensable element of our nation’s power in support of the NSS.

Overseas presence and power projection are critical elements of the National Military Strategy (NMS), which is derived from the NSS. Key to the execution of this strategy is a flexible, capable and secure communications capability which can rapidly support the command and control requirements of highly mobile, dispersed, joint, U.S. forces around the world. Meeting global commitments, with a military force that continues to downsize, hinges on our ability to provide warfighting CINCs with a real time, accurate picture of the battlespace, high technology weapons to enhance the lethality of a smaller force, the ability to rapidly project and sustain deployed forces, and an integrated, ubiquitous command and control capability to ensure synchronization of combat power. SATCOM will continue to play a significant role in all future operations in support of the NMS.

The future operational concepts, articulated in Joint Vision 2010 and fully embraced by the Army leadership, describe how our forces will dominate the full range of military operations from humanitarian assistance, through peace operations, up to and through the highest level intensity conflict. These future operational concepts include the following:

Dominant Maneuver: the multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint, air, land, sea, and space forces to accomplish the assigned tasks.

Precision Engagement: a system of systems that enables our forces to locate the objective or target, provide responsive C2, generate the desired effect, assess our level of success and retain flexibility to re-engage with precision when required - even from extended ranges.

Full Dimensional Protection: the control of the battlespace to ensure our forces can maintain freedom of action during deployment, maneuver and engagement, while providing multi-layered defenses of our forces and facilities at all levels - again, across the full battlespace.

Focused logistics is the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while en-route, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations. It will be fully adaptive to the needs of our increasingly dispersed and mobile forces....

SATCOM will be the means of transporting critical information, over extended ranges, to our mobile forces within Theater and will enable our mobile forces to reachback to the sustaining base, thus, allowing the Army to fulfill our power project mission.

SATCOM systems must support every phase of our future operations to include mobilization, deployment, initial combat, sustained operations, the transition to peace, and re-constitution. To be truly responsive to the warfighter SATCOM systems must provide global coverage, must allow rapid deployability and improved mobility on the battlefield. The systems must be flexible, survivable, and highly capable of meeting warfighter information and operational demands. Rapid access to information gives our forces in the field greater situational awareness -- a decisive advantage which results in more effective combat operations and fewer friendly losses. Sustaining the responsive, high quality data processing and information needed for joint military operations will require more than just an edge over an adversary. We must have information superiority: the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same. This is a fundamental SATCOM requirement for Army operations, i.e., SATCOM support must be available on-demand, for the duration of a mission, and once given to the warfighter, it must not be taken away or denied ("uninterrupted flow of information").

So how will the Army use SATCOM in it's future operations. Desert Shield/Desert Storm and operations such as Restore Hope, Uphold Democracy, Joint Endeavor, and others, demonstrated that SATCOM is vital when deploying far from the sustaining base to areas of the world where there is little or no communications support infrastructure. Figure 2 provides a diagram of the various uses of SATCOM throughout all phases of operations. This is a high level view showing that a variety of SATCOM systems are necessary to meet the full range of Army operations; from pre-deployment from power projection platforms; while forces are en-route to an objective area; to build up of forces in an objective area; to a full up deployment in a theater of operations; and lastly, to transition to peace and re-constitution. SATCOM will enable our forces to communicate over extended ranges such as the Long Range Surveillance Units (LRSUs) of the standard forces as well as those units of the Army Special Operational Forces (SOF). SATCOM will provide the range extension necessary between command posts, tactical operation centers (TOCs), tactical activity centers (TACs), and other support and operation centers of the various battlefield functional proponents (Intelligence, Logistics, Medical, etc.) across all echelons. SATCOM will also enable our forces to reachback to the sustaining base through Standard Tactical Entry Points (STEP), thus, allowing the bulk of the non-combat support infrastructure to remain behind -- freeing up vital transportation assets -- enabling our forces to execute our power projection mission. STEP sites offer a set of prepositioned equipment, resources, and services to allow the tactical forces to gain access to the Defense Information Systems Network (DISN), which ties together the power projection platforms of the sustaining base.

What follows are additional details describing the operational concepts for the use of SATCOM in support of Army missions. It also discusses in operational terms the characteristics required of these systems. It is impossible to address all the operations that one could potentially envision. Rather, this paper addresses those operations that significantly stress our SATCOM systems and cover the majority of Army uses for SATCOM. This paper is also written to provide information at an unclassified level in an attempt to allow maximum distribution for all who have a need to know. The level of detail provided reflects that which is unclassified.

PRE-DEPLOYMENT PHASE

Army operations will not be conducted in isolation. Army units will be a part of a Joint Task Force (JTF) and must fully coordinate all aspects of the operations with the JTF commander as well as throughout the other services (so too other nations if part of a coalition). For an emergency reaction operations, a contingency (forced entry) unit has to be prepared within 4 to 18 hours, from receipt of a no-notice Joint Staff execution order, to deploy the prescribed task force to any location worldwide. Operations planning requires the establishment of communications with the JTF commander, Army Corps/Division command elements, Air Force transport aircraft, National and in theater intelligence elements, Air Force, Navy, Coast Guard commanders, Corps/Division marshaling area, Personnel holding area, Corps/Division planning cells, to name a few. This is, and will continue to be, accomplished with the terrestrial communications infrastructure, supplemented with SATCOM.

EN-ROUTE PHASE

For an Airborne forced entry scenario, the vast majority of the task force and command group will deploy by Air Force aircraft. The key to command and control for the Corps/Division commander, while en-route to the objective area is his/her ability to communicate with various command elements for current situation and intelligence reports as well as mission changes/updates. These elements would include the JTF Commander, AWACS/Reconnaissance aircraft, National CONUS based intelligence systems, the Division Ready Force commanders, Air, Marine, and Naval force commanders, coalition commanders, and objective area, advanced ground intelligence “eyes on target” forces (see figure 3). In a highly volatile scenario, coordinated pre-emptive strikes against enemy targets, led by the Air Force or Navy may be necessary. Real time battle damage assessment (BDA) of the initial strikes would provide critical information to the en-route forces prior to their execution of the forced entry phase.

Today, due to the mature technology and low cost of implementation, single channel UHF SATCOM provides the primary links between the en-route platforms and the various elements. This in many scenarios involves linkage between multiple satellite coverage areas simultaneously, i.e., deploying to areas not covered by CONUS satellites. Typical UHF single channel terminals utilized today include the AN/PSC-3, MST-20, LST-5, HST-4, as well as a host of other UHF terminals.

The secure (encrypted communications) en-route communications package (SECOMP) is a signal, JTF/Corps, Division brigade asset used today to support the corps commander, his subordinate commander and principle staff during airborne deployment and during air assault operations. This system comprises an Army single channel UHF SATCOM radio connected to a hatch mount antenna, an Army line-of-sight FM radio, an Air Force aircraft HF radio, COMSEC and radio control equipment, and computer equipment hosting a variety of command and control and intelligence applications. The SECOMP Improved (SECOMP-I) is being pursued for Force

XXI to provide additional communications and computer capabilities and will support up to three simultaneous SATCOM links for voice/data command and control and intelligence networks.

Current single channel UHF SATCOM is secure, but, primarily low data rate, i.e., 16 kilo-bits per second (Kbps) or less. Although UHF SATCOM systems offer benefits in the areas of the ability to network with multiple users, the ease of communicating while en-route, and the ability communicate through some foliage, UHF SATCOM today is over subscribed. SATCOM terminals for ground forces must also be lightweight, easy to operate, and allow for quick set-up and tear-down times. The Army is pursuing the next generation UHF SATCOM terminal called the SPITFIRE. It improves upon today's systems by providing an embedded communications security (COMSEC) capability (thus, lightening the overall load of the ground user) as well as by incorporating a satellite access technique called demand assigned multiple access (DAMA) to allow more users to simultaneously share a satellite channel. Multiple users can share a satellite channel provided they effectively communicate at lower data rates. For example, up to five 2.4 Kbps voice users can communicate over a single 25 kilo-hertz channel. There is a trade-off between the number of users you want to service versus the data rate at which users want to transmit.

Besides voice communications and text data, to include positioning information, other information that could be transmitted to commanders while en-route will include digital still images from combat cameras utilized by the "eyes on" forces. Typical combat cameras today record an image that takes approximately 4.5 megabits of storage capacity. Depending on the compression algorithm, at a transmission rate of 16 Kbps, it typically takes on the order of 7 to 10 minutes to transmit a single image. This is an adequate transmission rate when the commanders being transported to an area of operations are significantly far from the objective area, and there are few images being transmitted. However, there may be multiple objective targets in an area of operations and as the forces get close to their points of entry, the enemy situation may quickly change (enemy response based on the pre-emptive strikes or information obtained from their intelligence), thus, necessitating the need to transmit multiple digital images quickly. Transmission of data at rates higher than 16 Kbps is, therefore, desired for single channel purposes.

Access to the satellites for communications is essential during critical phases of the forced entry operations and communications must not be denied (uninterrupted flow). UHF systems do not offer anti-jam (AJ) protection (can be easily interfered with), and do not offer much in terms of low probability of intercept/detection (LPI/LPD) characteristics often required in military operations. The "eyes on" forces, for instance, rely on their covertness and require LPI/LPD for their communications. The Army has initiated a program to develop and deploy EHF manpack terminals, which will be utilized by the ground forces, to enhance their communications during stressed (jamming) situations or for covert purposes. This EHF single channel, anti-jam, manportable (SCAMP) terminal will provide significant protection against jamming required for critical command and control and will offer a high degree of LPI/LPD for covert operations. Again, for ground forces the terminals must be lightweight, easy to operate, and allow for quick set-up and tear-down times. Initially the terminal will provide voice and data communications at 2.4 Kbps. Improvements to increase the data rate, yet still keep the necessary levels of protection, are being pursued for the reasons stated above.

The EHF systems also have their drawbacks (cannot operate through light foliage and communications-on-the-move is more costly and complex). For the near term (next ten to fifteen years) there will still be a need for en-route force commanders to continue to utilize UHF SATCOM for communications, i.e., communicate over wide area coverages, communicate on-the-move, interoperate with other services, etc., as well as utilize EHF SATCOM for communications with the objective area ground intelligence forces equipped with EHF terminals. Communications gear continuously competes with weapon systems for limited space on transport aircraft, thus, multiple radio systems are not desirable. Automatic (transparent to the user) EHF/UHF, UHF/EHF crossbanding (allowing an EHF terminal to interoperate with a UHF terminal and vice versa) will be required. The preferred solution is crossbanding through direct satellite processing since ground processing introduces significant communications delays (requires multiple satellite hops). Ultimately, a single terminal (family of terminals) with multi-frequency band capability and satellites that offer automatic/transparent crossbanding from one frequency to another, would offer the greatest flexibility to our operational forces.

The capability to receive large data files/imagery/video products in a more timely fashion while en-route, is driving an emerging requirement for one way, high data rate broadcast of information to commanders in en-route aircraft. BDA from national intelligence sources is one example of this type of information. A national source, secondary still image product for example is 2048 x 2048 pixels, or 33.5 megabits in size. With today's technology, these images can be compressed to 8.4 megabits for transmission. At a 16 Kbps transmission rate, it would take approximately 525 minutes to transmit this image. Therefore, the Army (as well as the other services) are pursuing a Global Broadcast Service (GBS) system (based on commercial satellite TV broadcast services) that will enable higher speed, one way data transmission. Transmission speeds of T1 (1.544 megabits per second (Mbps)) directly to small user receive terminals, would enable transmission of today's compressed image in 5 to 6 minutes. Future improvements in compression technology, or increases in data rate transmission speed could improve upon this performance. Again, because of limited space available on transport aircraft, the GBS receive terminals must be made as small as possible (desired to integrate into a future single radio/receiver).

EARLY/FORCED ENTRY PHASE

Our response to hostilities must be quick and decisive. SATCOM systems must be immediately available to our forces upon their arrival into an area of responsibility (AOR) -- no time to negotiate host nation agreements. The early/forced entry forces must be prepared to fight their way in, and soon after arrival, expand their battlespace. The most demanding entry in this phase is via passenger/equipment air-drop. In addition to weapon systems, initial communications gear is carried with the forces being dropped, thus, requiring the communications systems to be small and lightweight. Today, single channel UHF SATCOM is the primary long distance (provides units the capability to communicate with each other over ranges from a single mile to thousands of miles) means of communications with all force elements during the initial stages. Combat Net Radio (CNR) systems are also utilized to coordinate actions of units who remain within close proximity of each other. Soldiers desire that future systems be of handheld size, have the capability of being secured to a belt, or placed in a uniform pocket, be capable of operating while on-the move, and allow hands free operations capabilities.

Communications with the ground forces, the commanders in the aircraft, and other services must be continuous, secure, and uninterrupted, thus the need to pursue advanced EHF single channel systems. Once the ground situation is stabilized, the JTF and Army Forces (ARFOR) Main and Assault Command Posts are established (assuming this is the initial stages of a build up of forces for continuing operations). In an effort to protect the forces, these command posts will be widely dispersed and may not necessarily all be located where forces are engaged. A JTF command post may be located in a ship at sea for example. The Corps/Divisions have an option at this point to establish an Intermediate Staging Base (ISB) and/or a Forward Staging Base (FSB). Command and intelligence communications networks are transferred from the command post aircraft to the forward deployed JTF, ARFOR and assault command posts and communications with ISBs/FSBs are established. Communications to commanders in aircraft bringing follow-on re-enforcing forces is required to coordinate their actions just prior to and upon arrival into the AOR. Again, there could be multiple objective targets in the initial phases, spread out over vast distances that will require the JTF commander's direction. SOF SATCOM nets, supporting the JTF will be established. Depending on the location of operations, the AOR may be beyond CONUS satellite coverage, thus the need to communicate through multiple satellite footprints, either through satellite crosslinking (communications passing directly from one satellite through another rather than use ground relays) or reachback through STEP sites to the sustaining base. Due to user concerns with voice delays, multiple satellite multi-hops through ground relays are not desired. Voice recognition in noisy, sometimes chaotic environments is essential to a commander's assessment of the situation.

FORCE BUILD UP TO A FULLY MATURE THEATER OF OPERATIONS

SINGLE CHANNEL SATCOM OPERATIONS

In ground operations, Corps, Divisions and maneuver brigades will initially utilize Combat Net Radio (CNR) as the primary means of communications for their maneuver forces. SINCGARS will provide the line of sight communications. Other line of sight data transfer systems will also be brought into an AOR. The UHF single channel SPITFIRE SATCOM terminal will, in the near and far term, provide users with critical command and control connectivity (both voice and data) over extended ranges. Corps and Division SATCOM Warfighter Nets are established. The Warfighter Net is used by commanders to pass immediate command and operational information. The commander uses this net for tactical control, combat coordination, and tactical data reporting of combat forces, LRSUs, support units such as the Corps and Division support commands (COSCOM/DISCOM), and the engineer units. Graphical depictions of Corps and Division Warfighter Nets are shown in figure 4. The commanders distribute the terminals based on the mission and their preference for communications. Although the intent of the Warfighter Net is that only subordinate commanders/command posts receive a terminal, the Corps/Division commander can use the terminals based on his vision of the battle scenario. These terminals are required to operate in concealed or open air settings, fixed command post settings, and while on-the-move (either in commander's wheeled or tracked vehicles or aviation platforms).

Other Corps and Division single channel SATCOM networks to be established include Intelligence, Fire Support, Artillery Command Operations, Multiple Launch Rocket System (MLRS) Command Operations, and Logistics/Administrative Nets. Larger conflicts will necessitate the deployment of echelon above corps (EAC) units. EAC units requiring single channel SATCOM nets include military police, engineer, signal, military intelligence, air defense artillery, and combat service support to include medical.

Army Special Operations Forces (ARSOF) are an integral part of the Army total force structure and comprises five elements: Special Forces (SF), Rangers, Army Special Operations Aviation (ARSOA), Psychological Operations (PSYOP), and Civil Affairs (CA). These elements operate independently or in conjunction with conventional forces in a variety of missions. Each element relies on single channel SATCOM; however, due to the uniqueness of each mission, there is no one net that characterizes a typical ARSOF single channel SATCOM net. Figure 5 is a representation of a SOF single channel SATCOM net. The jointness of special operations requires multi-service integration as well as coalition military and civilian combat support and intelligence integration. Secrecy, and security are key to protect the covertness of ARSOF missions.

Because of the different attributes and performance that both UHF and EHF systems bring to the warfighter (EHF for AJ/LPI/LPD; UHF for ease of use, comm-on -the move and foliage penetration), both systems will be utilized to satisfy the numerous SATCOM network requirements. The Army will be fielding in the near term the EHF SCAMP Block I terminal (a manportable terminal weighing approximately 37.5 pounds) for selected users in critical Warfighter, Intelligence, Fire Support, Artillery, MLRS and selected SOF nets. These users require the protection offered by the EHF system, however, due to the state of the current technology, and the funding available, only select users in each net will be fielded the terminal. The commanders will then have the option to utilize whatever terminal best suits his/her mission at the time. The objective is to replace the entire population of UHF terminals for these critical nets only, with the SCAMP Block I and an improved EHF SCAMP Block II terminal (a manpack terminal weighing approximately 12 to 15 pounds and providing a communications-on-the-move capability). Fielding of the Block II SCAMP will occur through the timeframe 9 to 13 years into the future (requires technology development effort to downsize today's components). The EHF terminals will not replace all UHF terminal requirements. Many networks in the future will still continue to be satisfied by the UHF terminals. Particularly through the transition of UHF users to EHF user but also afterwards, users with EHF terminals may need to communicate with users of UHF and visa-versa. Thus, the continued need for EHF/UHF and UHF/EHF crossbanding. Again, the far term objective would be to develop a SATCOM terminal with multi-band capability for both the UHF and EHF network requirements.

Single channel SATCOM terminals must be integrated into commanders' vehicles (to include aviation platforms) and must operate while on-the-move. Due to space and vehicle size limitations multiple terminals with multiple antenna systems are cumbersome. Commanders' vehicles must not be easily identified targets, therefore, advances in low profile antenna technologies, as well as LPI/LPD must be pursued. A single terminal and antenna system with multiband capabilities is desired. Soldiers on the ground must have the freedom and flexibility to move quickly on the battlefield and not be hindered by heavy cumbersome terminals; manpack required, handheld desired. Today's terminals require that the operators on the ground stop and set-up the terminal in order to communicate. A paging capability to notify ground terminal operators of the need to come up on the net while they are in motion would suffice as an interim capability. Independent, small lightweight paging receivers, capable of receiving limited text messages, would also provide a means of providing force direction without having to come up on the net, and could provide information such as advanced warnings messages to multiple recipients, i.e., biological chemical attack. Use of a paging receiver could conserve battery power of a receiver/transmitter radio by providing short quick messages as they occur, thus avoiding the need to constantly have the receiver/transmitter radio in an on status. Ultimately, a terminal that allows communications on-the-move, with hands free operation is desired.

The total number of single channel SATCOM networks that could be established within an AOR is dependent on the total number of forces deployed. A complete data base entry of all the single channel SATCOM nets possible is provided in Appendix B. As an example, a two

Corps deployment with up to 5 divisions (total of 5 Divisions for the two Corps) could require the establishment of up to 60 single channel SATCOM nets. If EAC, ARSOF, and other nets were added, this would add an additional 60 nets. So in a full up theater of operations, potentially the total number of nets required to support an Army force in a major regional conflict scenario could be up to 120 nets (combination of EHF (about 50 nets) and UHF (about 70 nets) -- again, depends on the adversary and the expected mission conditions).

Maximum efficient use of satellite resources, i.e., Demand Assigned Multiple Access (DAMA) techniques: increased use of new frequency bands, i.e., EHF 30 - 44 MHz; and augmentation via commercial systems will be required to meet the full range of single channel SATCOM needs.

Use of commercial satellites and single channel terminals will augment the military systems. Commercial systems will be used by those users who do not require AJ/LPI/LPD, cannot gain access to the satellites due to availability of resources, and who primarily operate in a point-to-point fashion, in lieu of a netted voice/data fashion. The Combat Service Support Communities (medical and logistics communities) have successfully used INMARSAT for their point to point needs (subject to international restrictions on usage, host nation approval and landing rights agreements), i.e., medical records and image transfer as well as logistic data base transfer. The INMARSAT system today provides up to a 64 Kbps voice and data capability. The medical community, like the national intelligence community, is interested in larger transmission rates for medical imagery. Likewise, the logistics and personnel communities are interested in larger transmission rates for large data base transfers. The GBS system discussed previously could satisfy some of these types of requirements. In the future, it is expected that emerging, commercial, low earth orbit satellite systems (called mobile satellite service) in conjunction with small handheld personnel communications systems (PCS) could be utilized for point-to-point phone calls or low data rate transfer of data.

MULTI-CHANNEL SATCOM OPERATIONS

If the conflict escalates, heavy forces will be brought into the AOR. Area Common User System (ACUS) switches will be brought in to support the various command posts, TOCs, TACs, support centers etc. Today, tactical multi-channel SHF SATCOM terminals (AN/TSC-85B and AN/TSC-93B) provide the range extension between the switches supporting the command posts, TOCs, TACs, support centers, etc., which are widely dispersed throughout the battlefield (supports echelons from Theater /JTF down to brigade level). They are also deployed in contingencies and for special operations in support of Army missions. These terminals are compatible with the area common user system (ACUS) Tri Service Tactical (TRI-TAC) switches at echelons above Corps (EAC) and Mobile Subscriber Equipment (MSE) switches at echelons Corps and Below (ECB). The digital switches use time division multiplexing operating at 16 or 32 Kbps per channel. TRI-TAC switches are employed supported by transmissions systems that typically range from 4 ½ channels up to 144 channels. MSE switches are typically supported by transmission systems that range from 8 channels to 64 channels. Current Digital Transmission Groups (DTGs) between switches operate at a rate of up to 1024 Kbps for MSE and 1152 Kbps for TRI-TAC. The AN/TSC-85B and AN/TSC-93B provide beyond-line-of-sight range extension for critical nodes such as the Node Center Switch (NCS), the Large Extension Node (LEN), and the Small Extension Node (SEN). In total, the MSE system provides area communications to a Corps; servicing up to 1900 mobile subscribers and 8500 wire subscribers . Both TRI-TAC and MSE use primarily digital subscriber loops and are capable of using Radio Access Units (RAUs) to support mobile subscribers.

Other communities such as the Military Intelligence (MI) and Combat Service Support (CSS) communities also require multi-channel SATCOM capabilities to support their missions. In some cases, the requirements of these communities today cannot be satisfied by the above multi-channel systems and must be supported by other military and commercial systems. The TROJAN SPIRIT is a mobile terminal designed primarily as a near term solution for MI unique communications requirements at EAC and ECB. The TROJAN SPIRIT system is C-130 transport roll-on/roll-off capable. EAC TROJAN SPIRIT terminals are tri-band capable (support the military SHF X-band as well as the commercial C and Ku bands), while ECB terminals support only commercial C and Ku band operations within the commercial SHF space segment.

The nature of CSS operations has changed dramatically since Operation Desert Shield/Storm. A Force XXI concept for CSS is split based operations. In split based operations, only minimal essential assets are deployed and linked via military and commercial SATCOM back to larger forces/processors/data bases at the U.S. sustaining bases. This reduces the number of personnel and quantity of equipment in the AOR and enhances the mobility and responsiveness of the deployed forces. The SATCOM architecture for the CSS is still being developed. Commercial SATCOM systems such as INMARSAT are currently being used to support some medical operations; however, emerging Telemedicine requirements will require SATCOM solutions that offer increased bandwidth.

Because of changes in doctrine, i.e., shift to a force projection Army and economic considerations such as the downsizing of forces, the ground forces will not be able to control/occupy all territory in the AOR as they have in the past, and therefore, will be required to operate in enclaves throughout the battlespace. An increase in beyond line of sight connectivities between MSE and TRI-TAC switches will be realized. In addition, the expected growth in information transport requirements as well as the operational tempo of future battles will require the multichannel SATCOM terminals to be more capable, transportable, deployable and mobile. The limited strategic airlift and sealift assets drive the requirement for the multi-channel terminals to be small, highly transportable and highly mobile to keep up with the forces they are supporting. To meet future demands, the Army has initiated two multi-channel terminal programs to replace the AN/TSC-85B and 93B terminals. These terminals are discussed in the following paragraphs:

At Echelons Corps and Below (ECB) enclaved forces could be separated from one another by enemy forces and nearby enemy forces may attempt jamming. These jammers could conceivably be located close to friendly terminals, thus the requirement for a significant AJ capability that provides minimum jammer to terminal stand-off distances. The Milstar Medium Data Rate (MDR) satellite will be launched and the EHF Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T) will be fielded to support MSE range extension. The AJ capability offered by the EHF system and the use of the SMART-T will allow ground forces to pass essential command and control information over extended ranges even through high levels of jamming. Each SMART-T will be High Mobility Multi-Wheeled Vehicle HMMWV mounted and C-130 transport roll-on/roll-off capable. The near term (till end of year 2005) SMART-T will support an aggregate, full-duplex data rate of 1024 Kbps, at full margin over the satellite (terminal capable of transmitting at 1.544 Mbps rates), which may be comprised of up to 4 MSE Digital Transmission Groups (DTGs).

At Echelons Corps and above , the multi-channel range extension requirements will be satisfied by the SHF Tri-Band Range Extension Terminal (STAR-T). The STAR-T is a Heavy HMMWV mounted terminal capable of C-130 transport roll-on/roll-off. It will operate over commercial and military SHF satellites and will interface with both commercial and military switching systems. The terminal will provide data, imagery, and voice communications at various data rates up to four T1/E1 circuits per trunk group (up to 2.048 Mbps per trunk group) for a total aggregate data rate of 8.192 Mbps. There will be two versions of the STAR-T; a standard version and a switched version. The switched version will contain an embedded switch capable of terminating up to 50 local subscribers. Follow-on ancillary equipment will allow the switch to terminate up to 280 subscribers. The standard STAR-T will not have an embedded switch, however, it will be configured to allow the switch to be carried if deemed necessary at a later date. The STAR-T will provide TRI-TAC connectivity within theater and connectivity back to CONUS through STEP sites. The STEPs are critical to getting the deployed tactical user back to the sustaining base infrastructure and thus, must be flexible and sized accordingly.

Although the Army will require protection against realizable tactical jammers, one would expect larger jammer to terminal separation distances at EAC and thus the overall AJ requirement will not be as stressing as ECB scenarios. However, significant amounts of logistics data are critical to the ongoing mission and must be assured/protected (uninterrupted) due to the time sensitive nature of the data. For example, with Armor units, we keep track of gallons used per mile vice miles per gallon. We need to know where the next fuel truck is; whether it is en-route to the proper filling location; and when it will arrive. This also true of ammunition, blood supply, etc. Since this information is riding a common user system, all the range-extended links must have some level of anti-jam protection. For Corps and Below, need maximum protection against jammers, since most of the data is critical C2. For EAC, links need protection from tactical jammers as a minimum. Future SHF systems, therefore, need to be developed with nominal AJ capability.

The operational employment concepts for forced/early entry through force buildup to a mature theater of operations will be relevant well into the 21st century. However, in recent years there has been an explosion of information requirements. This trend is expected to continue with the advent of Telemedicine, Total Asset Visibility, Battlefield Distribution, In-transit Visibility, Video Teleconferencing, Situational Awareness, access to distributed data bases, to name a few. The MSE and TRI-TAC systems are primarily a switched voice architecture. In recent years a 64 Kbps tactical packet network overlay was incorporated into the switches for data transfer. However, to meet the growing requirements for information transport, significant improvements to the tactical voice and data signal support systems will be required. Today’s command posts, TOCs, TACs, and operational and support centers are being populated with information systems such as Maneuver Control System (MCS), All Source Analysis System (ASAS), Combat Service Support Control System (CSSCS), Forward Area Air Defense Command, Control and Intelligence (FAADC2I), Advanced Field Artillery Tactical Data System (AFATDS) as well as a host of Standard Army Management Information Systems (STAMIS). There are over 1200 computers being utilized in Task Force XXI, which is a brigade exercise. It is forecasted that there will be over 5000 computers in a heavy digitized Force XXI Division. Improvements are required in the areas of bandwidth utilization, tactical to strategic interoperability and inter-service and intra-service data network interoperability. Enhancements in the interoperability with commercial and Joint, Combined, and Coalition data communication systems need to be made along with solutions to multi-level security to allow a seamless interface to strategic data networks. Efforts must be made to standardize hardware interfaces, common operational application software, communication protocols, security, addressing and routing schemes. The need for high speed data and video/imagery communications, higher bandwidth transmission links, and effective use and allocation of bandwidth are becoming more essential. The warfighter requires wireless local area network (LAN) capability to support mobile operations as well as integration and seamless interoperability with tactical automated support/data systems.

The US Army Signal Center has approved, and is moving out to implement a revolutionary concept that will drastically change the current Area Common User System architecture, thus, requiring increased multi-channel SATCOM support post year 2005. This concept has been deemed the Warfighter Information Network (WIN) Concept and is briefly discussed in the following paragraphs:

The goal of WIN is to design an architecture that will support Force XXI well into the 21^{st} century with leap-ahead technology that allows simultaneous voice, data, and video communications services on a single channel at all security levels. The objective WIN architecture will be supported by Asynchronous Transfer Mode (ATM) backbone switches with Integrated Services Digital Network (ISDN) functionality. The WIN will result in the complete overhaul of the copper based, low bandwidth telecommunication technology that now exists.

The key components of the WIN architecture will be the ATM hub switch, which is a HMMWV mounted, sheltered switching system that will provide tactical ATM backbone switching support for all tactical users, and a Future SEN (FSEN), which is a tandem switch that uses maturing ISDN technology and allows simultaneous voice, data, and video communications services at moderate bandwidth speeds. The ATM hub switch will terminate wideband fiber optics, High Capacity Trunk radios, Radio Access Points, and Synchronous Optic Network (SONET) radios as well as all current tactical transmission radios (modified) and tactical Digital Transmission Group (DTG) network interfaces. Transmission rates range from 1.544 Kbps up to 622 Mbps. The ATM Hub switch will replace the current TRI-TAC and MSE tandem switches while maintaining backward compatibility. The ATM Hub switch will be fielded in two versions. Version I will be embedded in a TRI-Band SHF satellite terminal (STAR-T) and will primarily be used to support JTF/Army Forces. Version II will be a stand-alone switch. The FSEN is a HMMWV mounted switchboard system and will be fielded in three configurations. Version I is embedded in a radio line-of-sight shelter. Version II will be embedded in the TRI-Band SHF and EHF SMART-T satellite terminals. Version III will be a stand alone switch.

WIN will be implemented in phases with the objective system fielded by the 2005 timeframe. The WIN architecture will be a significant driver of future SATCOM requirements past the year 2005 timeframe. The current programmed SMART-T supports up to 4 separate DTG's for an aggregate throughput of 1.024 Mbps (with full link margin). A single FSEN to ATM Hub SATCOM supported DTG will require a minimum throughput of between 1.544 Mbps to 2.048 Mbps. The current programmed STAR-T supports up to 4 separate DTG's (via SATCOM) at 2.048 Mbps for a total aggregate throughput of 8.192 Mbps. A single ATM hub to ATM hub SATCOM supported DTG will require a minimum throughput of between 4 - 10 Mbps. Since SMART-T's and STAR-T's are designed to operate in a hub-spoke or mesh configuration, and since procurement of additional terminals will be highly unlikely due to funding constraints, modifications to upgrade the terminal's throughput capabilities (possibly four fold) as well as the development and launch of new satellites with substantially increased capability need to be pursued. Terminal radio frequency equipment must continue to be downsized to accommodate the future ATM switches. Maximum use of DAMA and new technologies to support true bandwidth on demand also need to be pursued. A single, multiband (SHF/EHF), HMMWV multichannel terminal with switch capability will be the follow-on terminal to the SMART-T and STAR-T. Notional deployments for ECB and EAC in a major regional conflict are depicted in figures 6 and 7 respectively. These figures highlights the required SATCOM connectivities, thus, a majority of line of sight connectivities have been omitted for figure clarity.

WIN is being developed to satisfy the communications needs of the total Army. It is envisioned that as the current TROJAN SPIRIT system reaches end of life, the communications requirements of the Military Intelligence community will migrate to the WIN architecture, thus, negating the need for a uniquely developed system. Likewise, WIN is being developed to also service the communications requirements of the Combat Service Support Community. Their requirements are being driven by the concepts of split based operations, objective supply, and total asset visibility.

Even with the WIN initiatives, there is still an unfulfilled emerging requirement for the one way broadcast of very high data files/video/imagery as discussed previously. Large data products such as national intelligence, news, weather reports, personnel/medical records, air tasking orders, maintenance procedures, simulation programs, in-theater intelligence products, etc., require a means of dissemination to various echelons throughout the battlefield (to include those echelons seviced by the tactical internet which is serviced by lower data rate pipes than those provided by WIN). A Global Broadcast Service (GBS) system is being pursued to augment the WIN and provide the high capacity transport mechanism for large data products generated both within CONUS and within a Theater of Operations. Data insertion at the tactical level is a valid requirement. Tactical insertion terminals must get to the AOR and, therefore, are subject to the same transport restrictions as other communications systems. They must be developed so they are C-130 aircraft transportable with roll-on/roll-off capability. Warfighter receive terminals will be required to be small, lightweight, easy to transport and set-up, and provide ports to interface with the Army Tactical Command and Control Systems (ATCCS) and STAMIS systems mentioned previously as well as with video displays. Certain commander's platforms (vehicle, aviation, onboard aircraft en-route to an AOR) will require receipt of information while on-the-move. Total throughput requirements have yet to be determined. Request or "pull" for data will be accomplished via existing tactical communications systems.

SATCOM ACCESS, PLANNING, AND CONTROL

Assured access to SATCOM services is the most fundamental SATCOM need of the warfighter. As discussed above deployed and mobile warfighters are dependent on SATCOM to satisfy critical information transfer needs. Warfighters rely on SATCOM to maintain situational awareness, to exercise positive C2, and to collect and disseminate intelligence, warning, and target acquisition information. Unified Combatant Commanders have repeatedly requested the ability to access SATCOM on demand and to control the resources apportioned to them by the JCS. A warfighter's access to SATCOM support must, therefore, be available on-demand when and where needed for the duration of the mission (uninterrupted). Such access allows the joint warfighter to collect and disseminate intelligence and orders rapidly enough to operate inside the enemy's decision cycle and retain the initiative.

Because SATCOM capacity is a limited resource, commanders and warfighters must have control over their SATCOM and information domain and be certain that access is planned, granted, and hierarchically managed in accordance with operational priorities. Warfighters must plan for and be allocated satellite resources and then have the capability to control and reconfigure those resources in a decentralized manner to ensure they can support the mission.

SATCOM network planning, monitoring, and management will be accomplished at the appropriate Integrated System Control (ISYSCON), i.e., Theater/Corps/Division consistent with the mission. The ISYSCON will require the necessary planning, management, and monitoring tools to plan, establish, and reconfigure SATCOM networks as the mission dictates. Automated, highly responsive, fast-acting, easy-to-use, integrated planning and control system(s) of databases and tools that combine network planning and management, decision support and analysis tools, satellite access request procedures, as well as terminal and payload/platform control for *all apportioned SATCOM resources* are required. Satellite resources need to be managed as a warfighting asset and need to be suballocated to the lowest levels of control. Once satellite resources are allocated, these resources must not be taken away. Maximum efficient use of the satellite resources to include real time planning and real time set-up and tear down of communications links as the mission dictates is essential. Theater control of the satellite communications resources, to include tactical insertion of broadcast information is also required.

CONCLUSION

SATCOM systems must support every phase of our future Force XXI operations to include mobilization, deployment, initial combat, sustained operations, the transition to peace, and re-constitution. To be truly responsive to the warfighter SATCOM systems must provide global coverage, must allow rapid deployability and improved mobility on the battlefield. The systems must be flexible, survivable, and highly capable of meeting warfighter information and operational demands. Rapid access to information gives our forces in the field greater situational awareness -- a decisive advantage which results in more effective combat operations and fewer friendly losses. Sustaining the responsive, high quality data processing and information needed for joint military operations will require more than just an edge over an adversary. We must have information superiority: the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary’s ability to do the same. This is a fundamental SATCOM requirement for Army operations, i.e., SATCOM support must be available on-demand, for the duration of a mission, and once given to the warfighter, it must not be taken away or denied (“uninterrupted flow of information”).

SATCOM will be the means of transporting critical information, over extended ranges, to our mobile forces within Theater and will enable our mobile forces to reachback to the sustaining base, thus, allowing the Army to fulfill our power project mission.

This research paper provided insight into the Army's operational use of Satellite Communications (SATCOM) in support of Force XXI. It is intended as a supplement to the Advanced Military Satellite Communications (MILSATCOM) Capstone Requirements Document (CRD). This paper provides necessary operational information to support the documented Army requirements for future SATCOM, in upcoming requirements versus performance versus cost trade-off analyses, as the DoD pursues the next generation SATCOM systems.

APPENDIX A
REFERENCES

CONCEPTS:

TRADOC PAM 525-5 Force XXI Operations, 1 Aug 94

Warfighter Information Network (WIN) and Next Generation of Switches Using Asynchronous Transfer Mode (ATM) and Integrated Services Digital Network (ISDN) Technology, Version 3, USASC&FG, 4 Dec 95

Concept of Operations for Milstar, USASC&FG, 1 Apr 94

Operational Concept Statement, Corps and Division Warfighter Net, USASC&FG, 15 Sep 93

TRI-Band Satellite Communications in Support of Joint Operations, Concept of Operations, Final Draft, DISA, 10 Mar 95

Multi-Service Concept of Operations for TRI-Band Satellite Terminals, USASC&FG, Jun 94

Concept Statement Global Broadcast Service (GBS), USASC&FG, 2 Oct 95

Global Broadcast Service (GBS) Concept of Operations, Draft, USSPACECOM, 30 Aug 95

Concept of Operations for DoD Enhanced Mobile Satellite Service (MSS), draft

Concept for the Functional Migration of the Trojan Spirit II to the Area Common User System (ACUS), draft

FIELD MANUALS (FMS)

FM 100-5, Operations, HQ DA, Jun 93

FM 11-24, Signal Tactical Satellite Communications

FM 11-37, MSE Primer for Small-Unit Leaders, Nov 90

FM 11-41, Signal Support: Echelons Corps and Below, Draft, Feb 95

FM 11-50, Combat Communications Within the Division

FM 11-54, Satellite Operations, draft

FM 11-92, Combat Communications Within the Corps

FM 24-11, Tactical Satellite Communications

FM 100-18, Space Support to Army Operations, Jul 95

MEMORANDUMS/BRIEFINGS

SPITFIRE Distribution Memorandum, USASC&FG, 8 Feb 96

U.S. Army Special Operations Command, AN/PSC-5, Enhanced Manpack UHF Terminal EMUT Distribution Plan Briefing

Joint Endeavor Briefing to the USA SIGCEN, COL Rodakowski, June 96

INTEL Center briefing on Global Broadcast Service Requirements, Feb 97

Task Force XXI Architecture Briefing, to include GBS/BADD Architecture, SIGCEN, Feb 97

The following briefings from the 1995 and 1996 MILSATCOM Army User's Conference:

35th Signal Brigade
10th Mountain Signal Battalion
11th Signal Brigade
125th Signal Brigade
513th MI Brigade
III Corps

USASOC briefings to the USA SIGCEN, 30 Oct 96

MISSION NEED STATEMENTS/OPERATIONAL NEED STATEMENTS/OPERATIONAL REQUIREMENTS DOCUMENTS

Operational Need Statement (ONS) for Airdrop Mobile Subscriber Equipment (MSE) and Satellite Communication (SATCOM) System, XVIII Abn Corps, Feb 94

Operational Requirements Document (ORD) for the Ultra High Frequency (UHF) Single Channel Tactical Satellite (SCTACSAT) Demand Assigned Multiple Access (DAMA) Capable Terminal, USASC&FG,

Draft Joint Operational Requirements Document (JORD) for the Global Broadcast System, USASC&FG, Jan 97

Operational Requirements Document (ORD) for the SHF Tri-Band Advanced Range Extension Terminal (STAR-T), Jan 96

Operational Requirements Document (ORD) for the MILSTAR Advanced Satellite Terminals (MAST), Mar 92

Operational Requirements Document (ORD) for the Objective Defense Satellite Communications System (DSCS) Operations Center (ODOCS), Jan 96

Advance Copy of the Revised Draft Operational Requirements Document for the Joint (UHF) MILSATCOM Network Integrated (JMINI) Control System, 22 Nov 95

The United States Space Command (USSPACECOM) Advanced MILSATCOM Mission Need Statement (MNS), May 1995

DoD Satellite Communications Capstone Requirements Document (CRD), Draft, USSPACECOM, 7 Mar 96

Operational Need Statement (ONS) for the Secure En-route Communications Package (SECOMP), XVIII Corps, 14 Sep 92

Operational Requirements Document (ORD) for the Secure En-route Communications Package - Improved (SECOMP-I), 31 Dec 96

PUBLICATIONS

The Joint Chiefs of Staff, Joint Vision 2010, not dated

A National Security Strategy of Engagement and Enlargement, The White House, Feb 1995

National Military Strategy of the United States, 1995

The Army Satellite Communications (SATCOM) Architecture, USASC&FG, Apr 96

Satellite Communications on-the-move: Is Everyone's Requirement the Same?, Army Communicator, Summer 1994

The Army's Vision of Satellite Communications, Army Communicator, Fall 1995

Operation Uphold Democracy: Contingency Communications and Forced Entry Operations for Haiti, Army Communicator, Winter 1995

New Wave Multichannel TACSAT, Army Communicator, Winter 1995

Operation Uphold Democracy: Contingency Communications and Forced Entry Operations for Haiti, Army Communicator, Winter 95

Battlefield Visualization, Battlefield Imagery and Success in War, Army Communicator, Spring 1996

Transmitting Digital Images in the Combat-Camera Environment, Army Communicator, Spring 1996

The Warfighter Information Network and the Next Generation of Switches, Army Communicator, Spring 1996

1st Satellite Control Battalion: "You can't reach home without us!", Army Communicator, Summer 1996

An Overview of the Warfighter Information Network, Army Communicator, Fall 1996

Satellite Transport Over the Warfighter Information Network, Army Communicator, Fall 1996